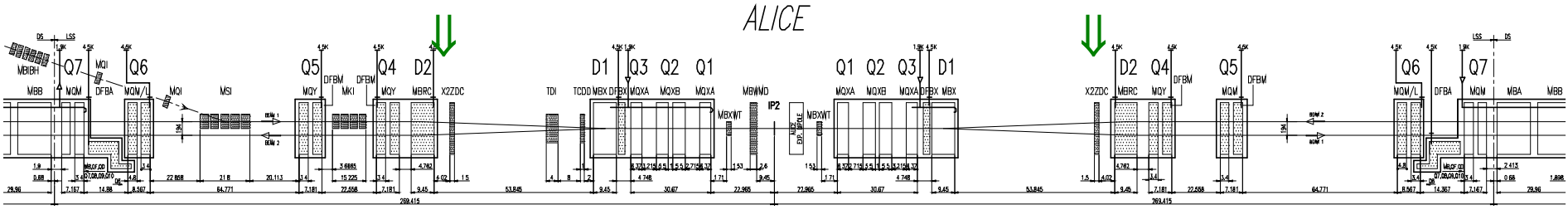
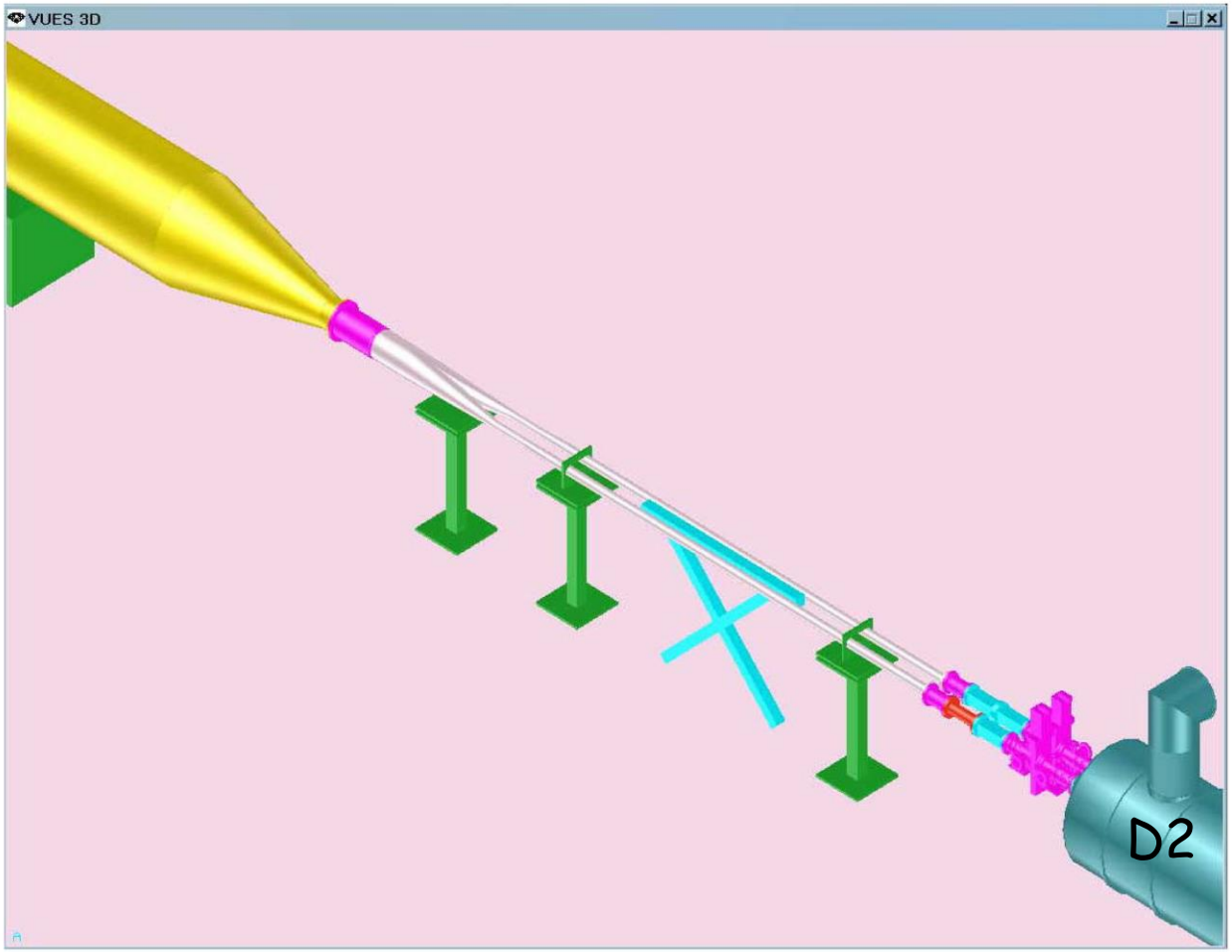
Operation issues for the ALICE ZDC

- Integration problem at IR2 where the AB/BDI luminometer have to coexist with the ALICE ZDC
- The LTC held on 3/9/2003 asked to set up a little study group to integrate the AB/BDI luminometer and the ALICE ZDC at IR2
- WEB page at:
  http://macina.home.cern.ch/macina/ZDC-Lumi/
- First meeting held on 3/10/2003

Location


ALICE
IP2
Q7
Q6
Q5
Q4
D2
D1
Q3
Q2
Q1
MBB
MQM
MQI
DFBA
MQM/L
MSI
MQY
DFBM
MKI
MBRC
X2ZDC
TDI
TCDD
MBX
DFBX
MQXA
MQXB
MBWMD
MBXWT

Recombination chamber (C. Rathjen)

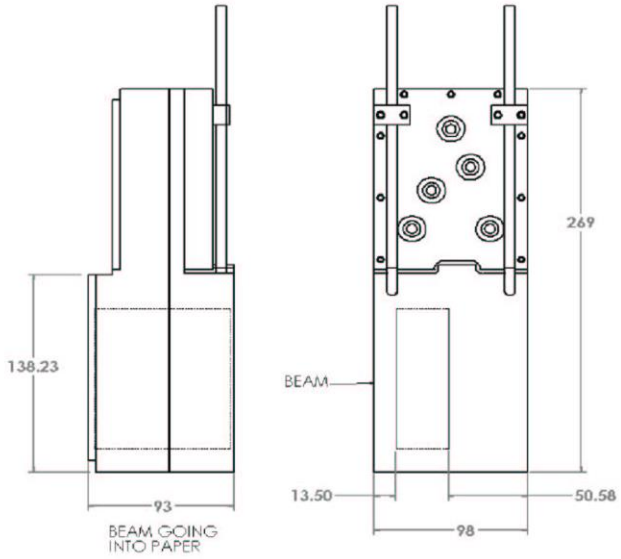


AB/BDI Luminometer (E. Bravin)

- Two technologies under study:
  - Polycrystalline CdTe Detectors
    - Very fast signal (FWHM ~ 5 ns)
    - High sensitivity -> do not need to be located at the shower maximum (~ 3 cm Cu as passive material)
    - Active device dimensions (mm) : 94 (h) x 66 (v) x 36.5 (l)
    - Not sufficiently RAD-HARD
  - Fast Ionization Chamber
    - Signal peaking time ~ 17 ns
    - Sensitivity: need to be located at the shower maximum (~ 30 cm Cu as passive material
    - Active device dimensions (mm) : 93 (h) x 269 (v) x 98 (l)
    - RAD-HARD

Ionization Chamber

The ionization chamber requires ~30cm of Cu in front of it to act as a converter and start the shower



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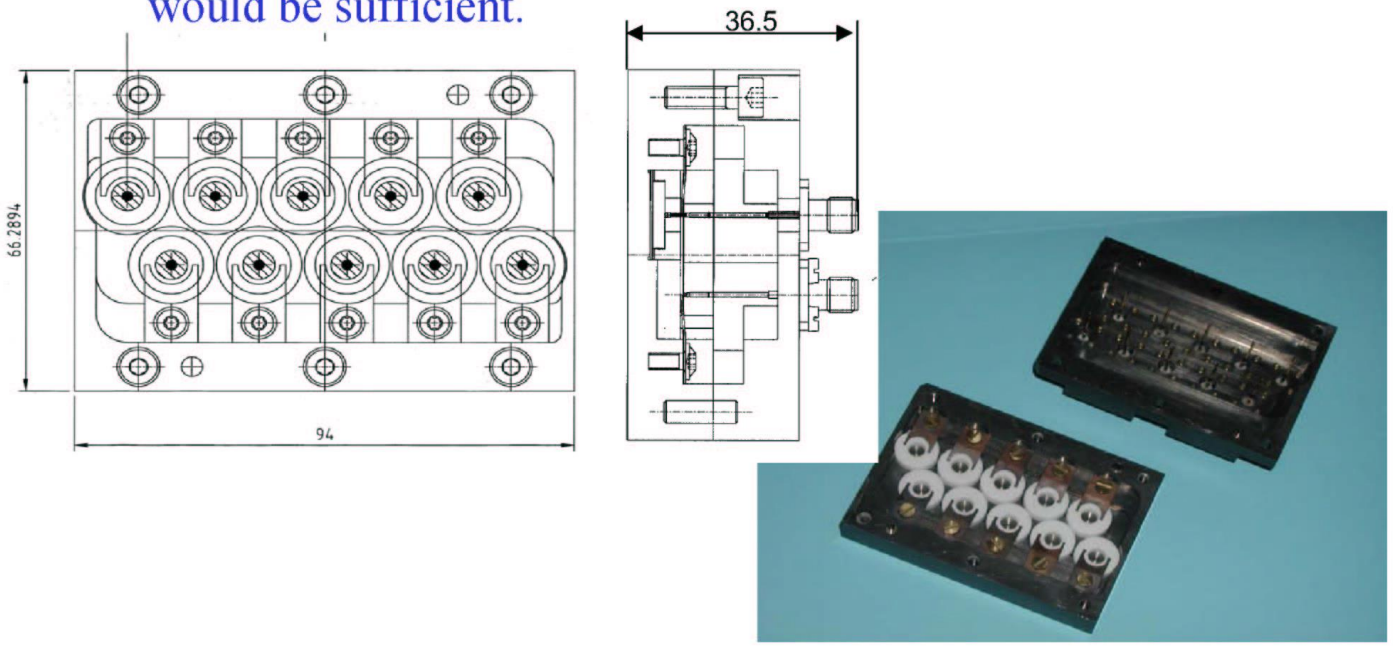
The CdTe detector

Due to the better sensitivity the CdTe detector does not need to sit at the shower maximum, a few cm of copper would be sufficient.



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ALICE ZDCs (M. GALLIO)

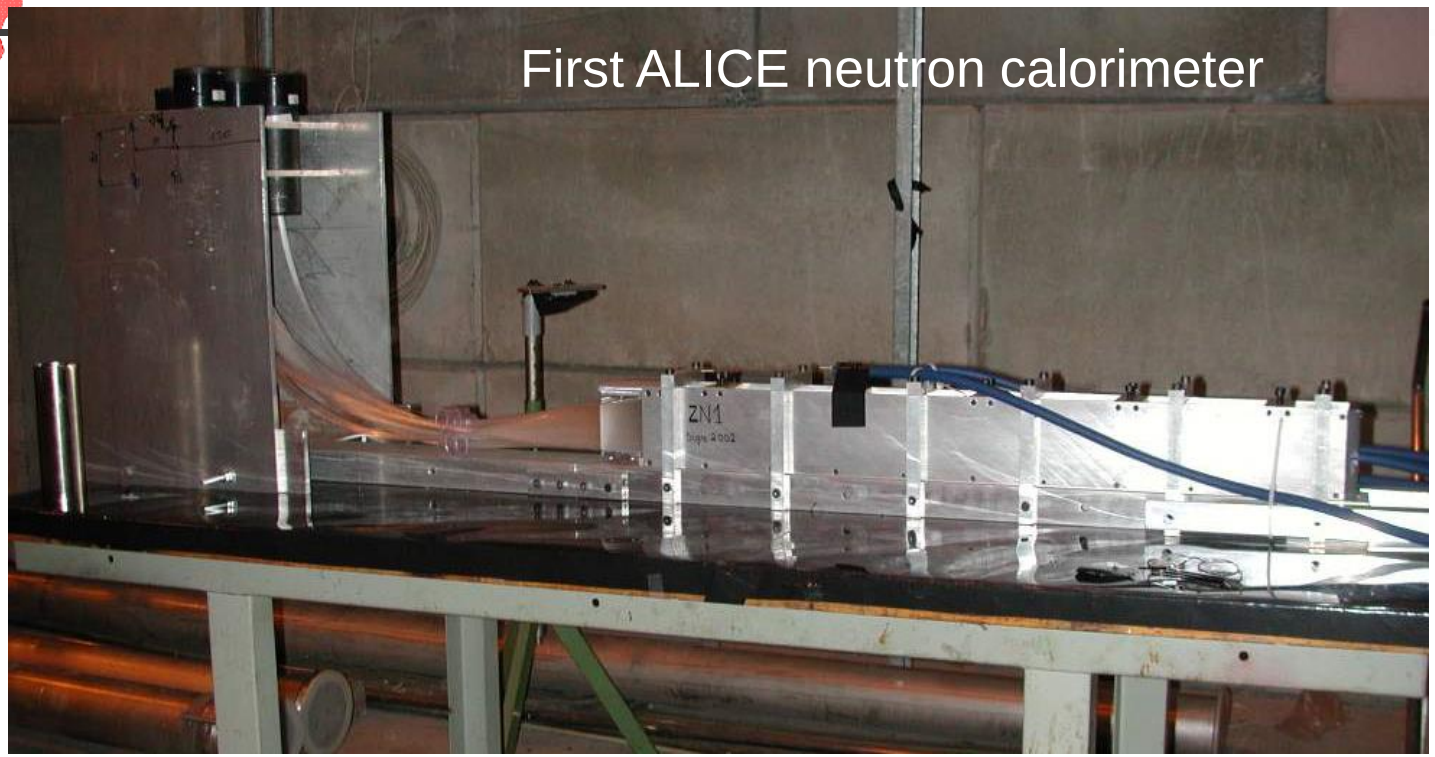
- ZDCs measure the centrality of the HI collision via the measurement of the spectator neutrons and protons
- The neutron ZDC will measure the absolute luminosity detecting the mutual EM dissociation in the 1n+1n channel
- The neutron ZDC will be used only during the HI runs while the proton ZDC may be used during the pp runs too
- Technology used is the quartz fiber calorimetry:
  - RAD – HARD (~ 1 Mrad/day at $L=10^{27}cm^{-2}s^{-1}$)
  - Compact detector -> nZDC dimension (mm): 82(h) x 82(v) x 2500(l)
- Fulfills most of the luminometer functional specifications (ZDCs are used at RHIC as machine luminosity monitors):
  - Fast signal (20 ns at the base)
  - Response grouped in four towers -> info on the Xing angle

ZDC

- The ZDC energy resolution is not affected by 3 cm of Cu in front of it. However 30 cm of Cu are not tolerable

To minimize the radiation damage the ZDCs will be located on a movable platform and put in the data taking position only when collisions are established

Space needed for detector and services



Space needed for ZN :

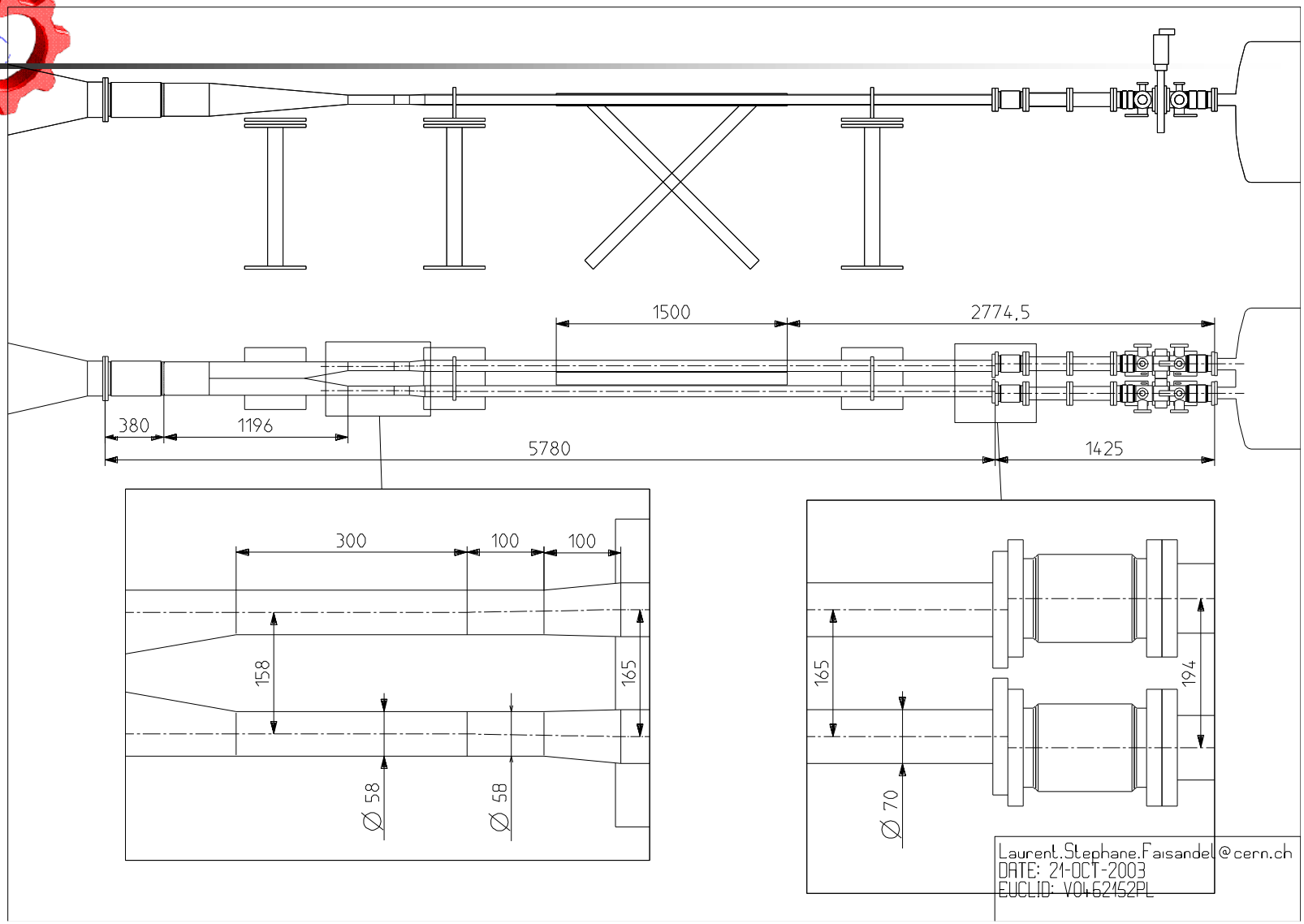
Z (along the beam) ➔ ~ 2.50 m
Y (vertical) ➔ ~ 0.8 m
X (horizontal) ➔ 0.082 m at y=0
X (horizontal) ➔ ~ 0.3 m at y=-0.2

Space needed for ZP :

Z (along the beam) ➔ ~ 3.0 m
Y (vertical) ➔ ~ 0.8 m
X (horizontal) ➔ .234 m
X (horizontal) ➔ ~ 0.3 m at y=-0.2

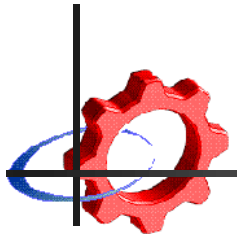
Integration at IR2 (C. Rathjen)

- The recombination chamber layout is identical to the one adopted for IR1 and IR5
- Beam pipes dimensions are reduced to the minimum to maximize the available space between them (beam aperture to be checked by AB/ABP)
- Design needs to be finalized as soon as possible


1500
2774,5
380
1196
5780
1425
300
100
100
158
165
Ø 58
Ø 58
165
194
Ø 70
Laurent.Stephane.Faisandel@cern.ch
DATE: 21-OCT-2003
EUCLID: V04-62452PL

Possible solutions

- ZDC is a good candidate as luminometer. However the machine shouldn't rely on devices belonging to the experiments
- The CdTe option for IR2/8 (not sufficiently RAD-HAD for IR1/5) can solve the problem since it is compatible with the ZDC and can be always operational (two technologies have to be developed)
- The FIC option:
  - Integration not easy (either in front or on top of the ZDC)
  - It cannot be operational during the HI run ->
    - **Machine has to rely on the ZDC information and ALICE needs to agree to use the ZDC to bring beams into collision (after ramp, squeeze and pre-collisions adjustment)**
    - **To use the luminometer to bring beams into collisions and then switch to the ZDC is not convenient from the beam operation point of view**



- $\sigma_{inelastic}$ = 8 barn
- L = 10^{27} cm^{-2} s^{-1}
- Rate (min) = 8000 s^{-1}
- ⟨spec. n ⟩ = 70/min
- ⟨spec. p ⟩ = 60/min
- Rate spec. n = 5.6 x 10^5 sec^{-1}
- Rate spec. p = 5 x 10^5 sec^{-1}

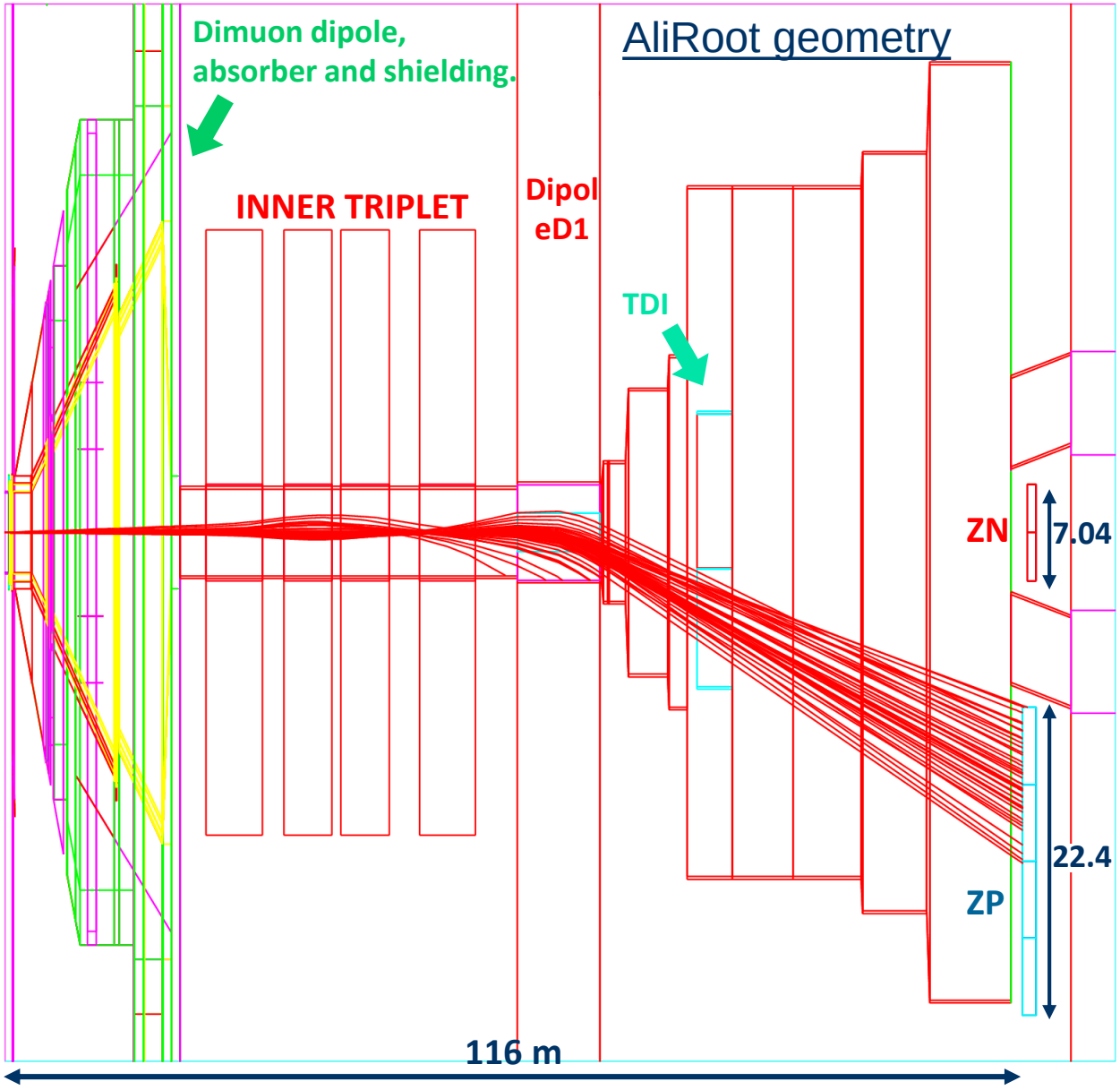
- σ_{emd} = 225 barn
- ⟨emd n ⟩ = 1.2/int
- Rate n_{emd} = 3 x 10^5 sec^{-1}

Total

~ 10^6 particle / sec^{-1}
⟨E⟩ =2.76 TeV
1 cm^2 impact region on the nZDC

Spectator protons tracking (old vacuum chamber)

The spatial distribution of spectator protons depends on LHC optics and on Fermi momentum.



Simulations of p tracking, taking into account momentum broadening due to Fermi motion

➡ **p losses along the beam line**

Volume	p lost (%)
Inner triplet	0.2 %
D1 dipole	13.8 %
TDI volume	0.11 %
Outside acc.	8.5 %
Detected	77.4 %

In this configuration of LHC optics, D1 aperture is the main limitation on ZP acceptance.