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Analysis and Reconstruction tasks

Our ideal world

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What are the goals of this group

- Need of a working group (you 😊) to make an effort to have "soon" a full reconstruction able to produce MC fragmentation (double) differential cross section and verify them with a MC closure test.
- Having a solid machinery is mandatory for:
 - Ongoing data analysis
 - Future data taking in order to be prepared to what we want and can measure, how do it, optimize the geometry setup (TW-SC distance, VTX and MSD distances ecc), know how many physics, background data are needed to obtain a cross section with a known statistical uncertainties, in order not to decide it on the spot during the beam time
- 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). And I'm speaking for the moment only of direct fragmentation cross sections

What is needed?

- MC studies for (MC with primaries included, no more biased MC):
 - Full setup (to know the FOOT final performances)
 - Data taking setups (to know the FOOT current performances for data analysis)
- In order to have a ready machinery for XS we need to have under control (fast list):
 - Resolutions of all local and global reconstructed quantities
 - Comparison of the same quantities with data
 - Efficiency and purity for local and global reconstructed quantities
 - Background rejection through global reconstruction (efficiency and systematics) vs background subtraction → (how many physics and background events)
 - Combinatorial background
 - Introduce systematics for local and global reconstructed quantities (these systematics will be added to the ones coming from experiment) → sys on the geometry due to uncertainties in detector position, on tracking, detector clustering, Z and mass identification, and so on...
 - In most of the cases such things have to be done in bin in which we want to perform the measurement (theta, beta, e_{kin}) so this means also take under control migration between bins --> implement an unfolding procedure

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Be careful:

- Starting to do MC reco/true comparison, MC/data comparison and introducing systematics there is the risk to enter in infinite loops to have the best agreement
- This should be avoided keeping in mind what are the goal precision, let's keep small effects (small means $<$ of our stat uncertainty) out or put them at the end of the list.
- Let's concentrate our effort on the bigger one first :)
- Somehow systematics will drive the needed statistics during data taking and vice versa statistics will set a limit to the study of our systematics

The workflow (suggestion)

- Let's understand what everyone of us is doing and what is going to do and divide between us some of the listed tasks.
- Some of the things listed have been done and implemented in shoe some of them are done and not implemented yet and some other are completely missing.
- People involved in this group are already working on high level analysis (G.Ubaldi, Riccardo) and some other guys like Giuseppe, Ilaria and Yun are looking at the output of the final reconstruction. Others are going to join this job (Giacomo)
- Starting from their output we can discover problems at global and local level and so ping the involved people.
- Usually local reco has been done by hardware expert of a given detector. We can ping them to fix problems on their detector reconstruction and when/if needed some people of this group can provide their help support for some local reconstruction task (see for example calo clustering and MSD eta-function)

The data and experimental effects

- People involved in doing global and local analysis can spot and study experimental effects (dead time, pile-up, high rates effects, detector alignment, DAQ and detectors problems during the acquisition, lost of information for some detectors, VTX synchronization, detector efficiency, TW efficiency to protons and so on...)
- Big effort of the collaboration on this side due to the many data campaign of last months and a lack in the reconstruction work that now can be filled
- Usually detector expert analyze data of their detector. Again people doing global analysis in this group can spot problem, missing config/calib/map file needed in shoe for local detector reconstruction and ping the experts

Data available and analysis tasks

- **GSI2021 data:** $^{16}\text{O}+\text{C}, \text{C}_2\text{H}_4 \rightarrow$ 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 \rightarrow elemental fragmentation cross section in theta bin \rightarrow G. Ubaldi for 400 MeV/u
- **HIT2022 data:** 4He and p beams \rightarrow good for calorimeter and MSD. If calo can be properly calibrated cross section for ^3He production and p, d and t if TW efficiency under control
- **CNAO2022 data:** C and p beams \rightarrow if calo calibrated mass identification and corresponding cross sections. Need to wait for calib/config files from detector groups
- **Full / partial setup MC analysis**



