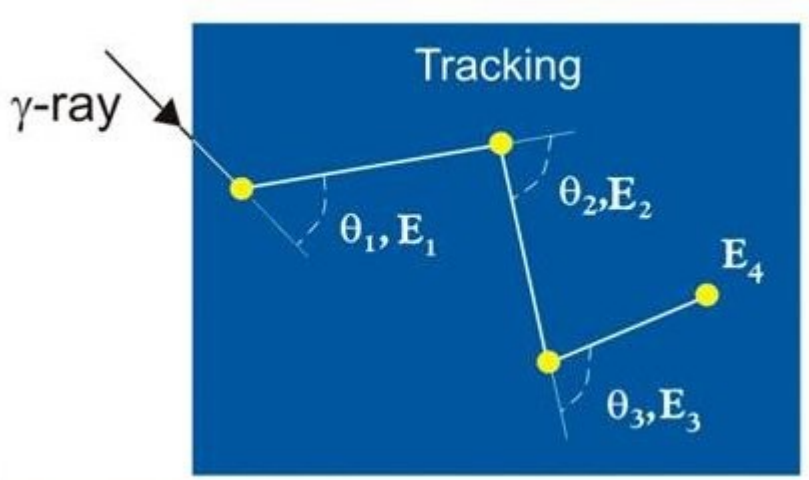
The GRETINA tracking code

- Intro, 'review'
- How to use
- Few new developments:
- efirst function
- elast function
- Pipe data

Torben Lauritsen, ANL
Amel Korichi, CSNSM

Tracking 101: determining the interaction sequence and how 'good' a gamma ray is



Cluster, then find interaction sequence

Evaluate scattering angle

<–> energy consistency with

the Compton scattering formula:

$$E'_\gamma = \frac{0.511}{1 + \frac{0.511}{E_\gamma}(1 - cos(\theta))}$$

FOM < ~0.6-0.8
considered GOOD

FOM > ~0.8
considered BAD
(Compton events)

The GT

Not the only one possible

$$FOM = \frac{\sqrt{\sum_i (\theta_i^{theo} - \theta_i^{obs})^2}}{n_i - 1}; n_i > 1$$

(in rad)

Note: Single interactions cannot be tracked

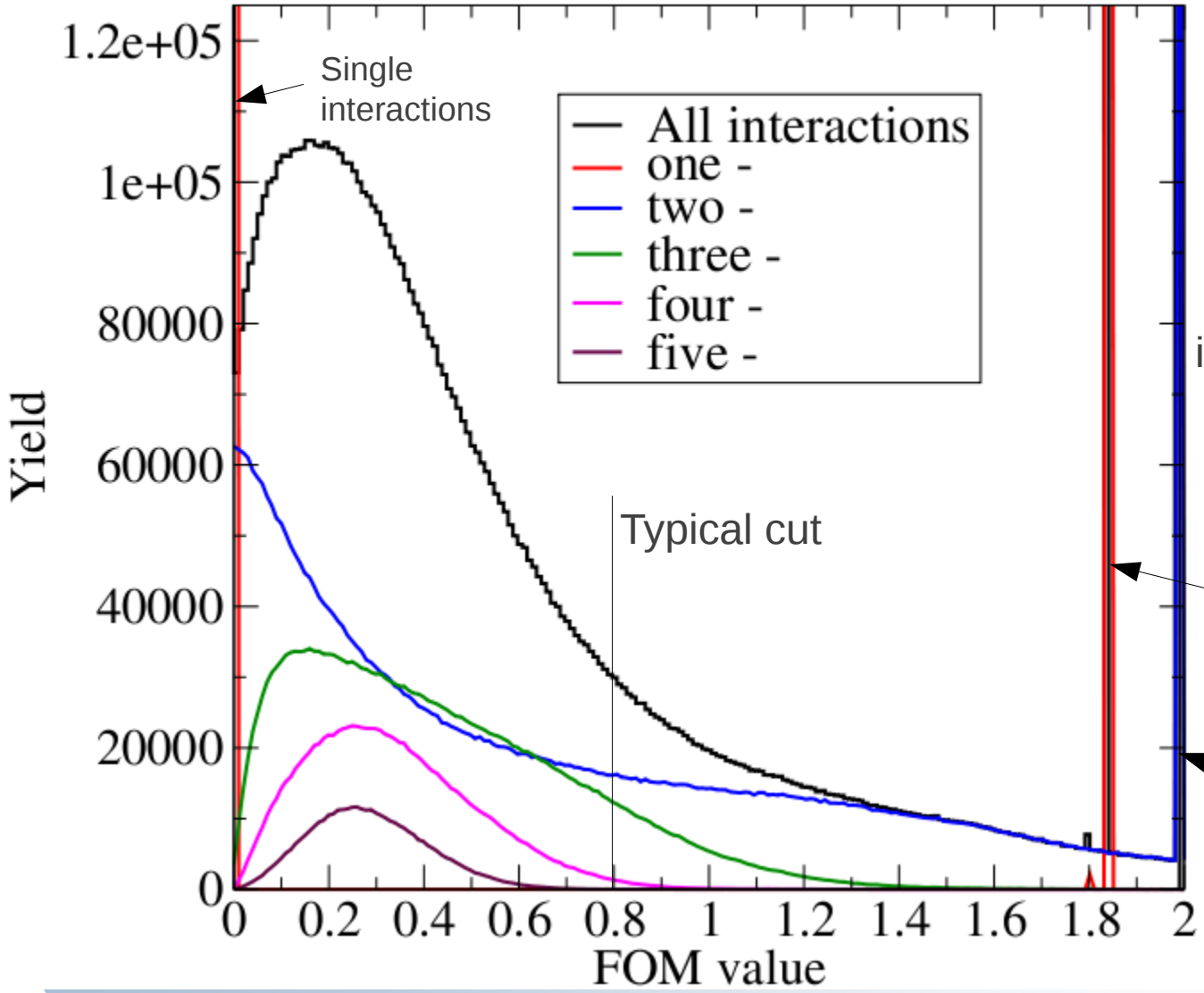
1: We find the interaction sequence

2: We evaluate how 'good' the gamma rays is

(BTW: We re-scale to CC energy before tracking)

FOM: ***a measure of how well the interaction angles and interaction energies follow the Compton scattering formula for the interaction points in a gamma ray.***

Typical spectrum of FOM values:



Typical FOM cut: 0.8 (up to the user to choose)

Automatically, preferentially cut two interaction gamma rays

Over range single interactions

overflow

ALWAYS
You have to choose:
good P/T or good efficiency
or
A compromise for the data at hand

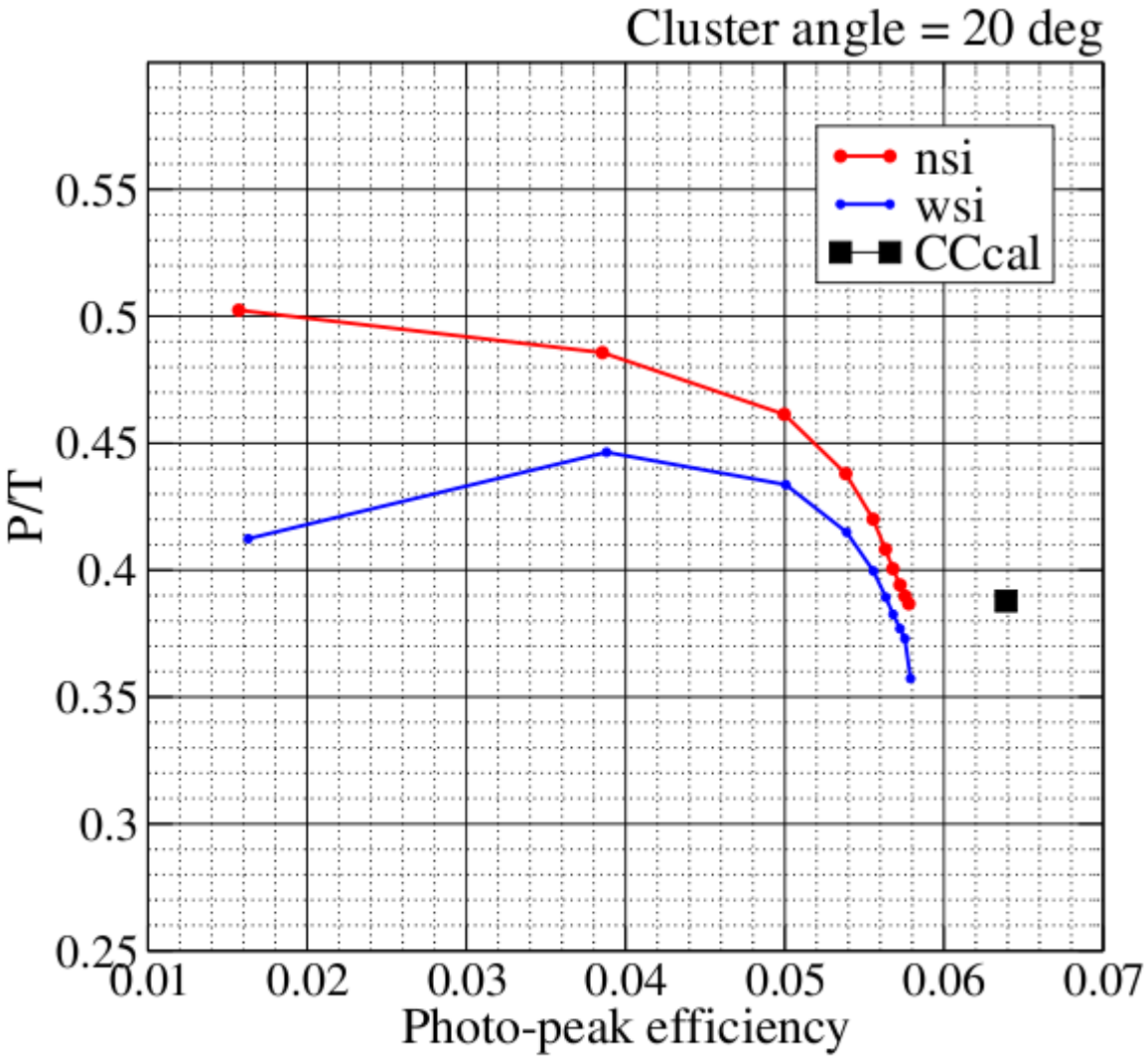


Figure 6: The (P/T) ratio vs. photopeak efficiency curves for GRETINA (ANL setup), with 7 closed-packed modules, when a clustering angle of 20° is used. The lower curve includes single interactions (wsi) and the upper curve is obtained without these interactions (nsi).

Selected Chat file options:

```
./trackMain \
 track_GT.chat  \
 GTDATA/mode2.dat  \
 GTDATA/mode1.gtd > GTDATA/trackMain.log
```

BTW: We can handle AGATA data too!

```
dtwin          30
target_x 0
target_y 0
target_z 0
CCcal CCenergy.cal
useCCEnergy
clusterangle   1  20
clusterangle  30  20
enabled "0-180"
trackingstrategy 1 0
trackingstrategy 2 0
trackingstrategy 3 0
trackingstrategy 4 0
trackingstrategy 5 0
trackingstrategy 6 5 ggtttt
trackingstrategy 7 5 gggtttt
trackingstrategy 8 5 gggttttt
```

(10 nsec units)

GTAG1

```
recluster1   0.01  0.1  3 10  0.90
nprint 20
singlehitmaxdepth 23 1.9 18.5 1.0
0.000 0.59
.
.
8.000 10.17
10.00 10.01
16.3  20.0
```

There are many more options!
Here we just show the basic ones.

We add mode1 data to the mode 2 data!!!!

Some functions in ANL tracking code

- Single interaction range [GTAG1]
- Splitclusters: try to split clusters that have a bad FOM into two gamma rays that have good FOMs. [SUMMED LINES!?]
- Combine clusters: try to combine that have bad FOMs into one gamma rays that has a good FOM
- Recluster: split gamma rays with bad FOM decreasing the clustering angle. [TBD: *can go the other way too*]
- Matchmaker: combine two single interaction gamma rays into one gamma ray with a good FOM [tricky!]
- PairProd: TBD

GTAG1

We can execute these functions iteratively until we have made the best out of the data we were given

The problem: ***sometimes we make the wrong call because the experimental data is not perfect (i.e., we accidentally destroy what were actually good gamma rays)***

What is new?

J. van der Marel and B. Cederwall. **Backtracking as a way to reconstruct Compton scattered gamma rays.** *Nuclear Instruments and Methods in Physics Research Section A*, 437:538, 1999.

> See if adding a penalty if the last interaction is not in the range from ~10 to ~300keV helps, [elast function]

I. Piqueras, F. A. Beck, E. Pachoud, and G. Duchene. **A probabilistic γ-ray tracking method for germanium detectors.** *Nucl.Instrum.Methods Phys.Res.*, A516:122, 2004.

> Add a penalty if the first interaction point does not have the largest energy deposite, if the energy is larger than ~500keV, [efirst function]

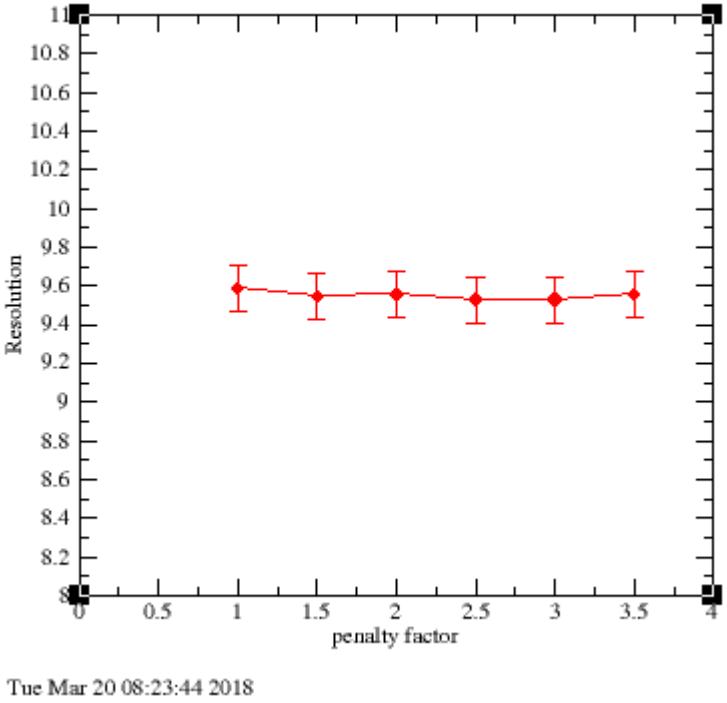
$$^{12}C(^{84}Kr[394MeV], 4n)^{92}Mo$$

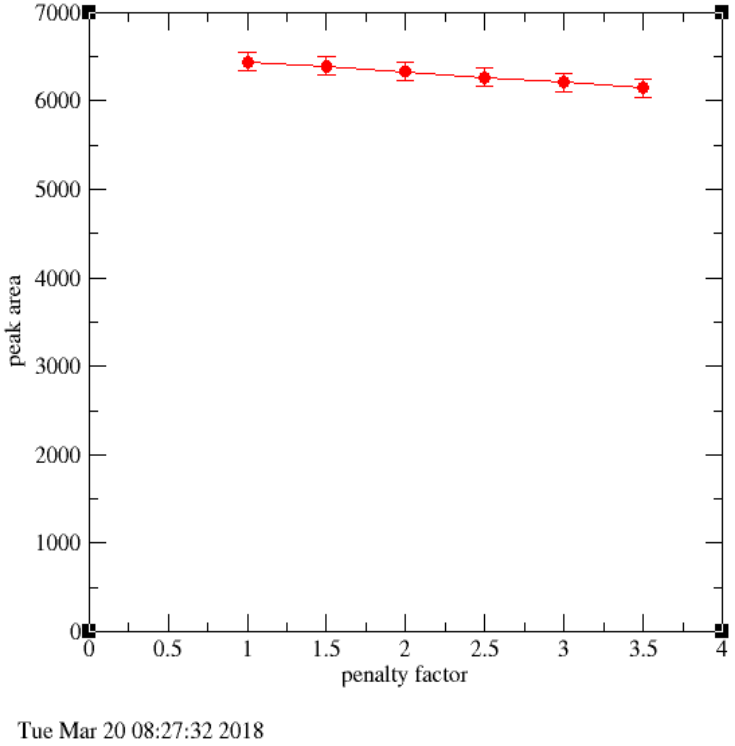
Look at 2064 keV line of in-beam experimental data. v/c~8.2%, so first interaction can be gauged by the Doppler correction

elast function:

```
#       +-- lowest accepted energy (MeV)
#       |       +-- highest accepted energy (MeV)
#       |       |       +- penalty factor
elast 0.050 0.300 1.5
```

As a function of the penalty factor, resolution and peak area:

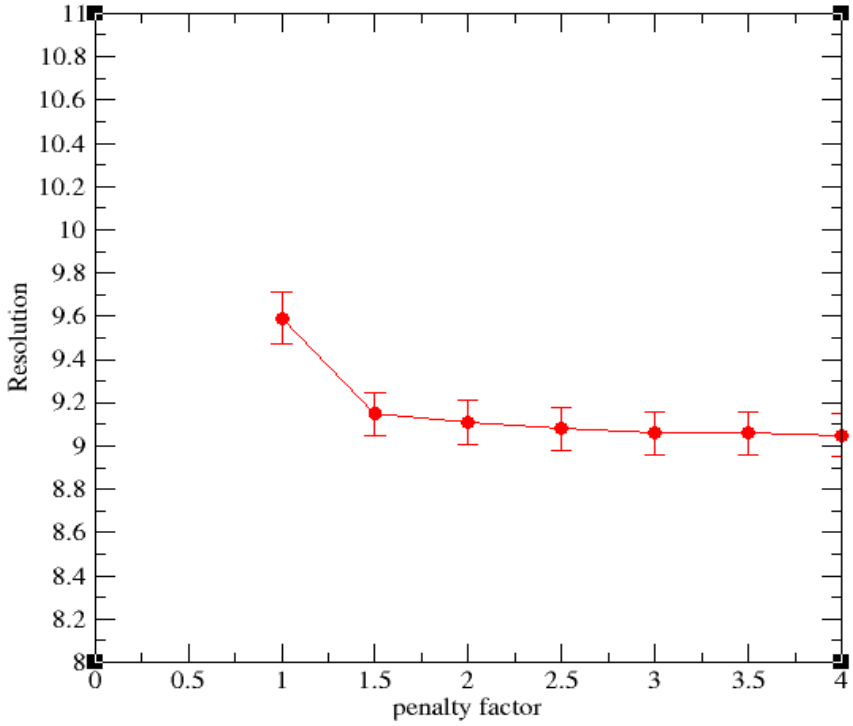


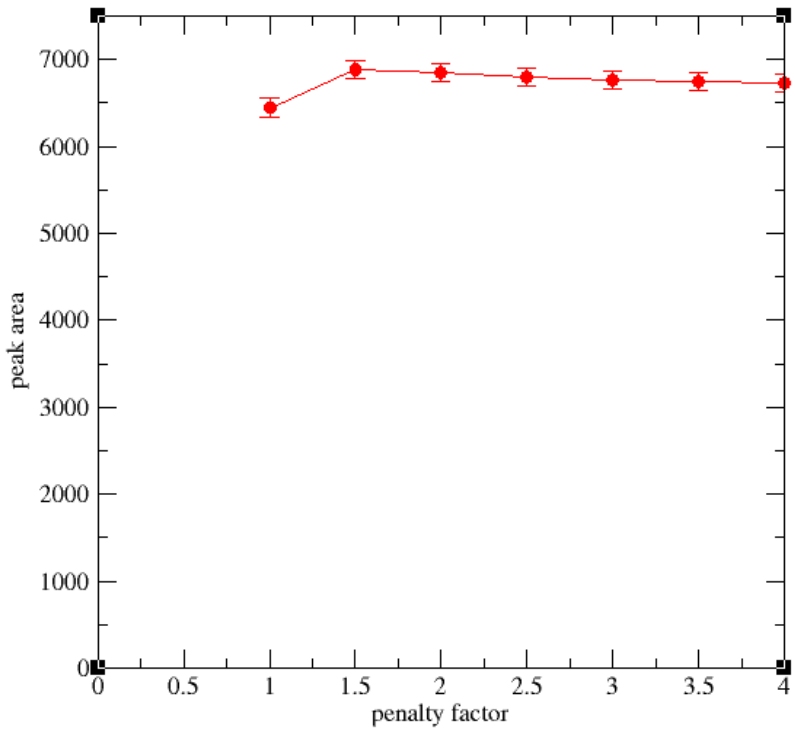


… does not seem to help us

Efirst function

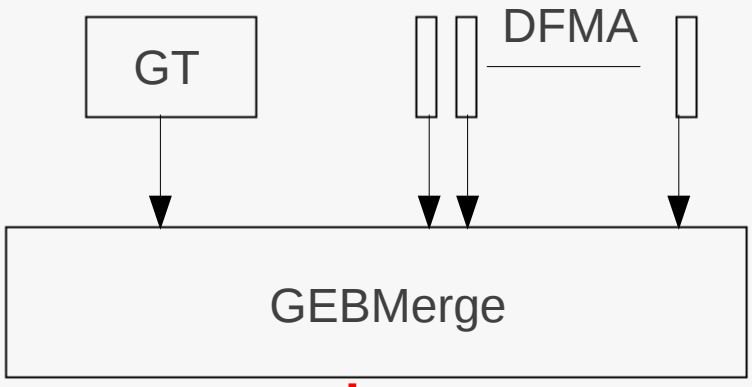
```
#       + min gamma ray energy (MeV)
#       |       + penalty factor
efirst 0.500 3.5
```





Function seems to help us find the first interaction point better :)
~5% better energy resolution, ~5% more peak area for the same FOM cut

Can now pipe data through the tracker



'waitfordata' option

Pipe

GT Tracker

Less IO

Pipe

GEBSort

On-line monitoring

root

Map file

rootn.exe

Conclusions and future

- Not many changes to the GT tracking code since last
- But tried the new efirst and elast functions
- elast does not seem to work. Maybe the same problem as with backtracking which also does not work so well? Is the assumption wrong or is it bad data?
- The efirst function appears to work. It effectively **trivializes** the tracking at high energy; *but so be it*. The function and the functional form of the penalty needs to be optimized and we need to make sure it does not hurt us in other energy regions
- Piping data may help us speed up the tracking.
- We still need to add tracking of pair production to the code.
- Try other FOM measures?