

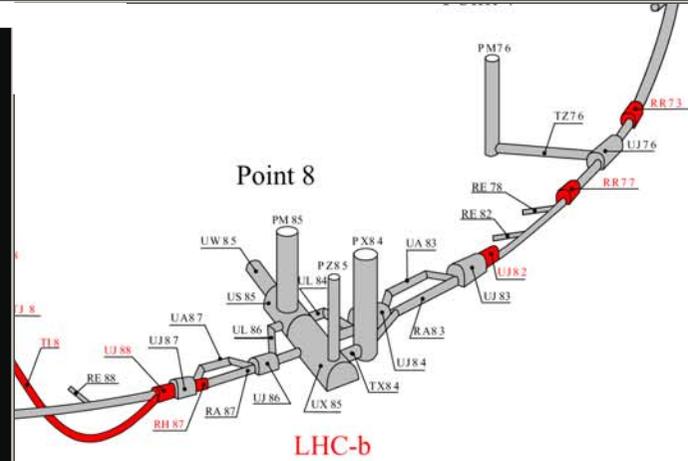
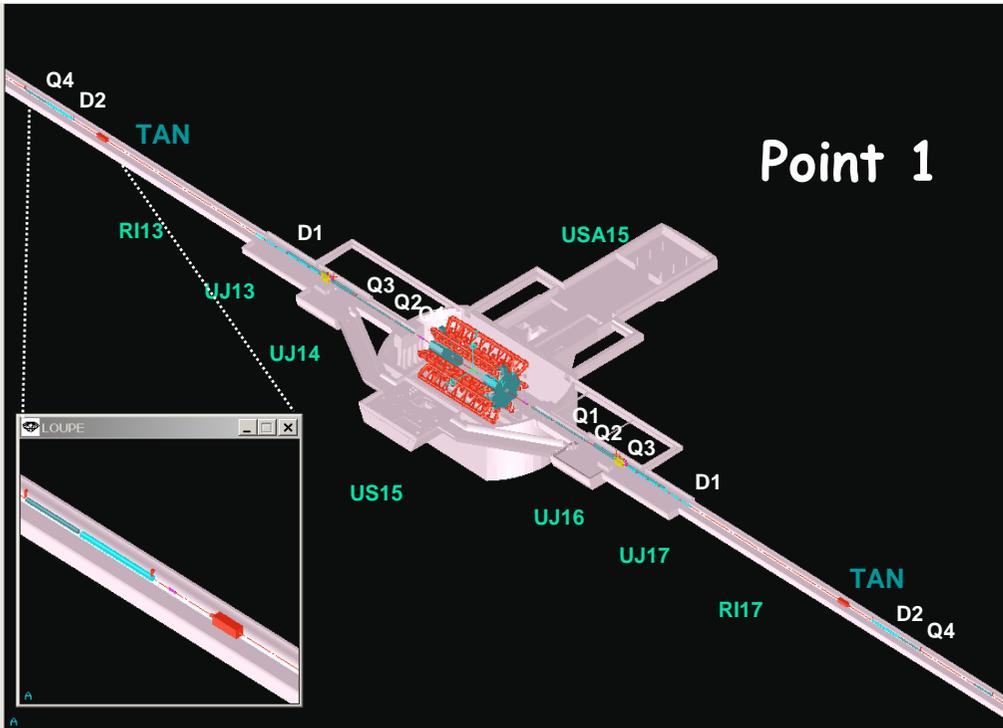
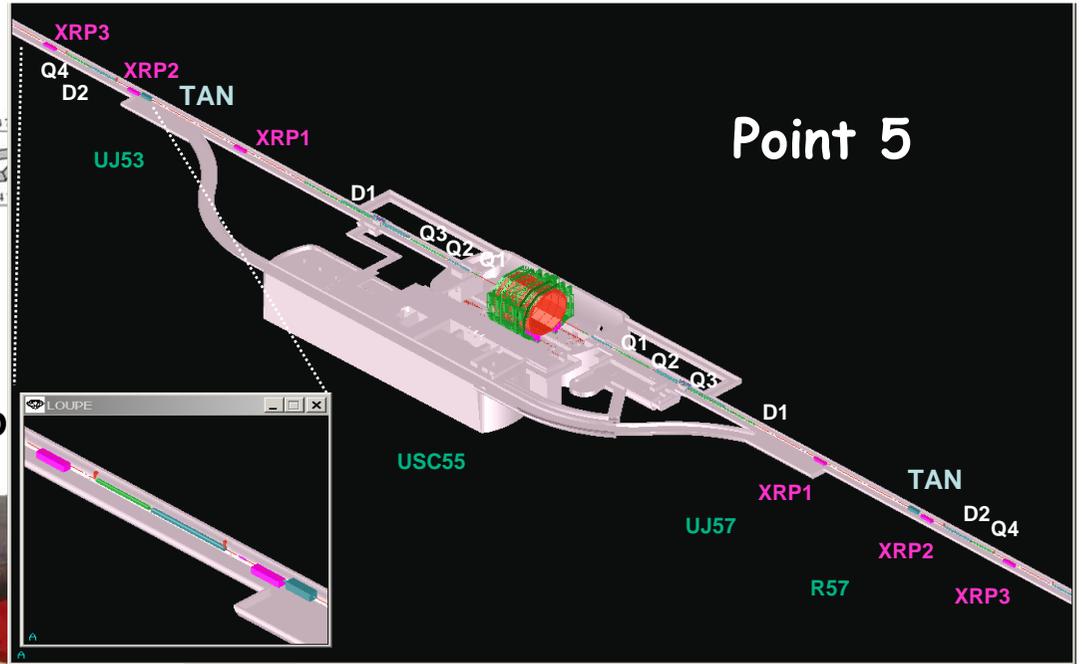
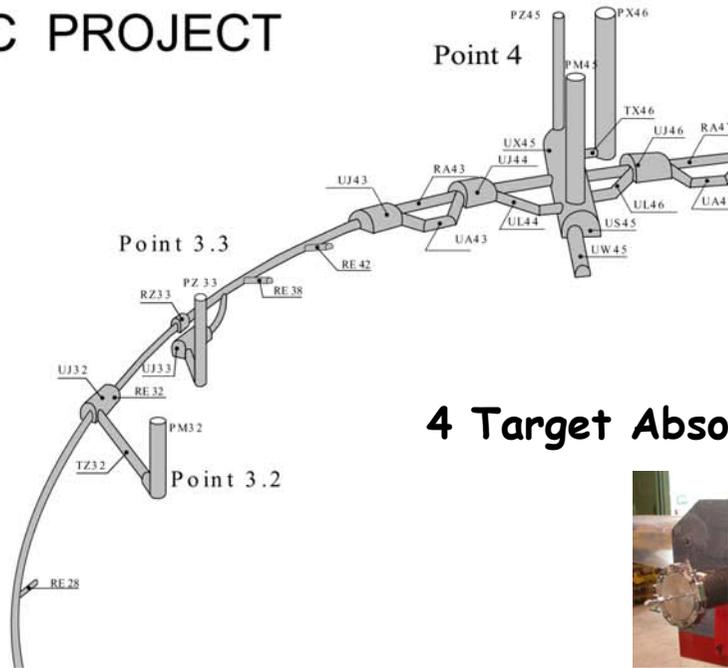


**Detectors installation in the TAN at IR1 and IR5:
status and planning**

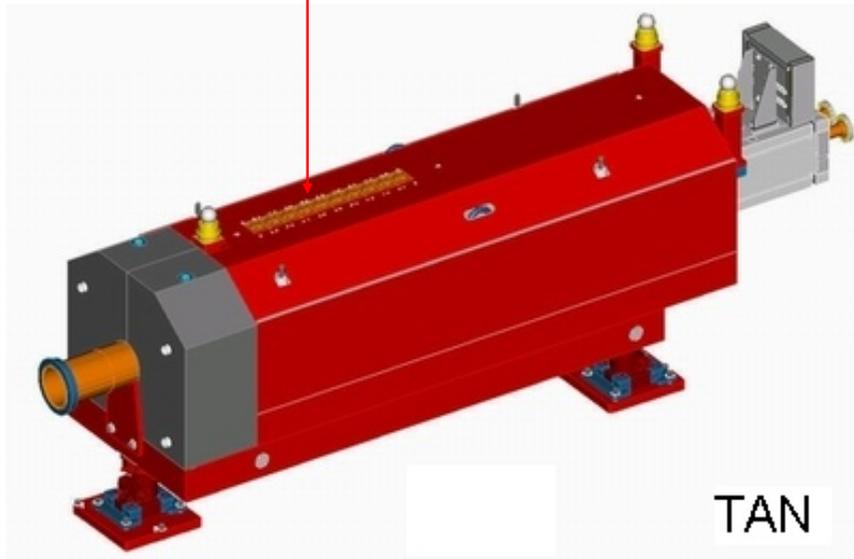
A. L. Perrot (TS/LEA-Int)

Joint LHC Machine Experiments Workshop on very forward detectors, CERN, 25 January 2007

LHC PROJECT



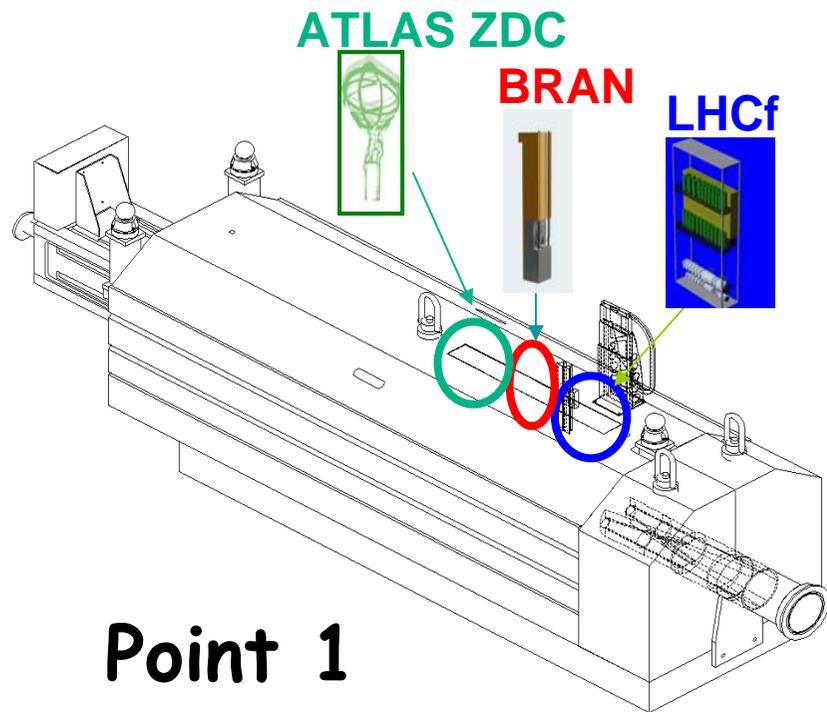
In each TAN
1 slot with 10 movable Cu bars



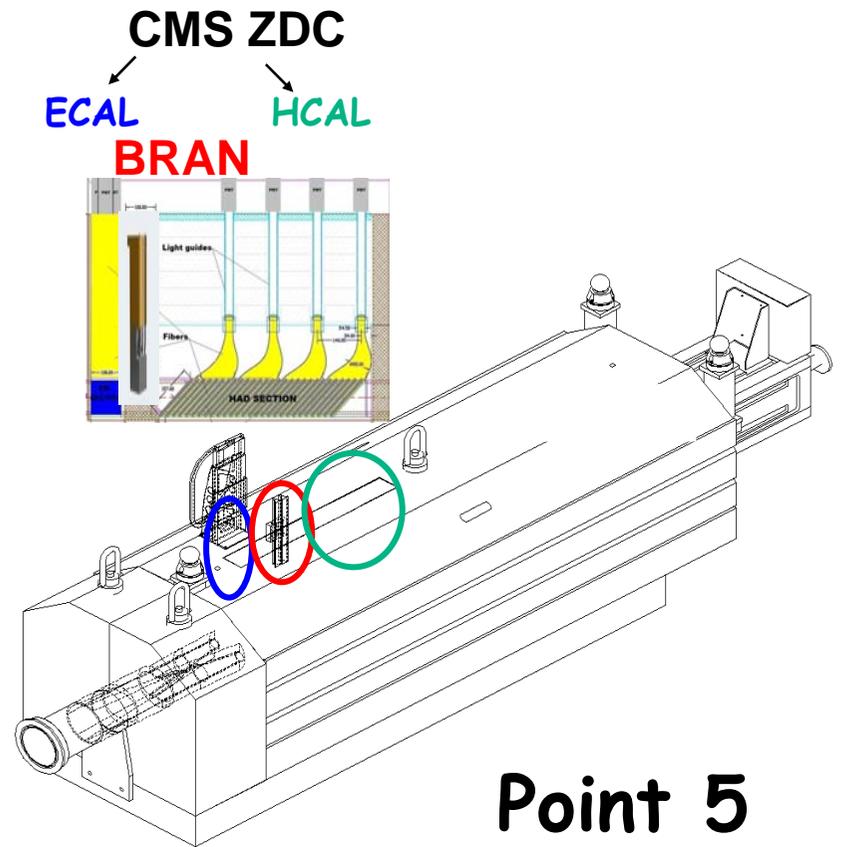
Slot : l1000 x w95 x h605



Possibility to add instrumentation



Point 1



Point 5

Courtesy of D. Macina

LHCf: LHC forward physics
BRAN: Beam Radiation Neutrals monitor
ZDC: Zero Degree Calorimeter

ECAL = Electromagnetic CALorimeter
HCAL = Hadronic CALorimeter

Installation of detectors in TAN - introduction

- Space allocation around the TAN in the LHC tunnel
- Services
- Handling / Transport
- LHCf and BRAN first installation
- Integration in LHC schedule
- Radiation monitoring close to the TAN

Several teams involved in the installation:

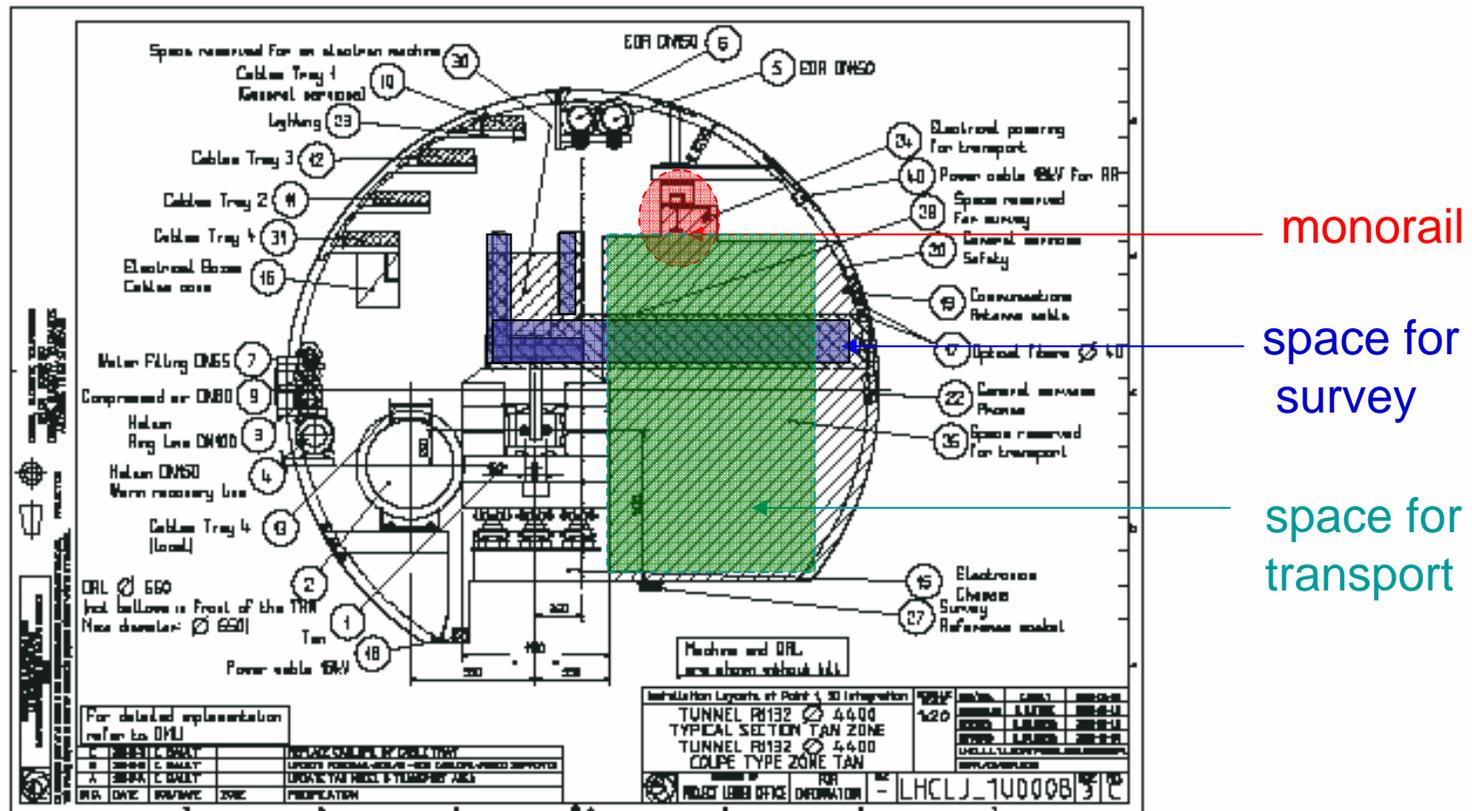
- radio-protection (SC/RP),
- transport (TS/IC),
- gas installation (TS/LEA), cabling (TS/EL, TS/LEA),
- LHC operators (AB/OP),
- LHC planning and commissioning teams (TS/IC, TS/HDO),
- scientific collabs. (LHCf, BRAN, CMS-ZDC, ATLAS-ZDC).

Coordination
(TS/LEA-int)

Space allocation in the TAN surrounding

All the experiments use about 30 cm above the TAN top surface
 Ok with the survey team

Survey team => move the 3 alignment target spheres (fiducials) located on each TAN top surface



Services integration inside the LHC, ATLAS & CMS environments

Services installations = integrated in the LHC schedule

Constant contact with the planning officers (TS/IC, TS/LEA) and the hardware commissioning team (TS/HDO).

Work performed on TAN: holes drilling for patch-panels installation of LHCf and BRAN (TS/IC, TS/LEA).

Common to all experiments:

- **cabling and fibers pulling** from the location in the tunnel to the rack control rooms of ATLAS and CMS experiments (TS/EL, TS/LEA).

LHCf + ATLAS ZDC (& ATLAS RP):

- cables follow different paths:

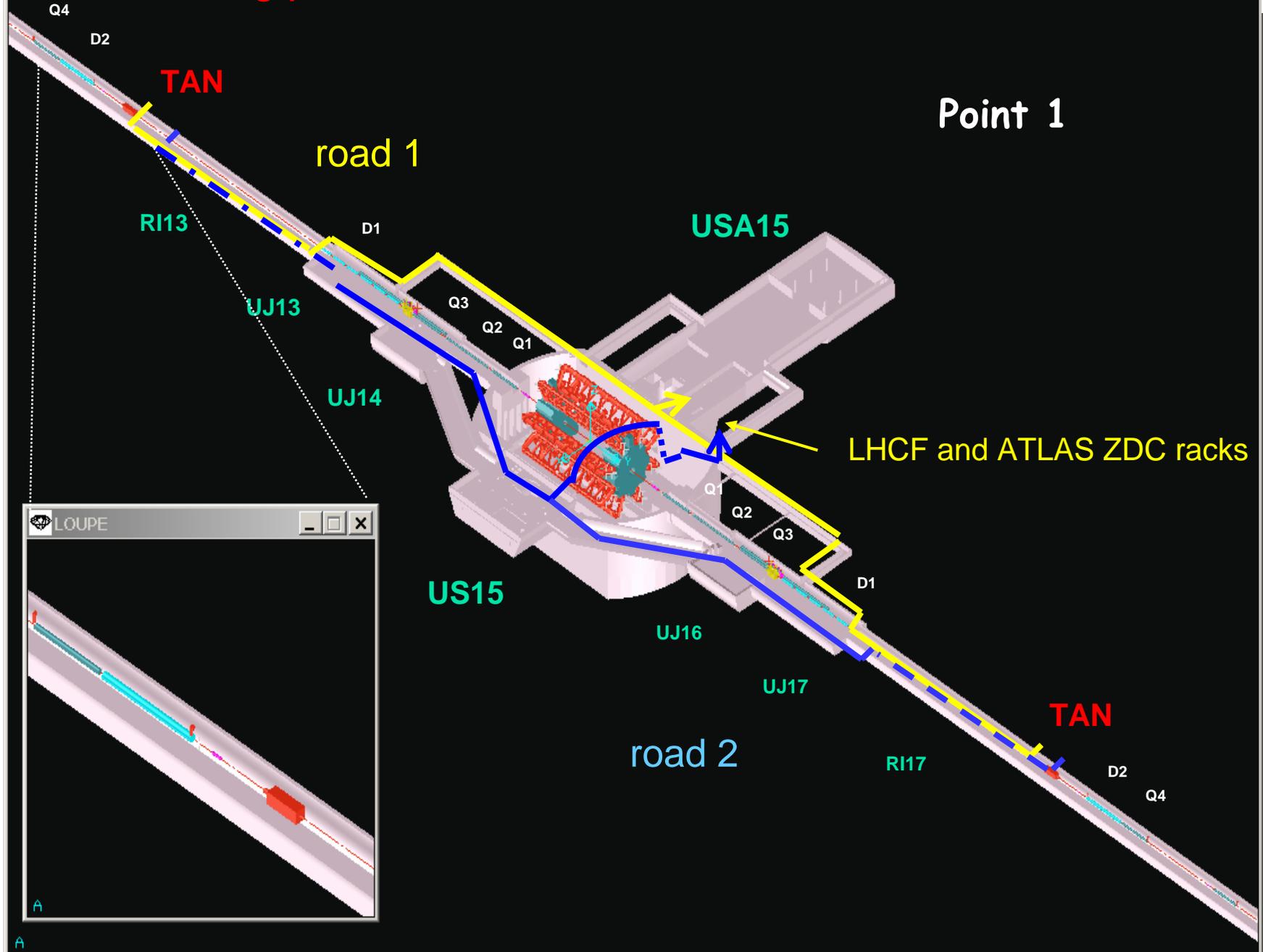
request of expts.: shorter path especially for trigger cables;

compatibility with the cables already installed/foreseen for the machine and the ATLAS experiment.

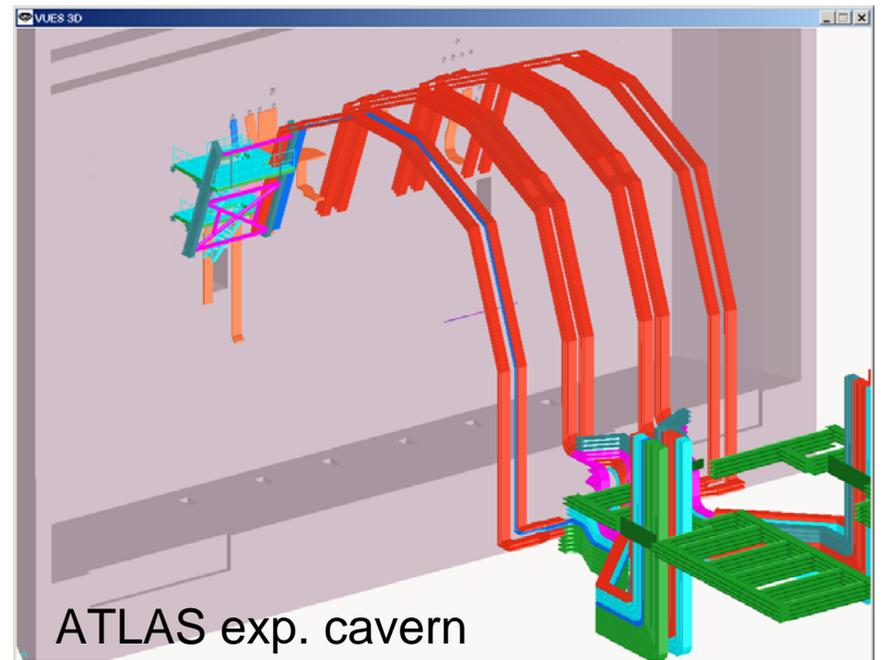
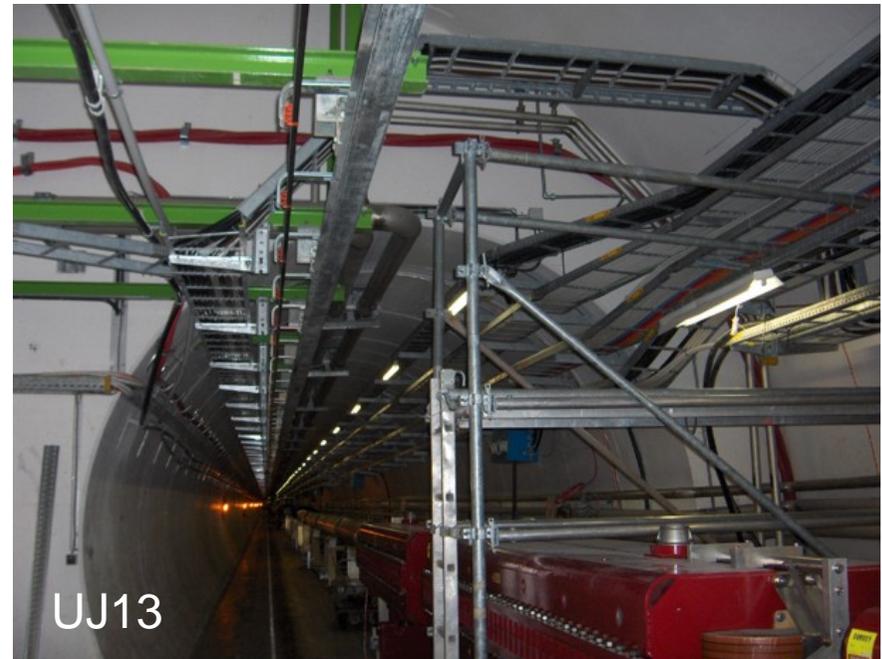
- **additional cable trays** installation in UPS galleries, machine areas and ATLAS cavern (TS/EL and TS/LEA),

- use of cables trays already installed in the ATLAS experimental cavern (UX15) to surround the ATLAS detector.

Cabling paths from TANs to LHCf and ATLAS ZDC racks



Cables trays inst. and cabling for LHCf and ATLAS ZDC



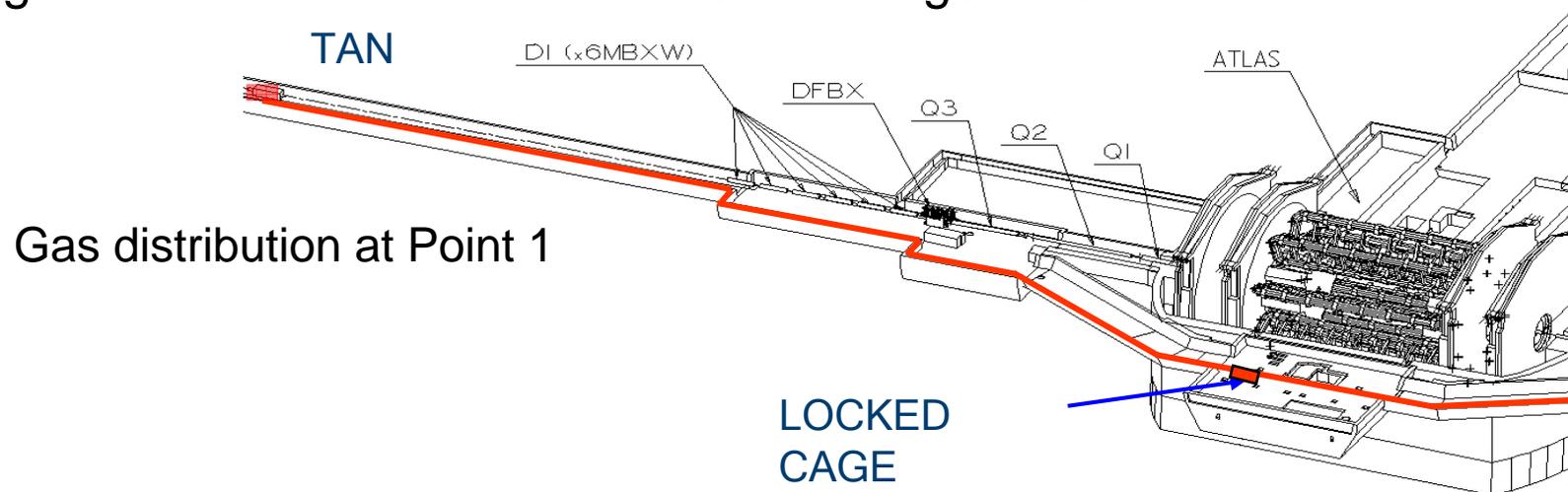
Services integration inside the LHC, ATLAS & CMS environments

LHCf:

- plugs installation in the tunnel (TS/EL),
- cooling study for LHCf arm#2 (TS/CV)

BRAN:

- cabling by TS/EL; coordination by AB/BI.
- gas installation and distribution (TS/LEA/gas section)
- locked caged area + change over panel (Pt1-US15 and Pt5-UJ56)
- gas distribution network between the caged area and the TAN

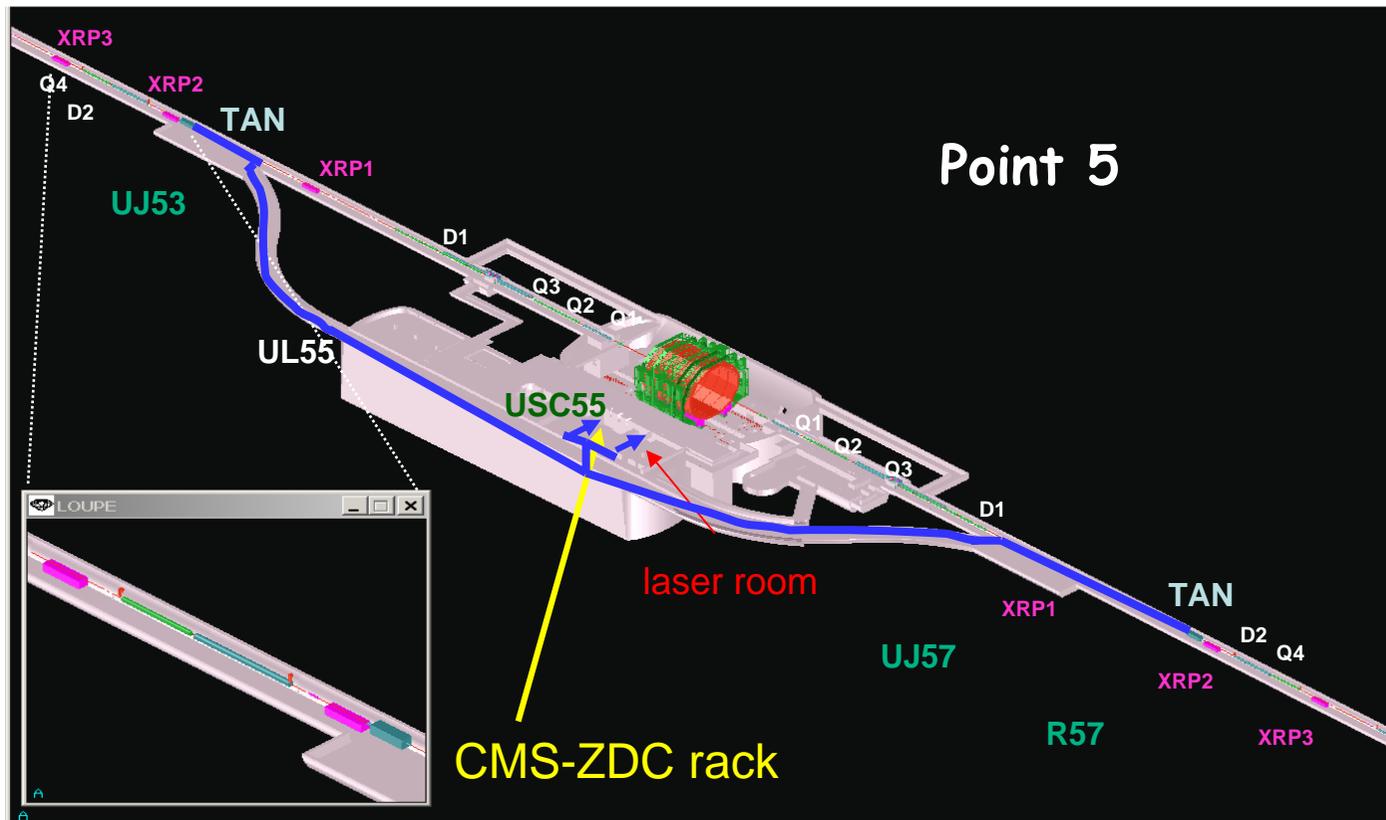


Special **agreement with safety dept.** to have gas bottles underground
Future interventions: replacement of a set of gas bottles

Services integration inside the LHC, ATLAS & CMS environments

CMS-ZDC (&TOTEM):

- additional cable trays installation from UL55 to USC55 (CR and Laser room) (TS/EL) , in UJ53 and UJ57 (TS/LEA), in LSS5 (TS/EL).
- use of cables trays already installed in the machine and rack room area



Handling

With which device?

Guide line: simplicity + use the same device for Cu bars and all the detectors

Experiments request: insertion of the detectors in the TAN in 1 'block' (taking into account the height of electronics, manipulator) => faster installation.

1st step: mock-ups construction (TAN TS/LEA –detectors physicists coll.)

2nd step: simulations

3rd step: dry run with the first TAN at Pt5 (Apr. 2006)

4th step: adaptation of the forklift arm (design and construction- TS/IC)



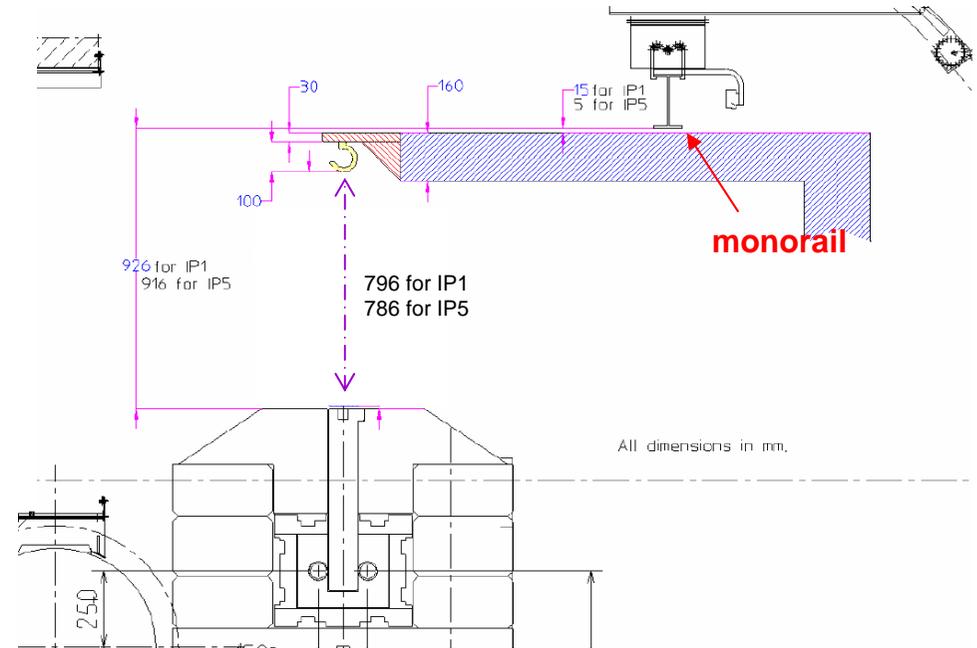
Handling

Constraints

Tunnel

Point 1: TAN top surface - monorail= 926 mm
 TAN top surface - hook = 796 mm

Point 5: TAN top surface - monorail= 916 mm
 TAN top surface - hook= 786 mm



Cu bar and detectors dimensions and weight

COPPER BAR

46 kg l=98mm w= 94mm h= 605mm

DETECTORS

LHCf

20kg l=290mm w= 90mm h=608mm (+ 362 mm for the manipulator)

BRAN

41kg l=99mm w= 94mm h=853mm to the top of the hoist ring

CMS ZDC ECAL

65 kg l=116mm w= 92mm h=705mm (+ 150 mm for the electronics)

CMS ZDC HCAL

200 kg l=711mm w= 92mm h=705mm (+150mm for the electronics)

ATLAS ZDC ECAL

80 kg l=123 mm w= 93.8 mm h=738 mm

ATLAS ZDC HCAL

240 kg l=450 mm w= 93.8 mm h=738 mm

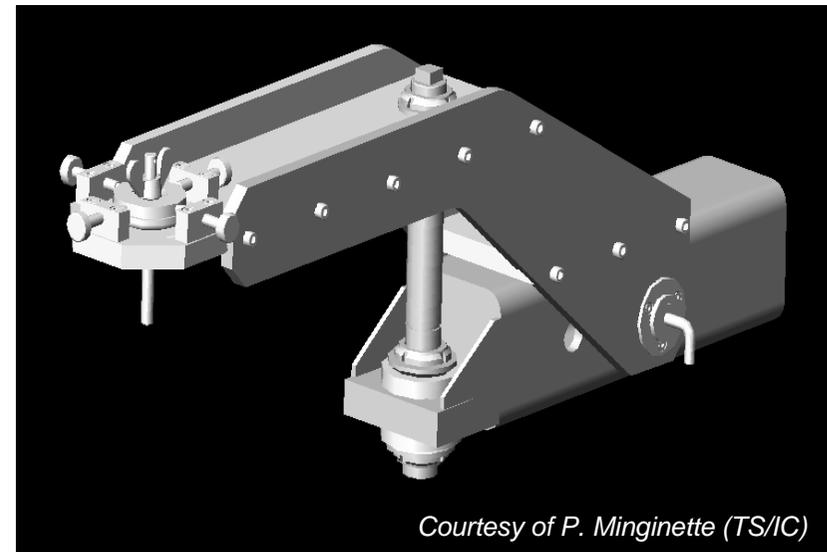
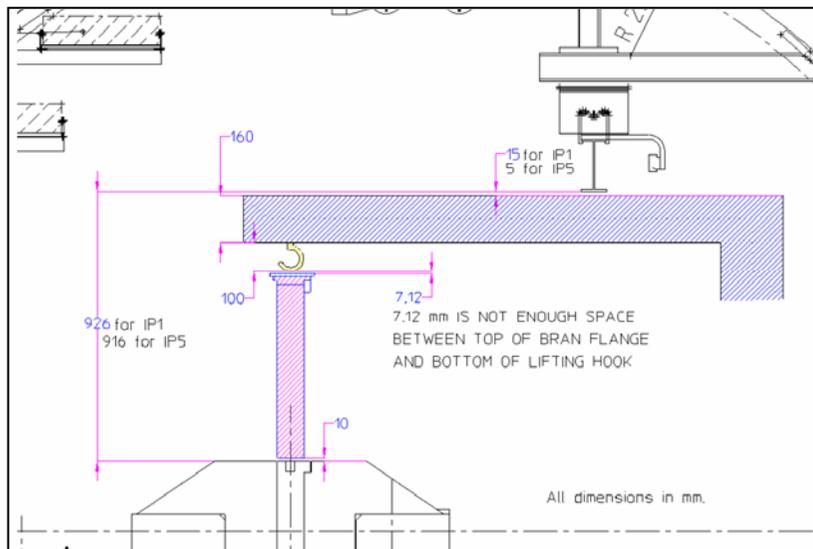
Handling

Transport team (TS/IC) solution

extension of the usual forklift arm => enhancement of the available space above the TAN top surface.

Transport team (TS/IC) request

M12 screwed hole on top surface of each detector.



Total gain in height ~ 31cm.

Handling

Usual forklift arm



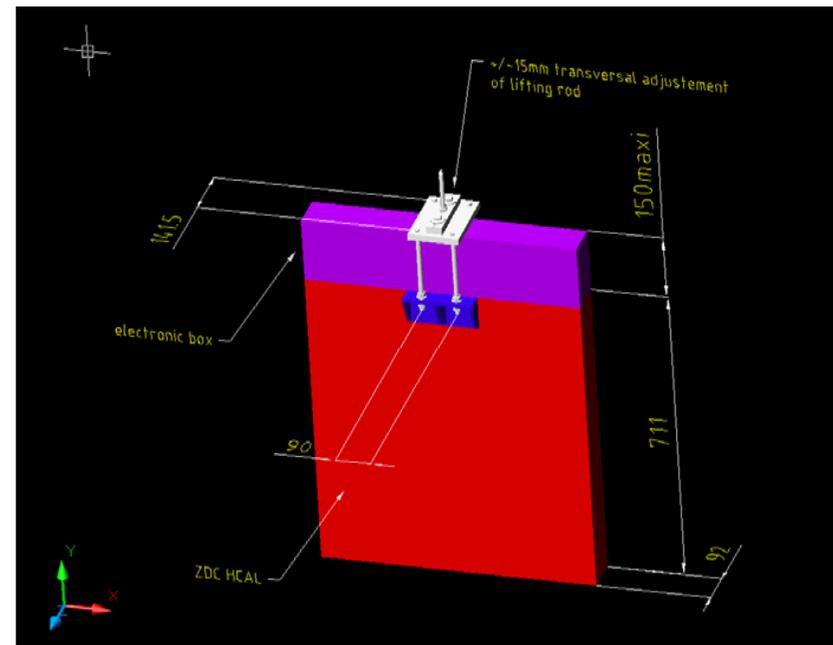
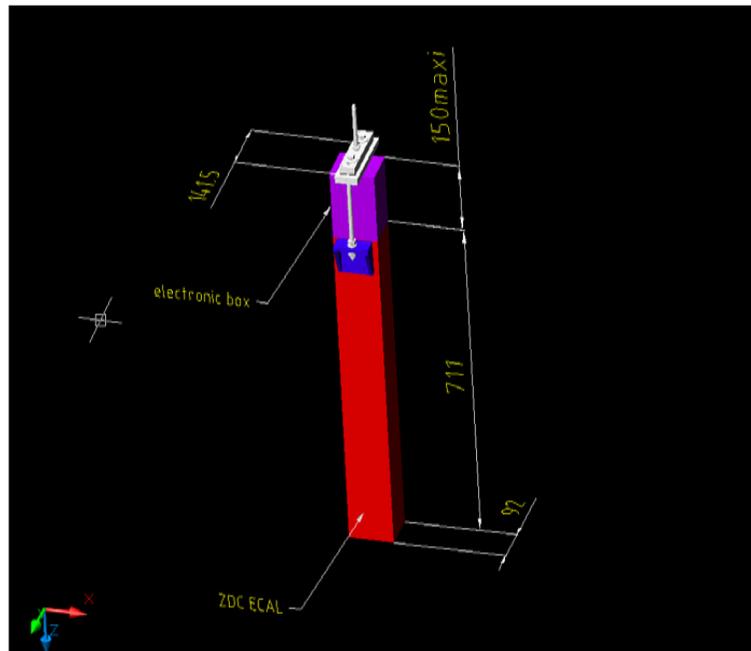
New extension arm for the usual forklift



Handling

Transport team proposal for CMS-ZDC

- not possible to have the required M12 screwed hole on top surface of detector because of electronics boxes all along the surface.
- TS/IC: draft design of 2 supports.
- CMS-ZDC team: final design and construction of the 2 new supports
- Tests performed at CERN with the new supports on 8 Dec. 2006 and on 23 Jan. 2007 (TS/IC, CMS-ZDC and TS/LEA)

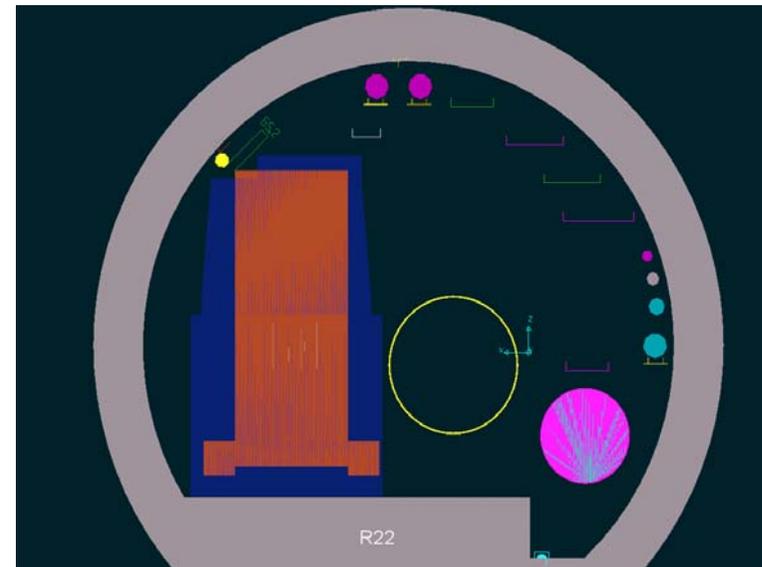
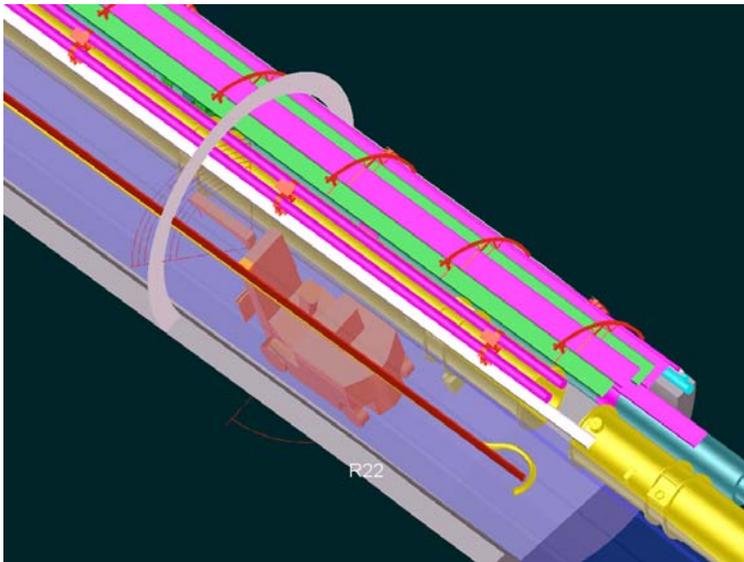
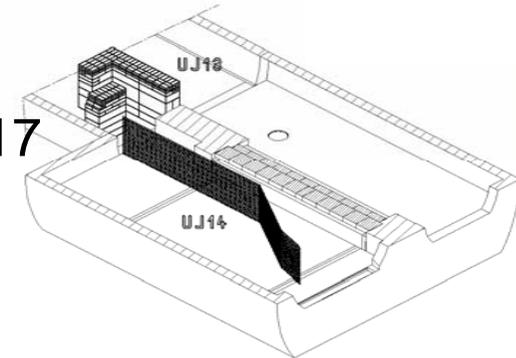


Courtesy of P. Minginette (TS/IC)

Transport

Point 1 (RI132-RI171)

- Access by Pt1:
Shielding between UJ13-UJ14, and between UJ16-UJ17
=> forklift too large to pass
- Access by Pt 2 and Pt8: ok
Travel underground until TANS= ok
(study by O. Choisnet TS/MME)



Transport

Pt5 (UJ53 –R571)

- Access by Pt5:
only a 'normal persons' lift => forklift too large to pass
- Access by Pt4 and Pt6: ok
Travel underground until TANS ok

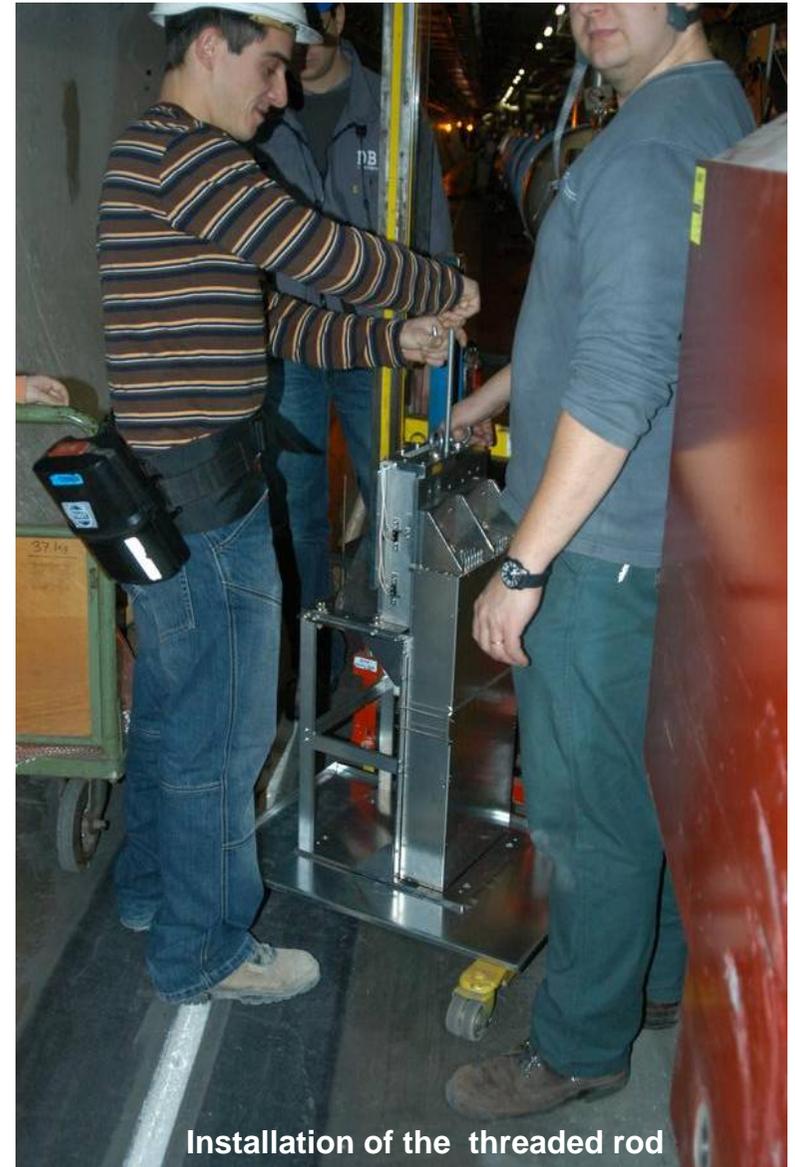
LHCf first installation on 15 January 2007



Departure from USA15



Slot on the TAN top surface



Installation of the threaded rod



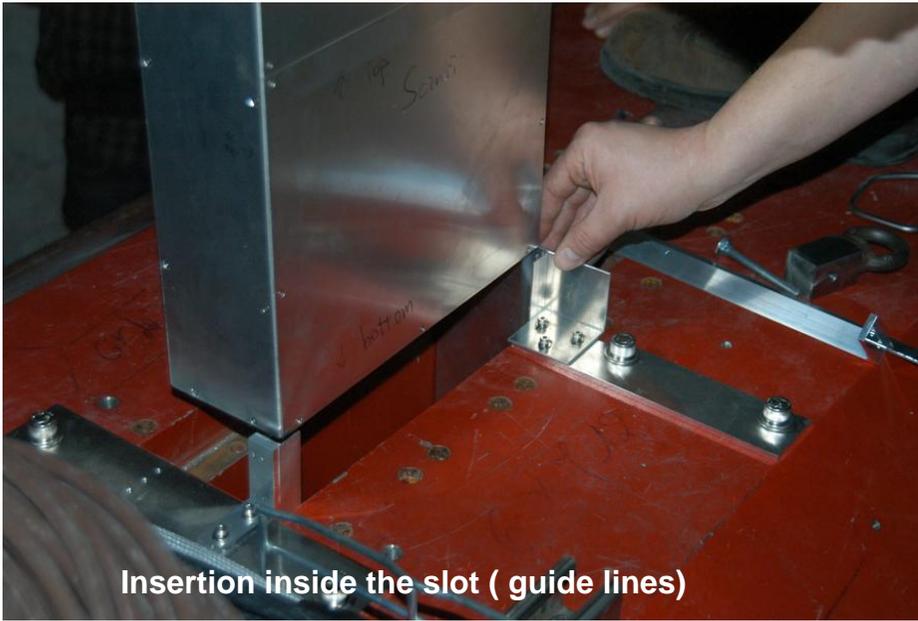
Detector hold on the forklift arm



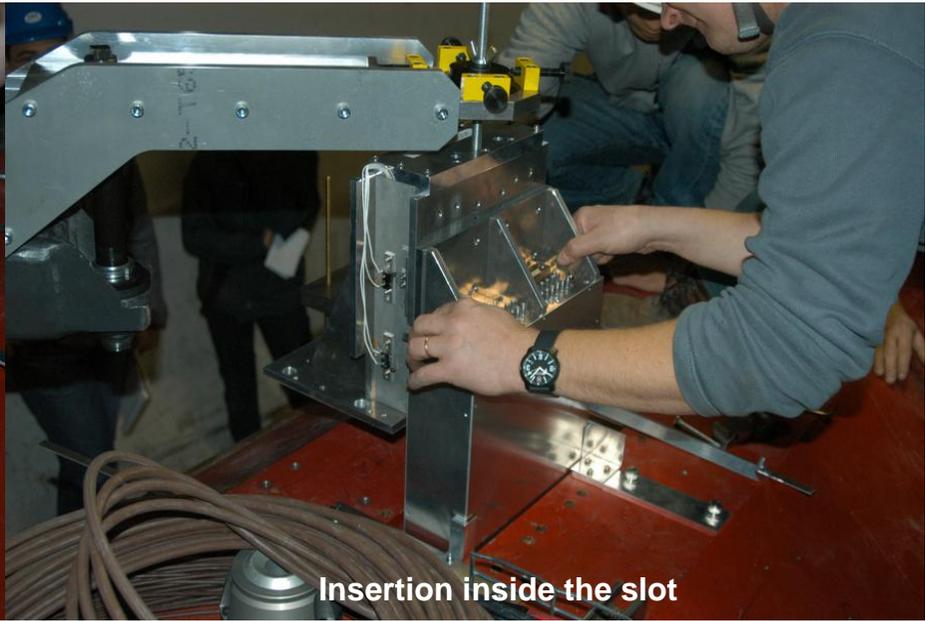
Removal of the detector chassis and support elevator



Holding of the detector towards the TAN slot



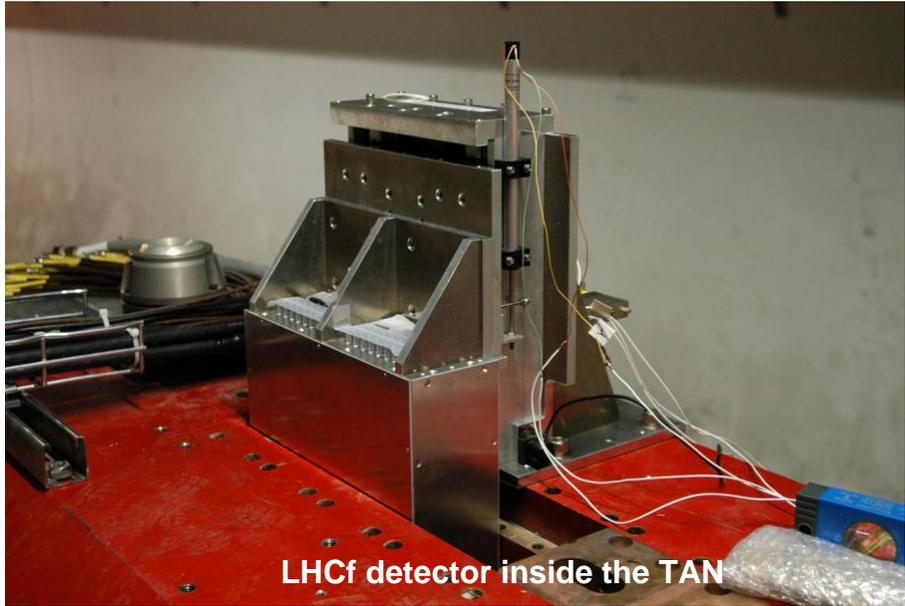
Insertion inside the slot (guide lines)



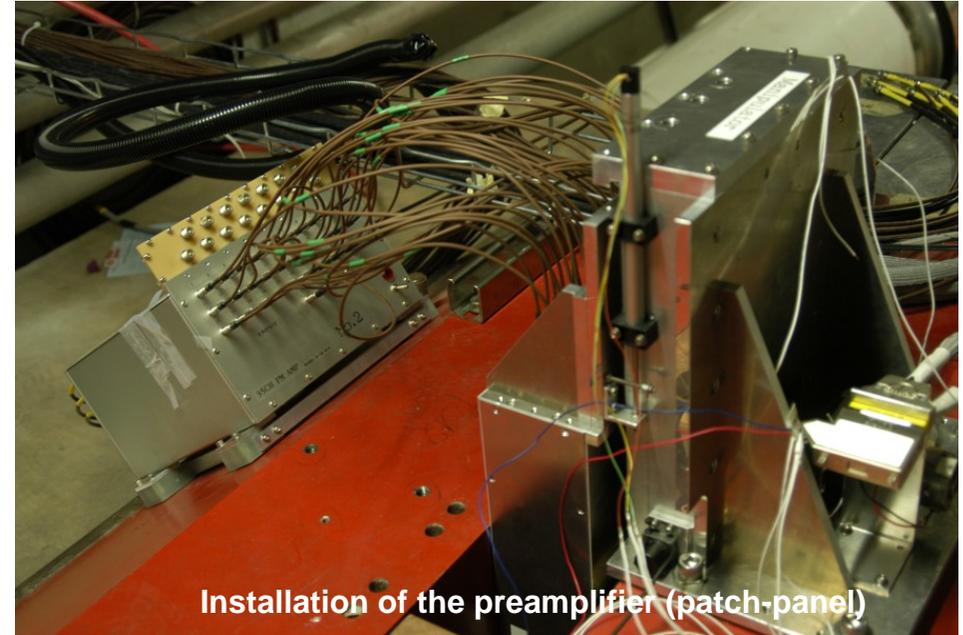
Insertion inside the slot



Removal of the threaded rod



LHCf detector inside the TAN



Successful installation

Points to optimise:

- removal of the detector from the chassis (less screws!)

Transport team proposal: a box with the shape of the actual chassis

- displace one screw hole than is difficult to reach when BRAN is in TAN.

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



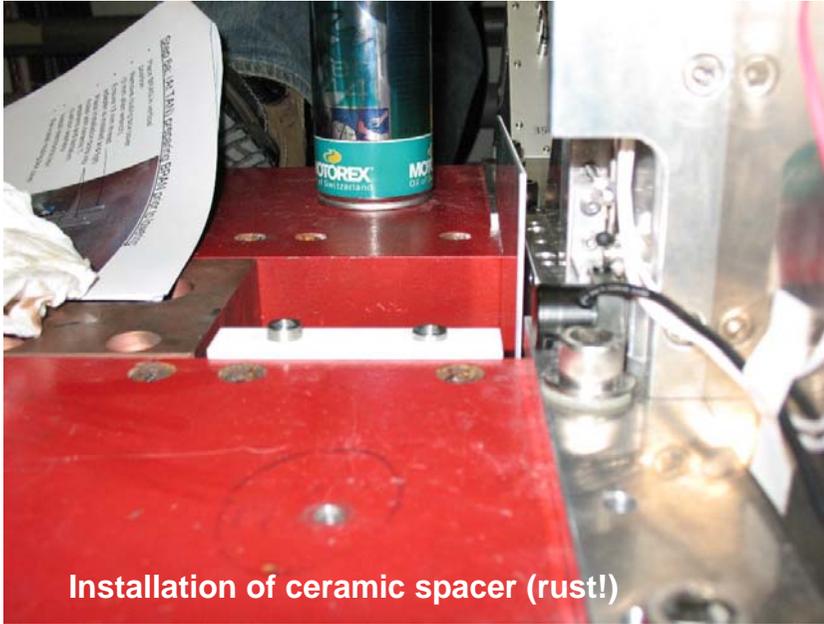
Removal of the routing box protection



Installation of the 12 mm thread adapter



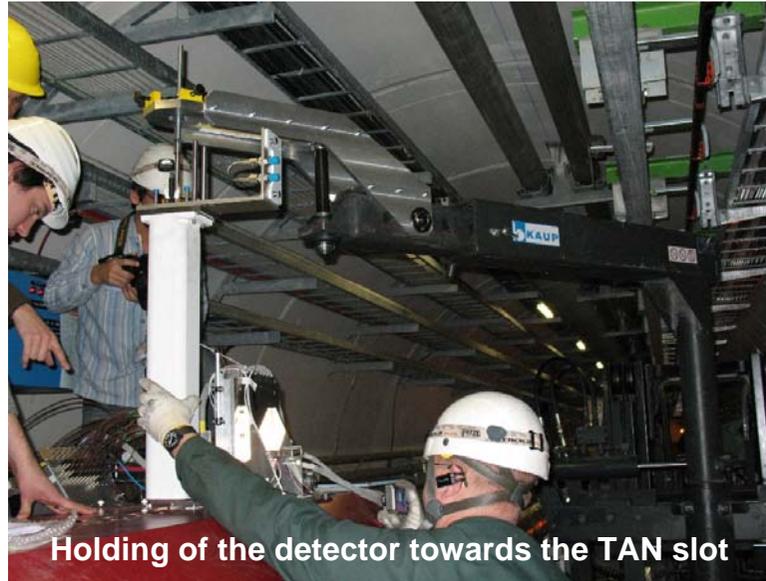
Detector hold on the forklift arm



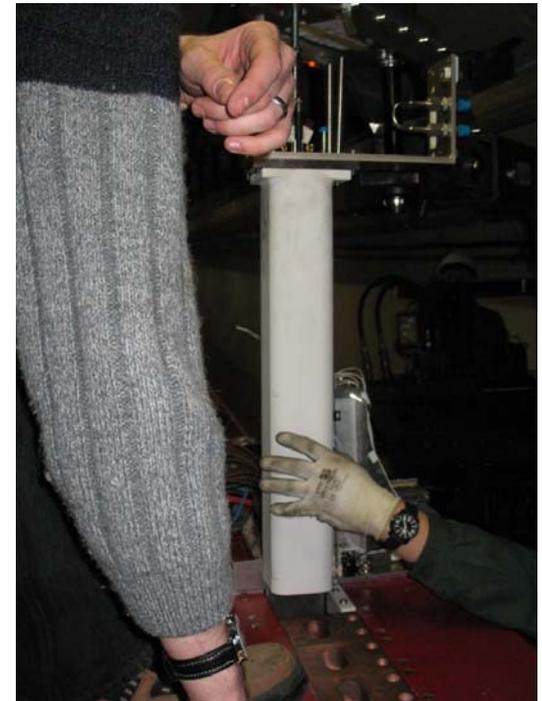
Installation of ceramic spacer (rust!)



Installation of ceramic spacer

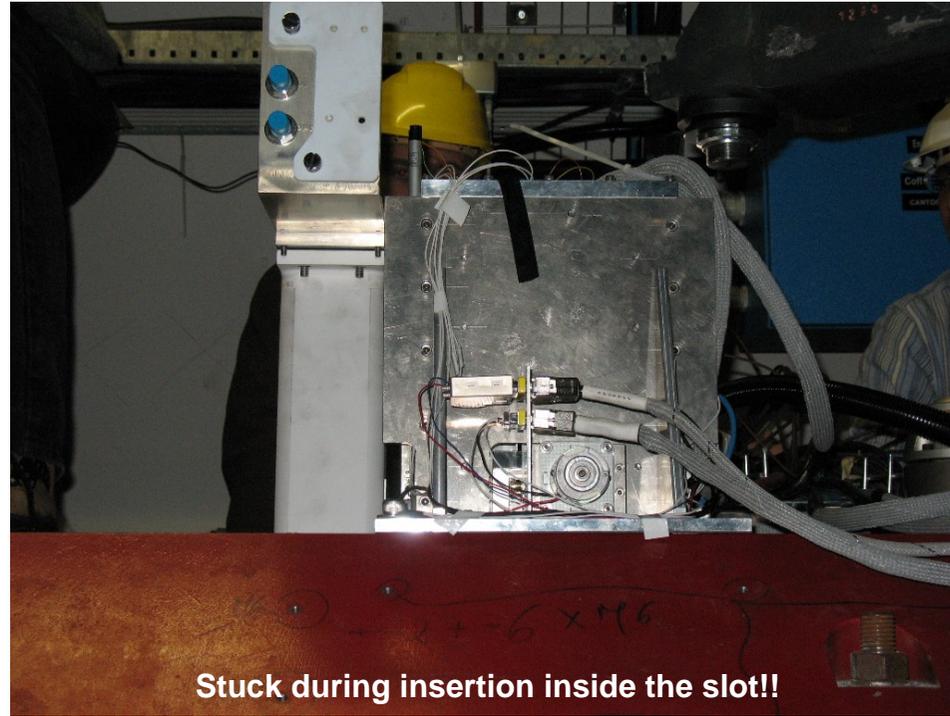


Holding of the detector towards the TAN slot





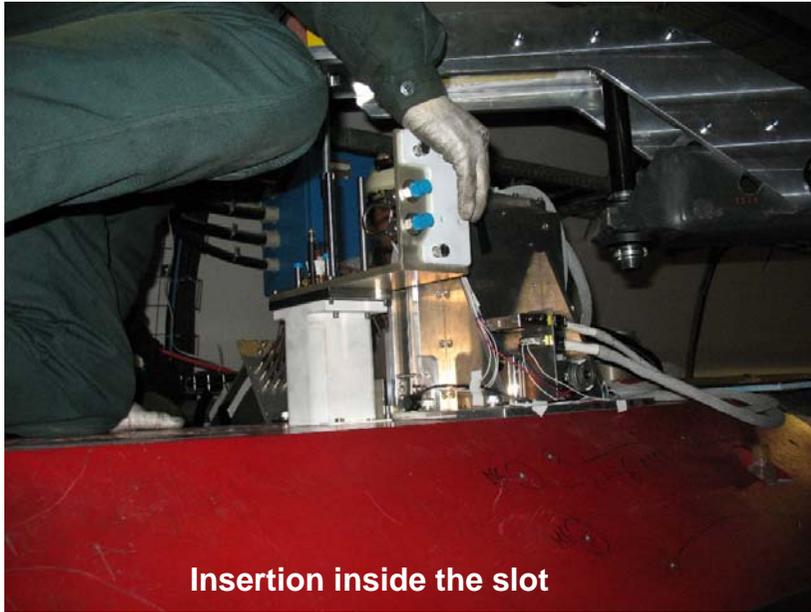
Insertion inside the slot



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

BRAN first installation on 22 January 2007

Installation has been performed but some points have to be optimised:

- decrease the thickness to allow the detector to 'slide' inside the TAN slot and to reach the bottom surface of the slot.
- move the gas connections from the tunnel side to the machine side (cryo line side);
- move the cables connectors on the routing box towards the machine side;
- clean all the TAN holes that will be used to fix the BRAN detectors (ceramic spacer);
- finalise the cables arrival to the detector.

Manual help to insert/remove the detector inside/from the slot = difficult to be avoided

=> to be minimised for the installation during LHC runs

Comments of Radioprotection team

- SC/RP agreed use of forklift for start-up installation and low luminosity run ($L < 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$)

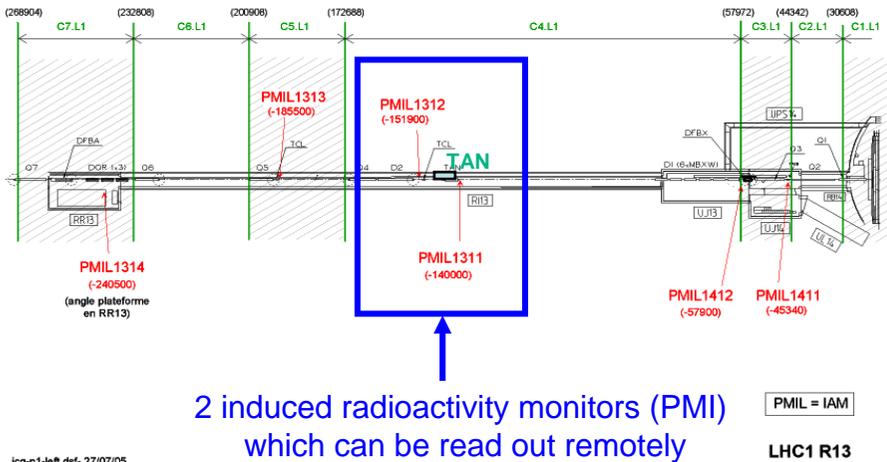
- for higher doses rates => - study to optimise the intervention
 - remote procedure study



Contact with integration team in charge of the remote handling for the LHC element (TS/IC- K.Kershaw)

Radiation monitoring in the TAN surrounding

LSS1



jcg-p1-left.dsf- 27/07/05

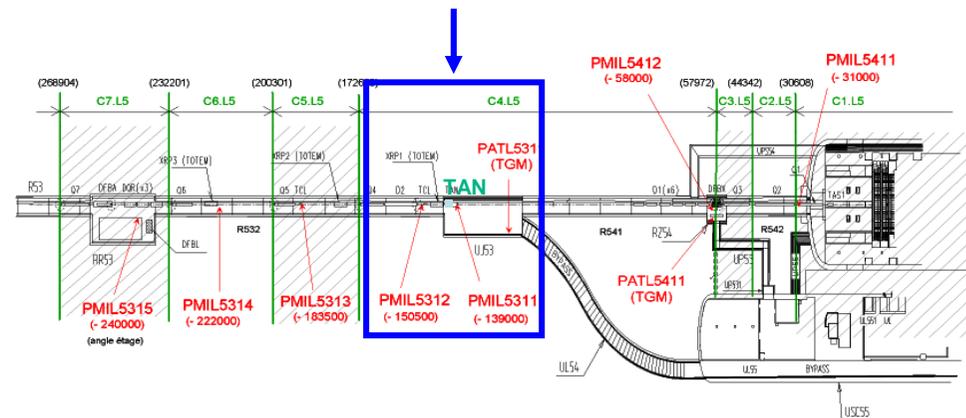
Courtesy of S. Roesler (SC/RP)

- Help for
- design of containers for detect. and Cu bars storage
 - agreement for storage locations on surface

SC/RP + RSO

- def. work procedure
- radiological survey before any interventions
- RAMSES monitoring close to TANs

2 induced radioactivity monitors (PMI) which can be read out remotely



LSS5

jcg-p5-left.dsf - 15/07/05

LHC5 R53-54

Courtesy of S. Roesler (SC/RP)

Integration in the LHC installation schedule

Detectors status:

LHCf arm#1= ready;

LHCf arm#2= will be ready beginning of April

BRAN= 2 first units ready in April; 2 last units ready in June.

CMS-ZDC= 1 set is ready; the second one will be assembled at CERN in March.

Point 1

LHCf and BRAN simultaneously

LSS1L: first installation / commissioning: 8/01-26/01/2007

bake-out of the machine ⇔ removal on 24/01/2007

LSS1R: first installation / commissioning: 23/04-11/05/2007

bake-out of the machine ⇔ removal at the end of the period

Point 5

CMS-ZDC and BRAN simultaneously

1 final installation / commissioning period (no prior period)

Integration in the LHC installation schedule

Final installations of all the detectors: dates under discussion (draft dates to be re-discussed)

Constant discussion with

- the planning team (TS/IC) and hardware commissioning team (TS/HDO) in view of the advancement of the machine installation/commissioning status
- the experiments in view of a possible combined test beam in the SPS extracted lines

We should keep in mind:

- LHCf, ATLAS ZDC, CMS ZDC => **installs./removals during LHC runs**
- BRAN = **always in the TANs**
- Temporary removal if bake-out needed to restore good vacuum conditions

Many thanks for collaboration and help to

SC/GS: R. Magnier,

SC/RP: S. Roesler, M. Brugger,

TS/CV: M. Kuhn,

TS/EL: JP Billon-Grand, L. De Jonge, JC Guillaume, A. Feron

TS/HDO: hardware commissioning team: B. Perea Solano, R. Saban,

TS/IC: - transport /handling team: C. Bertone, P. Minginette, S. Pelletier,
J. Sakkinen

- TAN team (coord. inst.): S. Bartolomé-Jimenez, G. Trinquart

- infrastructure support: R. Valbuena, K. Kershaw, K. Artoos

- machine planning officer: K. Foraz, H. Gaillard, S. Weisz

- designers: JM Bianco, JP Corso, Y. Muttoni, E. Sabin

TS/MME: O. Choynet, F. Delsaux

TS/LEA: - cabling: C. Dechelette, M. Wilhelmsson,

- workshop: F. G. Murino and his team

- experiments planning officer: M. Gastal

- gas inst.: D. McFarlane, M. Wilhelmsson

- designer: P. A. Préau

TS/SU: H. Mainaud-Durand, JP Quesnel, Laure Sandri, D. Missaen

AB/OP: H. Burkhardt, R. Bailey

BRAN, CMS-ZDC, LHCf, ATLAS & CMS collaborations.

addendum

Installation of the detectors - run scenario

Point 1

LHCf :

Phase-1: Parasitic running during LHC commissioning at $L < 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$
(radiation hardness => LHCf removed when $L = 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$)

Phase 2: Parasitic running with TOTEM ($L = 10^{28} \text{ cm}^{-2} \text{ s}^{-1}$)
(radiation hardness => LHCf removed at the end of the run)

BRAN: Installation before LHC closure - run during all LHC lifetime

ATLAS ZDC: Under discussion (rad.hard. tests to be performed this summer)

Point 5

CMS ZDC: Low L pp runs ($10^{32} \text{ cm}^{-2} \text{ s}^{-1}$) + heavy ions runs

BRAN: Installation before LHC closure - run during all LHC lifetime

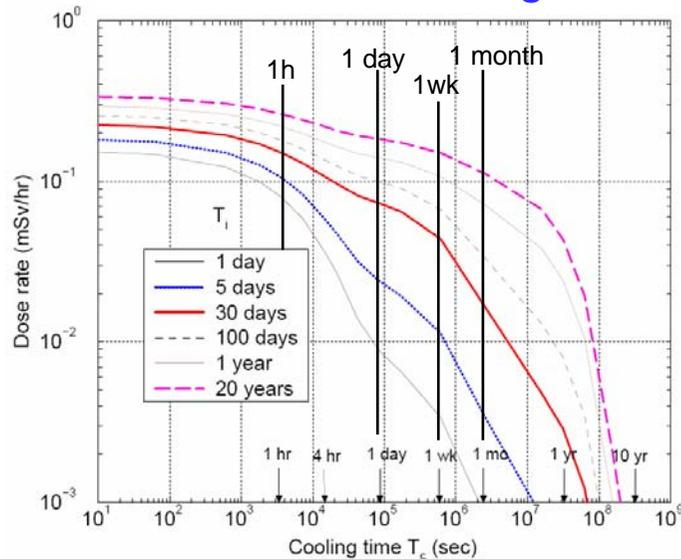
LHCf, ATLAS ZDC, CMS ZDC => **installs./removals during LHC runs**
BRAN= **always in the TANs**

Radiation environment at the TAN during LHC runs

TAN average residual dose vs time at $L=10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

Simulations by N. Mokhov

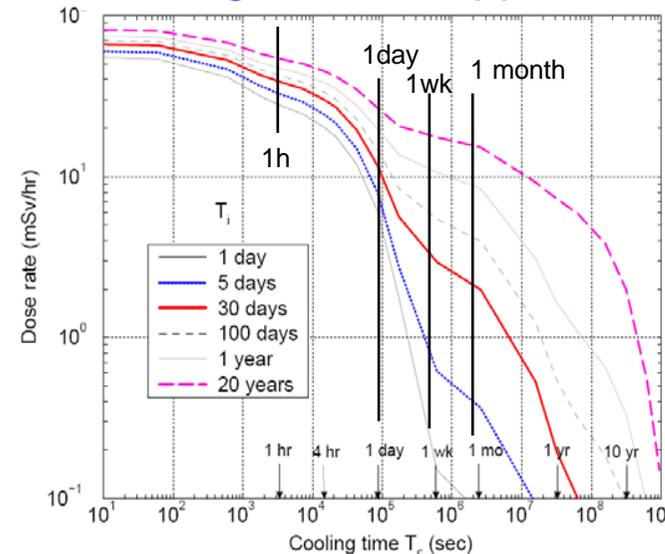
Averaged over aisle side of the shielding



coolig irrad.	1 hour	1day	1wk	1 month
30 days	200	70	45	20
1 year	250	150	100	70

all values in $\mu\text{Sv/h}$

Averaged over copper bars



cooling irrad.	1 hour	1day	1wk	1 month
30 days	30	10	2	0.2
1 year	40	20	9	2

all values in mSv/h

Courtesy of N. Mokhov (Fermilab)

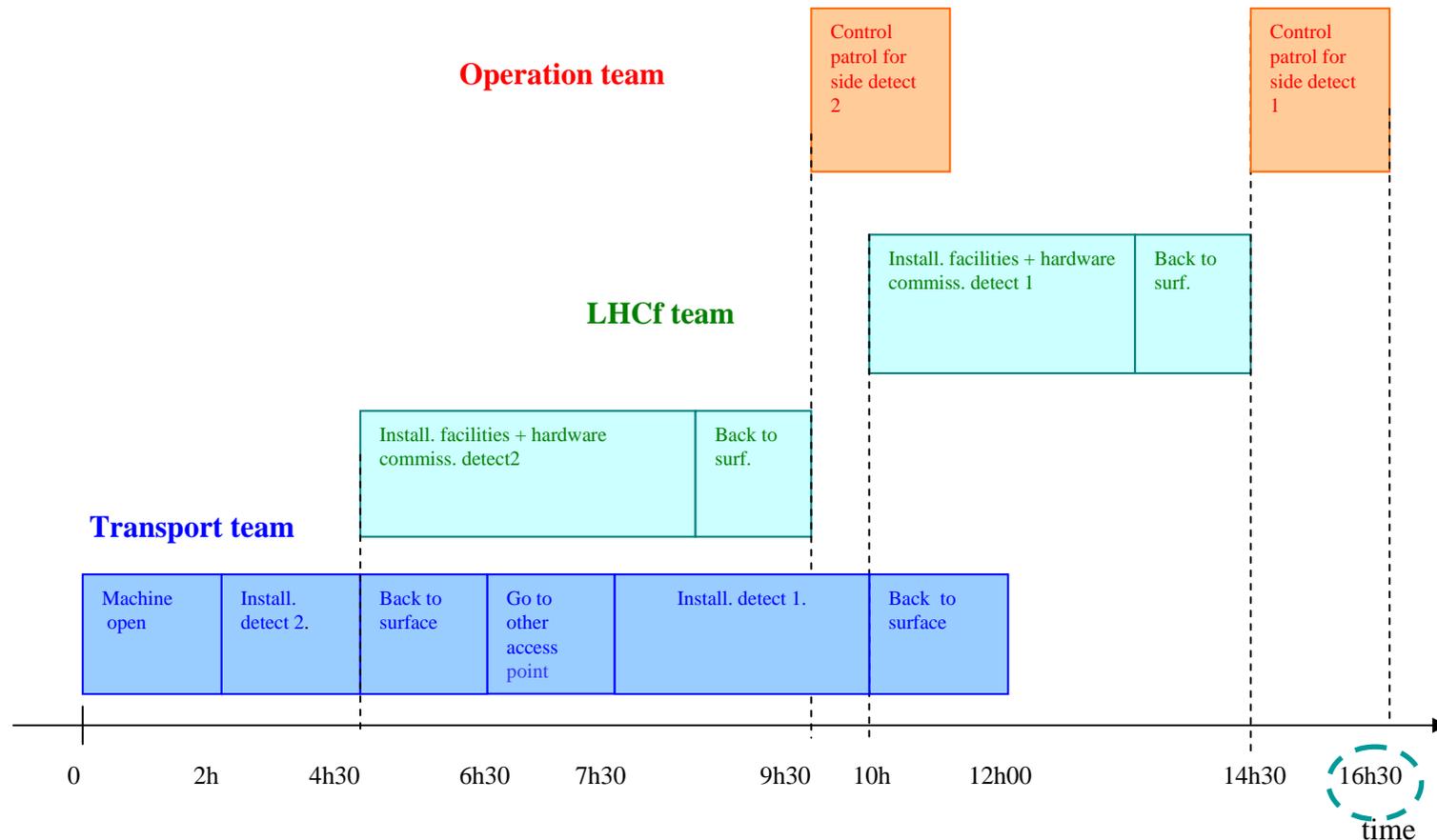
Radiation protection:

Intervention doses: **ALARA** => def. of cooling period (SC/RP)

CERN design criterion: **2 mSv/person/intervention**

LHCf detectors installation (sequential mode) – first proposal

Co-activity of transport, LHCf and operation teams



Dry run of the installation in the tunnel and commissioning of the all detectors
=> should be performed **before the LHC machine closure**