

# Luminosity Monitoring and Measurement

from the 2 days TS/EA Joint LHC Machine - Experiments Workshop

Joint LHC Machine-Experiments Workshop on **Very Forward Detectors** (CERN, 25 January 2007)

Joint LHC Machine-Experiments Workshop on the **Luminosity Monitoring and Measurement** (CERN, 26 January 2007)



## Joint LHC Machine-Experiments Workshop on Very Forward Detectors

**Thursday 25 January 2007**  
 from **09:00 to 19:00**  
 at **CERN ( [AT auditorium.](#) )**

















**Description:** The workshop is the follow-up of the TAN integration workshop of last year extended to all very forward detectors installed in the LHC tunnel. The aim is to review the status of the installation and the plans for commissioning and operation.

[Thursday 25 January 2007](#) |
















Thursday 25 January 2007

[top](#)↑

### 09:00->12:50 **Morning Session** (Convener: Daniela Macina (CERN) )

- 09:00 Welcome (10') (  Slides   ) D. Macina (CERN)
- 09:10 LHC startup plans for 2007 and 2008 (20') (  Slides  ) R. Bailey (CERN)
- 09:35 Signal and background simulation at the recombination chamber (25') (  Slides   ) V. Talanov (CERN, IHEP Protvino)
- 10:05 Detectors installation in the TAN at IR1and IR5: status and planning (25') (  Slides ) A L Perrot (CERN)
- 10:35 coffee break
- 11:00 BRAN at IR1 and IR5: status, commissioning and operation (1) (10') (  Slides   ) H. Matis (LBNL)
- 11:10 BRAN at IR1 and IR5: status, commissioning and operation (2) (20') (  Slides  ) Alessandro Ratti (LBNL)
- 11:35 LHCf detectors: status, commissioning and operation (25') (  Slides   ) O. Adriani (Firenze University and INFN)
- 12:05 ATLAS ZDC: status, commissioning and operation (25') (  Slides   ) S. White (BNL)
- 12:35 lunch break

### 14:00->18:10 **Afternoon Session** (Convener: Anne-Laure Perrot (CERN) )

- 14:00 CMS ZDC: status, commissioning and operation (25') (  Slides  ) O. Grachov (University of Kansas)
- 14:30 ALICE ZDC: status, commissioning and operation (25') (  Slides   ) M. Gallio (Torino University and INFN)
- 15:00 BRAN at IR2 and IR8: status, commissioning and operation (25') (  Slides  ) E. Bravin (CERN)
- 15:30 coffee break
- 16:00 TOTEM Roman Pots: status, commissioning and operation (25') M. Oriunno (CERN)
- 16:30 ATLAS Roman Pots: status, commissioning and operation (25') (  Slides   ) B. Di Girolamo (CERN)
- 17:00 FP420: a project for Proton tagging in the 420m region around ATLAS and CMS (25') (  Slides  ) B. Cox (University of Manchester)
- 17:30 Conclusions (20') (  Slides   ) E. Tsesmelis (CERN)



## Joint LHC Machine-Experiments workshop on the luminosity monitoring and measurement

**Friday 26 January 2007**  
 from **08:30 to 17:30**  
 at CERN ( [AT auditorium](#) )

**Description:** The workshop will focus on the 2007 run at 450 GeV and on the 2008 run at 7 TeV. The aim is to review how the machine and the experiments plan to monitor (and measure) the luminosity during the LHC commissioning and start-up phase.



[Friday 26 January 2007](#) |

Friday 26 January 2007

[top](#) ↑

**09:30->12:30 Morning Session** (Convener: Massimiliano Ferro-Luzzi (*CERN*) )

09:30 Welcome (05') (  Slides   ) E. Tsesmelis (*CERN*)

09:35 Summary of the Joint LHC Machine-Experiments workshop on Very Forward Detectors (25') (  Slides  ) D. Macina (*CERN*)

10:05 ALICE: Luminosity monitoring and measurement (25') (  Slides  ) T. Nayak (*CERN*)

10:35 coffee break

11:00 ATLAS: Luminosity monitoring and measurement (25') (  Slides  ) L. Fabbri (*Bologna University*)

11:30 CMS: Luminosity monitoring and measurement (25') (  Slides  ) D. Marlow (*Princeton Univeristy*)

12:00 LHCb: Luminosity monitoring and measurement (25') (  Slides  ) T. Lastovicka (*CERN*)



12:30 lunch break

**14:30->17:30 Afternoon Session** (Convener: Emmanuel Tsesmelis (*CERN*) )

14:30 LHCf: Luminosity monitoring and measurement (25') (  Slides  ) T. Sako (*Nagoya University*)

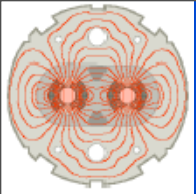
15:00 TOTEM: Luminosity monitoring and measurement (25') (  Slides   ) M. Deile (*CERN*)

15:30 coffee break

16:00 LHC Machine: Luminosity monitoring and measurement (25') (  Slides  ) H. Burkhardt (*CERN*)

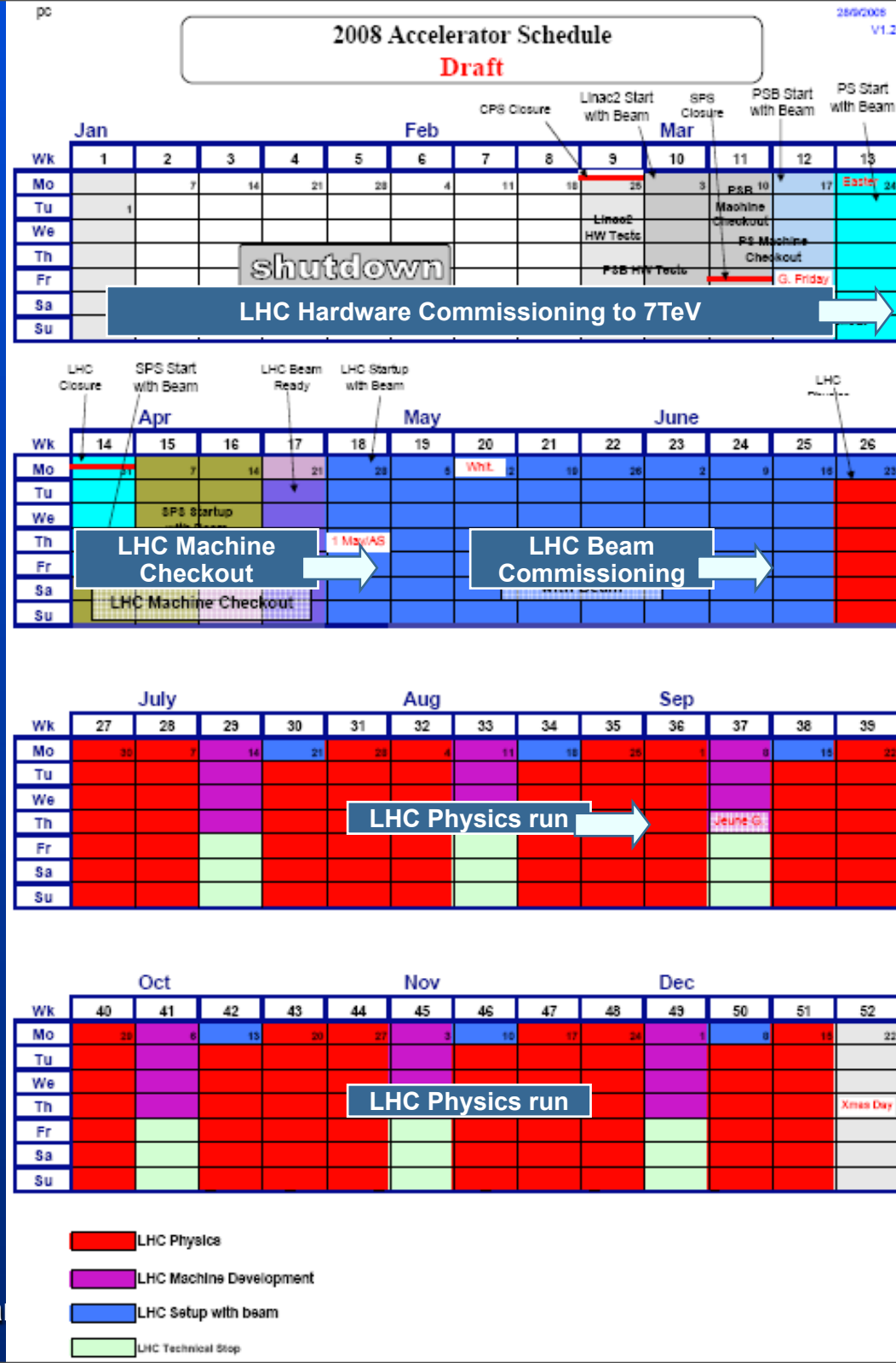
16:30 Machine-Experiments data exchange (25') (  Slides  ) D. Swoboda (*CERN*)

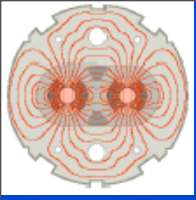
17:00 Conclusions (20') (  Slides  ) M. Ferro-Luzzi (*CERN*)



# 2008 draft schedule

- 3 month ++ shutdown (no beam)
- 4 weeks checkout (no beam)
- 8 weeks beam commissioning
  
- 26 weeks -- physics run (protons)
  - 20 days physics
  - 4 days MD
  - 3 days technical stop





# New Master Planning – main points for commissioning

## Power tests on magnet circuits

**Sectors 78, 81, 45 fully hardware commissioned**

Cycled to 7.2TeV with full protection systems

7-8 8-1 kept on standby below 80K after HWC

4-5 kept at nominal operating temperature after HWC

**Sectors 34, 56, 67 hardware commissioned for 450GeV**

Cycled to ~1TeV with limited protection systems

Kept at nominal operating temperature after HWC

**Sector 23, 12 hardware commissioned for 450GeV just in time**

**All special function equipment has been tested to 450GeV and more**

Transfer lines, Injection systems, Extraction systems

RF, BI, Collimators

RP systems, MP systems (users)

**Vacuum closed end August 2007**

**Global test of Access Control System October 2007**

**Engineering run in 2007**

**Shutdown to commission hardware to top energy**

**Commission with beam to top energy in 2008**

**Need soon to get  
into the details of  
late 2007 ...**

**cooling down,  
vacuum system,  
power tests,  
operation tests,  
access tests,  
beam**

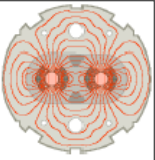
# Detectors for Relative Luminometry

	<u>IP</u>	<u>Detector</u>	<u>Installed</u>	(not very useful for eng. run)
ATLAS/LHCf	1	BRAN-A	before eng. run	
		ZDC	before eng. run	
		Lucid, BCM	before eng. run	
		MB Trig Sc, Fwd Cal	before eng. run	
		LHCf	before eng. run	(later, removed ...)
		Roman pots ALFA	2008/2009 shutdown or later	
ALICE	2	BRAN-B	before eng. run	
		ZDC	before eng. run	
		V0, T0	before eng. run	
CMS/TOTEM	5	BRAN-A	before eng. run	
		ZDC	before eng. run	
		Iron Fib Cal	before eng. run	
		Pix Telesc	?	
		T2	before eng. run	
		Roman pots TOTEM	probably 2007/2008 shutdown or later	
LHCb	8	BRAN-B	before eng. run	
		Pile-Up Detector	before eng. run	

# Absolute luminosity

<u>Experiment</u>	<u>Method(s)</u>	<u>Aim</u>	<u>When</u>
LHC	LHC params vd Meer scan	20-30% 10-20%	eng. run and on eng. run and on
ALICE (pp)	„Totem+MC“	10% 5%	initial final
(HI)	Mutual EM dissoc	?	
ATLAS	LHC params W/Z and ee/ $\mu\mu$ Elastic (Coulomb)	10% 5-10% 2-3%	initial medium term long term, 2010?
CMS	LHC params W/Z and ee/ $\mu\mu$ „Totem“	10% ? 5% ? <5%	initial final final
LHCb	beam-gas	20% 10% < 5%	eng. run and on 2008 later
LHCf	„Totem+MC“	?	
TOTEM	Optical Theorem	10% <2%	early 14TeV run, $\beta^* = 90$ m final, $\beta^* = 1540$ m

EXpts during Eng. run: use SpPs+MC



$$\mathcal{L} = \frac{N^2 f_{\text{rev}} n_b}{4\pi\sigma^{*2}}$$

For head-on collisions of round beams and  
N particles / bunch for  $n_b$  bunches

Gives **absolute** luminosity

Accuracy : knowledge of effective beam sizes  
(overlap integral) at IP

$$\sqrt{1 + \left(\frac{\theta_c \sigma_z}{2\sigma^*}\right)^2}$$

Reduction by crossing angle.  $\theta_c$  is the full crossing  
angle, nominally  $\sim 300$  mrad

**Not an issue for commissioning.**

$\sim 1\%$  or still rather negligible for 7 TeV,  $\beta^* = 11$  m  
only really significant ( $\sim 20\%$ ) at 7 TeV squeezed  
 $\sigma_z$  is the r.m.s bunch length, 7.55 cm at 7 TeV

**We expect to be able to predict absolute luminosities for head-on collisions based on beam intensities and dimensions, to maybe 20-30 % and potentially much better if a special effort is made.**

Planned : LHC Machine luminosity determination - as subject of PhD thesis.



# **Some comments and implications**

**Luminosity Monitoring will be done by all experiments**

**Hardware all ready for engineering run - but performance at 450 GeV rather limited**

**my talk on : LHC machine luminosity**

**generally strong interest, lots of questions.**

**very positive feedback on :**

**Absolute Luminosity from Machine parameter**

**particularly in commissioning, including 450 GeV run**