

SAND Physics/Software WG

M. Tenti - Bologna

The Contributors

Paolo Gauzzi	Sapienza/Roma1	Valerio Pia	Bologna
Grigory Vorobyev	JINR	Giulia Lupi	Bologna
Artem Chukanov	JINR	Gianfranco Ingratta	Bologna
Paolo Bernardini	Lecce	Valentina Cicero	Bologna
Antonio Surdo	Lecce	M. Tenti	Bologna
Francesca Alemanno	Lecce	Matteo Sorbara	Roma2
Denise Casazza	Ferrara	Antonio Giosiosa	Roma2
Riccardo D'amico	Ferrara	Lea Di Noto	Genova

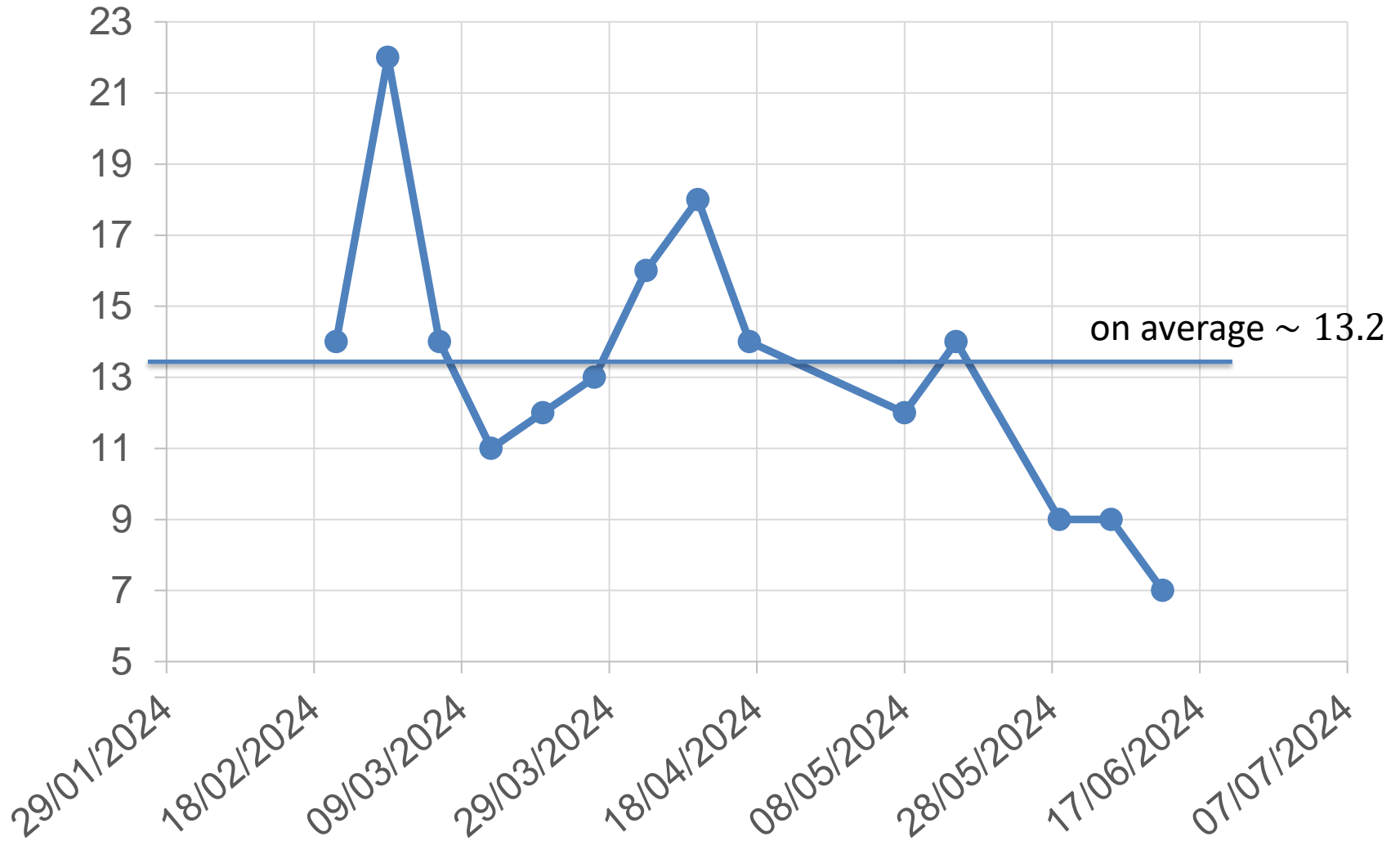
16 people in total

ECAL clustering + PID w/ ECAL	Kalman Filter	Kalman Filter w/ GENFIT	H sample w/ fast reco	Straw -VS drift- based tracker	Event reconstruction	CAF	Integration
D. Casazza R. D'amico P. Gauzzi	V. Pia G. Lupi	A. Chukanov G. Vorobyev	G. Ingratta	M. Sorbara A. Gioiosa	P. Bernardini A. Surdo F. Alemanno	L. Di Noto	M. Tenti

Meetings

- Starting from 21/02 we have regular weekly meetings
- A shared google docs is used to take notes [[here the folder](#)]
- Meetings are recorded [[here the folder](#)]
- A list of action items is produced and checked during the meeting
- Notes, video and action items can be found in the corresponding indico agenda

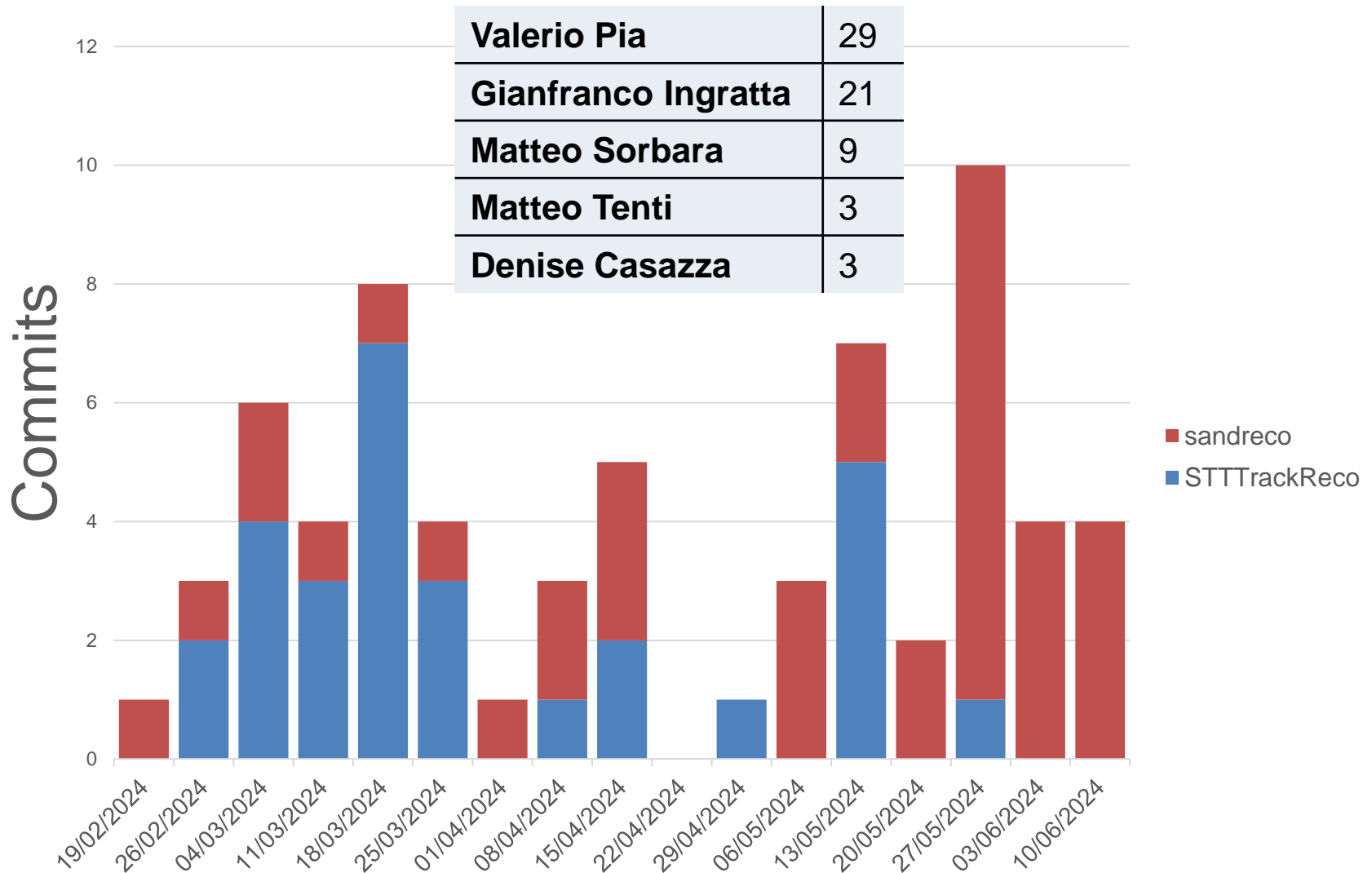
Participants



SAND in DUNE

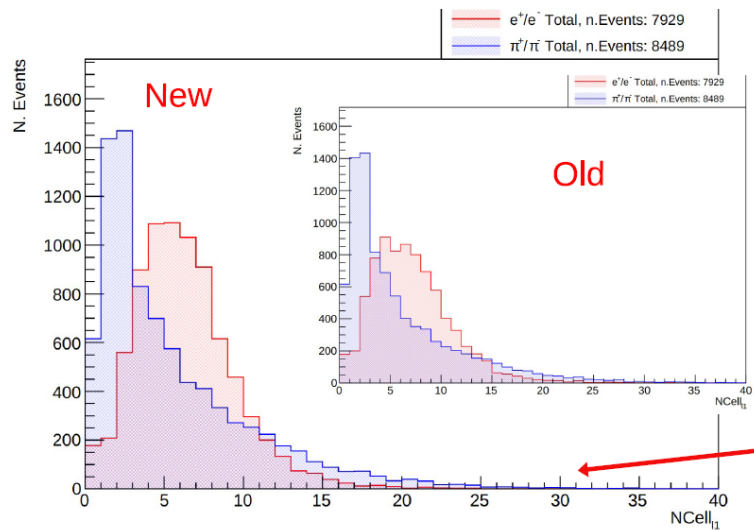
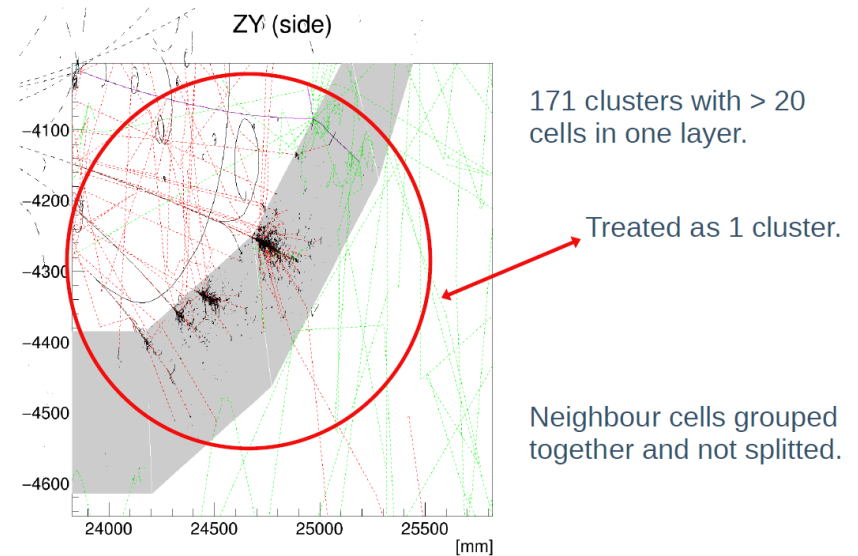
- SAND needs to be much more integrated in the DUNE Collaboration
- We need liaison people
 - **NIUWG** : **missing**
 - Neutrino interaction uncertainties
 - **LBL** : L. Di Noto [Genova]
 - Long baseline oscillations
 - **ND sim/reco** : M. Tenti [Bologna]
 - ND simulation and reco
 - **BSM** : D. Montanino [Lecce]
 - Beyond Standard Model
 - **BIWG** : **missing**
 - Beam Interface

Activities on repositories



ECAL clustering and PID

- Main activities:
 - Validation of cluster algo
 - Integration in sandreco
 - PID studies

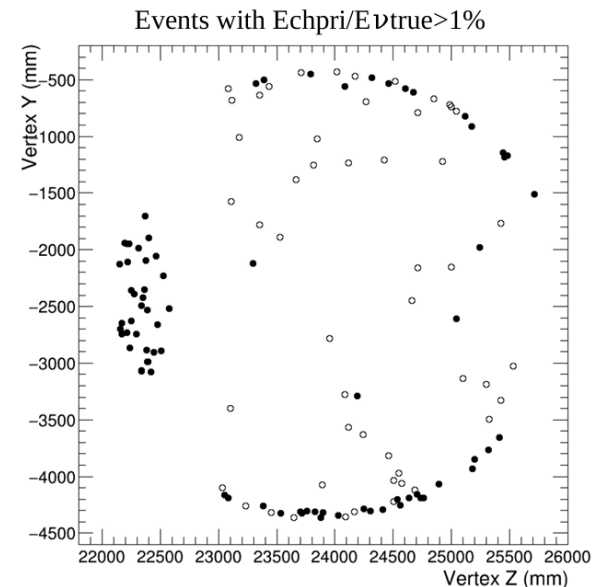
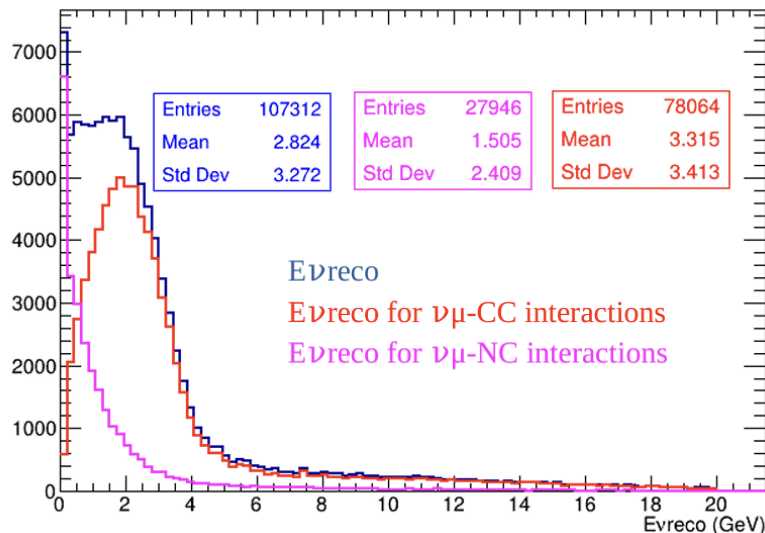


Some cells were counted more than once since those cells had multiple pulses.

Without duplicates the tail is reduced.

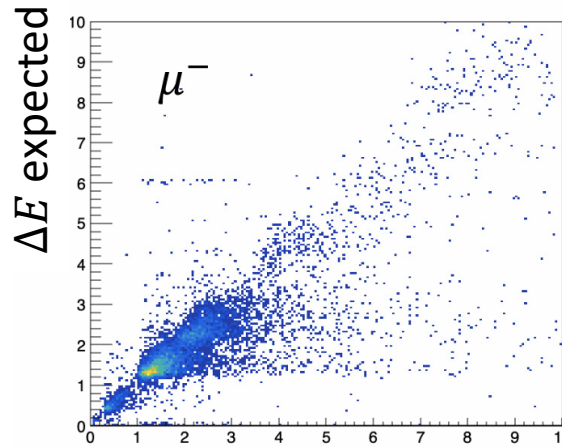
Event Reconstruction

- Reconstructed neutrino energy and vertex multiplicity were investigated
- Investigation on pathological null reconstructed neutrino energy events leads to find bug (waiting to be implemented in *sandreco*)

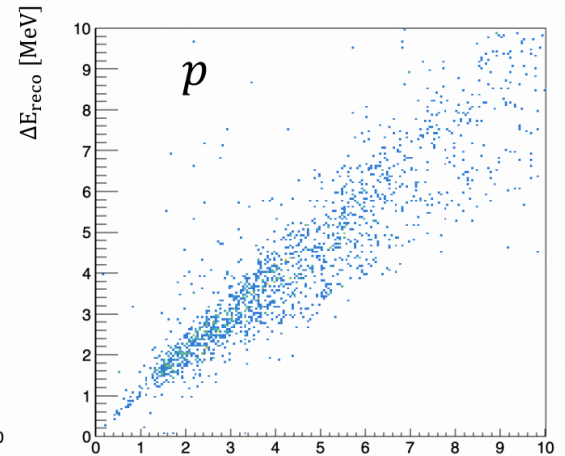


Kalman Filter

- Full **Bethe-Bloch** implemented
- Improved **MCS** expectation



ΔE true



ΔE true

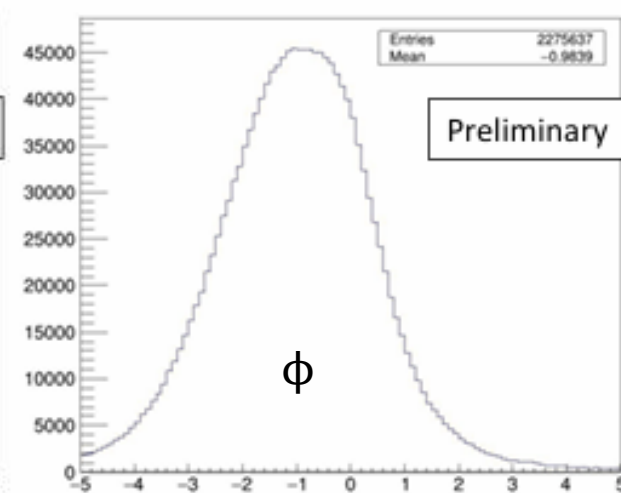
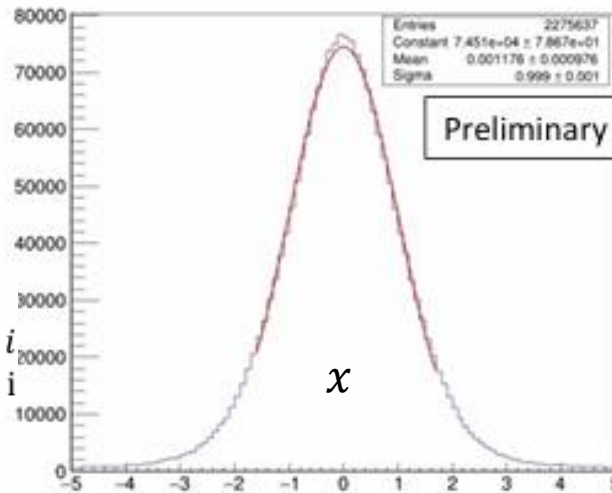
$$\prod_i \equiv \frac{v_i}{\sqrt{C_{ii}}} \sim \text{Gaus}(0, 1)$$

v = prediction - true

v_i = predicted element i - true element i

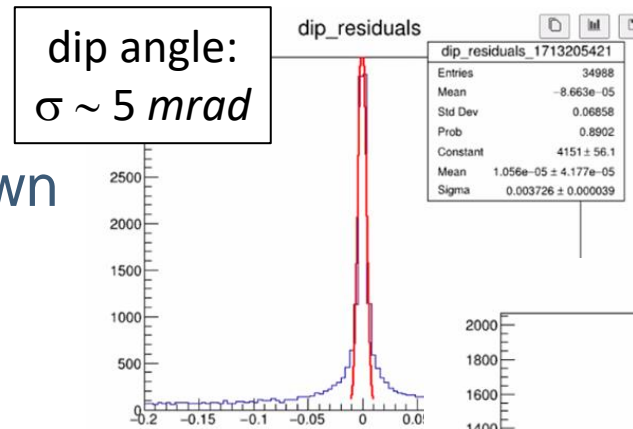
C_{ii} = diagonal covariance matrix element i

for μ

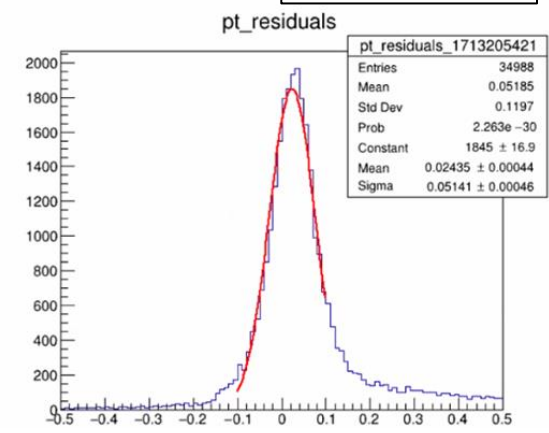


H sample w/ fastreco

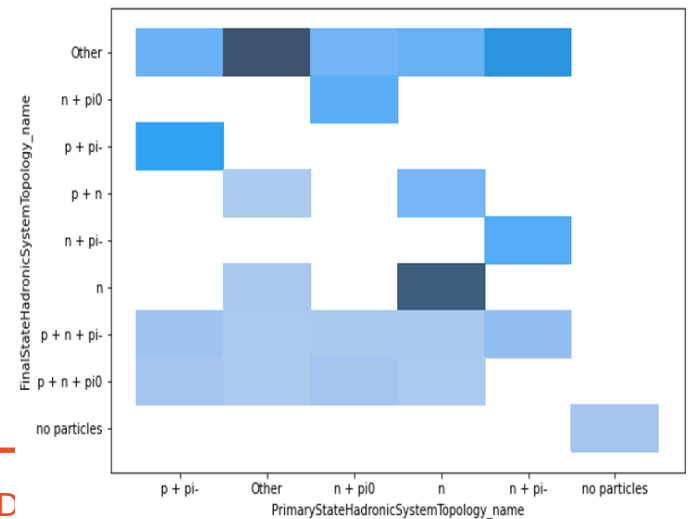
- GI is developing a fast reconstruction based on likelihood exploiting expected and reconstructed distances from wires (radii)
- A bug was found and fixed. Preliminary results were shown
- The next step is to redo H analysis ($\bar{\nu}_\mu + p \rightarrow \mu^+ + n$ channel)



$p_t: \sigma \sim 5\%$



First look at initial and final topologies



In addition

- **Rome2**: Matteo Sorbara and Antonio Gioiosa are working on the straw- vs drift- based trackers comparison
- **CAF**: Lea Di Noto works on SandRecoBranchFiller to correctly fill the variables in SANDStdRecordObject.
Two steps strategy: first integration with duneanaobj and, secondly SAND-wide discussion on the content
- Porting sandreco in **AL9** and **SPACK** is on hold
- **Integration** in ND sim/reco machinery is on hold

TDR

[Link](#) to the TDR status

Software and Computing

Section	Title	Contributor(s)	Status	Deadline	Notes
1	Code	Tenti	empty ▼	31/07/2024	
1.1	Repositories	Tenti	empty ▼	31/07/2024	
1.2	Code Formatting	Tenti	empty ▼	31/07/2024	
1.2	Code Documentation	Tenti	empty ▼	31/07/2024	
1.4	Continuous Integration	Tenti	empty ▼	31/07/2024	
2	Simulations	Tenti	empty ▼	31/07/2024	
2.1	Neutrino Fluxes	Chukanov	empty ▼		
2.2	Geometry	Ingratta	empty ▼	31/07/2024	
2.3	Event Generator	Tenti	empty ▼	31/07/2024	
2.4	Overlays	Tenti	empty ▼	31/07/2024	
2.5	Particle Propagation	Pia	empty ▼		
2.6	Detector Simulation	Tenti	empty ▼	31/07/2024	
2.6.1	Tracker	Ingratta	empty ▼		
2.6.2	GRAIN	Cicero + Pia	empty ▼		
2.6.3	ECAL	Casazza, + D'Amico + Gauzzi	empty ▼	31/07/2024	
3	Reconstruction (algorithm)	Tenti	empty ▼	31/07/2024	
3.1	Tracker	V. Pia	empty ▼		
3.2	GRAIN	Cicero + Di Noto + Martina	empty ▼		
3.3	ECAL	Casazza + D'Amico	empty ▼	31/07/2024	
3.4	Global event reconstruction	Surdo	empty ▼	31/07/2024	
4	Data Formats	Tenti	empty ▼	31/07/2024	
4.1	edepsim output	Pia	empty ▼		
4.2	Detector simulation output	Tenti	empty ▼	31/07/2024	
4.3	Reconstruction output	Tenti	empty ▼	31/07/2024	
4.4	Common Analysis Files	Di Noto	empty ▼		
5	Computing resources	Tenti	empty ▼	31/07/2024	
5.1	Data volume	Tenti	empty ▼	31/07/2024	
5.2	Data processing	Tenti	empty ▼	31/07/2024	
6	Visualization	Pia + Chukanov	empty ▼		
7	Integration	Tenti	empty ▼	31/07/2024	

Event Reconstruction

Section	Title	Contributor(s)	Status	Deadline	Notes
1	Single Particle Reconstruction		complete ▾		
2	Track reconstruction in GRAIN		empty ▾		
3	Two-dimensional fitting ("fast-fitting") of lens provided images (results)	Genova (?)	empty ▾		(Matteo V. work/GE)
1.1.2	Stereo reconstruction based on projective geometry (results)	De Matteis	empty ▾		
1.1.3	Voxel approach for direct 3D track reconstruction (results)	Cicero	empty ▾		
1.2	Track reconstruction in the Tracker (STT)		complete ▾		
1.2.1	Kalman Filter	Pia	empty ▾		
1.2.2	Helix 3D fast fit	Ingratta	empty ▾		
1.3	Muon Momentum and Angular Resolutions (from STT track)		complete ▾		
1.4	Electron Momentum and Angular Resolutions (from STT track)		complete ▾		
1.5	π^0 and γ Reconstruction in STT		complete ▾		
1.6	π^0 Identification and Reconstruction in ECAL		complete ▾		
1.7	Proton Reconstruction		complete ▾		
1.8	Neutron Detection		complete ▾		
1.9	K^0 and Λ^0 Reconstruction		complete ▾		
1.10	Momentum resolution and Tracker target configuration		empty ▾		
1.11	Acceptance and Thresholds for the Tracker		empty ▾		
2	Particle Identification		complete ▾		
2.1	Electron Identification in STT		complete ▾		
2.1.1	Optimization of the STT Radiators for e \pm Identification		complete ▾		
2.2	Electron Identification in ECAL ... (criteria/results)	Casazza	in prog... ▾		(docdb-13262 + Denise C.)
2.3	Proton Identification		complete ▾		
2.4	Muon Identification		complete ▾		
2.5	Muon/pion separation		complete ▾		
3	Neutrino interaction identification in the spill	Tenti	empty ▾	31/07/2024	
3.1	Expected Rates per Spill		empty ▾		
3.2	Event separation inside the spill		empty ▾		
4	Event Reconstruction in GRAIN		empty ▾		
4.1	Vertex reconstruction	Genova (?)	empty ▾		(Matteo V. work/GE)
4.2	Multiple track reconstruction	Genova (?) + De Matteis + Cicero	empty ▾		(Matteo V. work/GE) + Giovanni D.M. + Valentina C.
4.3	Energy deposit reconstruction	Pia	empty ▾		
4.3.1	Calorimetric approach		empty ▾	31/07/2024	
4.3.2	Track-by-track approach		empty ▾		
5	Tracker and ECAL acceptance for muons, protons, pions	Surdo	empty ▾	31/07/2024	
6	Event Reconstruction in STT		complete ▾		(docdb-13262 + ..)
7	Neutrino Energy Reconstruction in inclusive CC Events		complete ▾		
7.1	Neutrino interaction in STT		complete ▾		
7.2	Neutrino interaction in GRAIN		complete ▾		
7.3	Neutrino interaction in Upstream ECAL		empty ▾		

Section	Title	Contributor(s)	Status	Deadline	Notes
1	Selection of CC interactions	Surdo	complete ▼		
1.1	Kinematic Tagging of Leading CC Lepton	Surdo	complete ▼		
1.2	Selection of $\nu\mu$ & $\bar{\nu}\mu$ CC interactions	Surdo	complete ▼		
1.3	Selection of νe & $\bar{\nu}e$ CC interactions	Surdo	empty ▼	31/07/2024	
2	Measurements of $\nu(\bar{\nu})$ -Hydrogen Interactions	Surdo	empty ▼	31/07/2024	
3	Determination of Relative and Absolute Fluxes	Surdo	empty ▼	31/07/2024	
4	Constraining the Nuclear Smearing in Ar	Surdo	empty ▼	31/07/2024	
5	ν -e Elastic Scattering	Surdo	empty ▼	31/07/2024	
6	Coherent π^\pm Production	Surdo	empty ▼	31/07/2024	
7	$\nu e/\nu\mu$ & $\bar{\nu}e/\bar{\nu}\mu$ Flux Ratios	Surdo	empty ▼	31/07/2024	
XXXX	Low- ν Relative Flux	Surdo	empty ▼	31/07/2024	
8	On-Axis Beam Monitoring	Chukanov	empty ▼	31/07/2024	
8.1	Monitoring of the Beam Parameters	Surdo	empty ▼	31/07/2024	
8.2	Monitoring of the Beam Direction	Surdo	empty ▼	31/07/2024	
9	External Backgrounds	Surdo	empty ▼	31/07/2024	
9.1	Expected Rates per Spill	Surdo	empty ▼	31/07/2024	
9.2	Rejection of Random Neutron Background in $\nu(\bar{\nu})$ -H Interactions	Surdo	empty ▼	31/07/2024	
9.3	Rejection of Random Neutron Background in Inclusive $\nu(\bar{\nu})$ CC	Surdo	empty ▼	31/07/2024	
9.4	Rejection of Rock Muons and Magnet Events in Upstream ECAL	Surdo	empty ▼	31/07/2024	
9.5	Rejection of External Neutrino Interactions in STT	Surdo	empty ▼	31/07/2024	
9.6	Pile-up Background in Upstream barrel ECAL	Surdo	empty ▼	31/07/2024	

Thank you