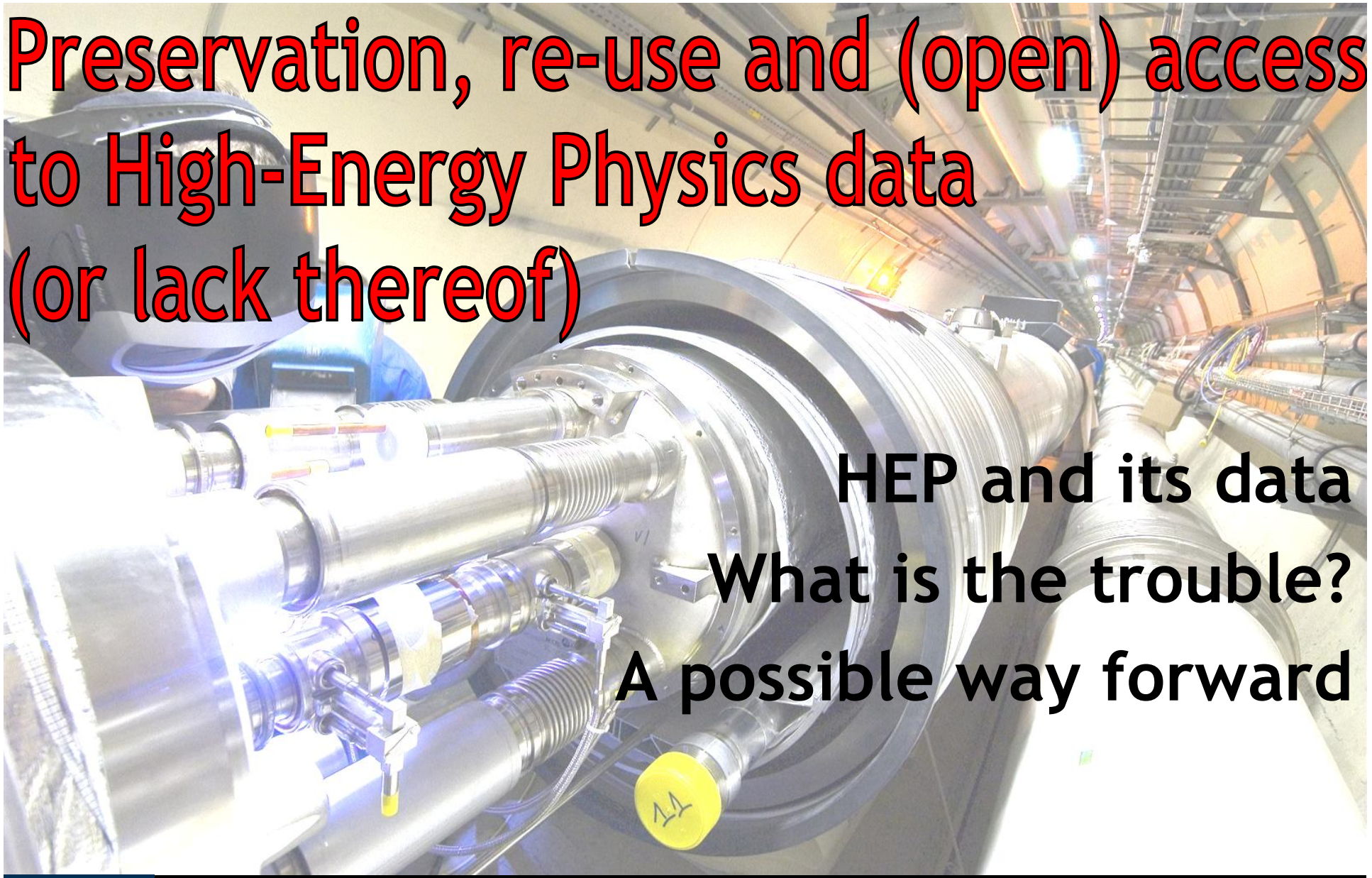
Preservation, re-use and (open) access to High-Energy Physics data (or lack thereof)



HEP and its data

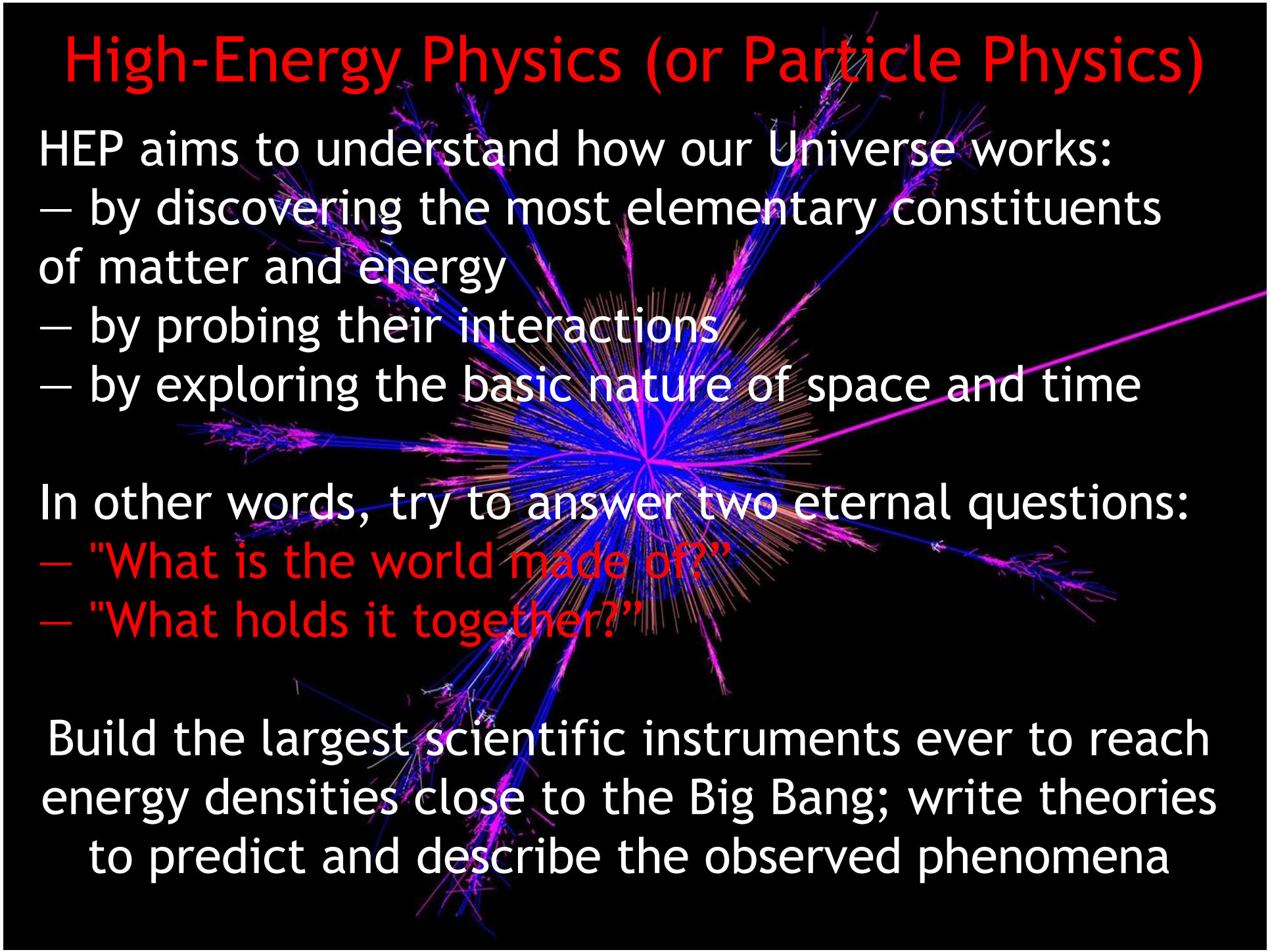
What is the trouble?

A possible way forward

Salvatore Mele
CERN

Costs, Benefits and Motivations for Digital Preservation
Nice - November 28th 2008

High-Energy Physics (or Particle Physics)



HEP aims to understand how our Universe works:
— by discovering the most elementary constituents of matter and energy
— by probing their interactions
— by exploring the basic nature of space and time

In other words, try to answer two eternal questions:
— "What is the world made of?"
— "What holds it together?"

Build the largest scientific instruments ever to reach energy densities close to the Big Bang; write theories to predict and describe the observed phenomena

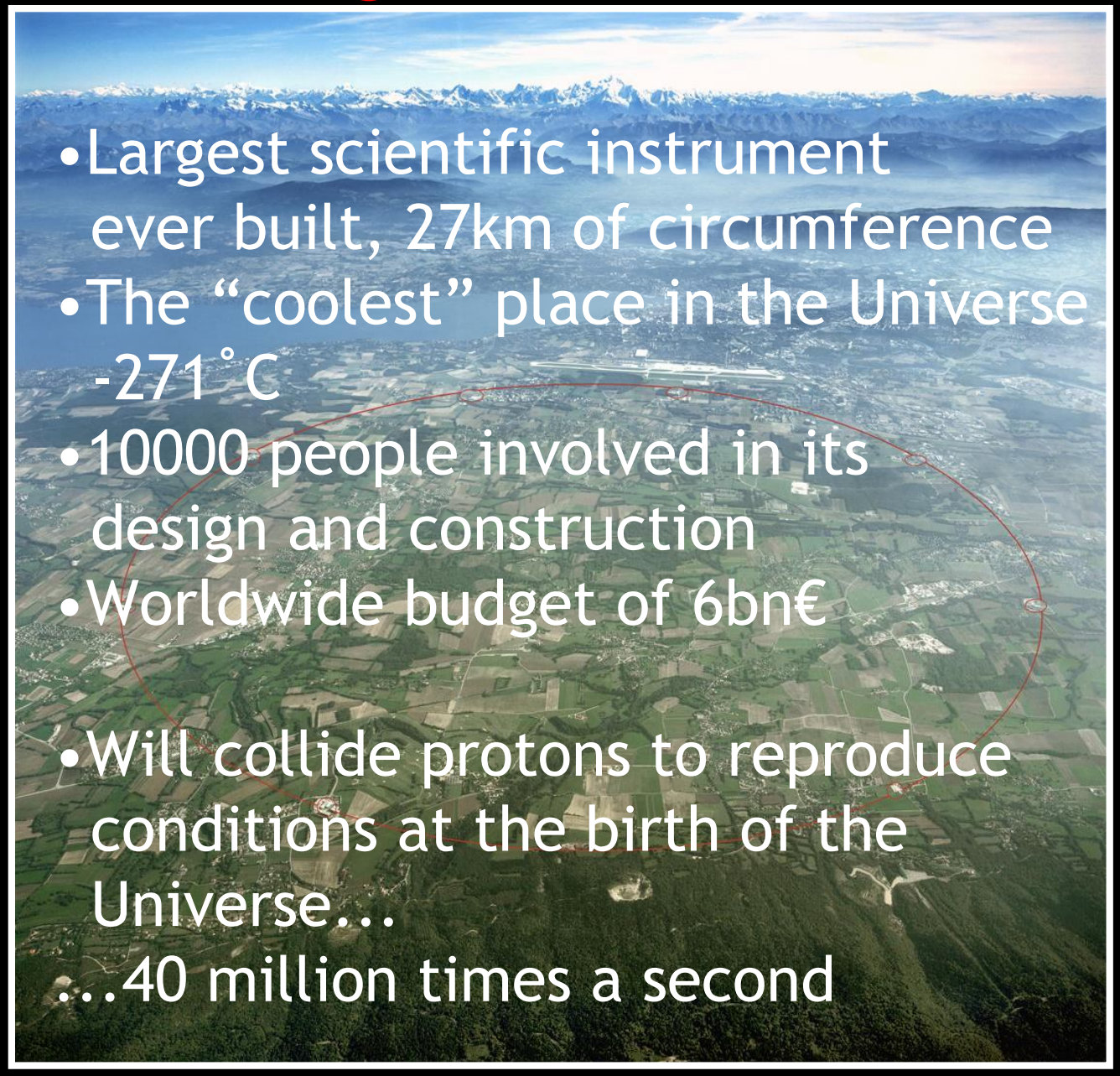
CERN: European Organization for Nuclear Research (since 1954)

- The world leading HEP laboratory, Geneva (CH)
- 2500 staff (mostly engineers, from Europe)
- 9000 users (mostly physicists, from 580 institutes in 85 countries)
- 3 Nobel prizes (Accelerators, Detectors, Discoveries)
- Invented the web    
- Just switched on the 27-km (6bn€) LHC accelerator
- Runs a 1-million objects Digital Library

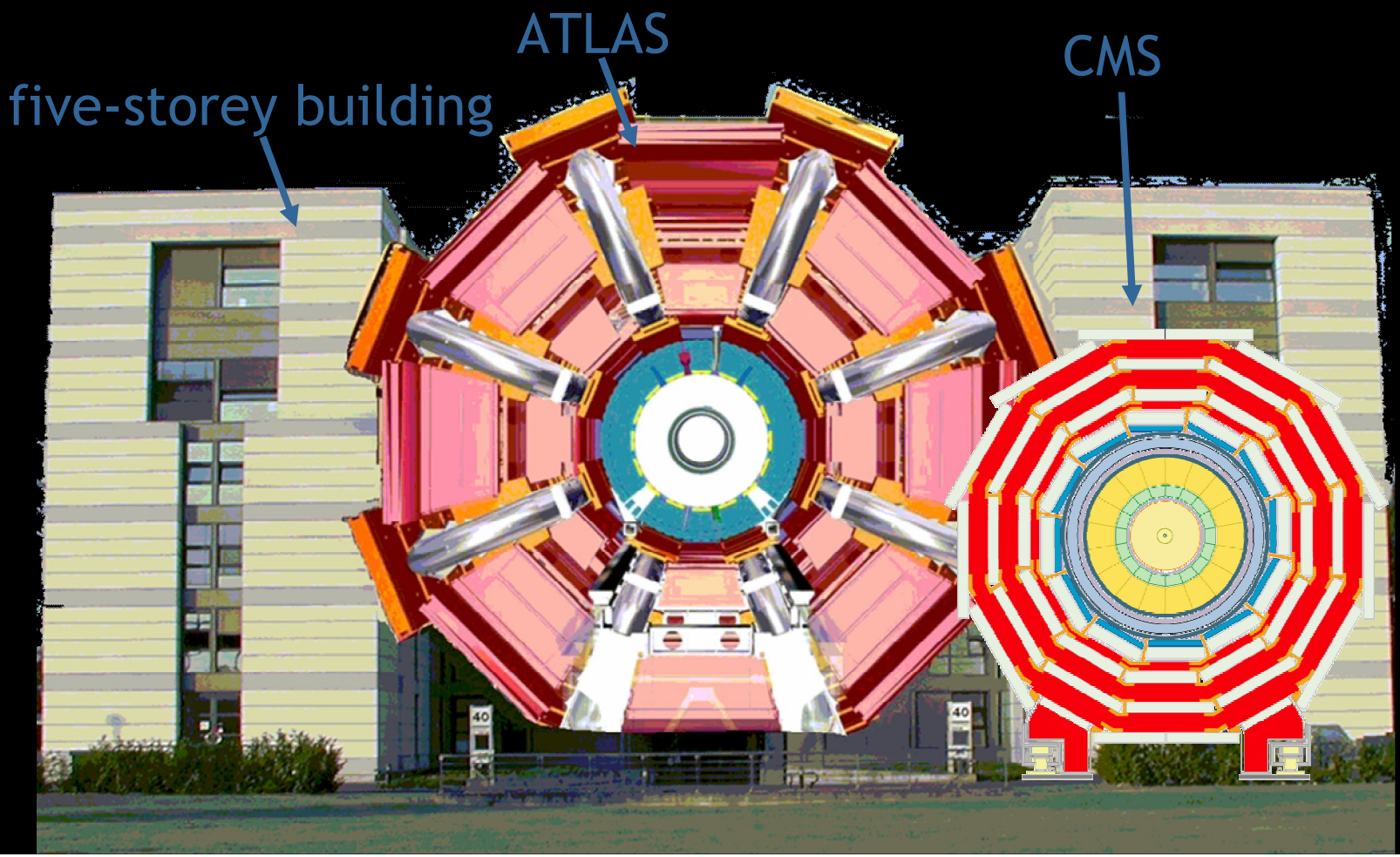
CERN Convention (1953): *ante-litteram* Open Access mandate

"… the results of its experimental and theoretical work shall be published or otherwise made generally available"

The Large Hadron Collider



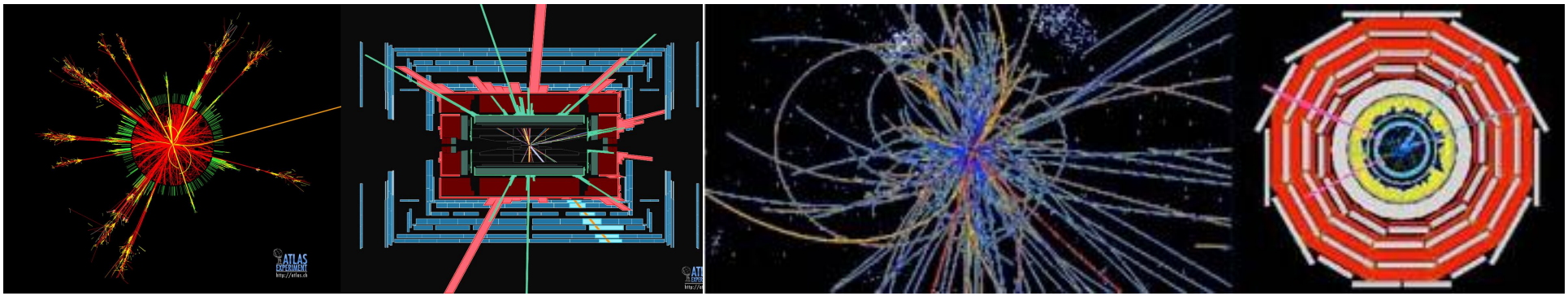
The LHC experiments:
about 100 million "sensors" each
[think your 6MP digital camera...
...taking 40 million pictures a second]



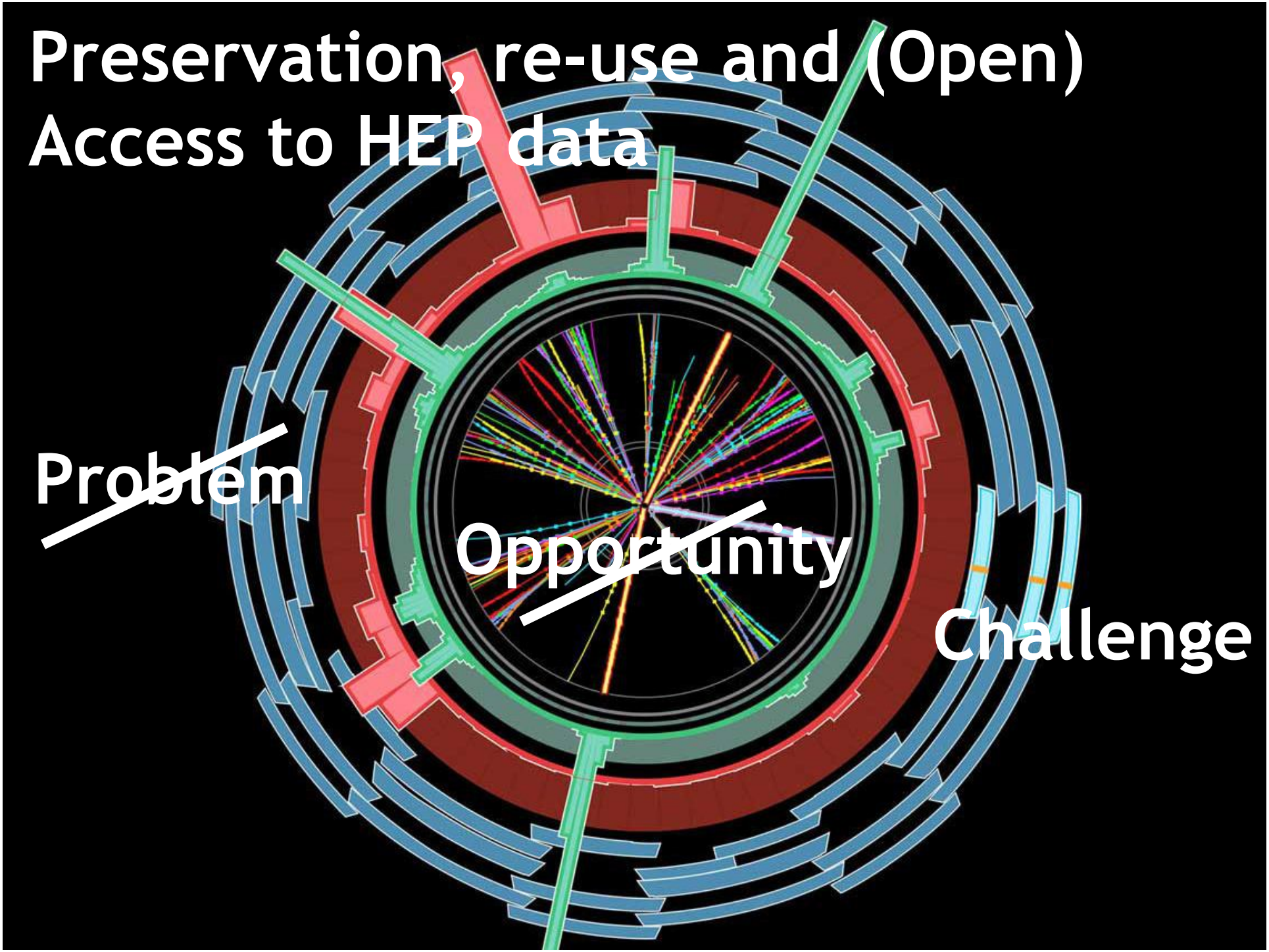
The LHC data

- 40 million events (pictures) per second
- Select (on the fly) the ~200 interesting events per second to write on tape
- "Reconstruct" data and convert for analysis: "physics data" [inventing the grid...]

(x4 experiments x15 years)	Per event	Per year
Raw data	1.6 MB	3200 TB
Reconstructed data	1.0 MB	2000 TB
Physics data	0.1 MB	200 TB



Preservation, re-use and (Open) Access to HEP data



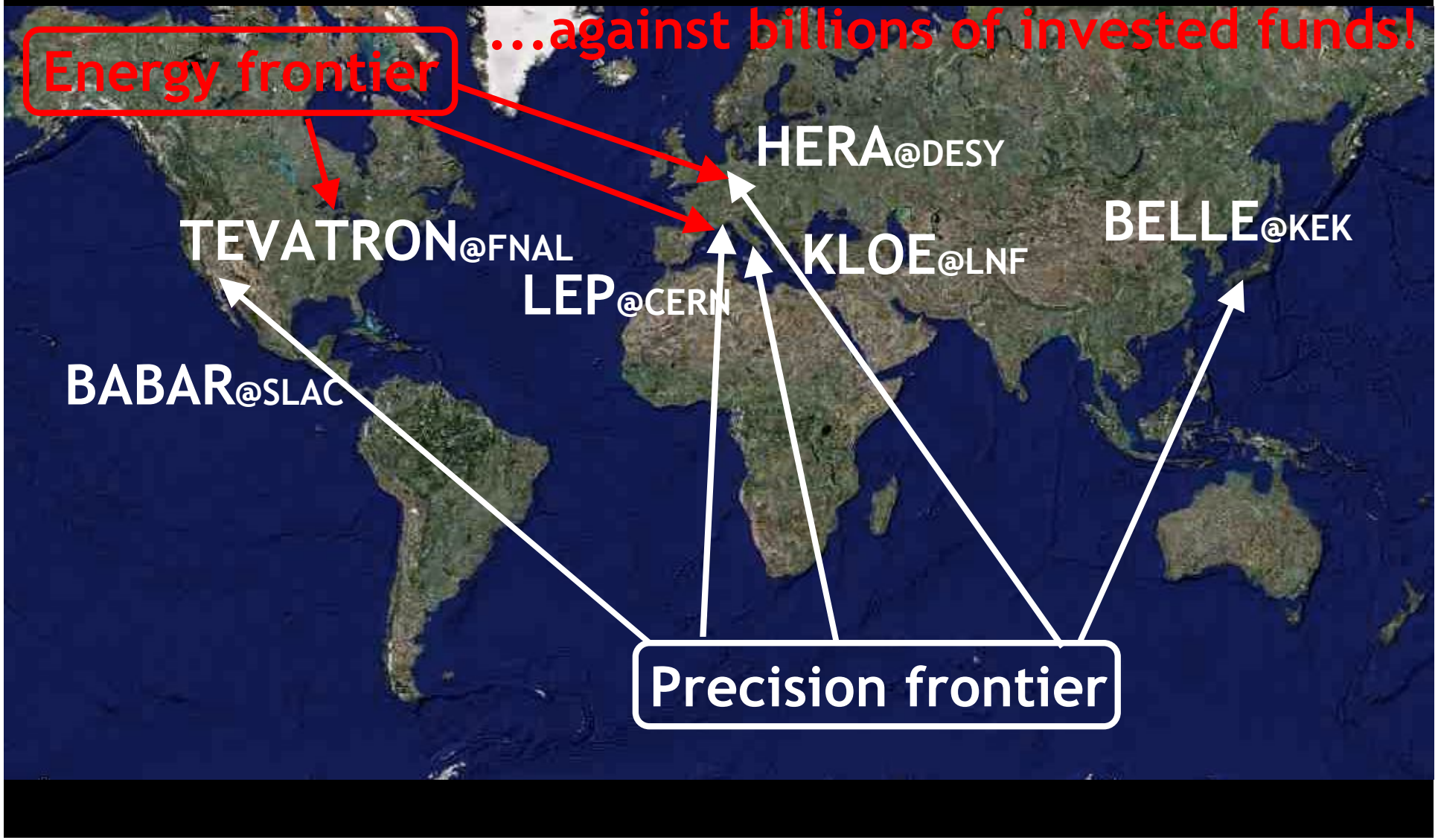
~~Problem~~

~~Opportunity~~

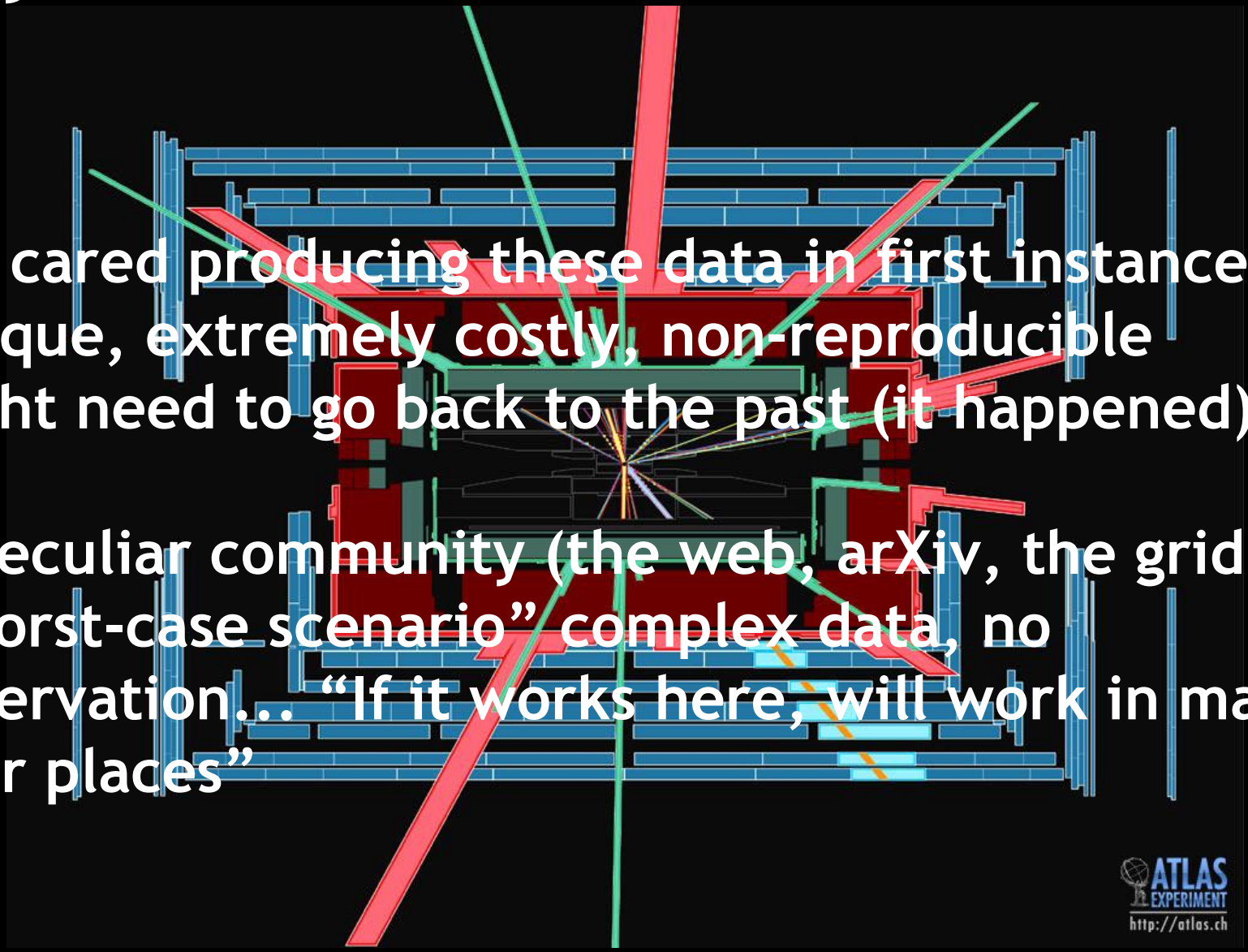
Challenge

Some other HEP facilities (recently stopped or about to stop)

No real long-term archival strategy...



Why shall we care?



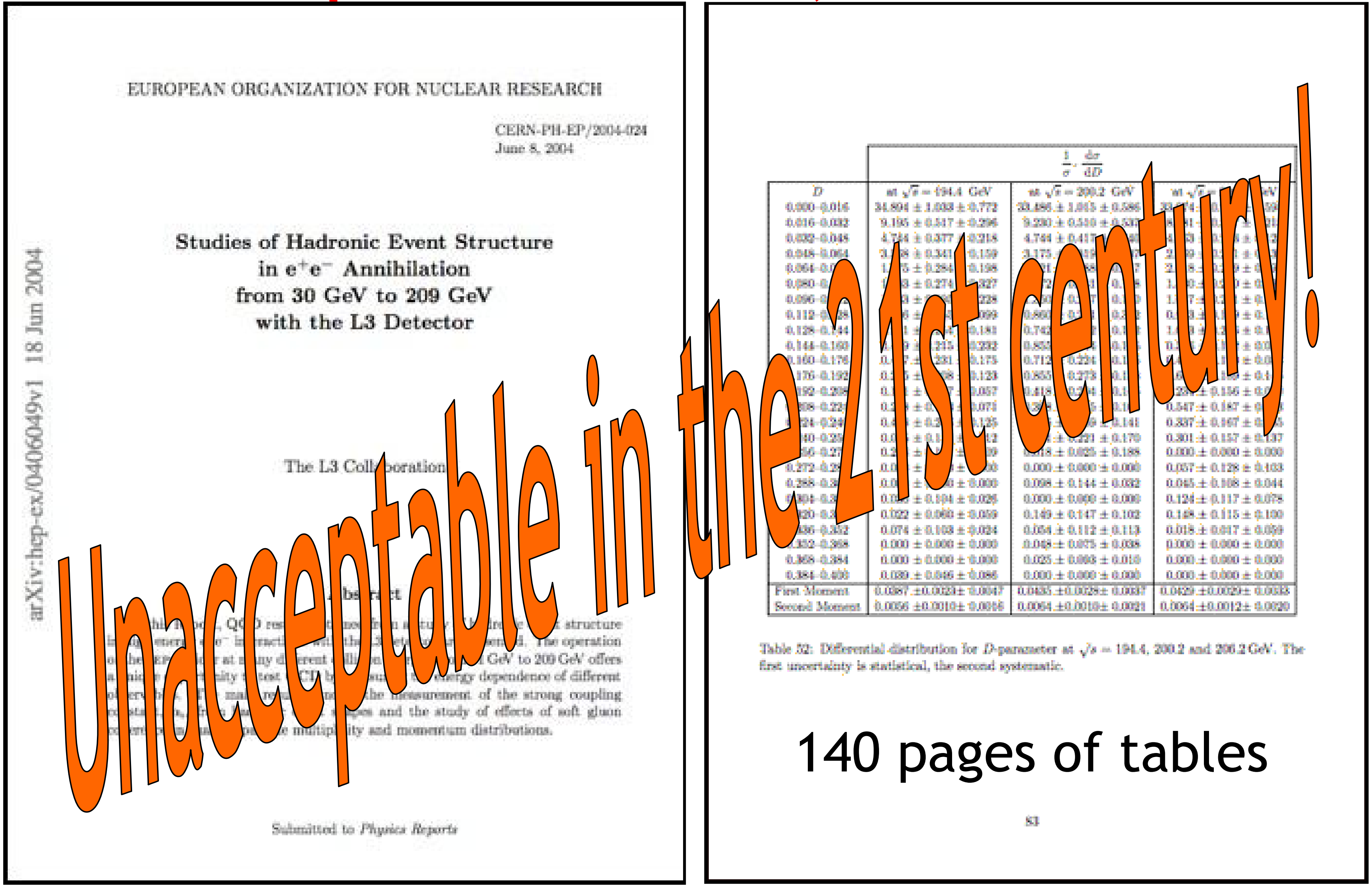
- We cared producing these data in first instance
- Unique, extremely costly, non-reproducible
- Might need to go back to the past (it happened)

- A peculiar community (the web, arXiv, the grid...)
- "Worst-case scenario" complex data, no preservation... "If it works here, will work in many other places"

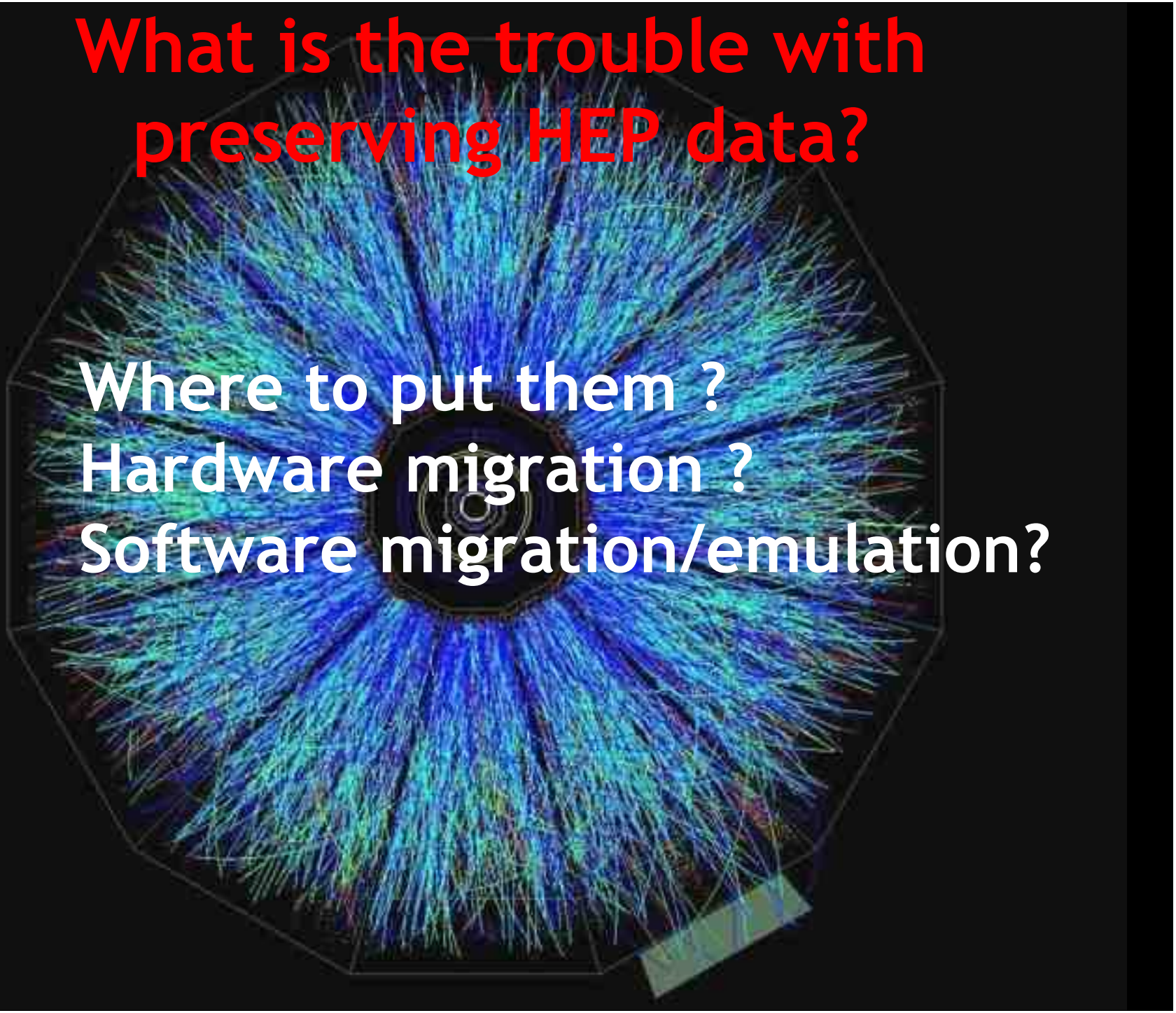
Preservation, re-use and (open) access continua (who and when)

- The same researchers who took the data, after the closure of the facility (~1 year, ~10 years)
- Researchers working at similar experiments at the same time (~1 day, week, month, year)
- Researchers of future experiments (~20 years)
- Theoretical physicists who may want to re-interpret the data (~1 month, ~1 year, ~10 years)
- Theoretical physicists who may want to test future ideas (~1 year, ~10 years, ~20 years)

Data preservation, circa 2004



What is the trouble with preserving HEP data?



Where to put them ?
Hardware migration ?
Software migration/emulation?

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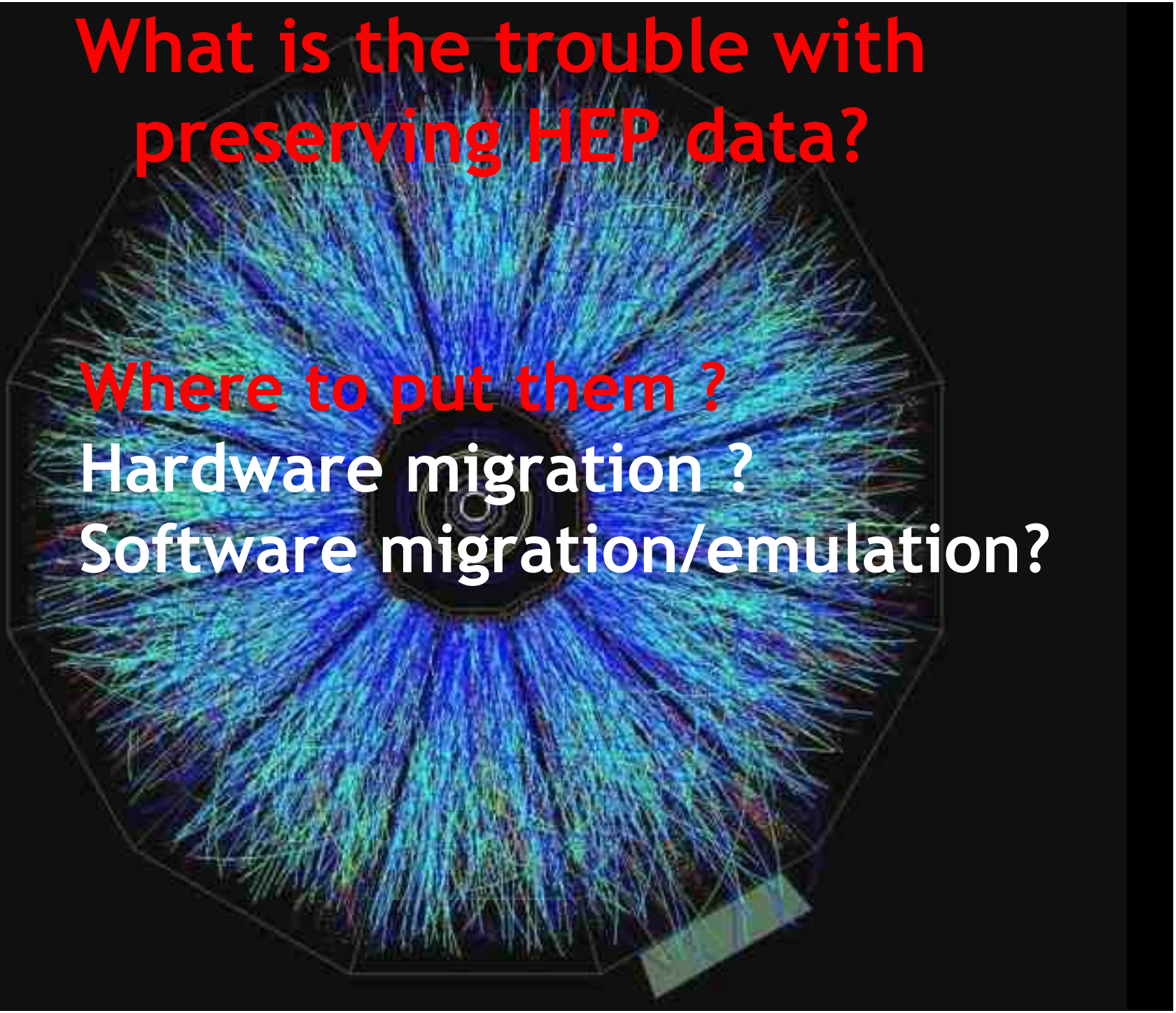

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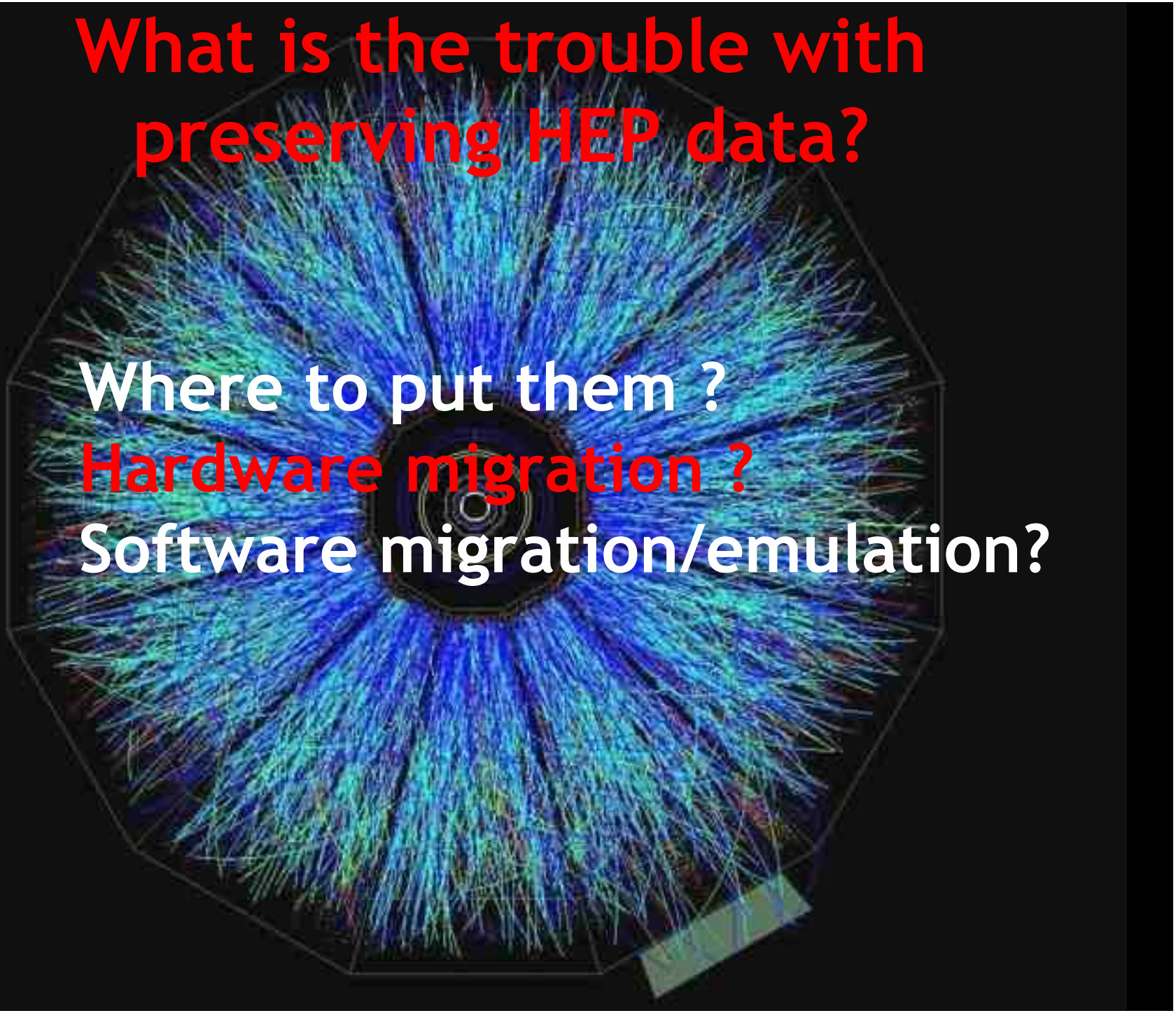
HEP, Open Access & Repositories

- HEP is decades ahead in thinking Open Access:
  - Mountains of paper preprints shipped around the world for 40 years (at author/institute expenses!)
  - Launched arXiv (1991), archetypal Open Archive
  - >90% HEP production self-archived in repositories
  - 100% HEP production indexed in SPIRES(community run database, first WWW server on US soil)
- OA is second nature: posting on arXiv before submitting to a journal is common practice
  - No mandate, no debate. Author-driven.
- HEP scholars have the tradition of arXiving their output (helas, articles) somewhere

Data repositories would be a natural concept

What is the trouble with preserving HEP data?



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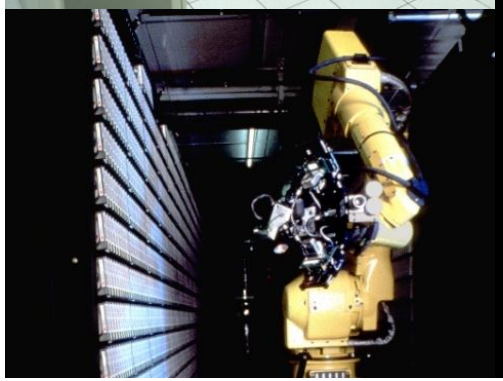

Life-cycle of previous-generation CERN experiment L3 at LEP

1984 Begin of construction

1989 Start of data taking

2000 End of data taking

2002 End of *in-silico* experiments

2005 End of (most) data analysis

Storage and migration of data at the CERN computing centre

1993	~150'000 9track → 3480	0.2GB
1997	~250'000 3480 → Redwood	20GB
2001	~25'000 Redwood → 9940	60GB
2004	~5'000 9940A → 9940B	200GB
2007	~22'000 9940B → T1000A	500GB

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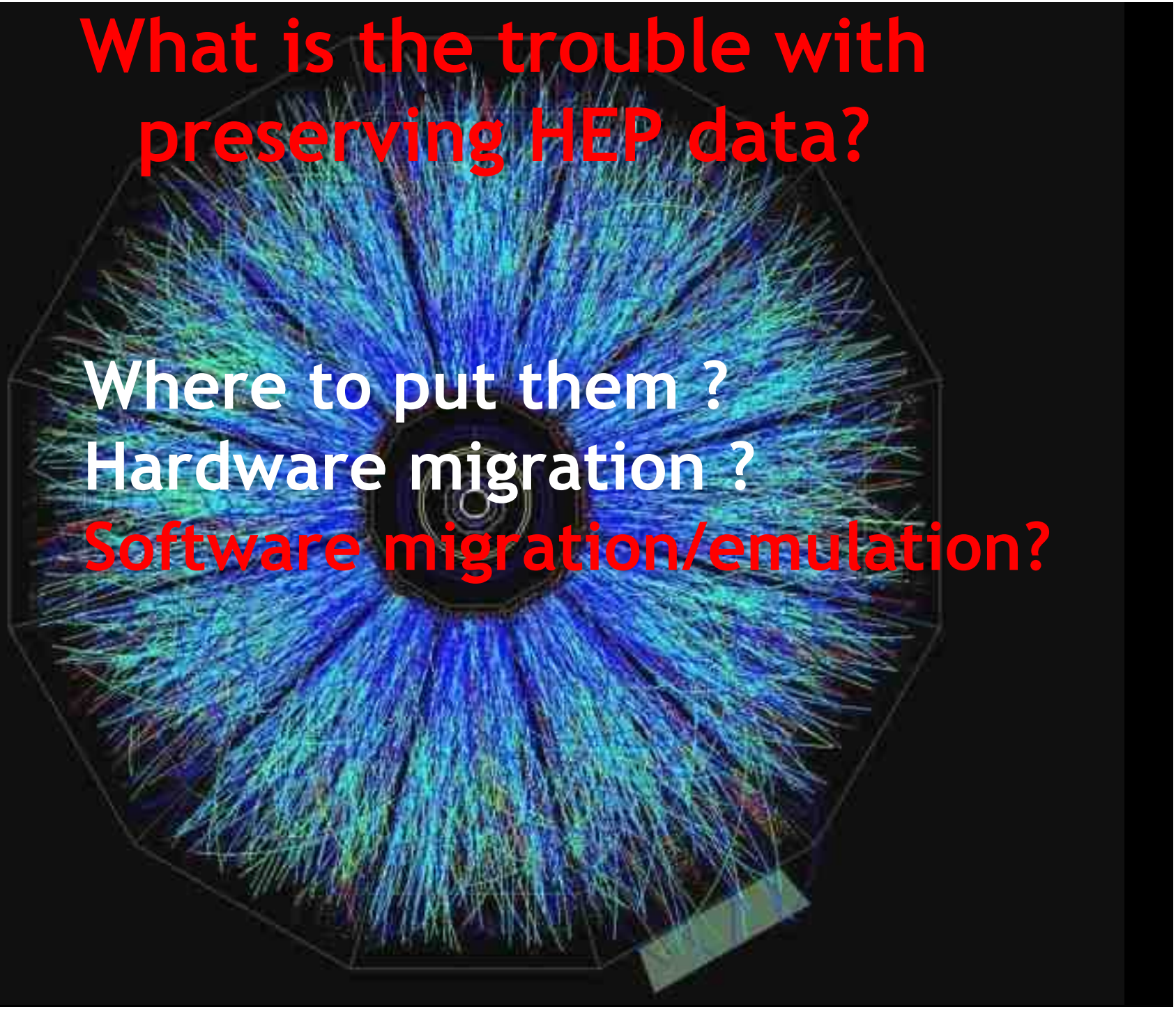

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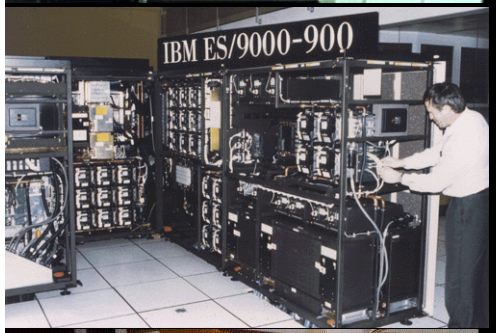

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Computing environment of the L3 experiment at LEP

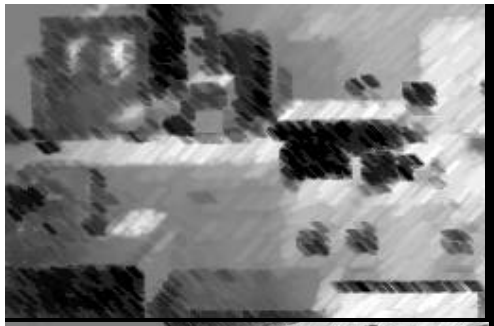
1989-2001 VAX for data taking

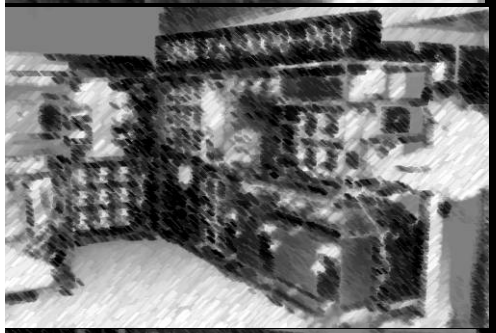
1986-1994 IBM for data analysis

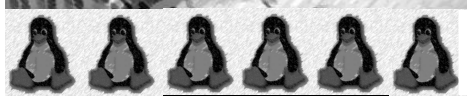
1992-1998 Apollo (HP) workstations

1996-2001 SGI mainframe

1997-2007 Linux boxes







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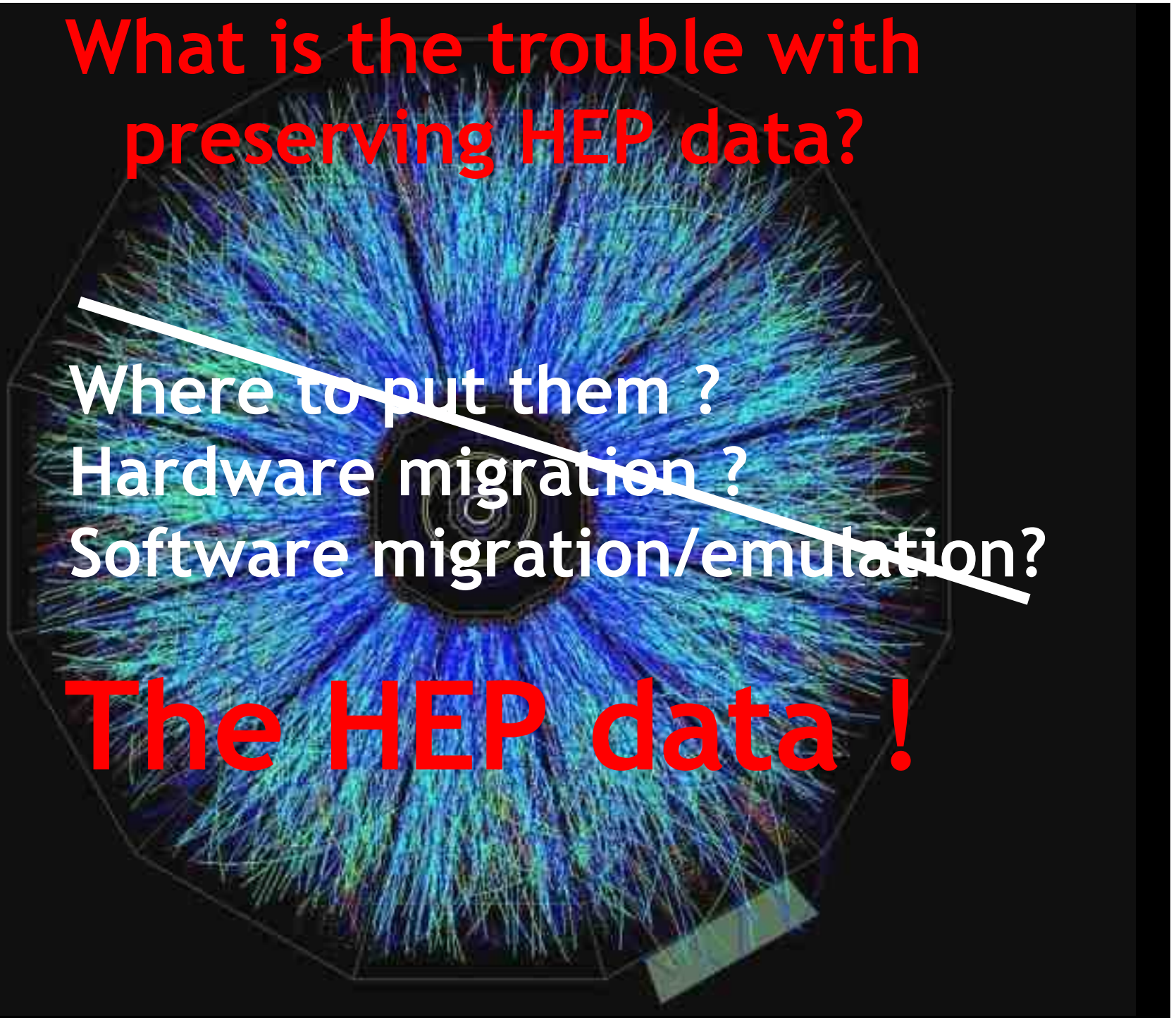
...as long as the experiment runs!

All is good...

(Après moi le déluge)

What is the trouble with preserving HEP data?

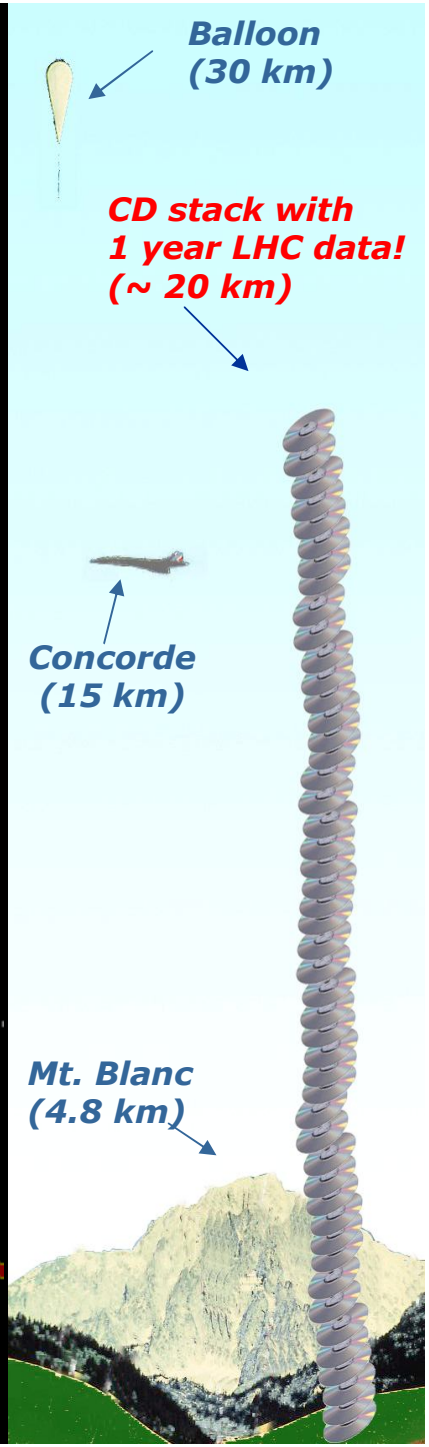


~~Where to put them ?~~
~~Hardware migration ?~~
~~Software migration/emulation?~~

The HEP data !

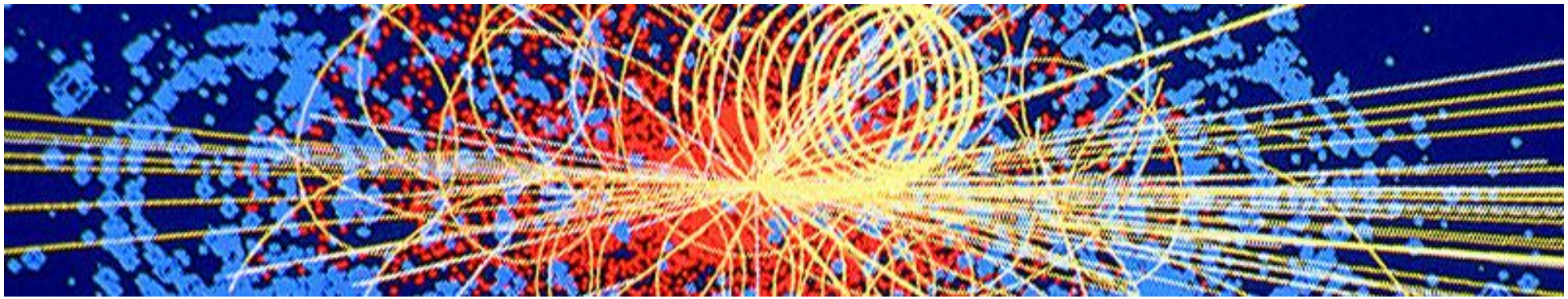
Preserving HEP data?

- The HEP data model is highly complex. Data are traditionally not re-used as in Astronomy or Climate science.
- Raw data → calibrated data → skimmed data → high-level objects → physics analyses → results.
- All of the above duplicated for *in-silico* experiments, necessary to interpret the highly-complex data.
- Final results depend on the grey literature on calibration constants, human knowledge and algorithms needed for each pass...oral tradition!
- Years of training for a successful analysis



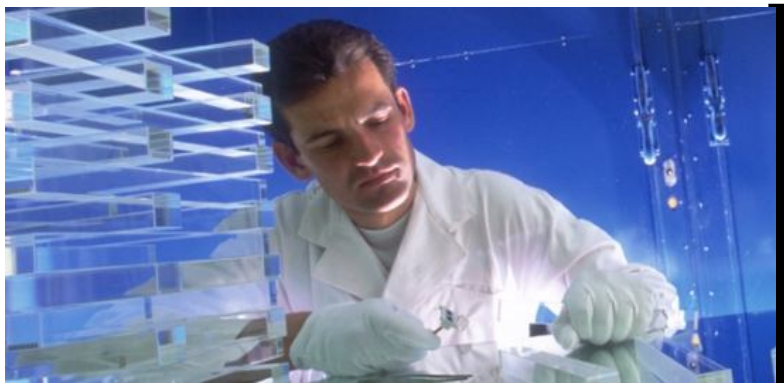
Need a“parallel way” to publish/preserve/re-use/OpenAccess

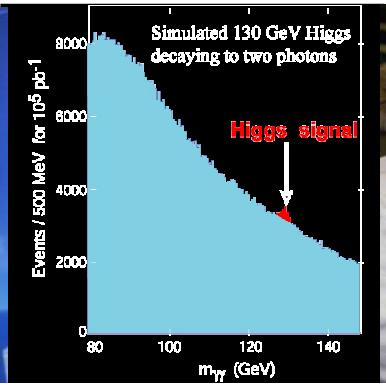
- In addition to experiment data models, elaborate a parallel format for (re-)usable high-level objects
  - In times of need (to combine data of “competing” experiments) this approach has worked
  - Embed the “oral” and “additional” knowledge
- A format understandable and thus re-usable by practitioners in other experiments and theorists
- Start from tables and work back towards primary data
- How much additional work? 1%, 5%, 10%?



Issues with the “parallel” way

- A small fraction of a big number gives a large number
- Activity in competition with research time
- 1000s person-years for parallel data models need enormous (impossible?) academic incentives for realization ...or additional (external) funds
- Need insider knowledge to produce parallel data
- Address issues of (open) access, credit, accountability, “careless measurements”, “careless discoveries”, reproducibility of results, depth of peer-reviewing
- A monolithic way of doing business needs rethinking



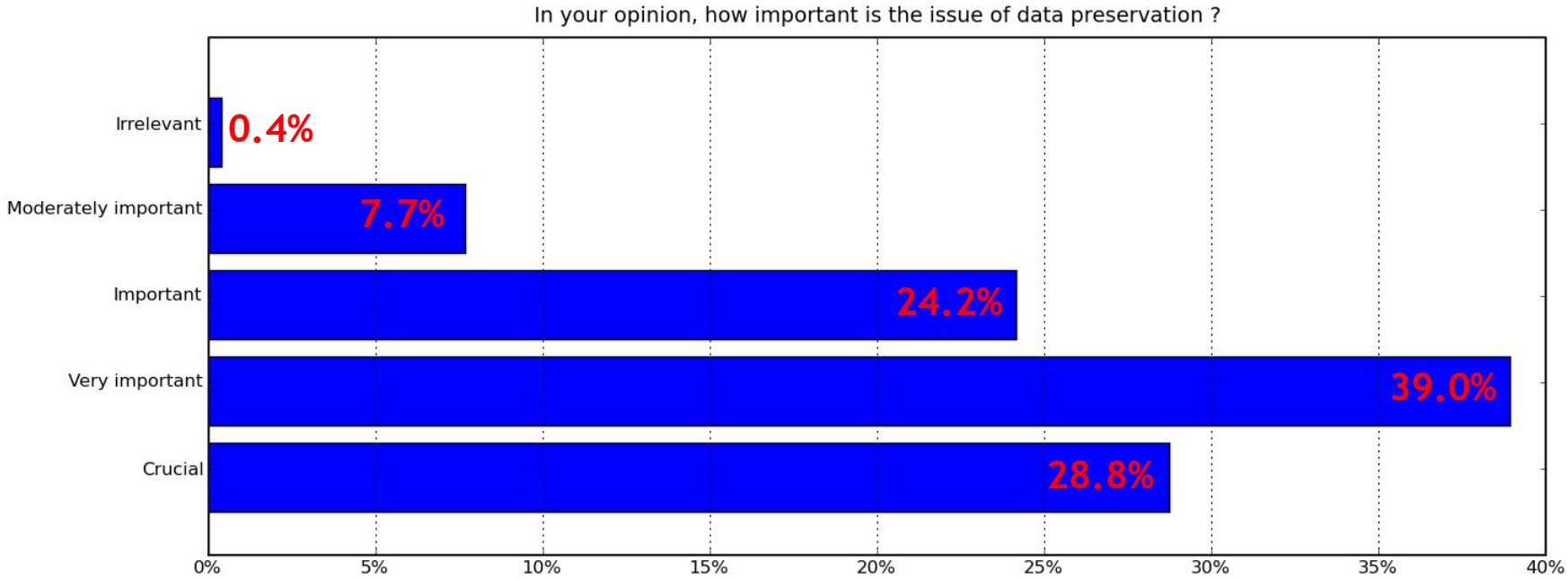


Preservation, re-use and (Open) Access to HEP data… first steps!

- Outgrowing an institutionalized state of denial
- A difficult and costly way ahead
- An issue which starts surfacing on the agenda
  - Part of an integrated digital-library vision
  - CERN joined the Alliance for Permanent Access
  - CERN part of the FP7 PARSE.Insight project
- PARSE.Insight case study on HEP preservation:
  - HEP tradition: community-inspired and community-built (e-)infrastructures for research
  - Understand the desires and concerns of the community
  - Chart a way out for data preservation in the "worst-case scenario" of HEP, benefiting other communities
  - Debates and workshops planned in next months

HEP Community Survey - First findings

500+ scientists answering a survey in its 1st week. 50% from Europe, 25% from the US. 34% left their e-mail address to hear more. 17% wants to be interviewed to say more!



- **92%**: data preservation is important, very important or crucial
- **40%**: thinks important HEP data have been lost
- **45%**: access to old data would have improved my scientific results
- **74%**: a trans-national infrastructure for long-term preservation of all kinds of scientific data should be built

Two dozen more questions about do's and dont's in HEP preservation

Conclusions

- HEP spearheaded (Open) Access to Scientific Information: 50 years of preprints, 16 of repositories

  ... but data preservation is not yet on the radar
- Heterogeneous continua to preserve data for
- No insurmountable technical problems
- The issue is the data model itself
  - (Primary) data intelligible only to the producers
  - A monolithic culture need a paradigm shift
  - Preservation implies massive person-power costs
- **Need cultural consensus and financial support**