Integration of forward physics detectors into the LSS of the LHC

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Outline

Physics motivation for
the very forward detectors

Integration of the TOTEM Roman Pots at IR5

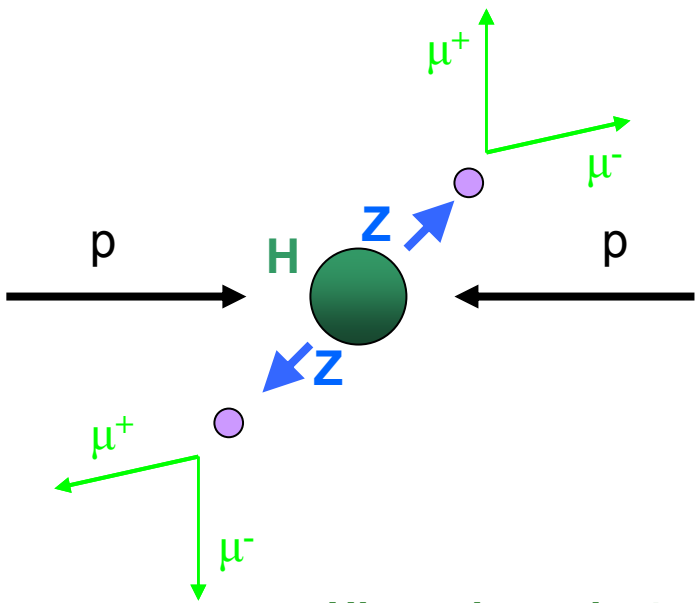
Integration of the ALICE ZDCs at IR2

New proposals

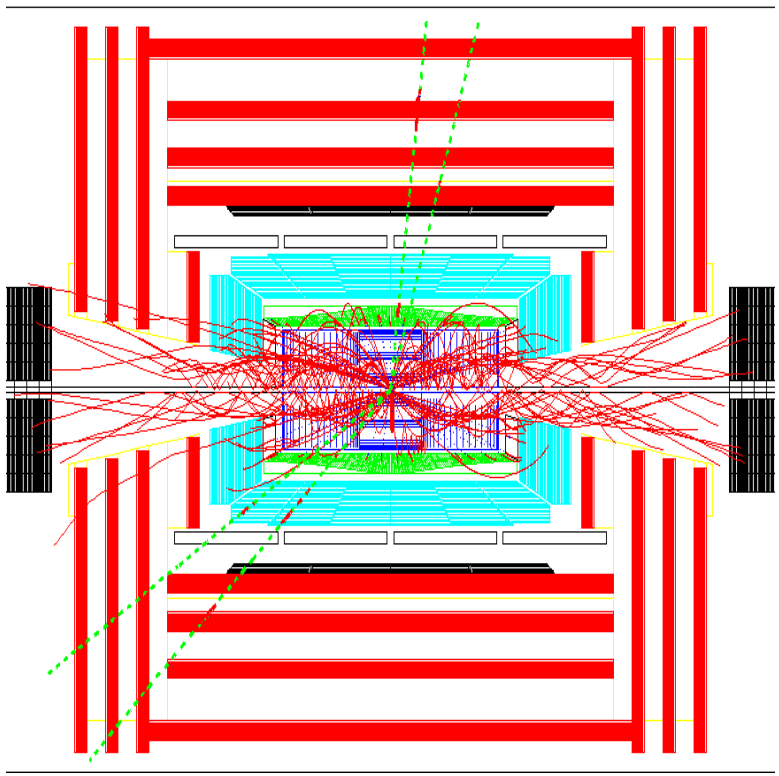
Measurement of central phenomena (pp collisions)

For finding new physics : production of new heavy particles etc…

$|\eta| < 5$ ($\theta > 0.77°$) detector coverage is sufficient

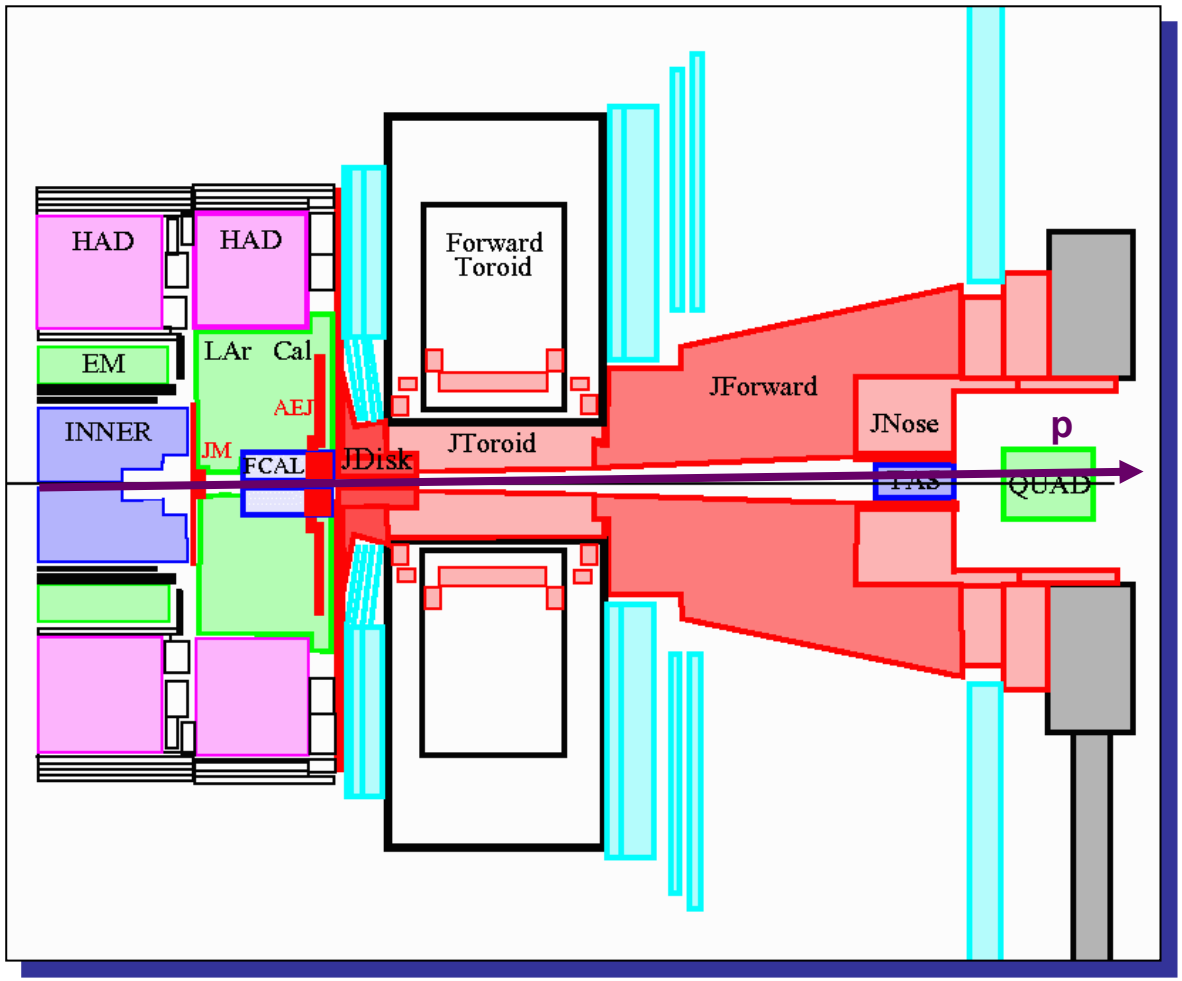


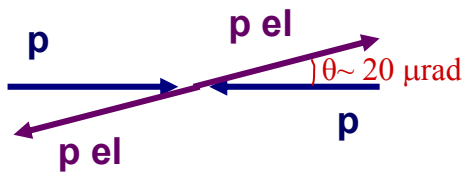
Higgs decay in 4μ



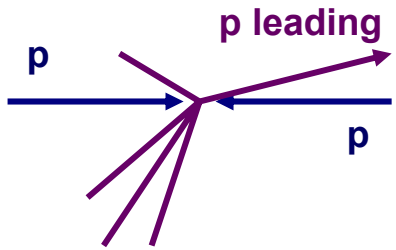
Very forward physics (pp)

Zoom around the experimental beam pipe





elastic scattering

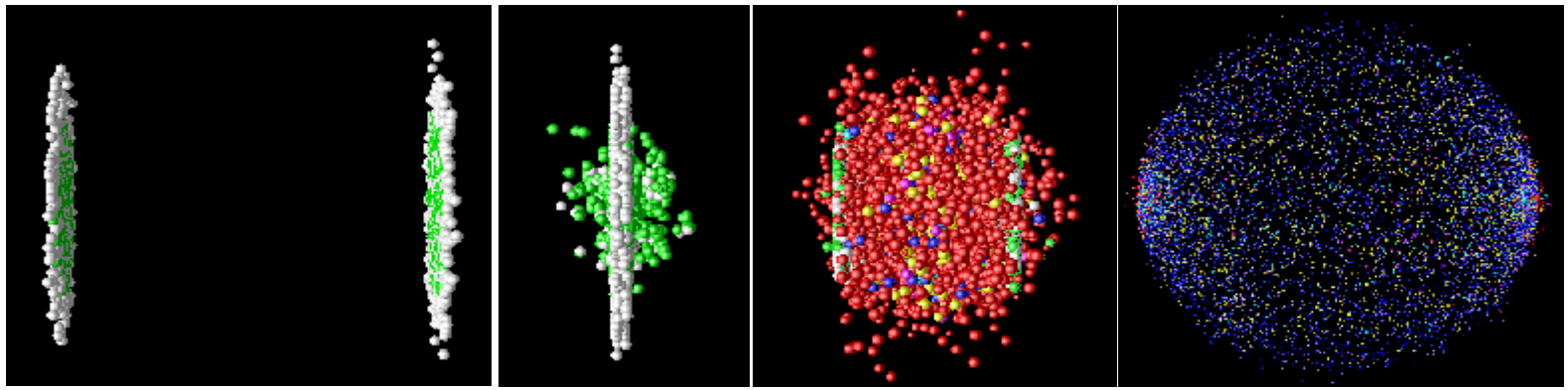


single diffractive

$$\sigma_{tot} = \frac{16\,\pi}{1+\rho^2} \times \frac{(dN/dt)|_{t=0}}{N_{el}+N_{inel}}$$

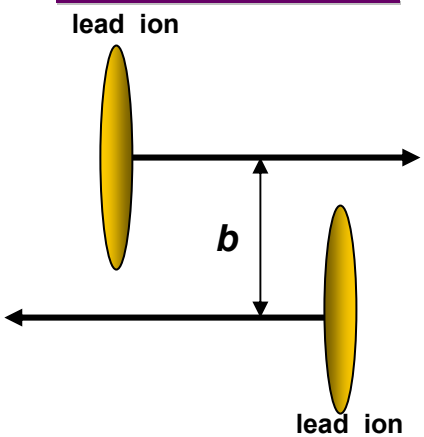
σ_{tot} measurement with the luminosity independent method

Heavy ion collisions



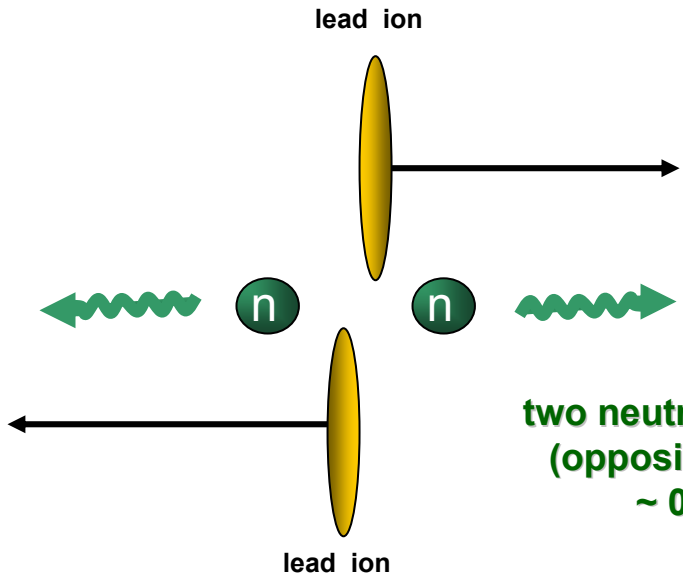
Heavy ion central collision at LHC (nucleon – nucleon collision energy 5.5 TeV)

Impact parameter *b*



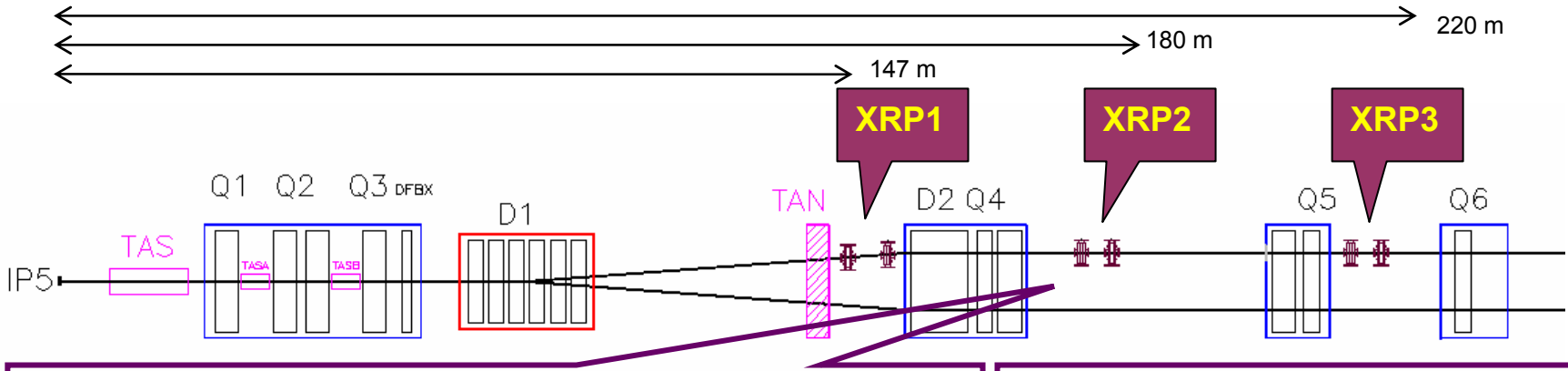
b **is related to the number of non-interacting nucleons flying at ~ 0 degrees**

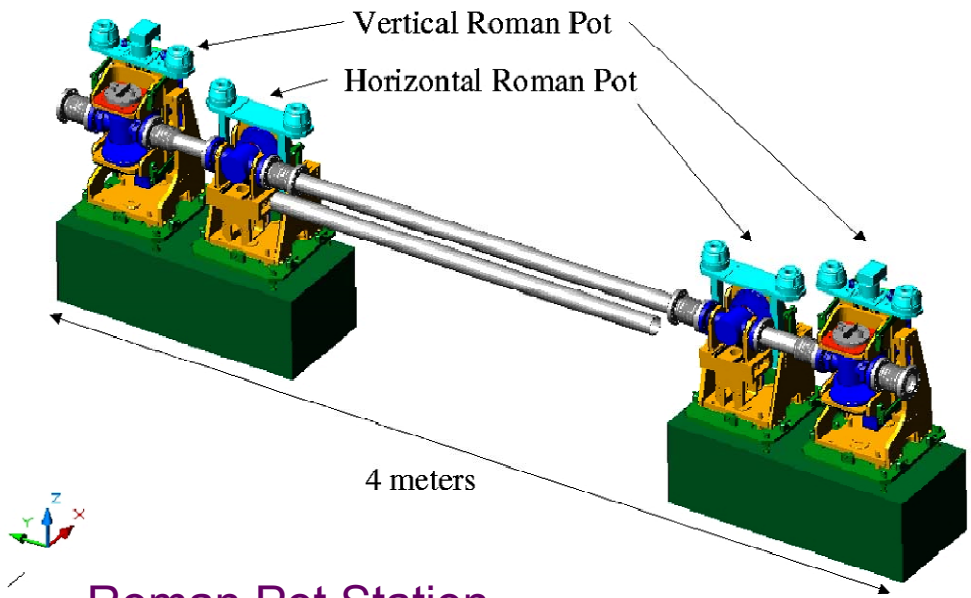
Electromagnetic mutual dissociation and luminosity measurement



two neutrons are emitted (opposite direction) at ~ 0 degrees

TOTEM Roman Pots at IR5



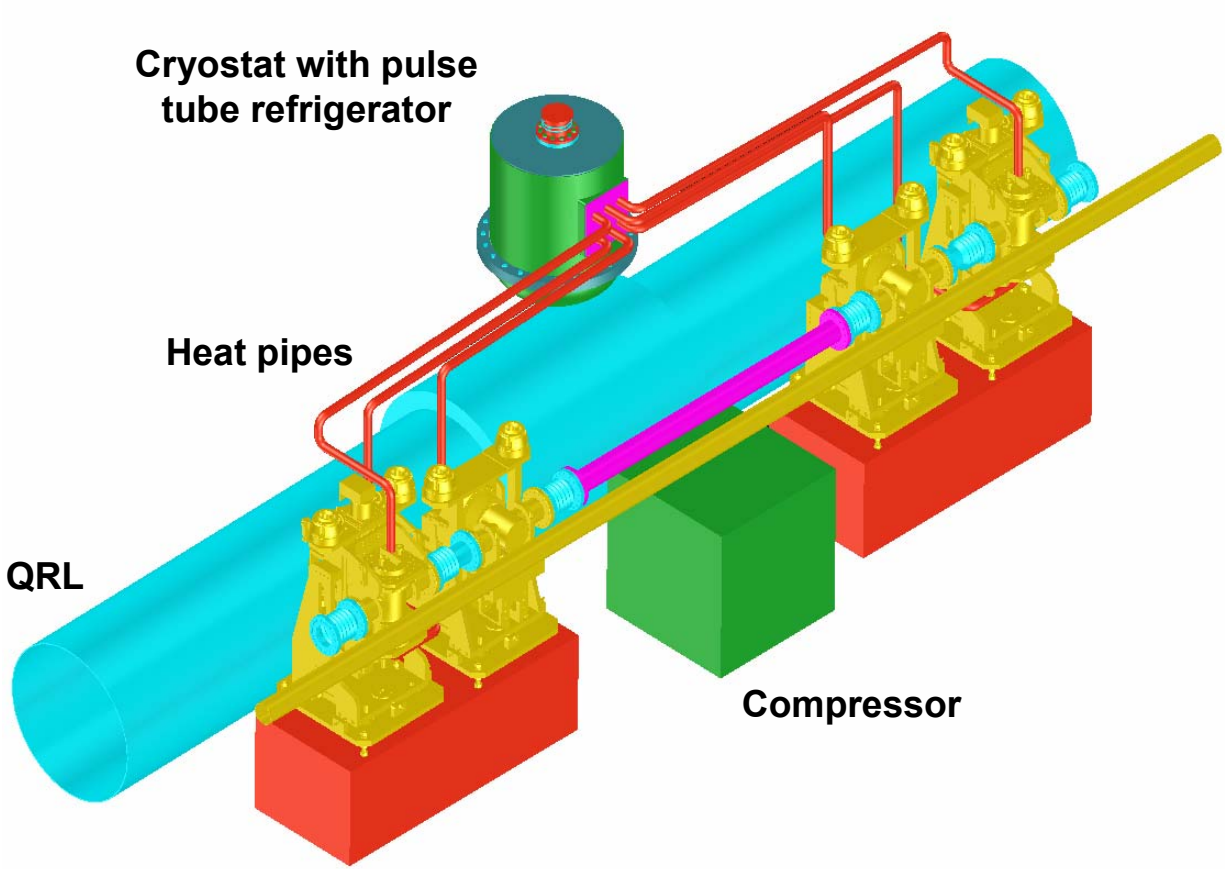


Roman Pot Station

Integration in the tunnel

- Cables: minimize length for trigger issues
- Asymmetric design (beam spaced by 194 mm)
- Pedestal for stable and fine positioning
- Electronic racks below the beam pipe
- Stand alone cooling for silicon detectors and electronics

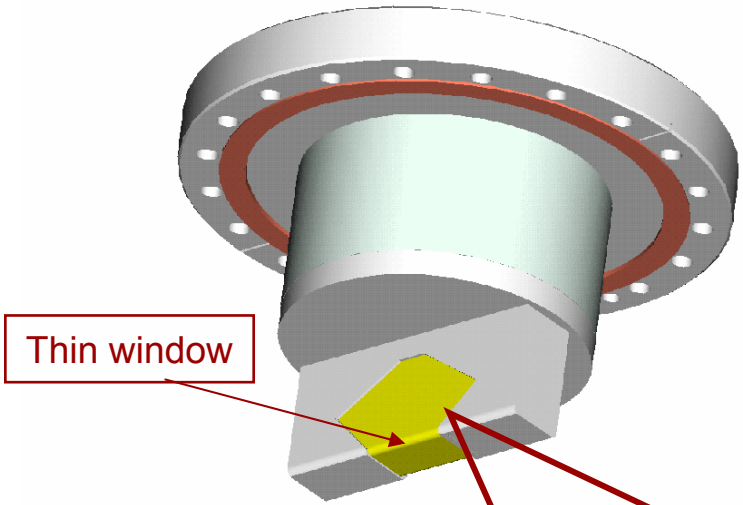
TOTEM RP cooling system
(schematic layout)



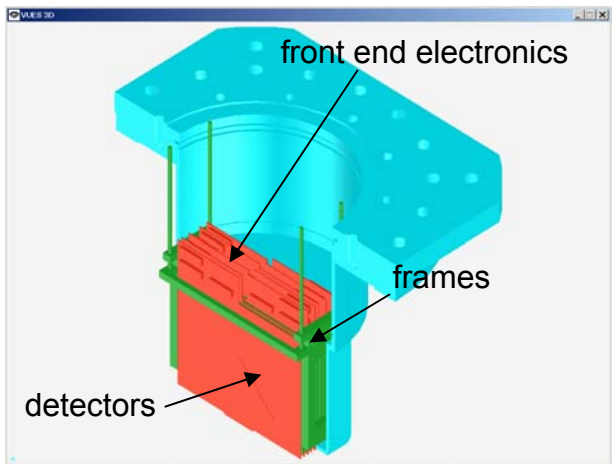
(TOTEM / AT-ECR)

TOTEM Roman Pot Prototype

Roman Pot : internal view



Vertical Cut



Integration in primary vacuum

- **U.H.V. compatible materials (and RF shielding) => detectors and electronics in a pot:**
  Main body "SS" – Pot "Inconel"
- **TOTEM physics => thin (0.2 mm) window:**
  - **3 technologies under study with TS/MME (brazing, electro erosion,T.I.G.)**
  - **secondary vacuum (minimizes pot deformation towards beam)**
  - **designed to stand 1 bar**
  - **designed to stand bake out**
- **Minimization of the machine impedance (RF fingers in garage position)**
- **Machine and Roman Pot Protection from beam accidents:**
  - **beam loss monitors**
  - **detailed strategy under study**

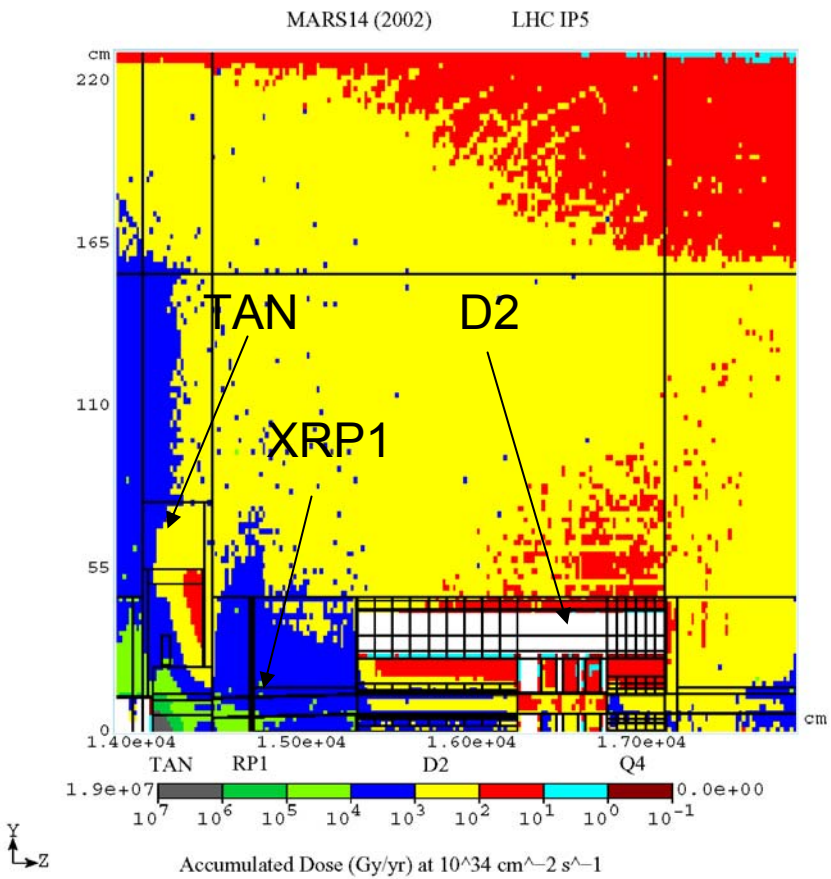
Radiation dose in LS5

Assumptions:

- Simulation has been done from IP5 to Q7 (v. 6.4, $\beta* = 0.5$ m)
- Peak luminosity is $L=10^{34}$ cm^{-2} s^{-1}
- Absorbed dose is normalized to :
  - 180 days
  - 24 hours per day
  - $\langle L \rangle = 0.5 \cdot 10^{34}$ cm^{-2} s^{-1}

Results:

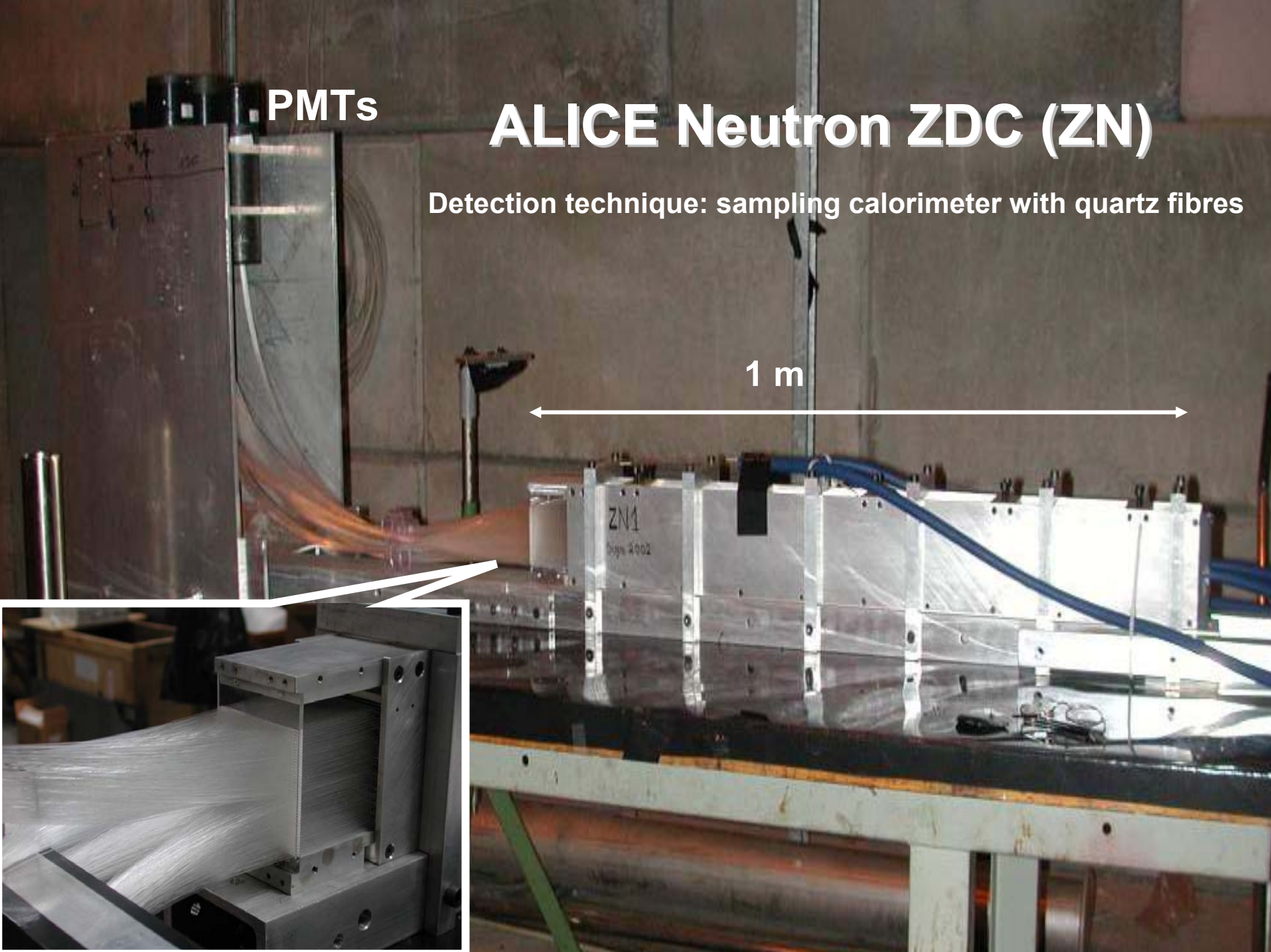
Accumulated dose around XRP1 is ~ 10^3 Gy/yr



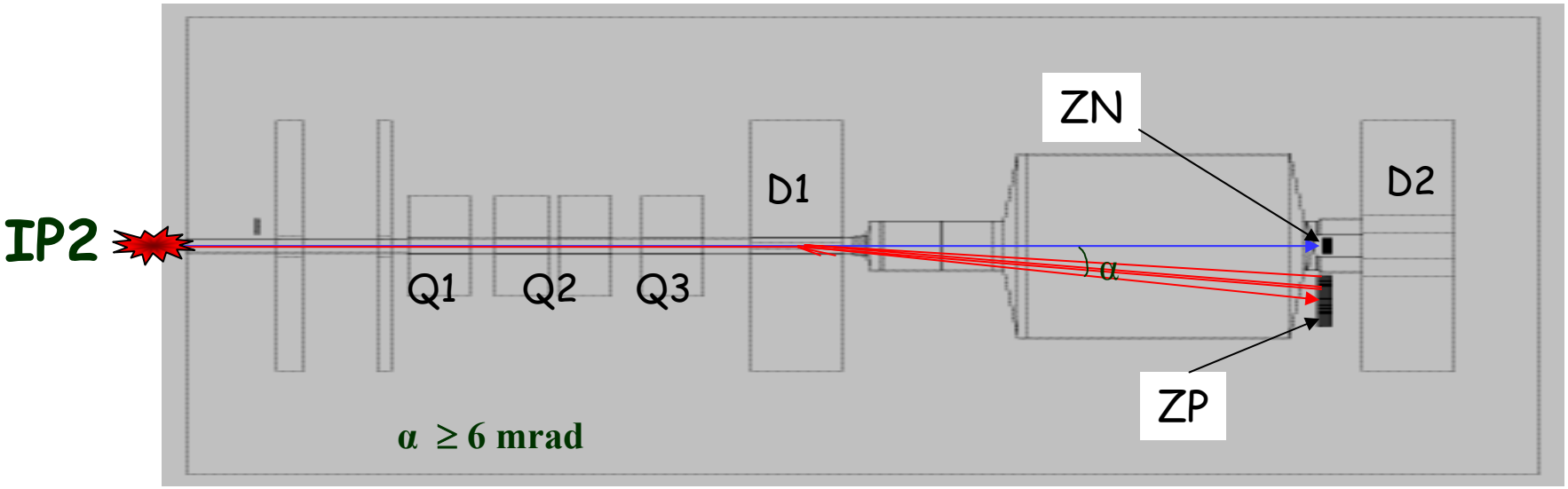
Radiation hard components (cooling, local triggers, power supplies…..)

ALICE Neutron ZDC (ZN)

Detection technique: sampling calorimeter with quartz fibres



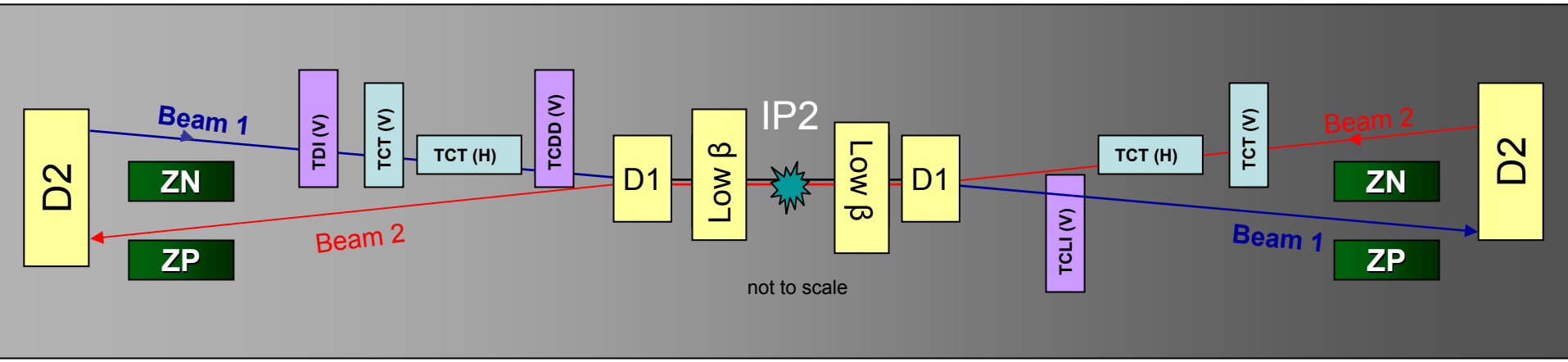
ALICE ZDCs at IR2



Integration in the tunnel

- Aperture from D1 to ZP: maximize the spectator protons acceptance in the ZP
- Minimize the amount of material in front of the ZDCs
- Enough space between the two beam pipes for the ZN

IR2: injection and interaction region

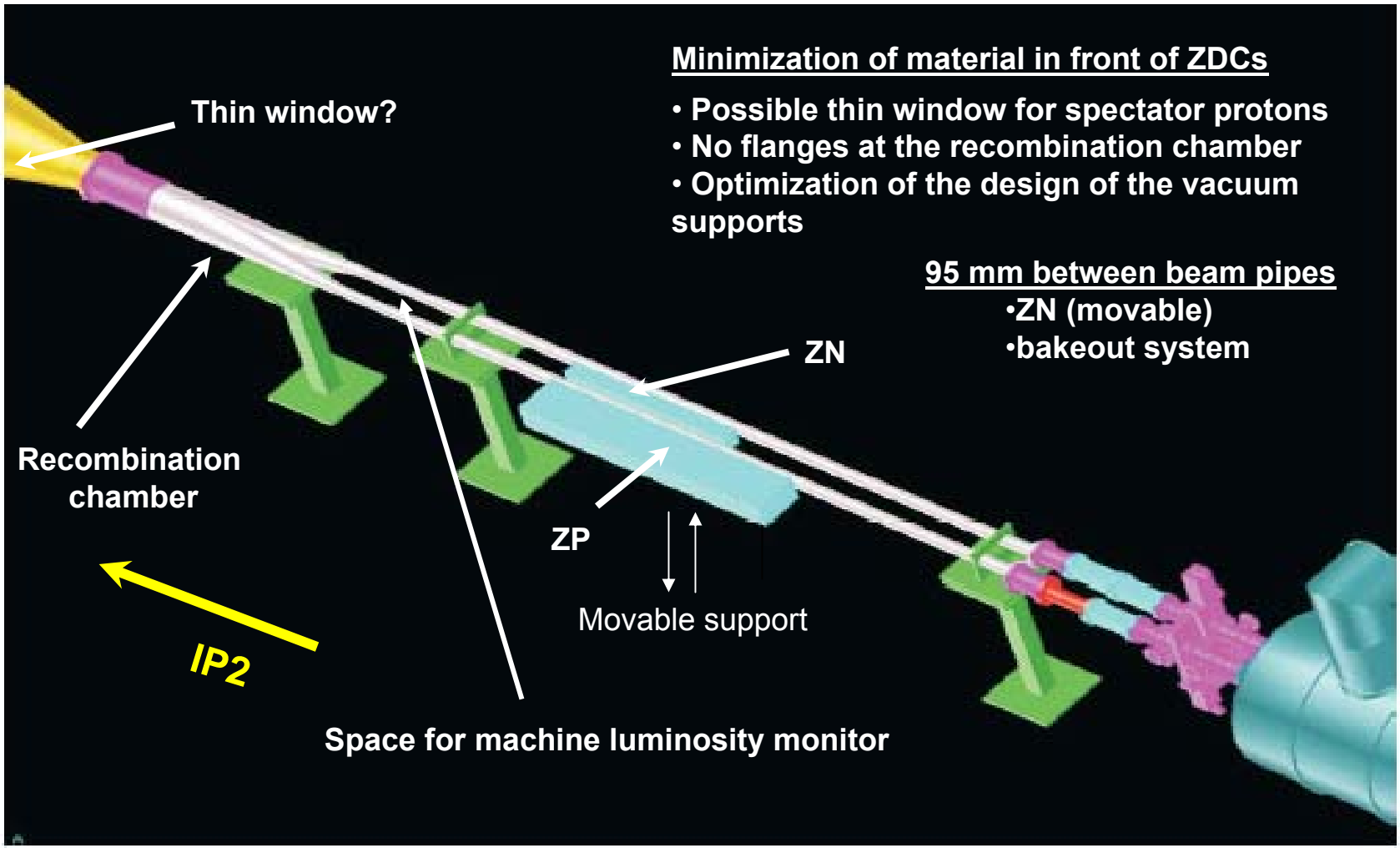


Movable absorbers to protect from injection errors

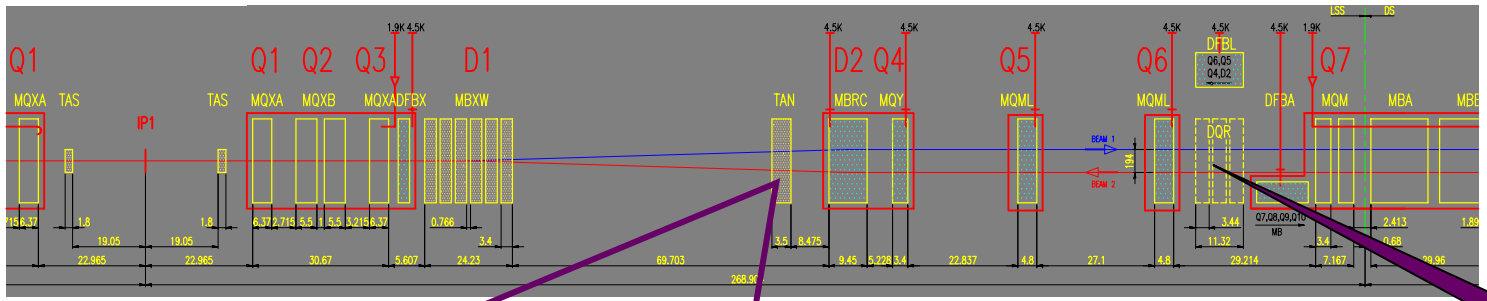
Movable absorbers to protect the low β triplet from peaks in the secondary beam halo (proposal)

Their design takes into account the ZDCs aperture requirements (one common beam pipe)

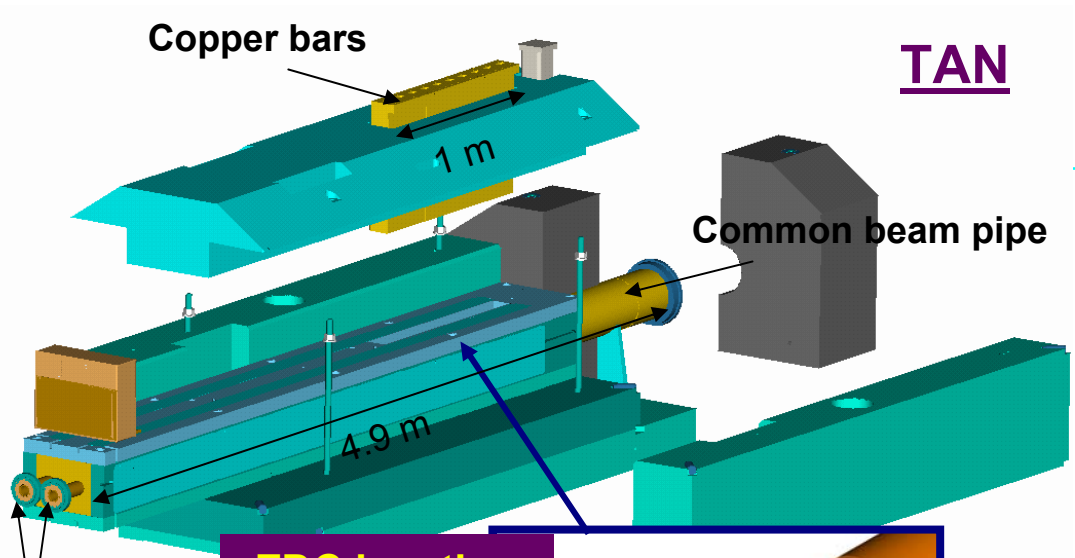
Beam pipe layout close to ZDCs



New proposals

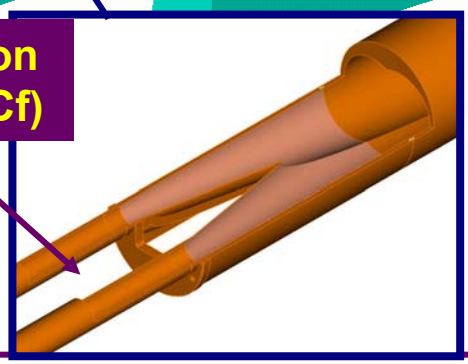


XRP



TAN

ZDC location (ATLAS/LHCf)



ATLAS Collaboration

Two Roman Pots (XRP) between Q6-Q7

ZDC in the TAN absorber (slots foreseen for instrumentation)

LHCf Collaboration

ZDC placed at the recombination chamber. Possible locations: TAN (IP1 or IP5) or IP8

Conclusions

- Very interesting physics can be studied with detectors located in the experimental LSS
- The integration of these detectors is often not trivial and it requires a close collaboration with several LHC machine groups which has been very successful up to now
- If the new proposals will be approved, all 4 experimental LSS may be equipped with experimental detectors