

# Chamonix 2011

## Proposals for Decisions

The CERN Directorate will deliberate on these proposals, take into account the opinion of the CERN MAC, and make the **final decisions**

# Sessions

1. Review of 2010 Operations
2. Shutdown 2012 (Part 1)
3. Shutdown 2012 (Part 2)
4. Beam Energy
5. High Intensity: Present and Future
6. Machine Development in 2011 and beyond
7. Run 2011 – Luminosity
8. High Luminosity (HL-LHC)
9. LHC Injectors Upgrade (LIU)
10. Summary and Proposals for Decisions

Reported by the session chair persons

# Needing « Proposals for Decisions »

- Operation after 2011
  - Impact of a delay in the **long shutdown** from (2012) to 2013. (LS1)
    - RP (ALARA, ...), maintenance requirements, impact on future projects...
  - Impact on the following long shutdown (LS2)
- Performance in 2011
  - Maximum **safe beam energy**
  - **Luminosity** (Peak and **Integrated**) Baseline still 1fb-1!
    - Bunch spacing (electron cloud, bunch instabilities, scrubbing..)
    - Intensity per bunch (Injectors, beam-beam effects, impedance and instabilities...)
    - collimation, machine protection, UFOs,
    - beta\*, crossing angles, ...
    - SEU ; radiation to electronics
    - ALICE and LHCb; how to operate at low luminosity

# 2012: Physics or Splices? **Technical Issues**

- RP: ALARA turns out not to be a serious issue
- Splice Consolidation: benefit (technical and resources)
- Cryo-Collimation. Delay is essential for the project
- Kickers and dumps: beneficial
- **CV and EL; delayed maintenance may reduce reliability**
  - (study the possibility of carrying out maintenance during an extended Christmas TS)
- Access and alarms: overall beneficial
- Experiments: in favour but would like a **new 10 year plan** including Tech Stops (CMS need 15.5 months plus possibly 2 additional for bakeout)

# 2012: Physics or Splices?

- Postponing the 2011-12 shutdown (LS1) to 2012-13:
  - Will delay the work to be done in LS1 by one year.
  - May allow some tasks already scheduled for LS2 to be advanced (?LINAC4, Collimators with BPMs...)
  - Will Increase the need for maintenance and repairs to allow efficient running through 2012 (EN/CV...)
  - May necessitate an increase in the duration of the Technical stop at Christmas (2011-12)

Consequently postponement of the LS1 should be accompanied by a change in the date of LS2 as well as modifications to the frequency and duration of the technical stops.

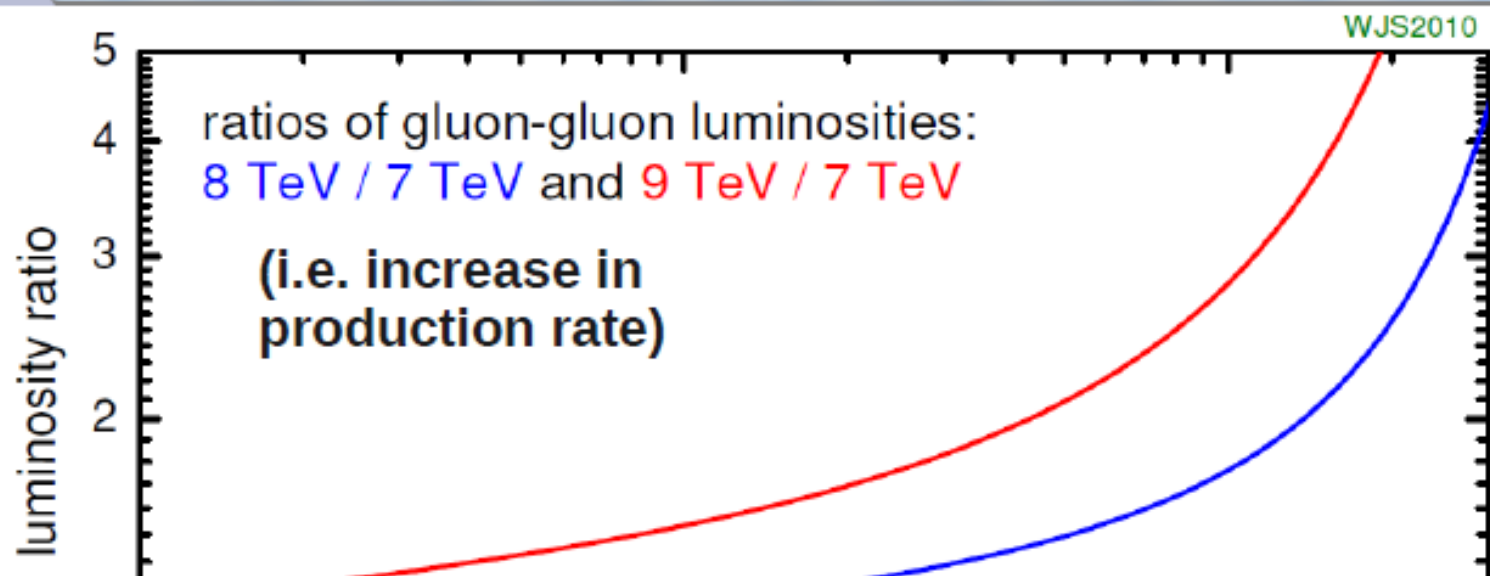
# Proposal

## Do physics in 2012

- BUT study
  - Maintenance and repairs needs for such a long running period
    - Consider how CV/EL maintenance could be carried out during an extended TS in 2011-2012
  - Make a new 10 year plan including all shutdowns and technical stops (LMC + experiments)
  - Try to keep to a minimum the duration of the shutdown
    - Critical review of need for cryo-collimation system in June 2011



# Effect of raising $E_{\text{CMS}}$



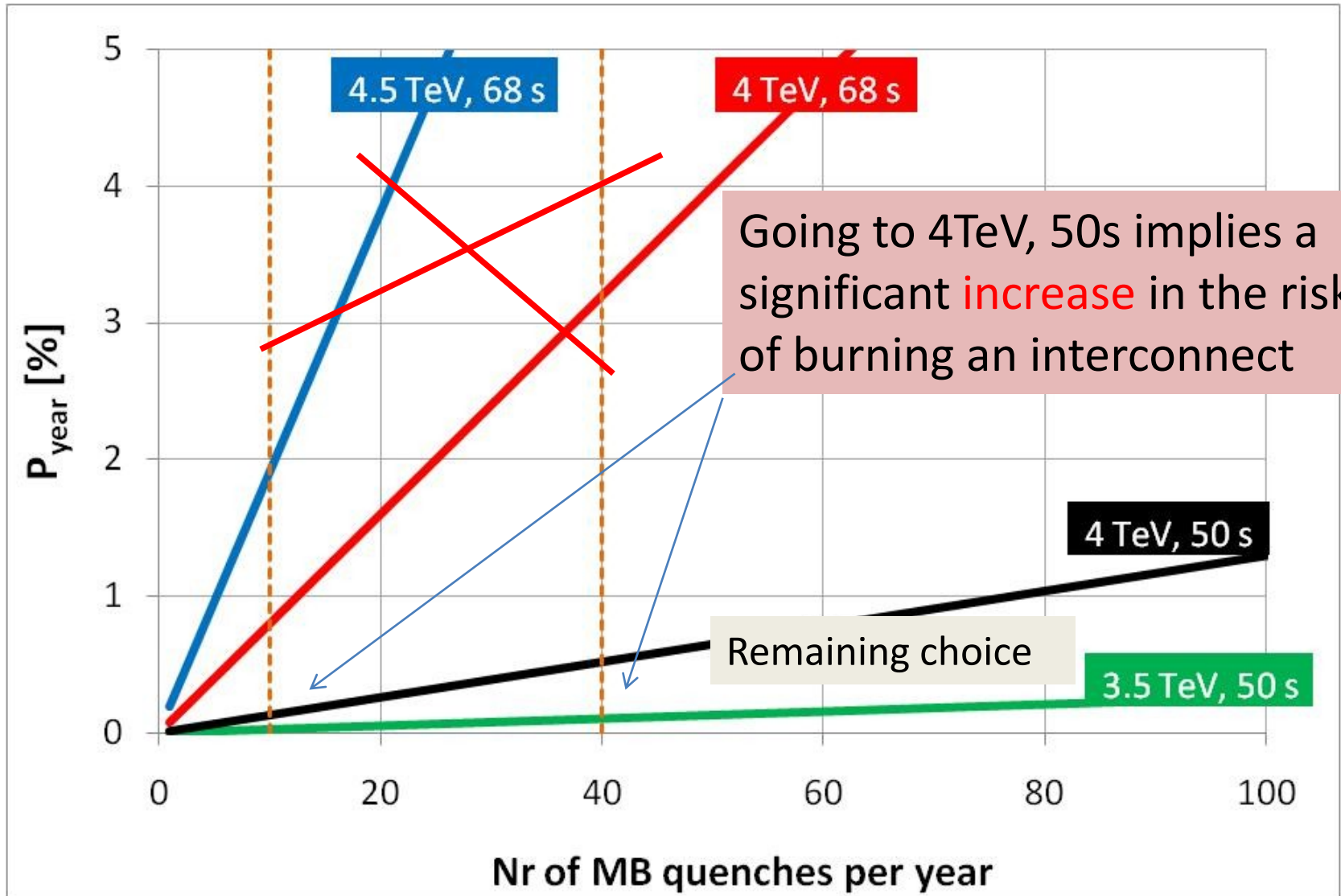
The Return for the Risk associated with energy increase

- Doubled for 9 TeV
- Higgs increased by 30% 😊

Thanks to James Stirling

# (Probability) Maximum Safe Energy

Probability per Year of burning an interconnect





# (Impact) Maximum Safe Energy

- Electrical arc in an interconnect:
  - The present consolidation, up to 5 TeV, will suppress mechanical collateral damages in adjacent sub-sectors.
  - Nevertheless, mechanical damage of the MLI in the concerned sub-sector as well as contamination of the beam pipe(s) could require heavy repair work.
  - With the present consolidation status, a new incident will still have a big impact on the machine down time (8 to 12 months)
  - PLUS severe damage to CERN's reputation

# Issues with 4 TeV (50s)

- Number of Quenches expected
  - In 2010, 20 quenches (>5000A) (none were beam related)
  - Asynchronous dumps (sectors 56 and 67)
  - UFOs (event rate may increase with intensity, however the UFO signal is independent of energy)
- (Weak dipole limits energy to 4TeV)
- (QPS: strong preference to use snubbers)
- (Little or no impact on set up time)
- Probability is relatively low but the impact is high
  - i.e. the risk factor is medium

# My Proposal

Return/Risk is not favourable

**Stay at 3.5TeV for 2011**

Small benefit due to reduced need for luminosity calibration

Question: Would it be a better risk investment to go for a lower beta\*

We should operate in 2011 with the « snubber » capacitors

Thermal amplifier development during 2011 and measurements during shutdown will allow a decision on energy increase for 2012. Hopefully higher than 4 TeV

# Running in 2011

| Item                        | Days       |
|-----------------------------|------------|
| Total p OP - 37 ½ weeks     | 262        |
| 11 MDs (2 days)             | -22        |
| 6 TS (4+1 days)             | -30        |
| Special requests            | -10        |
| Commissioning               | -28        |
| Intensity ramp up           | -40        |
| Scrubbing run               | -8         |
| <b>Total HIGH INTENSITY</b> | <b>124</b> |

?

?

We need to refine this list and specify the cost in integrated luminosity.

Try to improve the overall efficiency and still perform the necessary tasks on the list.

# Start up scenari (Ongoing)

## 75 ns beam re-commissioning – Scrub with 50 ns – 75/50 ns operation

- ❑ Recommissioning with 75 ns bunch spacing - 3 w
- ❑ Increase bunch number (~300b?) – 2 w
- ❑ Scrub with 50ns when needed - 1.5 w

After scrubbing experience, decide on 50/75 ns

- ❑ 50/75 ns operation and increase bunch number -2.5w      300 – 400 – 600 – 800 – 936 -??1404 MP and OP qualification –
- ❑ Physics operation 50/75 ns – 936/1404 b
- ❑ (Back up: restore 150 ns operation – couple days)

## 150 ns beam re-commissioning – Scrub with 50 ns – 75 ns operation

## 50 ns beam re-commissioning – Scrub with 50 ns – 75 ns operation

## 50 ns beam re-commissioning – Scrub with 50 ns – 50 ns operation

# Beam parameters 2011

@ exit SPS

| Beam parameters                        | 150 ns              | 75 ns                              | 50 ns   |
|--|---------------------|------------------------------------|---|
| Bunch intensity [e11 p/b]              | 1.2                 | 1.2 (1-batch)<br>1.2 (2-batch) tbc | 1.2 (1-batch)<br>1.6 (1-batch)<br>1.2 (2-batch) |
| Normalised Emittance [ $\mu\text{m}$ ] | 2<br>(1.6 achieved) | 2<br>~1. to 1.5 – tbc              | 2<br>3.5<br>~1.5                                |

Retained for L calculation (LHC):

| Beam parameters                        | 150 ns      | 75 ns      | 50 ns       |
|--|-------------|------------|-------------|
| Bunch intensity [e11 p/b]              | <b>1.2</b>  | <b>1.2</b> | <b>1.2</b>  |
| Normalised Emittance [ $\mu\text{m}$ ] | <b>2.5</b>  | <b>2.5</b> | <b>2.5</b>  |
| Colliding bunches                      | <b>368*</b> | <b>936</b> | <b>1404</b> |

\*assume 368 b as proven from 2010 - should be able to go to ~424 b

# Estimated Peak and Integrated Luminosity

- **Baseline is 2E32 Peak and 1fb-1 (integrated)** (expectation management)
- But following 2010, we are confident we will do better

$\beta^* = 1.5\text{m}$

| day<br>s   | H.F        | Comm<br>with | Fills<br>with | kb         | Nb<br>e11  | $\epsilon$<br>$\mu\text{m}$ | $\xi/\text{IP}$ | L<br>Hz/cm <sup>2</sup> | Stored<br>energy<br>MJ | L Int<br>fb <sup>-1</sup><br>4<br>TeV | L Int<br>fb <sup>-1</sup><br>3.5<br>TeV |
|------------|------------|--------------|---------------|------------|------------|-----------------------------|-----------------|-------------------------|------------------------|---------------------------------------|---|
| 160        | 0.3        | 150 ns       | 150 ns        | 368        | 1.2        | 2.5                         | 0.006           | ~5.2e32                 | ~30                    | ~2.1                                  | ~1.9                                    |
| <b>135</b> | <b>0.2</b> | <b>75 ns</b> | <b>75 ns</b>  | <b>936</b> | <b>1.2</b> | <b>2.5</b>                  | <b>0.006</b>    | <b>~1.3e33</b>          | <b>~75</b>             | <b>~3</b>                             | <b>~2.7</b>                             |
|            |            |              |               |            |            | <b>2</b>                    | <b>0.007</b>    | <b>~1.6e33</b>          |                        | <b>~3.8</b>                           | <b>~3.3</b>                             |
|            |            |              |               |            |            | <b>1.8</b>                  | <b>0.008</b>    | <b>~1.8e33</b>          |                        | <b>~4.2</b>                           | <b>~3.7</b>                             |
| 125        | 0.15       | 50 ns        | 50 ns         | 1404       | 1.2        | 2.5                         | 0.006           | ~2e33                   | ~110                   | ~3.2                                  | ~2.8                                    |

Possible integrated Luminosity of 2-3 fb-1

# Ions 2011

- Substantial factor in luminosity possible for 2011
  - Options for filling etc, will be clarified in injector commissioning, experiments are flexible
- 2012 appears to be a good opportunity for p-Pb
  - Otherwise it will be a long time
  - Feasibility test in MD can be tried in 2011

Request from ALICE to shoot for design already in 2011

More work needed in the first half of this year



Thank you for your attention