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

R. Losito – LHC Performance Workshop

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Acknowledgements

- Members of R2E
- Members of RADWG
- Members of PH-ESE, EN-STI, EN-MEF etc…
- A few other people, in particular M. Brugger, S. Weisz, A.-L. Perrot, G. Spiezia, D. Kramer, S. Roesler, R. Assmann, M. Lamont, Y. Thurel, J. Osborne, J. Serrano.

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

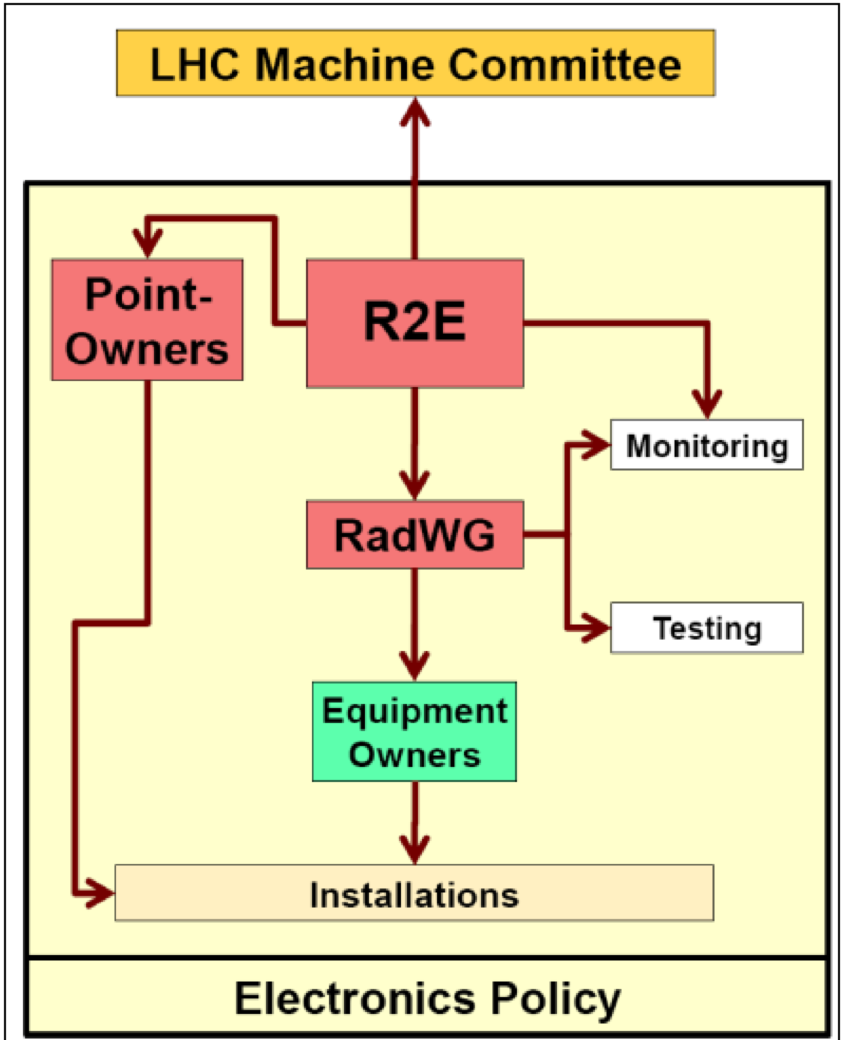
PRINCIPLES : 4) System Test

- 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 level 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 organising 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.

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**

LHC Tunnel

- 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.

P2 – P3 – P4 – P6

- 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: ~5÷10 MCHF ?**

  ~20 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: ~10÷15 MCHF?
  ~20 FTEs?

RRs in P1 and P5

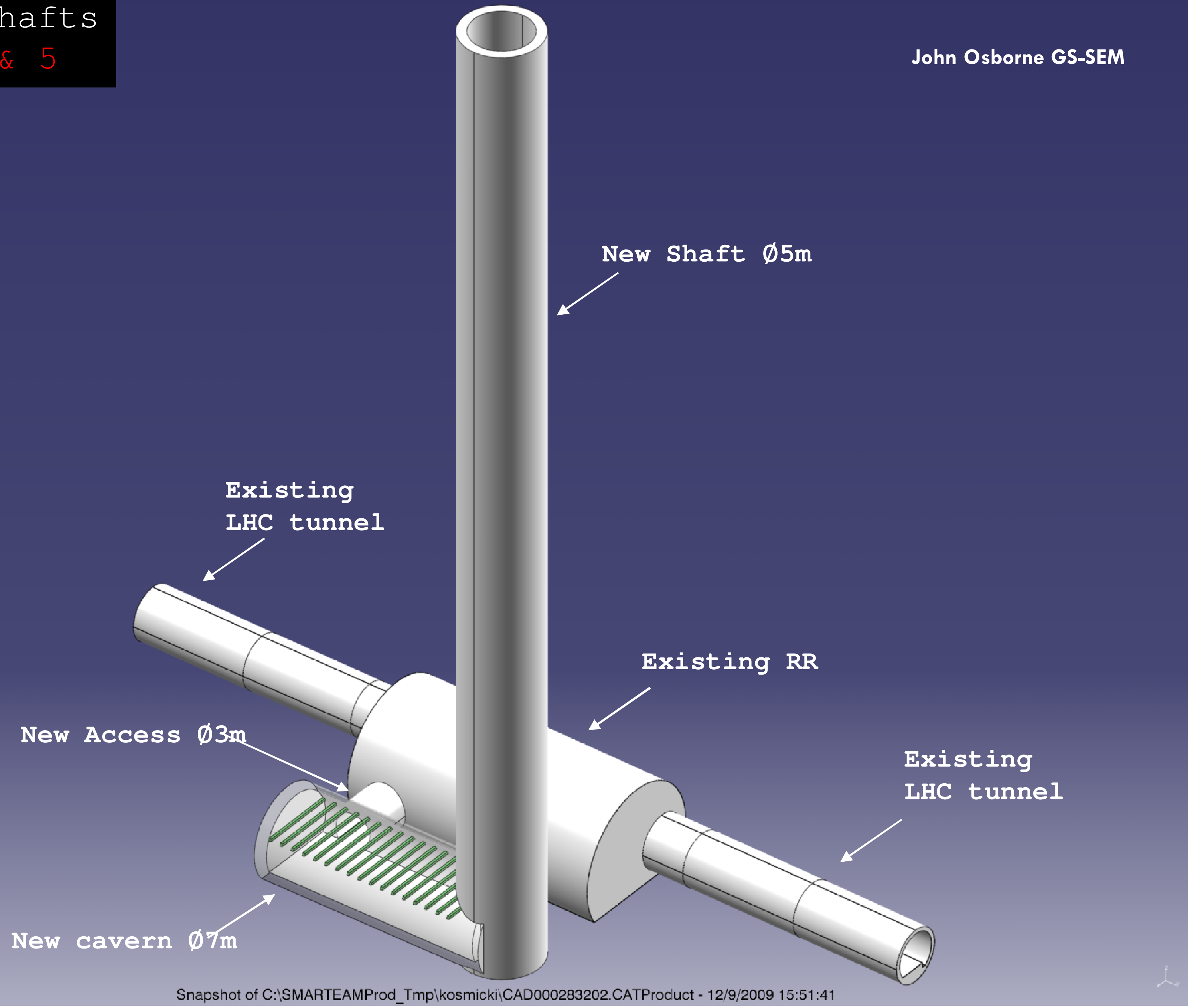
- Re-design of power converters not a credible option (4-6 kAmps not present in P7)

- 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

John Osborne GS-SEM



UJ 14/16/56

- 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
- **≥ 10^9 hadrons / cm^2 / year**
- How can we reduce the risk?
- ....(beware: numbers following mostly my guess)

Conclusions (2/5)

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

	Material [MCHF]	MANPOWER [FTEs]	decision	Ready
Early shielding/reloc ation	5÷10	20	Now	2011
Relocation UJs (no new civil engineering)	15	30	2010	2013

Conclusions (3/5)

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

	Material [MCHF]	MANPOWER [FTEs]	decision	Ready
Redesign 120/600 Amps	5÷10	15÷25	May 2010	2014

Conclusions (4/5)

- Solve problem of 4-6 kAmp in RRs

	Material [MCHF]	MANPOWER [FTEs]	decision	Ready
New Shafts and relocation	50÷60	40	June 2010	2014÷2015

Conclusions (5/5)

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

	Material [MCHF]	MANPOWER [FTEs]	decision	Ready
4 New UAs	50÷100 MCHF ?	60?	2011?	2015

Summary

- Beware, these numbers are only my guess!!

	Material [MCHF]	MANPOWER [FTEs]	decision	Ready
Early shielding/relocation	5÷10	20	Now	2011
Redesign 120/600 Amps	10	15÷20	May 2010	2014
New Shafts and relocation	50÷60	40	June 2010	2014÷2015
Relocation UJs (no new civil engineering)	15	30	2010	2013
4 New UAs	100 MCHF ?	60?	2011?	2015

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.
- <u>It is necessary to invest substantial manpower in 2010 for integration studies (in the widest sense!).</u> 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 microprocesors (ex: generic field-bus, or acquisition module for temperature, pressure, low precision voltage measurement etc…)
- Would need money and resources as well

SPARE SLIDE

Summary Of Areas – See Direct Link