
Task 12.1. Coordination and Communication

See introductory section on page 29.

Task 12.2. Turnkey Software

- Integrated Turnkey Software Stack, for physics and performance studies
- Simplified data model toolkit for modern hardware platforms
- Digitisation extensions for geometry toolkit
- R&D study on frameworks to manage heterogeneous resources

Task 12.3. Simulation

- Fast simulation techniques integrated into Geant4
- Machine learning based calorimeter simulation toolkit for training and inference

Task 12.4. Track Reconstruction

- Develop complete track reconstruction chain with Acts composable algorithms
- Implement a portable version of Acts algorithms, for heterogeneous computing
- Machine learning reconstruction algorithm for MPGD detectors

Task 12.5. Particle Flow Reconstruction

- Advanced PFA algorithms for DUNE detectors using new readout technologies
- PFA algorithm with particle ID for dual-readout calorimeters
- Optimised APRIL PFA algorithm for hadronic jets

WP12

12.4 TRACK RECONSTRUCTION

INFN sites: Bologna, Ferrara, LNF, Torino

Contact person: Gianluigi Cibinetto (Ferrara)

DEVELOPMENT OF MACHINE LEARNING ALGORITHMS FOR MICRO PATTERN GASEOUS DETECTORS

Task timeline and deliverables

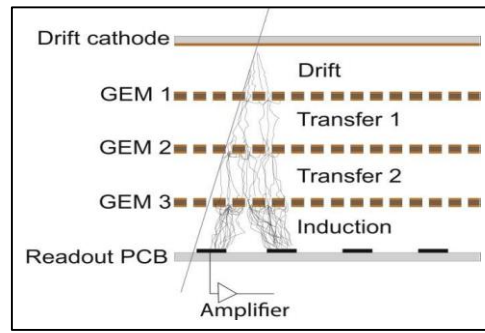
- **Timeline and task: 4 years**

- First year: uRWELL simulation → cluster reconstruction GEM and uRWELL.
- Second year: development of track finding
- Third year: track cleaning and refinement
- Fourth year: application to IDEA detector pre-shower and muon → optimization

- **Deliverables**

1. A scientific paper describing the performed activity and the results.
2. An open-source software suite for training and testing ML algorithms with MPGD data and simulations.

Simulation and ML development



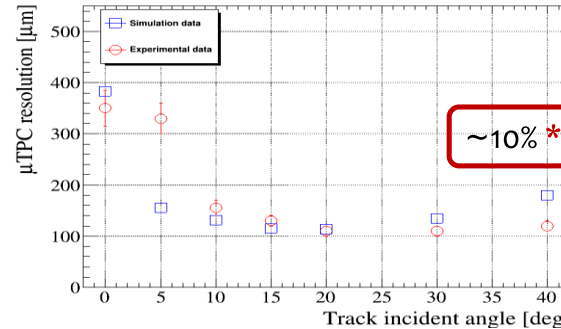
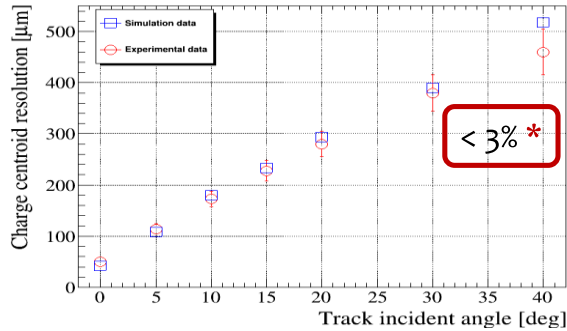
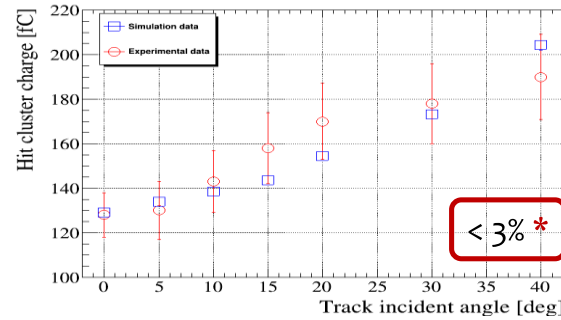
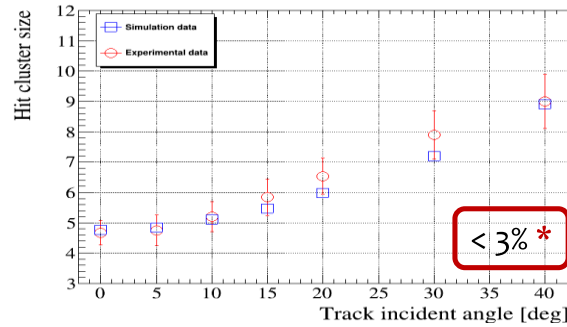
For triple-GEM, we developed a parametric simulation which takes into account diffusion, transparency, gain, induction and readout electronics.

We tuned it to test beam data → both charge and time readout for CoG and uTPC cluster reconstruction.

R. Farinelli and L. Lavezzi, RD51 coll. Meeting - Oct 2019

Tuning to real data

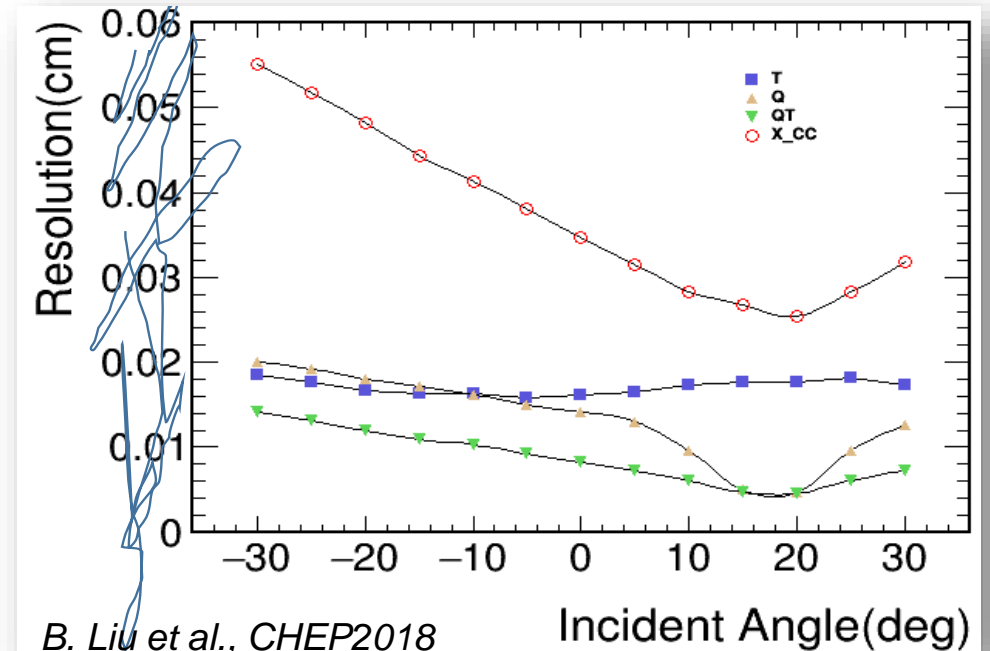
Best result $\chi^2/\text{NDF} \sim 3 \leftarrow \text{gain tuning} = 6.8 \leftarrow \text{diffusion tuning} = 1.5$



* (experimental - simulated)/experimental

Goal I: extend the simulation to other MPGD detectors.

Goal II: develop general purpose Machine Learning tracking algorithms.



B. Liu et al., CHEP2018

Simulation and ML algorithms can be developed in the general framework

THE GROUP

- The group
 - INFN Bologna: main sub-task → porting and integration with IDEA general framework
 - INFN Ferrara/Torino: MPGD parametric simulation, uTPC development and ML algorithms
 - INFN Frascati Laboratory: responsible for uRWELL technology and test beam data
 - INFN Ferrara/Torino and IHEP (Beijing): tracking and ML development