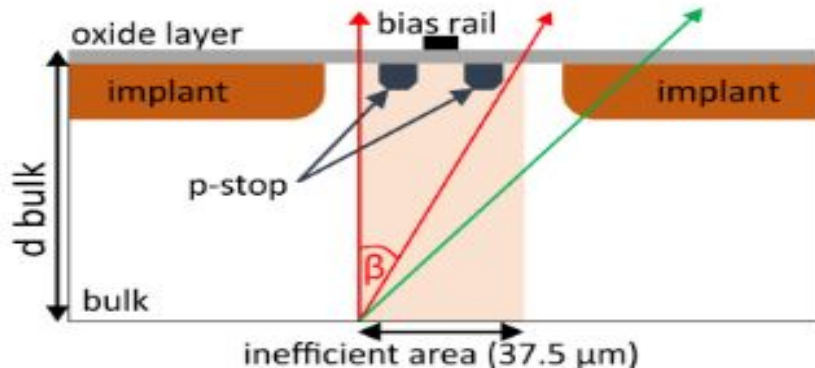


Implementation of Bias Rail inefficiency in macro-pixel sensor

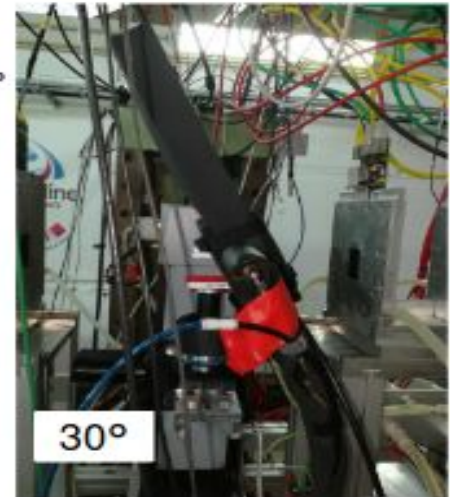
Suchandra Dutta and Subir Sarkar
SINP-Kolkata

Efficiencies at Inclined Particle Incidence

- inefficiencies are caused by the **bias rail** and the **PT-structures** at vertical particle incidence
 - assuming an inefficient area of $37.5 \mu\text{m}$ (half the distance between two implants), an incident angle $> 7.4^\circ$ is necessary to overcome the inefficient bias rail area
 - measurements with tilted assemblies to see how the efficiency increases with the tilting angle
 - focus on Standard design $\rightarrow 0 \cdot 10^0$ and $1 \cdot 10^{15}$ neq/cm²
 - investigation of 5 different angles (5° , 10° , 15° , 20° , 30°)
 - setup mountings are 3D printed \rightarrow angular uncertainty $\sim 2^\circ$

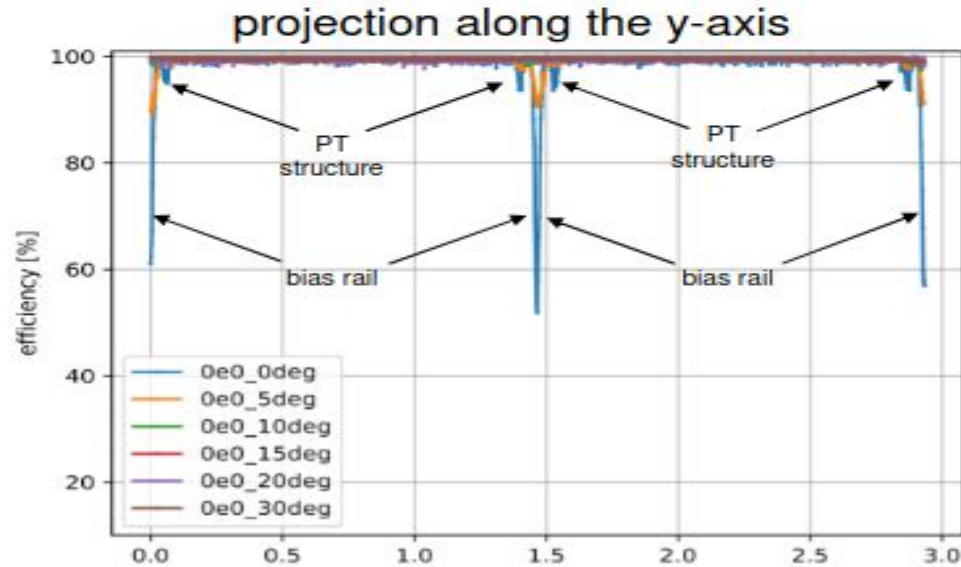


[Florian Witting's slide on 03/09/3030](#)



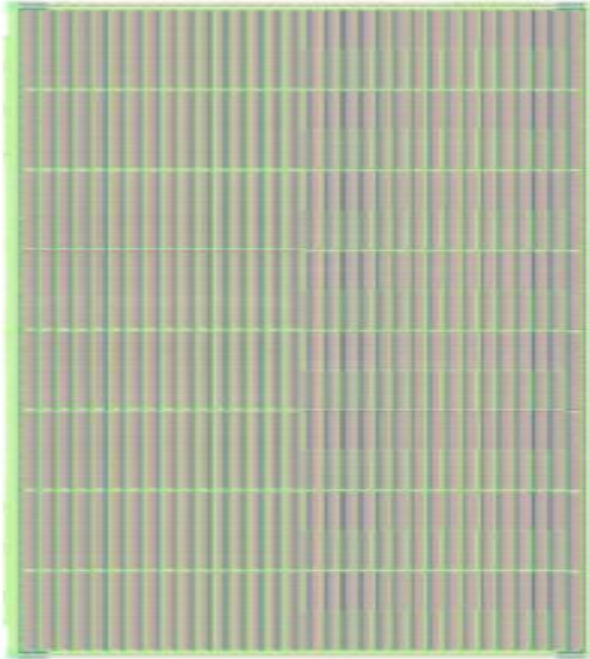
Inpixel Efficiency – Unirradiated Standard

- efficiency at the bias-rail region drops below 60% for perpendicular particle incident
- already small tilting angles tilting angles (5°) have a significant impact on the efficiency
- for angles greater 10° , efficiency dip is not longer visible



The Macro Pixel Sensor

- Divided into 32X960 pixels
- 100 μm pitch
- 1.467 mm long



Sensor Dimension 5 cm X 10 cm

Inefficient Region :

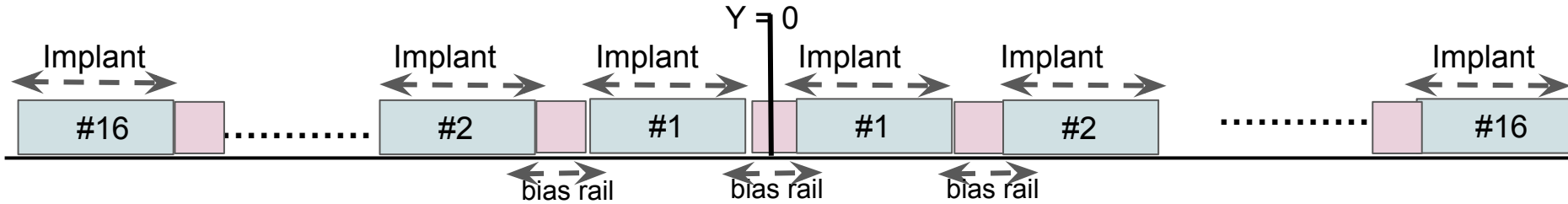
$$\begin{aligned} 37.5 \mu\text{m} * 31 &= 1162.5 \mu\text{m} \\ &= 1162.5 \times 10^{-4} \text{ cm} \end{aligned}$$

$$\Rightarrow 1162.5 \times 10^{-4} / 5$$

$$\Rightarrow 2.325\%$$

Implementation

A very crude sketch



PSPDigitizerAlgorithm : while looping over SIM hits

- Check the entry/exit point of the SimHit
- Both should lie within the implant region
 - $\text{mod}(y_{\text{pos}}, \text{implant} + \text{bias rail}) \leq \text{implant length}$
 - If not, discard the SimHit

Implant length 0.1467cm

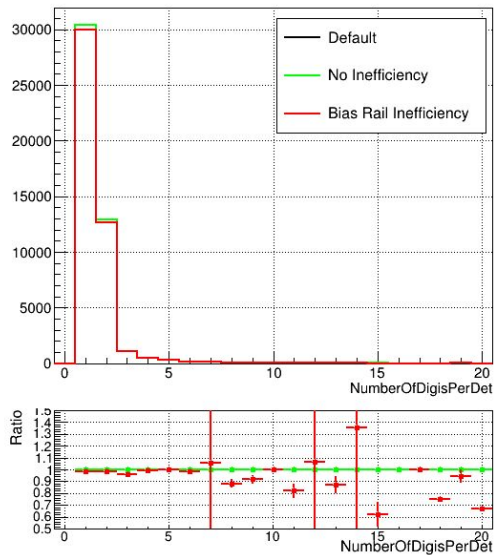
Pstop length 0.0037cm

Validation

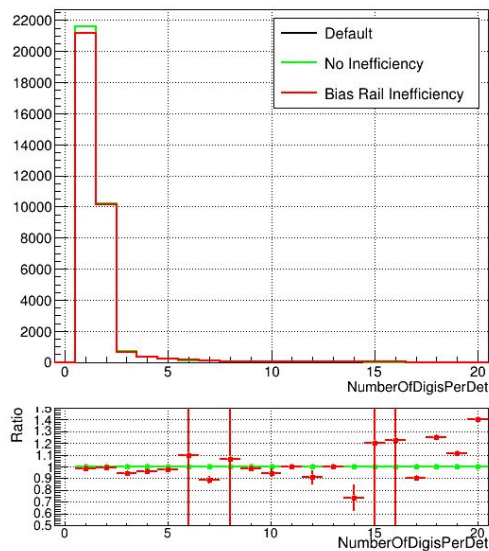
- Release : CMSSW_12_3_0_pre5
- Private Production of particle gun Muons (4Mu) 2-200 GeV
 - `runTheMatrix.py --what upgrade -ne -l 39010.0`
- 5000 events produced
- Digitization done 3 times
 - Default
 - New code but switching off Bias Rail inefficiency
 - New code with Bias Rail inefficiency

Number of Digis per Detector Module (PSP + PSS module)

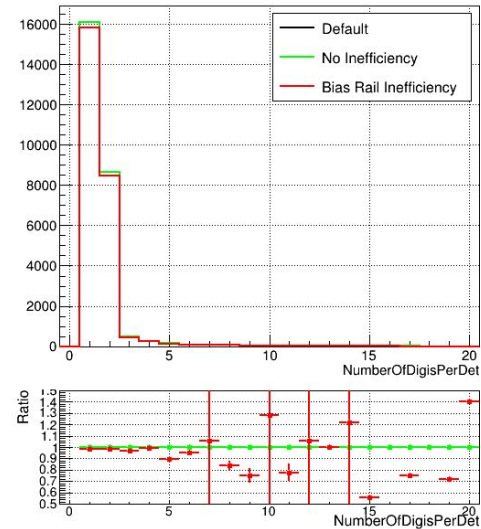
Layer 1



Layer 2

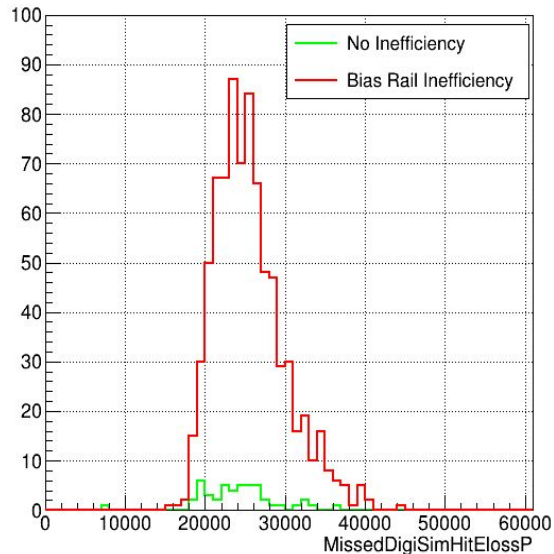


Layer 3

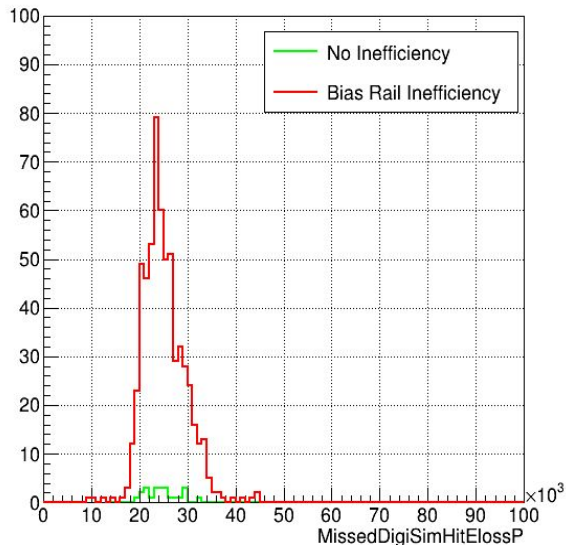


Eloss from missed SimHits from (PSP modules)

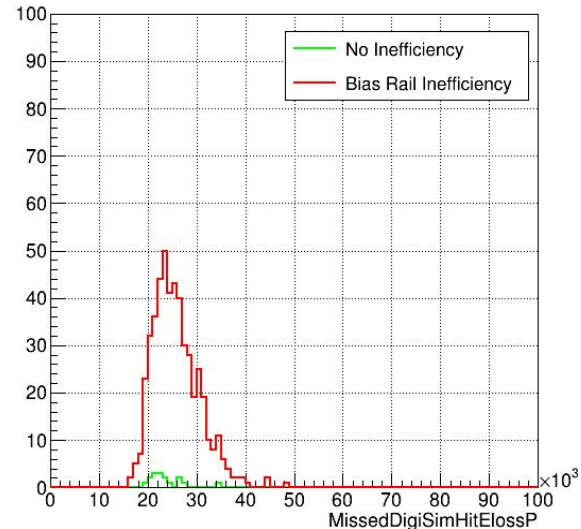
Layer 1



Layer 2

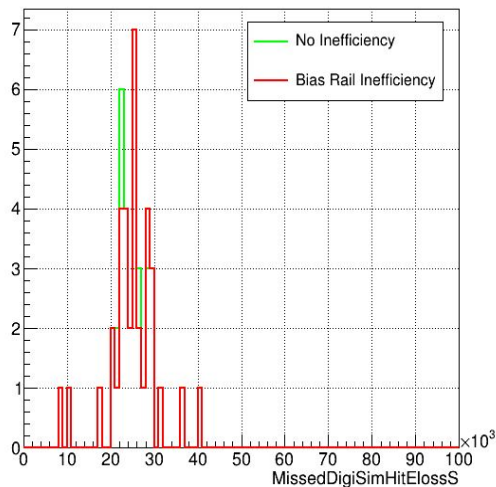


Layer 3

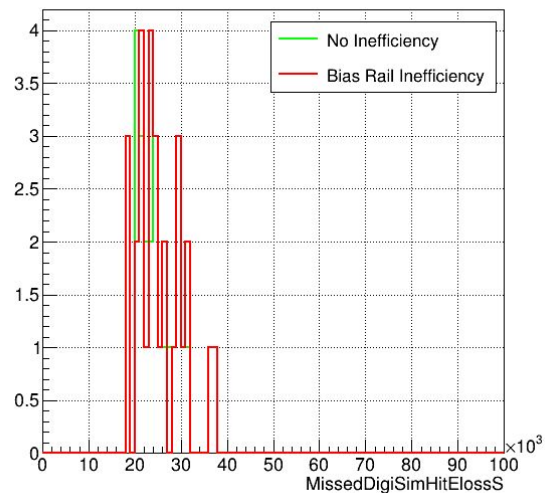


Loss from missed SimHits from (PSS modules)

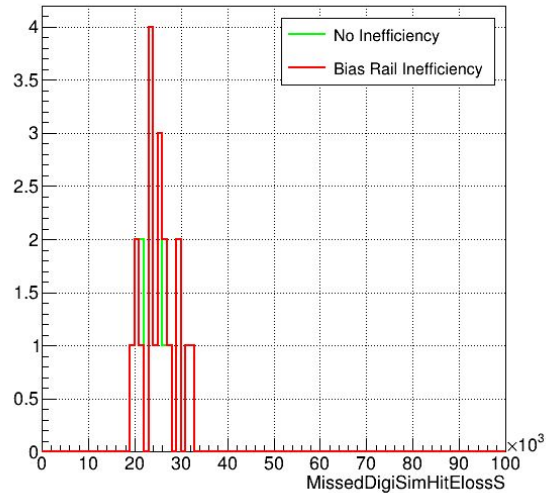
Layer 1



Layer 2

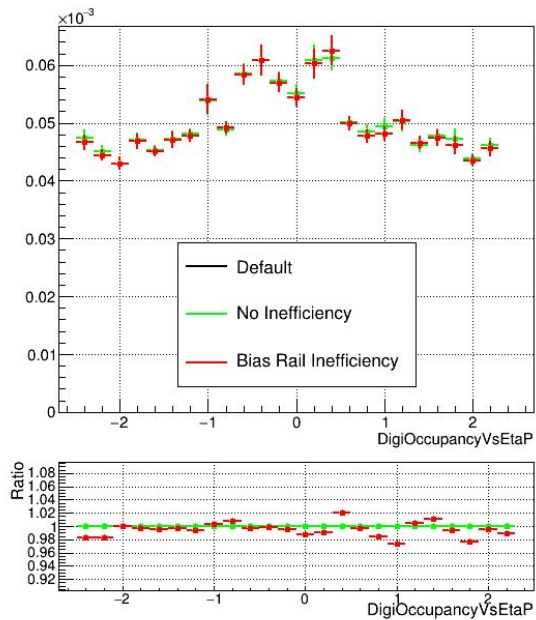


Layer 3

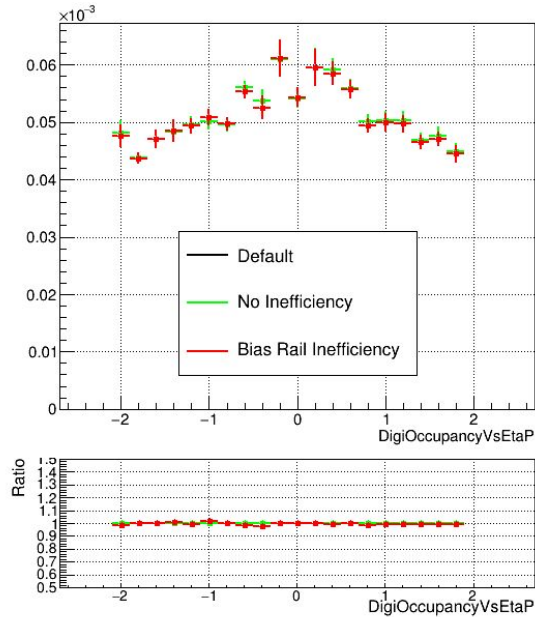


Occupancy Vs Eta (PSP)

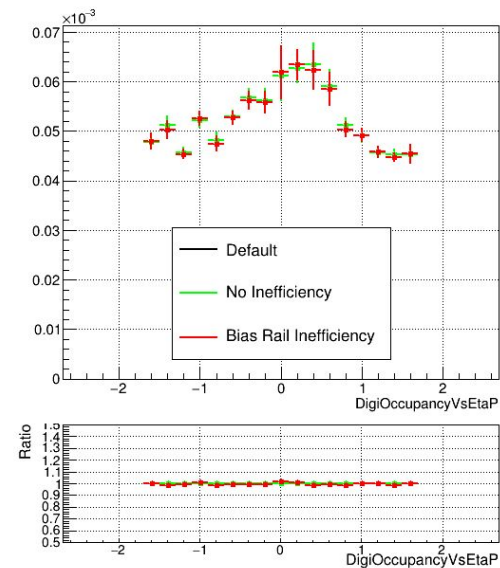
Layer 1



Layer 2

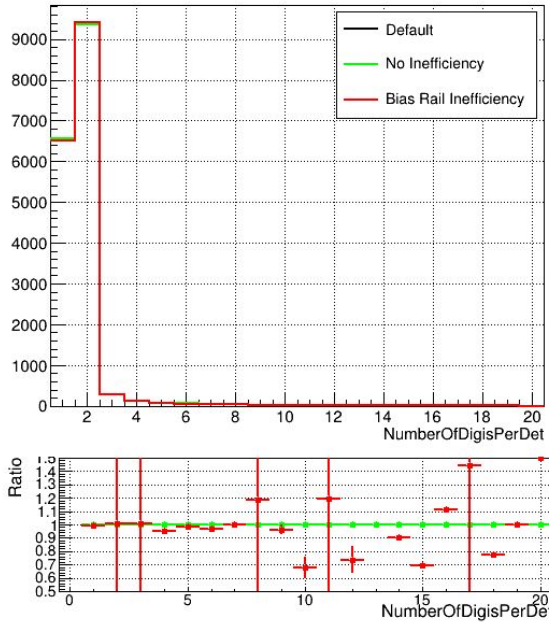


Layer 3

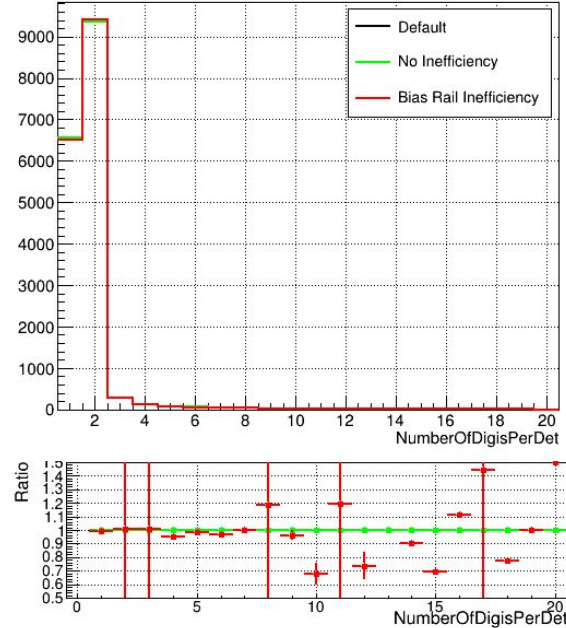


Number of Digis per Detector Module (SS module)

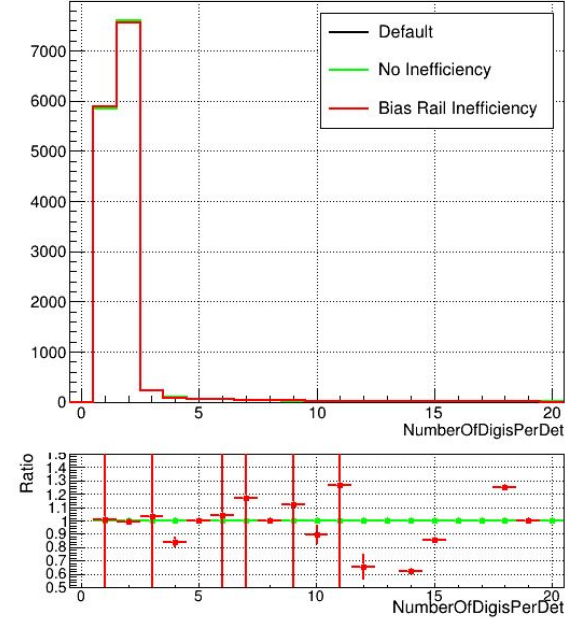
Layer 4



Layer 5



Layer 6



Cross checked carefully and such slight disagreement is due to the change in the random seed (within the digitizer) when hits are rejected in any of the modules.