SciFi Simulation and Reconstruction

Jessy DANIEL , on behalf of the SciFi Software Group
Zehua Xu, Louis Henry, Sophie Hollitt, Emmy Gabriel,
Izaac Sanderswood, Juan Leite, …

SciFi General Meeting
CERN - 27 February 2023

Overview

- SciFi Simulation and Reconstruction :
  - Group Meetings, Mondays at 1:00 PM
  - Twiki
  - Mail list : lhcb-upgrade-ft-software

- Summary of key updates since last General Meeting :
  - Geometry (Zehua Xu, Jessy Daniel):
    - Test consistency between DetDesc and DD4Hep (Gauss, Boole and material budget) -> OK
  - Mat contraction (Izaac Sanderswood) :
    - Adding mat contraction conditions to the stack -> Correction in a per-channel basis -> Completing Merge Request
    - Development of a realistic model for simulation and assess its effect on performance -> In Progress
    - Developing strategy to measure the contractions and determine the calibration values -> In Progress
  - Automated dead/unefficient SiPM/HalfROB detection script (Juan Leite) -> First version finished / look into producing shorter logs using references

Mat Contraction

Izaac Sanderswood

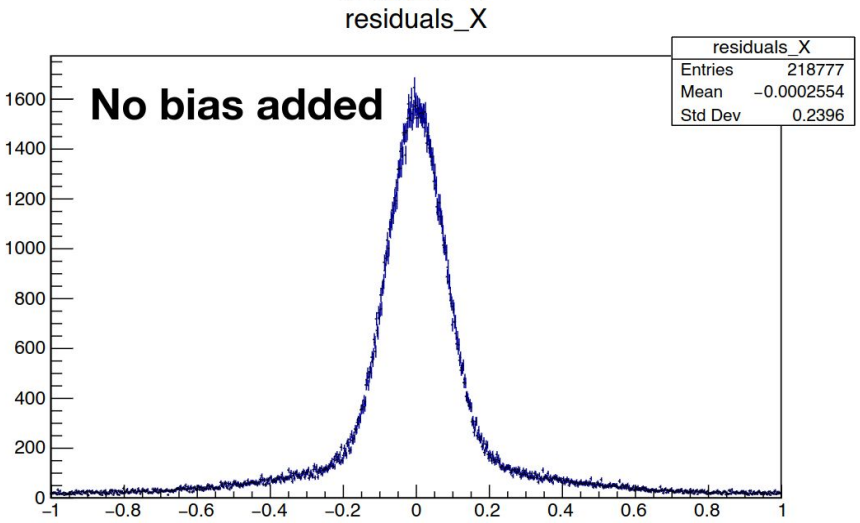
Mat Contraction Definition

Izaac Sanderswood

- The cooling of the SiPMs in the SciFi causes the fibre ends to contract -> Mat deformation up to 0.2mm in X
  - -> Channel-to-x-position mappings requires calibration
  - -> Different deformations between mats and across a given mat

Rough attempt at approximating expected bias

- "Worst case scenario" if every mat experienced the maximum expected contraction
- Calculated an approximate bias with a cubic function centred in the middle of the mat with maximum values in the first/last of ±0.2mm in x, such that is pointing to the centre of a mat
- Standard deviation of X residuals increases by over 50%
- Work underway to improve this model using actual temperature data



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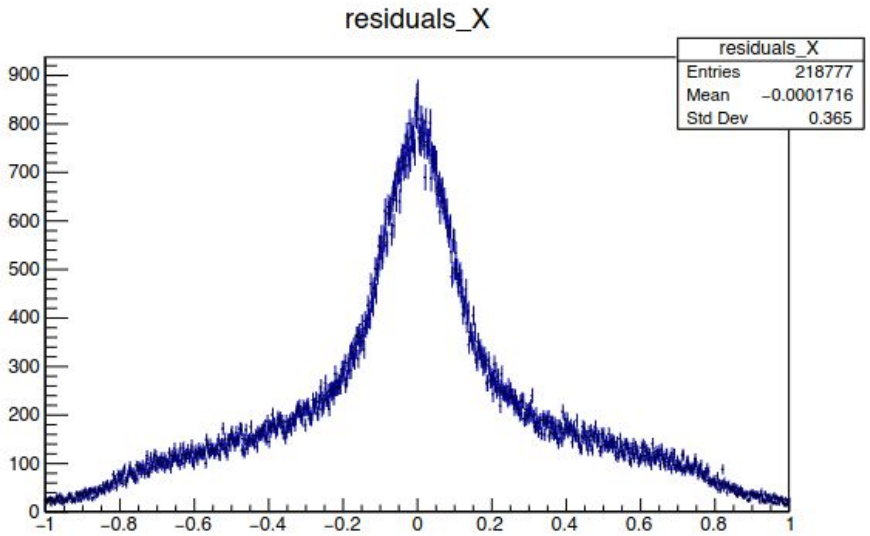


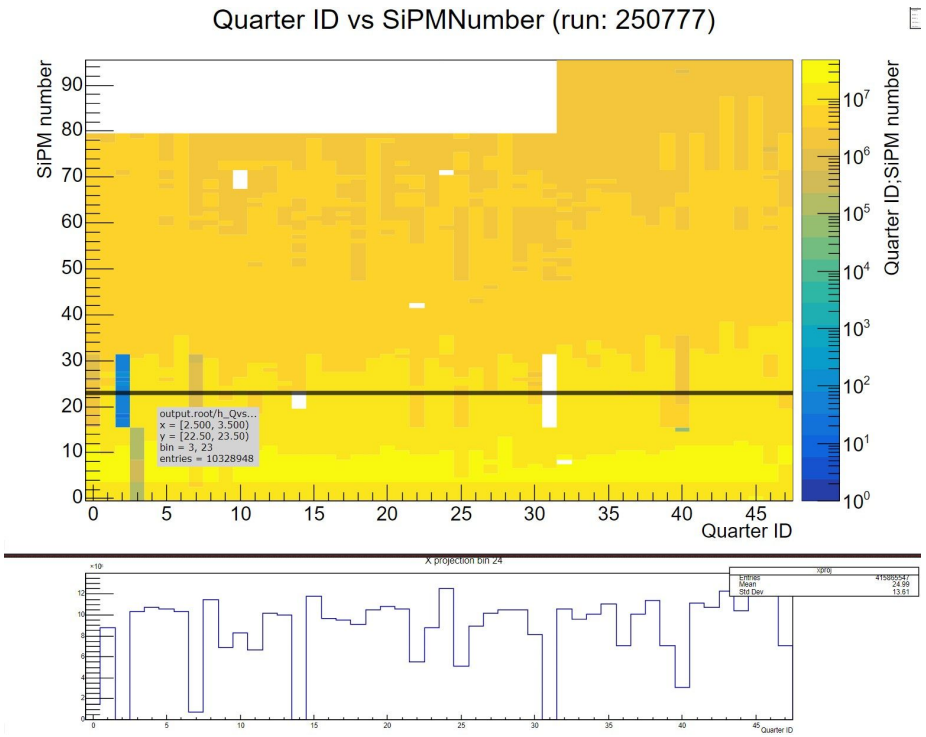
Dead/Unefficient SiPM Detection

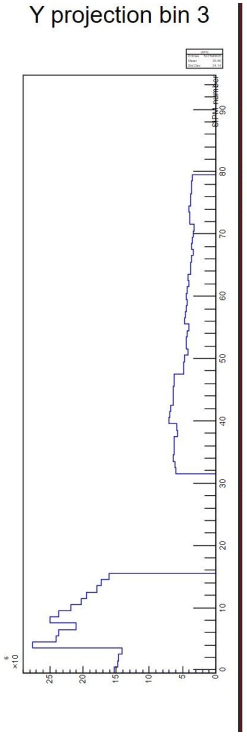
Juan Leite

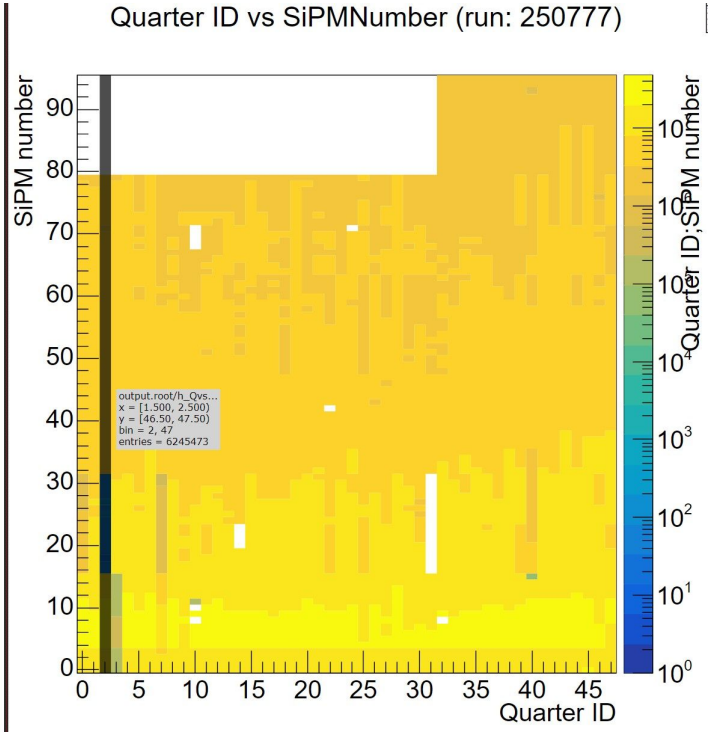
Automatic dead SiPM detection

Juan Leite

Working on an automated dead/inefficient SiPM/HalfROB detection script
-> First version finished, now looking into producing shorter logs using reference.







Goal : From this kind of histogram, extract a .txt file with a list of missing or unefficient SiPMs and HalfROBs

DD4hep Migration

Zehua Xu, Jessy Daniel, Louis Henry

DD4hep geometry validation in simulation

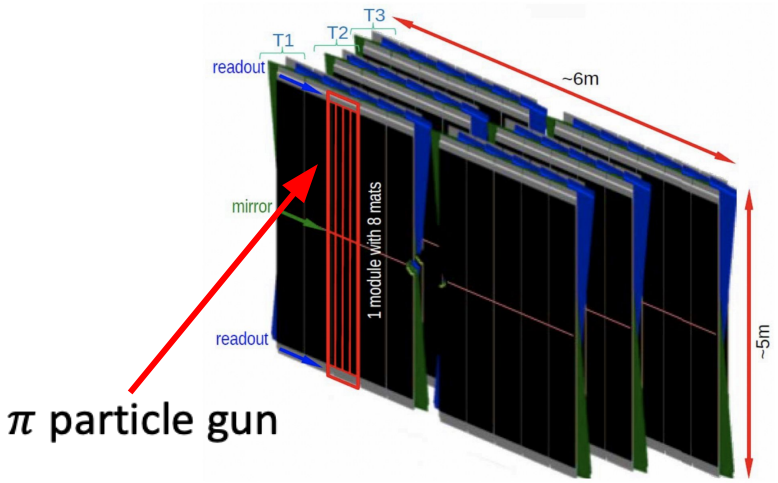
Zehua Xu, Jessy Daniel

Particle gun:

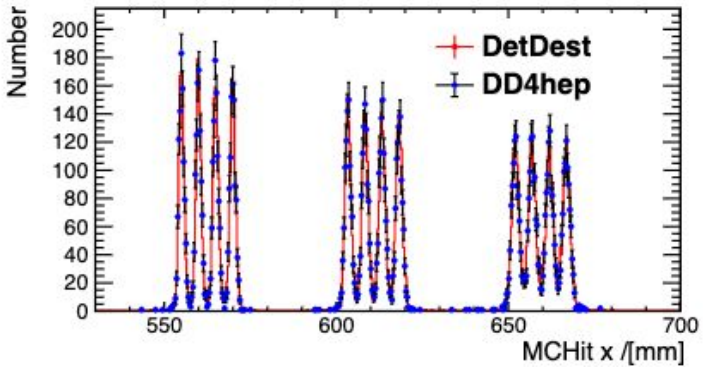
- Origin vertex: (0,0,0);
- Momentum fixed:

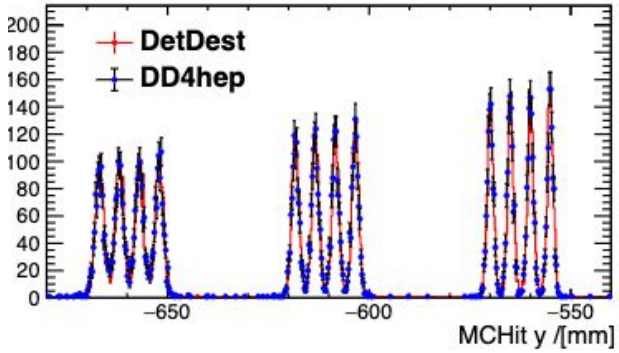
$$E = 10\ \text{GeV}; \theta = 0.1; \phi = 45°$$

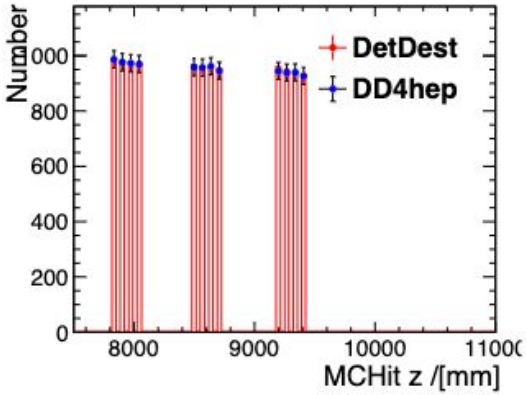
Simulated Det: FT



MCHit output from Gauss, compare response using DetDesc and DD4hep:







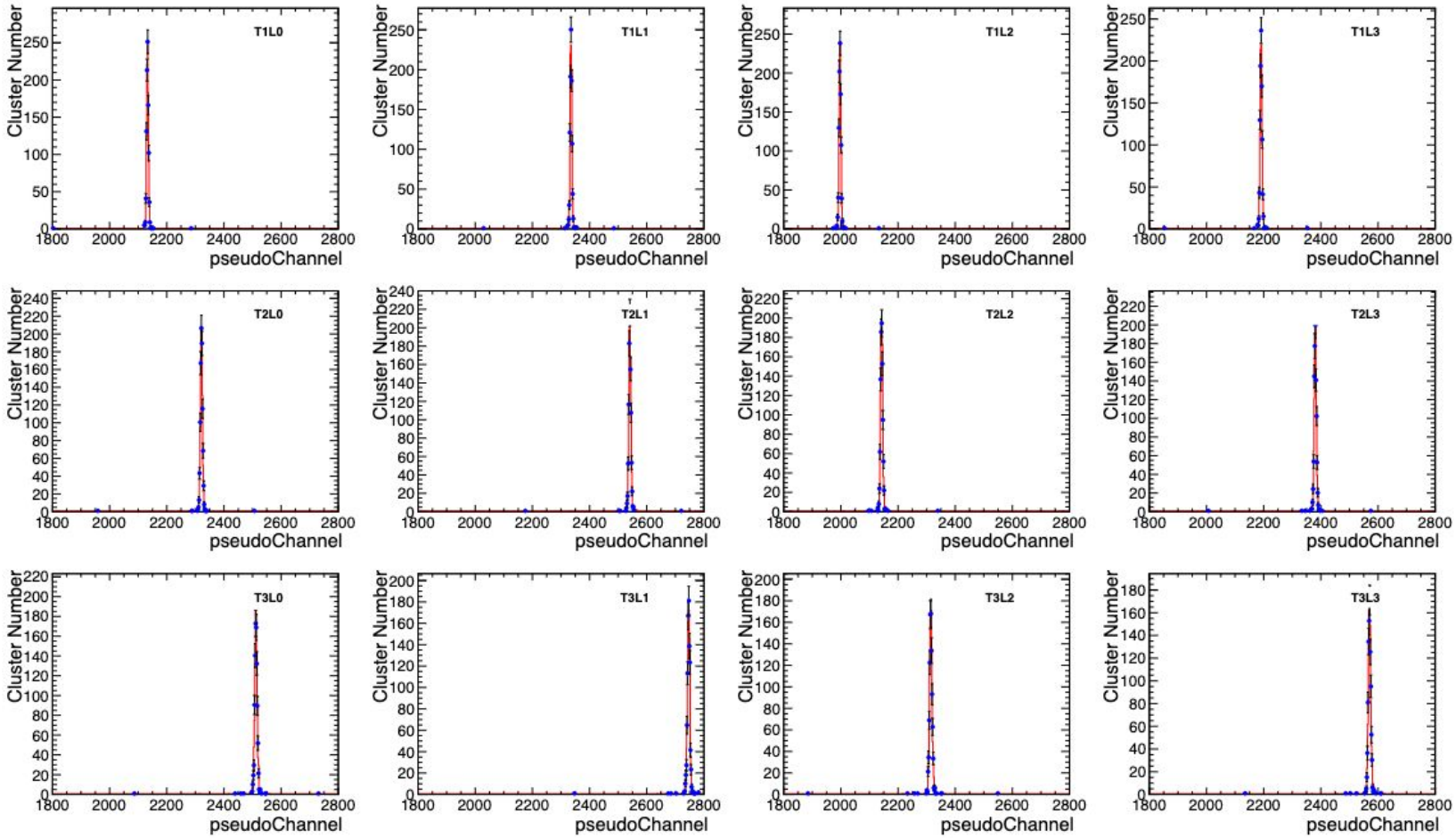
MCHit distributions with DetDesc & DD4hep are compatible

Boole Digitization response

Zehua Xu, Jessy Daniel

*.sim files as input of Boole digitization FT simulation

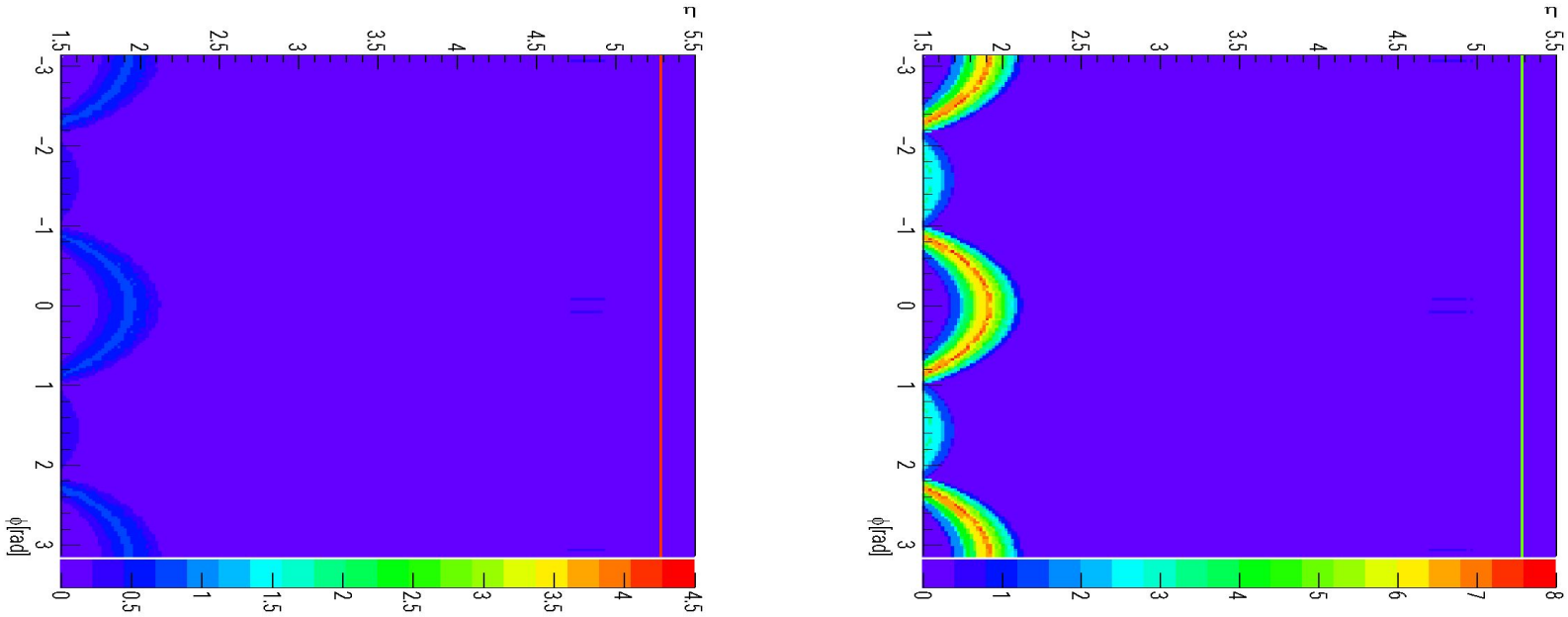
- SciFi response checked:



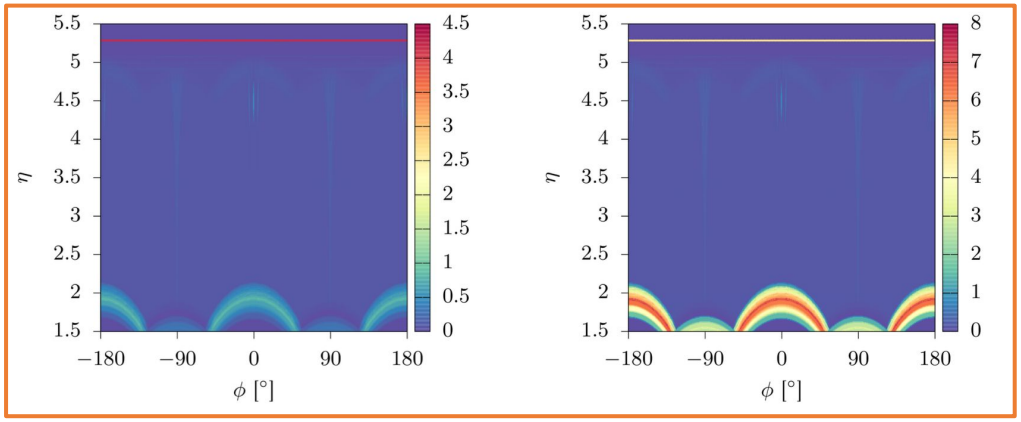
Preliminary validation for SciFi Geo&Conditions in DD4hep geometry

SciFi material scan in DD4Hep

Zehua Xu



- Left: In units of interaction length as function of (ϕ, η)
- Right: In units of hadronic radiation length as function of (ϕ, η)



DetDesc

[LHCb-INT-2017-027]

SciFi material scan in DD4Hep

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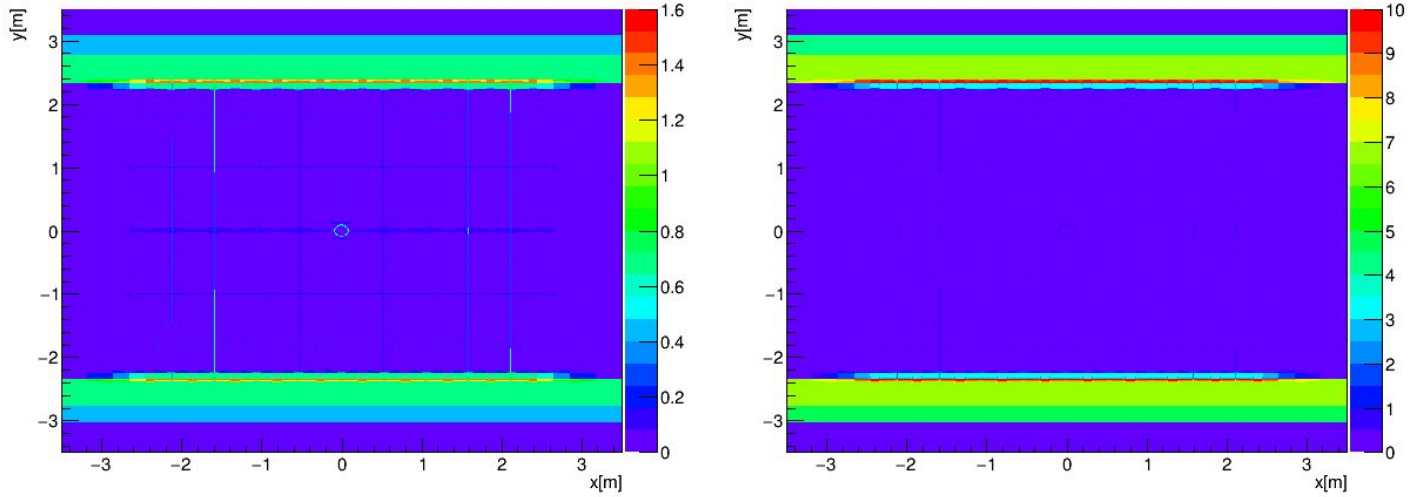
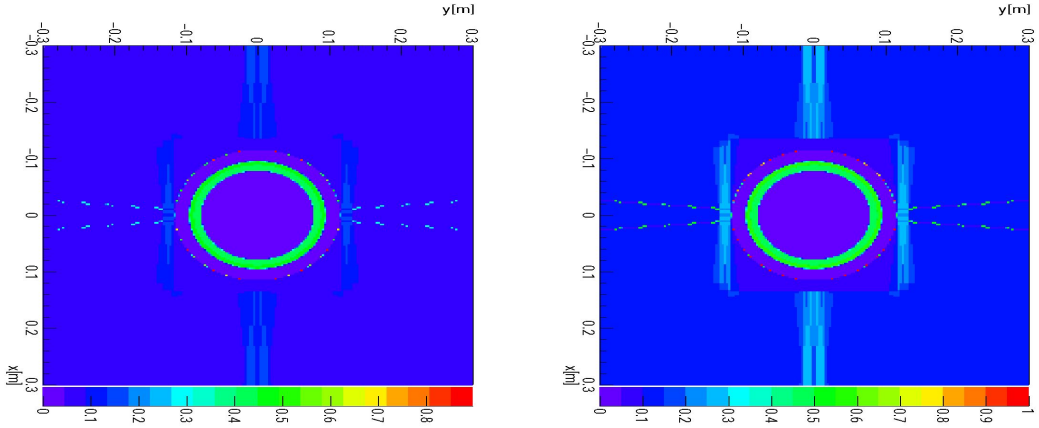


- Left: In units of hadronic interaction length as function of (x, y)
- Right: In units of radiation length as function of (x, y)



Material budget around beam pipe hole (zoom in)

SciFi material scan in DD4Hep

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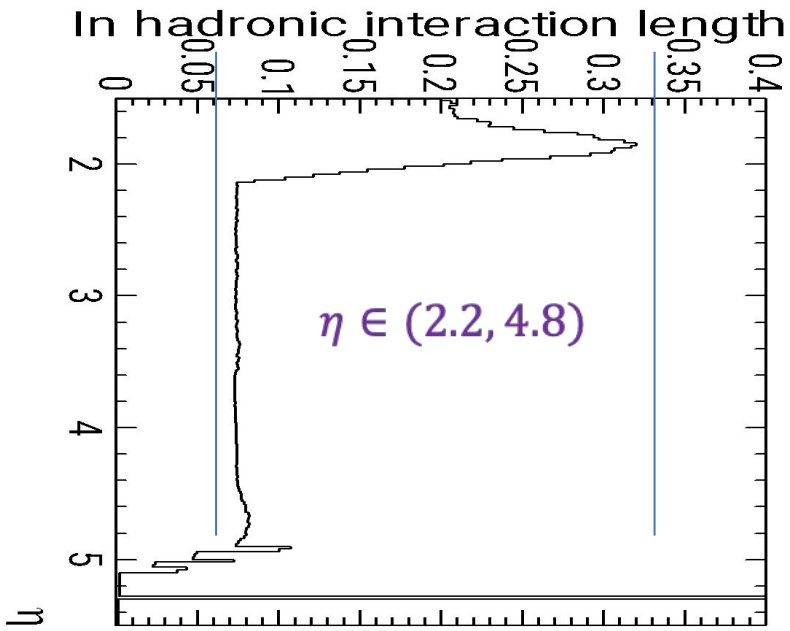
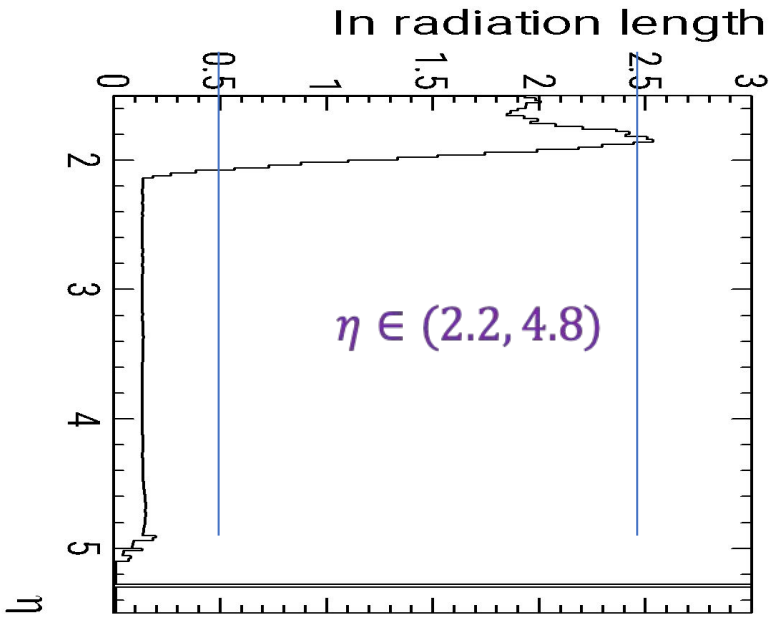




$$\left\langle \int \frac{dz}{\lambda_{int}} \right\rangle_{\phi} \approx 7.5\%$$

$$\left\langle \int \frac{dz}{X_0} \right\rangle_{\phi} \approx 14\%$$

- When tracks $\eta \in (2.2, 4.8)$, material budget of SciFi is small and steady

DD4hep migration : Summary and plans

Zehua Xu, Jessy Daniel, Louis Henry

- SciFi geometry migration into DD4hep almost completed
  A note to summary model improvement and validation.

- Louis debugged Boole test locally : DetDesc and DD4Hep results are now compatible

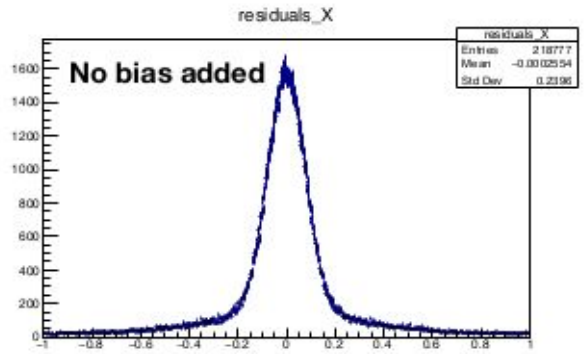
- Plans:
  - SimDQ monitoring
  - Data/MC comparison
  - Cooperate with simulation project for the final SimDQ check
  - Final goal: simulation model used for Run 3 physics analysis

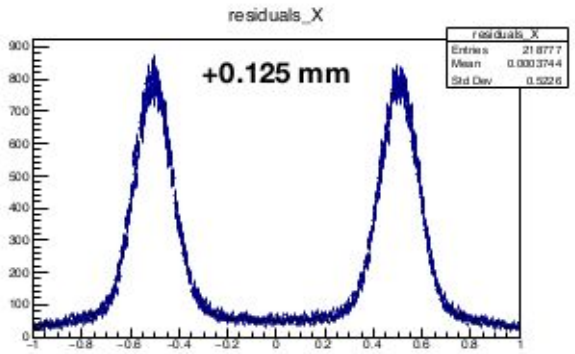
BACKUP

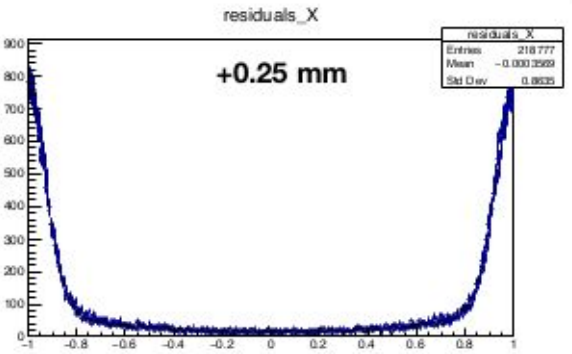
Mat Contraction Definition

Izaac Sanderswood

Showing that the new conditions can move the residuals by desired amount

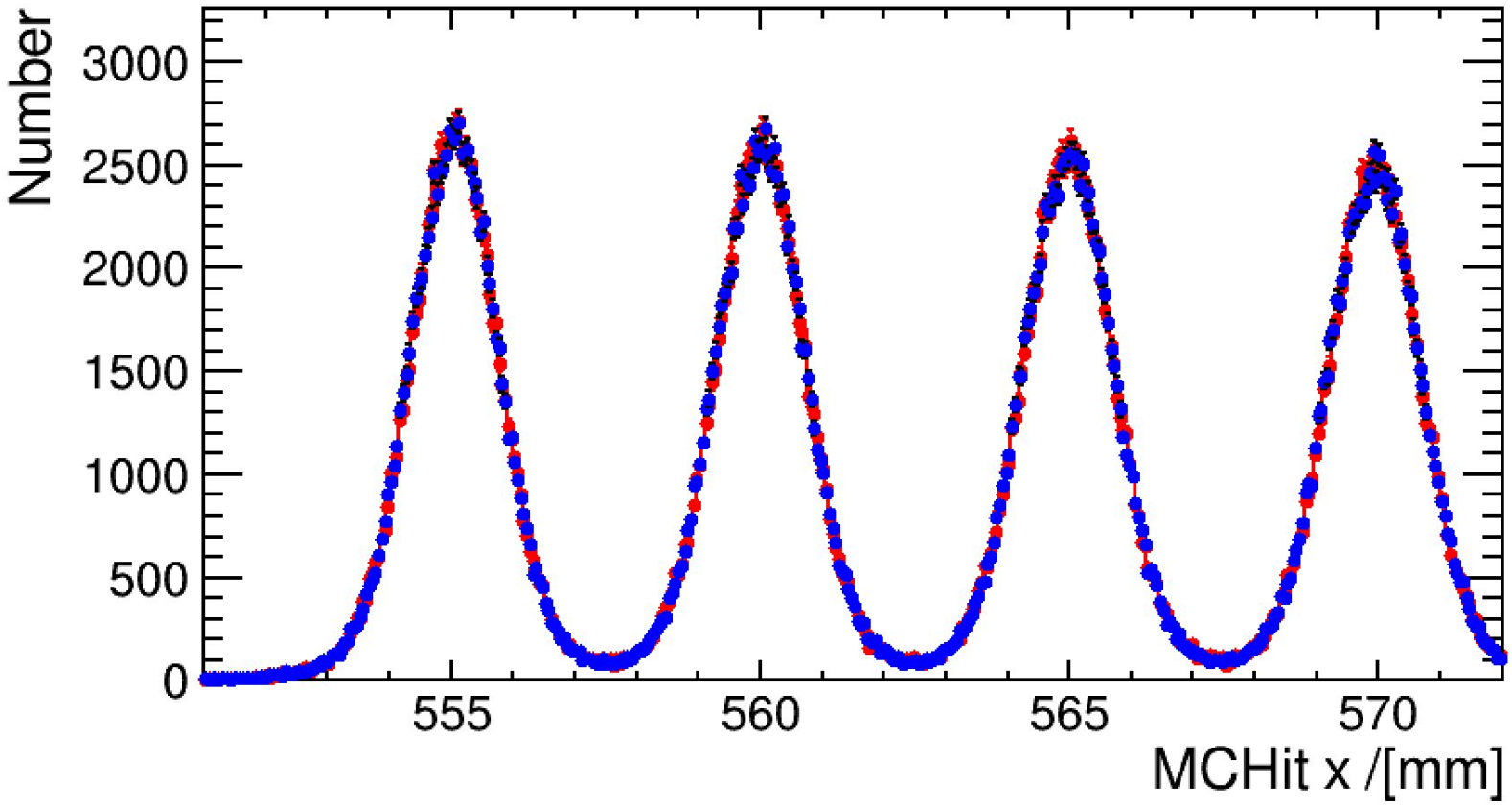






More Detailed Comparison

Zehua Xu, Jessy Daniel



- Kolmogorov-Smirnov test ~0.97

Plans

- Link mapping
- SimDQ monitoring
- Data/MC comparison

SCIFI

- **Geometry** description in DD4hep
  - Ready in master. Several issues fixed (orientations, orderings, etc. of layers/mats) and overlaps checked
  - Detector elements tested
- **Conditions**
  - Ready except for mat contraction calibration https://gitlab.cern.ch/lhcb/LHCb/-/merge_requests/3591 and SiPM response & clustering thresholds in SIMCOND and also in LHCbCond
  - **Link mapping:** proper strategy to make sure both simulation and data-taking are OK. Contains both semi-permanent (cabling) and temporary (disabled links) information.
- **Boole** with DD4hep
  - Code to access geometry ready
  - Local use of Gauss-on-Gaussino + Boole works
  - DD4hep vs DetDesc ongoing. Define common tools to be used
  - SimDQ monitoring: histos wish list ready
- **Next steps**
  - Detector + Boole Validation
  - Boole monitoring in SimDQ
  - Data/MC comparison