WHERE ARE WE WITH THE LONG-TERM PLANS AND THE CERN-WIDE RADIATION POLICY
Acknowlegdements

- Members of R2E
- Members of RADWG
- Members of PH-ESE, EN-STI, EN-MEF etc...
Radiation Policy

• The principles
• The implementation for LHC
PRINCIPLES

- Thought and proposed for LHC machine
- Sufficiently general to be usable for all underground or exposed areas
- Only the main principles of good practice in the policy.
- Detailed Application of the policy to be expressed in addenda specific to each big project/machine.
- Test procedures and reports to be adapted by system, installation, project, experiment etc…
PRINCIPLES : 1) Environment

- First of all, the environment needs to be known. Every possibly critical area has to be simulated, a central repository for the project/installation need to be created : (e.g. R2E website for the LHC Machine).

- Need of at least:
  - TID: Dose (Gray/year in silicon)
  - NIEL: 1MeV eq. Neutron fluence
  - SEU: >20 MeV fluence

- We need to specify a parameter for thermal neutrons
  - Ratio Thermal/high energy + fluence?

- Spectra
PRINCIPLES: 2) Selection of Components

- Designers shall have to select components compatible with the expected level of radiation.
- Test procedures and reports adapted to the fluence/dose.
- Tests need to be performed for every new batch.
- While a central database may be established, this is not felt fundamental by users: it quickly gets obsolete...
- A central procurement of rad-tolerant components might be more useful.
- Working groups to approve selection of the components (RADWG?). Unrealistic, too much workload for the available manpower. Can only be done for main systems and components.
PRINCIPLES : 3) Design Reviews

- Classification of equipment: responsibility of project/experiment
  - Personnel safety
  - Machine/experiment protection
  - Critical for operation/ downtime
  - “monitoring”

- Equipment critical for personnel safety and machine/experiment protection should not be installed underground if possible
  - If not, they have to undergo a strict procedure of design review and test to ensure a minimum risk of failure.

- Systems responsible for relevant beam downtime should undergo design reviews as well.

- Monitoring: only on request of its owner
PRINCIPLES : 4) System Test

- Final systems need to be tested in a reference environment similar to the final one
  - CNGS for LHC machine (nTOF? HiRadMat?)
    - RP does not consider CNGS a long term facility…
- For machine equipment, tests inside and outside CERN shall be coordinated through the RADWG
- Test reports:
  - impossible to provide a general template: groups must produce written technical reports for each test.
  - Groups must present their results in RADWG and, if requested, in yearly Radiation workshops organised (for machine) by RADWG.
PRINCIPLES : 5) Quality Assurance

- Equipment groups shall have to provide in the MTF values of sensitivity to the parameters set out in the Environment part:
  - TID, NIEL, SEU, Thermal Neutrons.

- Equipment Groups shall be responsible to set operational procedures with OP to ensure the risk is minimised
  - e.g. access controls underground switched off before sending beam
  - e.g. Preferential use of given collimators...

- Control
  - Needs dedicated qualified personnel, both centrally and in each (main) group, to verify that the numbers correspond to what simulated.
  - OP in charge to implement operational procedures
Implementation: LHC Machine

- For LHC Machine, the LMC will supervise and give priorities.
- **R2E** will coordinate technical work at different levels and give coherence between simulations, design, test, machine integration.
- **RADWG** will support equipment groups for design (component selection, design reviews) and radiation test.
- **Equipment owners** are responsible for implementation and quality assurance.
- **Point owners** (or persons to be identified) shall be informed of installed equipment and in charge of organizing control. Ensure that OP is aware of special procedures suggested for a given equipment.
Conclusions on Radiation Policy

- The policy implies work
- It will remain just a document without manpower
  - It implies manpower available, both in equipment groups and for working groups
Consolidation Program

• LHC Tunnel
• Service galleries
Can we quantify the risk?

- Options for LHC operational scenarios (and imperfections) bring uncertainty on radiation levels.
- The real uncertainty comes from the equipment sensitivity:
  - Even if we knew it now, it would change in the future with repairs, updates, upgrades etc..
  - Sensitivity to low energy neutrons cannot be excluded.

- So the answer is NO, but the risk is there.
- First SEE during transfer line commissioning.

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Our assumption

- We assume SEU are caused only by High Energy hadrons
- We assume the risk is acceptable for fluencies $\leq 10^7$ hadrons / cm$^2$ / year
Main systems at risk tested in CNGS:
- QPS - ok
- Cryo – under way….ok
- BLM – ok
- BPM – ok

then
- Power Converters: as discussed by Yves (ok)
- FIP: only real concern.
Good news!!!!

Nothing to do

- P4: assuming no catastrophic beam-gas interaction happens
- P6: assuming filling of ducts successful (intensity up to now not sufficient to verify!)
The wooden option

- We touch wood and hope it will be ok!!
- To help, we add some shielding here and there, relocate some equipment as possible.
- We gain maybe 1 year, 2 or 3 in some areas
- Includes full relocation in P8

- Cost: $\sim 5 \div 10 \text{ MCHF} ?$
  
  $\sim 20 \text{ FTE} ?$
A further step: RRs in P7

- Redesign 120A and 600A converters to either be
  - rad-tolerant
    - Implies additional specialised manpower
    - Solution can be deployed anywhere else
  - or distance tolerant
    - Only valid for P7 and few additional places
    - Implies complete re-integration of TZ76
- Or use Super Conducting Links

- COST: \( \sim 10 \div 15 \text{ MCHF?} \)
  - \( \sim 20 \text{ FTEs?} \)
RRs in P1 and P5

- Re-design of power converters not a credible option (4-6 kAmps not present in P7)
- 4 new shafts (as presented yesterday by Sylvain)
- Relocation: services infrastructure, PC and further electronics

Cost: ~50÷60 MCHF
RR's + shafts
Point 1 & 5

New Shaft Ø5m

Existing LHC tunnel

Existing RR

New Access Ø3m

New cavern Ø7m

Existing LHC tunnel
Full solution for relocation only credible for P1, at the price of taking all the space reserved for the LHC upgrade.

For P5 no full solution:
- Either we use PM56 (or UP/USC): integration study to confirm
- Or we need further civil engineering works in P5: new UAs? See Sylvain’s talk tomorrow.

Relocation cost: 5÷15 MCHF?
Conclusions (1/5)

- In a nominal year at 7 TeV per beam we will have several areas with fluencies
  - $\geq 10^9$ hadrons / cm$^2$ / year
- How can we reduce the risk?
- ...(beware: numbers following mostly my guess)
Conclusions (2/5)

- To ensure everywhere $\leq 10^8$ hadrons / cm$^2$ / year and move all the electronics supposed to be sensitive to that level (apart from power converters).

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<th>MANPOWER [FTEs]</th>
<th>decision</th>
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<td>Early shielding/relocation</td>
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Conclusions (3/5)

- Redesign power converters to be compatible with $10^8$ hadrons / cm$^2$ / year

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Conclusions (4/5)

- Solve problem of 4-6 kAmp in RRs

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If we want a safe solution in P1 and P5, and invest in an infrastructure ready for further challenges (LHC upgrade, crab cavities etc...)

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Beware, these numbers are only my guess!!

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Conclusions

- Numbers are enormous, and we cannot wait too long.
- Decisions have to be taken BEFORE the risk can be quantified.
- A workshop will be organised after Easter (mid April) to consolidate the information
  - Equipment groups shall come with their numbers.
  - Safety groups and LHC upgrade shall have to be part of the decision.
- It is necessary to invest substantial manpower in 2010 for integration studies (in the widest sense!). The different options have to be studied with sufficiently high priority in the integration team.
- We should also consolidate CNGS or design/invest in a new long term facility
Addendum...

- Start to invest on the future...
- Set-up joint working group with PH-ESE for common development of FPGA or microprocessors (ex: generic field-bus, or acquisition module for temperature, pressure, low precision voltage measurement etc...)
- Would need money and resources as well
Summary Of Areas – See Direct Link

[Graph showing high energy hadron fluence for different years and types of electronics.]

Needed Type of Electronics:
- Special Design
- Well Tested
- Tested COTS

Chamonix 2010: January 27th