

LHC f : Integration and compatibility with the luminosity monitor

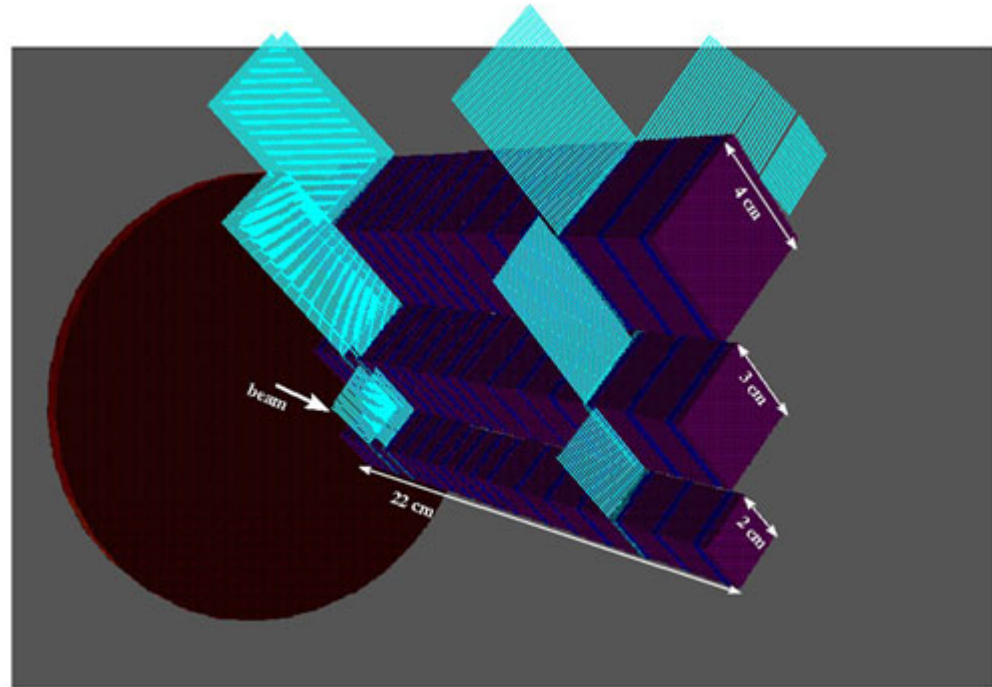
Takashi SAKO for the LHCf collaboration

9 January 2006 TAN integration meeting

LHCf

- Neutral particle calorimeters for the calibration of the CR physics
- Sampling calorimeter of the 50r.l. of Tungsten and plastic scintillator (~30cm)
- Imaging calorimeter with SciFi and MAPMT/Silicon detector.
- Two detectors (SciFi/Silicon) are placed in both sides of TAN at IP1

LHCf (prototype photo/CG)

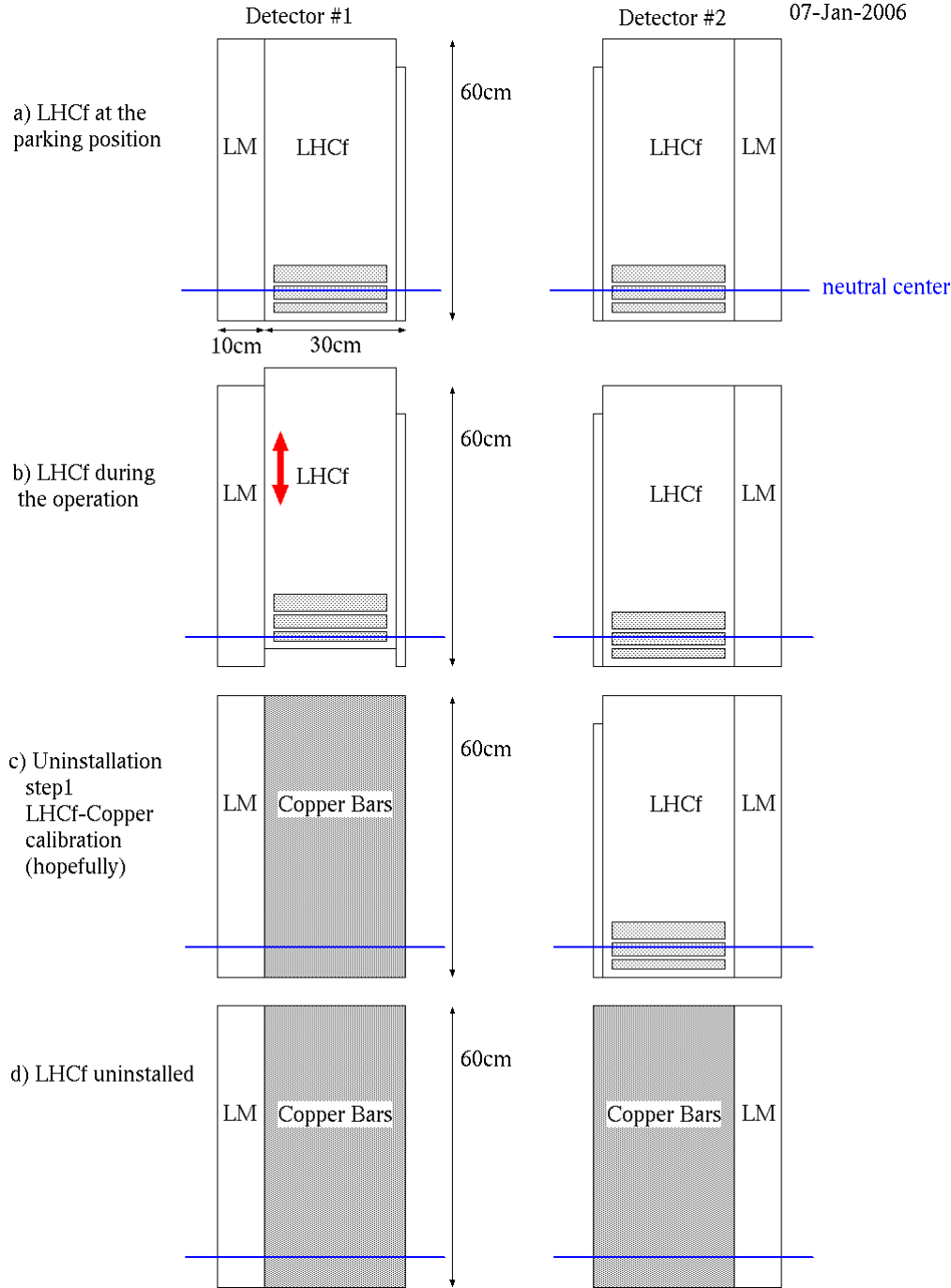


LHCf Operation Strategy

- LHCf will be installed from the beginning of the commissioning in 2007.
- LHCf is installed in the 30cm slot in front of LM.
- LHCf operates as parasite during 2007.
- LHCf requests maximum crossing angle during its operation.
- LHCf will be uninstalled when the luminosity exceeds 10^{30} to avoid radiation damage and multihit events.
- LHCf requests a dedicated run when LHC will operate at a low luminosity for TOTEM.

Compatibility with LM

- LHCf stays at the same position except its operation, which will last a few days.
- During the operation LHCf vertically moves at maximum about 10cm.
- Even during the operation, one of the two detectors stay at the parking position.
- For the LHCf movement, response of LM is calibrated before the LHCf operation.
- At the time of LHCf uninstallation, LHCf-Copper bars intercalibration will be made if necessary.



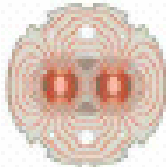
a) LHCf at the parking position

b) LHCf operation

Only one of the two changes the position.

c) LHCf-Copper inter calibration (if necessary)

d) LHCf uninstalled



Stage 1 – pilot run luminosities

$$L = \frac{N^2 k_b f \gamma}{4\pi \epsilon_0 \beta^*} F$$

- No squeeze to start
- 43 bunches per beam (some displaced in one beam for LHCb)
- Around 10^{10} per bunch

$$\text{Event rate / Cross} = \frac{L \sigma_{TOT}}{k_b f}$$

BEST for LHCf

Beam energy (TeV)	6.0, 6.5 or 7.0	6.0, 6.5 or 7.0	6.0, 6.5 or 7.0
Number of bunches per beam	43	43	156
β^* in IP 1, 2, 5, 8 (m)	18,10,18,10	2,10,2,10	2,10,2,10
Crossing Angle (μrad)	0	0	0
Transverse emittance ($\mu\text{m rad}$)	3.75	3.75	3.75
Bunch spacing (μs)	2.025	2.025	0.525
Bunch Intensity	$1 \cdot 10^{10}$	$4 \cdot 10^{10}$	$9 \cdot 10^{10}$
Luminosity IP 1 & 5 ($\text{cm}^{-2} \text{s}^{-1}$)	$\sim 3 \cdot 10^{28}$	$\sim 5 \cdot 10^{28}$	$\sim 1 \cdot 10^{29}$
Event rate / crossing IP 1 & 5	low	0.76	3.9
Luminosity IP 2 ($\text{cm}^{-2} \text{s}^{-1}$)	$\sim 6 \cdot 10^{28}$	$\sim 1 \cdot 10^{29}$	$\sim 2 \cdot 10^{29}$
Event rate / crossing IP 2	low	0.15	0.76

- Push one or all of
 - Partial optics squeeze in 1 and 5 (2m ???)
 - Increase bunch intensity
 - 156 bunches per beam (some displaced in one beam for LHCb)

Misc - How long?

	Phase	R1/2	Time [days]	Total
1	Injection	2	1	2
2	First turn	2	3	6
3	Circulating beam	2	3	6
4	450 GeV: initial commissioning	2	4	8
5	450 GeV: detailed measurements	2	4	8
6	450 GeV: 2 beams	1	2	2
7	Nominal cycle	1	5	5
8	Snapback – single beam	2	3	6
9	Ramp – single beam	2	4	8
10	Single beam	2	2	4
11	Two beams to physics energy	1	3	3
12	Establish Physics	1	2	2
13	Commission squeeze	2	4	4
14	Physics partially squeezed			
	TOTAL			60

hopefully LHCf Operation

BEST for LHCf Operation

How long does LHCf operate? (1)

$$\text{Beta} = 18\text{m}$$

$$\epsilon = 3.75\mu\text{m rad}$$

$$N = 10^{10} \text{ ppb}$$

$$\gamma = 7500$$

$$\sigma_{pp} = 80\text{mb} = 8\text{E-}30\text{m}^2$$

$$R_{pp} = \frac{\gamma M N^2 \sigma_{pp}}{4\pi \beta \epsilon} = 7\text{E-}3 / \text{cross}$$

$$R_{pg} = 5\text{E-}5 / \text{cross} \quad \text{for } 1.8\text{E}12 \text{ H}^2\text{-equiv/m}^3$$

$$L = 280\text{m}$$

$$f_{rev} = 1.1\text{E}4 \text{ Hz}$$

$$N_{bunch} = 43$$

$$7\text{E-}3 \times 1.1\text{E}4 \times 43 = 3500 \text{ int / sec}$$

$$\gamma \quad 0.05 \quad = \quad 175$$

Require 10^4 gamma / run
=> 1 min

g/s

$$n \quad 0.05 \times 0.3 \quad = \quad 60 \text{ n/s}$$

Require 10^4 π^0 / run
=> $3\text{E}3$ sec (50min.)

$$\pi^0 \quad 0.05 \times 1/50 \quad = \quad 3.5\pi^0/\text{s}$$

How long does LHCf operate? (2)

Run scenario (preliminary example)

w/ angl	arm1	arm2
50min	-2cm	-2cm
80min ?	-3cm	-2cm
120min ?	-4cm	-2cm
80min ?	-1cm	-2cm
120min ?	0 cm	-2cm
200min ?	+1cm	-2cm
200min ?	+2cm	-2cm
5 min	+3cm	-2cm
5 min	+4cm	-2cm

w/ angl	arm1	arm2
50min	-2cm	-2cm
80min ?	-2cm	-3cm
120min ?	-2cm	-4cm
80min ?	-2cm	-1cm
120min ?	-2 cm	0cm
200min ?	-2cm	1cm
200min ?	-2cm	2cm
5 min	-2cm	3cm
5 min	-2cm	4 cm

→ total ~1800 min ~1.5day