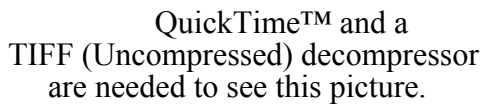
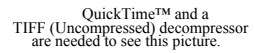
Peer review in the era of LHC experiments

Experimental particle physics as a Big Science paradigm





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Charting experimental particle physics

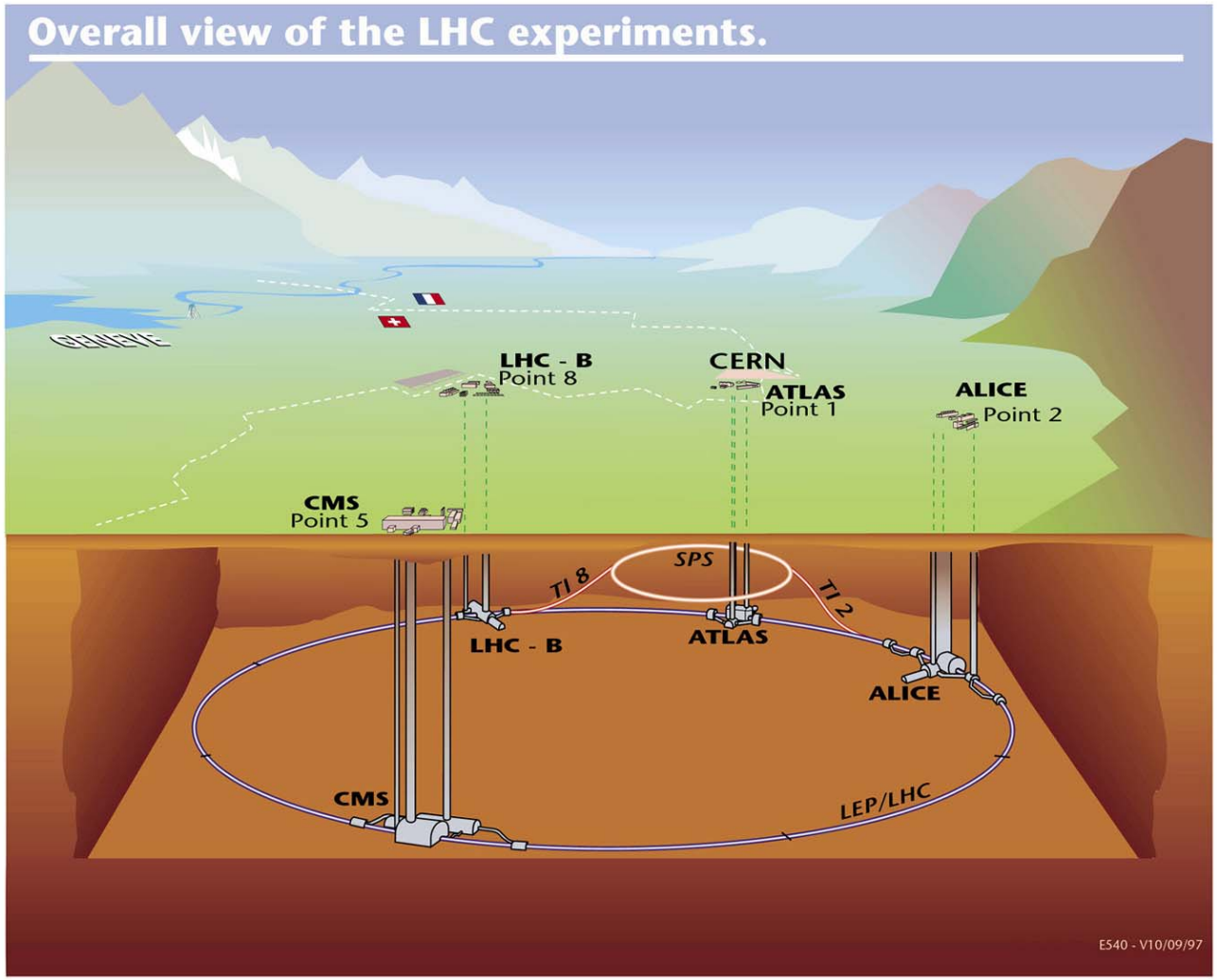
- Strongly centralised in a few big accelerator labs (CERN, Fermilab, DESY, SLAC, KEK …)
- Increasingly concentrating on few very big projects:
  - CERN: LHC (4 experiments, under construction)
  - Fermilab: Tevatron (2 experiments)
  - DESY: HERA (4 experiments) (until end-2006?)
  - SLAC: PEP-II (BaBar)
  - KEK: KEK-B (BELLE)
- N.B. Astroparticle physics not discussed here

Charting…. (continued)

- The community:
  - ≈ 10 000 scientists worldwide
  - ≈ 50% Europe
  - ≈ 50% rest of the world (US, Russia, Japan)
- ≈ 80-90% work on the ‘big’ projects
- Corollary: CERN has a base of 6500 registered scientific users

The LHC project

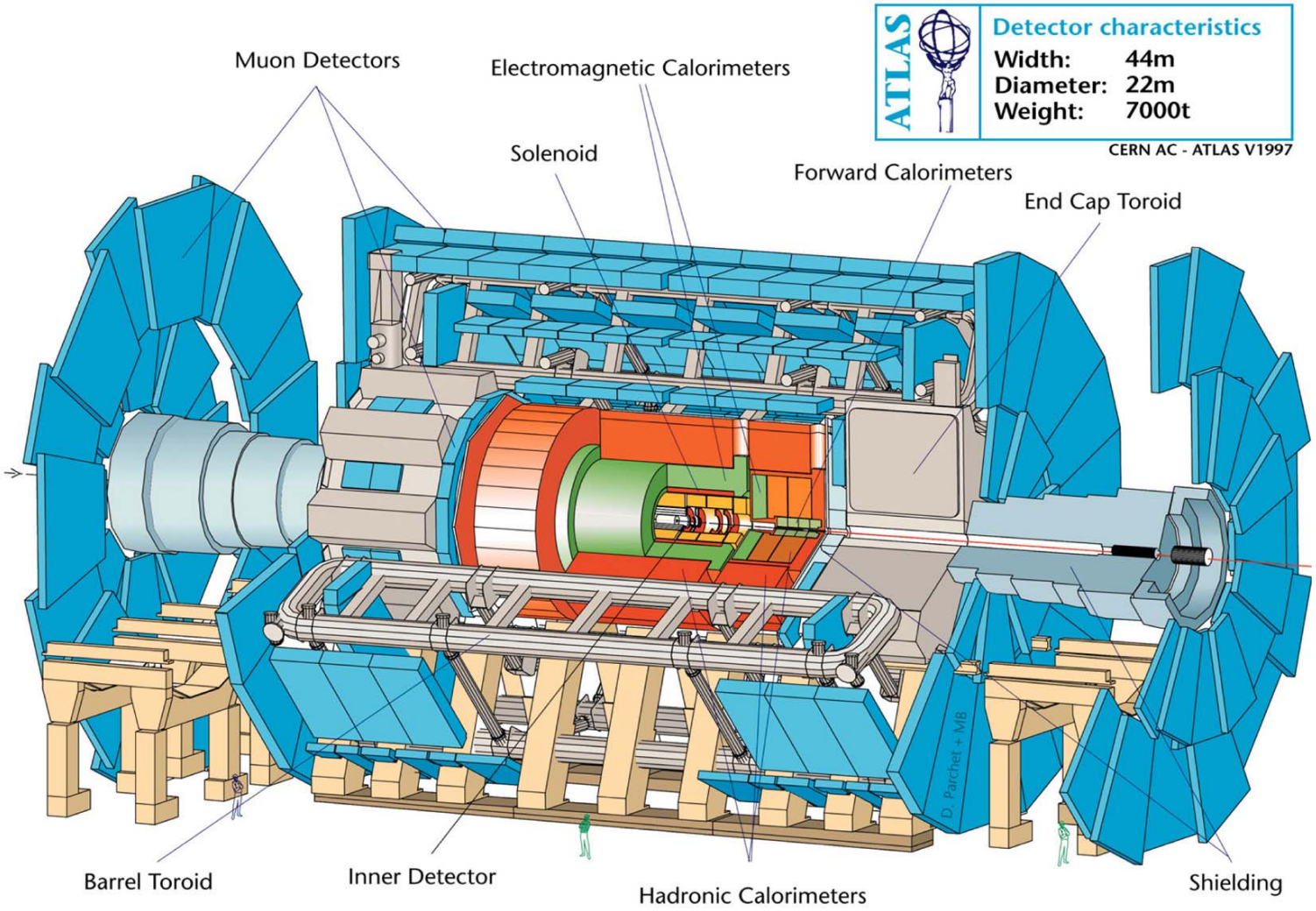
LHC experiments in ex-LEP tunnel



The ATLAS example

- Multi-purpose detector for the LHC
- 2000 physicists, 150 institutes, 34 countries
- 500 MCHF investment
- Preparation since ≈ 1990, operation starts 2007
- Estimated lifetime: 10 – 20 years
- Unprecedented technical complexity of
  - Hardware
  - Software
  - Data analysis

The ATLAS detector



Q: Can traditional peer review cope?

- Since era of LEP/HERA/Tevatron detectors (≈ 15 years ago), experiments have grown too complex to be mastered by the single scientist
- The LHC example: ATLAS/CMS will each generate a raw data flow ≈ today's world throughput in telecommunications:
  - Imagine the real-time data processing challenge
  - Difficult not to make mistakes….
- Technical correctness of design, operation and analysis difficult (impossible?) to assess by classical peer review

A: Internal review by collaboration

- Strictly regulated multi-step process:
  1. Papers written by (small) 'Editorial Board'
  2. Review by 'Publication Committee' (PC) (non-anonymous)
  3. Draft made 'public' inside collaboration for comments
- Iterate steps 1-3 (sometimes restrictively) until PC decrees convergence
- Based on 'open archive local to collaboration'
  - Essential for efficient and transparent management of authoring and refereeing process
- 'Formal peer review with subsequent commentary'
- Successfully implemented by LEP and other major, non-CERN collaborations

Role of traditional peer review?

- Final publication still mostly in ‘conventional’ refereed journals
- Difficult to scratch deeper than the surface
- Largely reduced to rubber-stamping exercise, but still important and useful:
  - Formal/editorial aspects
  - Phrasing (conclusions!)
  - Interpretation & integration of final results in wider scientific context
- Minor revisions (at most)
- Strong self-selection of journals by authors
- ~0% rejection rate

Benefits of two-stage refereeing

- No wrong results known to data
  - but don't confuse with publication of 'effects' or 'particles' from statistical fluctuations
- Strong protection against scientific fraud!
  - Not due to formal review of publications only – large dispersed collaborations with flat hierarchies exercise informal but efficient self-control at many levels and all stages of the experiment

‘Organized redundancy’

- Ultimately, quality assurance in particle physics is enforced by ‘organized redundancy’: build 2, 3, … detectors to pursue same/similar scientific goals with
  - Different/complementary technologies
  - Different people
- First large-scale policy implementation with UA1/UA2 experiments at CERN (≈ 1975!)
- Climax in LEP programme (1989-2000): 4 detectors
- So far… redundant???
- Don’t confuse with (friendly) scientific competition

Any useful conclusions?

- Experimental particle physicists have successfully implemented and operated for 15 years now a two-stage scheme of peer review that works
- It even works well! (judging by the results)
- Can it be mapped onto other disciplines?
  - Critical mass (> 100 scientists?)
  - Common project/facility
  - Flat hierarchies – scientific independence of sub-groups and individuals