Mechanics basics for CMS TFPX upgrade

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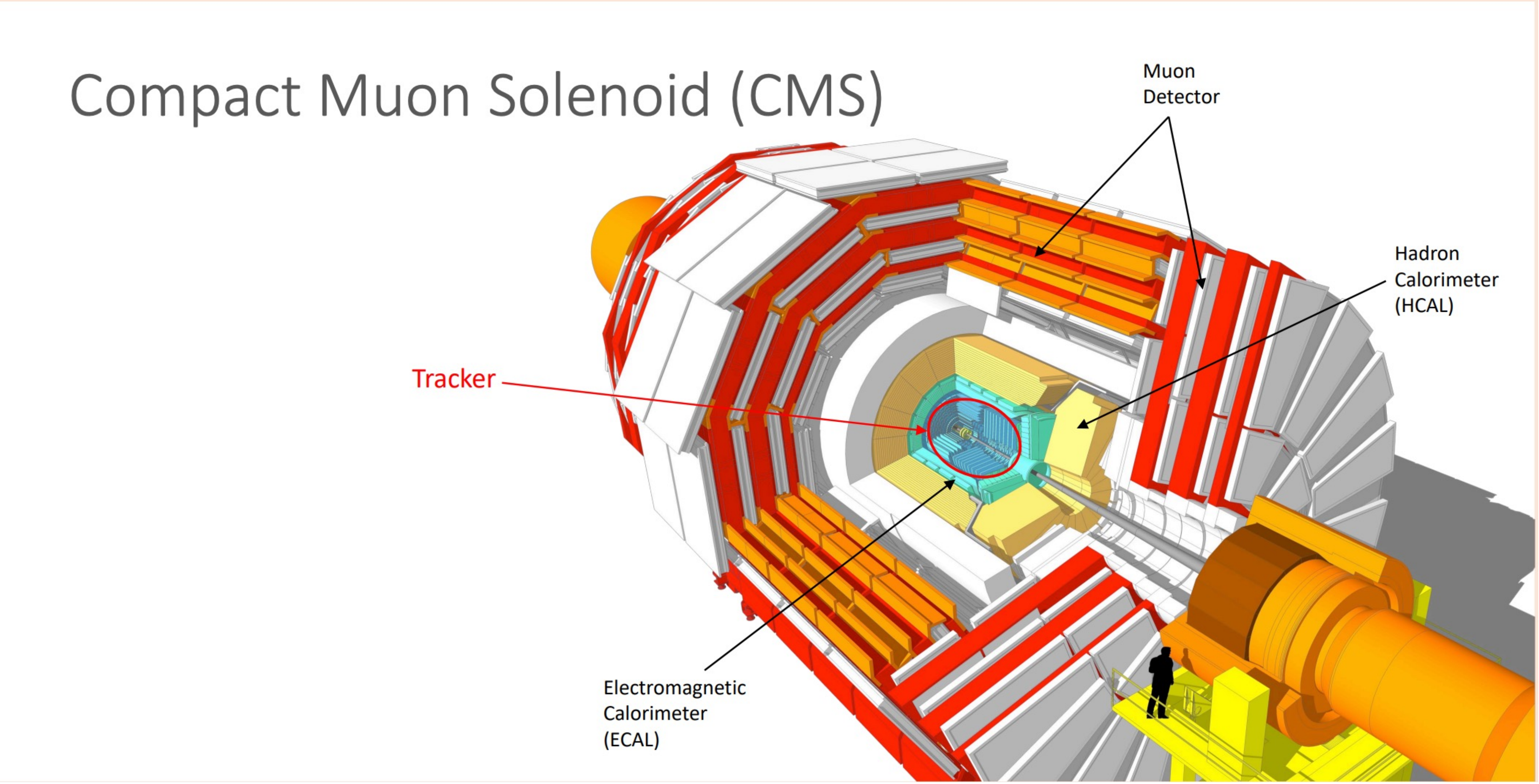
TFPX upgrade mini - workshop

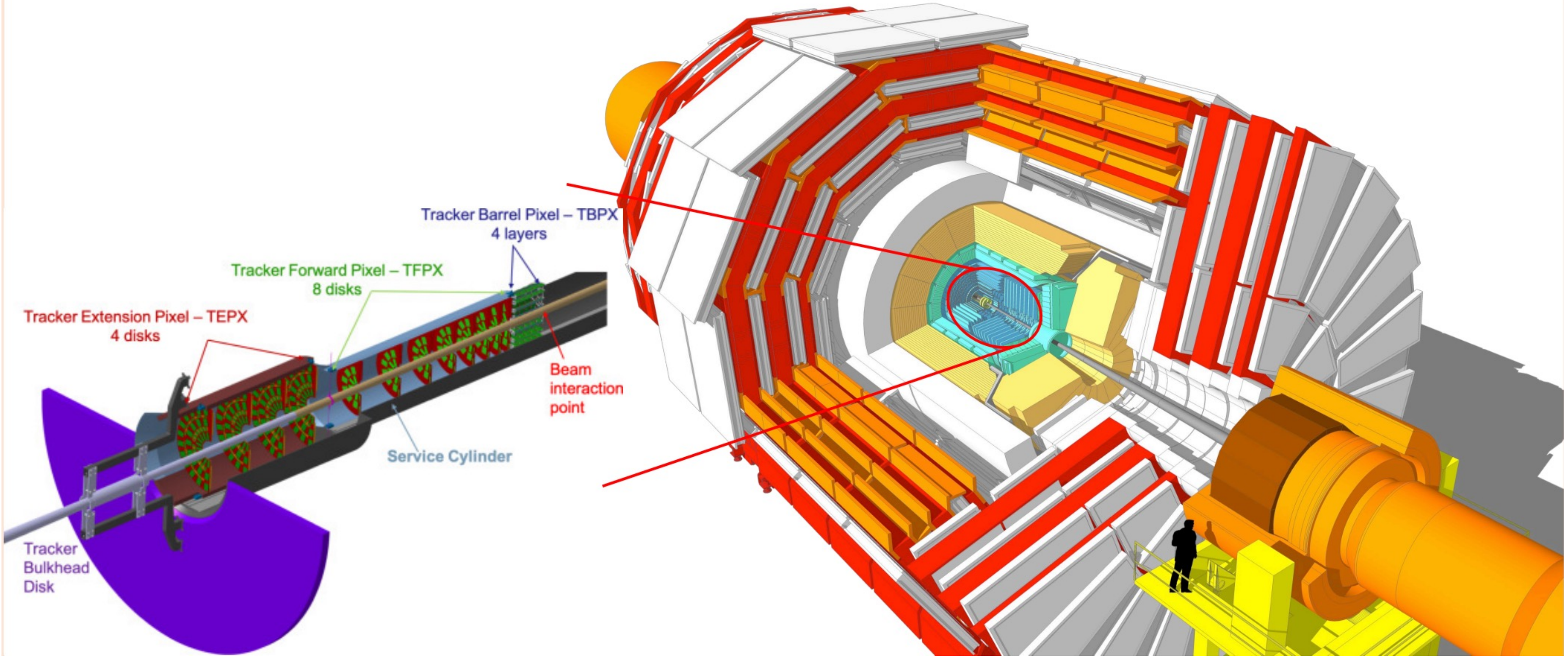
02/08/24

Where is the CMS TFPX detector



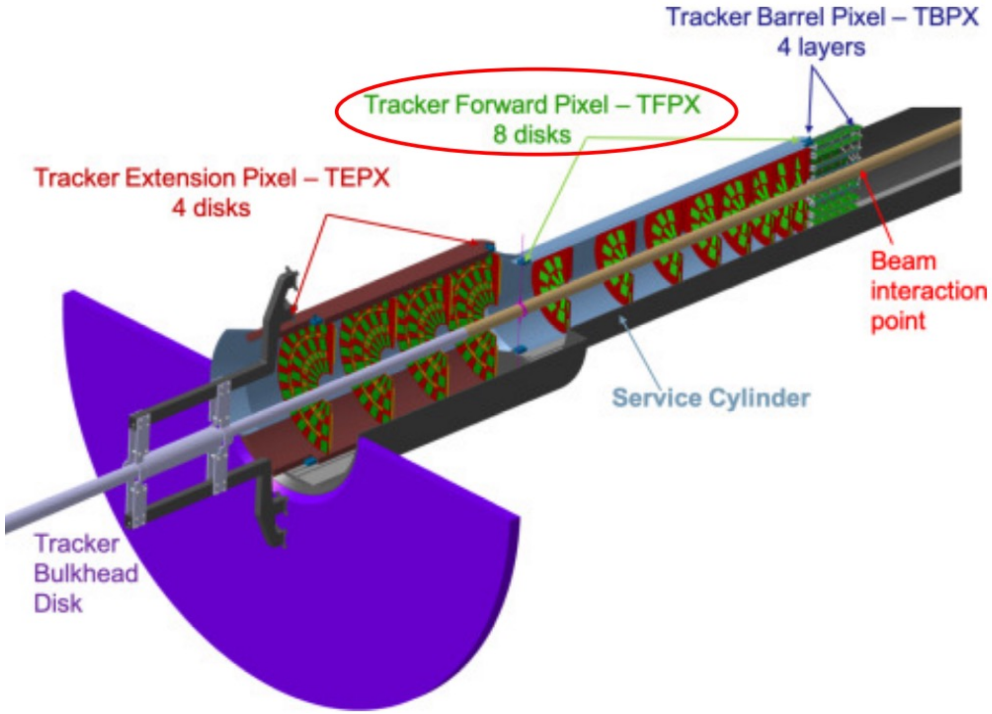
Where is the CMS TFPX detector

CMS / Tracker

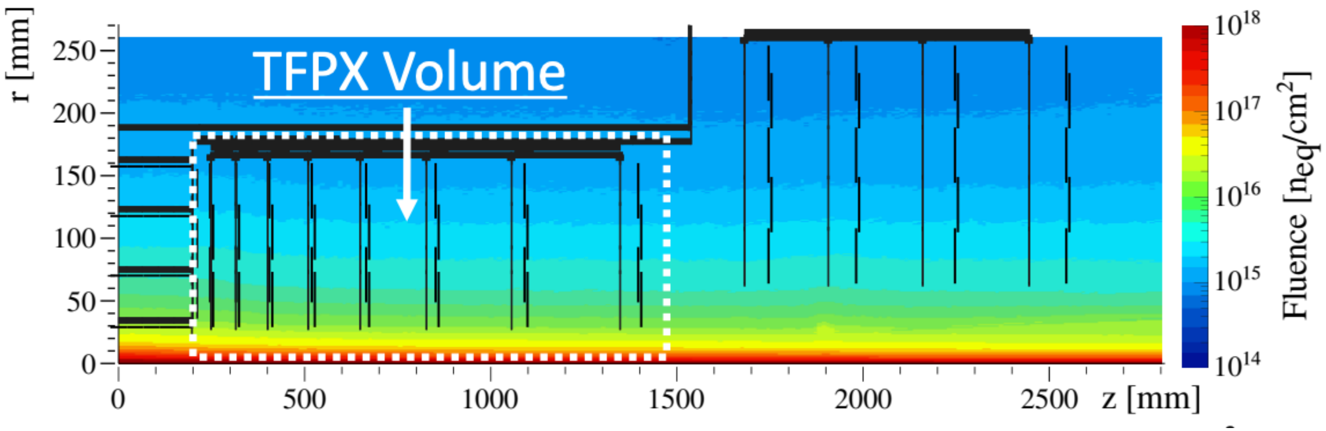


Why to upgrade (physics)

Tracker / TFPX

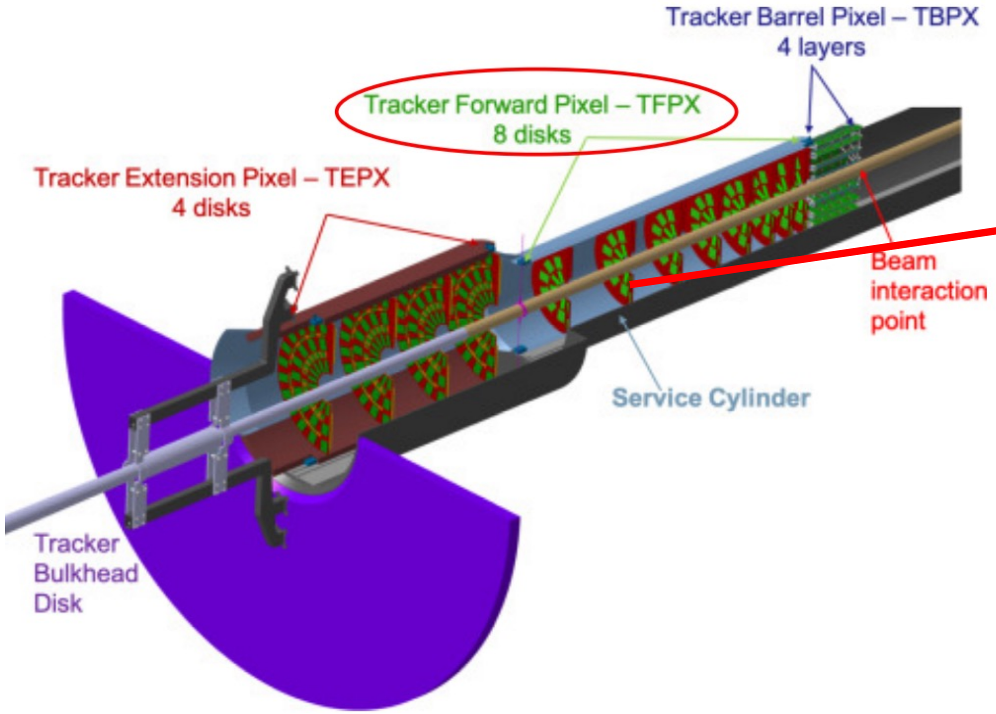


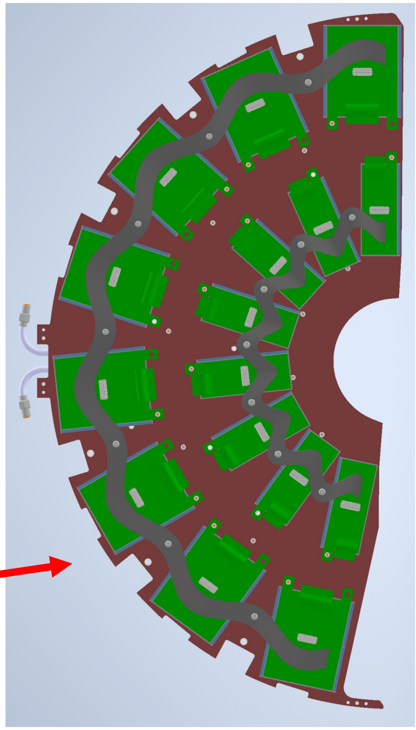
- TFPX shall have 25x100 and 50x50 micrometer pixel sizes. Finer granularity
- TFPX shall increase the Tracker coverage to |eta|=4.0
- TFPX Mass and Density Budget
- TFPX shall operate within the CMS detector in the HL-LHC environment for a minimum of 10 years.
- The TFPX data readout rate shall be 10 Gbps

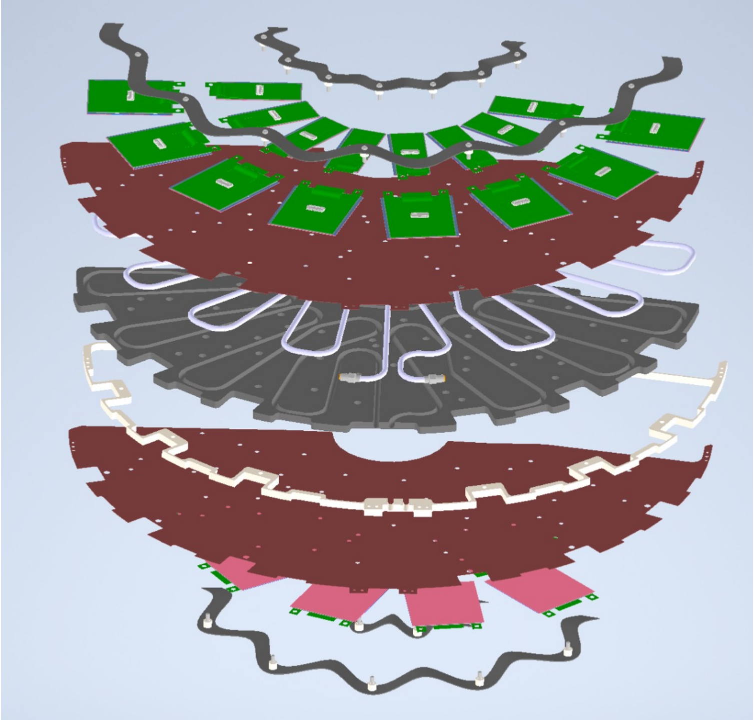


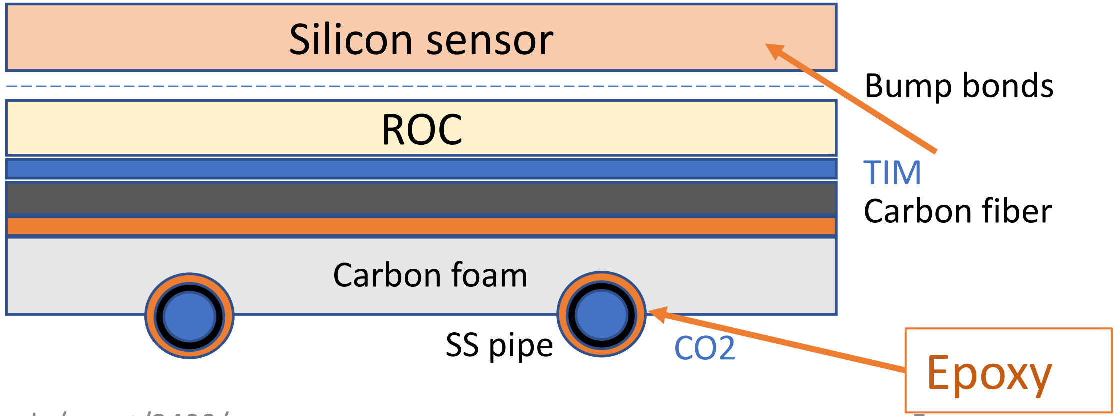
DEE structure

Tracker / TFPX

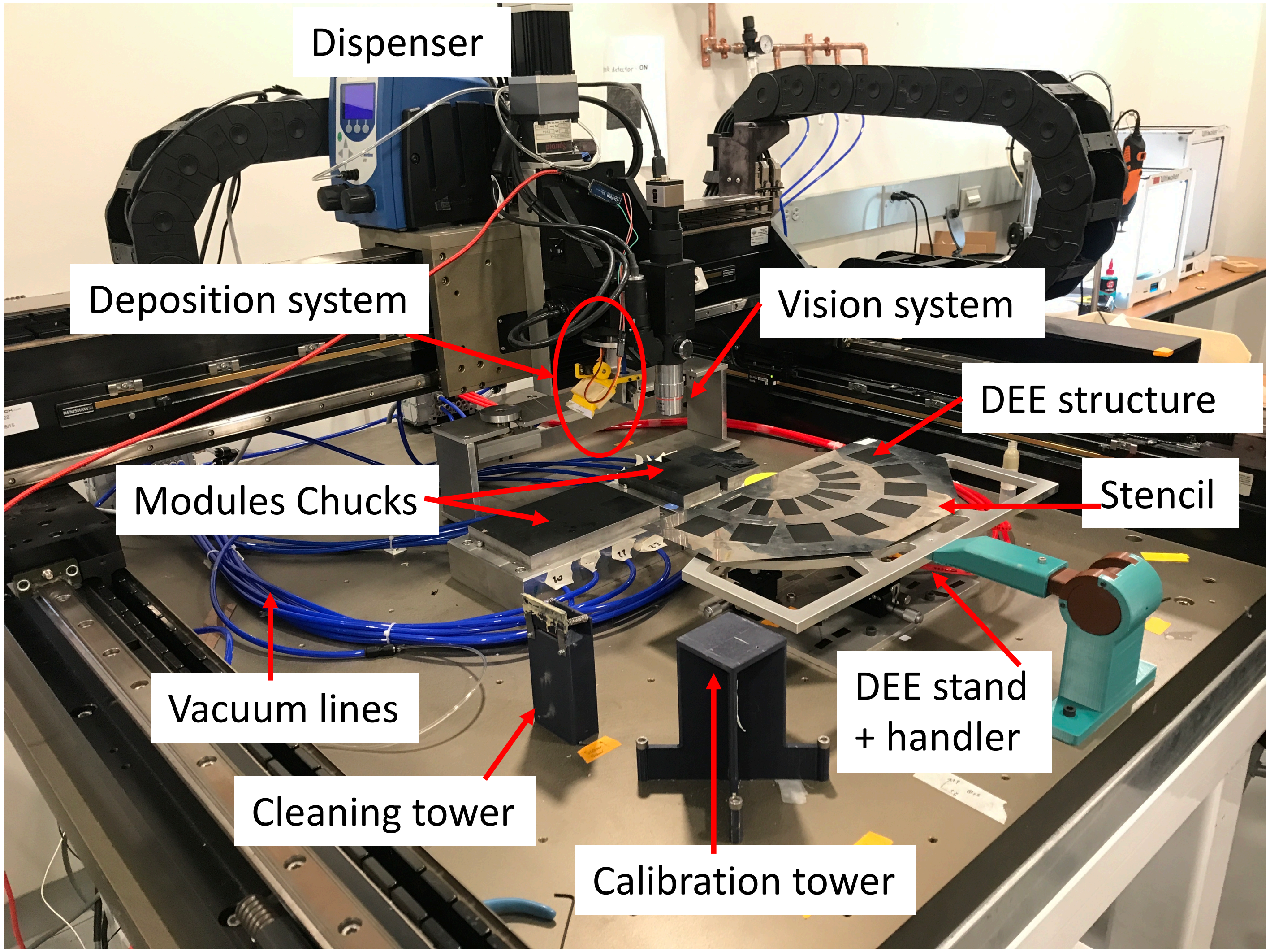




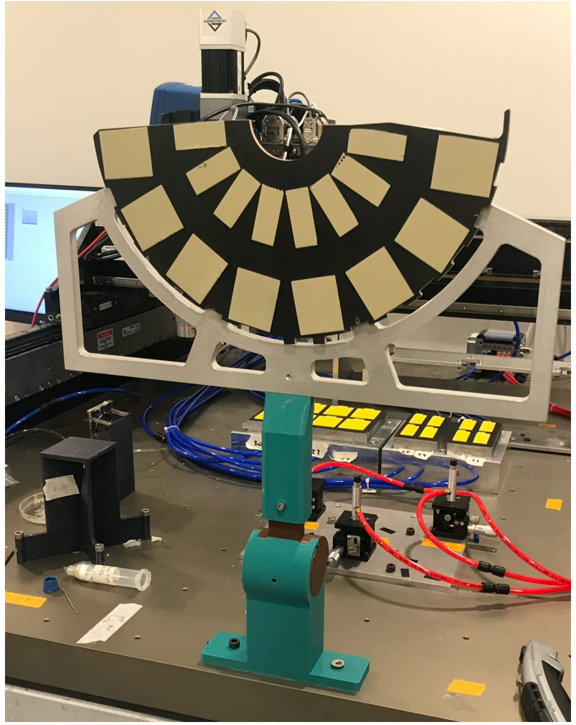




Main tool: Gantry



- Robotic gantry-based Setup programed using LabVIEW.
- Motion precision ~ 5-10 um



- How we make the DEE: Timofei's talk
- How we install the modules on the DEE: Sterre's talk
- In parallel, module function and performance is stablished so they cam be mounted: Joseph's talk
- Once the mechanical structure is ready and the modules are mounted and secured, the thermal performance is the focus: Xuan's and Shikha's talks

Thanks

Questions?

Backup

Radiation Environment

- High radiation
  - Strong radial gradient
  - ~uniform in beam direction
- Particle Fluence
  - $10^{15} - 10^{16}$ $n_{eq.}$ cm^{-2}
  - Max Ring 1: (3cm) 2.3×10^{16} $n_{eq.}$ cm^{-2}
  - Max Support Tube: $<1.2\times10^{16}$ $n_{eq.}$ cm^{-2}
- TID @ 3000 fb^{-1}
  - Ring 1: (5.1cm) 925 Mrad
  - Ring 1 (3cm) Inner: 1.2 GRad
  - Support cylinder: 70 Mrad (17cm)

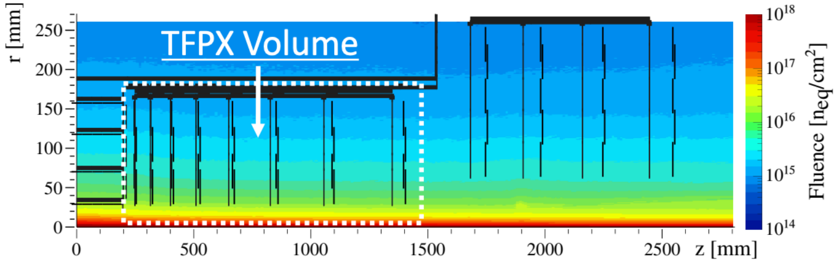


Figure 8.2: Integrated particle fluence in 1 MeV neutron equivalent in silicon per cm^2, for the region of the CMS Inner Tracker. The estimates shown correspond to a total integrated luminosity of 3000 fb^{-1} of pp collisions at $\sqrt{s} = 14$ TeV, and have been obtained with the CMS FLUKA geometry version 3.7.2.0.

Radiation simulation from CMS TK TDR
- Model of CMS material after upgrade
- FLUKA

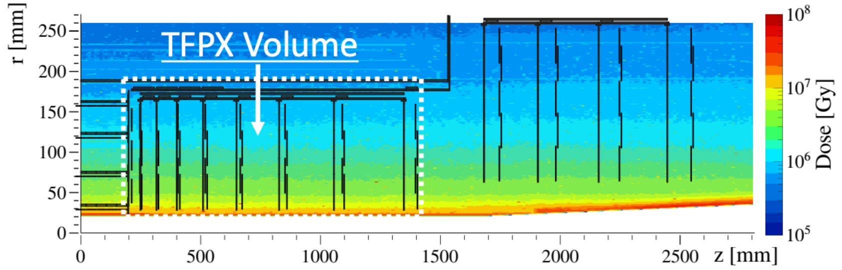


Figure 8.4: Total ionizing dose in Gy, for the region of the CMS Inner Tracker. The estimates shown correspond to a total integrated luminosity of 3000 fb^{-1} of pp collisions at $\sqrt{s} = 14$ TeV, and have been obtained with the CMS FLUKA geometry version 3.7.2.0.

Science Requirements

- Science goals drive 14 science requirements (docdb 13337)
- All but two relevant for TFPX. TFPX key role in 7.

Requirement	ID	Rationale
Redundancy & Robustness	sci-req-1	capable of high performance until 3 ab-1 integrated to carry out physics program.
Charged Particle Tracking Efficiency (and purity)	sci-req-3	Efficient reconstruction of Higgs decays, DM candidates, rare SM processes, or BSM signals requires efficient charged particle tracking.
Momentum Resolution	sci-req-4	Accurate reconstruction of Higgs decays requires excellent momentum (H to ZZ to 4l) resolution. Excellent resolution is also necessary for DM candidates, rare SM processes, or BSM signals.
Dijet Resolution	sci-req-5	Accurate reconstruction of Higgs decays requires excellent dijet (H to bb) resolution. Accurate reconstruction is also necessary for DM candidates, rare SM processes, or BSM signals.
Primary Vertex Identification (and purity)	sci-req-7	Accurate reconstruction of Higgs decays requires accurate primary vertex identification (H to γγ). Accurate reconstruction is also necessary for DM candidates, rare SM processes, or BSM signals.
b-jet Tagging Efficiency (and purity)	sci-req-8	Efficient reconstruction of Higgs decays requires efficient secondary vertex identification, (b-jet tagging, H to bb). Efficient b-tagging is also necessary for DM candidates, rare SM processes, or BSM signals.
VBF Tagging Efficiency (and purity)	sci-req-9	CMS is required to have high efficiency VBF jet tagging andbe able to accurately associate them to primary vertices in order to disentangle Higgs production modes (gg vs VBF). Efficient jet tagging is also necessary for DM candidates, rare SM processes, or BSM signals, where VBS processess can also occur.
Pileup Mitigation	sci-req-10	CMS requires mitigation of the effects of pileup such that LHC performance is recovered at HL-LHC (with up to 200 PU)
MET Resolution	sci-req-11	CMS requires excellent missing transverse energy resolution to indirectly detect non-interacting BSM particles due to momentum imbalance, e.g. dark matter and/or SUSY LSP. Excellent resolution is also necessary for invisible Higgs decays and rare SM processes involving neutrinos.
Lepton Identification Efficiency	sci-req-12	Efficient id of leptons from Higgs decays (e.g. H to ZZ to 4l), DM candidates, rare SM or BSM signals.
Photon Identification Efficiency	sci-req-13	Efficient id of photons from Higgs decays (e.g. H to γγ), DM candidates, rare SM, or BSM signals.
Tolerance of high instantaneous luminosity	sci-req-14	In order to integrate 3 ab-1, CMS must be able to tolerate instantaneous luminosities up 7.5e34 cm-2s-1 (which will result in 200 PU)