Chamonix 2011

The LHC Performance Workshop at Chamonix is a technical meeting which makes recommendations to the CERN management.

These recommendations are considered by the management which also takes into account recommendations/advice from the CERN Machine Committee before making the final decisions.

Proposals for Decisions

Sessions

- **Review of 2010 Operations** 1.
- Shutdown 2012 (Part 1) 2.
- Shutdown 2012 (Part 2) 3.
- Beam Energy 4.
- High Intensity: Pre 5.
- Machine P 6.
- ... Pro session chair persons Rיי 7. 8
- LHC Injectors Upgrade (LIU) 9.
- 10. Summaries and Proposals for Decisions

Needing " (Proposals for) Decisions "

- Operation after 2011
 - Impact of a delay in long shutdown (LS1) from 2012 to 2013.
 - RP (ALARA, ...), maintenance requirements, impact on future projects...
 - Impact on the following long shutdown (LS2;2016)
- 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 Christmas/Technical Stops (CMS need 15.5 months plus possibly 2 additional for bakeout)

2012: Physics or Splices?

- Postponing the "2012" shutdown (LS1) to "2013":
 - Will delay the work to be done in LS1 by one year.
 - May allow some tasks already scheduled for LS2 (2016) to be advanced (Injectors, 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 Christmas and technical stops.

Proposal

Do physics in 2012!

- BUT study
 - Maintenance and repairs needs for such a long running period (2009-2012)
 - Consider e.g. how CV/EL maintenance could be carried out during the Christmas 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 in 2013
 - Critical review (in June 2011) of the need for including cryocollimation system in the LS1 shutdown or delay to LS2



The Return for the Risk associated with energy increase



- Doubled for 9TeV
- Higgs increased by 30%



I nanks 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
 <u>mechanical</u> collateral damages in adjacent subsectors.
 - 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) (only one was beam related)
 - Possibility of multiple quenches provoked by asynchronous dumps (sectors 56 and 67)
 - UFOs (event rate will increase with intensity, however the UFO signal amplitude appears to be independent of beam energy)
- (Weak dipole limits energy to 4TeV)
- (QPS: strong preference to use snubber capacitors to reduce the possible number of quenches)
- (Little or no impact on set up time)
- Probability is relatively low but the impact is high
 - i.e. the risk factor is medium

Safety Integration Level (SIL)

To achieve a given SIL, the device must meet targets for the maximum (allowable) probability of dangerous failure..... PFD (Probability of Failure on Demand)for different SILs as defined in IEC EN 61508 are as follows:

1 $0.1-0.01$ $10^{-1} - 10^{-2}$ 4TeV/50s 2 $0.01-0.001$ $10^{-2} - 10^{-3}$ 4TeV/50s 3 $0.001-0.0001$ $10^{-3} - 10^{-4}$ 3.5TeV/50s	SIL	PFD	PFD (power)			
2 0.01-0.001 10 ⁻² - 10 ⁻³ 4TeV/50s 3 0.001-0.0001 10 ⁻³ - 10 ⁻⁴ 3.5TeV/50s	1	0.1-0.01	10 ⁻¹ - 10 ⁻²			
3 0.001-0.0001 10 ⁻³ - 10 ⁻⁴ 3.5TeV/50s	2	0.01-0.001	10-2 - 10-3	4TeV/50s		
	3	0.001-0.0001	10-3 - 10-4	3.5TeV/50s		
$4 0.0001-0.00001 10^{-4} - 10^{-5}$ LHC safety systems are designed to	4	0.0001-0.00001	10-4 - 10-5	LHC safety systems are designed fo		

SIL2 is not acceptable. Return/Risk is not favourable

Proposal

Stay at 3.5TeV for 2011

We should operate in 2011 with the "snubber" capacitors to reduce further the possible number of quenches (SIL4)

Small performance benefit due to reduced need for luminosity calibration

Thermal amplifier to be developped during 2011 to allow measurements during Christmas shutdown for a deterministic decision on a possible energy increase for 2012.

Performance: lons 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

Running in 2011; Distribution of Days

Protons	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
	Total HIGH INTENSITY	124

We need to refine this list and specify the "cost" of each item in units of integrated luminosity.
Improve the overall efficiency and still perform the necessary tasks on the list.

Start up scenari

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)
- Other possible start up scenari were discussed

Beam parameters 2011

@ exit SPS

Beam parameters	150 ns	75 ns	50 ns	
Bunch intensity [e11 p/b]	1.2	1.2 (1-batch) 1.2 (2-batch) tbc	1.2 (1-batch) 1.6 (1-batch) 1.2 (2-batch)	
Normalised Emittance [µm]	2 (1.6 achieved)	2 ~1. to 1.5 – tbc	2 3.5 ~1.5	

Retained for L calculation (LHC):

Beam parameters	150 ns	75 ns	50 ns
Bunch intensity [e11 p/b]	1.2	1.2	1.2
Normalised Emittance [µm]	2.5	2.5	2.5
Colliding bunches	368*	936	1404

*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

 $\beta^* = 1.5m$

days	H.F	Comm with	Fills with	kb	Nb e11	ε μm	ξ/IP	L Hz/cm ²	Stored energy MJ	L Int fb ⁻¹ 4 TeV	L Int fb ⁻¹ 3.5 TeV
160	0.3	150 ns	150 ns	368	1.2	2.5	0.006	~5.2e32	~30	~2.1	~1.9
135	0.2	75 ns	75 ns	936	1.2	2.5	0.006	~1.3e33	~75	~3	~2.7
						2	0.007	~1.6e33		~3.8	~3.3
						1.8	0.008	~1.8e33		~4.2	~3.7
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

Thank you for your attention