Analysis status and strategy

Analysis and reconstruction meeting
06/09/2023

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Calibration status for different campaigns

Campaign	BM	VTX	MSD	TW	Calo	Alignment	Full MC
GSI 2021	✓	✓	Pedestal Eta function	Calibration Eloss/Tof ZID Threshold MC Positions along bar	-	✓	✓
HIT 2022	✓	✓	Pedestal Eta function	Calibration Eloss/Tof ZID Threshold MC Positions along bar	Calibration Threshold MC	✗	✓
CNAO 2022	✓	✓	Pedestal Eta function	Calibration Eloss/Tof ZID Threshold MC Positions along bar	Calibration Threshold MC	✗	✓
Full setup MC (12C_200_2023v2)	-	-	Eta function	ZID Threshold MC	-	-	✓
	Yun	Chris	Gianluigi, Lucia, Matteo F	Aafke, Esther, Marco, Matteo M, RobZ	Alessandro, Francesca, Piergiorgio	Yun	Giuseppe, Silvia

- What else is missing? BM/VTX?
- In MSD with eta function also ZID, position along the bar and the threshold for MC would be possible

Strategy

- In order to have a ready machinery for XS we need to have under control for each detector and for global tracking (and for each campaign):
  - Study the performaces of local (each detector) and global reconstruction
  - Efficiency, purity and resolutions for local and global reconstructed quantities
  - Comparison of the same quanties with data
  - Introduce systematics for local and global reconstructed quantities (sys on the geometry due to uncertanties in detector position, on tracking, clustering, ZID and mass identification, and so on…)
  - Background rejection through global reconstruction (efficiency and systematics) vs background subtraction→ (how many physics and background events)
  - Combinatorial background
  - In most of the cases such things have to be done in bin in which we want to perform the measurement (theta, beta, ekin) so this means also take under control migration between bins --> implement an unfolding procedure

Performances, data/MC comparison

	BM	VTX	MSD	TW	Calo	Global Tracking
Performances, data/MC comparison	• Track Efficiency (Data/MC) and Purity • Residuals/Pulls • Noise Data/MC ?	• Clustering, tracking and vertexing • Efficiency and Purity for each Z in angukar bins • Residual/Pulls for each Z • Cluster size for each Z (data/MC) • Efficiency wrt sensor position (Data) • Noise Data/MC ?	• Efficiency and Purity for cluster and points (and tracks) for each Z • Resolution in cluster and point position • Cluster size for each Z (data/MC) • Noise Data/MC ?	• Efficiency and Purity for TW points for each Z • Resolution in Eloss, Tof and Position for each Z • CMM • Eloss, Tof and position along the bar for each Z (data/MC)	• Efficiency and Purity for clustering for each Z • Kinetic energy and position resolution for each Z (data/MC)	• Efficiency and Purity for each Z and A in angular and kinetic energy bins • Residual/Pulls for each Z • Comparison data/MC glb trk outputs • Resolution in angle, Ekin, Momentum, Mass
Status	done	In progress	In progress	done	In progress	In progress
People	Yun	Chris, Giacomo U	Leonello, Benedetto, Yun	Marco	Alessandro, Francesca	Roberto Z / Matteo F

- Systematics for local systems and global reconstruction need to be studied and introduced in shoe

Analysis status

Campaign	MC analysis: Closure test (Efficiency, Purity, background rejection)	MC analysis: unfolding	Systematics	Raw Data analysis	Calo matching	Physics
GSI 2021	No track: Riccardo Tracking: Giacomo U.	No track: Riccardo Tracking: Giacomo U.	No track: Riccardo Tracking: Giacomo U.	Pile-up, efficiency (VTX, MSD, BM), Fragmentation trigger, angular distribution, data/MC analysis for different detectors, …	-	• O+C @400MeV/u direct • O+C2H4 @400MeV/u direct • O+C,C2H4 @ 200MeV/u direct, indirect
HIT 2022					Mass spectra: Alessandro, Francesca, Tino	He+C @ 100, 140, 200, 220 (direct XS)
CNAO 2022						C+C @ 200
Full setup MC (12C_200_2023v2)	RobZ			-		C+C @ 200 (Z and A)

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HIT 2022	GSI MC studies are easily extended to HIT and CNAO 2022 campaigns				Mass spectra: Alessandro, Francesca, Tino	He+C @ 100, 140, 200, 220 (direct XS)
CNAO 2022						C+C @ 200
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Data taking CNAO 2023

- **Not ready for a full reconstruction, anyhow**
  - Beyond the plots on-line on our DAQ:
  - Each detector expert can think to additional plots useful to debug things during data taking and have them ready on the shoe output histos (maybe the same of the QC implemented by Chris + more?)
  - RobZ will show in his presentation that glb trk is already partially possible with a Z guess from TW not good→ event display can be used to see glb tracks [spoiler 1]
- **From reconstruction point of view:**
  - It could be useful to further investigate about the backgroung impact (Giacomo U analsyis shows some nice results) and the compromise with the needed statistics
  - Preliminary Rob Z results already show good mass separation (resolution of some detector already included). This provides an indication about SC-TW distance [spoiler 2]


come fai..SBAI

Data available and analysis tasks

- **GSI2021 data**: ^{16}O+C,C_2H_4 → physics runs with VTX-MSD (most of the 400 MeV/u data), runs without VTX (most of the 200 MeV/u data), essentially no calo-> elemental fragmentation cross section in theta/beta bins
- **HIT2022 data**: ^{4}He (@ 100, 140, 200, 220 MeV/u) and p beams → good for calorimeter and MSD. Mass spectra with TW/calo calibration. Cross section for ^{3}He production and p, d and t.
- **CNAO2022 data**: C + C @ 200 MeV/u and p beams → if calo calibrated mass identification and corresponding cross sections. Need to wait for calib/config files from detector groups
- **Full / partial setup MC analysis**

Work in progress for the Analysis

- **Analysis working group:**
  - First milestone: to have as soon as possible a full reconstruction "under control" able to produce cross sections and verify them with a MC closure test.
  - At this moment FOOT doesn't know what is the precision it can reach in measuring MC cross section (and for data will be worse)
  - Ongoing analysis for GSI2021 data→ talks of Riccardo and Giacomo (Ubaldi)
- **TW working group:**
  - Matteo/Esther -> studying thresholds and resolutions for GSI 2021 campaign -> talk today
  - Aafke -> taking care of TW calibration @ CNAO2022 -> talk today
  - Tino/Miriam -> taking care of TW calibration @ HIT2022 -> talk today
  - RobZ-> Already provided positions calibrations for all campaigns -> talk today
  - me -> taking care of TW reco in shoe and fix/update in order to have performance plots ok for every campaign

Work in progress for the Analysis

- **CALO working group:**
  - CALO guys provided calibration @ CNAO and HIT 2022 -> talk today
  - Alessandro/Francesca/Tino candidate for TW-calo match for HIT2022 to produce mass distributions (following calo and TW calib)
- **MSD working group:**
  - Matteo/new master student-> new clustering + eta function @ HIT2022
  - Leonello/Benedetto -> MSD efficiencies with protons @ Trento
  - Gianluigi/Lucia -> working on pedestals @ HIT2022 → talk today
  - Tino -> efficiencies @ HIT2022
- **MC group:**
  - Giuseppe and Silvia produced all the MC campaigns relative to data taking and full setup

Work in progress for the Analysis

- **BM:**
  - Yun is working on improvement of BM tracking algorithm -> talk today
- **SC:**
  - Giacomo already made everything working :)
- **VTX:**
  - Giacomo Ubaldi with Chris supervision is taking care of studying VTX algorithm performances –> talk today
- **Glb tracking:**
  - Rob, Giacomo Ubaldi and Matteo studying performances of Glb tracking and methods to reject bkg -> talk today