Draft -1 of our DDCS paper

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FOREWORD

- our INFN referees asked for a paper on DDCS in order to "unlock" the INFN funds.
- this paper is DUE by next february

We have to focus ourselves in getting this measurement published ASAP. Effort from ANYONE is crucial to have this done in due time.

Our publications current situation

- Updated info in
  - http://wiki.gsi.de/cgi-bin/view/FIRST/FirstPapers
- What have we published so far:
  - IR detectors: "Performance of upstream interaction region detectors for the FIRST experiment at GSI, 2012" on JINST
  - FIRST experiment: "The FIRST experiment at GSI" on NIM
- Proceedings
  - V. Patera, Simulation: Nuclear physics experiment for hadrontherapy application
  - B. Golosio, Proceedings of IEEE.
  - T. Bohlen, In preparation: contribution to latest Varenna conference.

The measurement

- What are we going to publish first? For both C-C and C-Au
  - Total X section (integrated in energy/angle)
  - SDCS ds/dE and ds/dθ and DDCS measurements
- Strategy proposal:
  - Divide the measurement in two acceptance regions: VTX + ToF (a) and VTX + Kentros (b). a: θ < 97 mrad , b: θ > 81 mrad. I will call them LA [large angle] and SA [small angle] in the following.
  - Use the region in BTW (θ btw 80 and 97 mrad) to compare results....
- Definition proposal (integration in E or θ is trivial):

$$\frac{d\sigma_i}{dE,d\theta} = \frac{Y_i}{N_{^{12}C} \times N_{t,S} \times BW_E \times BW_\theta \times \Omega(\theta) \times \varepsilon_{rec}(E,\theta) \times \varepsilon_{sel}(E,\theta)}$$

Will cover each term in the following slides.

Experimental Status

The experimental setup

- So far already discussed/outlined in other papers
  - NIM + BM,SC paper (I do not know if there are other "subdetector" papers in preparation)
  - Will refer to those in order to keep the paper as short as possible
- However lot of key points still not addressed
  - Next slides: review needed items for each detector
  - I propose an "editor/writer" for each subdetector that will have the duty of
    - collecting all the necessary info/plots/numbers
    - supervise the writing of a given tex file / section

It is important to keep this "section" as short as possible giving ONLY the info relevant for the paper! [understanding the efficiencies and the resolutions]

SC & BM

- SC: only key parameter is efficiency (that is already published elsewhere).
  - Will quickly refer to it
  - Need to think about adding a syst (but this is really a 2nd order problem)
- BM: key parameters are efficiency and resolution (already published elsewhere)
  - outline standalone tracking and report the VTX calibration procedure
  - Tracking efficiency procedure available: will be redone with latest tracking software + need to add a syst
    - Plot: stability plot
  - Resolution numbers already published: Xchk and refer to them

Material already available: START to WRITE!

VTX

- Little or nothing published (that I am aware of)
- Need to discuss/document
  - Purpose of detector, geometry: KEY detector for both measurements (<97 mrad and >81 mrad)
  - Tracking efficiency (Run stability, ε vs θ)
  - Track angle resolution (vs θ)
  - Vertexing efficiency and resolution (vs θ)
- I propose also introduce here the pileup and the matching with the BM as a Xchk (wrt standalone vertexing) to address the PU issue.
- Once final track reco is available should X-chk also the energy dependence of resolutions/efficiencies (I do expect a small effect)
- Strategy to evaluate systematic uncertainties has to be developed.

Most of material already available: START to WRITE!

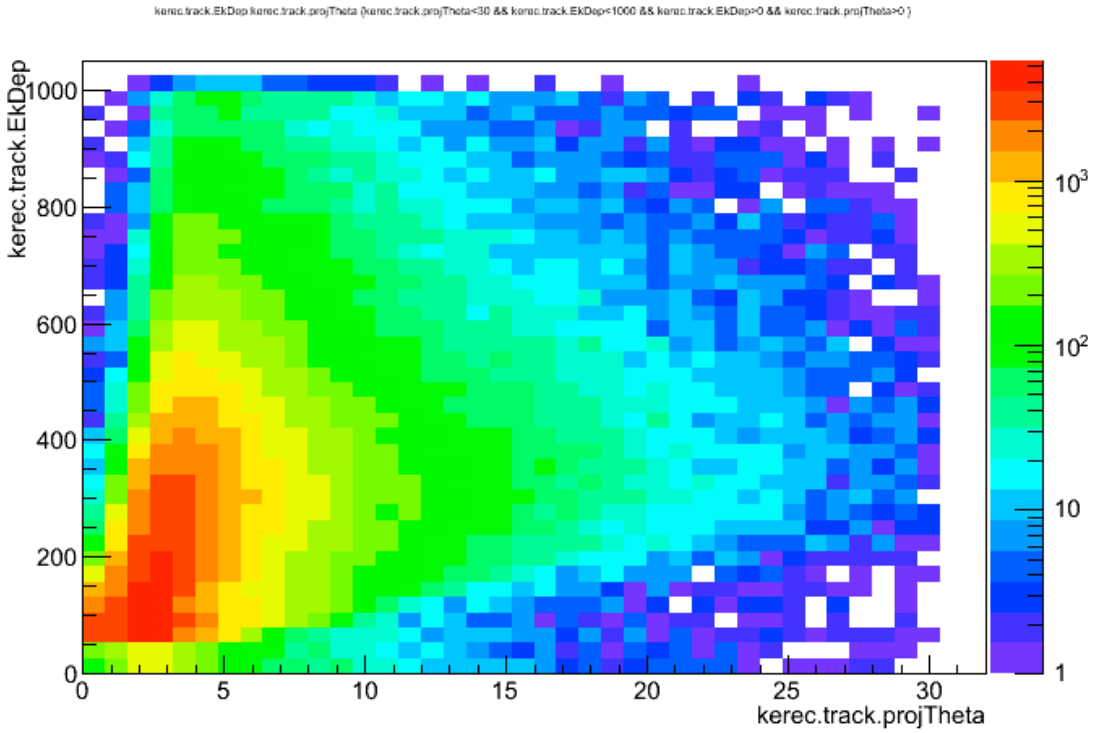
Kentros

- Little or nothing published (that I am aware of)
- Need to discuss/document
  - purpose of detector, geometry: key detector for >81 mrad (large angles)
  - Energy calibration: plot + stability vs run number
  - PID algorithm: ε and systematics related (Xfeed for p,a hypothesis)
  - Reconstruction efficiency (as a function of θ): from MC?
- Matching with VTX
  - Important to quantify a possible systematics
- Global reco code
  - Implemented the "reading" of Kentros objects inside HlReco package
  - Differences btw KE rec and trk objects?

kentros II

- My concern:
  - So far for the "Large Angle" analysis we're going to use the vtx for the angle BUT we need kentros for the energy. My feeling is that we are FAR away from a situation in which we are able to quote an absolute value for the Energy in kentros. So far we have aligned the modules but an absolute calibration is hard to obtain. Am I right?

How to link EkDep to the energy of the fragment?



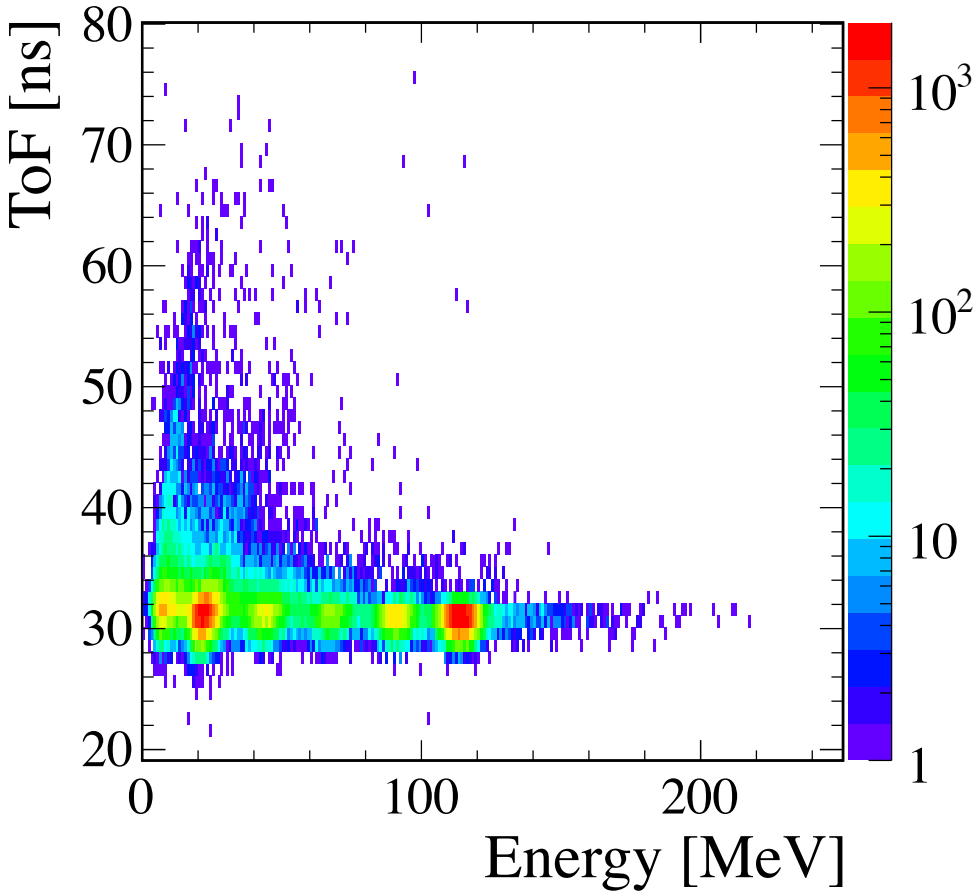
Magnet

- Here we probably need to spend few words on
  - how well we know the mag field map
  - B field scale with current
  - implementation in the global reconstruction

Most of material already available, it is going to be a pain (I know) to recollect everything.... but we can: START to WRITE!

Tof Wall

- Little or nothing published
- Need to document/publish
  - Calibration of the detector / stability vs run number
  - Hit/tracklet position, E, time resolution (stability vs run number, resolution vs E, θ)
  - Hit/tracklet reconstruction efficiency (vs E, θ)
  - PID algorithm efficiency and related systematics



DAQ / Global reconstruction

- Need to document/publish
  - DAQ, Trigger performances: key parameters entering directly the cross section measurements are the efficiencies. **Those are needed if we want to publish ABSOLUTE fragment fluxes**
- Global reconstruction
  - SA analysis: algorithm for global tracking (θ <97 mrad): forward tracking.
  - LA analysis: algorithm for VTX - kentros matching (θ >81 mrad)

Here, we probably want to pick up a nice fragmented event and publish it on the super duper event display that chris nicely assembled!

Data - MC comparison

- I think that also at some point we need to show that we know what we're doing with our MC
  - Our MC has to be described (referring to the NIM of course so I would keep it really short), outlining the key features needed for our measurements
  - Data - MC comparisons of the key quantities (such vtx tracks, Tof hits, etc etc) can be included in the paper:
    - Good candidates are of course the distributions that we use to asses the efficiencies....

Measurement

Impinging carbons, total part. on target

$$\frac{d\sigma_i}{dE,d\theta} = \frac{Y_i}{N_{^{12}C} \times N_{t,S} \times BW_E \times BW_\theta \times \Omega(\theta) \times \varepsilon_{rec}(E,\theta) \times \varepsilon_{sel}(E,\theta)}$$

- The total number of impinging carbons ($N_{^{12}C}$) will be measured from:
  - Scaler info. Carbons will be counted from SC triggers and corrected for SC efficiency.
  - Dead time is covered (next slides) by ε_{DAQ} and it is needed only for absolute fluxes.
- N_t is the number of nuclei of the C and Au target(s)
  - What uncertainty do we quote on that?

Binning

$$\frac{d\sigma_i}{dE, d\theta} = \frac{Y_i}{N_{12C} \times N_{t,S} \times BW_E \times BW_\theta \times \Omega(\theta) \times \varepsilon_{rec}(E,\theta) \times \varepsilon_{sel}(E,\theta)}$$

- The choice of the binning will be done once we have the Energy and Angle distributions
- Key parameters are:
  - Energy resolution:
    - For ToF wall: to be estimated from MC studies, dominated from momentum resolution from "track-scanning" procedure [forward tracking].
    - Matching with "released on slat" energy can be possibile: large systematics associated?
  - Angle resolution:
    - Coming from VTX, to be evaluated on MC. A resolution as a function of theta should be studied and also an estimate of the relative systematics has to be given.

Angular acceptance

$$\frac{d\sigma_i}{dE, d\theta} = \frac{Y_i}{N_{^{12}C} \times N_{t,S} \times BW_E \times BW_\theta \times \Omega(\theta) \times \varepsilon_{rec}(E,\theta) \times \varepsilon_{sel}(E,\theta)}$$

- The angular acceptance will be measured from MC simulations
  - depending on the track angles
- Systematics will be assessed by generating different geometries (in the MC) varying the known positions of the detectors within the known uncertainties

Reconstruction efficiency

$$\frac{d\sigma_i}{dE, d\theta} = \frac{Y_i}{N_{12C} \times N_{t,S} \times BW_E \times BW_\theta \times \Omega(\theta) \times \varepsilon_{rec}(E,\theta) \times \varepsilon_{sel}(E,\theta)}$$

- The reconstruction efficiency $\varepsilon_{rec}(E,\theta)$ will be measured using MC events and is defined as N_{rec}/N_{tot}, where:
  - N_{rec} is the number of reconstructed fragments for a given Energy (measured in ToF or Kentros) and Angle (measured by VTX)
  - N_{tot} is the total number of fragments produced in the target
- A definition of what is "reconstructable" in our detectors is needed to define such efficiency: here I do need input from kentros, vtx and tof experts!
- The ε_{rec} efficiency needs to be split up for the two measurement regions, and a plot as a function of θ and E will be needed

In order to evaluate the efficiencies it is crucial that a DATAlike processing of the MC is implemented ASAP, defining "reconstructable" criteria.

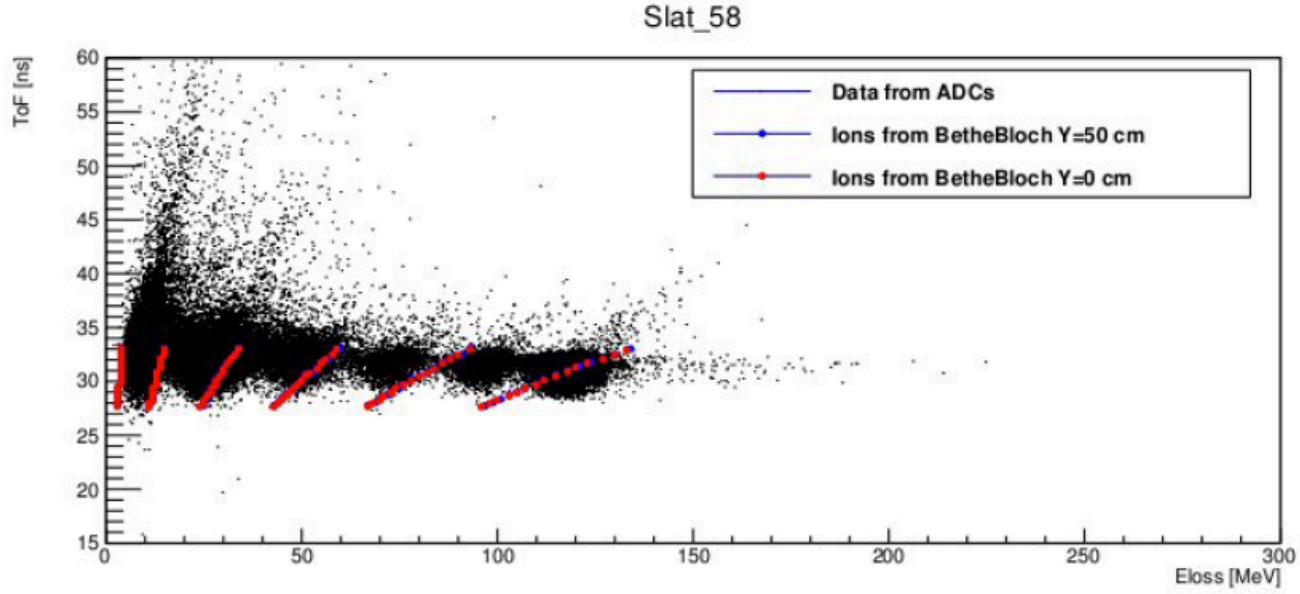
MC matching

- Currently the MC matching with our MC is not possible:
  - The track block contains only "origin" info for each particle. Such info are not updated at each interaction with the various subdetectors unless a new particle is generated.
  - We need thus to propagate the needed info (already computed in our MC) directly from the scoring routines.
- I am currently implementing the necessary changes (discussed together with Till) in the code in order to enable the MC matching at processing level (either L0 or high level)
  - This requires few changes in order to be able to dump the relevant info being able to "navigate" back to the track block that contains the relevant info for each track in fluka.
- I hope to release such code next week.

Selection efficiency

$$\frac{d\sigma_i}{dE, d\theta} = \frac{Y_i}{N_{^{12}C} \times N_{t,S} \times BW_E \times BW_\theta \times \Omega(\theta) \times \varepsilon_{rec}(E,\theta) \times \varepsilon_{sel}(E,\theta)}$$

- The selection efficiency accounts for all the PID/selection cuts applied on the already reconstructed tracks. Once we have matched the tracks:
  - we need to assign to it a given "particle specie" (AKA charge): this particle ID has a given efficiency and a given systematic uncertainty
  - Not all the tracks matched are used: we can imagine to use refinement cuts on the already IDentified fragments ….. For this additional selection we have to foresee a computation of the efficiency and the related syst.

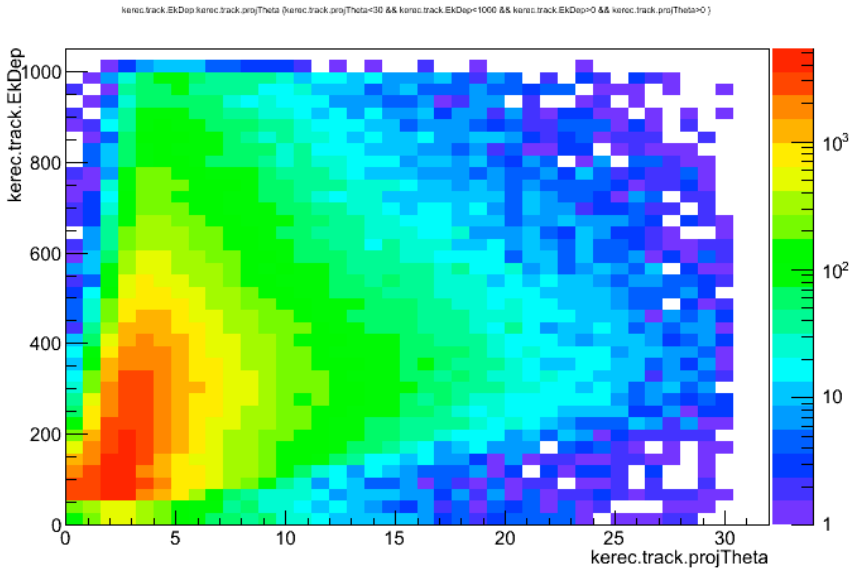


Yields

$$\frac{d\sigma_i}{dE,d\theta} = \frac{Y_i}{N_{^{12}C} \times N_{t,S} \times BW_E \times BW_\theta \times \Omega(\theta) \times \varepsilon_{rec}(E,\theta) \times \varepsilon_{sel}(E,\theta)}$$

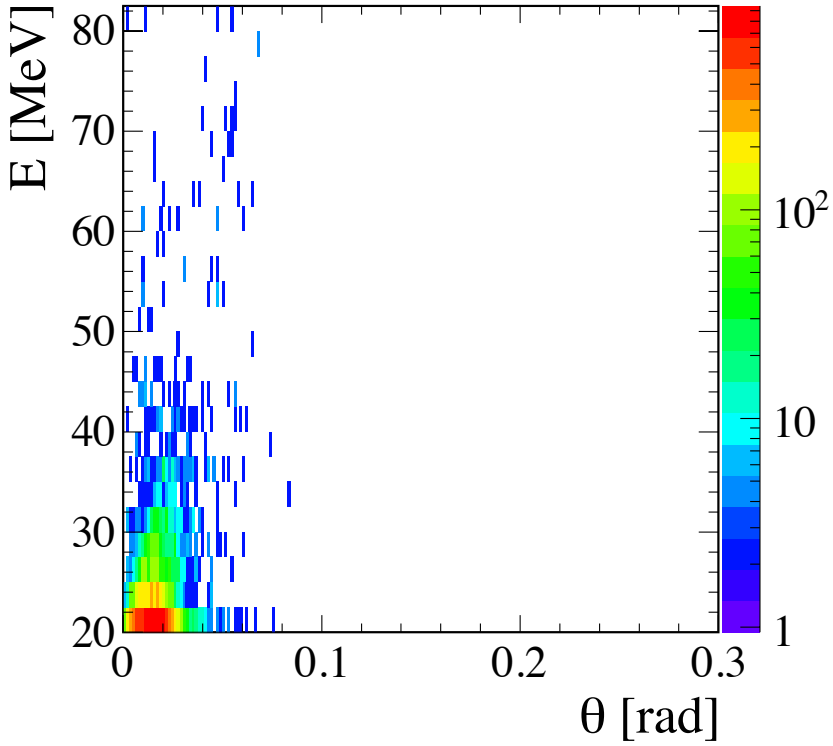
- The final yields will be extracted from a plot like..

All runs together.



LA angle analysis....

SA angle analysis....



The paper

Title + Abstract + Conclusions

- What is the best Journal to be targeted?
  - For now example under PMB, but open for suggestions
- To be updated once we do have our final results
- Author list to be checked
- Abstract to be written + keywords
  - File to be edited: Main.tex

Writers Proposal: V. Patera and S. Leray

Experimental setup

2. Experimental setup

- 2.1 IR: SC and BM
  - 2.1.1 Start Counter Detector
  - 2.1.2 Beam Monitor Detector
- 2.2 IR: VTX
  - 2.2.1 Matching with BM
- 2.3 IR: Kentros
  - 2.3.1 Kentros Calibration
  - 2.3.2 Kentros PID and reconstrction efficiency
- 2.4 Aladin Magnet
- 2.5 Tof Wall
- 2.6 Trigger and DAQ
- 2.7 DAQ, Trigger performances
- 2.8 Global Recontruction
  - 2.8.1 Forward tracking: VTX and Tof
  - 2.8.2 Large angle tracking: Kentros and VTX alignment

Each section has an independent tex file in the software project

2

```
%% V. Patera S. Leray
\abstract{Hadrontherapy is coool.}

\keywords{Hadrontherapy; carbon ion beam}

\begin{document}

%% V. Patera S. Leray
\input{introduction}

%% A. Sarti
\input{exp_setup}

%% A. Sarti
\input{scandbm}

%% C. Finck
\input{vtx}

%% B. Golosio
\input{kentros}

%% V. Monaco
\input{aladin}

%% R. Introzzi
\input{tof}

%% V. Monaco
\input{daq}

%% A. Sarti
\input{global_reco}

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% V. Monaco && T. Bohlen
\input{mcsimu}

%% A. Sarti
\input{crossection}
```

Measurement

Plan

- **A first version (draft 0) of the paper should be ready WITH WHAT WE HAVE by next coll. meeting in december**
- "editors" for each chapter/section have to be found ASAP in order to start the material organization-recollection
- paper is available under first svn project in folder first/paper/trunk
  - Browse it using trac: https://subversion.gsi.de/trac/first
  - Dowloading using svn (see instructions in FirstPapers wiki at GSI, http://wiki.gsi.de/cgi-bin/view/FIRST/FirstPapers)
  - To contribute (commit a file) you need to have proper rights/gsi computing account: i can give you the rights ONCE you have the gsi account.

Technicalities

- Figures should go in figs/ folder
- Suggestion: while editors collect material/text please update the twiki pages in such a way that we also have a reference among ourselves for talks/presentations in the future:
  - http://wiki.gsi.de/cgi-bin/view/FIRST/DataAnalysis (very nice example is TriggerReconstructionSoftware topic)
- I have provided a ROOT macro (firstStyle.C) that I recommend to use in preparing plots for the paper: PLEASE USE IT
  - examples on how to use it are given in figs/AdvertiseTof.C
  - To run the demos: "root -b -q AdvertiseTof.C": you need the totalhisto_v38.root file downloadable from /lustre/bio/first/