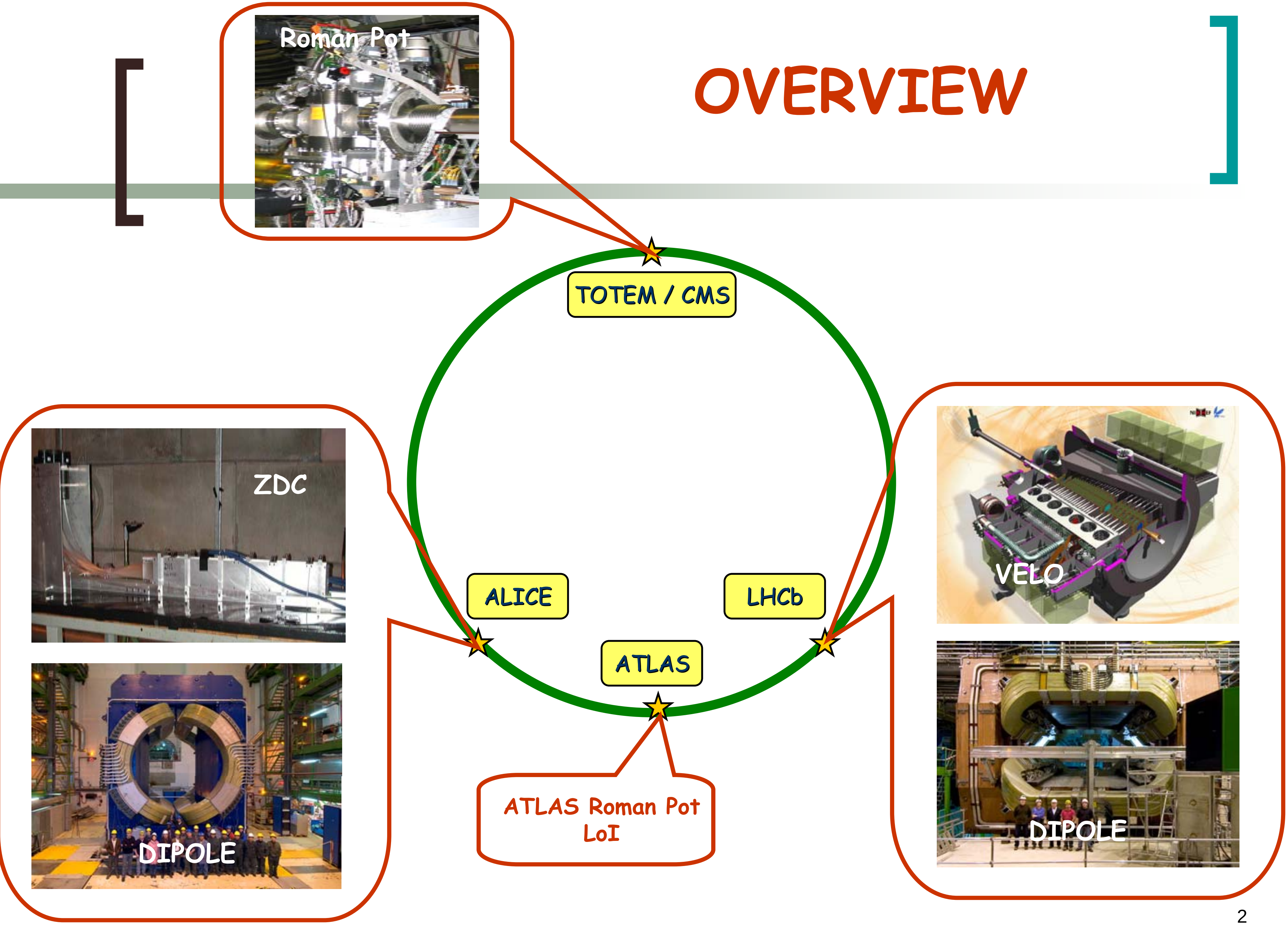
Workshop Chamonix XIV: 17-21 January 2005

Equipment of experiments directly interfering with the beam operation

D. Macina TS/LEA

Many thanks to the experiments and the machine people for their fundamental input to this talk

OVERVIEW


Roman Pot
TOTEM / CMS
ZDC
DIPOLE
ALICE
ATLAS
LHCb
VELO
DIPOLE
ATLAS Roman Pot
LoI

Experimental Dipole Magnets and Compensator Magnets

Experiment*	Distance of magnetic center from IP [m]	$\int Bdl$ [Tm]
ALICE Warm Compensators	-20.49 -10.75	1.8 3.4
ALICE Dipole	9.75	3.1
ALICE Warm Compensator	20.49	1.5
LHCb Warm Compensators	-20.765 -5.25	1.1 4.2
LHCb Dipole	5.25	4.0 (measured)
LHCb Warm Compensator	20.765	1.1

*In addition ALICE-ATLAS-CMS Solenoids and ATLAS Toroid

Experimental Magnets: common aspects*

*solenoids and toroids included

- The PH/DT1 group is in charge of controls and safety (located in the underground caverns of the experiments) of all magnets
- All magnets commissioned by the experiments in collaboration with PH/DT1 group. This includes the procedures to be followed during ramping
- All magnets will be operated from the Machine Control Room
- The experiments will log the current values and measure the field via probes located in the magnets: the experiments may ask the operator to change the current values if the measured field is not nominal
- All magnets <-> beam safety issues under discussion between the experiments/DT1 group and the MPWG. <u>Special attention should be given to the dipole magnets since they have to be ramped together with the compensator magnets</u> (always ON and scaled with energy?)

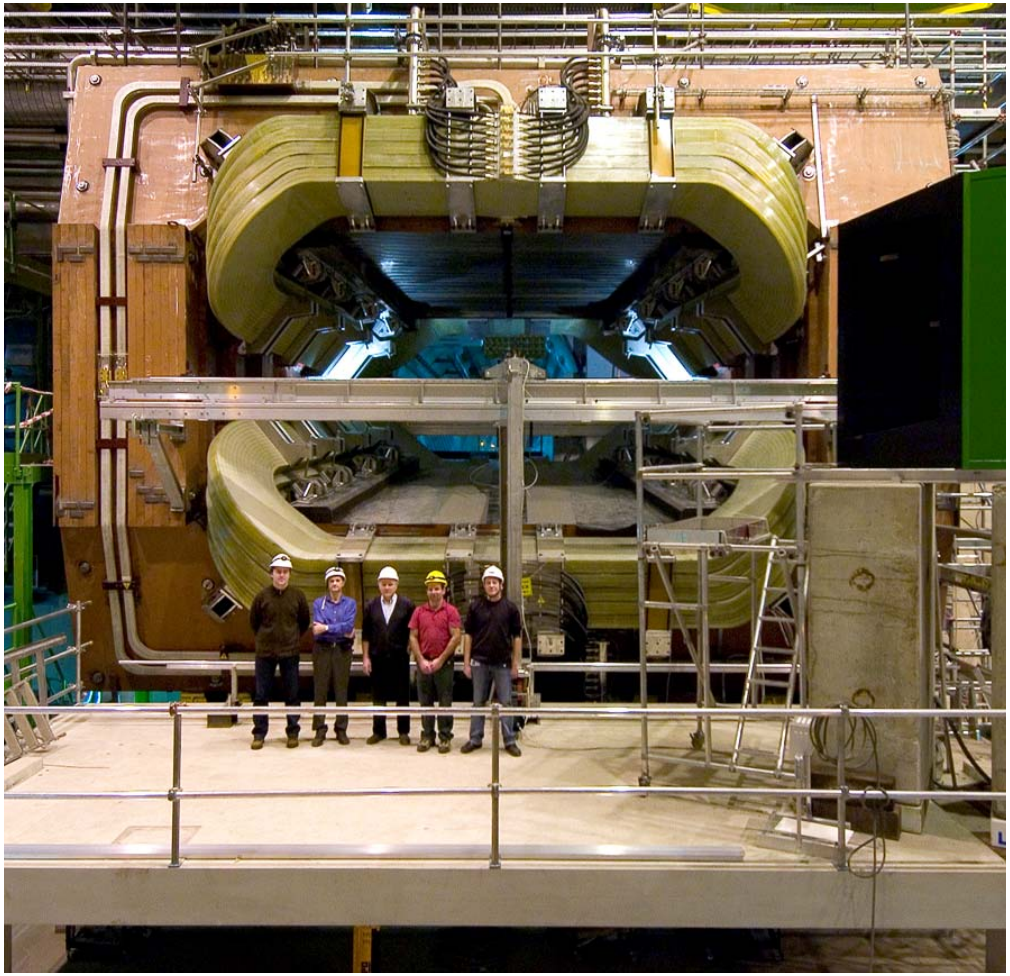
Dipole (and solenoid) operation:

Polarity changed ~ 1 - 4 times per year (this includes both pp and heavy ion operation)

Magnets OFF or full strength, but may be also intermediate strength (the last one for a later phase of the LHC operation)

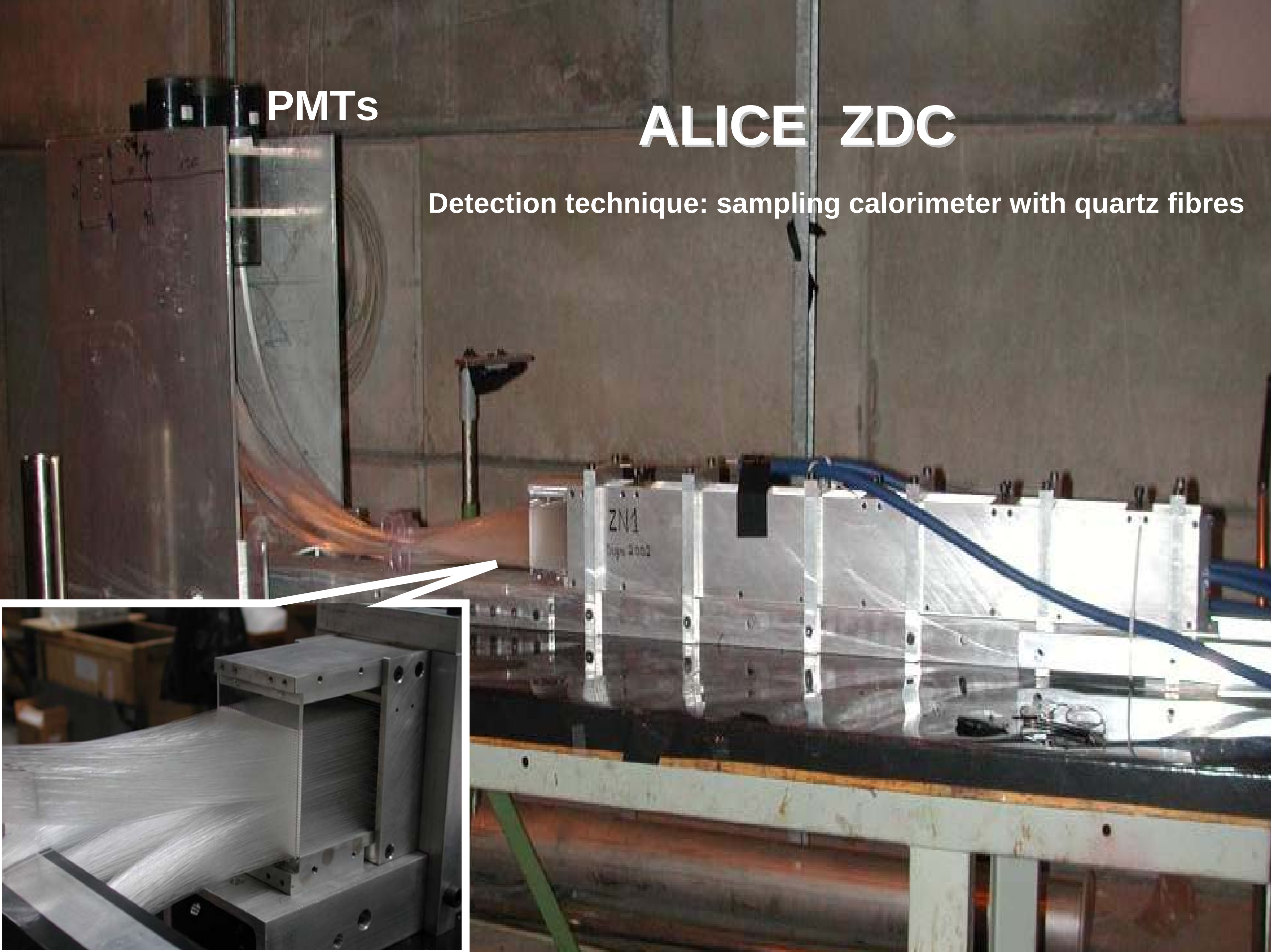
Both polarities, OFF and full strength need to be commissioned during the pilot run

Dipole operation:

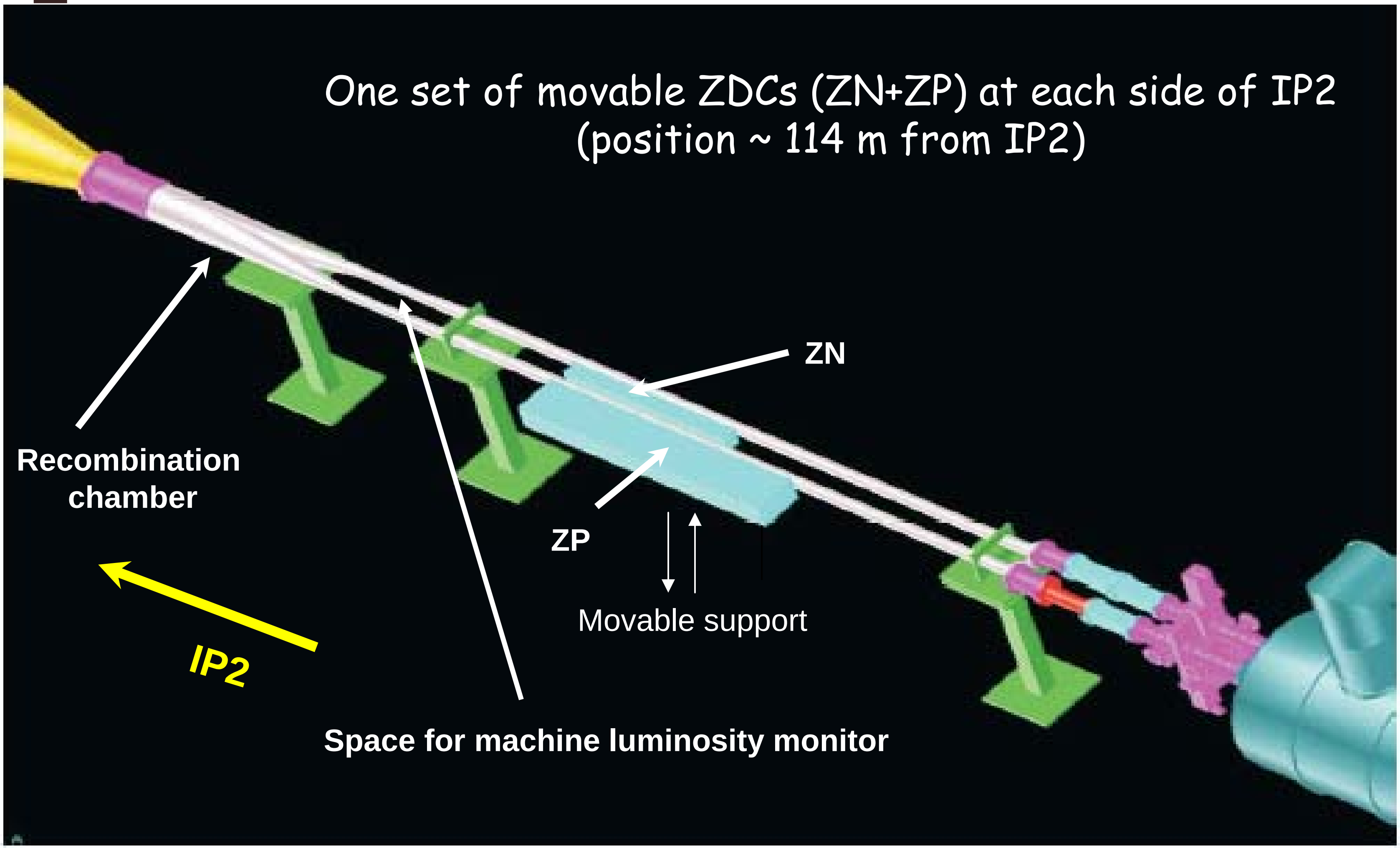


LHCb baseline with dipole magnet ON and polarity changed every fill during physics runs (magnet OFF may be required for detector commissioning)

During the pilot run the dipole polarity may remain unchanged over a number of fills. However, both polarities and magnet OFF should be commissioned during the pilot run


ALICE ZDC
Detection technique: sampling calorimeter with quartz fibres
PMTs
ZN1

ALICE ZDC: location



ZDC operation (1)

General remarks

- Remotely controlled platform sliding in the vertical plane. ZN and ZP move independently
- Fixed ZDCs' transverse position with respect to the platform
- ZCDs aligned with respect to the platform
- Platform aligned with respect to the beam pipes and beam plane. Nominal vertical coordinates established
- Garage position: lowered by ~ 20 cm with respect to the beam plane (safety and integrated radiation dose)
- Data taking position: in the beam plane
- ZP in data taking position both during pp and heavy ion operation
- ZN in data taking position only during heavy ion operation (according to the current plan)

ZDC operation (2)

Mode of operation

- In garage position during injection with machine interlock forbidding any movement
- Stable beam: machine interlock OFF=> platform raised until the ZDC center is at the "nominal" vertical coordinate (beam plane)
- Crossing angle measured detecting the signal from the 4 towers of the ZN and computing the centroid of the spectator neutrons at the ZN's front face (information available on-line via ADC readout)
- Detailed study of the uncertainty on the crossing angle measurement has still to be done; preliminary results indicate that the coordinate of the centroid of the spectator neutrons can be reconstructed with an uncertainty which goes from 0.5 mm up to 1.4 mm (depends on the number of spectator neutrons)
- Once the value of the crossing angle is known, the vertical position of the platform can be optimized until the vertical coordinate of the centroid of the spectator neutrons is zero.

ZDC operation (3)

Remarks:

- The ZDCs are located far from the IP2 experimental cavern in a restricted access area close to collimators
- In their data-taking position the ZDCs are situated only a few mm from the vacuum chamber
- A false maneuver of the ZDC mobile platform would have very serious consequences for the LHC operation
- In view of these facts, ALICE proposes that the ZDC is operated from the Machine Control Room on ALICE's request
- This would allow:
  - Consistent operation procedures
  - No change in procedure in case the ZN will be used as machine luminosity monitor
  - Better control of search procedures (search for "forgotten tools" close/on the platform which could damage the ZDCs or the beam pipe during the movement)

ZDC operation (3)

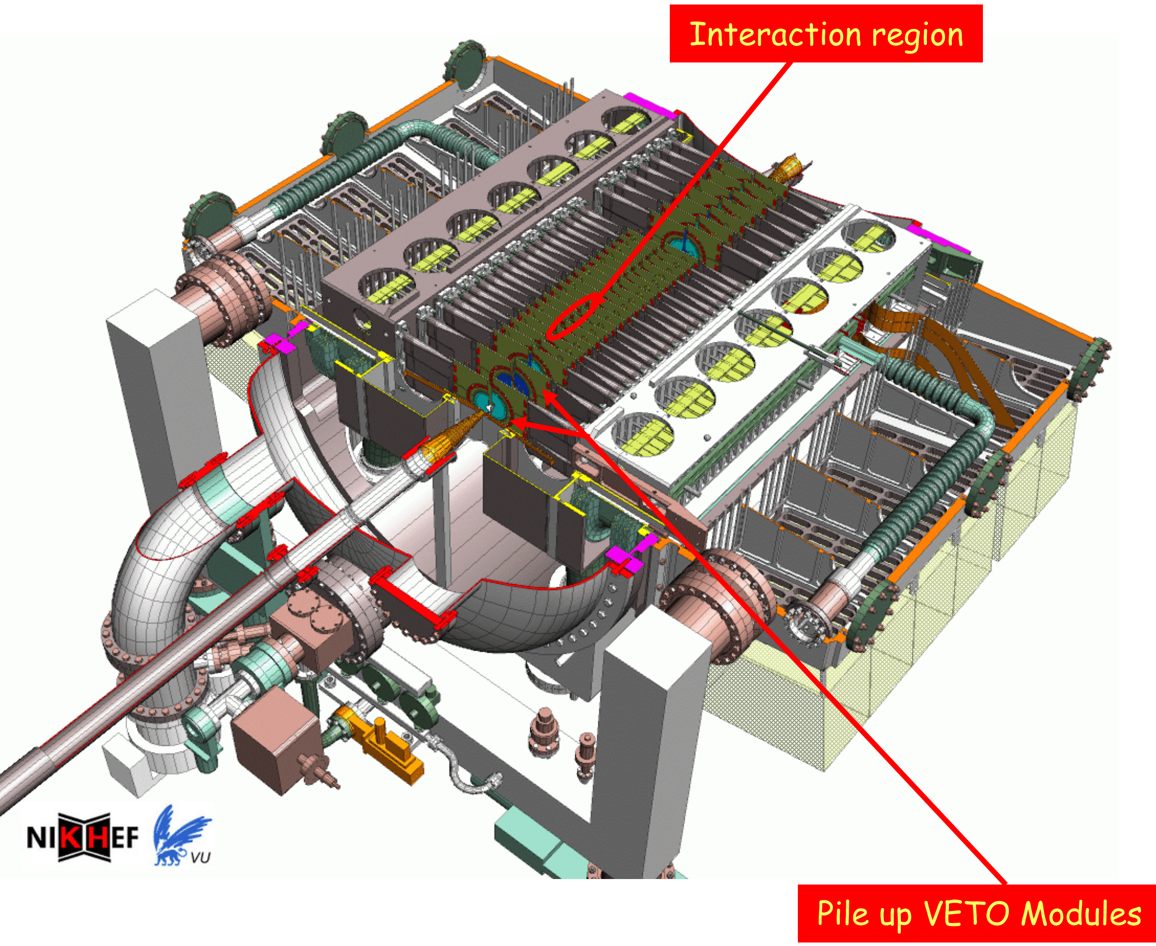
Safety

- Interlocks to disable the movement during injection until beams ready to collide
- End switches to avoid any collisions with beam pipes (few mm clearance) during the movements of the platform

Follow up

- Signal exchange with the machine
- Interlocks
- ZN as machine luminosity monitor? If yes, additional hardware and signal exchange should be foreseen

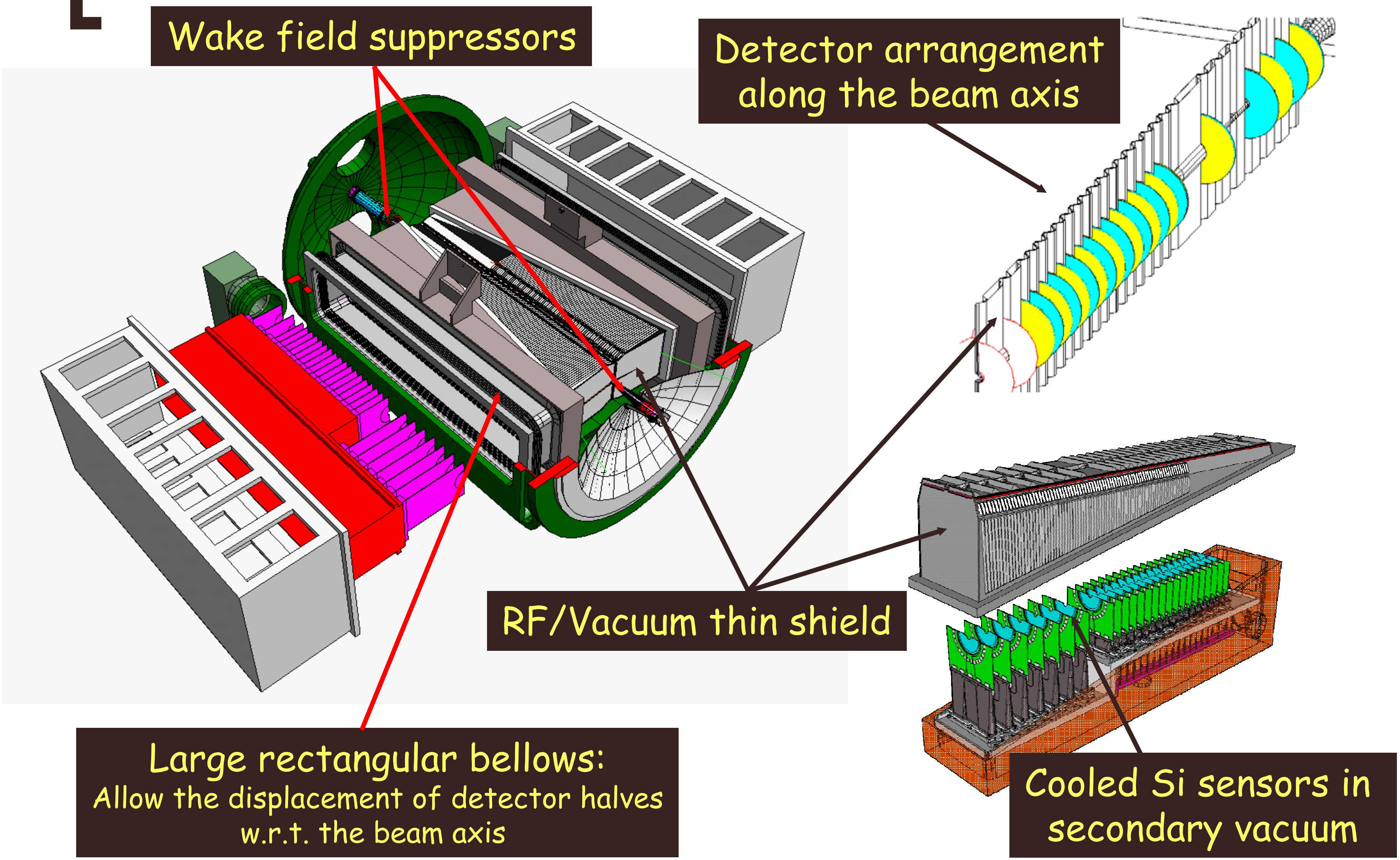
The VELO detector



Requirements

- Primary and Secondary vertex reconstruction (b-decays show displaced vertices)
  - Sensitive area as close to beam as possible (5 mm from beam axis)
  - Minimal amount of material between vertex and first measured point
- Give a “vital” input to the L1-trigger to enrich the b-decay content of the data via a fast and stand-alone pattern recognition

VELO Mechanical design



VELO operation

Mode of operation

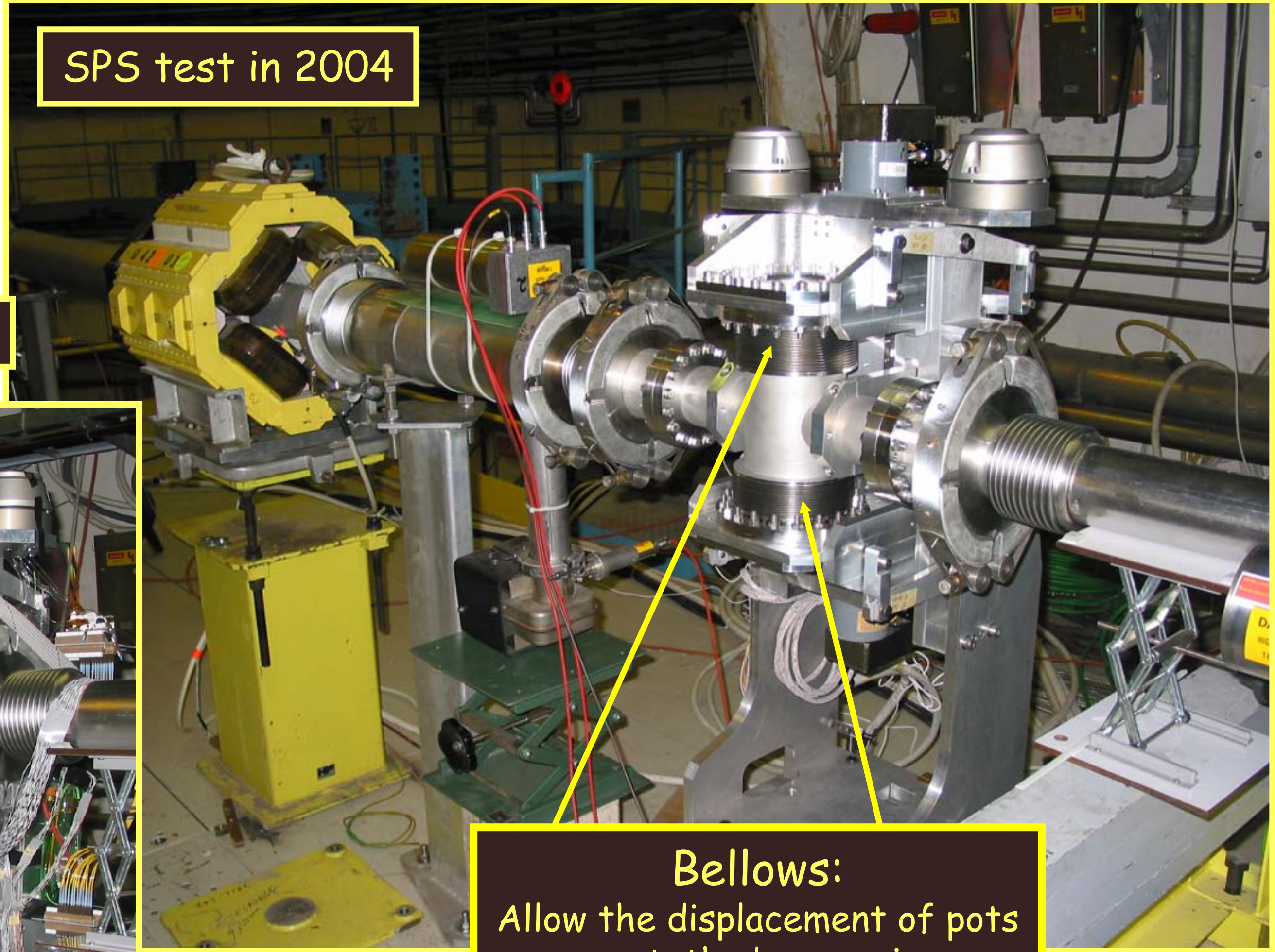
- Injection: VELO is in the open position (3.5 cm from beam axis) and machine interlock forbids any movement
- Stable beam: machine interlock OFF => VELO starts to move:
  - VELO has a fast precise standalone tracking system and it is able to locate vertices with a precision of ~ 10 μm in the transverse plane in a fraction of a second (in fact, during nominal operation, it provides input to the L1 whose output rate is 40 kHz). This also applies when VELO is in the open position
  - The precise on-line vertex location allows a precise gradual positioning of the VELO detector into the final position (5 mm ~ 70 σ from beam axis at β^* = 10 m)

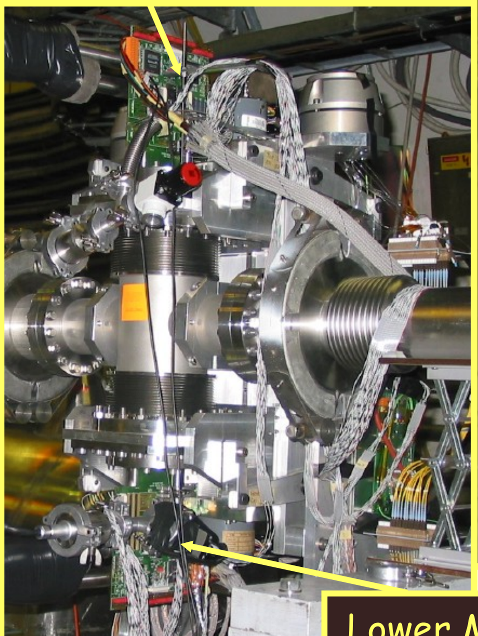
Therefore LHCb plans to operate VELO from the LHCb Control Room

Follow up

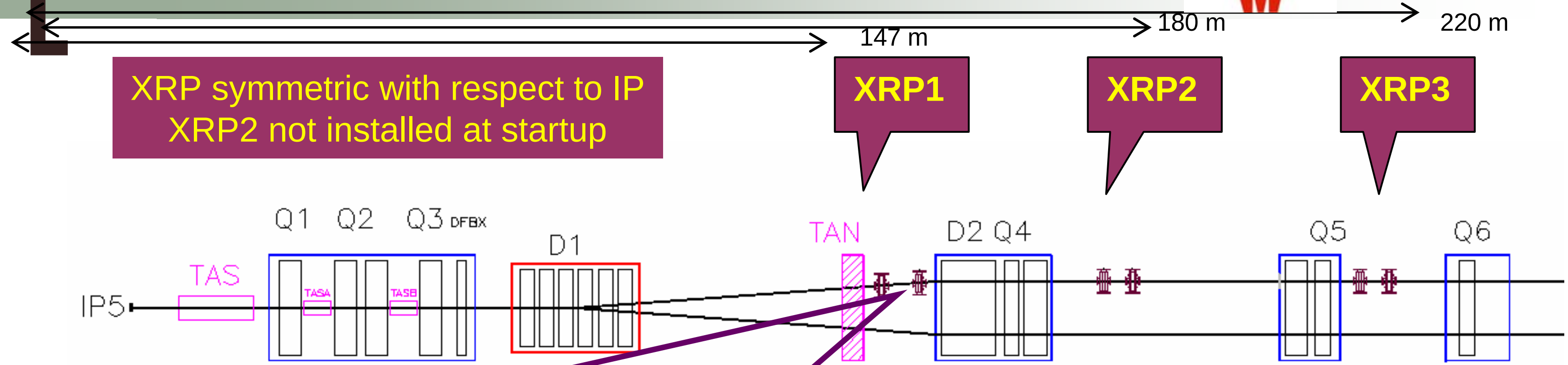
- Signal exchange with the machine
- Interlocks to forbid unsafe beam operations with VELO IN and to forbid the VELO positioning during unsafe beam operations (like injection, etc..)

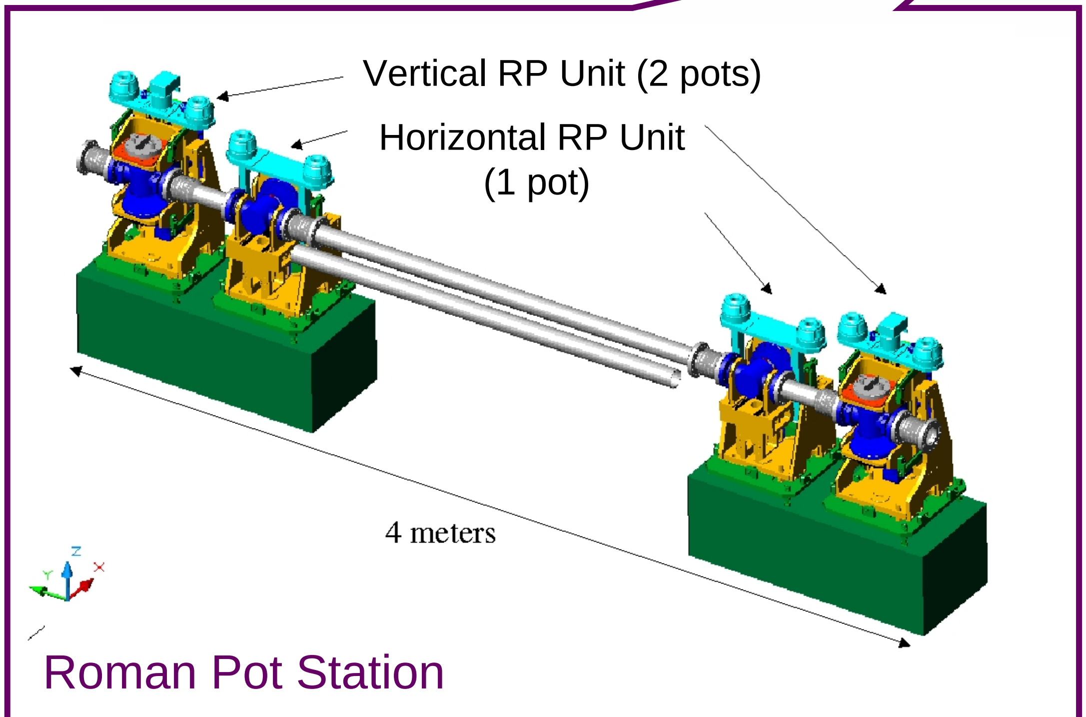
TOTEM Roman Pots

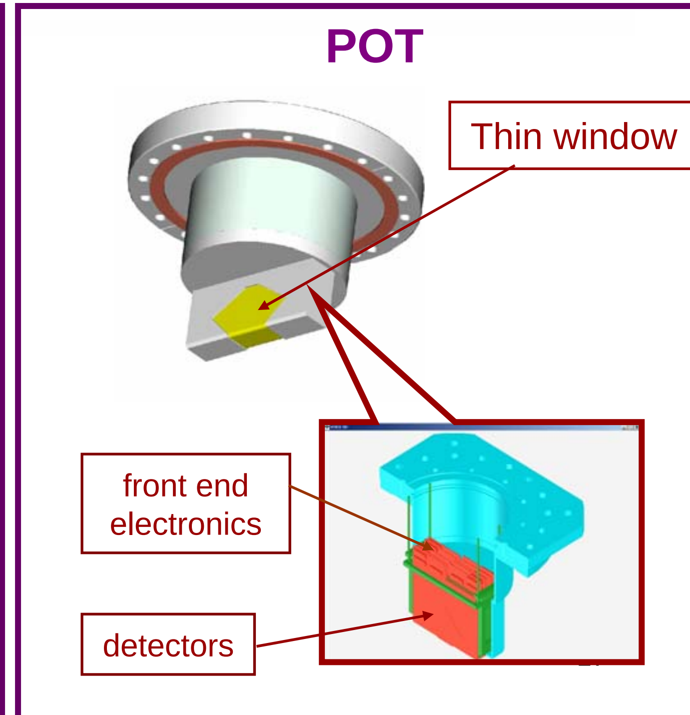




Roman Pots at IR5







Roman Pot operation (1)

Mode of operation

- Injection: RP is in the open position (4 cm from beam axis) and machine interlock forbids any movement
- Stable beam: machine interlock OFF => RP starts to move:
  - Initial information on the beam position is given by the BPMs located close to the RP stations (additional ones may be needed)
  - BLMs information is also very useful as demonstrated during the SPS test (BLMs have been already foreseen at each RP station)
  - The vertical pots are centered around the beam axis using the on-line data from the detectors located inside the pots and equalizing the data-rate. The distance between the two vertical pots is measured with LVDT sensors with a precision of few microns
  - Then the horizontal pot is moved in using the data rates on its detectors
  - The nominal distance from beam axis is 10 σ. However the final distance will be dictated by the machine running conditions (trigger rates in the RP detectors and safety)

Roman Pot operation (2)

TOTEM is planning to operate the RP from the CMS/TOTEM Control Room

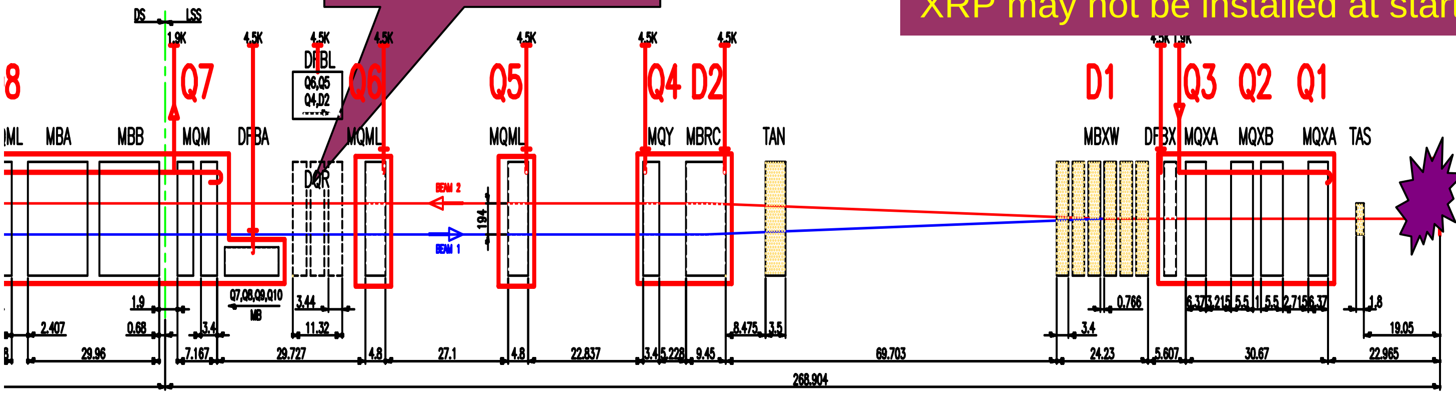
Follow up

- Risk analysis to identify possible failure scenarios at the RP and estimate the ensuing damage to equipment and downtime for LHC
- Signal exchange with the machine
- Interlocks to forbid unsafe beam operations with RP IN and to forbid the RP positioning during unsafe beam operations (like injection, etc..)

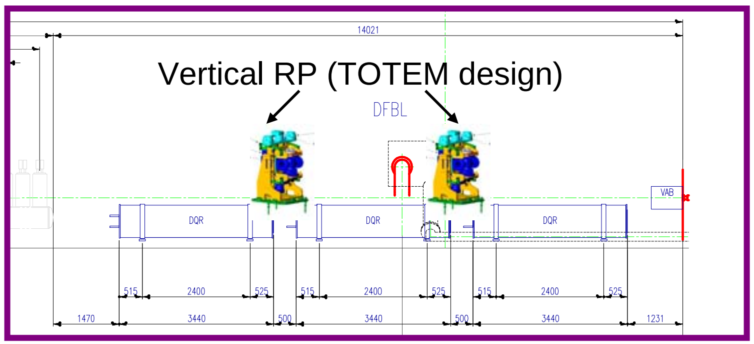
LoI encouraged by the LHCC Roman Pots at IR1

XRP STATION

XRP symmetric with respect to IP
XRP may not be installed at startup



XRP Station



RP operation

Project is still at the level of LoI. So the details of the RP operation have been not discussed yet. ATLAS would be in favor of operating the RP from the Machine Control Room

Conclusions

- Equipment which could interfere with the beam operation is located in all experimental insertions
- The interlocking of the experimental magnets is going to be finalized with the MPWG in the near future. Their operation looks quite well defined
- A rather urgent follow up is needed on all movable detectors for:
  - Setting up a safe procedure for their operation (signal exchange with the machine and "dedicated" interlocks)
  - Finalizing the responsibilities for their operation

  Personal remark: which Control Room is going to operate the detectors is most probably not an issue if the interlock system and the signal exchange is very well designed

Notice: additional detectors to be put in the LSSs which may interfere with beam operation are presently under discussion:

- ZDCs for both ATLAS and CMS (to be located in the TAN)
- Calorimeter for the LHCf Collaboration to be located either in the TAN at IR1 or at the recombination chamber at IR8