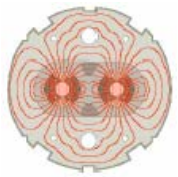


Joint LHC Machine-Experiments Workshop on Very Forward Detectors

Summary

D. Macina (CERN)

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

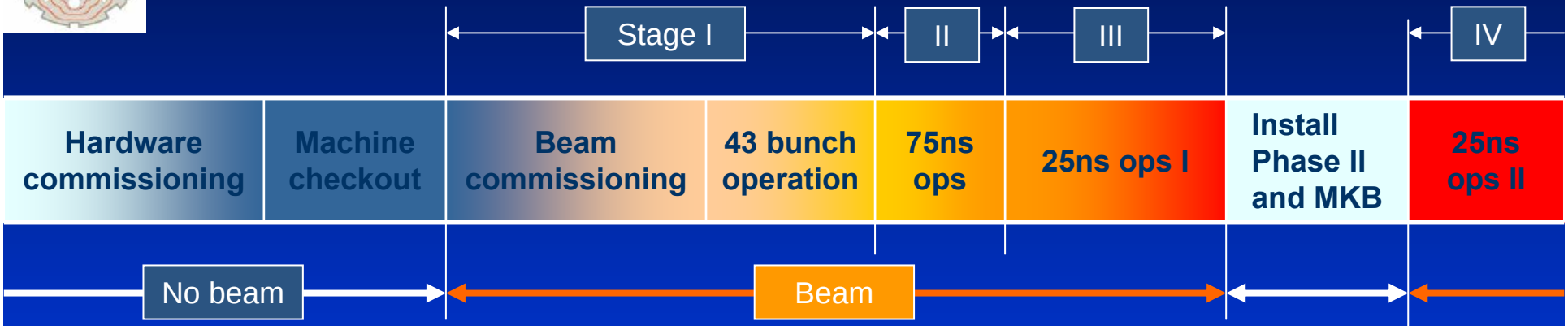
09:00->*12:50* Morning Session (Convener: Daniela Macina (*CERN*))

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*)

Overall commissioning strategy for protons (est^{d}. 2005)



I. Pilot physics run
- First collisions
- 43 bunches, no crossing angle, no squeeze, moderate intensities
- Push performance
- Performance limit 10^{32} cm^{-2} s^{-1} (event pileup)

II. 75ns operation
- Establish multi-bunch operation, moderate intensities
- Relaxed machine parameters (squeeze and crossing angle)
- Push squeeze and crossing angle
- Performance limit 10^{33} cm^{-2} s^{-1} (event pileup)

III. 25ns operation I
- Nominal crossing angle
- Push squeeze
- Increase intensity to 50% nominal
- Performance limit 2 10^{33} cm^{-2} s^{-1}

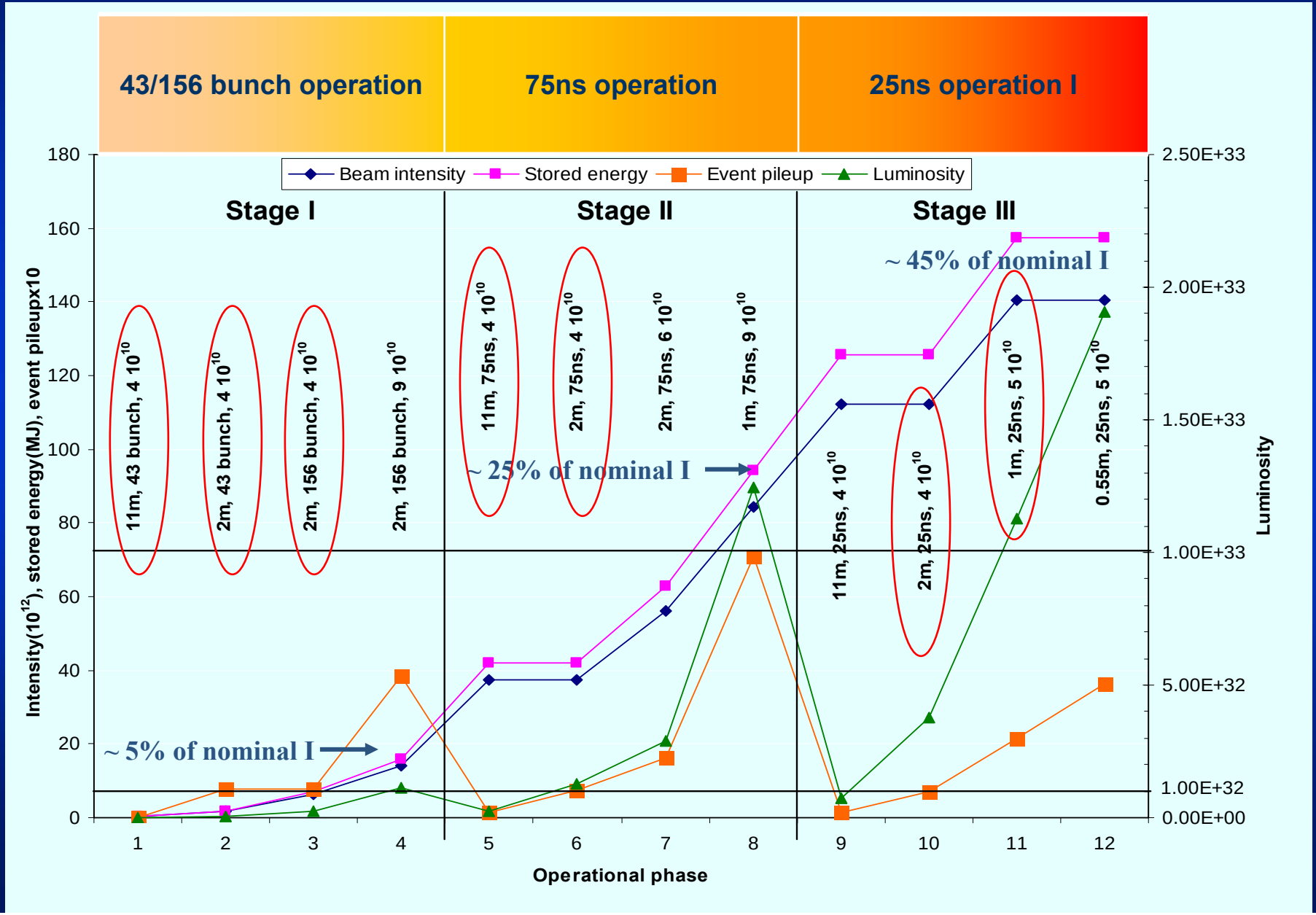
IV. 25ns operation II
- Push towards nominal performance

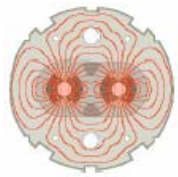
Minimise
- *Complexity*
- *Beampower*
- *Losses* (β^*)
- *Pileup*

Optimise
- N
- k_b
- β^*

R.Bailey, January 2007

Evolution of beam levels and luminosity stages I II & III





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

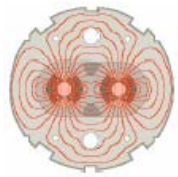
R.Bailey, January 2007

Need soon to get into the details of late 2007 …

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

But …

- During the pressure test of Sector 8-1 (25th November) the heat exchanger tube in the inner triplet failed at 9 bar differential pressure
- A repair procedure is being validated and will have to be implemented on all 24 quadrupoles (18 are already installed)
- Priority: Inner triplet quadrupoles in 5L and 5R to be repaired in time for Sectors 4-5 and 5-6 cooldown. Others afterwards.
- Consequences
  - Planning will have to change
  - Sector 8-1 will be cooled down and commissioned after 4-5
  - Sector 8-1 will be commissioned only to 450GeV in 2007
  - 450GeV run in 2007 is still the target
  - More time needed for commissioning hardware to high energy in 2008



Engineering run in 2007

0

Installation Hardware Commissioning	Hardware Commissioning 450GeV	Engineering Run 450GeV

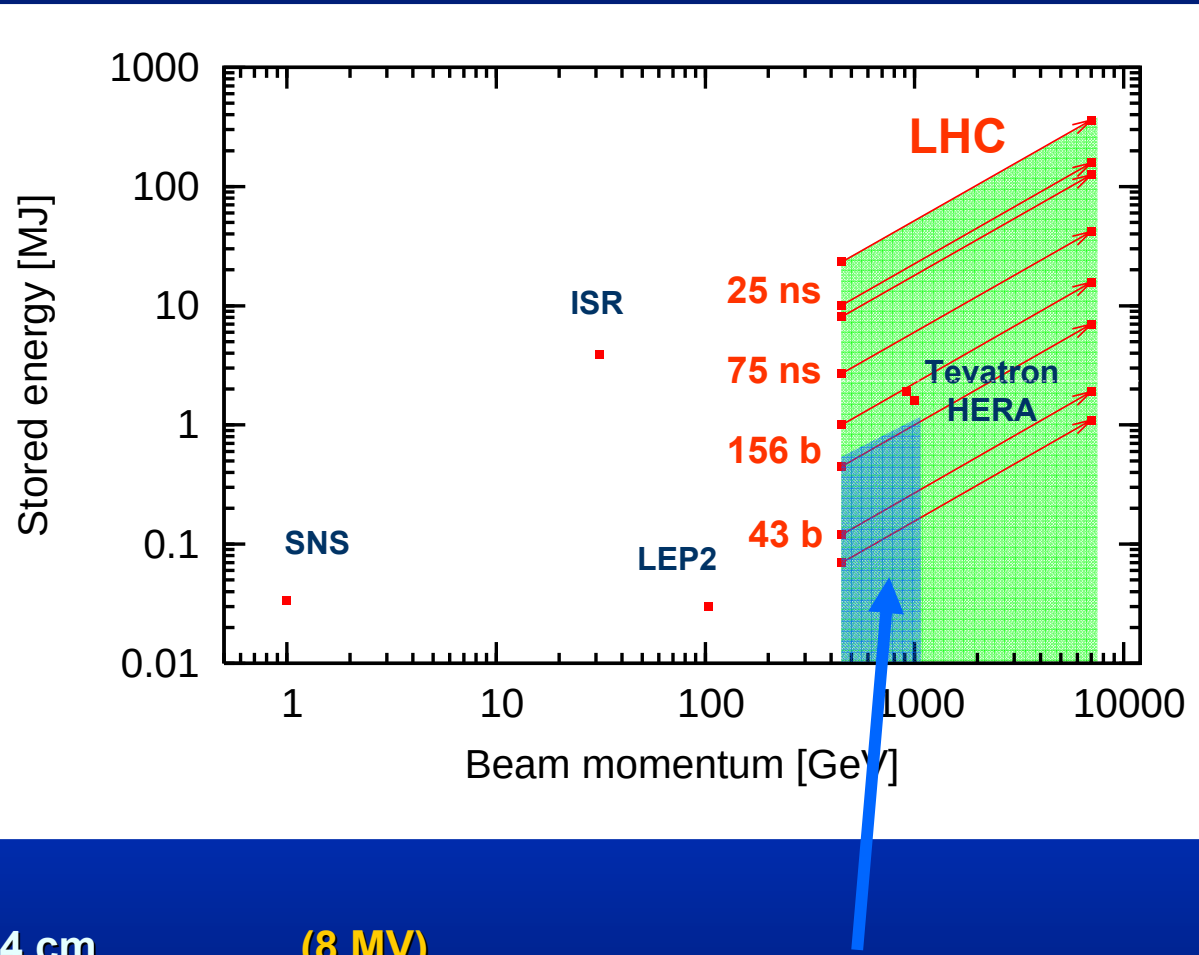
Machine checkout 450GeV	Beam commissioning 450GeV	Collisions 450GeV Ramp commissioning

- **Aims:**
  - Commission essential safety systems
  - Commission essential beam instrumentation
  - Commission essential hardware systems
  - Perform beam based measurements to check:
    - Polarities
    - Aperture
    - Field characteristics
  - Establish stable two beam operations
  - Provide collisions
  - Interleave with further machine development, in particular, the ramp

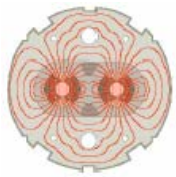
Should provide a firm platform for eventual commissioning to 7 TeV and provide lead time for problem resolution.

450GeV run - Machine Configuration

- Crossing angles off
  - 1, 12, 43, 156 bunches
- Separation bumps on
  - 2 beam operation
- Optics
  - β*= 11m in IR 1 & 5
  - β*= 10m in IR 2 & 8
- Transverse beam sizes
  - 290 μm at 1 and 5
  - 277 μm at 2 and 8
- Shift bunches for LHCb
  - 4 out of 43 bunches
  - 16 bunches out of 156



- Nominal bunch length: 11.24 cm (8 MV)
- Later shortened with higher RF voltage (16 MV)
- Solenoids & Exp. Dipoles etc. off (to start with)



450 GeV Phases and estimated time

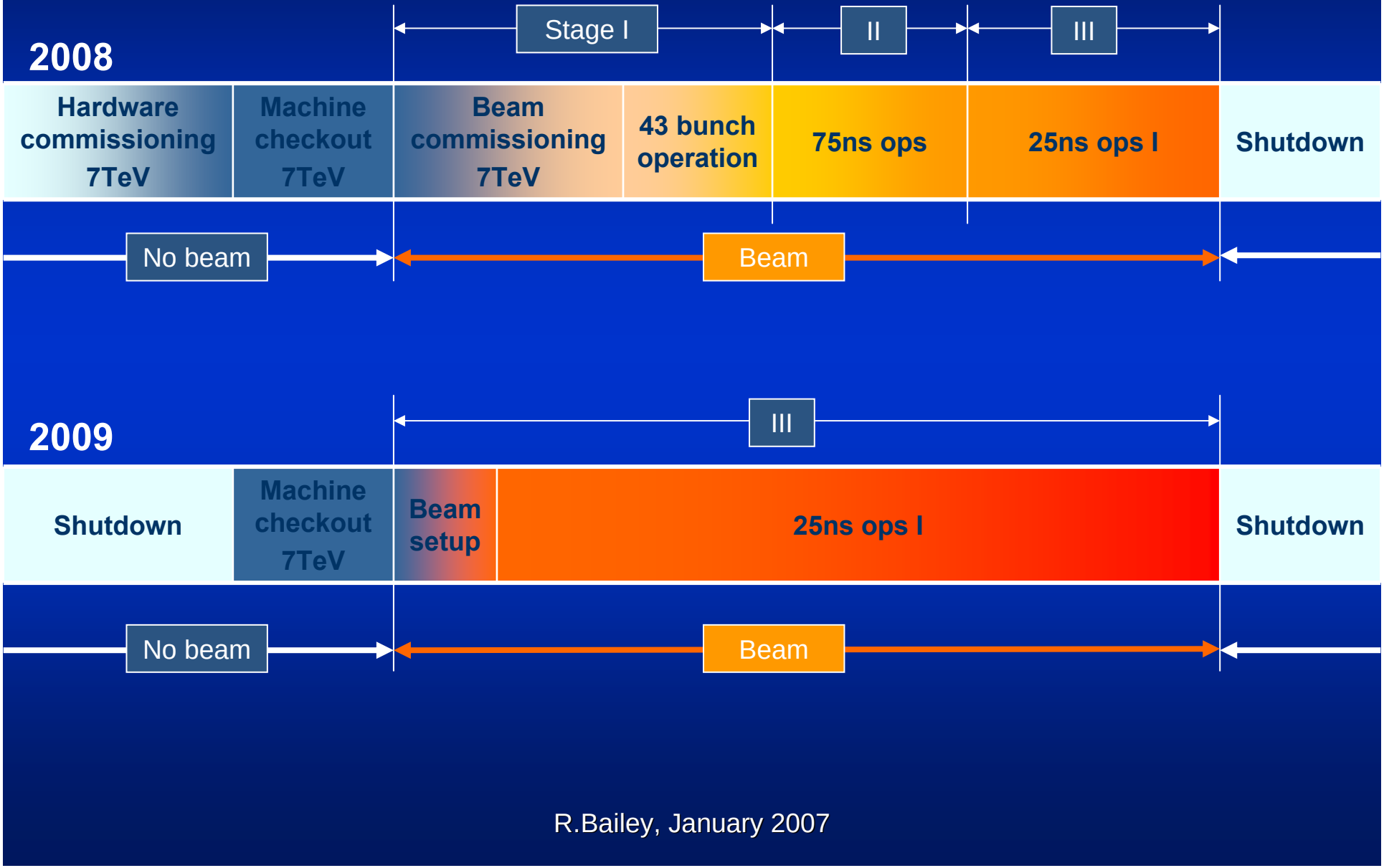
	Phase	Beam time [days]	Beam
1	First turn	4	1 x Pilot
2	Establish circulating beam	3	1 x Pilot
3	450 GeV – initial	3	1 x Pilot++
4a	450 GeV - consolidation	1-2	1 x Pilot++
4b	450 GeV – system commissioning	2-3	1 x Pilot++
5a	2 beam operations	1	2 x Pilot++
5b	Collisions	1-2	2 x Pilot++ →
		16 days	

Given an operational efficiency of 60%, this gives an elapsed time of about 26 days.

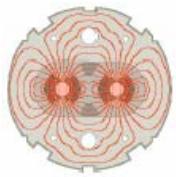
Some opportunities for parallel development and parasitic studies

R.Bailey, January 2007

Beyond 2007



R.Bailey, January 2007



Full commissioning

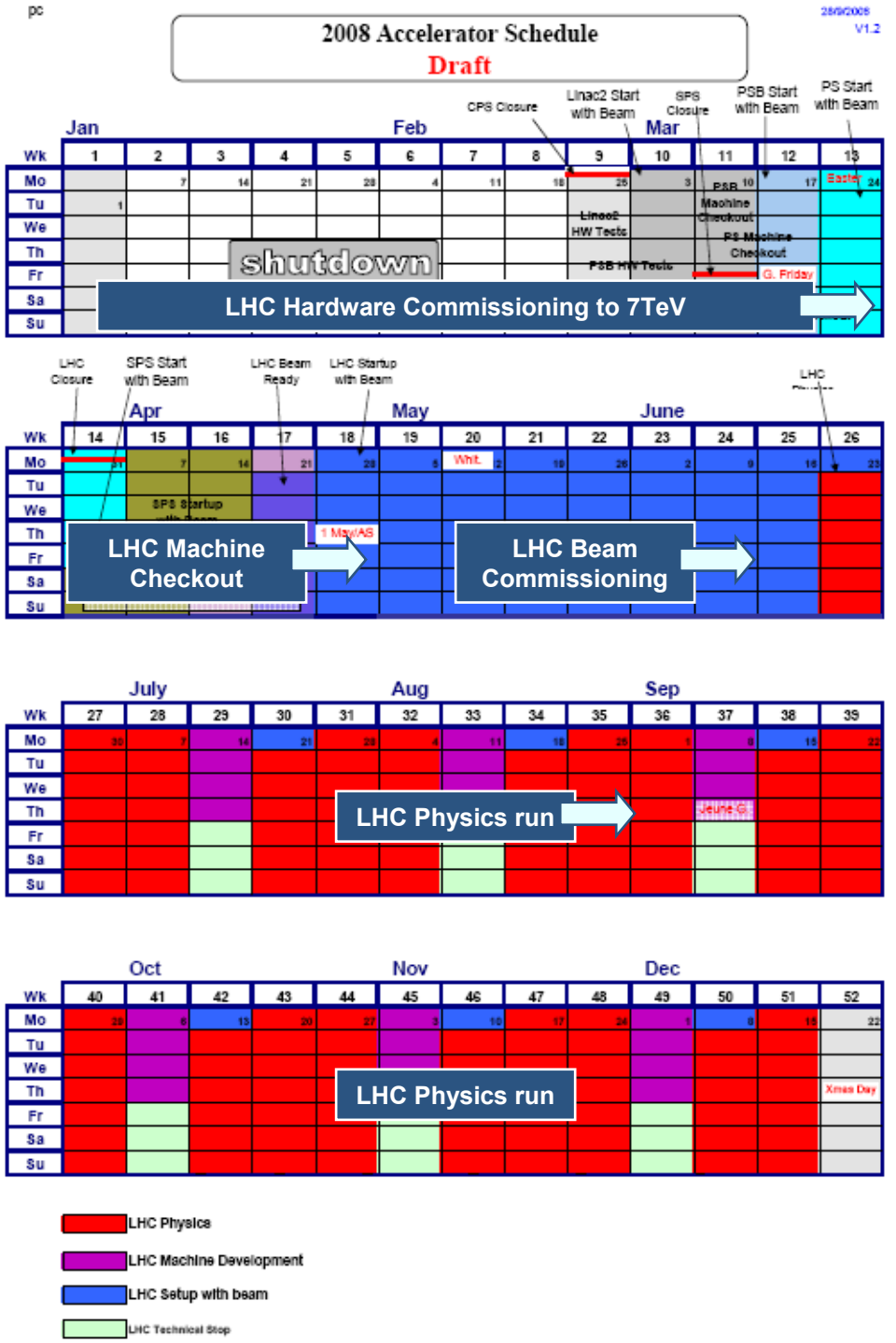
		Rings	Total [days] both rings
1	Injection and first turn	2	6
2	Circulating beam	2	3
3	450 GeV - initial	2	5
4	450 GeV - detailed	2	12
5	450 GeV - two beams	1	2
6	Snapback - single beam	2	4
7	Ramp - single beam	2	8
8	Ramp - both beams	1	3
9	7 TeV - setup for physics	1	2
10	Physics un-squeezed	1	-
	TOTAL to first collisions		45
11	Commission squeeze	2	6
12	Increase Intensity	2	6
13	Set-up physics - partially squeezed.	1	2
14	Pilot physics run		

Should benefit from 450 GeV run

Aiming to do this in around 2 months.

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



R.Bailey, Ja

Summary – aims for 2007

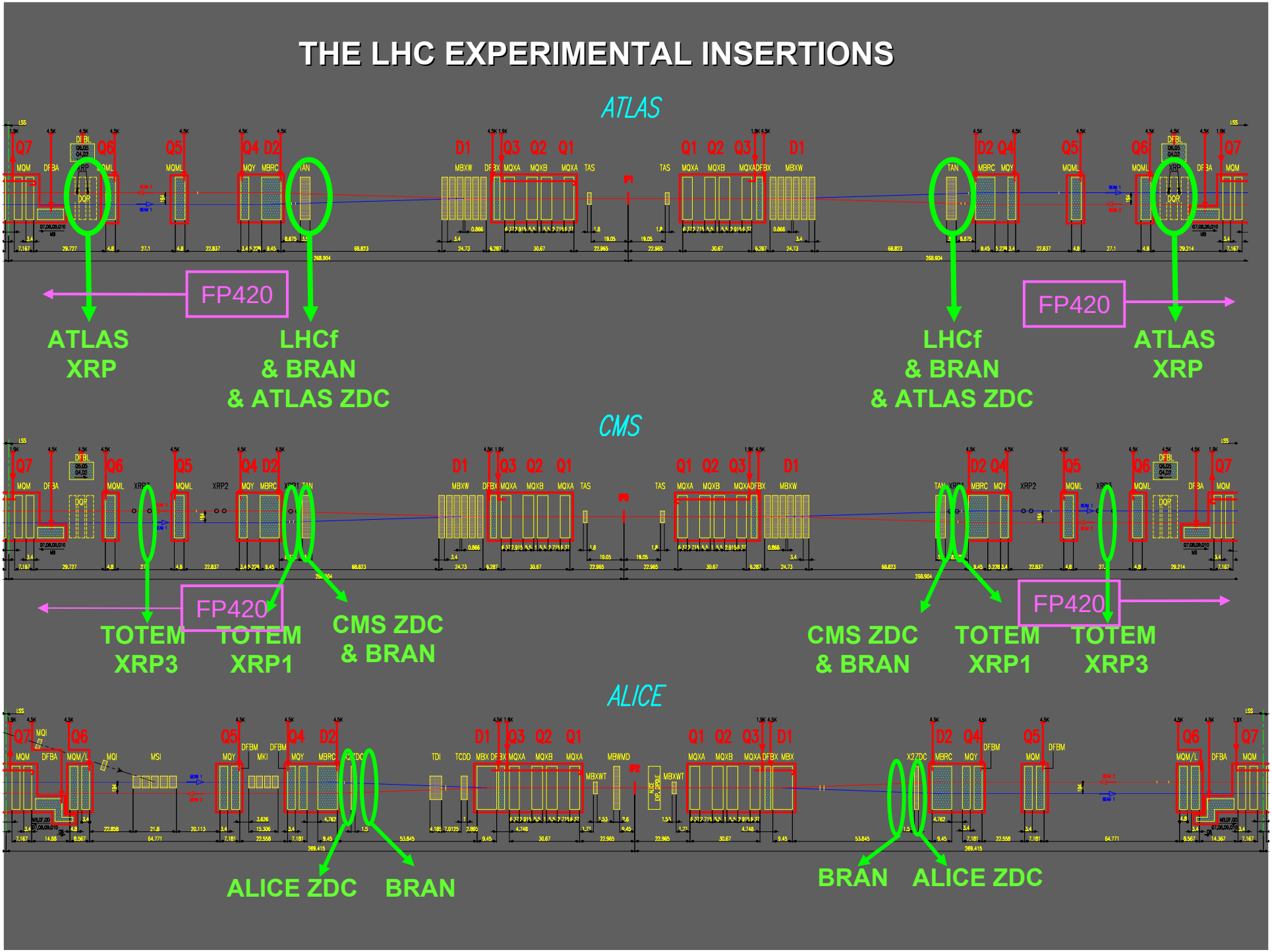
- Commission 450GeV machine
  - Multiple bunches (43) circulating in each ring
  - Single beam lifetimes ~ 30h
  - Injection optics (β^*= 11 m in IR 1 & 5, β^*= 10 m in IR 2 & 8)
  - No squeeze
  - No crossing angle
  - Collisions
- Secondary aims
  - Commission ramp to 1TeV
  - Commission crossing angle
  - Commission 75ns beams

Summary – aims for 2008

- Commission high energy operation
  - Aim for 7TeV (magnets will decide)
  - 43 /156 bunch running
    - No squeeze to start
    - Then commission partial squeeze (aim for 2m)
  - 75ns running
  - 25ns running
  - High 10^{32} cm^{-2} s^{-1} is in reach
- ~100 days for physics?
- Efficiency for physics ~40%?

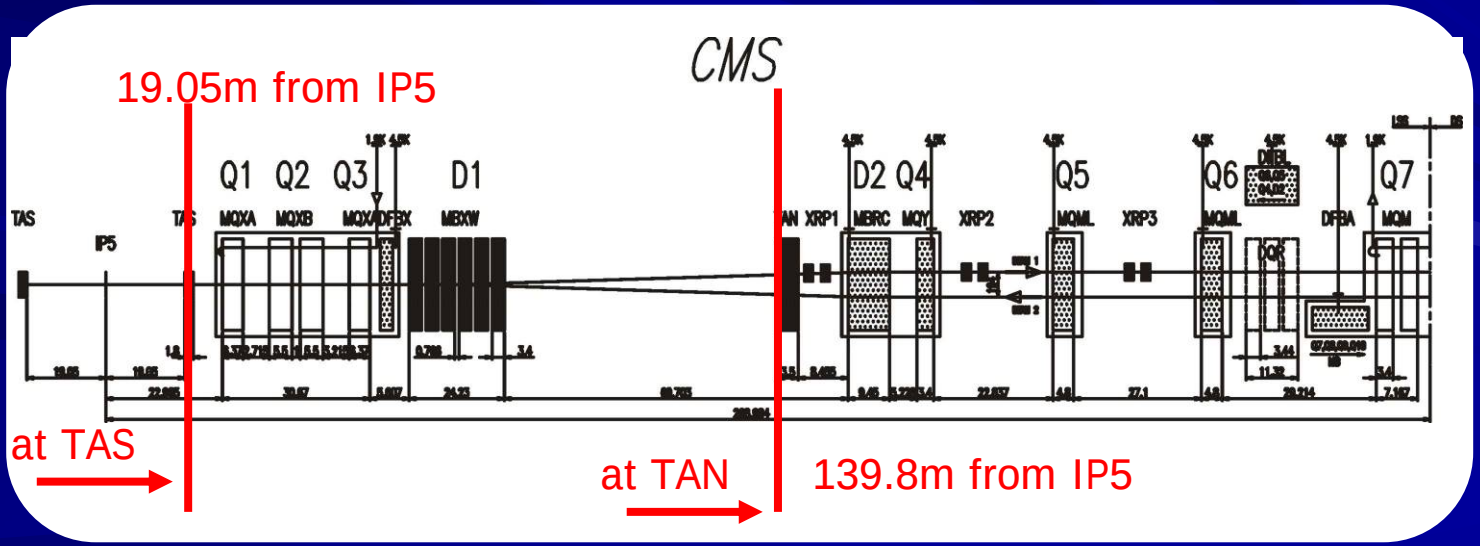
(10^6 seconds @ <L> of 10^{33} cm^{-2} s^{-1} → 1 fb^{-1})

THE LHC EXPERIMENTAL INSERTIONS

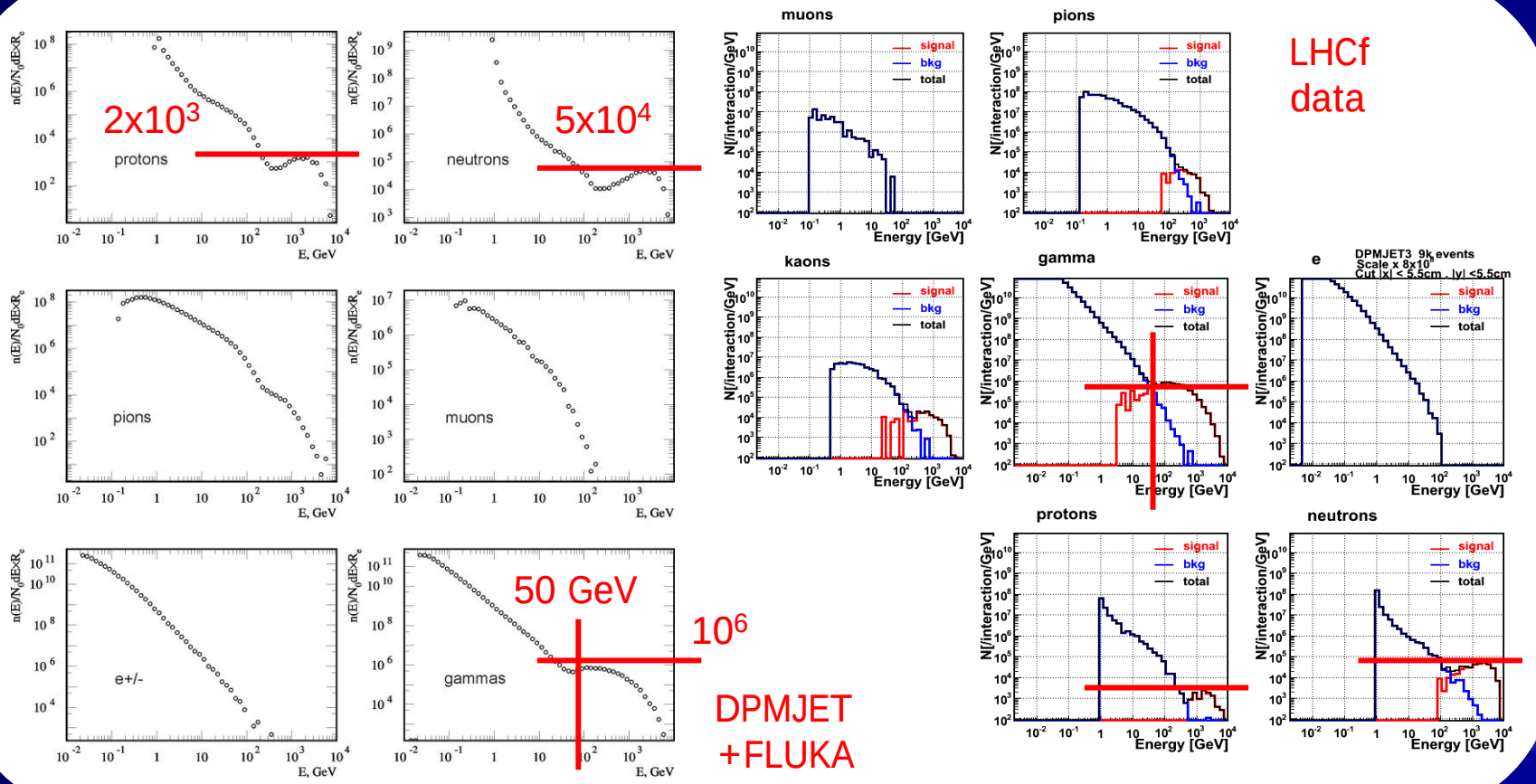


SIGNAL/BACKGROUND SIMULATION AT THE RECOMBINATION CHAMBER

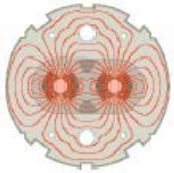
- DPMJET to get the primaries from the p-p interactions and to analyze the source term
- FLUKA to take the generated sources and transport the secondary cascades in the layout of the LSS down to the TAN
- Two sets of sources generated
  - 7x7 TeV, horizontal crossing with 285 μrad
  - 450x450 GeV and no crossing



PARTICLE SPECTRA AT THE TAN



– LEFT: DPMJET-FLUKA, RIGHT: LHCf data by H.Menjo



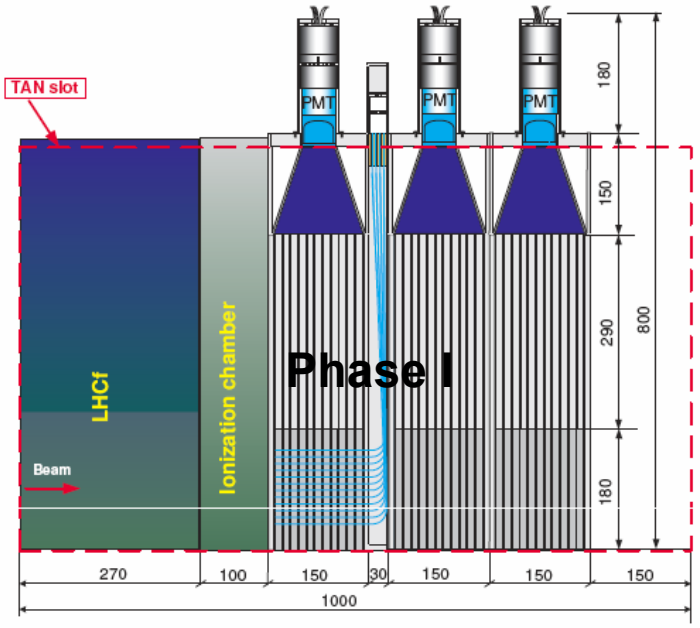
Detectors in the TAN absorber

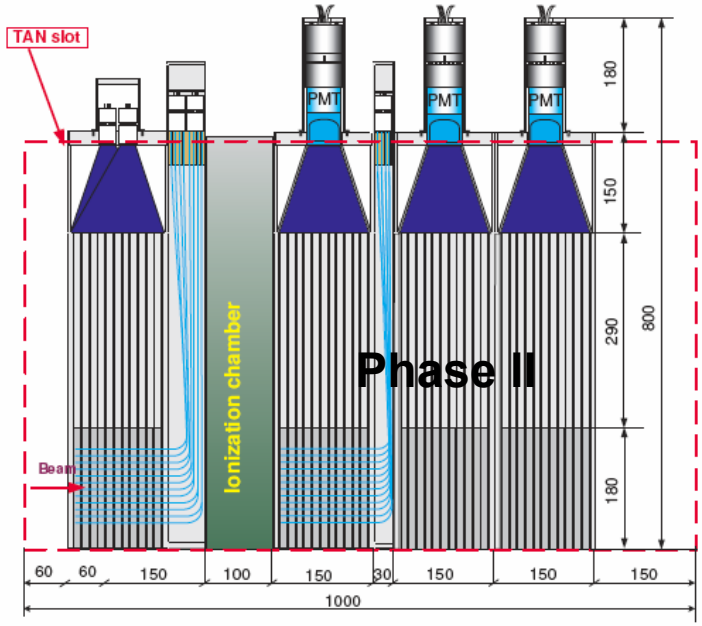
- **ATLAS & CMS ZDC**
  - HI: measure plane and magnitude of the impact parameter, absolute luminosity (mutual e.m. dissociation in the neutron channel)
  - PP: diffractive physics, forward production cross section for cosmic ray simulation, luminosity monitor, measure crossing angle….
- **LHCf detectors**
  - Neutral pions and photons production cross section at the highest energies in the very forward region for the study of atmospheric showers
- **BRAN**
  - 1% measurement at design luminosity (relative luminosity)
  - Can measure crossing angle of the beam
  - Can be used in slow feedback system to maintain optimum luminosity

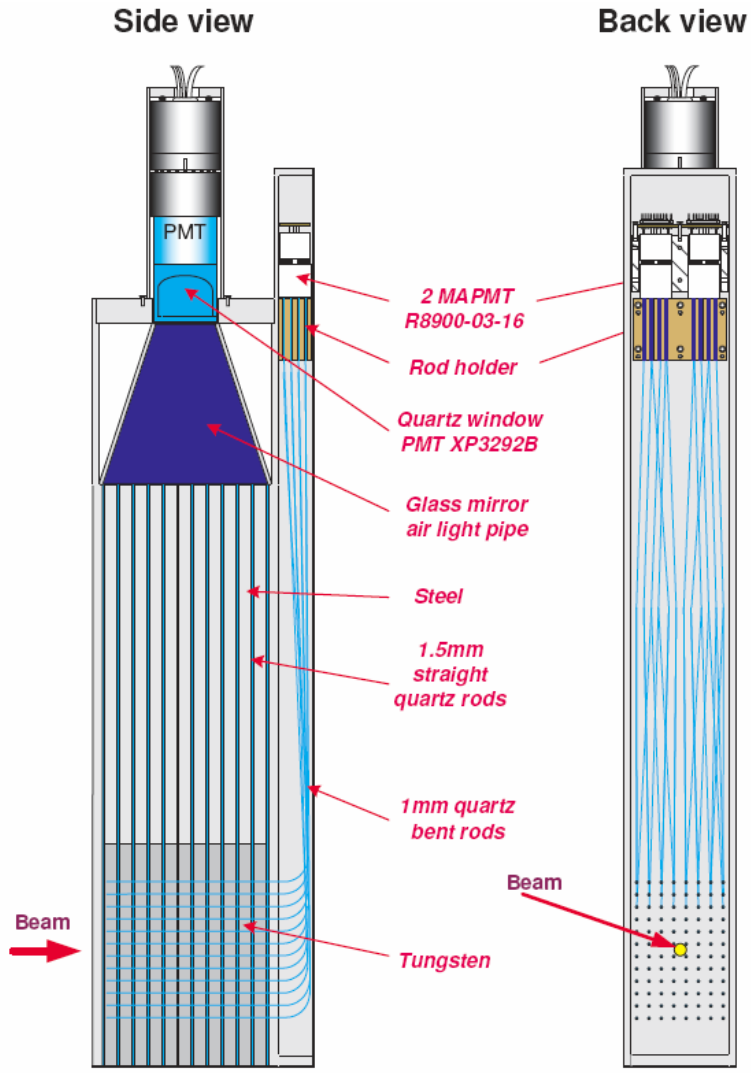
CMS ZDC

TEST BEAM RESULTS IN 2006: ENERGY RESOLUTION AND LINEARITY

ATLAS ZDC


TAN slot
PMT
PMT
PMT
180
150
290
800
180
LHCf
Beam
Ionization chamber
Phase I
270
100
150
30
150
150
150
1000


TAN slot
PMT
PMT
PMT
180
150
290
800
180
Beam
Ionization chamber
Phase II
60
60
150
100
150
30
150
150
150
1000


Side view
Back view
PMT
2 MAPMT
R8900-03-16
Rod holder
Quartz window
PMT XP3292B
Glass mirror
air light pipe
Steel
1.5mm
straight
quartz rods
1mm quartz
bent rods
Tungsten
Beam
Beam

ATLAS ZDC

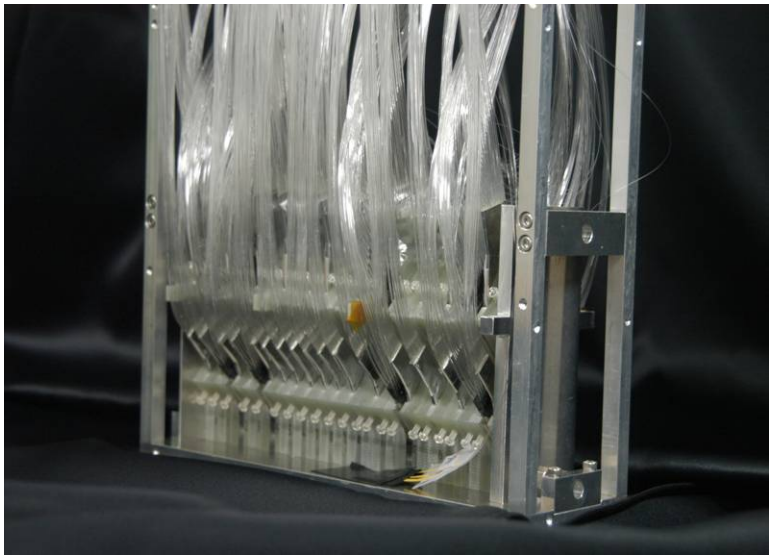
BRAN (Ionization chamber)

Prototypes have been built and continued to be tested

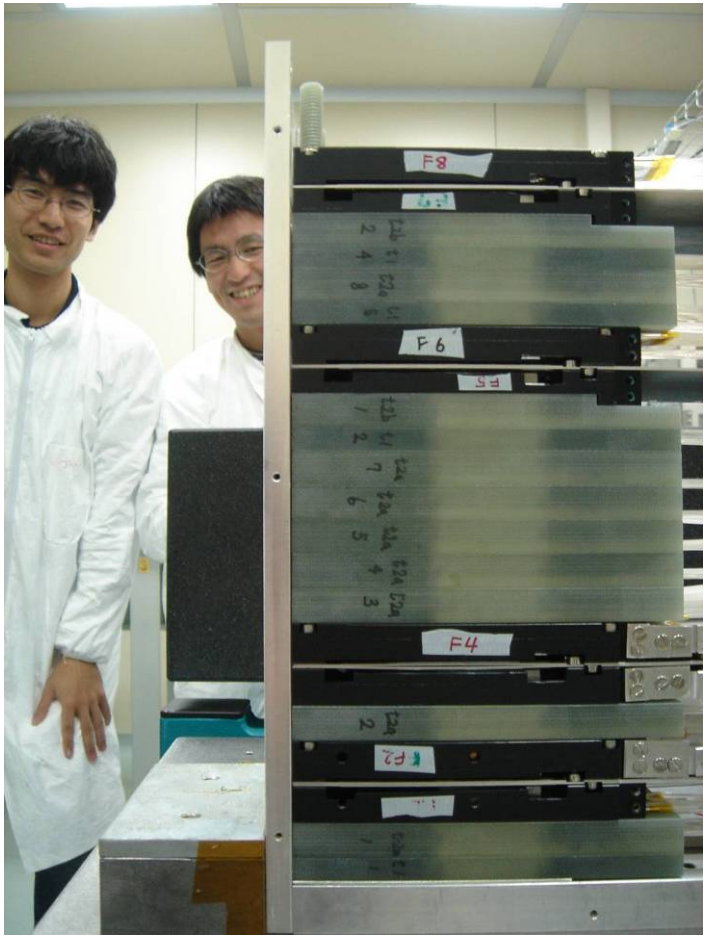
Proposal for test run in SPS in summer 2007

LHCf detectors

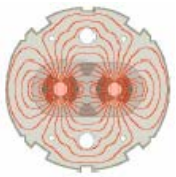
Arm #1
scintillators + fibers + Tungsten



- Test beam in 2006 successful
- Analysis under way



Arm#2 :
scintillators + Si Det + Tungsten



Status of the productions of the detectors to be installed in the TAN

- CMS ZDC: one set ready, second set assembled by end March 07
- BRAN: 2 detectors ready by April 07 and remaining 2 by June 07
    - Electronics under development
    - Readout and software will be developed as resources become available (subset of early commissioning will be available)
- ATLAS ZDC: LoI submitted to LHCC. Operation in 2007 not excluded
- LHCf Arm#1: ready, Arm#2: ready by April 07

Towards final installation in 2007

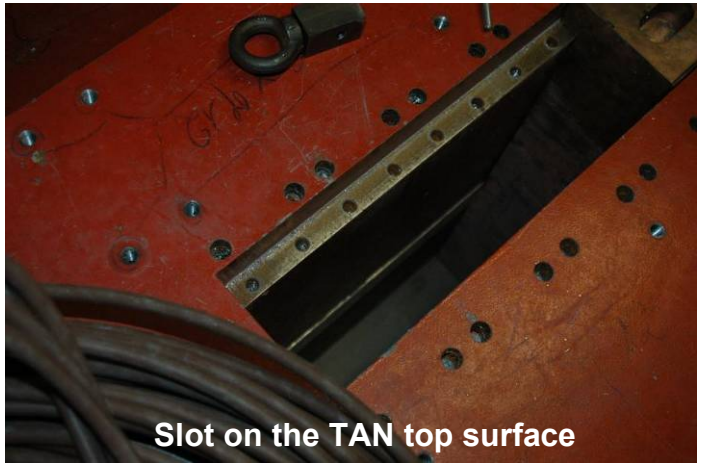
- Huge cable campaign finished. New path had to be defined both in the tunnel and in the experimental areas. New cable trays needed to be added

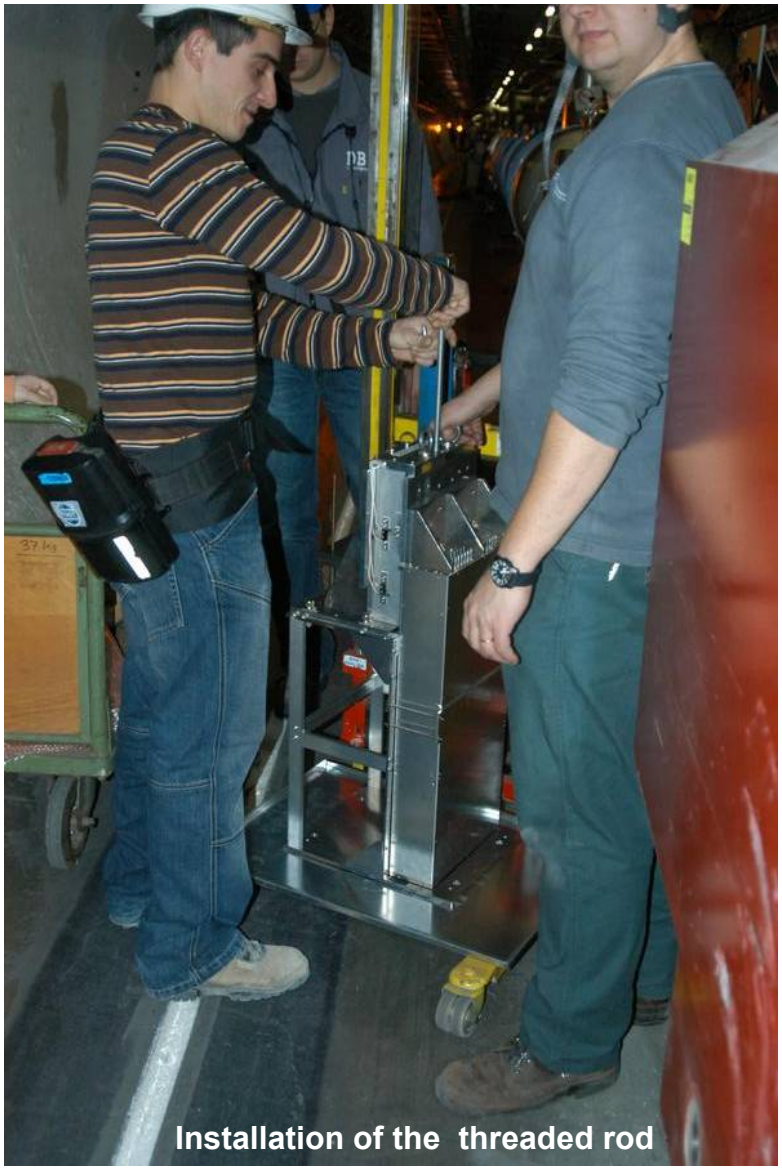
Towards final installation in 2007

- Modification of the CERN forklift to allow the installation the detectors with the electronics already mounted

LHCf first installation on 15 January 2007


Departure from USA15

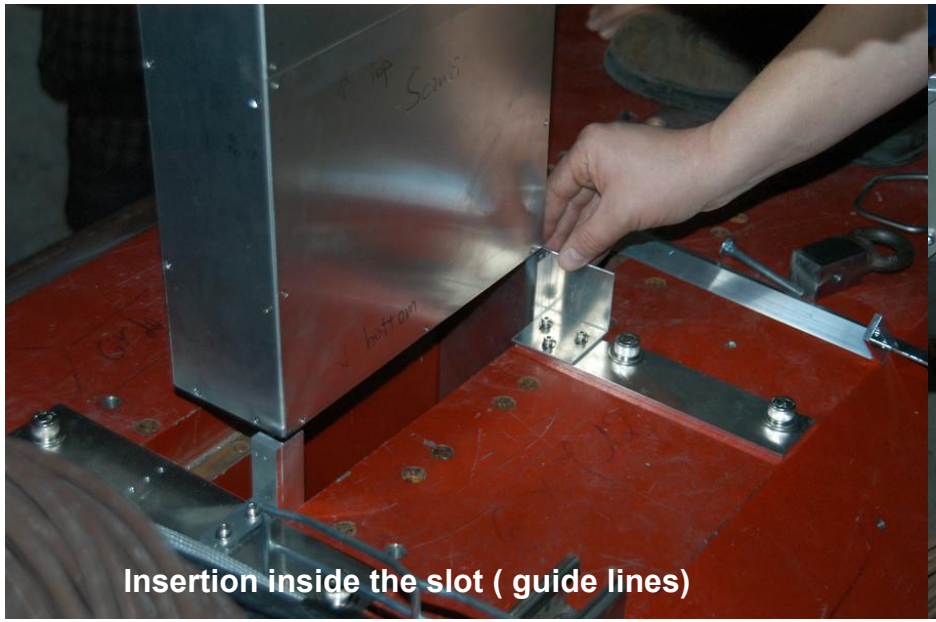

Slot on the TAN top surface


Installation of the threaded rod

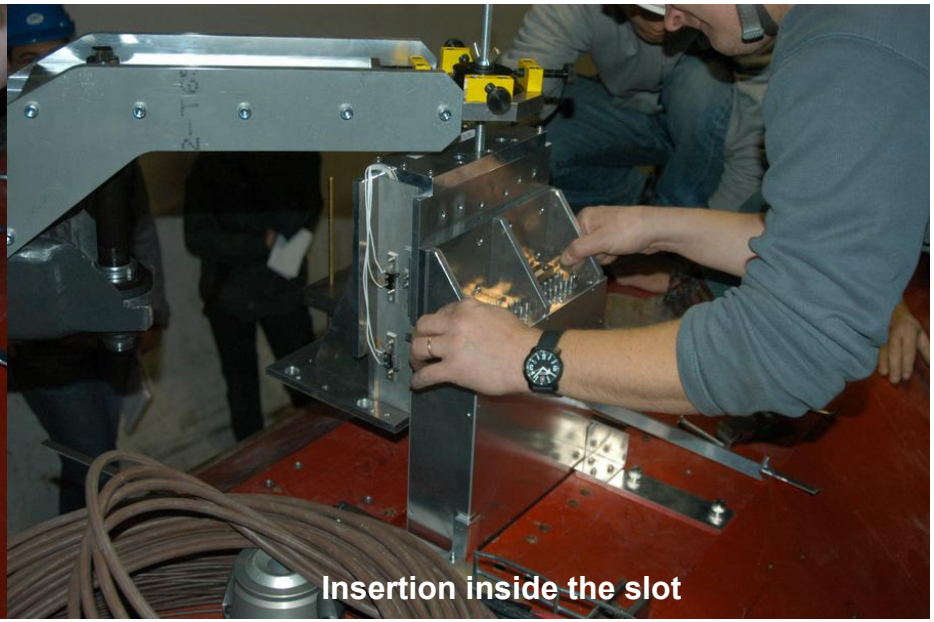
Detector hold on the forklift arm


Removal of the detector chassis and support elevator


Holding of the detector towards the TAN slot

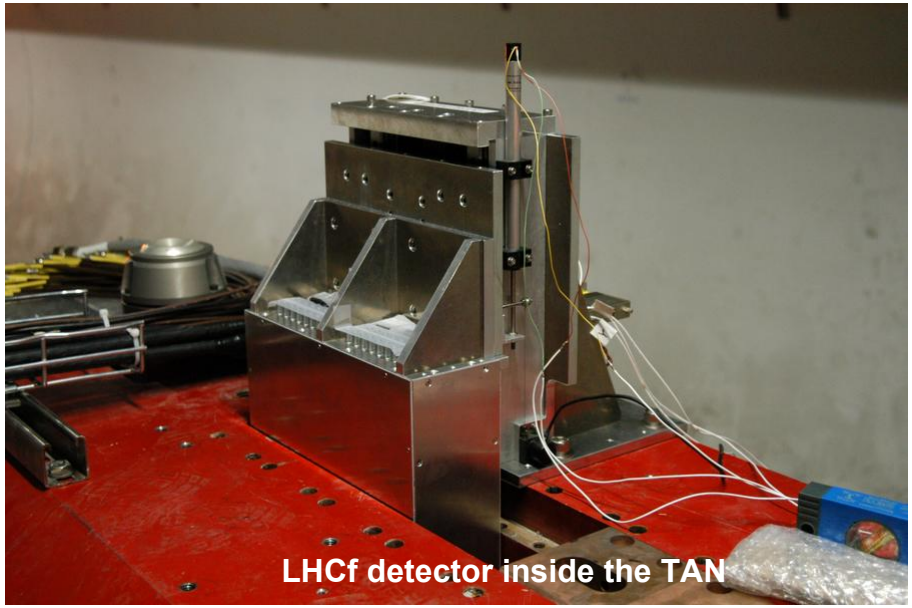


Insertion inside the slot (guide lines)

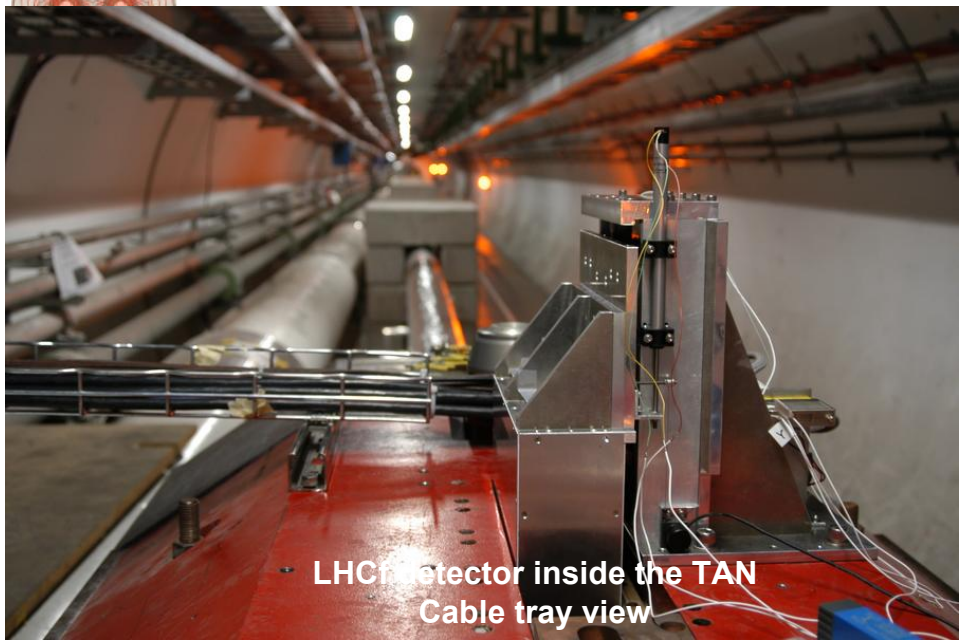


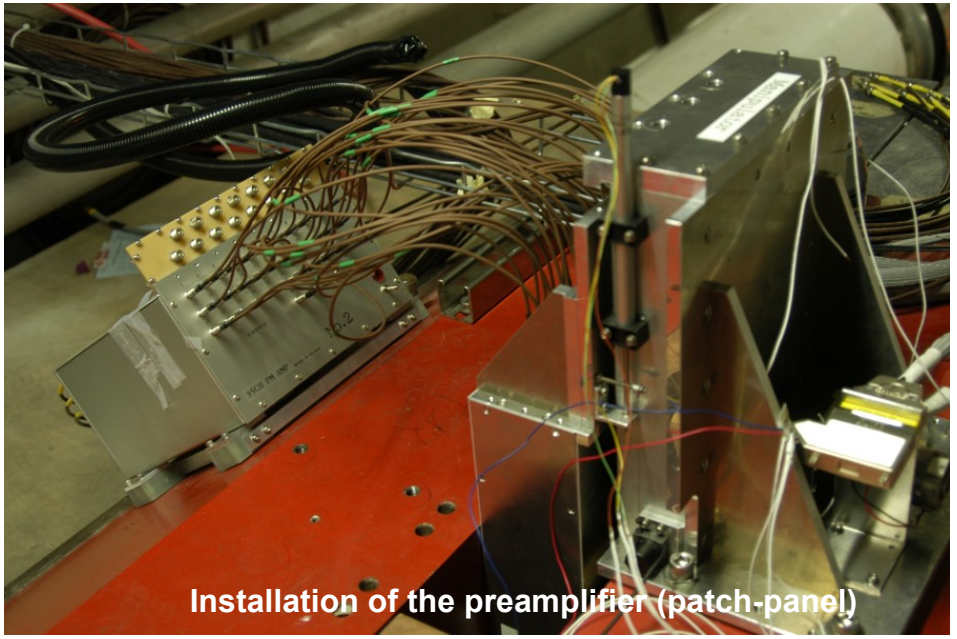
Insertion inside the slot

Removal of the threaded rod



LHCf detector inside the TAN


LHCf detector inside the TAN
Cable tray view


Installation of the preamplifier (patch-panel)

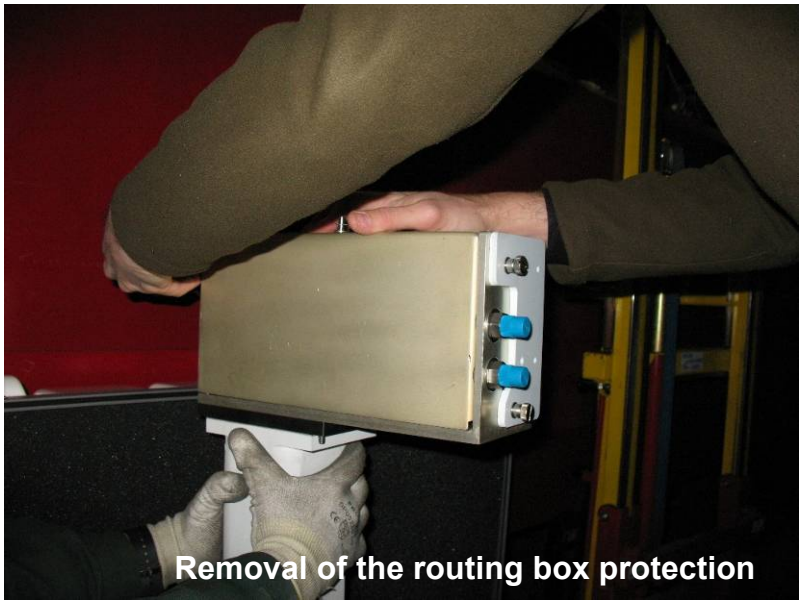
Successful installation (15 minutes!!)

Only a few steps to be optimized

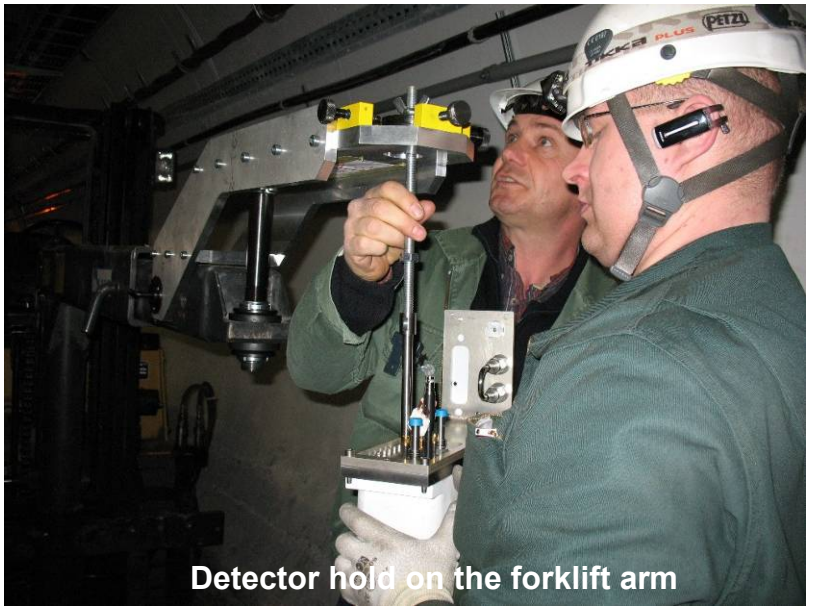
Manual help to insert/remove the detector inside/from the slot = difficult to be avoided
=> to be minimised for the installation during LHC runs

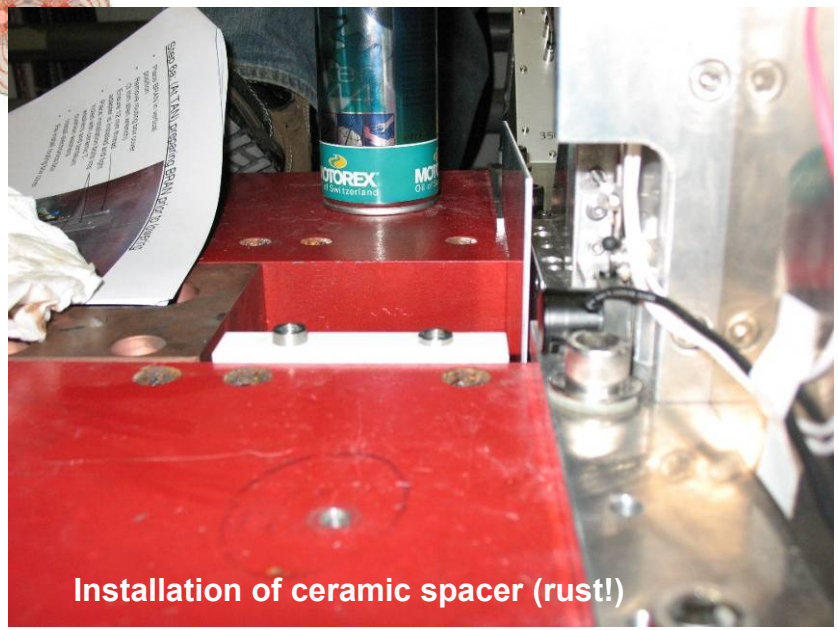
BRAN housing first installation on 22 January 2007


In shipping box

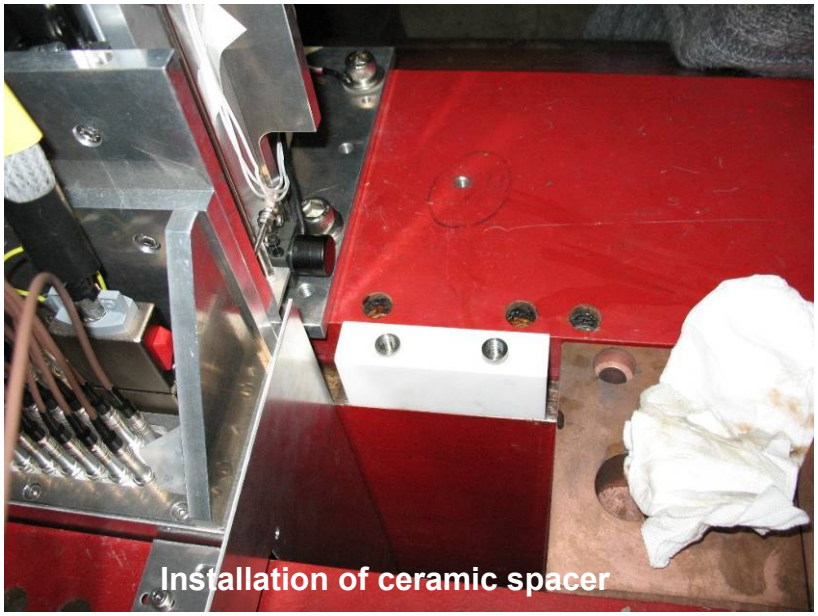

Removal of the routing box protection

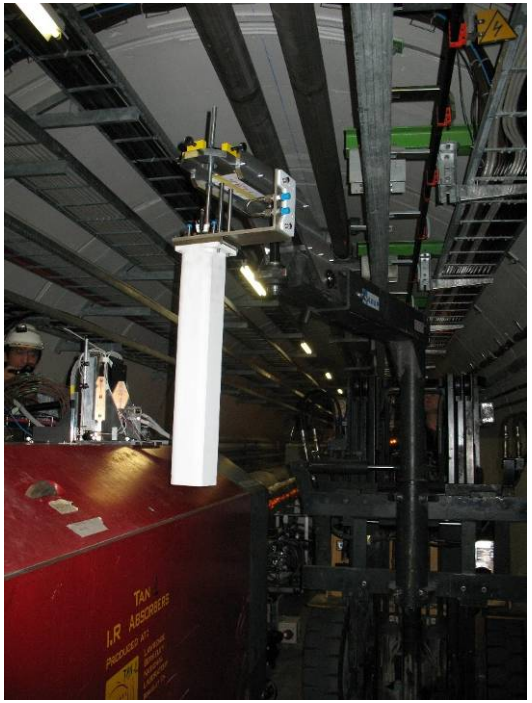

Installation of the 12 mm thread adapter

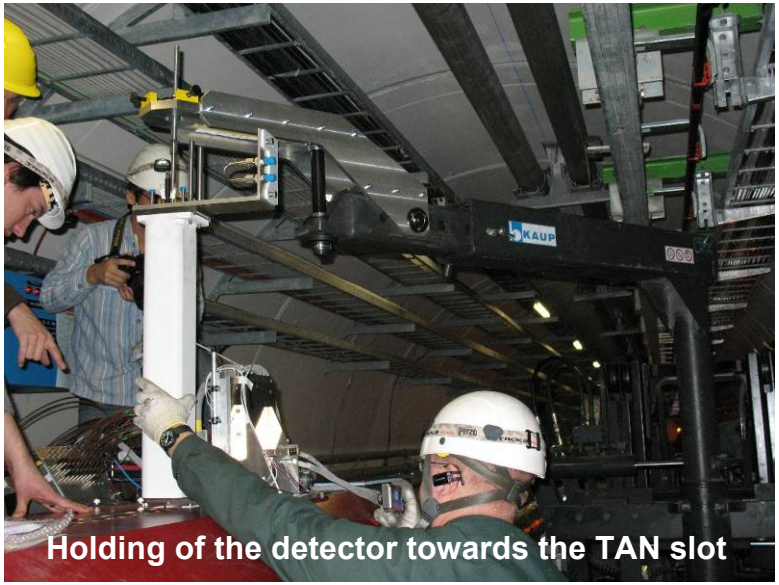

Detector hold on the forklift arm



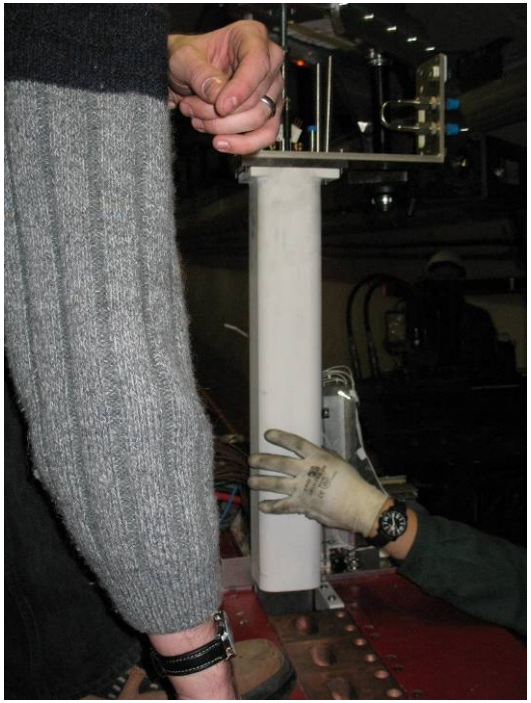
Installation of ceramic spacer (rust!)


Installation of ceramic spacer

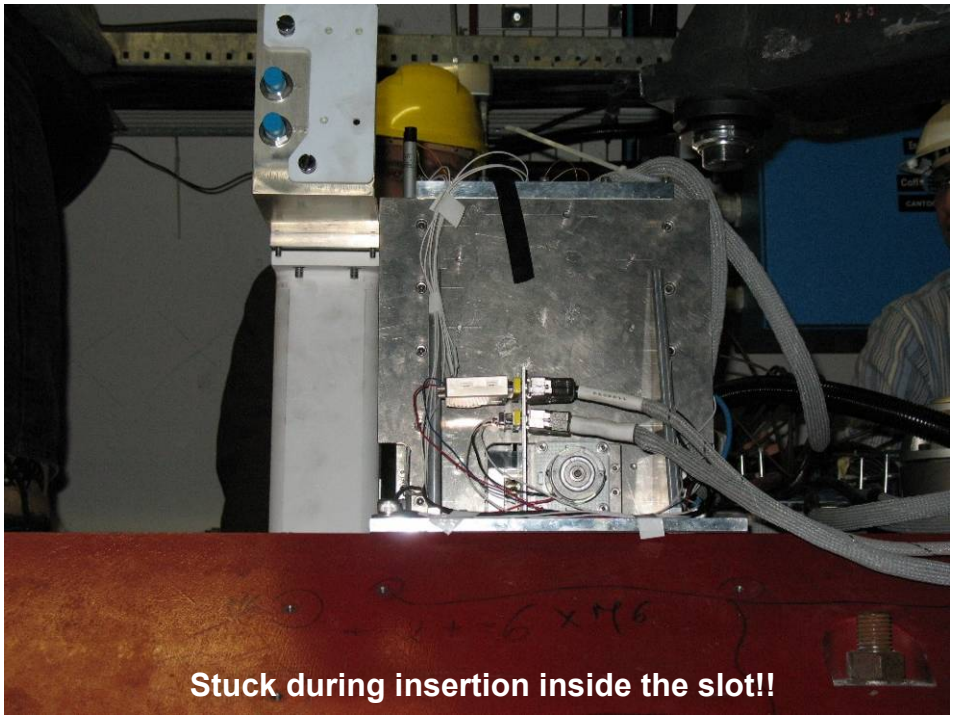




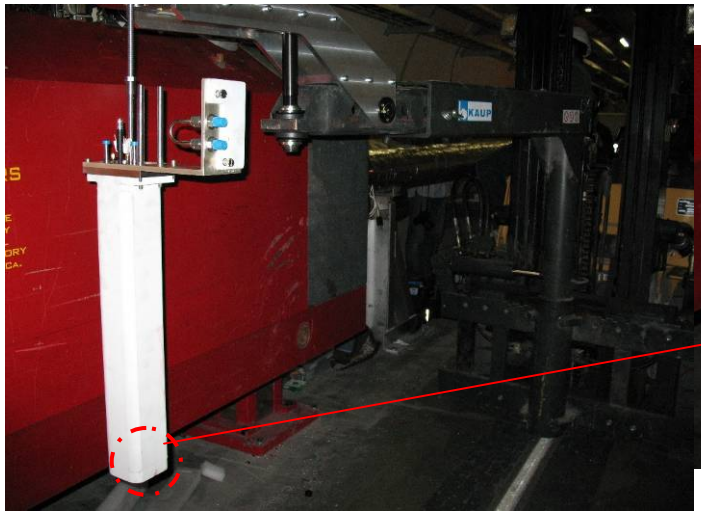
Holding of the detector towards the TAN slot

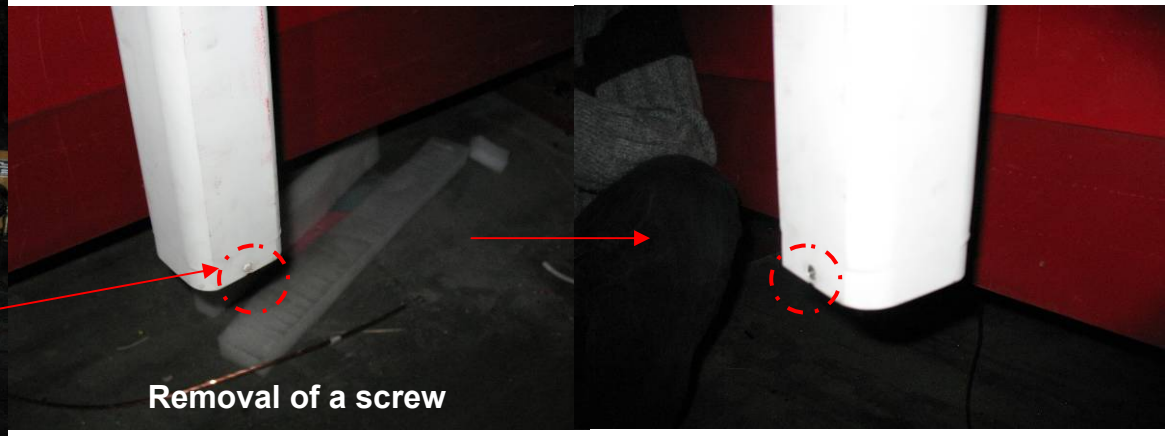


Insertion inside the slot

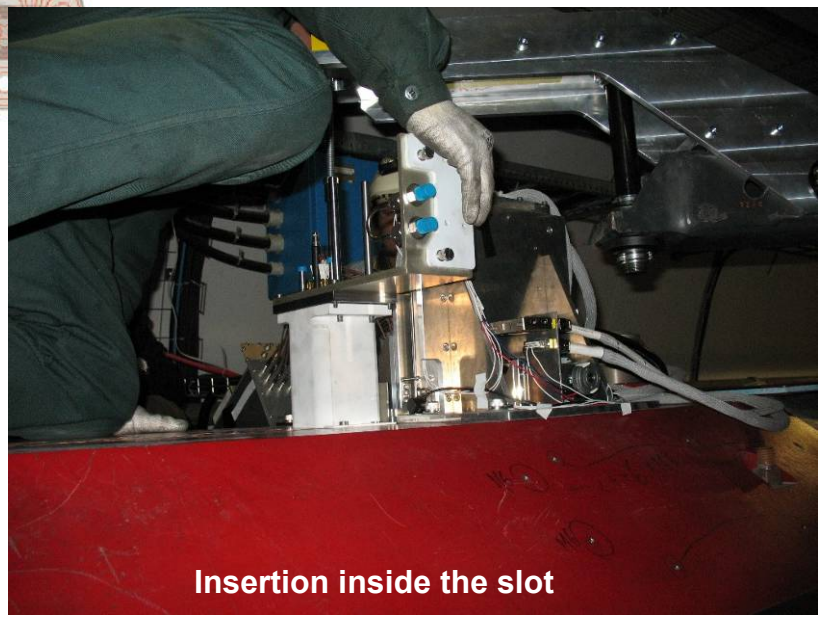


Stuck during insertion inside the slot!!





Removal of a screw



Insertion inside the slot

Final position and removal of the threaded rod

BRAN detector inside the TAN

BRAN and LHCf detectors inside the TAN

CMS ZDC Installation test

We did installation test of EM and HAD sections into wooden mockup of TAN in real conditions i.e. with the forklift and extension arm, installation supports and BRAN.

EM Section

CMS ZDC Installation test

HAD Section

We are grateful to the transport team (Caterine Bertone) and Anne-Laure Perrot (TS/LEA)

Final installation & long term operation

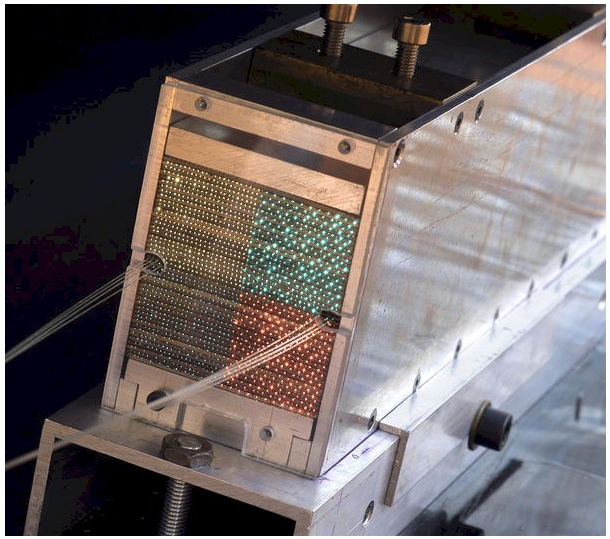
- Final installation is under discussion with the LHC installation planning officers and Hardware Commissioning team:
  - Installation after bakeout and NEG activation
  - Test beam in summer 2007 before final installation
  - Need to fit within a number of activities to be performed in the tunnel -> draft schedule available but it may change due to changes in the general LHC installation planning
- LHCf detectors need to be removed when L> 10^{30} cm^{-2} s^{-1}
- BRAN will stand nominal luminosity
- CMS (ATLAS) ZDC needs to be removed when L (pp)> 10^{33} cm^{-2} s^{-1} and installed only during the HI runs
- The installation procedure needs to be optimized when TAN will be very radioactive (remote handling)

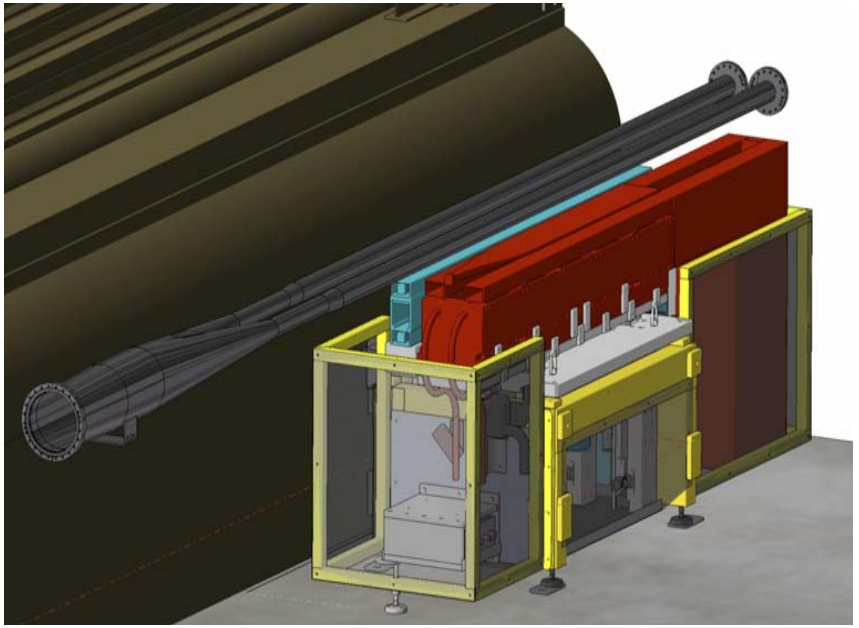
BRAN IP2/8
CdTe detector

- First full module delivered by the end of November 06
- Remaining 3 modules will be delivered in April 07
- Support designed to hold 2 converters of different length (interference with ALICE ZDC)
- Electronics and DAQ on track for the 2007 run

ALICE ZDC

- It consists of ZN and ZP
- It moves in vertical plane (protection during injection and less dose when data taking not needed)
- ZN compatible BRAN if ~3 cm Cu absorber
- It can be used as luminosity monitor (it is possible to measure the Xing angle)
- Cables to be installed in March 07
- Final installation in April and May 2007





TOTEM Roman Pots

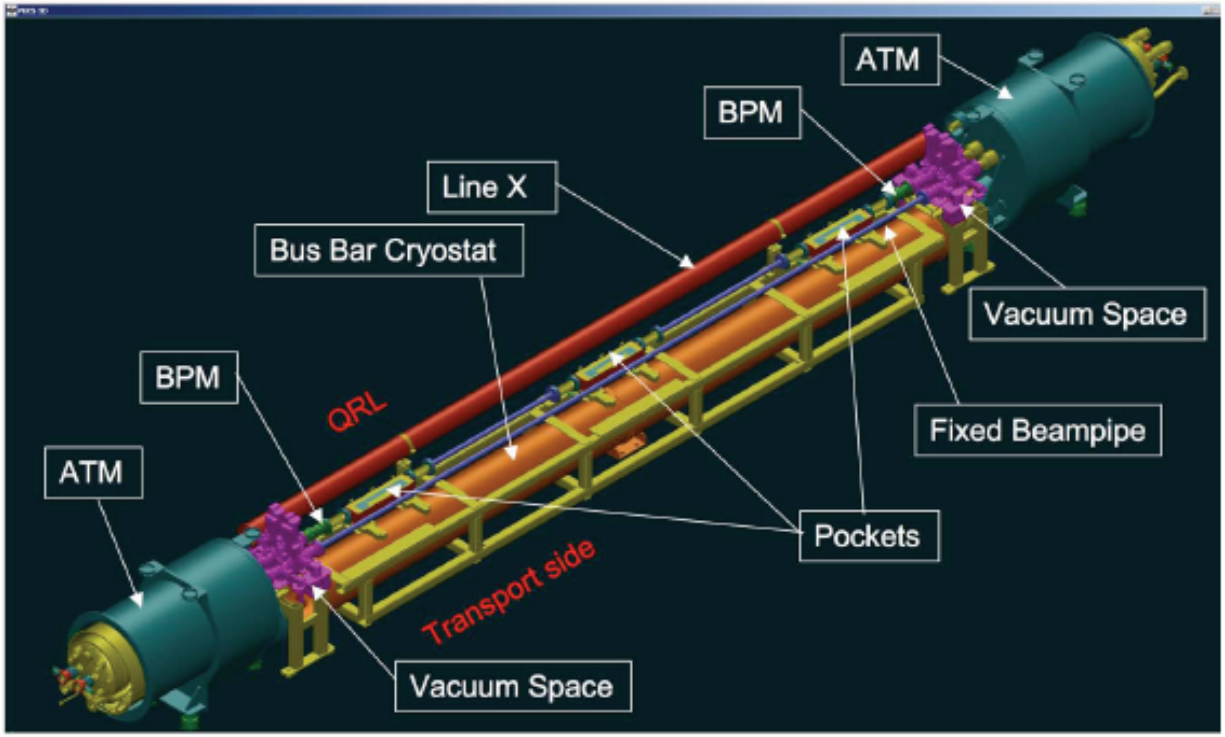
- 2 complete stations ready for installation by March 07
- The remaining 2 stations ready for installation by April 07
- Detectors (silicon detectors) ready for installation in October 07. However the installation will depend on the machine conditions.

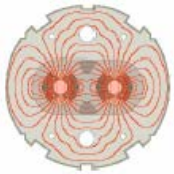
ATLAS Roman Pots

- Mechanics derived from the TOTEM one (no horizontal pot, no BPM)
- Mechanics may be ready by May 2007
- Detector (scintillating fibers) and electronics installation foreseen during shutdown 2008/9

FP420 R&D Project

- Proton tagging at 420 m from IP. It is believed it offers a unique opportunity to extend the LHC discovery potential
- Modification of the connection cryostat needed for the integration of a movable beampipe hosting the Si detectors





Conclusions

- All detectors (except ATLAS RP) plan to be installed and commissioned to take data during the LHC engineering run at the end of 2007
- Very busy months ahead to accomplish this
    - Complete detector production, and the installation & commissioning in LHC tunnel.
- Longer-term forward physics is being prepared
    - CMS/TOTEM, FP420
    - Expect continuing and extensive physics programme with detectors in the LHC tunnel
- Excellent collaboration reported between various CERN Departments (AB, PH, TS), the CERN Safety Commission and the Collaborations (ATLAS, CMS, LHCf, TOTEM).
    - This remain a central element for the timely and safe completion of the installation and commissioning of all near-beam detectors in the LHC tunnel.
- Schedules need to be closely and continuously followed-up with the planning officers of the LHC.
    - Intense level of activities planned for LHC tunnel in 2007