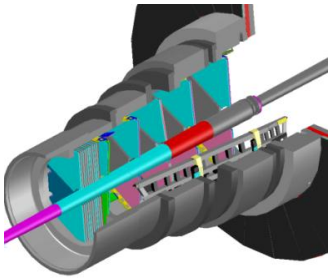
GEM TRD for CMS high η

- introduction of the project
- summary of the 1st prototype beam test

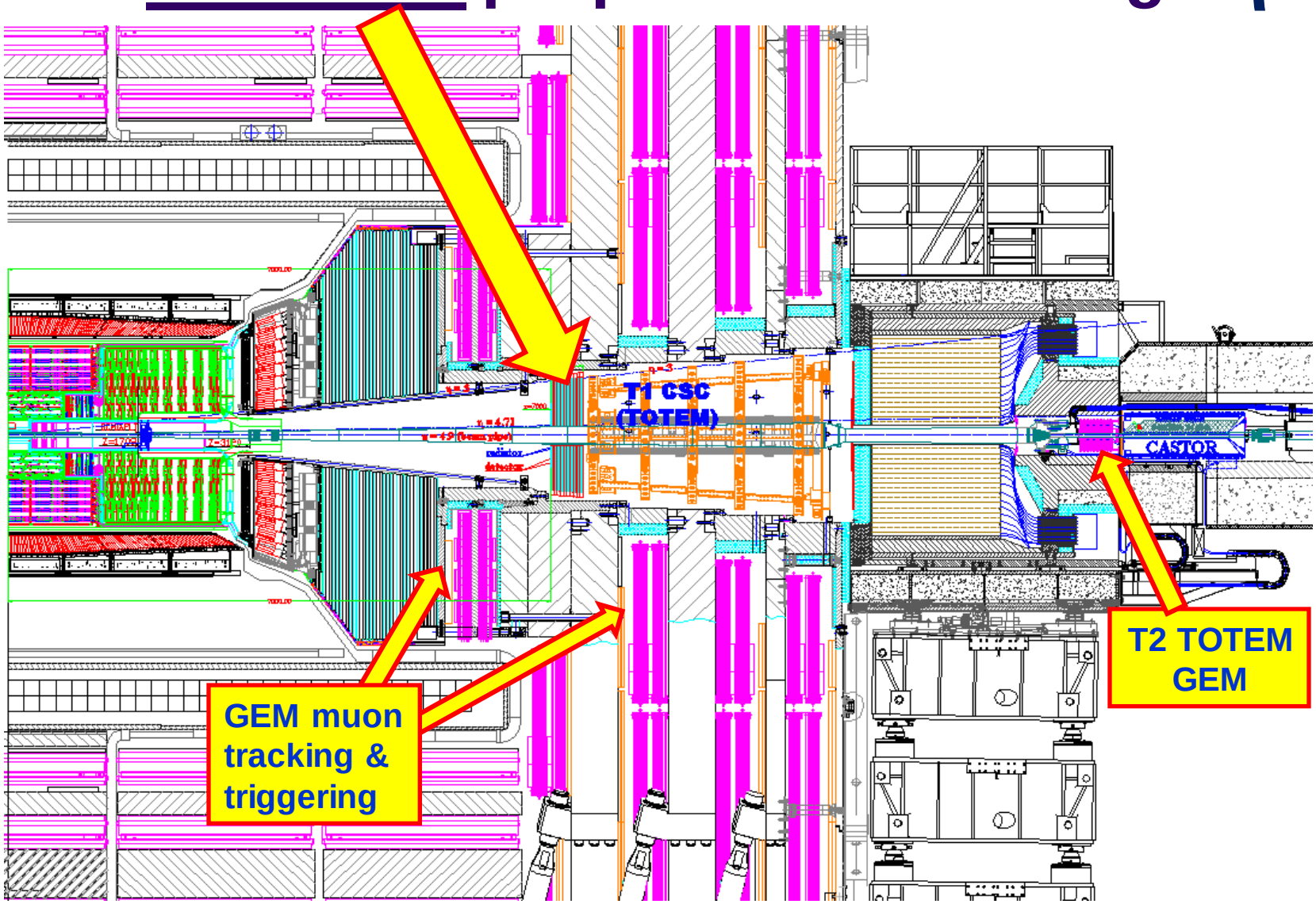


Alexander Malinin, Dmitry Druzhkin, Archana Sharma, Leszek Ropelewski, Andrey Marinov, Stefano Colafranceschi, Eraldo Oliveri.

GEM for CMS collaboration

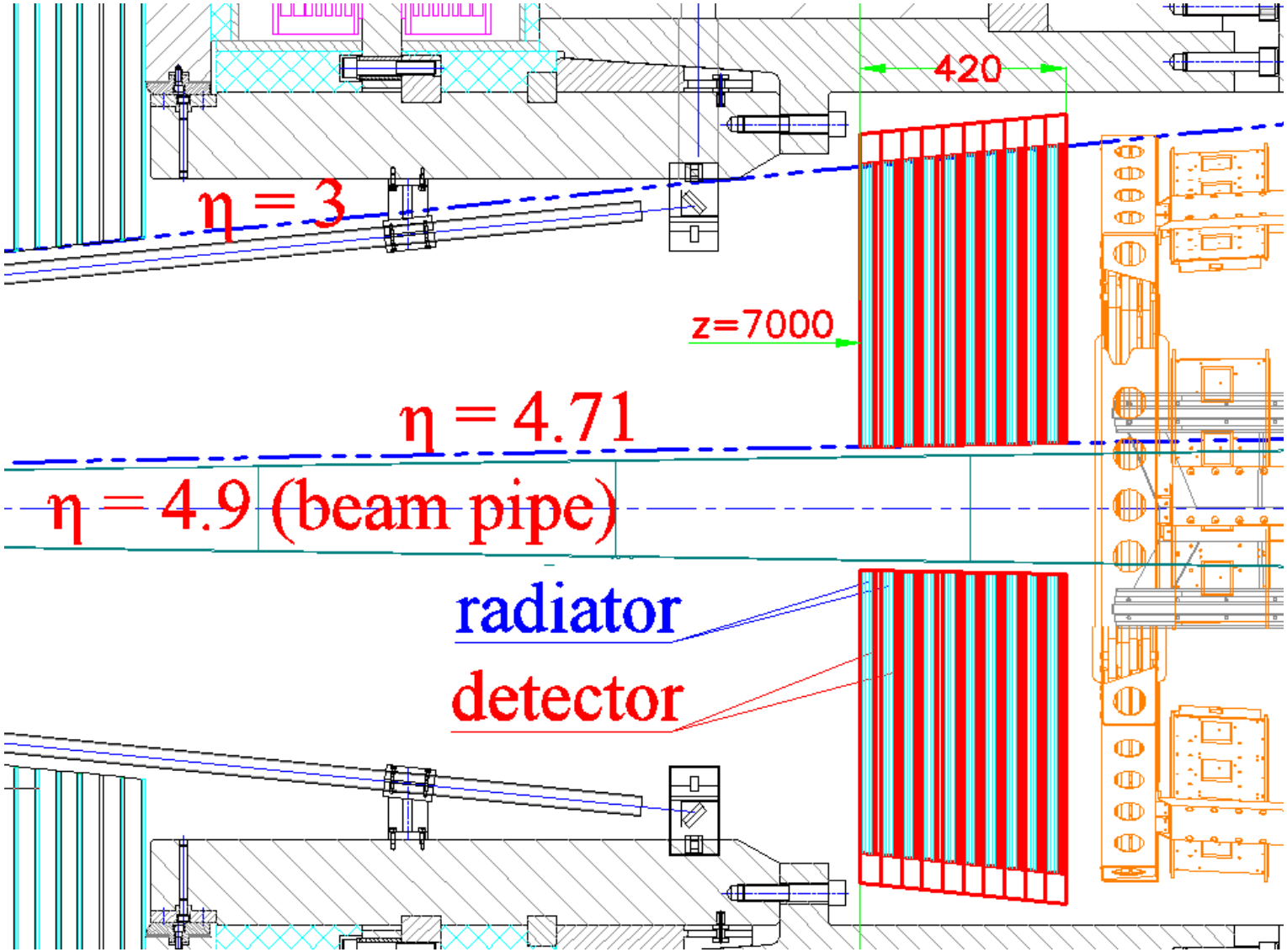
CERN, 16 November, 2011

The GEM-TRD proposal for CMS high η



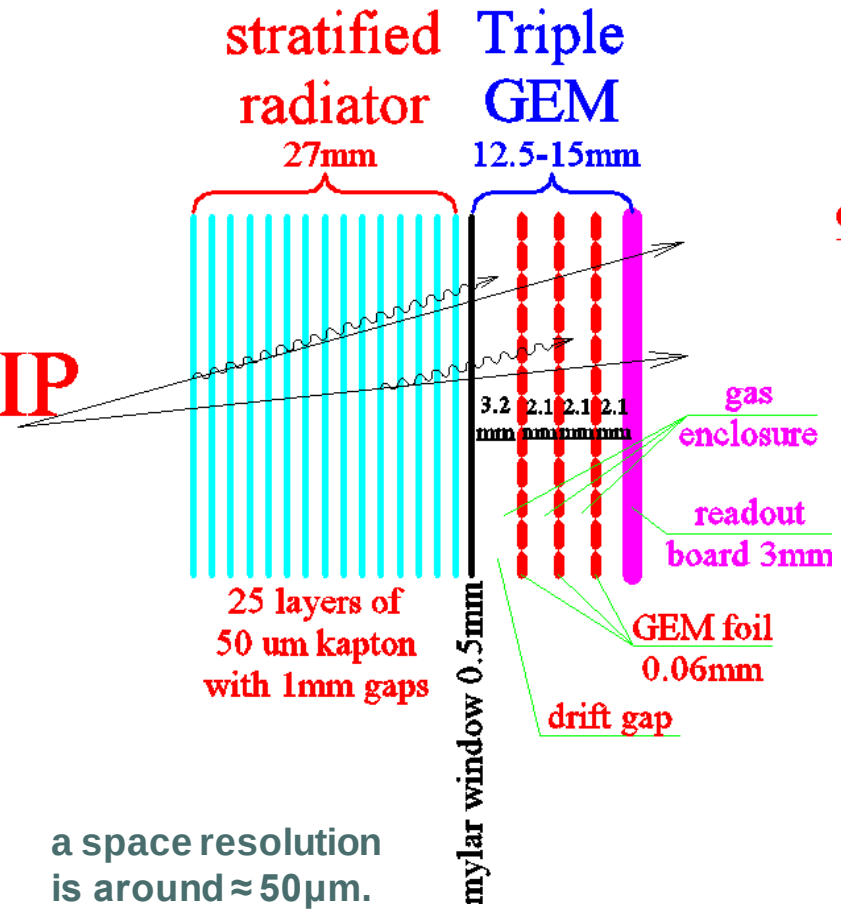
A multi-layer TRD based on Kapton film radiator and GEMs

The GEM-TRD proposal for CMS high η



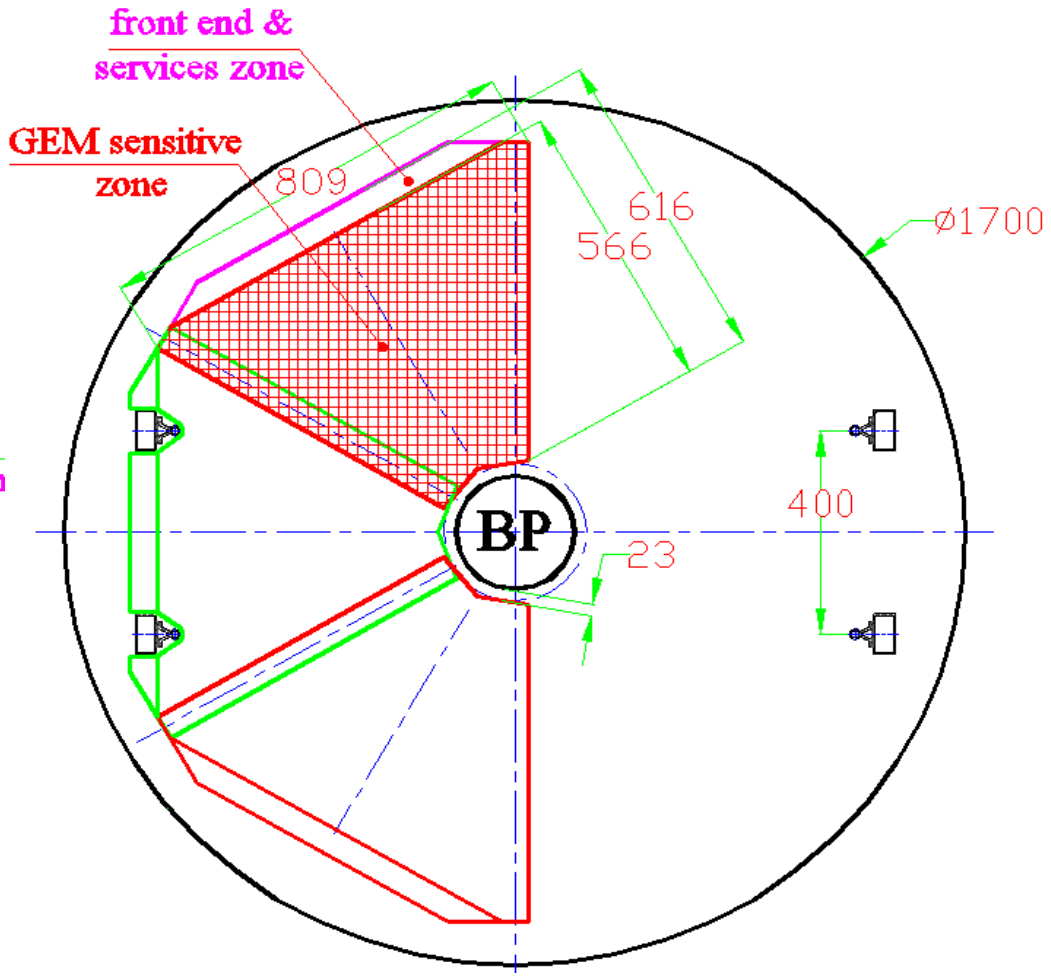
TRD covers the pseudo-rapidity region 3 < η < 4.7 at Z = ±7000

The GEM-TRD proposal for CMS high η



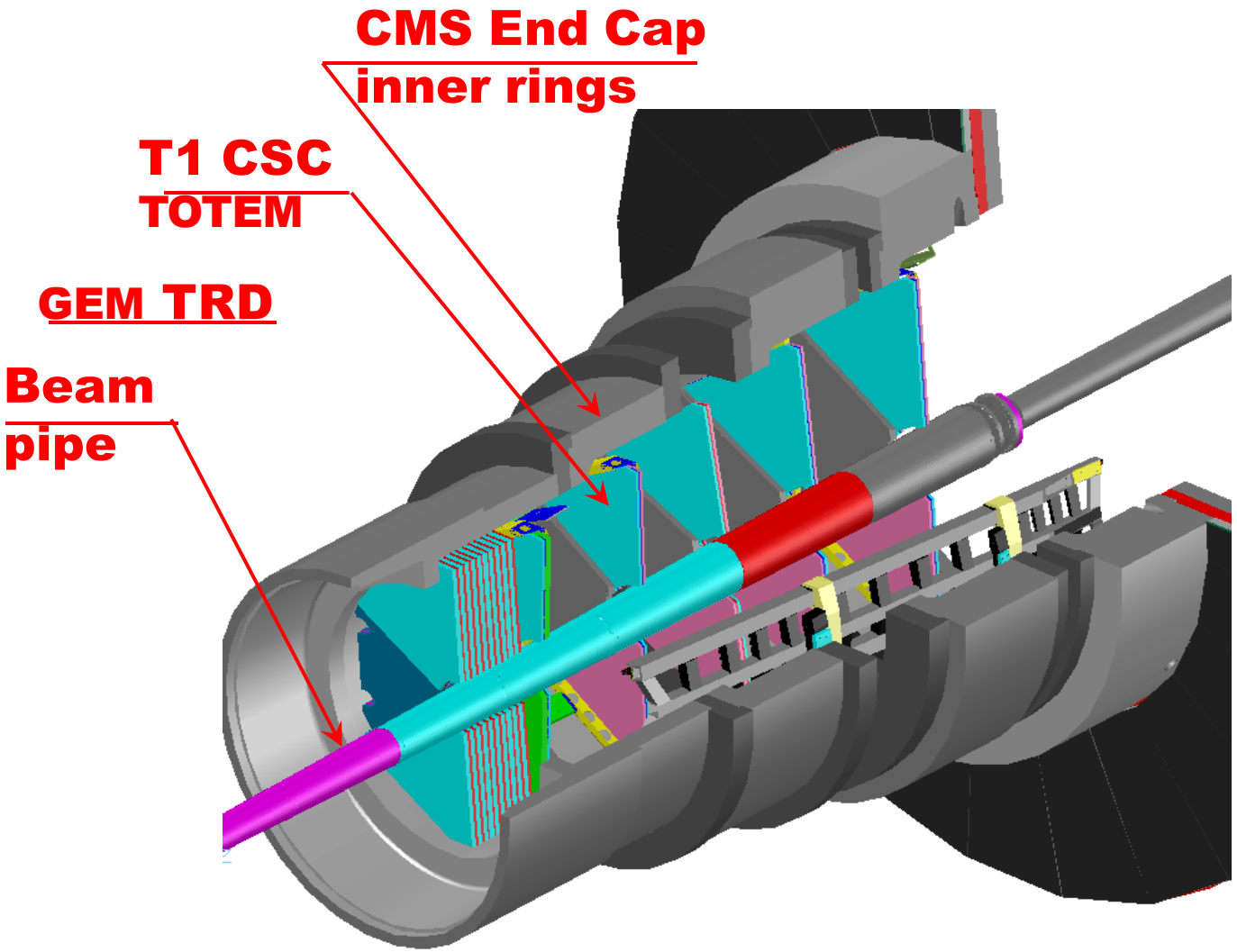
a space resolution is around ≈ 50μm.

cross section at Z = ±7420mm



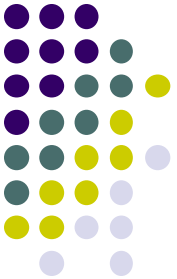
A front-end "system on chip" should provide fast trigger information and digitized data storage.

The GEM-TRD proposal for CMS high η



3D view of the GEM-TRD detector

The GEM-TRD proposal for CMS high η



Transition Radiation – few details:

Total TR energy emitted per interface (from vacuum to medium) is proportional to the Lorentz γ factor :

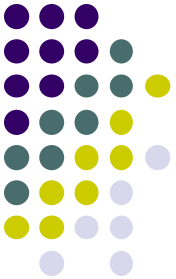
$$E = 1/3\ Z^2\ \alpha\ \gamma\ \hbar\omega_p$$

Z – incident particle charge
α – Fine-structure constant
ω_p – plasma frequency of medium (for Kapton $\hbar\omega_p = 24.5$ eV)

Formation zone for TR: $D_f = \gamma\ c\ /\ \omega_p$ (for Kapton, at the TR production threshold ($\gamma = 10^3$) $D_f = 8$ microns).

TR production saturation is ~ $\sqrt{\ I_1\ I_2\ }$, where I_1 – the radiator film thickness, I_2 – distance between two film layers.

The GEM-TRD proposal for CMS high η



Physics motivation:

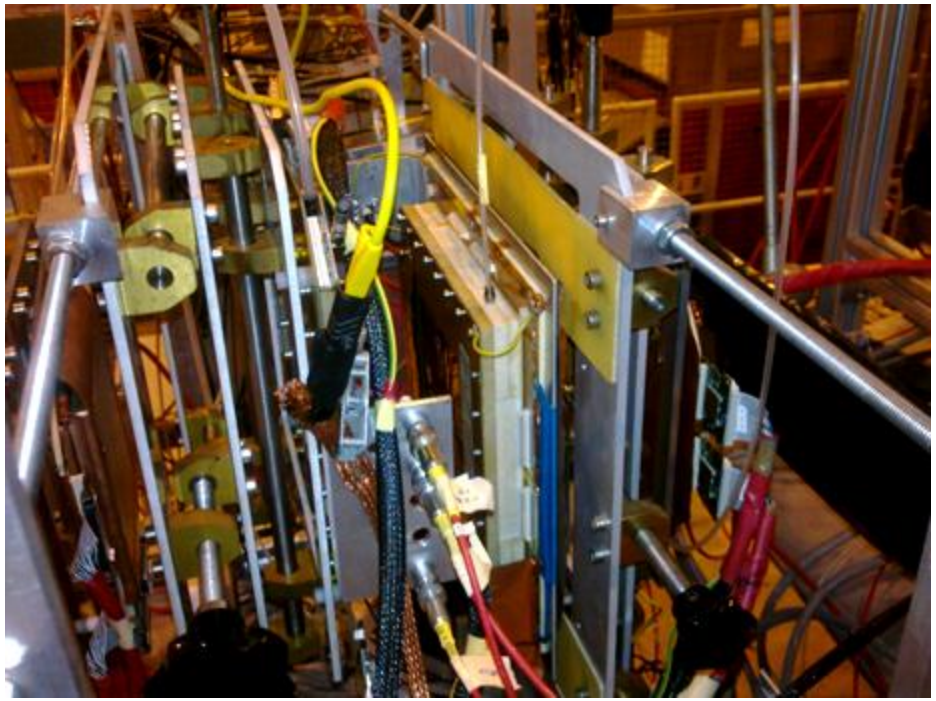
- A planned upgrade of the CMS experiment in the forward region makes possible to extend the particle triggering detection and tracking coverage up to the pseudo-rapidity range up to η = 4.7. Using the GEMs technique addition of a new gas TRD particle identification and tracking detector could substantially improve the sensitivity of the CMS experiment in the very forward region.

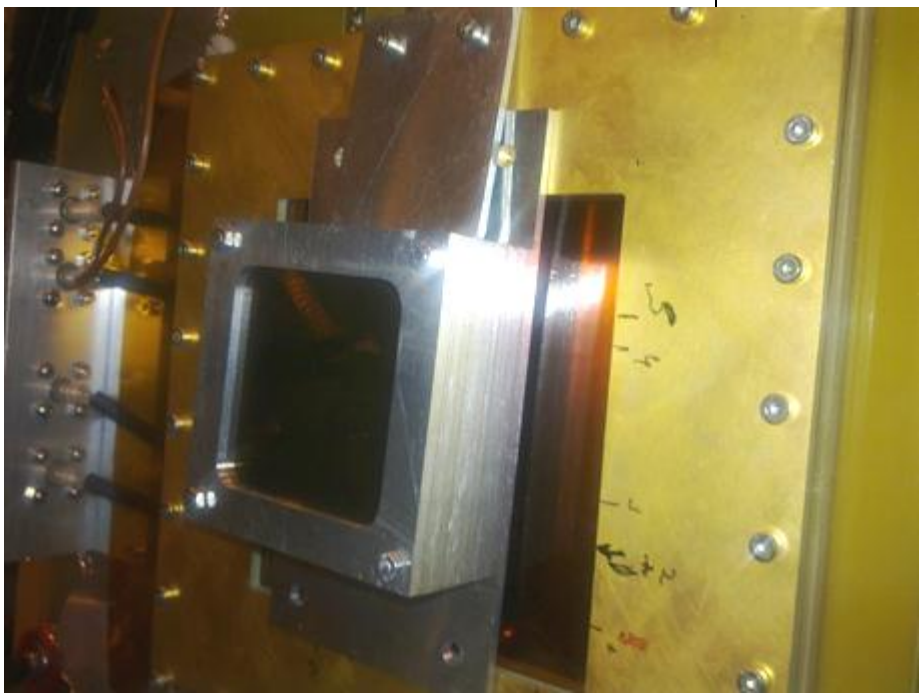
- Standard: Improving the calorimeter trigger by filtering out of the low energy hadronic component of the charge multiplicity. The forward-backward heavy quark asymmetry measurements in the very forward region.

- Exotics: HSCP, (transversal energy and momentum precision measurements), the differential total hadronic crossection measurements for the UV extra-dimensions signal search.

Summary of the first GEM TRD prototype beam test.

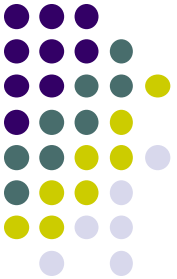
The RD51 setup at NA H4





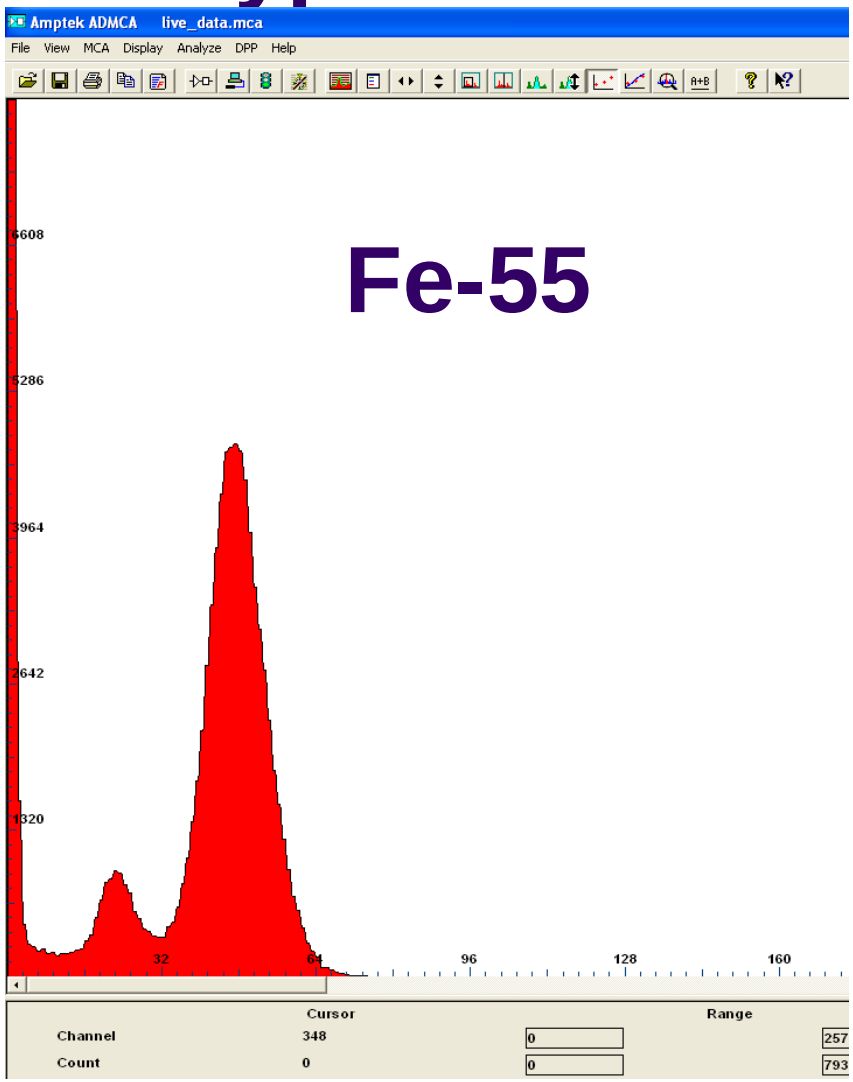
Prototype GEM-TRD detector

Summary of the first GEM TRD prototype beam test.



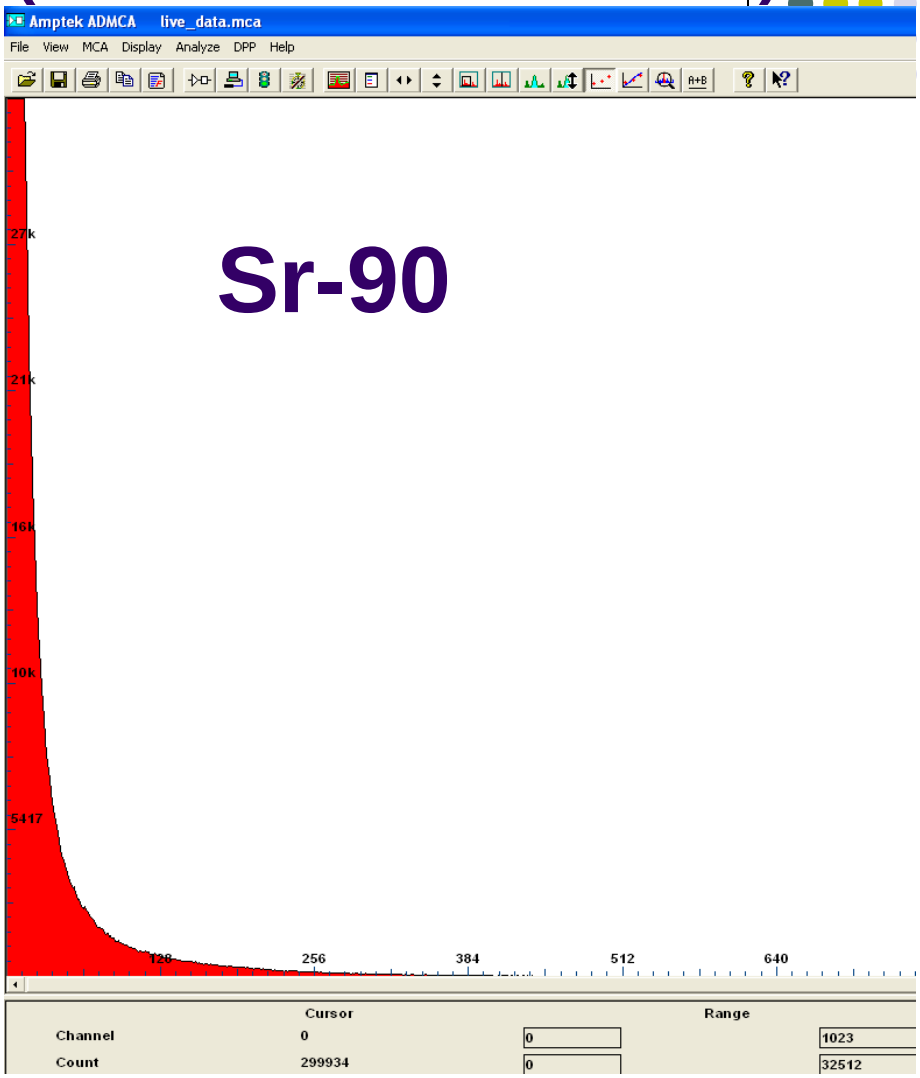
- The working gas mixture was: Xe/CO2 80/20%
- The 3-stage GEM with 50 micron Kapton window.
- Set of 4 radiators (measured subsequently):
    1) Empty (no radiator)
    1) Kapton 20x50 micron Kapton foils
    2) Ethafoam-220 polyethylene foam 50 mm thick
    3) Dow Styrofoam polystyrene foam 50 mm thick
- Electrons: 10 GeV, 30 GeV, 50 GeV, 100 GeV, 150 GeV.

Summary of the first GEM TRD prototype beam test (Fe55-source calibration).



Fe-55

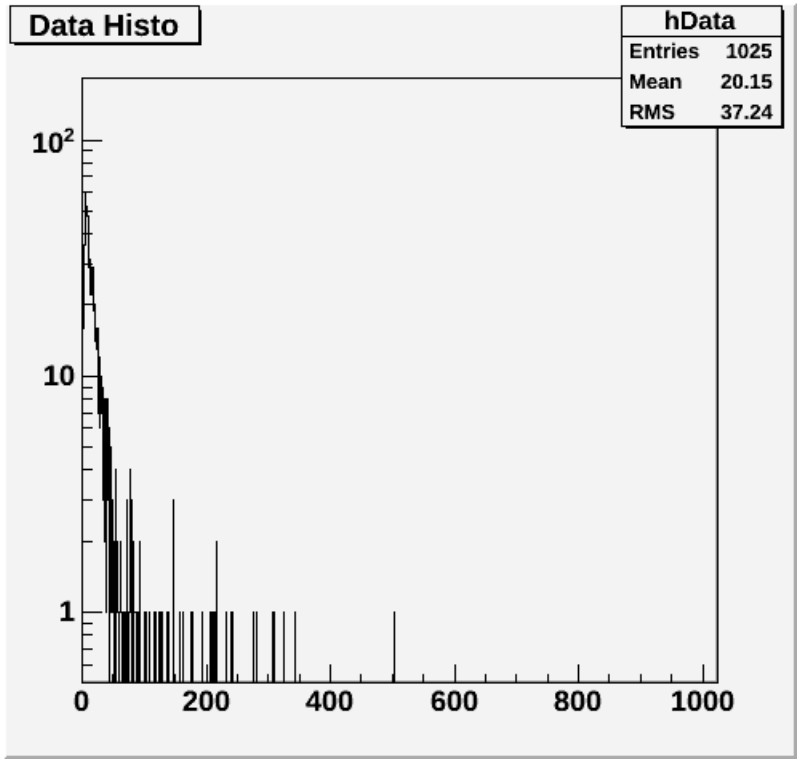
Vg1_460-Vg2_440-Vg3_400_Ed2p9_Et1t2-3p8-Ei4p4 with_source_coursegain20_smallOrtec_neg_ipnut.mcs



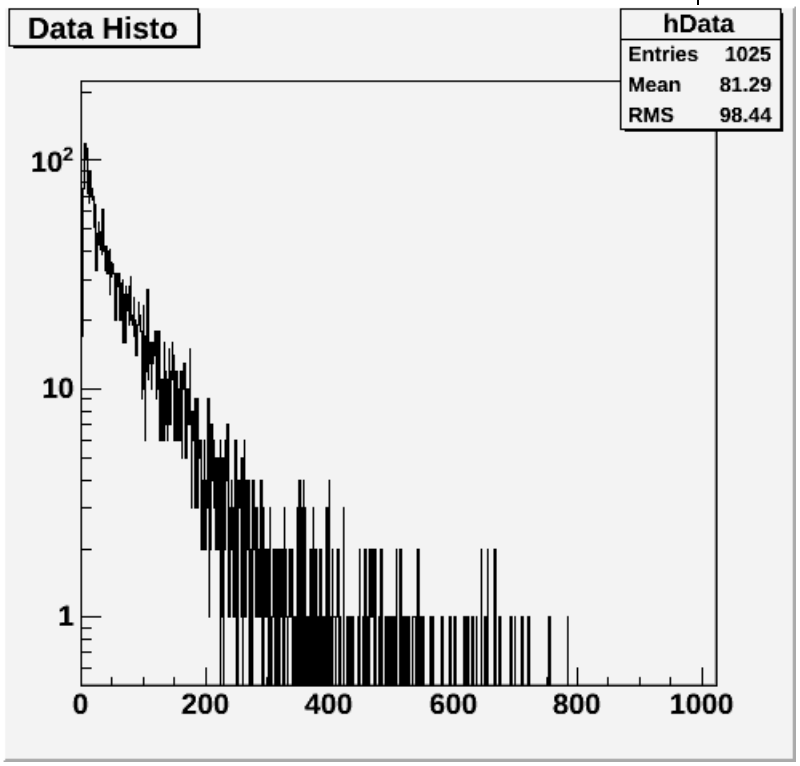
Sr-90

Vg1_460-Vg2_440-Vg3_400_Ed2p9_Et1t2-3p8-Ei4p4 with_source_coursegain20_smallOrtec_neg_ipnut_Sr90.mcs

Examples of the measured spectra during the first GEM TRD prototype beam test.



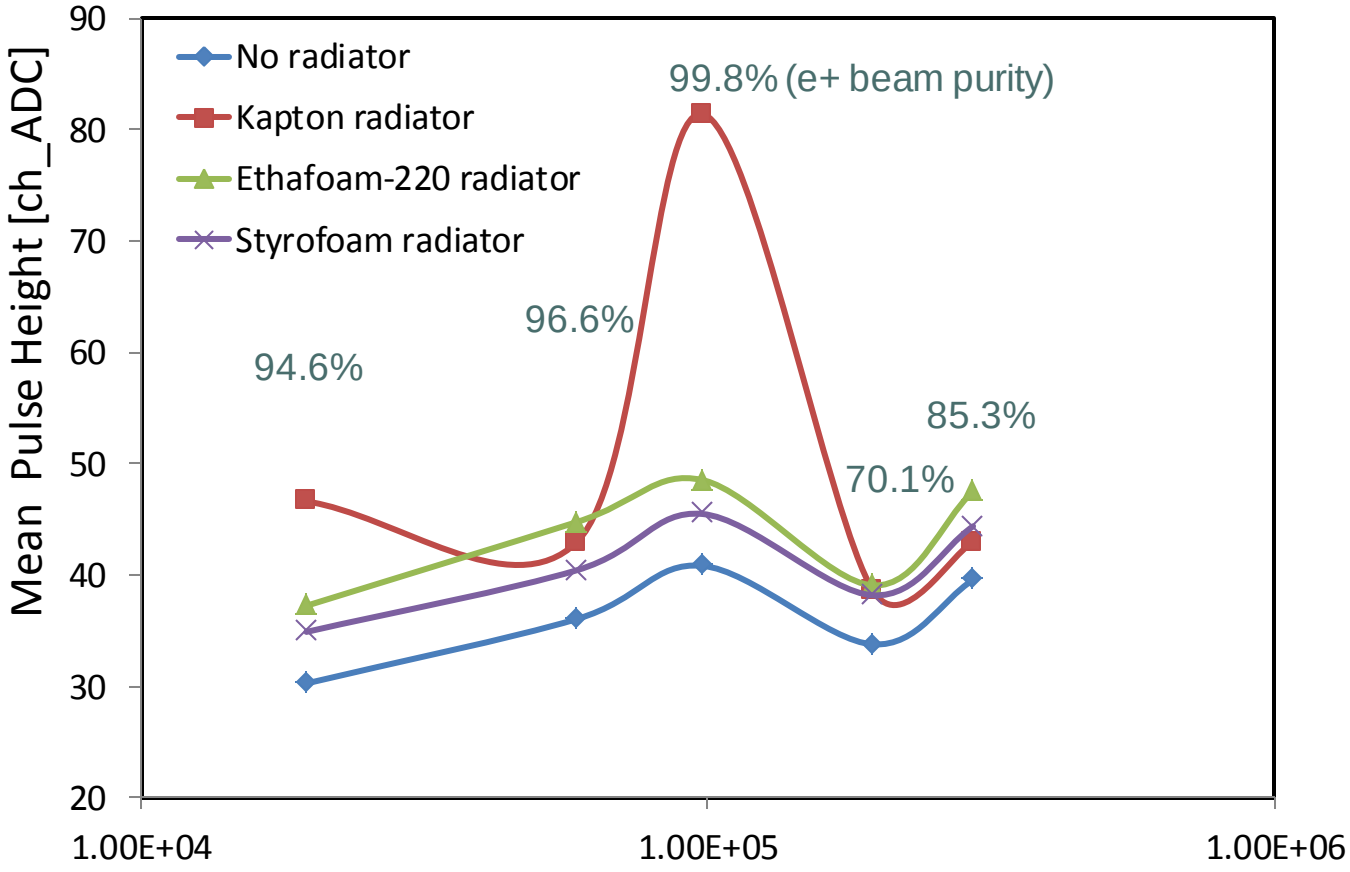
Muon beam 100 GeV



Electron beam 50 GeV

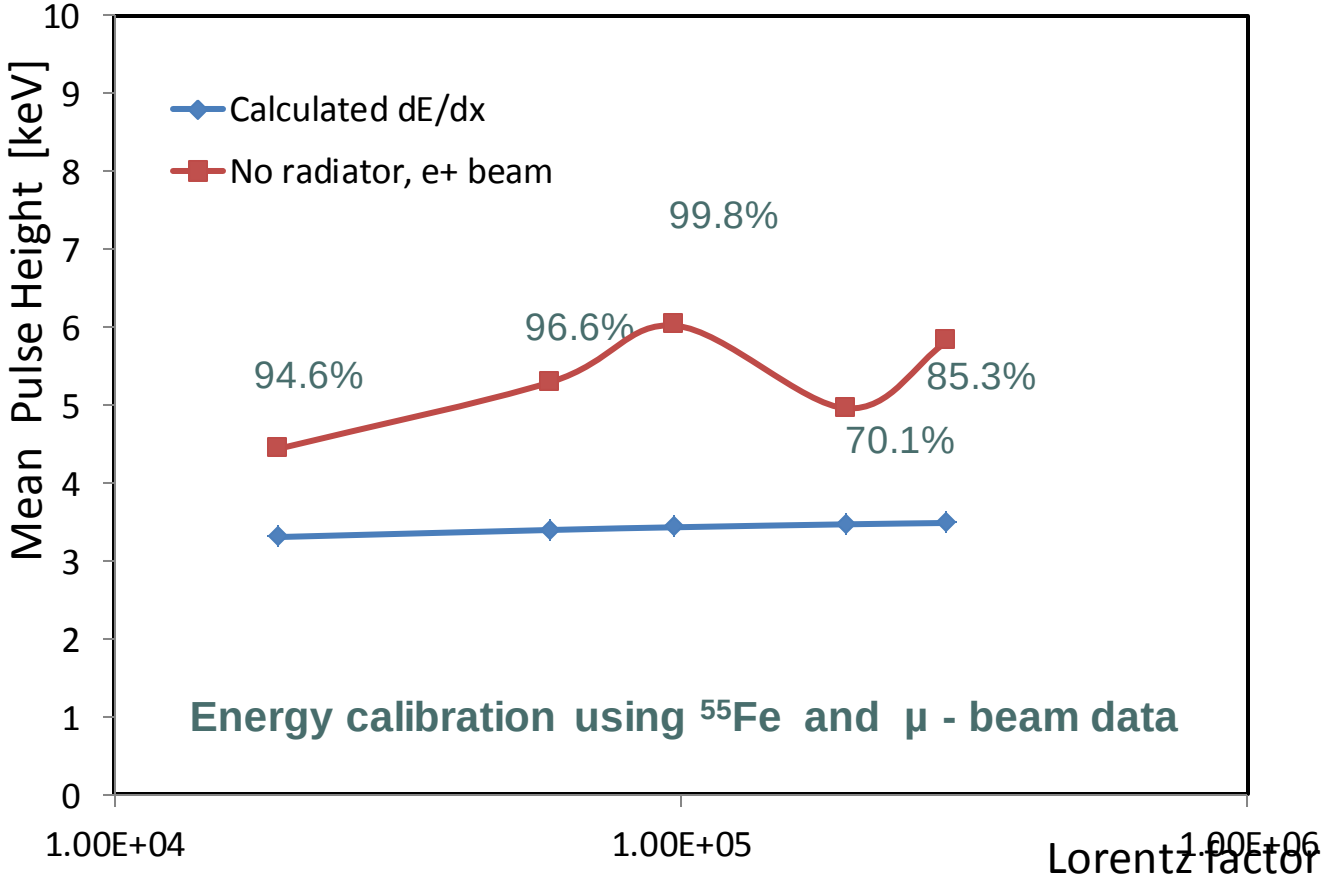
Kapton radiator, Xe/CO2 80/20% gas mixture

Measured data from the first GEM TRD prototype beam test. No corrections



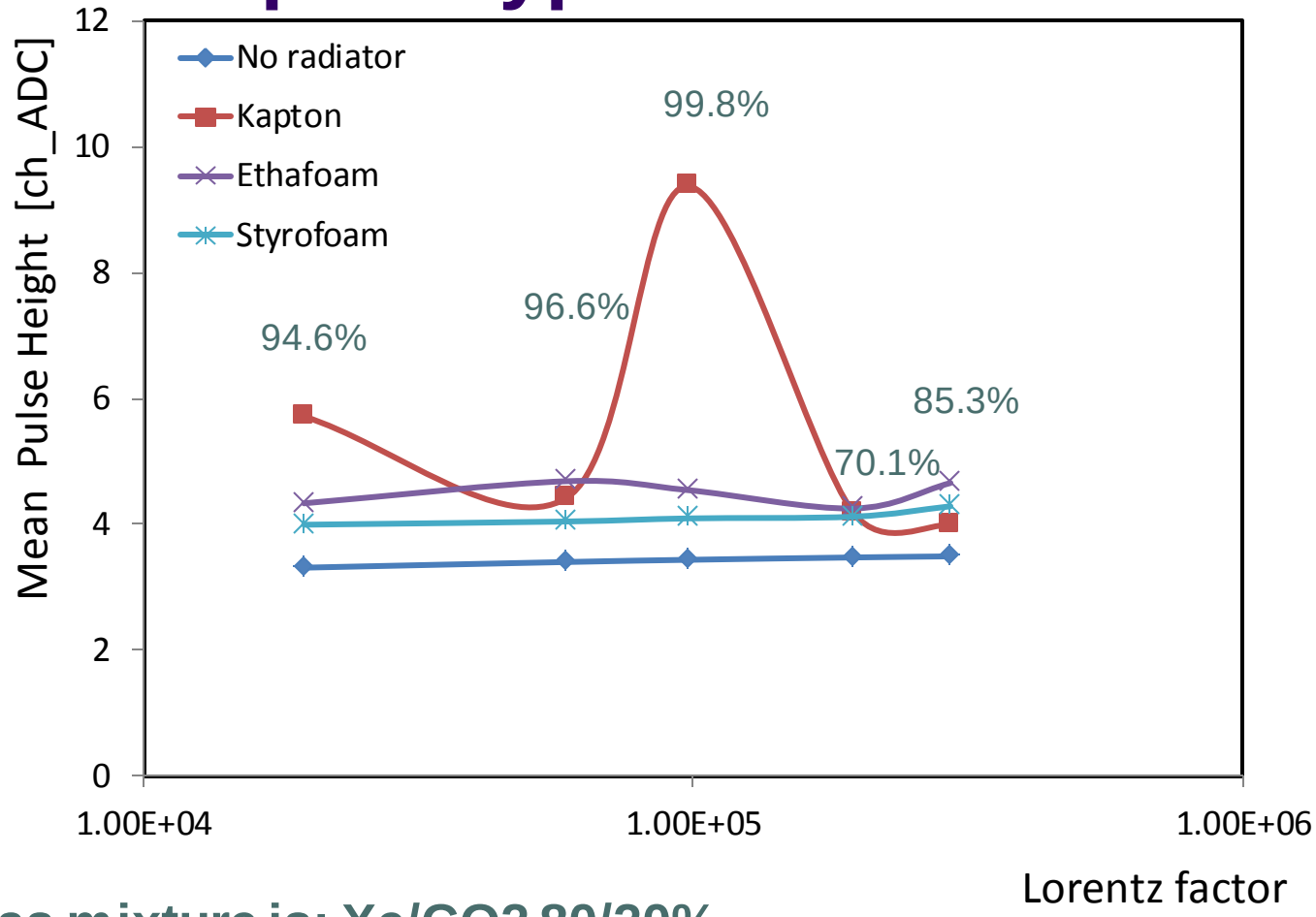
The gas mixture is: Xe/CO2 80/20%

Data without radiator from the first GEM TRD prototype beam test.



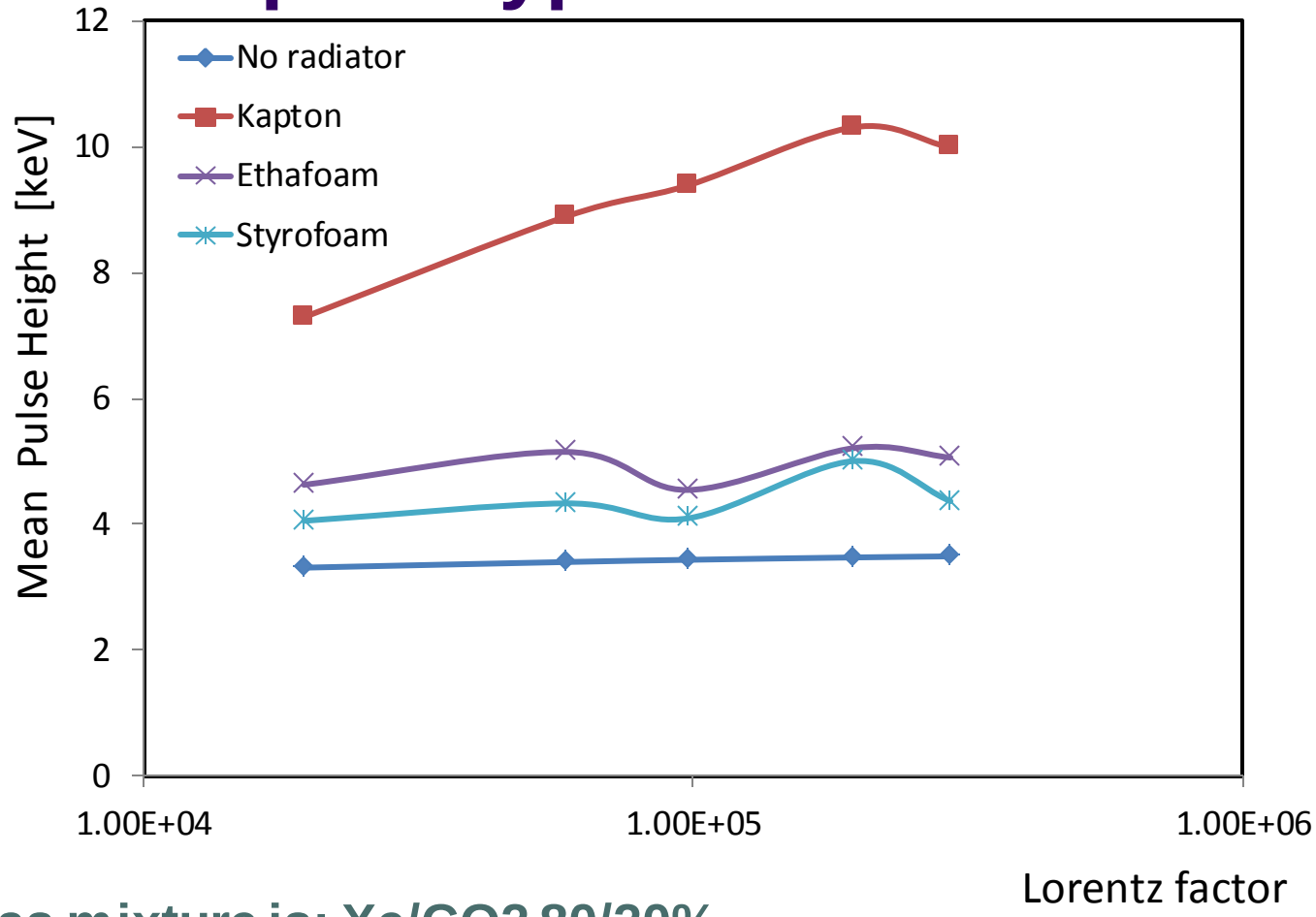
The gas mixture is: Xe/CO2 80/20%

Shower corrected data from the first GEM TRD prototype beam test.



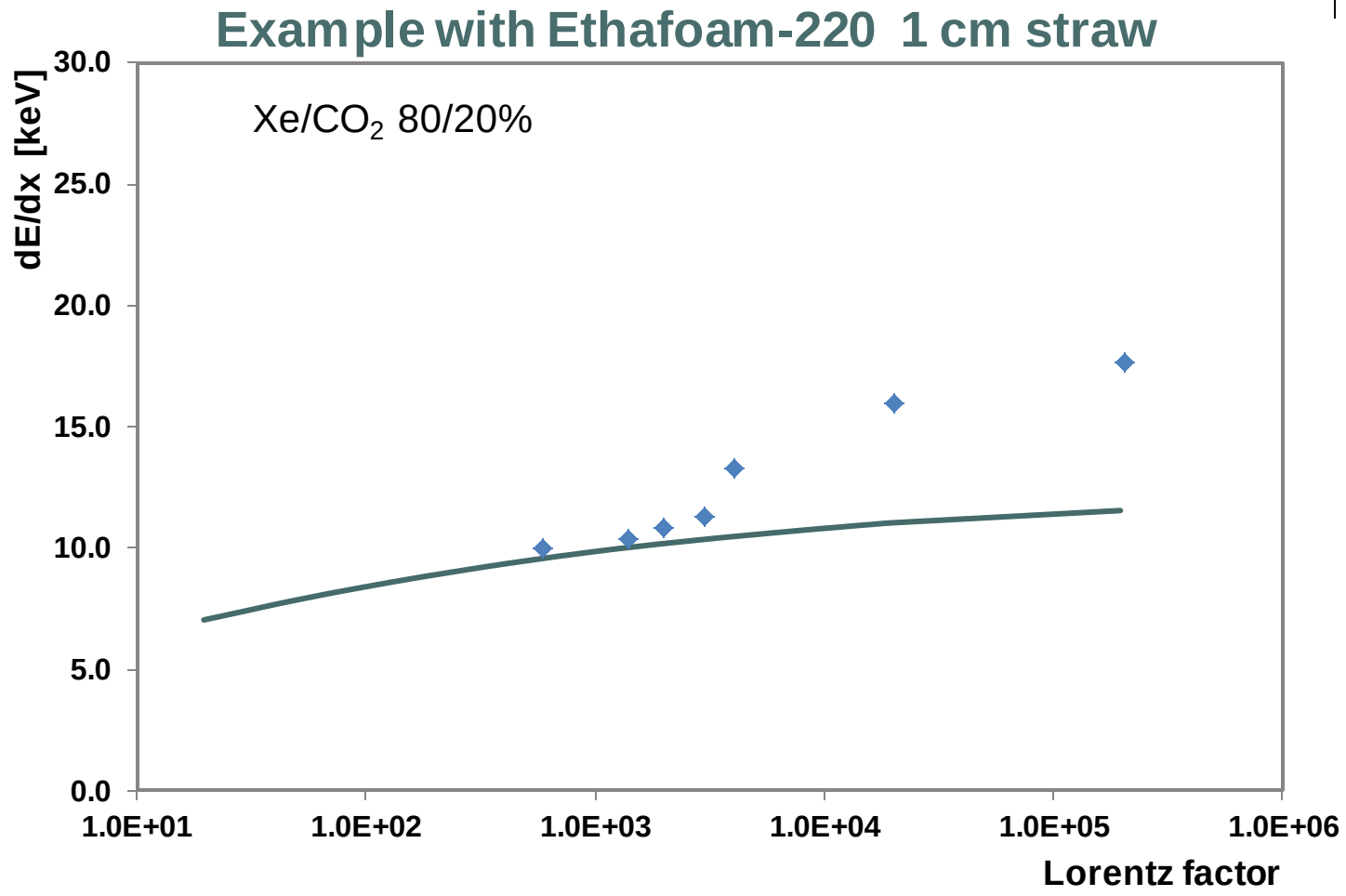
The gas mixture is: Xe/CO2 80/20%

Purity corrected data from the first GEM TRD prototype beam test.

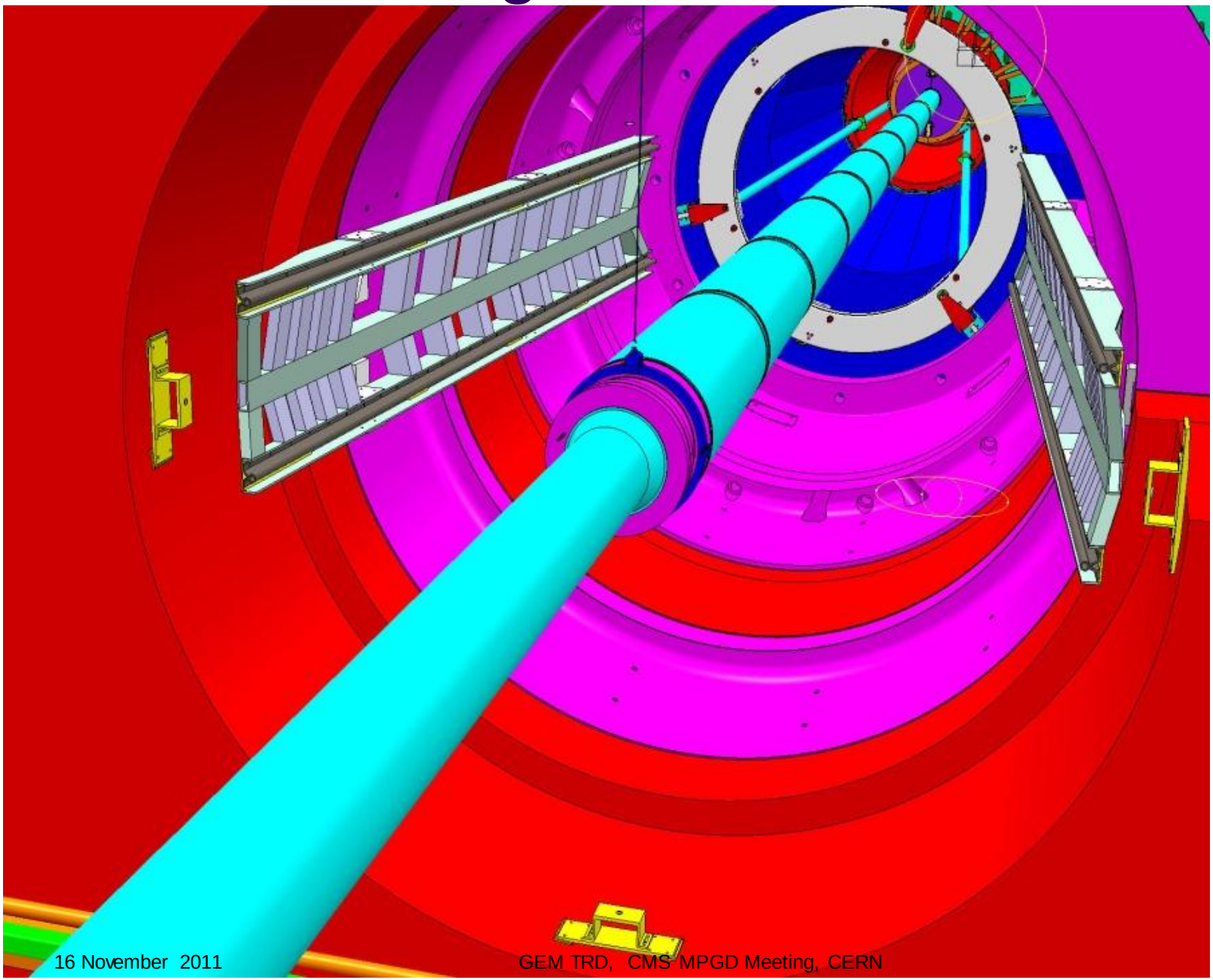


The gas mixture is: Xe/CO2 80/20%

Expected signal with 1 cm straw



Mechanical integration on CMS.

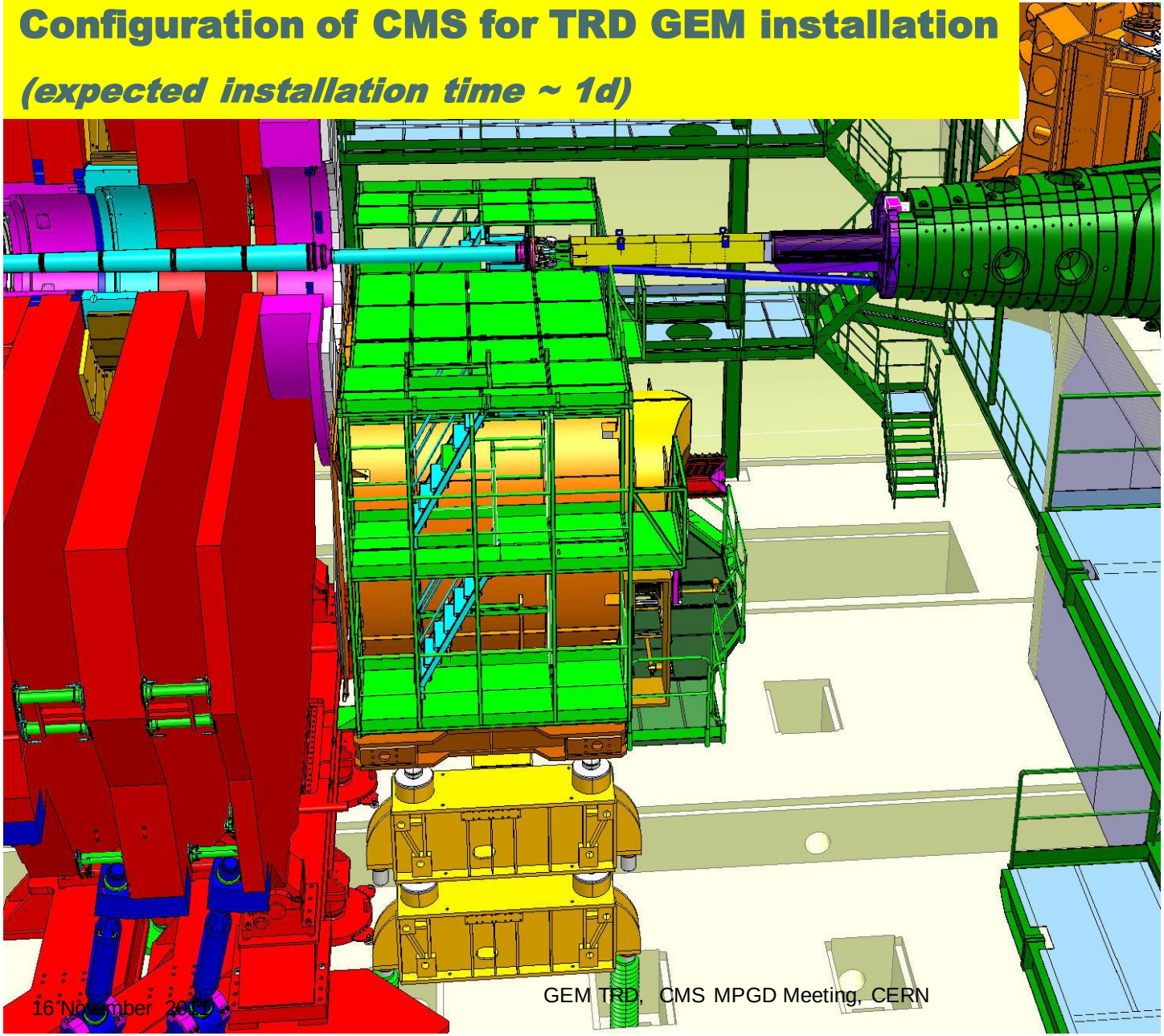


Mechanical integration on CMS.

Mechanical integration on CMS.

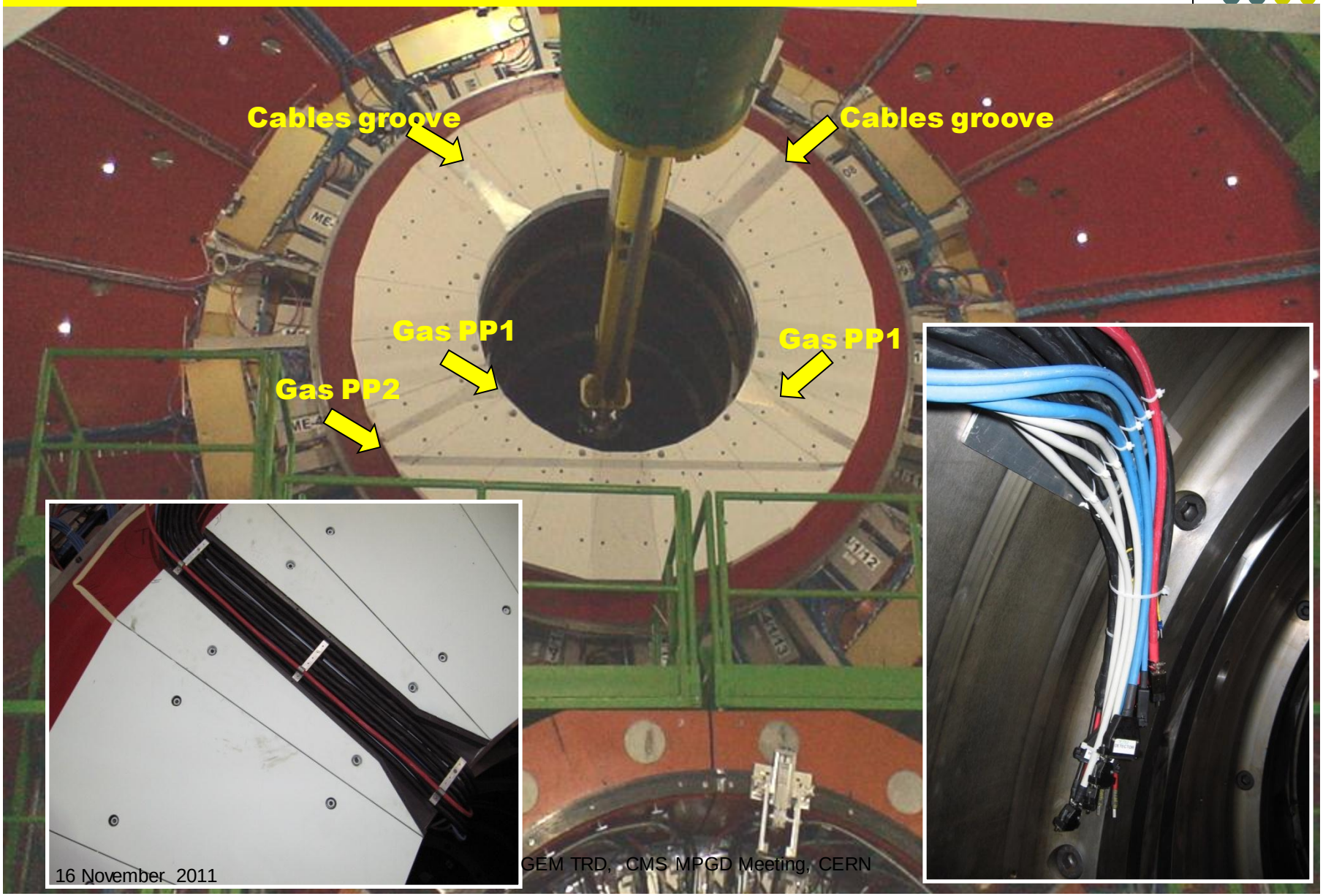
Configuration of CMS for TRD GEM installation

(expected installation time ~ 1d)



Mechanical integration on CMS.

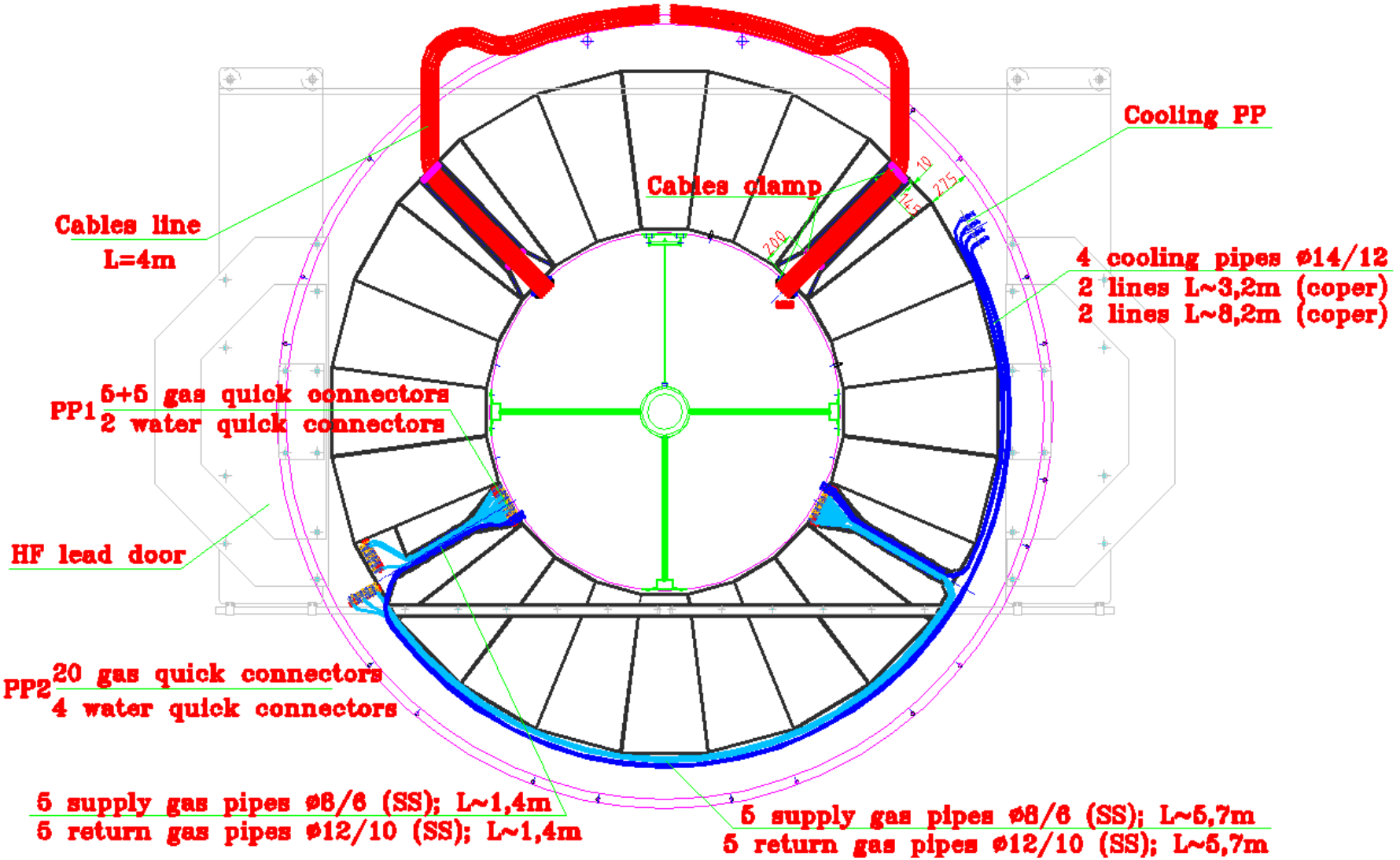
T1 services routing on YE4 inner disk



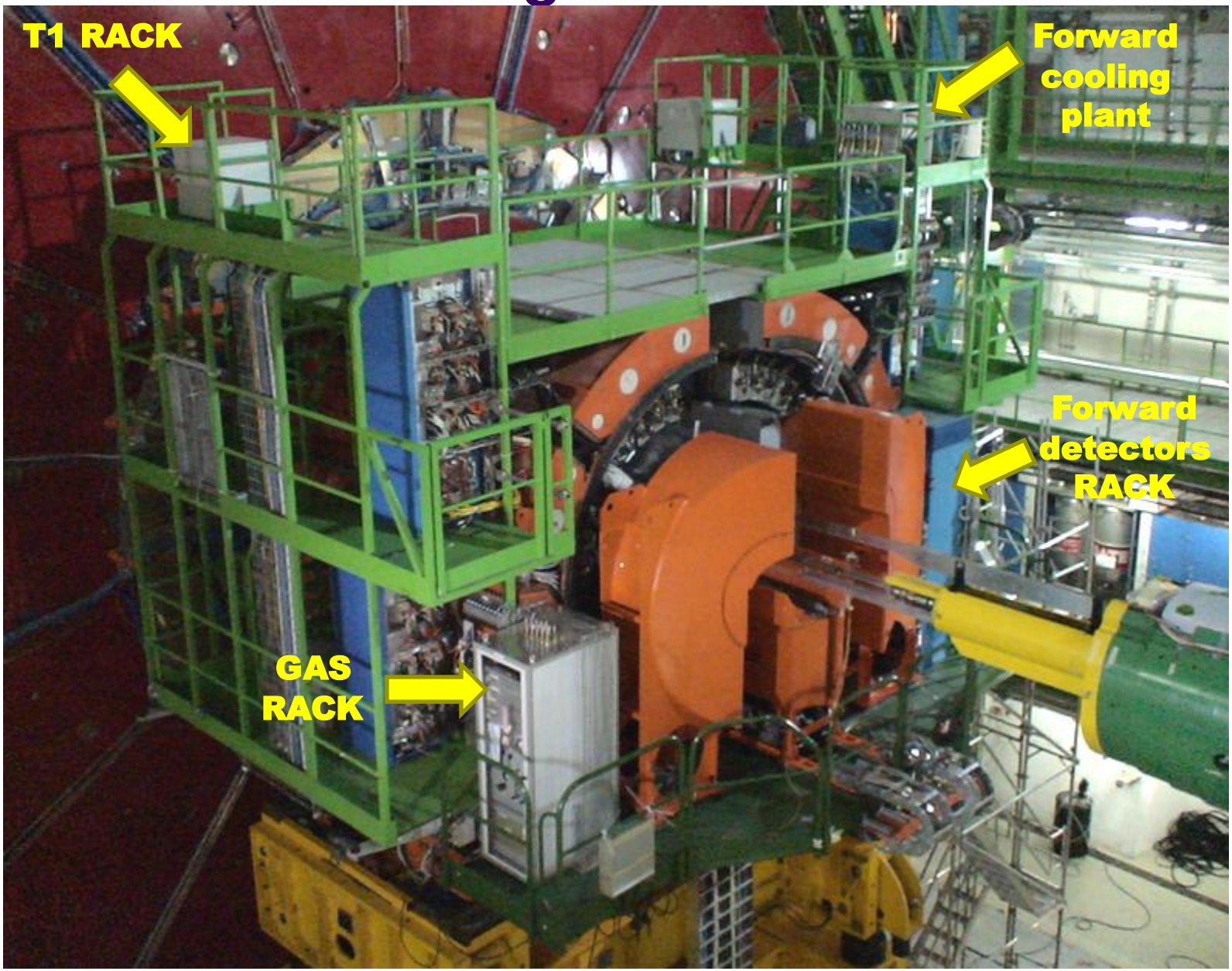
Mechanical integration on CMS.

T1 services routing on YE4 inner disk

(All services should be fixed before T1 installation)

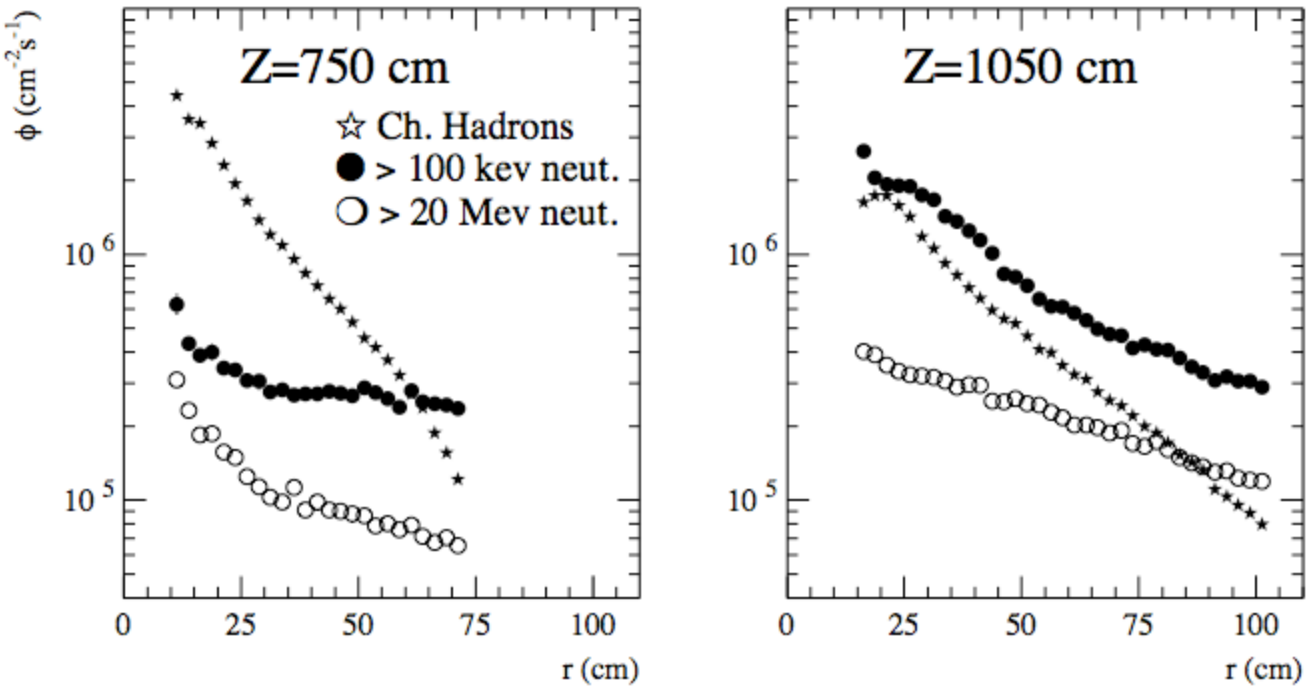


Mechanical integration on CMS.

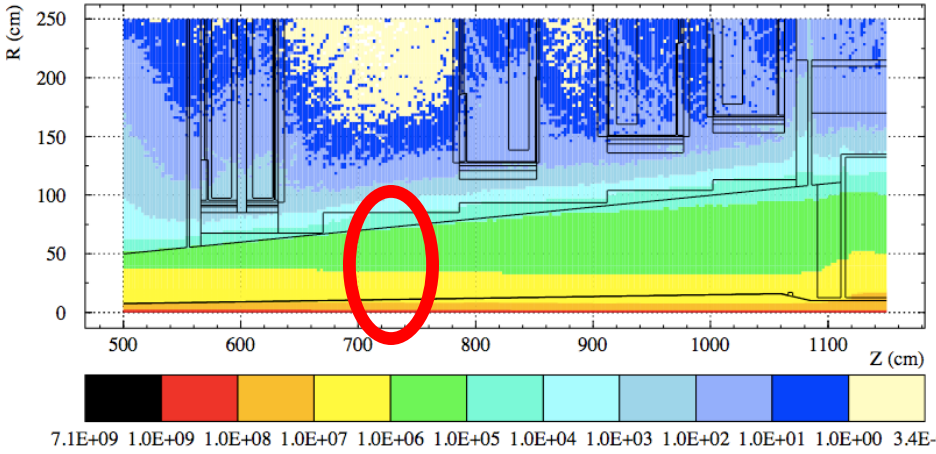


Mika Huhtinen; TOTEM T1 EDR, CERN, 7 March, 2006
all results are scaled to: 1 s at luminosity 10^{34} (≈ 10 nb^{-1} = 8E8 pp-collisions)

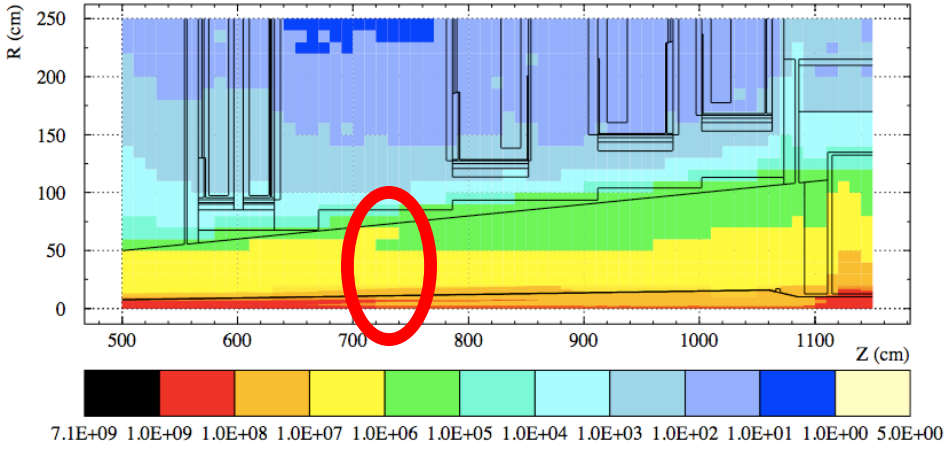
Flux vs. Radius



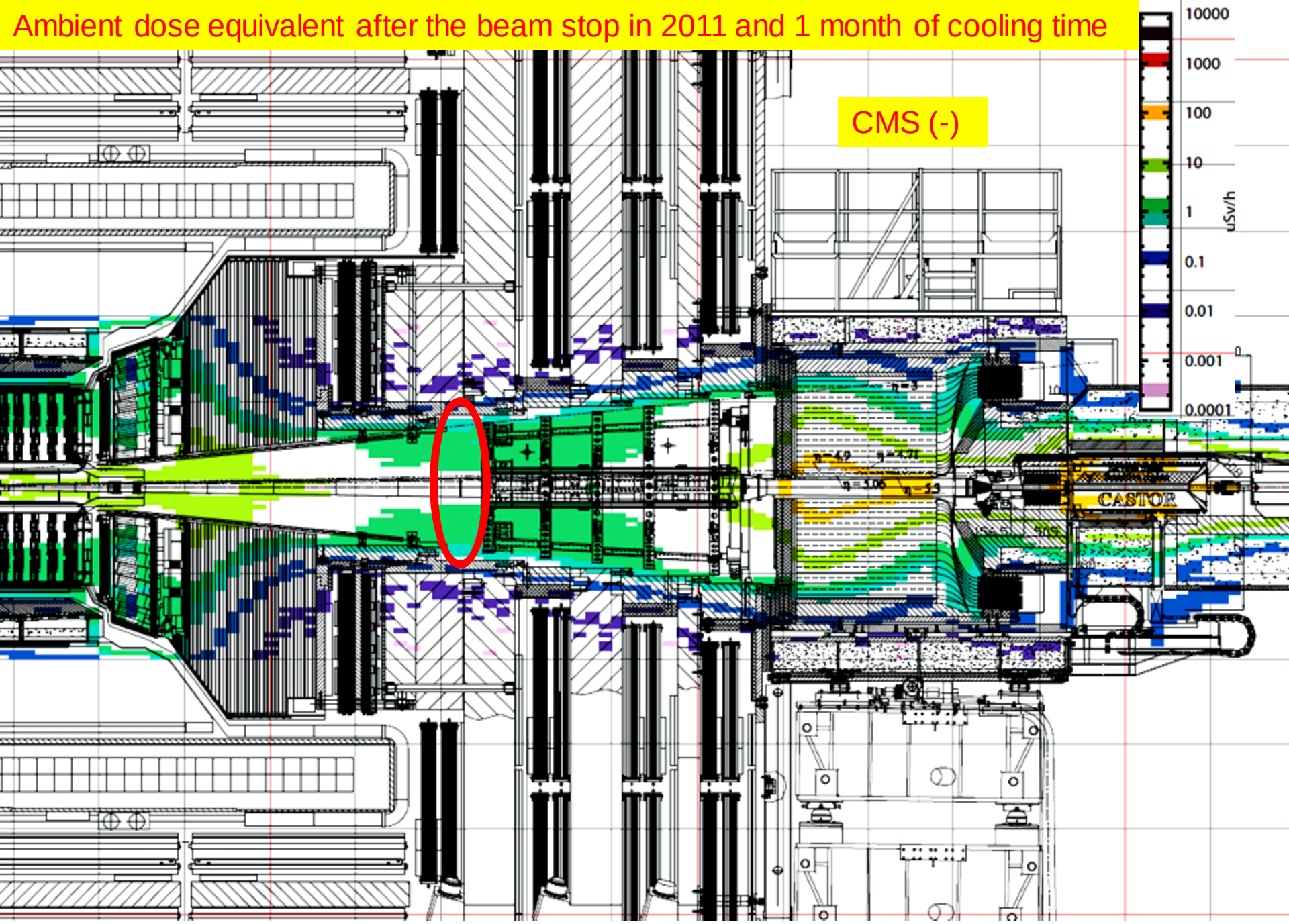
Ch. Hadron fluxes



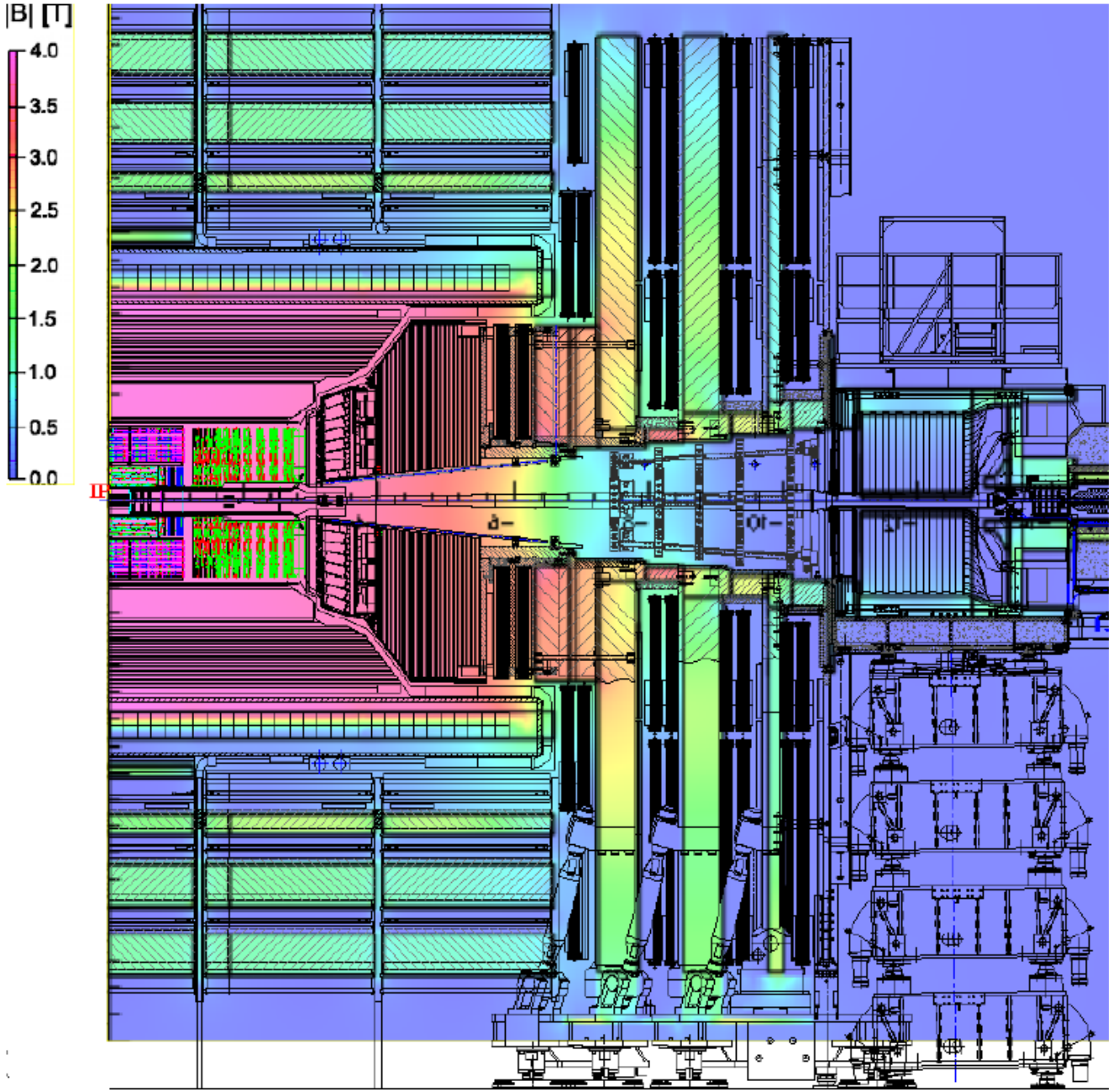
Charged flux (e+chh)

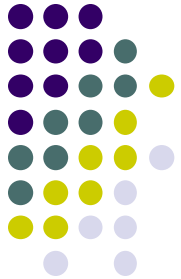


Ambient dose equivalent after the beam stop in 2011 and 1 month of cooling time



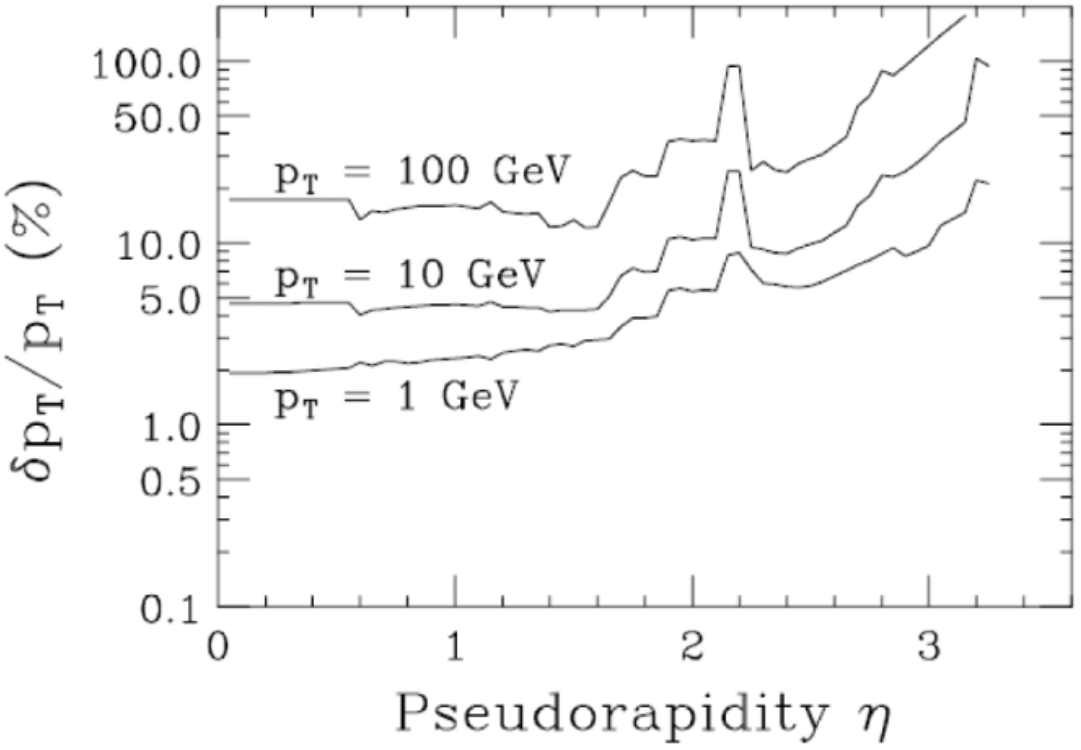
Magnetic field map





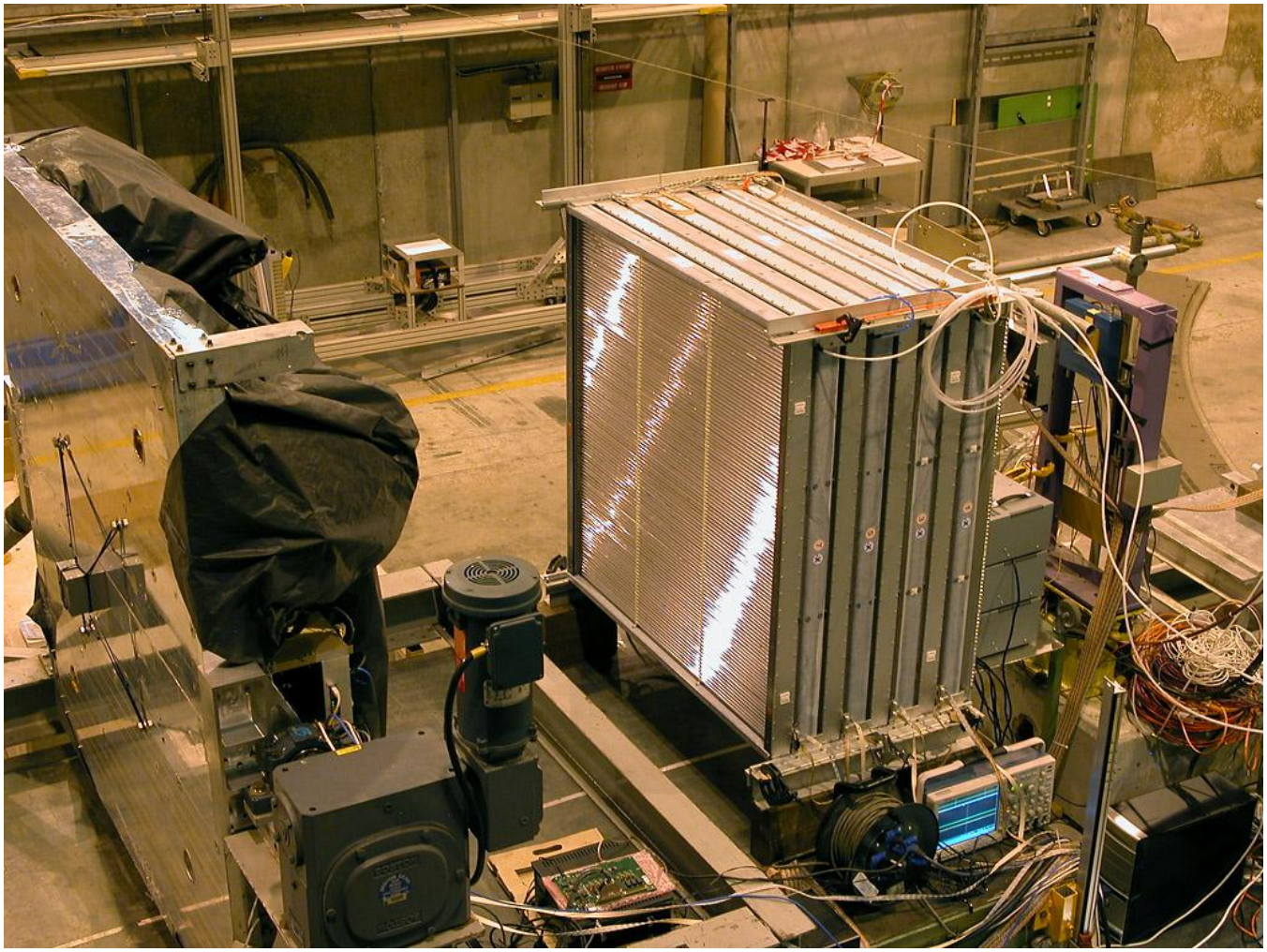
Thank you!

Additional slides



An example of momentum resolution of the D0 experiment (combined scintillating fiber tracker and silicon tracker systems).

Additional slides



TRD-II detector in the SPS H2 beam line November 1st 2010