Scenario for commissioning of the powering system

Kick off meeting to get "hardware commissioning" preparation fully started

- Objectives for the powering tests
- Challenges: what will make life more difficult
- Experience: what will make life easier

- Questions and Programme of the day
- Summary and Outlook

Website:
http://indico.cern.ch/conferenceOtherViews.py?view=standard&confId=54166

Objectives

- Physics run for about 1 year starting in autumn
  - No long winter shutdown (short stop over Christmas)
  - Energy of 5 TeV per beam
  - Energy of 4 TeV per beam for some time is acceptable

- Prepare the superconducting magnet circuits for beam operation up to an energy of 4-5 TeV by minimising the risk
- Hand over the last sector of the powering system to the next step in commissioning (machine checkout) in ~September
- Understand problems in the circuits – such as non conform resistances of splices in magnets and interconnects

Discovery channels for GPD, in summary

- Typically, with 50-100 pb^{-1} **good data** at 10-8 TeV $\Rightarrow$ many new limits set on hypothetical particles (some more stringent than Tevatron), or even discoveries possible!
- With 200-300 pb^{-1} g.d. at 10-8 TeV $\Rightarrow$ start competing with Tevatron for Higgs masses around 160 GeV
- With 1 fb^{-1} g.d. at 10 TeV $\Rightarrow$ find Higgs if around 160 GeV mass
- The higher the energy, the faster it goes...
- Note: below ~20-40 pb^{-1} g.d. at 10-8 TeV, or at any lower energy, one would probably start talking about an "engineering run"

(can still be very useful, but perhaps not in terms of immediate physics results)

A run at $s^{1/2}$ = 8-10 TeV and at least 100-50 pb^{-1} of good data would already be a FANTASTIC run with major physics impact

LHC performance

LHC performance workshop: main conclusions

Physics in late 2009 and running during winter months (2009-2010)

(Additional cost: ≅8.5 M€ with dedicated running of the injectors during winter)

2009-2010 goal: > 200 pb-1 at 5 TeV (with a stage at 4 TeV for few weeks)

Priorities:

- Repair 3-4 keeping the highest quality and the schedule (end of cool-down mid August).
- New quench detector (busbar and symmetric quench) (work package to other groups: EPC, PH,…) and UPS consolidation (EN-EL)

- Compensatory measures:
  - add DN200 ports to each dipole cryostat (1-2, 3-4, 5-6, 6-7) and convert 2 DN100 ports on each SSS to be pressure relief devices
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  - convert 2 DN100 (BPM ports) and 1 DN63 in the cold sectors (2-3, 4-5, 7-8 , 8-1)
  - anchoring of SSS with vacuum barriers to the floor
  - Standalone magnet consolidation: schedule impact must be studied with high urgency

59

Challenges for protection systems

- Decisions during and after Chamonix
- External reviews of the QPS system and External review on risks

QPS

- new system to detect faulty splices (already known before Chamonix)
- new system to detect symmetric quenches – to be operational before commissioning to high current
- consolidation of UPS systems, to be installed and commissioned, providing improved redundancy for QPS system
- still being discussed: modifications of voltage taps, qualification of splices at ambient temperature

Thermo switches to avoid overheating of HTS current leads for some circuits (limited impact on hardware commissioning)

Convert DN100 and DN63 in cold sectors to pressure relief valves on SSS in four sectors (two sectors just before the powering test period)

Operational Issues

Recommendation

- Power the accelerator only after the splice protection, symmetric quench protection and redundant UPS systems have been installed and commissioned.
- Prior to superconducting operation, either experimentally verify that all main bus copper stabilizers exhibit adequate longitudinal conductance or set appropriate operational limits
- Prior to physics operation, measure all splice resistances (bus and magnet) using developed techniques.

Planning Schedule

Comments

- The scope of the Enhanced QPS system required for operation in fall was considerably increased at the Chamonix Workshop without a change in schedule.

- We are encouraged that overall Enhanced QPS project management is being developed.

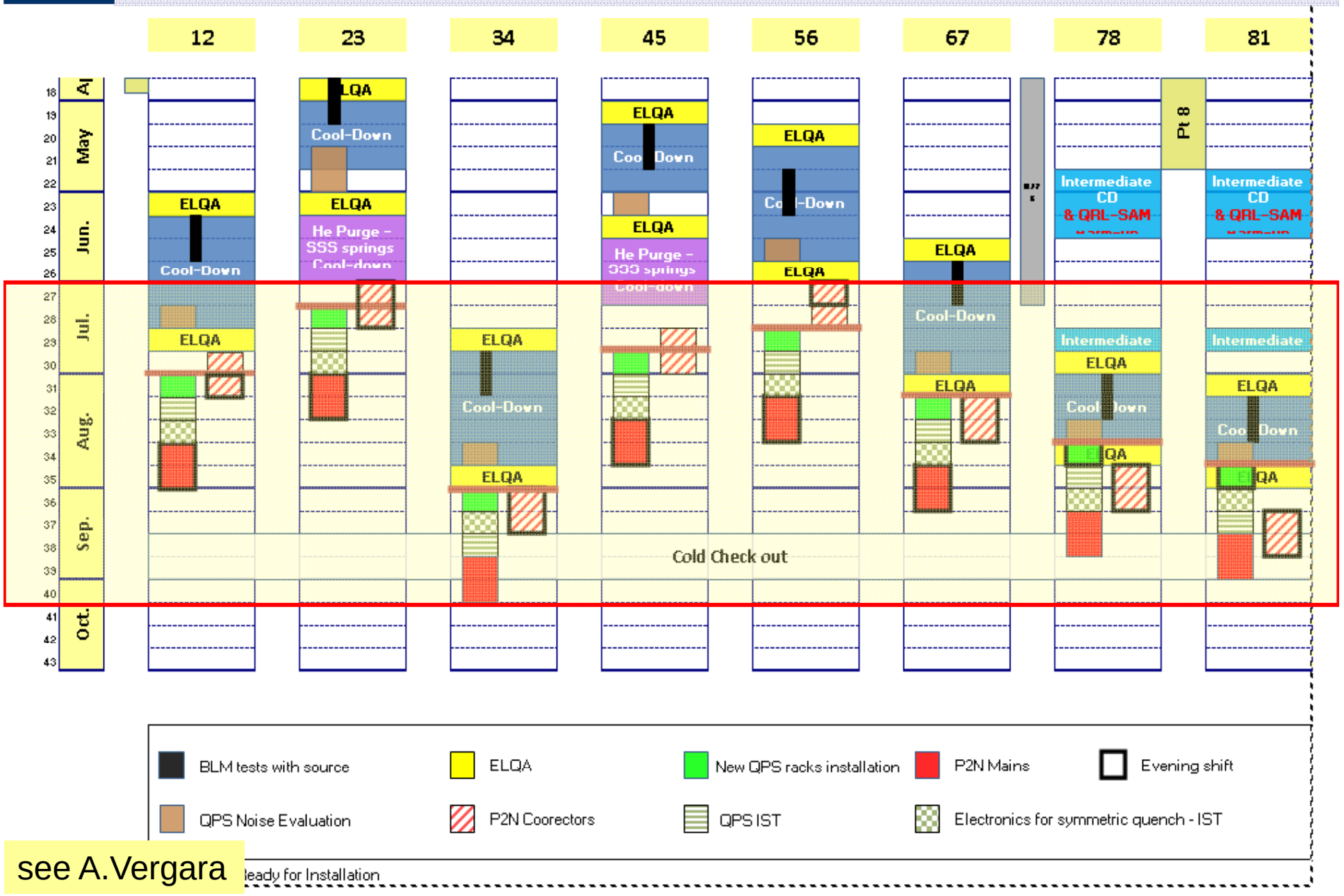
Other challenges

- Access during powering – will become more restrictive
- Four sectors warmed up – complete recommissioning required
- Large amount of changes to the LHC, including modifications of the powering system
  - Many, many people are spending a lot of time in the tunnel (what are we going to find….?)
- Calorimetry will be used to identify nonconformities (bad splices)
- Several experienced people left either the activity of hardware commissioning, or CERN

- Some consolidation to make the machine safer planned for next shutdown
- LHC operation will ALWAYS involve some risks

- Hardware commissioning is expected to be done in a short time: it will be a busy summer

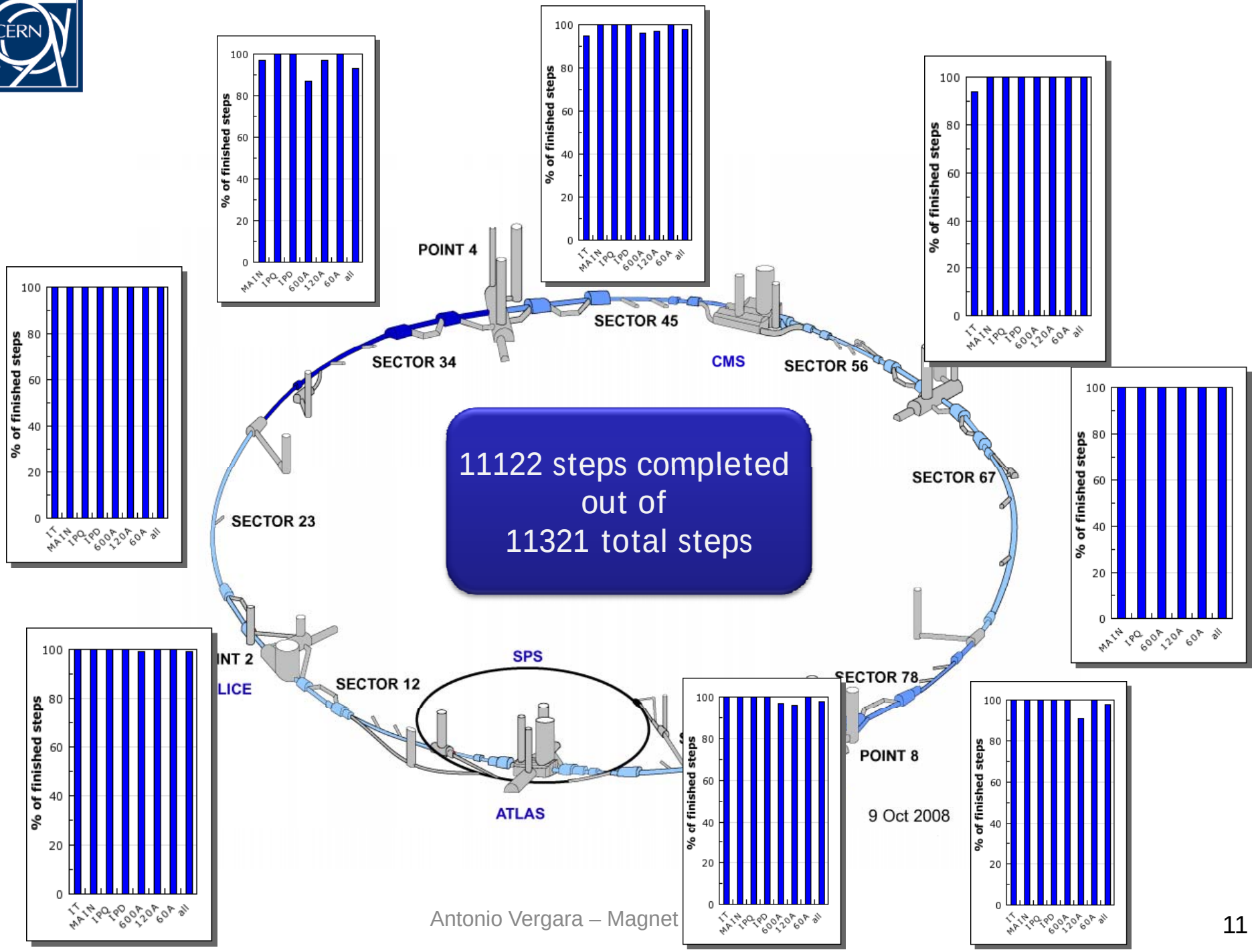
Period for powering tests – starting in July



see A.Vergara

Are we paranoid? We should not forget….

- Hardware commissioning was nearly finished, and the magnets were powered to a current corresponding to 5 TeV (some sectors several times to 5.5 TeV)
- We were operating the LHC with beam successfully for a some time (…even if this period was very short)
- There are new systems being installed to detect non-conformities and to limit the risks
- The nLHC will be a safer machine
- We have help! From the accelerator sector, but also from PH


POINT 4
SECTOR 45
SECTOR 34
CMS
SECTOR 56
SECTOR 67
SECTOR 23
SECTOR 12
SECTOR 78
POINT 8
SPS
ATLAS
11122 steps completed
out of
11321 total steps
9 Oct 2008
% of finished steps
IT
MAIN
IPQ
IPD
600A
120A
60A
all

Strategy for powering tests

- Commission most circuits to a current required for 5 TeV
- Commission a few circuits to an energy corresponding to 4 TeV (RB, maybe RQ, few others?)

- Operate the LHC for some time at 4 TeV, until operation is stable and we are confident that we understand the performance (analyse data from many different sources)
  - Ask the different teams: are we ready to go to 5 TeV (some kind of formal procedure), similar to what has been suggested for beam operation to increase beam power

Hardware commissioning and risks

- Risks to people
  - Access to the tunnel will become very restrictive during (high current) powering tests
  - Risk depends critically on the circuit since energy stored in the circuit has to be considered
  - Risks is negligible at low current for many circuits

- Risks to equipment
  - Risks increases when powering a circuit to high current

Challenge: develop a strategy for the powering tests that does not put people at risk, minimises risk for equipment and is compatible with efficient commissioning

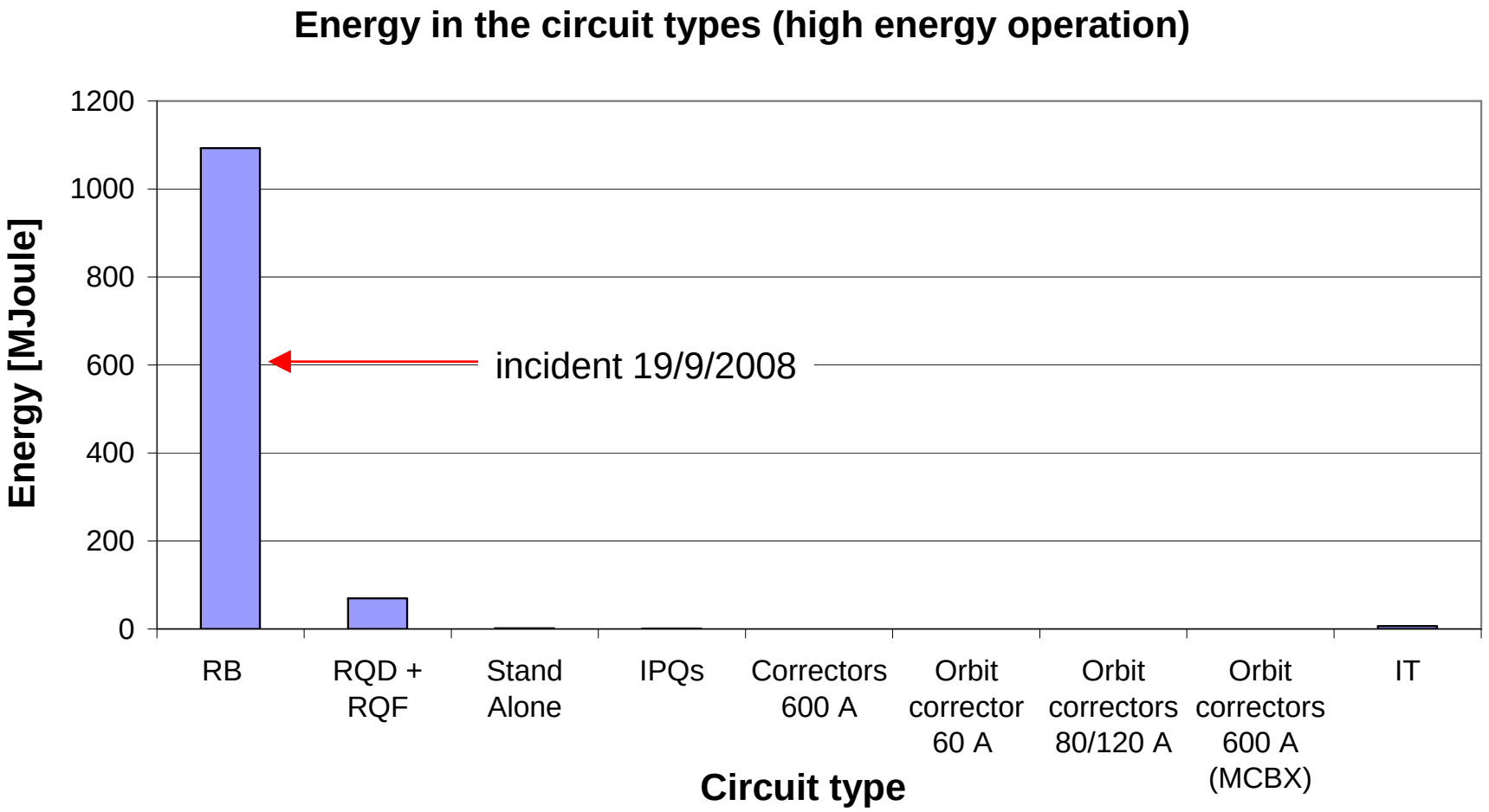
Do not make it harder than needed

Limit current during commissioning to what is required for 5 TeV
(commission a circuit to the current that required – **not higher**)

- Get a table of all the current for each circuit required to operate up to 5 TeV and limit the current
  - for RB, RQ and other high current circuits
  - strategy for 600 A circuits to be discussed
  - if later required, it is always possible to continue commissioning of a circuit to higher current

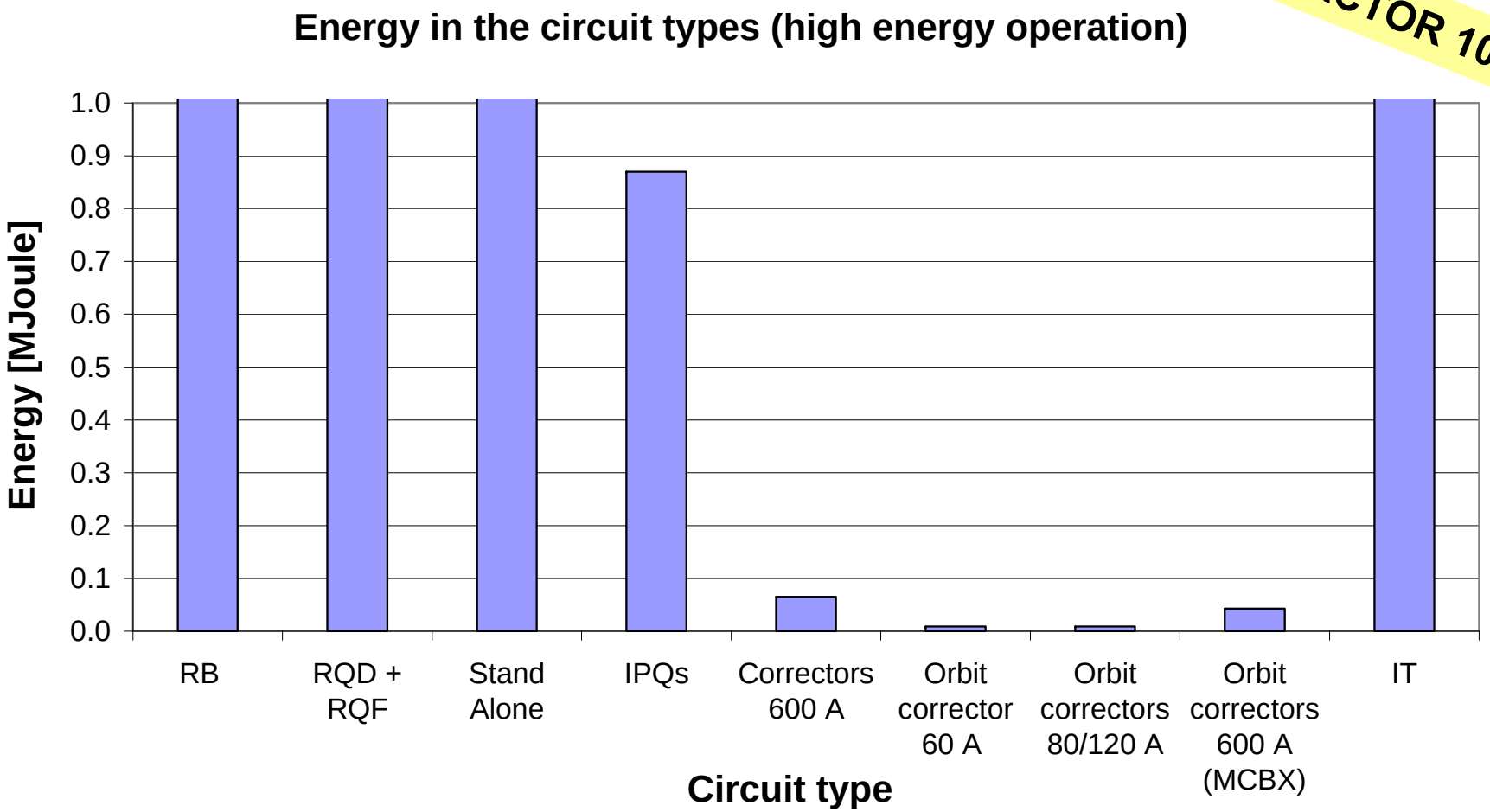
- Easier for access (limits energy stored in the circuit)
- Reduces the risk for the circuits
- Several problems that have been observed at high current will not be an issue

Energy in the different circuit types



Energy in the different circuit types

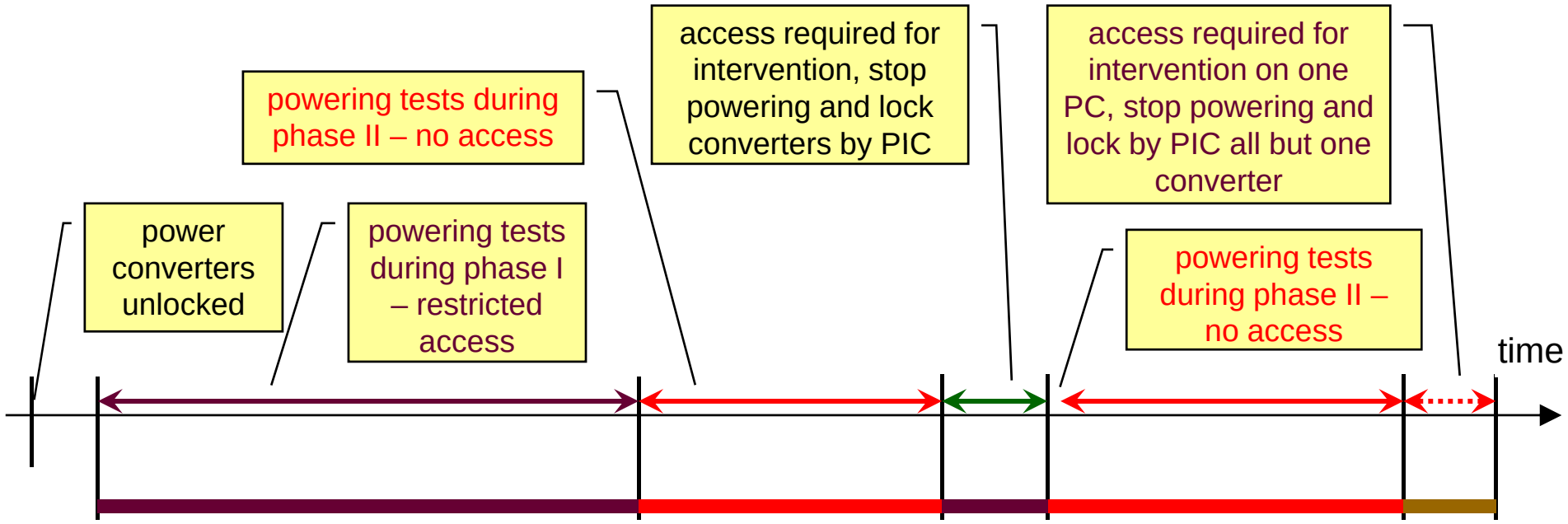
ZOOM FACTOR 1000



Most circuits very small amount of stored energy

Ensuring safety for people during powering tests

- Operate at the level of one sector (specific issues for 23-34 and 67-78)
- When power converters are unlocked, access will be in restricted mode
- Powering during Phase I with low current - restricted access still possible
  - most (~90%) of the commission steps can be done during this period
- Powering during Phase II with high current – in general, no access during powering tests



Questions to be addressed

- Commissioning targets: first 4 TeV and then 5 TeV? Consequences of such strategy? Plan B?
- What changes of the LHC hardware have an impact on powering tests?
- Which will be the access conditions during powering?
- Are there issues of resources?
- Which procedures need to be changed? What do we have to re-do?
- How to operate? Two shifts, three shifts, weekends? ….in presence of many activities, mainly related to the installation of the upgraded QPS system
- What known non-conformities might prevent us to go to 5 TeV?
- What if we splices with non conform resistance?

How to go on

- Identify open question, and follow them up in small teams
- Meeting every two weeks, in order to discuss progress

Topics that were left out - to be addressed in the near future

- Power Converters and Powering Interlock Controller
- Tools – general (MTF, Hardware Commissioning Pages, Sequencer, Test Tracking tool, ….)
- Tools – for the upgrade of the QPS system
- Organising patrols
- NC magnet commissioning
- Short circuit powering tests (for sector 34)
- Ensuring correct connections of warm cables, in particular to the current leads
- Define current level – conservative for magnet system

Next (extended) meeting in May

Programme

1. Scenario for commissioning of the powering system, Rüdiger Schmidt
2. Consolidation and major changes that have impact on the powering circuits, Reyes Alemany Fernandez
3. Powering Test Overview, Boris Bellesia
4. First Outcomes of the Safety Task Force (the RULES), Ralf Trant
5. How to ensure safety during powering? (ENFORCING the RULES) (30')
   Matteo SOLFAROLI
6. Safety issues related to commissioning and operation of the powering system, Hugues Thiesen
7. Cryo Performance & Operation, Serge Claudet
8. ELQA, Nuria Catalan Lasheras
9. Exceptional conditions during powering tests – the rules, Laurette Ponce
10. Quench Protection and Energy Extraction System, Knud Dahlerup-Petersen
11. How does it look altogether, Antonio Vergara Fernandez
12. How to deal with non-conformities, Mirko Pojer
13. How to detect bad splices? Mike Koratzinos
14. Status of procedures for powering, Walter Venturini Delsolaro