Critical Revision of LHC Risks

and

Communication

by 'ConCERNed International'

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The text of this paper was mainly prepared and finalized by associates and friends of the critical scientific networks "ConCERNed International" and "LHC Kritik (LHC Critique)" with direct participation, contributions, important input and kind support by many well-known critics and experts, risk researchers and experts in international law and by the international critics' community, supported by many concerned citizens.

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Introduction

1. Experiments are planned which, accepted theories suggest, create a risk of destruction to humanity and the entire planet.
2. The experiments concern high energy particle physics and are planned to be conducted on nuclear and sub-nuclear particles, by colliding them frontally together at extremely high energies under extreme artificial circumstances that have never prevailed on Earth before. These experiments are planned to be conducted in the world's most powerful particle accelerator (particle collider), the "Large Hadron Collider" (LHC), situated on the Swiss-French border near Geneva. The introduction of the proton beam is presently planned for November 2009. First experiments (collisions) are planned already shortly afterwards. First high-energy collisions are planned to start at mid-December 2009.
3. To date no official external and interdisciplinary risk evaluation of the LHC project has been initiated by the CERN member states, though this would be a self-understood and urgent requirement for high energy experiments at such a level. Only an assessment by CERN itself of the likelihood of the risks and dangers of these experiments has been conducted by the operators. This CERN-internal assessment by the LHC Safety Assessment Group (LSAG) involved a review of global dangers and risk factors which have been proposed and concluded the LHC collisions would present no danger. However, not a single one of the safety factors mentioned in this report can guarantee the safety of the planned experiments, because each of these safety factors can be put into question or relies on unproven hypotheses. Since the report was written, there have been persistent and scientifically profound criticisms from several scientists concerning the dangers of the planned high energy experiments and of substantial aspects of the LSAG assessment. These have been made by authoritative commentators including by those with documented recognition at the highest international level for expertise relevant to the case and concern the analysis of the physics of the risk, and the ethics of, and adequacy of, the composition of the panel assessing the risks.

The LHC-experiment, its purpose and dangers

The new Large Hadron Collider (LHC) at the experimental underground nuclear research facility CERN in Geneva is a massive particle collider designed to collide nuclei at high speeds to obtain new physics data. It will produce energy per proton that is seven times higher than that produced by previous colliders. [5] The LHC uses superconducting magnets to further accelerate pre-injected particle beams through a 27 km circumference circular tunnel in opposite directions at nearly the speed of light. The beams will intersect at four points around the circle. At these points, particles from the two beams will collide head-on. For the proton-proton beam experiments, colliding particles will be moving at 99.9999991% of light speed in opposite directions. This involves about 600 million particle collisions per second.[6] [7] Under these extreme artificial conditions, particles will disintegrate into their component parts and rare reactions and particles are expected to be created, some never before detected. Large particle detectors surrounding the collision points will record data, allowing scientists to determine the properties of the new particles.

Dangers acknowledged on the basis of theoretical arguments have not been invalidated, either theoretically or empirically, for example, through reference to astrophysical data or through interpretations of existing lower energy collision data - as we show below. Therefore some new objects that might be created, objects predicted by respectable theories, could be highly dangerous and pose a major threat to life and environment. In the worst case they could destroy the entire planet Earth. These new objects include ‘micro black holes’, which - according to existing applications of theories - could accrete the whole Earth (gradually destroying it through continual black hole absorption) and ‘strangelets’, which could catalyse conversion of normal matter into strange matter, turning Earth into a small ball of strange matter. The theories we reference are published in the peer-reviewed literature or are offered by experts with relevant professional academic status or related research involvement. The concrete dangers are destruction of Earth with all of its environments and all of its inhabitants, thus concretely endangering the complainants’ lives.

The aim of LHC research is to obtain clues about the structure of matter. The general expectations are to find a particle known as the ‘Higgs boson’ or ‘God particle’ that theoretically gives other particles their mass in the standard model of physics, find hypothetical 'super-symmetric' particles, and the study of a ‘quark gluon plasma’ which should have existed fractions of a second after the ‘big bang’. Finally, CERN also prepares to explore artificial production of ‘micro-black holes’. All these are official aims of the LHC project, stated in official CERN documents.

These experiments, as noted exceeding energy concentration levels ever previously achieved before by a factor of seven [5], explore unknown territory and could produce unanticipated dangers not considered for safety review, due to neglects and misunderstandings from those safety reviews. Modern physical theories have a wide, yet limited range of supporting empirical evidence. Relativity theory and quantum mechanics offer models that seem to work well with available evidence for certain areas. However, when gravity is extremely strong and distances are extremely small (conditions that will be produced at the LHC), both quantum mechanics and (Einstein’s) general relativity 'break down' [8] and mutually contradict each other. This is a generally accepted fact in present physics. Science is, of course, still far away from a complete ‘Theory of Everything’ [9] and physical theories are essentially models, which seek to make more promising predictions compared to the predecessor model. Generally, physical theories stand in a continuous process of being modified or excluded by empirical findings and thus are of temporary value by their very nature.

Modern theories such as those enabling black hole production are attempts to address this and other problems whilst addressing other known data. The history of science demonstrates the verification and falsification dynamics in the highly speculative field of physics, where numerous breaks and revisions occur regularly as the empirical evidence supports or invalidates the theories of the time. This naturally must be expected to continue in the future. Therefore, it is extremely important to carefully consider all possible outcomes of the experiments to protect something as valuable as Earth.

Physicists have in fact specifically and vividly acknowledged the current uncertainties that are associated with starting up the LHC:

In the BBC LHC-documentary 'The Six Billion Dollar Experiment', physicist Prof. Alvaro De Rújula (CERN) asks "*Will we find the Higgs particle at the LHC? That, of course, is the question. And the answer is, science is what we do when we don't know what we're doing.*"[10]

Physicist Brian Cox (U. Manchester & CERN) stated "*it's truly a leap into the unknown*".[11]

The ideal of the freedom of science has very great merit, and this is recognised by international law. But the survival of life and the planet is the condition and basis of our existence.

The difficulty of developing safety factors using physics that is incomplete and that is changing rapidly is demonstrated by the fact that several previous safety considerations have already eroded as documented in the chapter 'Erosion of black hole safety considerations' below.

But the best guide to seriously confronting possibilities of risks at the LHC is to first acknowledge destructive attributes of posited collision results. Considerations that claim to exclude such risks and dangers have to be rigorous, not able to be undermined. We will show that such considerations have not been put forward; hence the case for safety can not be guaranteed in no fewer than four categories of global dangers in ongoing scientific discussions.

We will show that the CERN-promised [12] artificial production of extreme physical conditions that prevailed a fraction of a second after the Big Bang, including the possible production of micro-black holes and other exotic extreme objects, includes high risks and concrete dangers that are far from being invalidated.

Unprecedented conditions will be created

Scientists creating a new instrument for observing nature quite often find things that they did not expect. These new phenomena should be safe if the new instrument is only observing phenomena that regularly occur in our natural environment. However, when the new instrument creates conditions that are also new, we no longer have this assurance of safety. Given new conditions, "*new things that scientists did not expect*" might well be dangerous. The LHC will create several conditions that did not exist before on Earth. Head-on collisions at the LHC will create new types of particles, nearly stationary with respect to Earth, and which may be captured by Earth's gravity for the first time (unlike particles created by cosmic rays that are moving at nearly the speed of light with respect to Earth, such particles therefore passing through Earth and not being captured).

Results will not be clear for years

According to CERN it could be about three years from initial experiments until technical evaluations of them are available. Micro black holes might be formed before evidence of their formation is evaluated. Because of the large number of collision events, only a small subset will be selected by computer for later evaluation. If the signatures of micro black hole formation do not fit the computer protocol for event selection, micro black hole formation might be completely missed by the detectors. Therefore even if the LHC were shut down at that point, substantial numbers of possibly highly dangerous objects would already have been released irreversibly into the environment.

Scientists express serious concerns

Before getting into the details of the ongoing physical discourse, three chosen observations from recognised scientists emphasise the high importance and urgency of the issue:

Astrophysicist Dr. Rainer Plaga writes: "*From these quotes I conclude: theories with extra dimensions robustly predict the existence of microscopic collider-producible black holes and Hawking radiation. But the detailed decay properties presently remain very uncertain. It then seems important to study alternatives to the standard thermodynamical treatment of Hawking radiation on the safety issue. This is the aim of my paper*." Conclusion: "*I stand to my general conclusion that there is a residual catastrophic risk from metastable microscopic black holes produced at particle colliders.*" [4]

Chaos theory pioneer Prof. Dr. Otto E. Rössler is quoted concerning the time period within which planet Earth could be destroyed after an artificial production of black holes at the LHC: *“not after millions of years of linear growth but after months of nonlinear growth.”*

“*In order to exclude that human-made mini black holes endanger the earth, it will be necessary to falsify the first of the 7 points, or if this is not possible the second, and so forth. Until this task has been solved, no one can shoulder the responsibility to give the “green light” to the LHC’s crossing the 2.000 GeV barrier, as this is currently planned to do within a few weeks.*” [18]

Author of several peer-reviewed physics papers, Dr. Paul Werbos writes on his website:

"*What happens if we start to do experiments in physics, clever enough to do things which haven’t happened already a hundred times in the atmosphere, and energetic enough that they have a real possibility (so far as we know, in our ignorance) to produce small black holes?*

Those calculations basically predicted that small black holes would burrow into the Earth, grow for a few thousand years, and result in a very sudden catastrophe gobbling up the whole Earth with little warning.

There are many uncertainties here, of course – but it would be irrational to ignore such a serious risk to humanity.

Of course, black holes gobbling up the Earth are a repulsive sort of possibility, and humans have a long history of trying to come up with excuses for putting their heads in the sand, and not thinking about repulsive possibilities which they don’t want to think about. Some humans even seem to feel it is their duty to try to force other people to put their heads in the sand." [14]

Concrete risks and dangers of the LHC experiment as reflected in physical discourse

In the case of the LHC, there are several theoretical arguments that point to a risk of negative outcomes. The existence of these theories shows that a negative outcome is plausible where reassuring arguments based on astrophysical or lower energy collision data are insufficient. The existence of these theories therefore demonstrates the untenability of CERN's official policy of stating that the risk is zero.

In an interview with the 'New Yorker' magazine, Jos Engelen, CERN's Chief Scientific Officer, was quoted as saying 'that CERN officials are now instructed, with respect to the LHC's world-destroying potential, "*not to say that the probability is very small but that the probability is zero*"' [15]

But quotes of CERN scientists themselves show that they in fact accept an official worst case scenario where the experiments at the LHC initiate the destruction of Earth (p.8 of [16]) (p.8 of [17]) in several billion years. Typically it is then stated that the Sun would by that time have destroyed the Earth anyway. CERN scientists accept the extreme implications of these experiments, with the only 'safety factor' being the long time until that potential is realised.

First, the existence of other cumulative dangers to planet Earth, such as those arising from the Sun, cannot in any way justify risking, much less initiating the destruction of the Earth, even if this artificial destruction - according to the statements mentioned above - is expected to happen in the far future but possibly initiated irreversibly right now by the planned experiments. However, as we shall see below, the length of that time is questionable, since it actually relies on insufficient appraisal of astrophysical data.

For example, an analysis of Prof. Otto Rössler (University of Tübingen) taking astrophysical data into account, would give a much shorter time than the billions of years on which CERN relies. Prof. Rössler's estimate is possibly *just 50 months* [18]

In the following section, we chose an understandable but scientifically serious way to describe the physical discussion on collider risks. All arguments are linked to the relevant scientific sources. This way the dangers and risks connected to the planned experiments could also be understood by non-physicists by regarding the state of discourse. Also summary of the physics is provided at page 36.

Then, after having demonstrated the scientific basis of our arguments in the current physical discourse, the sections following afterwards will describe other essential and more general scientific approaches to the issue, such as risk research and juridical aspects, demonstrated by citing independent expertise from the areas concerned.

Black Holes

One of the theories that allow catastrophe is the theory that LHC collisions might create micro black holes.

Stellar black holes are among the most extreme phenomena in the universe and have been found both in theory and by observation. These indirectly observable objects are commonly a result of a gravitational collapse after the supernova explosion of a giant star, where matter has been compressed to the extreme. The prevailing gravitational forces are so strong that not even light can escape, so the celestial body appears black. Modern, reputable theories of gravity at the micro scale, proposed five years after the LHC was approved, revise how gravity applies at this scale and propose that the LHC could create these objects in miniature form by proton collisions.

"If the scale of quantum gravity is near a TeV, the LHC will be producing one black hole (BH) about every second." Prof. Savas Dimopoulos (University of Stanford) and Prof. Greg Landsberg (Brown University) [19]

"If the fundamental Planck scale is of the order of a TeV, as is the case in some extra-dimensional scenarios, future hadron colliders such as the Large Hadron Collider will be black hole factories." Prof. Steve B. Giddings (Department of Physics and Institute for Theoretical Physics, University of California, Santa Barbara), Scott Thomas (Institute for Theoretical Physics, University of California, Santa Barbara, Department of Physics, Stanford University). [20]

A TeV (tera electron volt) is a unit of energy. It is 1,000,000,000,000 electron volts. Because of the equivalence of energy and mass, it is also a unit of mass.

Assertions about micro black hole creation are worth following in detail.

Safety concerns of scientists with a prior track record of publication authors in peer-reviewed physics journals

The work of astrophysicist Dr. Rainer Plaga [26] and scientist in multiple fields including physics Prof. Otto E. Rössler [27] outline how catastrophe from the LHC can be a realistic prospect, and both provide - among others - key theoretical bases for our complaint. As we later show, their risk arguments are either not correctly understood by CERN or are ignored by them. Both have written numerous papers published in physics journals.

Plaga's published papers include many on high energy particles known as cosmic rays – which are strongly relevant to LHC risk discussion, as we show. Plaga states:

"*With the very small accretion timescale (1 second) that was found with the parameters in subsection 3.2, a mBH [micro black hole] created with very small (thermal or subthermal) velocities in a collider would appear like a major nuclear explosion in the immediate vicinity of the collider*." [4]

Rössler helped pioneer 'Chaos theory' and its application to physical systems. Three of his many published physics papers involve discussion of black holes.

Dr. Paul Werbos is the author of several peer-reviewed physics papers. As partly already mentioned above, he writes on his website:

"..what will happen if we find really new experimental setups, different from what has happened by accident already in the atmosphere, which can produce small black holes? (Several major labs are spending money on major efforts to do just that.)" [13]

Those calculations basically predicted that small black holes would burrow into the Earth, grow for a few thousand years, and result in a very sudden catastrophe gobbling up the whole Earth with little warning. [14]

As mentioned subsequently, Dr. Tony Rothman (Princeton University), a physicist who specialises on black hole physics [28], outlines his potential basis for concerns relating to physicist G.A. Vilkovisky under 'Black holes at the LHC could only evaporate about half their mass' below.

Erosion of black hole safety considerations

Collider advocates have asserted several safety considerations that purport to demonstrate that micro black holes are not a danger. Many of the safety considerations first touted as adequate to protect us from black holes have eroded, and are no longer considered adequate in current safety papers, even papers by collider advocates. This erosion of past safety considerations suggests the possibility that current safety considerations may also erode.

RHIC collider operator Brookhaven conducted one safety study and LHC operator CERN conducted two safety studies that claim that there is no risk from black holes.

The first safety paper claimed that black hole formation requires energy beyond the reach of any collider, [43] then peer-reviewed physics papers appeared, unrelated to the collider controversy, that predicted production of black holes at colliders. [20] [19]

The second safety paper claimed that black holes would evaporate instantly in a puff of Hawking radiation, [21] then peer-reviewed physics papers appeared, unrelated to the collider controversy, that questioned even the fundamental theory behind Hawking radiation, a purely theoretical radiation that has never been observed. [22] Also the rapid decay interpretation itself was undermined by Casadio & Harms to allow a black hole lifetime of years [23] and an alternative analysis postulated that a black hole would not dissipate, but only lose half of its mass. [24] An analogy between collider-created black holes and cosmic-ray-created black holes was supposed to demonstrate safety, but the analogy as originally proposed was accepted by CERN as inexact, and had to be revised in CERN's paper [17] by Prof. Mangano (CERN) and Prof. Giddings (Department of Physics, University of California) (p.8-10) of [17]. Reliance upon their interpretation of astrophysical data implies that CERN's theoretical model for growth of black holes suggested growth to a dangerous size was supposed to take many billions of years [17], but some models enable faster growth [25].

Calculations regarding the time required for growing micro-black holes to swallow Earth have very different results. The most recent safety paper proposed new safety considerations, but these have been challenged. For example, CERN's Mangano & Giddings paper [17] argued this would take several billion years in the worst case. They further argue that neutron stars should capture micro black holes if they could be created, giving neutron stars lifetimes shorter than observed. However, Otto Rössler theorises that superfluidity in neutron stars may well prevent micro black hole capture [18] and Rainer Plaga relies upon the Casadio & Harms paper [23] to predict black hole radiation levels that would not be detectable from white dwarfs or neutron stars but would be devastating within Earth [4]. Neither of these counter-arguments have been addressed by CERN [16],[17].

Professor Rossler's paper is enclosed in full as Enclosure 6.

Challenging and invalidating LHC safety arguments

The safety of the Large Hadron Collider has been the subject of investigation by a number of physicists. The following section gives an overview of the arguments on LHC safety and undermines the claim that safety for life and environment can be taken for granted.

References in the following arguments include formulae from published papers (with formulae in parenthesis), in order to demonstrate theoretical backing.

Disagreement between safety reviews about micro black hole decay

There are two common methods of calculating black hole decay and radiation, called the 'canonical' and the 'micro-canonical' interpretations of Hawking radiation. Stocker et al. [29] for example describe the rapid decay scenario as the 'canonical' application (p.6). For micro black holes, the two different methods can yield significantly different results. While CERN considers that any black holes either immediately evaporate or do not decay at all [16],[17], according to Casadio et al. 2002 [23] LHC black holes can last over 30 years in isolation based on an alternative Hawking radiation calculation.

More recently, Casadio et al. 2009 [30] again considered LHC black holes with the slow decay 'micro-canonical' interpretation. Despite the fact that the 2002 parameter ('MC'=mp(L/lp) p.5) is still accepted by Casadio et al. 2009 [30] as "*One possible choice* .."(eq(16) of [30]); they only choose to calculate with a newer parameter giving a higher decay rate. In this way they conclude that the decay rate soon surpasses the accretion rate. After more than six months this Casadio et al. 2009 paper [30], unlike that of Casadio et al. 2002 [23], has not been accepted for a published journal. Furthermore Stocker et al. 2008, [29] already allow for the prospect that the black holes may continue to absorb matter at a faster rate than they decay thus implying continued black hole growth.

The micro black hole rapid decay 'canonical' approach has been the more conventional one for black holes, as it anyway gives the same results for ordinary (non micro) black holes. However, in principle, the alternative models for black hole decay have been startlingly described by S Hawking [31] in this way:

"*one cannot use the normal statistical-mechanical canonical [immediate decay] ensemble when gravitation interactions are important.*"

"*Although the canonical ensemble [immediate decay] does not work for black holes, one can still employ a microcanonical ensemble [enabling slow decay] of a large number of similar insulated systems each with a given fixed energy E.*"

The possibility that Hawking radiation does not exist and that black holes do not decay

The former main argument [21] for the safety of the LHC from black holes relied on rapid decay from ‘Hawking radiation’. However Hawking radiation remains an unproven hypothesis, and as such it is not a satisfactory safety factor.

Further, in several papers, it is argued by Professor Dr. Adam D. Helfer (University of Missouri) [22] and Prof. Vladimir A. Belinski (University of Rome, “La Sapienza”, [22] that the fundamental theory behind Hawking radiation is incorrect, so that Hawking radiation and decay would not occur. This possibility is principally accepted for exploration by Prof. Horst Stocker et al.[29] and by CERN [17], which published the most relevant CERN study for black hole safety arguments.

For the above both general and specific reasons, then, Hawking radiation is not a satisfactory safety factor.

Uncertainty about the accretion rate

Details of the accretion rate depend on parameters that are not known. This implies that there are no clear guides as to the accretion time of Earth.

Calculations regarding the time it will require for growing micro-black holes to swallow Earth have very different results. Author of published microgravity paper Prof. Otto E. Rössler (University of Tübingen) estimates “*not after millions of years of linear growth but after months of nonlinear growth*.” Prof. Horst Stöcker (University of Frankfurt) et al, in a first version of his paper on ‘arXiv’ [29], projected a purely theoretical growth phase of 27 years until total destruction of Earth in one scenario, but they remove this in subsequent versions. A non reassuring astrophysical interpretation (such as Rössler's) would still allow growth within tens of thousands of years even according to some of CERN’s purely theoretical considerations [16], [17] (p.51 for 'D=6').

Stocker et al. [29] point out that the approach to accretion of CERN [17] or (eq(12) p.9 of [29]) "*.. does not take into account any effects due to the [competing] strong interaction inside a nucleon.*” ([29] p.10). Doubts appear further justified concerning the lack of incorporation of the attributes of solid or liquid as the accretable medium and of the effect surrounding temperature could have upon accretion rate. The main and later accretion phase, known as the 'Bondi' phase, has been used previously for the gravitational accretion of gases by stars or astronomical black holes. Particularly eq(A.5) p.54 [17] relies again on a formula specific to gases. Concerning temperature in this accretion phase again, white dwarfs have an estimated interior temperature around 1500 times that within the Earth's core. Reference to eq (4.4) of [17] suggests the heat related vibrational atomic motion could significantly reduce the extent of gravitational capture, especially within the 10 million Kelvin of white dwarf interiors.

CERN's basis [17] for reassurance that the Earth would not be accreted in a time scale of a few decades relies on the survival of only a specific subcategory of 'white dwarf' stars and to a less confident extent on the survival of neutron stars. Reference is in the conclusion also to the greater influence of high energy neutrinos; but as accepted by [17] there is not yet evidence for them and there are doubts as to such interaction. CERN calculated with higher value parameters (Rc) that nevertheless allow accretion of Earth in either tens or hundreds of thousands of years based on calculations for only two of the of candidate 'TeV gravity' theories. (p.51 for D=6; D=5 p.26 Rc=.2mm [17]) The exclusion of these shorter duration calculations relies entirely on the survival of, and relative accretion rate estimates for, white dwarfs from cosmic-ray-caused black holes. Both these last claims are shown to be subject to question in the following section.

Another estimate [32] considers the implications of an analysis [33] of one TeV gravity theory that implies that an accreting micro black hole would continually subdivide. The accretion rate of the subdivided black holes is more rapid and the implication is of a whole Earth accretion (destruction) in an estimated time of around one hour. Again, such an analysis has not been explored by CERN.

Omissions and inconsistencies within safety reviews regarding relevance of astrophysical objects and 'cosmic rays'

There are several factors that are not taken into account in the argument of CERN [16], [17] or Stocker et al. [29] that survival of observed white dwarfs or neutron stars can be an indication of LHC black hole safety. Rössler argues that internal superfluidity of neutron stars would prevent capture of micro black holes and accretion. His other astrophysical non reassurance arguments [18] are also not considered.

Furthermore, no consideration is made of how the expected, relatively small numbers of suspected high energy cosmic ray sources [34] could be blocked by high concentrations of interstellar dust that make up either the very extensive dust lanes [35] surrounding inner galaxies such as our own; or of dark nebulae of which over 300 [36] are known, or of how the identified relevant white dwarfs could in any way be fortunate survivors. Involved issues of relative astronomical motions are also a factor, but it is clearly relevant as a neglected risk consideration. Owing to the fact that these often completely obscure light from stars behind them, we can infer that cosmic rays would collide with them, particularly as they do so even within our invisible atmosphere. So it becomes plausible these particular white dwarfs do not experience the flux of high energy cosmic rays that is key to Giddings and Mangano’s demonstration. A proper appraisal of this would involve a detailed analysis of the relative positions of dust lanes, dark nebulae, suspected cosmic ray sources and particular white dwarfs type to which CERN's Giddings and Mangano [17] refer.

A contradiction with CERN's [17] specific type of astrophysical reassurance argument is given in Stocker et al.'s paper [29]. This ([29]) states that the mechanism of accretion could be such that even white dwarfs (and by extension neutron stars) would not gravitationally capture cosmic ray-created black holes, where feasible low levels of accretion rate apply. This (eq(10) p.9 of [29]) depends upon the argument that only a very tiny proportion ('alpha' given on p.9 of [29]) of protons or neutrons (including their constituent 'quarks') that a micro black hole travels through, may be accreted. This is due to the fact that the strong nuclear force can be similarly effective to the 'TeV gravity' at short distances. So this approach, incorporating the competing influence of the strong nuclear force [29]) is then used to claim that the accretion of the Earth would take many times longer than the age of the universe. But it is admitted (p.9 of [29]) that this "*neglects a possible rapidity and area dependence of the black hole accretion.*" Yet the formula of eq(4.4) p.15 [17] indicates that the radius for capture of black holes, decreases with speed. This is supported by Mangano [37]. Therefore, it is suggested that where white dwarfs do not accrete rapidly enough to gravitationally capture black holes (caused by cosmic rays), an accretion of the whole Earth within its lifetime could then apply, as opposed to the slow accretion time argument of [29].

Physicists have generally assumed that cosmic rays are protons, the nucleus of the hydrogen atom. Recent data of the Pierre Auger Observatory, the biggest and most renowned facility to study high energy cosmic rays, suggest that the highest energy cosmic ray data are most likely to be the nucleus of the iron atom. This up to date analysis contradicts the mostly proton high energy cosmic ray claim of CERN (Mangano and Giddings) [17] the only basis for their inclusion of neutron star survival within their ’Summary and Conclusions’. Though this iron nuclei suggestion is likely more reliable than the earlier proton claim, it is based not on direct measurements, but on the height of the collision in the atmosphere and the shower of secondary particles. This data may yet be consistent with even more exotic particles such as magnetic monopoles or strangelets, [38] and if so they may not be analogous with energetic collider collisions. [32] This is somewhat more suggested for the higher range collision energies. But as Plaga's paper (Sect 4 [4]) implies, for conventional nuclei cosmic rays - just below such high collision energies - created black holes would not have sufficient mass to ensure they have the understood properties. Therefore, their stopping - and subsequent accretion - within white dwarfs may not apply [4].

Cosmic rays at the energy level of the LHC have never been observed directly. They have only been observed by measuring the shower of secondary particles and computing the energy required for the expected type of particle to produce that shower. This leaves doubts that cosmic ray collisions are in fact comparable to LHC collisions due to the differing interaction process of the collision [32]. Direct measurement with soon to be launched, or planned space probes (AMS, OWL, EUSO, AW) [33] could remove that doubt. So this safety argument is built on hypotheses that have recently been weakened by empirical research or are otherwise questionable.

Furthermore, Rössler's arguments [18] regarding how the internal superfluidity of neutron stars would prevent accretion and his other [18] astrophysical non reassurance arguments are not anywhere considered.

Dr. Rainer Plaga: Dangerous Hawking radiation from metastable black holes

Rainer Plaga [4] takes the view of Stocker et al. of accretion surpassing decay rate and argues for the application of a formula given by Casadio et al. [23] to consider the effects of the increasing radiation effect that Stocker et al. unjustifiably neglect. The recent choice of formula giving a parameter value (eq(25) for 'Mc') by Casadio et al. 2009 [30] for calculations, appears questionable as partly reliant upon circumstantial factors. However Plaga recalculates including for this, by considering a further parameter ('L'), at a larger, though still feasible, value, so that a catastrophic result can be obtained even for any of the three given parameter formulae of [30]. This is argued in the section 8 Appendix in version 3 of Plaga [4]. Plaga had already argued [4], that by considering a parameter, mid range between two indicated by [23] (also 'Mc' with eq(16) and (18)) of [30], the radiating behaviour of the micro black hole becomes catastrophic. Plaga calculates that micro black holes could reach a steady state, where they release energy through Hawking radiation that corresponds to the energy in the matter they accrete. The energy release would be of the order of a major thermonuclear explosion each second, but would continue for many millions of years. This would be disastrous at the surface of Earth, and also deep within Earth because of geothermal effects [4].

"*While the exact phenomenology provoked by such a mBH accreting at the Eddington limit remains to be worked out, eventually catastrophic consequences due to global heating on an unprecedented scale and global-scale earth-quakes would seem certain*." [4]

Plaga in the same study: *“From these quotes I conclude: theories with extra dimensions robustly predict the existence of microscopic collider-producible black holes and Hawking radiation. But the detailed decay properties presently remain very uncertain. It then seems important to study alternatives to the standard thermodynamical treatment of Hawking radiation on the safety issue. This is the aim of my paper.*” Conclusion*: “I stand to my general conclusion that there is a residual catastrophic risk from metastable microscopic black holes produced at particle colliders.*” [4]

Probably such an object (metastable black hole produced at LHC) could not be destroyed or removed from the Earth by any technique until all life on the planet is destroyed.

This highly relevant study is attached (Enclosure 5).

No astrophysical reassurance for dangerous Hawking radiation

Plaga argues that there is no astrophysical reassurance regarding the scenario in his paper [4]. Plaga predicts black hole radiation levels that would not be detectable from white dwarfs or neutron stars but would be devastating within Earth. This argument that there is no astrophysical reassurance has not been challenged. Cosmic ray-caused micro black holes emerging from other sides of earth or other planets would have undetectably low radiation because of their negligible mass (from [23] and p.8 of [16]).

Black hole absorption rate surpasses decay

Stocker et al. [29] claim to exclude risk from black hole absorption rate-surpassing decay such as Plaga outlines, however we show that they fail to do so.

In the relevant 'weak radiation' section it is argued that there can be no danger from this because black holes emerging from high energy cosmic ray collisions would maintain their charge sufficiently to enable their stopping within the Earth (due to long range electromagnetic interaction with surrounding matter[29]). The argument posits the following: If collisions can make black holes, and if black holes stop in Earth, and if they can destroy Earth, this would have already happened due to cosmic ray collisions with Earth, thus demonstrating by analogy that collider collisions are safe. However, if black holes lose their charge, relativistic black holes created travelling at near light speed by cosmic rays should travel virtually unimpeded through Earth like neutrinos, whereas slow black holes made by colliders would occasionally be captured by Earth.

Stocker et al. [29] claim that black holes would stop because of their charge, but they fail to incorporate the established theory of 'Schwinger radiation' (p.9 of [17]) which acts to immediately neutralise any charge that the black hole has at a given time. Yet Stocker et al. do incorporate this same Schwinger radiation in another, negligible radiation scenario (Sect D1-B, p.8 [29]) where CERN argues it is less likely to apply. This is stated in CERN’s paper [17] (p.9), where the ‘usual picture’ incorporates both Schwinger radiation (preventing dangers from black hole stopping) and Hawking radiation.

So black holes with slow decay Hawking radiation caused by cosmic rays striking the Earth would pass through with negligible interaction. The implication is that Stocker et al. offer no argument to exclude the prospect of a sufficient absorption of matter within Earth enabling Hawking radiation to cause catastrophic results from LHC black holes.

Misunderstandings by CERN's Giddings and Mangano on the basis for Plaga's catastrophe argument

In their paper "*Comments on Claimed Risk from Metastable Black Holes*" [39] Giddings and Mangano base their entire criticisms upon two arguments which can be shown to be relying on misunderstandings of Plaga's analysis. Plaga himself demonstrated this in his response to their critique of his paper [4] (*section 7 appendix v3*). One argument confuses the canonical rapid decay luminosity formula (eq(1), p.1 [39]) with the micro-canonical slow decay luminosity formula that Plaga relied upon (eq(1), p.5 of [4] from eq(28) p.5 of [23]. and (2), p.5) [4]. The other confuses Plaga's 'Eddington Limit' with their version. Plaga's version of the Eddington limit is the effect of the Hawking radiation upon the matter around the black hole, while in Mangano and Giddings' version the Eddington Limit is understood in terms of the low level radiation caused by the process of accretion itself. Plaga states [4] (v3, August 2009) that since the "Comments .." paper [39] he has been awaiting a "Further comments' paper. This has not been forthcoming. This is doubly mystifying as Plaga is well and currently published, only last year writing on astrophysics in the world's premier journal of science, *Nature.*

Black holes at the LHC could only evaporate about half their mass

Another theory of black holes at the LHC is provided by Grigory Vilkovisky [24]. When considered with the slow decay interpretation it appears likely to enable catastrophic results, through allowing accretion and by maintaining a still significant 10% of increasing radiation. But any analysis of this theory has been completely neglected in all LHC safety reviews. The prominent author and physicist Tony Rothman (Princeton University) refers to it [40] as follows:

"*A few years ago, Grigory Vilkovisky, a Russian physicist, published a trilogy of papers claiming that if one properly took this effect [of the Hawking radiation itself] into account, black holes would evaporate only about half their mass; the rest would remain. If Vilkovisky's conclusion is correct, it would not only radically alter our ideas of black-hole physics, but would have a tremendous impact on our ideas about dark matter and would pave the way for the possibility* *that any black holes created at CERN might actually survive long enough to be taken seriously."* [40]

Rainer Plaga's suggestion for safety improvement

Rainer Plaga proposes risk mitigation measures which he categorises as feasible methods to reduce but not eliminate risk, particularly applicable to the start up phase of the LHC [4]. Plaga's proposal seeks to detect warning signs of danger *before* irreversible outcomes are reached.

Plaga proposes altering LHC operations to increase energy levels by no more than a factor of two before studying and excluding potentially dangerous events, (Sect 5.1) [4] analyse all operational events rather than only a small fraction of events, (Sect 5.2) and to immediately and reliably detect meta-stable black holes and immediately interrupt LHC operation and conduct off-line investigation if meta-stable black holes are detected. (Sect 5.3).

However, irreversible outcomes could be reached suddenly and without prior indication, and the consequences to Earth of miscalculation are potentially *infinite*. Therefore Plaga's proposal only aims at reducing risks and it is insufficient to definitely exclude any global risks.

Strangelets

Former Berkeley University physics research assistant Walter Wagner proposed that lead-lead nuclei collisions at the LHC may enable the production of dangerous particles known as 'strangelets'. Such risk is acknowledged by high energy cosmic ray particle specialist and astrophysicist Rainer Plaga [32].

Normal matter consists of 'up' and 'down' quarks. Strange matter adds a third type of quark, called a 'strange' quark. A small lump of strange quark matter that includes strange quarks is called a 'strangelet'. Some hypothesise that neutron stars consist largely of strange matter. It is accepted as plausible [16], that a negatively charged strangelet could catalyse conversion of normal matter into more strange matter (as a result of having a lower energy state), thus converting Earth as a whole into strange matter.

One safety consideration that was supposed to protect us from strange matter was the idea that a strangelet would be electrically positive on its surface and not attract normal matter. It appears clear from the various high energy physics papers that consider the prospects for the existence of negative strangelets [41] that the analysis as offered by the LSAG report (2008) - is a partial representation of existing views. In at least three papers [42], from 1986 (Golowich et al.), Schaffner-Bielich et al. and C Greiner 1997 a negative strangelet has been theoretically proposed as a potential prospect in the context of collision experiments.

More importantly, this is for a predicted lifetime of longer than that minimum indicated as potentially catastrophic - longer than one ten millionth of a second (10^-7s) according to both Wilczek et al. [43] and Kent [44]. Note that these papers indicating longer lived negative strangelet duration were written before the catastrophic danger prospect was highlighted by 2000 [43] But no mention of this vitally relevant duration is made in either LSAG report, which, by failing to specify what a sufficiently 'long lived' strangelet is ((3) of p.13 in [16])) do not in effect specifically argue against such 'metastable' negative strangelets with such duration. This prediction enabling the existence of dangerous negative strangelets is not acknowledged by any safety reviews and no references are given for papers suggesting plausibility of negative strangelets.

A further 2006 paper [41] also unreferenced by LSAG 2008, supports the feasibility for existence of negative strangelets, despite LSAG claiming only positive strangelets are credible. The only argument offered then is that it is extremely unlikely that such could be produced. This is because of reliance upon interpretations known as 'thermal' or 'coalescence' models for data from the RHIC collider, which has only a tenth of the energy of LHC.

In the paper "*New solutions for the color-flavor locked strangelets*" Peng, Wen and Chen write "*Recent publications rule out the negatively charged beta equilibrium strangelets in ordinary phase, and the color-flavor locked (CFL) strangelets are reported to be also positively charged. This letter presents new solutions to the system equations where CFL strangelets are slightly negatively charged. If the ratio of the square-root bag constant to the gap parameter is smaller than 170 MeV, the CFL strangelets are more stable than iron and the normal unpaired* *strangelets. For the same parameters, however, the positively charged CFL strangelets are more stable.*”

The only argument offered then is that it is extremely unlikely that such could be produced. This is because of reliance upon interpretations known as 'thermal' or 'coalescence' models for data from the RHIC collider - which has only a tenth of the energy of LHC.

But there are three considerations that are neglected in this context:

1. The relevance of ‘TeV gravity’ theories to this question is not considered in safety reviews. Although we cannot be sure the parameter values for micro black holes would be dangerous, it is argued here that this may not then apply for strangelets. At levels approaching but not reaching that of TeV gravity, although gravity would not be as strong as the nuclei-binding 'strong nuclear' force, it could still be stronger than the electromagnetic force (which is many times weaker than TeV gravity would be anyway) responsible for interactions dependent upon charge. "*The strength of gravity depends so strongly on position along the fifth [extra] dimension*"[8] Collisions that are sufficiently off centre, where the full centre mass of the travelling nuclei does not contribute to the collision energy, would meet such criteria. One example of this electromagnetic force is the repulsive interaction of positively charged sub nuclear particles in collision. The inhibition of such elasticity effects of collision at higher energies can be made possible where sufficiently near TeV gravity energies are attained between colliding particles.

2. Among several other peers, an alternative model of collider particle production is given by [42], called the ‘strangelet distillation' model. This relates to details of how collision energy levels relates to the behaviour of the immediate post collision 'quark gluon plasma' (earlier mentioned). This model is still referred to as plausible in [45], which was published as recently as 2008. As stated by Schaffner-Bielich et al. [42] “*At higher energy, ..strangelet distillation still works but lower mass numbers of A<10 are expected, which might be detectable with the ALICE detector at the LHC.*” But even for such low mass numbers of a strangelet, dangerous duration is allowed for the relevant ‘long lived’ duration strangelet as shown by Sect V of Schnaffner-Bielich et al. (fig.5 [42]).

3. Computer projection [45], more recent than that relied on for LSAG, for production likelihoods of very similar lumps of strange matter described as 'multiple hypernuclei exotic objects', indicates increasing production for various negatively charged types of this from around the maximum yet achieved energies

for ion collision (200million 'electron Volts' from fig.2 p.3). This suggests that such increases could continue up to LHC lead-lead collision energies (2 TeV per nucleon collision) - such is certainly not excluded. By implication, similar predictions appear plausible for negative strangelets, but which are not considered in this paper. As with the latter case, here 'TeV gravity' relevance is not considered.

No satisfactory astrophysical argument for strangelet safety

Four papers of 1999/ 2000 [43],[44],[46],[47] addressed the question of whether astrophysical evidence demonstrates no danger from collider produced strangelets. One paper by Dar et al. [46] concluded that strangelets from cosmic rays would be disrupted after they are produced because of the rapid subsequent impacts. This meant that there was no reassurance from the survival of relevant bodies such as the moon. This was countered by Wilczek et al.[43], but they then pointed out that Dar et al.'s [46] only alternative astrophysical argument was insufficient given that the strangelet could last only a short time, as in the metastable strangelet predictions of [42]. In this other argument of Dar et al., such strangelets could emerge from collisions between cosmic rays. They could then emerge at slower speeds, making them undisruptible. But Adrian Kent of the Oxford University department of Theoretical Physics, outlines [44] that this astrophysical reassurance of Dar et al.[46] wouldn't be sufficient for the stable negative strangelets of [41] either. In fact, four arguments are offered in particular, as to how this could be. In the most highlighted argument [44], charge attraction implies that the negative strangelets would attract the hydrogen nuclei that are distributed throughout space. As a result strangelets could thereby gain speed due to feasible decay processes of these interactions, so that they would attain a disruptible speed by the time of reaching the nuclei within stars. Therefore no noticeable cataclysms involving stars and negative strangelets would occur.

Then Wilczek et al's astrophysical argument against disruption of strangelets was strongly criticised by theoretical physicist Adrian Kent [44] who explains how Wilczek et al's argument relies on unjustifiably narrow parameter values. The 2008 LSAG report fails even to acknowledge the doubts raised here by Kent, or by nuclear physicist Francesco Calogero [47] - who reached the same conclusion that Kent did. The Kent paper is a seminal document and is attached as Enclosure 4. The final conclusion is that there is no basis from astrophysical arguments to dismiss the danger of catastrophe at the LHC despite the fact that one of them is the basis for the upper bound risk value of one in five hundred thousand [46]

Theories involving transitions in the energy level of space

An established theory [48] postulates some form of phase transition in the energy level of space itself could be possible due to the high energy density created by a collider. This would have catastrophic implications and would involve a process known as 'quantum tunnelling' that would establish a sudden local expansion of the new space itself [49] through a transition of the fabric of space to a lower-energy vacuum state. A similar, but increased energy level of space transition, it has been postulated [3] could have occurred during the phase of Universe evolution known as 'inflationary', immediately after the theorised big bang, itself theorised as a zero point energy release. Nothing like this has been clearly seen, so this theory is speculative. However, it relates to well established theoretical work whose related dangers, we argue, have not been excluded, despite such claims [43], [16] that relate to astrophysical data.

The two safety papers ([43],[16]) considered a transition to a lower-energy vacuum state, and suggested the safety consideration that if such a transition were possible it would spread at the speed of light, and, having already occurred somewhere within our visible universe due to high energy cosmic rays would already have reached us.

This argument however does not address work by Professor Paul Dixon [49] concerning the 150 million high energy collisions that would occur per second within a volume of less than 1/100th of a cubic millimetre [50] at each (of the four) collision points at the LHC. This gives 22.4 billion (2.24 x 10^10) collisions per cubic millimetre every second. This is vastly more frequent than the actual correlated energy cosmic ray frequency (applying data from p.28 of [17]) where only one such collision would be expected to occur per cubic meter of the Earth's atmosphere (for example) over many thousands of years, even if the atmosphere were assumed to have a height of only 1 metre. Similarly, for cosmic ray particle collision energies approaching the highest level ever recorded (3 x 10^20eV), the energy is only a thousand times higher than the LHC correlated one, whilst the frequency would then be significantly less than one every thousands of years.

This then creates a significantly different circumstance than that of isolated cosmic ray collisions. Therefore the actual danger analysis itself relating to the effect upon space of a high frequency of high energy collisions occurring within a small volume has been avoided by the safety reviews.

Magnetic Monopoles

Former Berkeley University physics research assistant Dr. Walter Wagner (JD), once credited for co-discovery of the first possible magnetic monopole, outlined catastrophic danger from 'magnetic monopoles' at the LHC which has not been excluded and is thereby also a danger.

Magnetic monopoles would be particles that have only one magnetic pole. There are theoretical arguments that magnetic monopoles can exist and could be produced by the LHC. The argument is considered by LSAG 2008 [16] that such particles would catalyse the protons and neutrons of ordinary matter into electrons and 'neutrinos' thus destroying the matter around it at some unknown rate. LSAG 2008 [16] then argues that magnetic monopoles would be stopped by astronomical objects after emerging from cosmic ray collisions, so that if dangerous to Earth, they would also destroy other astronomical objects they enter, and since such astronomical bodies exist, Earth must be safe. However this argument appears to contradict the claim in the same paragraph that LHC-produced magnetic monopoles would not be trapped by the Earth - even though these magnetic monopoles would be much slower moving than in the other case. The basis for these two arguments is from two CERN papers LSSG (LHC Safety Study Group) 2003 [21] and LSAG (LHC Safety Assessment Group) 2008 [17]. Each paper makes no reference to the argument of the other paper, despite each having contradictory implications for the Earth in particular. Neither are the implications of one argument upon the other considered within LSAG 2008 [16], itself.

More specifically, no account is taken of the different speeds magnetic monopoles would travel when created by the LHC as opposed to much faster magnetic monopoles, that – like with black holes – would naturally emerge from cosmic ray collisions with Earth. Also with respect to speed, the potential existence of another accepted magnetic monopole type, the cosmic ray magnetic monopole, has been excluded in space at speeds below 12km/s [51] which is above the gravitationally capturable 10.5km/s, a prospect accepted for analogous LHC black hole speeds.

Hence the astrophysical reassurance argument has been neither satisfactory nor rigorous.

Dangers allowed by credible theory not excluded by safety arguments

Theories that imply danger are from theoretical principles of established physics and feasible parameters: black holes decaying over 30 years in isolation with increasing radiation, black holes absorbing the Earth in millennia, centuries or decades as allowed by feasible parameters, emerging negative strangelets or magnetic monopoles, and the transition to alternative energies of space.

The only empirical reassurance is from cosmic rays that strike astronomical bodies. If resulting particles are strangelets, they are susceptible to disruption at such high speeds. Yet no argument is offered to challenge Plaga's and Rössler's claims that astrophysical reassurances may not apply.[18], [4] For black-hole-capturing white dwarfs or neutron stars there are unestablished implications regarding how the black hole speed affects the proportion of protons or neutrons absorbed or of the applicability of accretion itself because cosmic rays may not reach some astronomical bodies (concentrated interstellar dust domains) or may pass through astronomical bodies (internal superfluidity of neutron stars).[18] Disruption of negative strangelets from cosmic rays, whether metastable or stable, has been argued to be feasible in three safety reviews. With energy transition, isolated cosmic rays do not satisfy the criteria for such transition according to Dr. Dixon and arguments concerning magnetic monopoles are not consistent or complete.

Things might well be expected to 'go wrong' when entering uncharted physical territory creating unprecedented conditions involving the creation of new types of matter in capturable states on Earth that have not existed for the billions of years of Earth's existence.

A summary of the physics

Every particle collision at the Large Hadron Collider will create a tremendous energy density in a small space. Energy and matter are interchangeable under the right conditions, so this energy will create a shower of new particles. Because the LHC will be more powerful than previous colliders, new particles and new states of matter that scientists have not seen before are expected. Scientists are eager to study these new things. They have many theories about what might be created. Unfortunately, some respectable theories predict creation of dangerous particles and dangerous states of matter and of space that could destroy the entire Earth. These include micro black holes that could swallow Earth or produce catastrophic energy release, strangelets that could convert Earth into a small ball of strange matter, and changes in space itself that could be catastrophic.

Collider advocates claim that the LHC will be safe. However, safety considerations that seemed adequate to collider advocates have been repeatedly negated by peer-reviewed papers, often papers generated independently of the collider controversy, or have been questioned by serious scientists. Black hole production by colliders was supposed to be impossible, then papers appeared, based on new physics, that predicted production of black holes by colliders. Black holes were supposed to dissipate via Hawking radiation, but several papers questioned the fundamental theory behind Hawking radiation, a radiation that has never been seen. Strangelets were supposed to be electrically positive on their surface and not attract normal matter, however several papers said they can be electrically negative. Cosmic rays were said to demonstrate safety because they would make natural black holes analogous to those made by colliders if colliders could make them. However, black holes created by cosmic rays would be moving rapidly and would zip right through Earth like a neutrino, whereas some collider-created black holes would get trapped in the Earth's gravitational field. The idea that cosmic-ray-created black holes would not stop in Earth has been provisionally accepted by collider advocates, requiring that they modify the collider/cosmic ray analogy to consider conditions in white dwarf stars. Collider advocates say that cosmic-ray-created black holes would stop there, giving white dwarf stars a lifetime that is lower than observed, if unknown rates of accretion by black holes are fast enough to accrete Earth in any short time. However, several scientists question this claim.

History shows that catastrophic failures are often attributable to experts in their fields failing to properly recognize catastrophic dangers and failures to properly manage risk. A notable example was the fatal launch of the space shuttle Challenger in freezing weather despite evidence of partial o-ring failures on previous flights and strenuous objections from responsible technicians. Other notable examples of preventable engineering management failures include the loss of the ‘practically unsinkable’ Titanic when all five of her sealed compartments flooded, the distribution of the drug thalidomide to pregnant mothers, loss of magnets at the Large Hadron Collider due to basic math errors, the deployment of the Hubble space telescope with flawed mirrors due to simple errors and a failure to test before launch, and most recently the meltdown of world financial markets largely attributable to regulator failure at many levels.

The safety of the planet may now be compromised by the management of a single laboratory which has not sufficiently included external multi-disciplinary experts in their risk research and assessment process.

Lack of proper risk assessment practice concerning the LHC

Important considerations from the field of risk management highlight the seriousness of collider risk. Unfortunately, these considerations are too rarely considered by collider advocates, and risk management procedures that have been followed have been far from risk management best practice.

Taking account of numbers of potential casualties in risk evaluation: 'Expected value'

The notion of 'expected value' has a profound impact on our appropriate philosophical reaction to the risk of destruction of Earth, an impact recognized by some of the participants in the debate, but too frequently ignored. [52] Expected value is the appropriate mathematics from the point of view of decision theory. Expected value multiplies the probability of an outcome times the value of that outcome. In the case of destruction of Earth, that value is negative, and it is no less than the death of 6.7 billion people, the current population of Earth. (It is really much more than that, since this ignores future generations.) It is contentious to specify a probability of collider disaster. However, it is clear that it is not the zero probability that is CERN official policy.[15] Any reasonable probability results in an enormous negative expected value measured in human lives.

We claim that the death of the entire population in the expected value approach is highly and directly relevant to our personal human rights, in this case our right to have progeny and family. It would be genocide by neglect**.** Threatening our right as humans to exist threatens *the rights of all humans, both actual living humans and potential progeny.* The whole human race proceeds from our personal ancestors both in religious cultural tradition and in science [53], and is therefore our personal family.

Probabilistic deaths are a threat to our human rights. A reckless driver endangers his passengers and those on the road around him, threatening their lives and their rights, even though he does not directly intend an accident, and even though he may get lucky and avoid one. The same applies to a reckless commercial pilot although we recognise that the number of lives at risk in his case is much greater and we accordingly treat his case much more seriously. Reckless collider advocates risk millions of times more lives than a reckless pilot.

The precautionary principle

One recent contribution to risk management is the exposition, and significant acceptance, of what is called 'the precautionary principle'. This is the idea that the group, scientific or industrial, that proposes risky activity has the responsibility of proving it safe. This differs from normal practice in law, where those injured have to prove injury, and it differs from normal practice in science, where those who propose the theory that an activity is risky are expected to pass normal tests of statistical significance and peer review in order to prove that theory, tests that are weighted towards vetting proofs, not towards caution. The European Union has formally accepted the precautionary principle. However, in the case of CERN, we could not find an official willing to take responsibility for enforcement of that principle.

Risk assessment and prevention practices – independent critical analysis of Dr. M. Leggett

A new review of LHC risk management practices by the safety expert Dr Mark Leggett (Key Centre for Ethics, Law, Justice and Governance, Griffith University, Australia): *"Review of the risk assessment process used for the 2008 LHC safety study"*, is attached [Enclosure 2].

This study is highly relevant for this case and one of the main expert analyses enclosed.

As background to this section on Dr Leggett's study, it is noted that, as mentioned, CERN has conducted two LHC safety reviews, in 2003 and 2008. [21] [16] Composition of the panels that conducted these reviews failed to address issues of conflict of interest, diversity of specialisation, and consultation of the public. The first panel was composed only of collider physicists. This led to complaints about conflict of interest. This lack of a fully disinterested arms-length safety assessment was also the model for the safety assessment of a previous US collider, the Relativistic Heavy Ion Collider (RHIC) at Brookhaven, which was started up in 2000.

According to the book "*Catastrophe: risk and response*" by the prominent (indeed regarded by many, according to the Atlantic Monthly, as a future US Supreme Court candidate) US Judge and Professor Richard Posner (and see a further section below referring to Professor Posner's work from a legal perspective), [54] the RHIC set the precedent for a less than arms-length assessment with a similar review by a panel of collider physicists. Posner observed the lack of such an assessment, and called for strict regulation of colliders. This view was further and uncompromisingly supported by Kenneth Foster in his review of Posner's book in no less than *Science* in 2005. [55] Foster encapsulated the process issues and, indeed, the underlying contributing mindset of some scientists in this section of the review:

Posner will infuriate many scientists whom, he writes, have an

"*attitude gap created by the different goals, and resulting different mindsets, of science on the one hand and public policy on the other. The scientist qua scientist wants to increase scientific knowledge, not make the world safer—especially from science*."

This is an important warning, and the strangelet scenario is a case in point. Shortly before a new high-energy accelerator was to begin operation at Brookhaven National Laboratory, a physicist raised concerns that a high-energy collision might trigger a runaway reaction that would quickly transform Earth into a 100-meter lump of inert matter. The lab director took the ethically dubious step of appointing an evaluation panel of physicists, all of whom had professional interests in seeing the experiments go forward. Posner dismisses as non sequiturs the various public statements by physicists intended to reassure the public of the improbability of the strangelet scenario. Seeing few economic benefits and a likely small but in fact unknown probability of disaster, he argues that high-energy research should be supported by universities rather than the government and that it should be brought under a strict regulatory umbrella.

The panel for the CERN LSAG study consisted of participants who were not planning experiments at the LHC – but they were still all theoretical physicists. This does not appear to materially reduce the conflict of interest because they were eager to analyse data from those experiments.

Further, there are more issues than conflict of interest. These are illustrated in the above-mentioned new comprehensive expert's report on LHC risk management practices: "*Review of the risk assessment process used for the 2008 LHC safety study*" (Leggett 2009). This study assesses the second LHC safety review not as a physics analysis, but as a safety analysis. In the study, the structure, method and content of the LSAG report is benchmarked against a survey of current published recommendations - including the official European Commission recommendations - for best practice safety analyses. Significantly, the study shows that the LSAG report has less than a quarter (in fact, only 18 per cent) of the elements that would be present if current recommendations for best-practice safety assessments were followed as shown in the survey.

One key point emphasized by the study is that several authoritative risk management studies (including that of the European Commission) advise that a group implementing risk management should contain a *diversity (or plurality) of expertise*.

The European Commission guidelines "*Improving the knowledge base for better policies (2002)*", "*commission on the collection and use of expertise*" Principles and Guidelines state that one of the three determinants of quality of advice is pluralism:

"*Wherever possible, a diversity of viewpoints should be assembled. This diversity may result from differences in scientific approach, different types of expertise, different institutional affiliations, or contrasting opinions over the fundamental assumptions underlying the issue. Is it appropriate to mobilise experts beyond the scientific community? These may include, for example, lawyers, ethicists...*"

How then does the CERN process used for the present 2008 CERN-commissioned reports compare with the EC guidelines on plurality of expertise?

The LSAG report itself was conducted by five particle physicists. The associated report "*Astronomical Implications of Hypothetical Stable TeV-Scale Black Holes*" was conducted by two particle physicists, one of whom was also in the LSAG report team. It was reviewed by the 20-member CERN Council Scientific Policy Committee, also composed only of particle physicists. [56] All of the contributors to the CERN 2008 safety review (including the SPC report) are presently listed in the CERN directory. [57]

So all these 26 were particle physicists. Despite this large number, none were "*experts beyond the scientific community… for example, lawyers, ethicists..*", despite that being recommended by the European Commission.

This particle physicists-only advice was then put to CERN Council for consideration and advice to the governments. CERN Council represents the 20 governments funding the LHC and consists of 14 particle physicists and 14 civil servants. [58]

Half of the Council is therefore the interest group concerned – particle physicists. And the other half is also not immune from possible vested interest. This is because the Council as a whole has approved the prior funding of and building of the LHC. As such, CERN Council is far from arms-length from the project, and may feel a bias to justify its prior decisions of support.

Given this possibility of bias in the decision-making within and about the LSAG report, the complainants are uneasy because of reference to a basic sense of fairness. This is embodied in one of the rules of natural justice or procedural fairness: the rule against bias *(nemo debet esse judex in propria sua cause* – "*no one to be a judge in their own cause*").

So, even though the EC guidelines on the use of expertise arose precisely out of an event (the mad cow disease crisis) in which people died partly because of narrowly-based scientific advice, CERN, also assessing the possibility of events in which people may die, has used none of the EC guidelines, indeed gives no inkling that it is aware they exist, and has produced *exquisitely* narrowly-based advice. The lessons learnt by society from the recent BSE and other crises may as well never have been learnt as far as CERN is concerned.

Here, for the LHC risk question, astronomers would have been helpful since a key safety consideration involved astronomical data, and risk management specialists would have been helpful since the task at hand was supposed to be risk management.

Dr Leggett's study concluded (p. 9):

“*The process used to produce and review the LSAG reports on the LHC risk can be seen to be, from a number of authoritative standpoints, out of date. Further, as the analogue of the regulator, CERN Council has a conflict of interest, and is under-constituted to assess such a novel, potentially catastrophic and therefore sensitive risk. On this basis, a new review panel based on best practice for such panels should be set up to advise national, EU, and governments worldwide on the adequacy or otherwise of the LSAG report, and the LHC not operate until that panel has reported.*”

While due to its extraterritoriality, CERN may be able to claim that in terms of the letter of the law, it is not bound to adopt a safety review panel involving a plurality of expertise, this outcome is at variance with the spirit of practice required in Europe, and that claimed to be followed by CERN.

Firstly, the requirement for a plurality of expertise was formally adopted at the elevated level of the European Parliament in a resolution of the parliament [59] as long ago as 2002, quite long enough for CERN’s safety and legal officers to have had the chance to become familiar with it.

Key excerpts of the resolution are:

'European Parliament resolution on European governance (COM(2002) 704 - COM(2002) 705 - COM(2002) 713 - C5-0200/2003 - 2003/2085(INI))'

The European Parliament …

– having regard to the communication from the Commission 'on the collection and use of expertise by the Commission: principles and guidelines - Improving the knowledge base for better policies' (COM(2002) 713)

14. Considers that the Commission, in the collection and use of expert opinions, must ensure compliance with the duty of responsibility, *pluralism* (complainants emphasis) and the integrity of experts…

27. Instructs its President to forward this resolution to the Council, the Commission, the European Economic and Social Committee, the Committee of the Regions and the governments and parliaments of the Member States, accession states and applicant countries.

Secondly, a member of CERN’s own legal department states [60] that, despite CERN’s extraterritoriality:

“*(while) CERN is entitled to establish its own internal rules necessary for its proper functioning, (concerning) CERN’s own safety rules: no direct applicability of national procedures, but standards of host States respected in practice (complainants’ emphasis).*”

For the notion of a plurality of expertise to be enshrined in a resolution of the European Parliament and forwarded to the parliaments of the Member States surely gives the notion some right, at least in the spirit of the law and in the spirit of seeking best practice, to be considered a significant “*standard of host States (to be) respected in practice*."

As the panels consisted totally of physicists, despite all the above background, the process is open to the appearance that CERN tried to avoid any procedure that was not weighted in favour of the conclusion it wanted to obtain. Such a flawed procedure is a violation of complainants’ right to be heard, and right to appropriate care in managing risks to which complainants are subject.

Zero risk official policy for CERN officials

As mentioned above, in a 2007 interview with the 'New Yorker' magazine, Jos Engelen, CERN's Chief Scientific Officer, was quoted as saying 'that CERN officials are now instructed, with respect to the LHC’s world-destroying potential, “*not to say that the probability is very small but that the probability is zero*”' [15]

This presents both an unscientific and a dangerous basis for CERN's safety reviews.

The notion of zero risk is even challenged in a paper of collider supporter Kapusta [61] who, by relying upon a risk analysis of a safety paper [46] seriously acknowledges the danger question:

'*The odds [one in five million] are tiny but not zero. A physicist never says never. Is this tiny probability acceptable ... given the potentially devastating consequences?*' [0804.4806v1]

The zero risk policy is likely to have made proper consideration and consultation with those of alternative views against the interests of the officials' position at

CERN impossible, such that review authors dare only offer an agreeable conclusion in order to avoid internal disciplinary problems. The question should have been 'can there in fact be a way that a catastrophe could occur from collision from the available physics?' not 'how can it be argued that there is safety?'

Summary in timeline form of the scientific discussion of collider risk

The following timeline summarizes some important papers on the question of LHC safety including the two (2003 and 2008) CERN LHC safety reports, some chosen papers with material relevant to the risks, and some major non-CERN analyses urging caution, including highly respected authors. This is only a selection:

- 1999/2000 Safety critiques relevant to LHC and RHIC by Nobel-Prize recipient and physicist Professor Francesco Calogero [47] and CERN-funded mathematician Dr Adrian Kent [44]. Critique of astrophysical arguments concerning particle collider safety.

- 2002 Casadio Harms paper [23] outlines possibility of LHC black hole lifetime of 30 years using a TeV gravity theory (Randall-Sundrum), by taking account of gravitational effect upon emerging Hawking radiating particles.

- 2003 First CERN LHC safety report is released [21] neglecting above three papers.

- 2003 Paul Dixon paper in 'Bionature' [49] incorporates high energy collision frequency per volume as further high energy collision criteria for energy space transition

- 2006 Peng et al. [41] paper finds further basis for credibility of negative strangelets in principle.

- 2007 ‘New Yorker’ reports CERN Chief Scientific Officer as saying that CERN officials are now instructed “*not to say that the probability is very small but that the probability is zero*” concerning risks from the LHC.

- September 2007 O Rössler paper calculating possibility of accretion of whole Earth within short period.

- 20 June 2008 CERN-sponsored *"Astrophysical implications of hypothetical stable TeV-scale black holes"* CERN later published as [17] appears. This paper does not address the above-mentioned 2003 paper by Professor Paul Dixon [49] relating to the effect upon space of a high frequency of high energy collisions occurring within a small volume.

- July 2008, Oxford's T. Ord argues at the Global Catastrophic Risk conference that multiplying the probabilities that the theory, model, and/or calculations on which the operation of the LHC rests are wrong, would dramatically increases the probability estimates that switching it on could destroy the world. Thus Ord suggested that the LHC should not be switched on. [69]

- July 2008 CERN *"SPC Report on LSAG Documents"* does not consider: above-mentioned September 2007 O Rössler paper allowing accretion of whole earth within 55 months; further 20 May 2008 O Rössler paper introducing counter-arguments to astrophysical assurance regarding LHC black hole risk.

- 10 Aug 2008 Paper by distinguished astrophysicist Dr R Plaga *"On the potential catastrophic risk from metastable quantum-black holes produced at particle colliders"* demonstrates residual catastrophic risk from a devastating explosion followed by several global threats.

- 29 Aug 2008 CERN replies to Plaga in *"Comments on claimed risk from metastable black holes."* Reply neglects implications of slow decay scenario [23] and of Plaga's application of Eddington limit.

- 5 Sep 2008 Second CERN LHC safety report: CERN LSAG *"Review of the Safety of LHC Collisions"* [16]. Neglects 1986-1997 papers re dangerous duration of negative strangelets, neglect of the lack of strangelet astrophysical assurance within pro-safety reviews for RHIC and LHC as indicated by Kent or Calogero [47]. Slow decay as with Casadio and Harms 2002 and Plaga 2008 again left out along with any consideration of Rössler's

2007/8 papers. Neglects the precise argument of Professor Dixon regarding cause of transition of space to lower energy.

- 26 Sep 2008 Plaga replies to *"Comments on claimed risk from metastable black holes"* stating that CERN's response paper relies on two misunderstandings. CERN has not responded to Plaga's reply.

- 27 Sep 2008 Despite being entitled *"Exclusion of Black Hole Disaster Scenarios at the LHC"*, a paper by Stocker et al. [29] affirms the risk that the protective black-hole slow decay can be surpassed by the black-hole accretion rate. This point has not been replied to by CERN.

- Jan 2009, Casadio, Fabi and Harm publish *"On the Possibility of Catastrophic Black Hole Growth in the Warped Brane-World Scenario at the LHC"* [30] concluding that the lifetime of micro black holes at the LHC would be much higher than in previous models.

- Aug 2009 Plaga v3 renews conclusions and mentions that 'Further comments' paper promised from CERN's Mangano and Giddings has still not been forthcoming. [4]

- September 2009, Dr. M. Leggett releases paper "Review of the risk assessment process used for the 2008 LHC safety study." http://lhc-concern.info/wp-content/uploads/2009/09/leggett_review_of_lsag_process_sept_1__09.pdf

- 6 Sep 2009, O. E. Rössler releases paper *"Is CERN about to trigger the worst imaginable accident with an odds of 1 to 6?"* http://www.wissensnavigator.com/documents/CERNTRIGGER.pdf [67]

- 10 Nov 2009, Casadio et al. publish *"Theoretical survey of tidal-charged black holes at the LHC"* predicts the possibility that "*black holes live long enough to escape from the accelerator (and even from the Earth's gravitational field) and result in missing energy from the detectors."* [68]

Further critique and remarks from independent scientists

Independent critical analysis of the Future of Humanity Institute, University of Oxford

The ‘Future of Humanity Institute’ of the prestigious University of Oxford (United Kingdom) in December 2008 published an analysis for proper assessment of low-percentage/high-stake situations This clearly concludes that risk-assessment for the second-most powerful apparatus ‘RHIC’ located in Brookhaven, Long Island, NY, USA has been insufficient and a correction of the as yet underestimated negative expected value is urgently required.

The Oxford experts also point out that the above mentioned LSAG-Report for the 7-fold more powerful LHC was inappropriate to settle the issue:

“*While the arguments for the safety of the LHC are commendable for their thoroughness, they are not infallible. Although the report considered several possible physical theories, it is eminently possible that these are all inadequate representations of the underlying physical reality. It is also possible that the models of processes in the LHC or the astronomical processes appealed to in the cosmic ray argument are flawed in an important way. Finally, it is possible that there is a calculation error in the report.*

...However, our analysis implies that the current safety report should not be the final word in the safety assessment of the LHC.

Such work would require expertise beyond theoretical physics, and an interdisciplinary group would be essential."

This highly relevant study is attached as Enclosure 3.

Prof. Wolfgang Kromp (Head of the Institute of Risk Research, University of Vienna, Austria) advocates for an extraordinary assessment of environmental agreeableness concerning the LHC.

Physicists supporting Independent Safety Agency concerning high energy colliders

High energy collider physicist J. Kapusta [61] sympathetically considers Judge Richard Posner's advocacy for an independent agency view (see below) and offers no criticism when describing it: *"In general, therefore, should there not be two sides to this and other arguments, each pushing the limits of scientific knowledge and justifying its choice of uncertain parameters to produce an outcome most favourable to its position?"*

Nuclear physicist and Nobel Prize recipient as Director general of the Pugwah Conferences Professor Francesco Calogero (University of Rome, "La Sapienza") in 'Might a laboratory experiment destroy planet Earth?' recommends the importance of an agency independent of the operator which operates so as to ensure proper consideration from the danger protagonist's perspective.

Physicist and black hole specialist Dr Tony Rothman (Princeton University) also positively considers this (see conclusion).

Recommendations from independent legal professionals

US court decision

In 2007 and 2008, a court case was held in the US seeking an injunction against the LHC continuing. This case was dismissed, on the grounds that the US court did not have jurisdiction. [62] However, in her decision, concerning decision-making on the risk from the LHC, Judge Helen Gillmor wrote: *"It is clear that Plaintiffs' action reflects disagreement among scientists about the possible ramifications of the operation of the Large Hadron Collider. This extremely complex debate is of concern to (our emphasis)* more than just the physicists.*" [62]*

CERN's failure to establish an independent multi-disciplinary safety review practice and to address the plausible arguments of the safety opposition implies a failure in the culture, social dynamics, psychology and politics in the risk assessment practice of CERN.

Commentary of former US court of appeal Judge Richard Posner

(The following is based on excerpts from his book, Catastrophe Risk and Response, published by the prestigious Oxford University Press in 2004)

According to the Wikipedia Richard Posner article [64]:

"*a 2004 poll by Legal Affairs magazine named Posner as one of the top twenty legal thinkers in the U.S…*"

"*The former dean of Yale Law School, Anthony T. Kronman, said that Posner was "one of the most rational human beings" he had ever met*".)

In *Catastrophe Risk and Response* (published by Oxford University Press in 2004), concerning the need for panels conducting risk assessments on colliders to be at arms-length, Judge Posner wrote (p.192):

"*It underscores the importance of having cost-benefit analyses of responses to catastrophic risks conducted by neutrals, who do not have financial, political, or psychological stakes in how the analyses come out.*"

"*Consider the RHIC risk assessment that I first mentioned in chapter 1. The authors of the commissioned assessment (not a cost-benefit or even risk-risk analysis, but merely an assessment of the risk of a planet or universe-destroying accident) were selected by the director of the Brookhaven National Laboratory. Three of the four not only are experimental particle physicists who therefore have a career stake in increasing the power of particle accelerators; they were also planning to conduct experiments at RHIC-and are now doing so. The fourth, the theoretician, was and is deeply interested in the results of the experiments.*

But career concerns can influence judgment in areas of scientific uncertainty, and scientists, like other people, can be overconfident. Should a (catastrophic) disaster occur, moreover, only a minute fraction of the costs would be borne by the scientists who caused it. If it does not occur and RHIC proves to be a scientific success story, the physicists who conduct research at RHIC will appropriate the lion's share of the benefits (unless there are immediate commercial applications, which is not anticipated) in the form of prestige, career advancement, and personal satisfaction…"

Judge Posner goes on to recommend, for the US:

"*Congress should consider enacting a law that would require all scientific research projects in specified areas, such as nanotechnology and experimental high-energy physics, to be reviewed by a federal catastrophic-risks assessment board and forbidden if the board found that the project would create an undue risk to human survival.*"

No such board was used for the LHC risk assessments, and the safety situation concerning the LHC would be better if it had been.

Judge Posner later (p.220) observes:

"*At present our government is largely oblivious to catastrophic risks as I am defining them, other than those created by the threat of nuclear or biological* *terrorism. For example, the Environment, Safety, and Health Division of the Department of Energy states that "hazards at [particle] accelerators are magnitudes below those of nuclear reactors." Yet as the department owns both Brookhaven, with its RHIC, and Fermilab and the Stanford Linear Accelerator Center, the other two major U.S. research accelerators, it ought to be aware of the potential dangers.*

Current federal policy toward asteroid collisions, global warming, biodiversity loss, and the other accidental doomsday dangers is, with the exception of natural pandemics and the partial exception of global warming, essentially one of ignoring them."

This judgement can directly be applied to the CERN member states. It is one which leaves the complainants and the rest of humanity at risk, and the authoritative views of Professor Posner are a further major reason for the UN to independently consider the safety of the LHC. [54] (332pp)

Independent juridical analyses by Prof. Eric E. Johnson

In the following paragraphs an independent expert in international law mentions possibilities for courts to deal with complex technical issues, directly relating to CERN and the LHC.

The following is from the central Part 3 of this analyses: "*Culture and Inscrutable Science: An Analytical Method for Preliminary Injunctions in Extreme Cases*" by Prof. Eric Johnson: "*While courts are not well equipped to evaluate theoretical science, they certainly are adequate to the task to investigating social dynamics, psychological factors, political influences, and organizational cultures. In evaluating a preliminary injunction request regarding the Large Hadron Collider, a court should scrutinize the culture of CERN and the particle-physics community, as well the political, social, and psychological context in which their decisions are made. Having done so, the court should then determine, with reference to those gathered facts, whether "serious questions" exist, and, thus, whether the case for a preliminary injunction has been made.*

An honest appraisal of the situation reveals that there are many apparently plausible reasons why the culture at CERN and within the particle-physics community could lead to flawed risk analysis. I will list several:

To begin with, it seems highly plausible that particle physicists might fear serious reprisals and negative repercussions for their careers if they were to speak out about perceived dangers of the LHC. Denial of tenure, unaccepted manuscripts, and ostracism by peers are among the penalties an academic in such a situation might plausibly face. Such an apprehension would appear to be all the more acute because the LHC is the crown jewel of particle-physics experimentation. It dwarfs all predecessors in size and power, and represents a leap forward that could radically advance fundamental theory, possibly answering some of the most basic questions about our universe. To say that the LHC is important to the particle-physics community seems to be an understatement.

Further, in mulling over whether to speak out, particle physicists with private doubts might well resign themselves to a fatalistic assessment. They might plausibly figure that they, as individuals, are powerless to overcome the momentum of a multinational multi-billion-dollar project. If that is their appraisal, then such individuals have nothing to gain, but much to lose, by making a public objection. Consider the possible outcomes: If a scientist speaks out and nothing bad happens, the scientist is a laughingstock. If a scientist speaks out and disaster does come to pass, professional vindication will be fleeting and bittersweet. If a scientist keeps mum or even extols the safety of the project, in a disaster scenario, embarrassment will be short-lived.

But let's suppose particle physicists with private doubts reach the opposite conclusion about the likely impact of their public dissent. Suppose a private doubter predicts that his or her voice could be the tipping point that leads to widespread public concern and a permanent shutdown of the LHC. In such a case, whether the objecting scientist is right or wrong, he or she can anticipate being blamed for ruining the most exciting opportunity for advancing scientific understanding in this generation. And there's no hope of vindication in such an event – naysayers cannot be proved right if the experiments are never run.

The math-oriented are often fond of using matrices to elucidate decision-making. A physicist creating such a matrix, using the logic detailed above, would be faced with a series of boxes in which all outcomes are quite bad, except one: to be a supporter of the LHC in the event that it turns out to be a benign scientific triumph.

Additional pressure on scientists not to question the LHC may also come from the fact that the LHC appears increasingly to be the only game in town for particle physicists wanting to work at the leading edge of discovery. In fact, the world's largest particle collider currently in operation, Fermilab's Tevatron outside of Chicago, Illinois, is slated for shutdown in 2010, apparently in large part because the LHC will render it obsolete. Other particle accelerators planned for the future have had their funding suspended or cutoff.

A psychological or sociological explanation for how particle physicists could reach a consensus on safety, despite the existence of real danger, is the phenomenon William H. Whyte, Jr. called "groupthink." This process allows individuals to maintain a worry-free outlook that is not justified by the facts. In such a dynamic, the existence of group consensus causes individuals to forego or dismiss their own independent thinking. A circularity develops: Group consensus justifies individual confidence, and individual confidence justifies group consensus. The result is flawed decision-making. Groupthink has been offered as an explanation for both the Challenger and Columbia space-shuttle disasters.

Another set of concerns arises from the question of how political realities might have affected the decision-making environment at CERN. As a consortium run by 20 member states, it is plausible that politics plays a significant role in the CERN milieu.

Still another point of worry is the independence, or lack thereof, of the safety reviews that have been advanced as evidence that the LHC is safe. While an independent report was completed in 2003, more current documents said to confirm the safety of the LHC, which were issued in response to recent criticism, are the product of CERN itself, and are not independent.

Other factors are worthy of investigation as well. It may be, for instance, that the timeline of infrastructure construction and critical theorizing is such that LHC interests were thoroughly vested by the time potentially convincing theoretical work on safety concerns surfaced. That is, the late hour at which objections were made could well have prevented their open-minded consideration, regardless of merit. Some elements of the broad timeline of the LHC endeavor suggests this: The LHC was approved in 1994, and construction began in 1998. Construction was nearing completion in September 2007 when Otto Rössler released a paper explaining his new mathematical work, which, according to Rössler, demonstrates the LHC's grave danger. Rainer Plaga's article making a negative assessment of the risk at the LHC was published in August 2008, a month before operational *testing began. At the point these papers were advanced, it is plausible that the LHC project had already reached the point where halting it was politically unthinkable.*

Supporters of the LHC have argued that Dr. Plaga and Dr. Rössler are not career-dedicated particle physicists, and, therefore, their theoretical work should not be taken seriously. As discussed above, it seems plausible that the cultural environment in which particle physicists operate is such that public objection to the LHC is discouraged and stifled to the point where it is non-existent. Given such a state, we would expect public objection to come from outside the particle-physics community. Thus, rather than being a reason for discounting such theoretical work, the outsider nature of such work might be a reason to embrace it.

Even putting aside the social and cultural pressure on particle physicists to conform, it is a well-talked about phenomenon, famously advanced by Thomas S. Kuhn, that paradigm-shifting revolutions in scientific thought often come from individuals who are new to a field of study, and thus not entrenched in its conventional modes of thinking. (Jim Chen wrote about the virtues of juniority in the legal academy on MoneyLaw.) Thus we might expect that career particle physicists would be slow to accept paradigm-shifting theoretical work that undermines confidence in the safety of the LHC. As a corollary, the lack of particle-physics bona fides among LHC critics, especially ones who are serious and respected scientists, should not be relied upon as a way to dismiss their concerns.

[...]

What I am arguing is that there is an analytical way for a court to reach a well-reasoned decision in cases such as this, even where the merits of the scientific controversy itself are opaque to judges lacking specialized scientific training, and where expert testimony is of dubious use in adjudicating the matter. In considering a preliminary injunction, the court should investigate the cultural, organizational, political, psychological, and sociological context in which safety determinations were made, and then ask whether the results of that inquiry raise serious questions on the merits. If serious questions are raised, and if the balance of hardships tips strongly in the plaintiffs' favor (as it clearly does with a black hole destroying the Earth), then an injunction should issue." [63]

Finally, Prof. Johnson states: *"The treaties establishing CERN have vested it with legal personality. The host countries, Switzerland and France, have given CERN* *and its employees broad immunity and protection against interference by the courts and host country laws and regulations. That immunity is preventing plaintiffs, who argue their lives are at stake, from being able to use judicial process to mount any kind of challenge to CERN's planned undertakings.1*

Immunity for intergovernmental organizations may, in general, be benign. Applied to CERN, however, I find it troubling. Unlike most intergovernmental organizations, CERN is engaged in a category of activities – even putting black holes aside – that clearly qualifies as "abnormally dangerous" and "ultrahazardous" under American common-law doctrine. Governed by a council of delegates from its 20 member countries, power over the organization, and responsibility for it, is diffuse. When it comes to safety, CERN appears to be entirely autonomous, making its own rules and deciding whether or not those rules are being obeyed. Moreover, where the alleged harm is a planet-ending catastrophe, there is no prospect of after-the-fact remediation by CERN's state sponsors.

This results in a situation in which CERN has many of the characteristics of a sovereign nation, but, unlike a normal state, CERN has no system of courts. CERN also lacks any constituency within its population beside scientists and their close associates. As such, CERN – and, perhaps, other intergovernmental organizations operating nuclear facilities – poses some interesting questions in the field of international law. CERN's quasi-sovereign nature means that it may constitute a "scientocracy" in even a more palpable sense than I appreciated in my previous posts.

In view of CERN's assertion of immunity from host-state courts, the failure of the European Court of Human Rights to deal with the case on its merits is even more unfortunate. […]

I do think the LHC critics should get their day in court, and it should count. The case should be taken seriously, decided on the merits, and memorialized in a published opinion. Anything less would be very disappointing." [63]

Professor Johnson's paper is provided as Enclosure 7.

The failure of an independent multi-disciplinary safety review practice to be established and the failure of CERN's safety reviews to address the various 'best arguments' of the non-safety positions, implies a failure in the culture, social dynamics, psychology and politics in the risk assessment practice of CERN and the CERN member states, that carry the ultimate responsibility for the LHC experiments. According to the analyses of Prof. Johnson, one of the best possibilities for courts to deal with this matter is to investigate such social dynamics, psychological factors, political influences, and organizational cultures.

An independent critical expertise of Dr Mark Leggett (Key Centre for Ethics, Law, Justice and Governance, Griffith University, Australia) focusing on these issues (as described in the section above: 'Risk assessment and prevention practices') is enclosed: [Enclosure 2]

Summary of the complaint

The Large Hadron Collider at CERN, a massive machine designed to collide protons and nuclei at unprecedented energies to obtain physics data and to test modern theories that predict the formation of novel particles, violates our human rights to life and environment by several concrete threats of short- and long term dangers of planetary extinction.

According to our present knowledge, these are risks, no certainties, but uncertainties with stakes being much too high. Several concrete dangers clearly cannot be excluded at the present time. Dangerous experiments are due to start soon with increasing energy.

CERN claims that the machine is safe. It's safety group has alleged that several safety factors are adequate to protect Earth. However, one after the other, those safety factors have proved to have important exceptions and lacunae. CERN's processes for claiming safety rely on personnel with conflicts of interest and on procedures that are far from risk management best practices. Several plausible theories enable disaster. This is a picture of danger, not of safety. Rights can be infringed by being seriously jeopardised, which is presently the case.

CERN is an intergovernmental consortium established by an international treaty, the CERN Convention. Because of CERN's international status, many of the safety protocols and laws that would apply to an organization without this status do not apply, and there are no domestic legal remedies.

We demonstrate in this paper that there is clearly a danger. We need a proper safety management process to assure the world that the experiments will not be conducted without proper risk management.

The states actively supporting and maintaining CERN have the legal obligation to ensure citizens' safety.

This **comprehensive and detailed communication** was worked out by well-known critics and experts, relying upon the work of specialists on black holes, cosmic rays, particle physics and on risk researchers and several experts in international law. The communication clearly demonstrates concrete dangers arising from the planned high-energy experiments at the LHC and weaknesses in CERN safety assessments.

To guarantee safety, the complaint demands an external risk evaluation done by those without ties to CERN. Further, closer study of cosmic ray (AUGER observatory) and other recent empirical data highly relevant for the LHC-safety arguments is urgently requested, as is awaiting upcoming observing experiments in the atmosphere.

The legal aspects focus on the special responsibility of Switzerland, France and Germany (by territory as ownership principle and CERN-council membership) and addresses also the other CERN member states not having insured LHC-safety on life and environment according to Art. 2, 6 and 17 of the International Protocol of Civil and Political Rights of the United Nations.

This complaint is **supported by several organizations and a wide group of international critics** of the planned "big bang experiment". It includes a clear and detailed description of the scientific discourse on several risks and dangers arising from the artifical and extreme states of matter planned to be created, such as risks from **"micro black holes"**and **"strangelets"** as described in a number of studies - and even dangers of transitions in the energy level of space.

Enclosed are critical studies of the method used in the CERN risk studies, one from members of the "Future of Humanity Institute" of the University of Oxford and another expert's review on the LHC safety assessment process concluding that **CERN at this date has fulfilled not more than a fifth of the necessary criteria** expected for a modern safety study.

As long as there is no clear evidence that the possible production of "micro black holes" (expected to be created by many CERN scientists) **pose neither long- nor short-term danger to life and to planet Earth, CERN and the member states should not aim for their production in high energy experiments at all.** Instead, it has first to be demonstrated by observation and empirical tests, 1.: that the comparison of natural events in the atmosphere to the experiments at the LHC (as proclaimed by CERN) is legitimate in all necessary respects and 2.: that the possible mass production of micro black holes at particle colliders (as regarded possible by CERN) is clearly and 100% harmless. Several ongoing and planned experiments (Earth based and in the atmosphere) on high energetic cosmic rays are expected to throw light on these questions.

Thus, as long as the credentials of a safe operation of the big bang machine are not provided, no high energy collisions should be conducted at the LHC.

Finally, the operation and planning of high energy colliders should be **controlled and regulated** by an agency similar to the **International Atomic Energy Agency** at the UN or directly established at the IAEA as soon as possible.

Conclusion

The creation of micro-black holes at the LHC, as indicated above, threatens to arise when the proton beams collide frontally at a previously unforeseen critical energy. The emergence of these potentially most dangerous objects could be observed far later, even years later, but would already be an irreversible reality.

In contrast with nuclear fission or nuclear fusion, the danger from stable black holes, negative strangelets, magnetic monopoles or energy of space transition that would have been created will not terminate when the collider is shut down. Nuclear reactors threaten radioactive pollution, but objects that might be created at CERN threaten the entire Earth. For these and many other reasons, the LHC could be potentially far more dangerous than any nuclear reactor facility ever built.

So far no legal restrictions seem to exist for these experiments, for example restrictions concerning the appropriate methods of risk assessment, the maximum collision energy, the possibility of step by step start up, the monitoring of the experiments, etc. This is a very dangerous legal loophole that has now to occupy the International Atomic Energy Agency (IAEA) of the United Nations or a comparable agency.

The purpose of the CERN experiments is disproportionate to the missing proof of security. CERN's 'security' arguments are primarily an unproven 'hypothesis guarantee' and are not yet sufficiently founded empirically.

As a consequence of the existence of the apocalyptic hazard potential of the LHC in combination with only insecure arguments to banish the danger (with not more than unproven ideas like the disputed rapid decay interpretation of 'Hawking radiation' or considerations involving extreme astronomical bodies like white dwarfs and neutron stars), the great danger of destruction of lives and of the environment, even of the whole world, possibly initiated by the experiments done at CERN clearly cannot be excluded at present.

According to the above mentioned Oxford study, to the expertise of Mark Leggett, to several physical and risk assessment experts and to an objective view on the current scientific debate, the safety of the LHC is an open scientific question and subject of current revisions, mainly deeply relativising or dismissing previous safety arguments. The failure to properly address risk arguments through failures of understanding or through neglect is shown by CERN's policy of not acknowledging non zero risk in official statements.

Therefore, a direct danger to life and environment would occur as soon as the planned experiments should be conducted on unprecedented energy levels.

We build upon the stated opinion of black hole specialist physicist Tony Rothman [40]: *"It is perhaps time that some permanent and impartial mechanism be established to deal with scientific safety issues. The LHC is far from the first scientific project to raise public alarm."*

"For its part, however, the physics community hasn't helped. In general its attitude has been typical: an arrogant dismissal of public concern. Few physicists have bothered to read Rössler's paper and fewer have countered his assertions in public. They can't be bothered and the reason they can't be bothered can be found in one of the three knee-jerk responses a physicist makes to any claim: 'It's wrong', 'It's trivial' or 'I did it first'."

As - with great historic significance - pointed out by the US Judge Helen Gillmor (see above), the issue of endangering the safety of the whole planet Earth clearly cannot be managed by physicists alone. *Judge Gillmor: "This extremely complex debate is of concern to more than just the physicists."* External and multidisciplinary risk evaluations and global standards and arms-length supervisions of such experiments are urgently needed.

The dangers that the nuclear experiments in the LHC entail are manifold and imperil the authors' lives, their properties and the integrity of the environment. All of these aspects are protected under the International Covenant on Civil and Political Rights. The usage of this machine therefore violates the authors' rights assured by the International Covenant on Civil and Political Rights.

It is pointed out again that the right to life, which is guaranteed in article 6 of the International Covenant on Civil and Political Rights, is violated by being seriously endangered, which is here the case, and that also the right to integrity of surrounding which is implicitly guaranteed in article 17 of the International Covenant on Civil and Political Rights, can also be violated by being seriously endangered, which is here the case, too.

As the respective states are, under human rights aspects, not allowed to set aside or diminish their fundamental rights obligations under the International Covenant on Civil and Political Rights by granting CERN immunity (which excludes any efficient domestic remedy of law), the states' human rights responsibilities – as established in the International Covenant on Civil and Political Rights – persist.

Therefore it is

demanded

1. not to operate the LHC (especially not at unprecedented energies) unless an external, independent and multidisciplinary risk evaluation that continues to properly engage with critics along with LHC advocates assures that there is no danger to life and environment in the high energy experiments;

2. to initiate international regulation and standardised external and multidisciplinary risk evaluation of this and similar (sub-)atomic high energy experiments on the level of the International Atomic Energy Agency of the UN or a comparable new agency (such an evaluation then would continue to properly engage with critics along with LHC advocates to ensure that no counterarguments are neglected nor misunderstandings can occur);

3. not to operate the LHC (especially not at unprecedented energies) until the time that recent and partly very surprising discoveries about highly energetic collisions of cosmic rays in nature are properly analysed and direct empirical observations in space of such natural collisions, like it is planned for the first time at the AMS 2 experiment in 2010 at the International Space Station (ISS), are well established. (AMS 2 will observe cosmic rays directly, without the inevitable collisions in the atmosphere, so the argument of a similarity or comparability between collisions at the LHC and cosmic ray collisions could be further clarified.) During this time, for example discoveries from the Fermi, GLAST, WMAP and more recent Planck space probes for any Hawking radiation from primordial micro black holes can be made, to prove hypothetical LHC safety arguments connected to only poorly understood astronomical bodies. Also Earth based empirical observatories like the AUGER serve important data to many open questions. As long as the credentials of a safe operation of the ‘big bang machine’ are not provided, no high energy collisions should be conducted at the LHC.

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List of enclosures

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Representing many others – including technicians, physicists, mathematicians, risk-researchers, philosophers and lawyers - that concretely contributed to or fully support this critical revision and communication.