Tracking for the demonstrator

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Aim of tracking

- get coincident PSA hits (position, energy) in all AGATA detectors
- determine the number of incident photons, trajectories and energies

What tracking needs:

- knowledge of the position of the source with respect to the geometrical centre of AGATA
- the positions of the interaction points in the laboratory reference frame (not the crystal frame)

What tracking assumes:

- no empty detector position in between detectors

What tracking does not need but is useful to see if things are working:

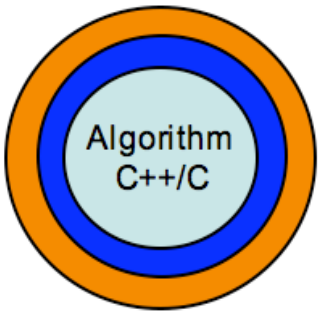
- recoil velocity vector

How is tracking done on-line

Tracking = Actor in Narval

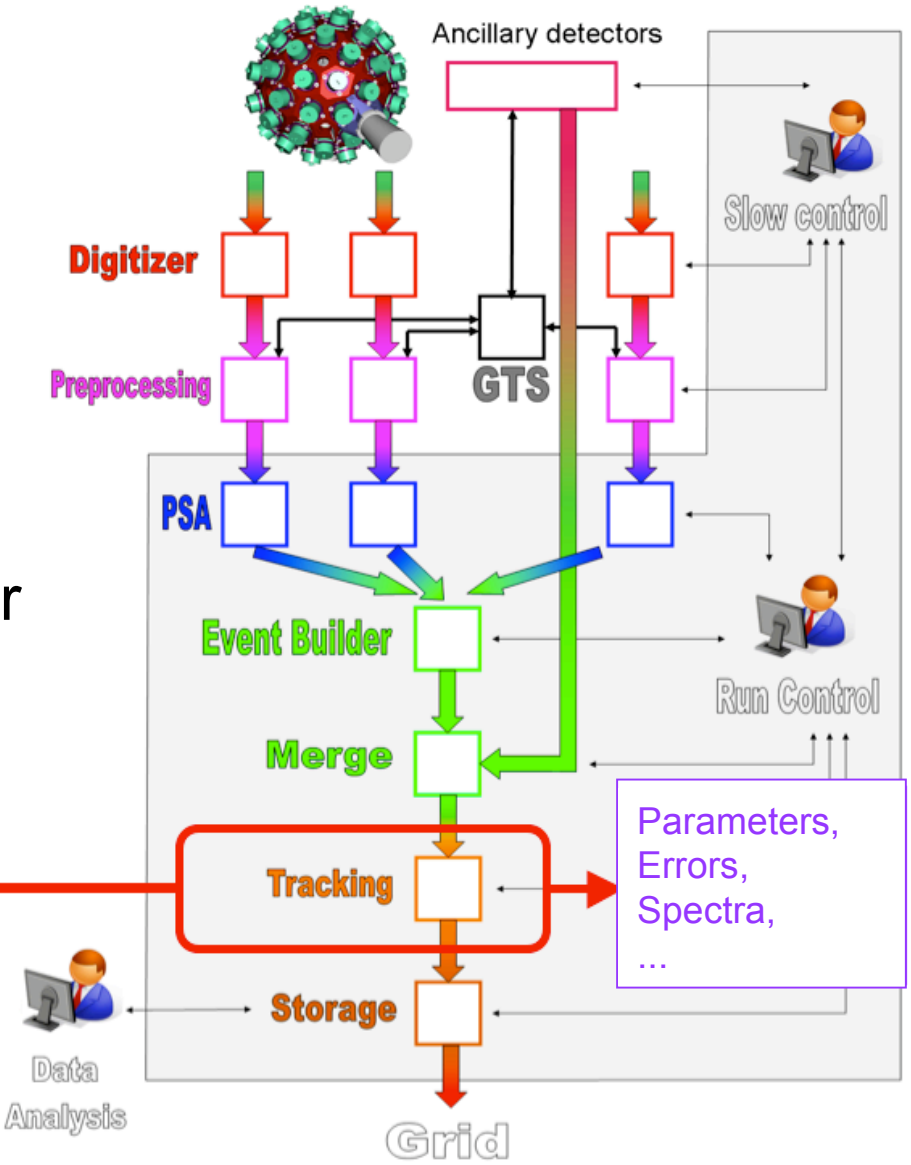
Actor type = Filter

Tracking libraries (such as OFT) are called from the TrackingFilter « mother » class



Narval interface

ADF interface



Organization of TrackingFilter

The TrackingFilter « mother » class

- defines what type of data is tracked
- opens and reads configuration and setup files and initializes variables
- gets Event-built and merged data from the data flow
- decodes PSA data
- can write PSA data to an Agata-type file
- performs some preprocessing (geometrical transformations)
- processes the events (currently, this is defined in the « daughter » class: TrackingFilterOFT)
- performs some postprocessing (Doppler correction)
- can write tracked data to file
- puts the tracked data (currently the positions and energies of 1st 2 interaction points in each track) into the data flow

The TackingFilter also return errors and message logs and it can transmit parameters and spectra to be monitored

OFT Tracking

the process() function fills the appropriate local data structures with the PSA data structure (FillOFTStructures()), processes the data (process_event()) and then moves the OFT data to the tracked data structure (MoveOFTStructures())

process_event: computes distances and angles between points and source, sorts positions according to increasing θ, computes all distance between points and calls the following functions:

- cluster_search: find the clusters (with a maximum of kmax points) for a given opening angle α, with $\alpha=\alpha_{min}+\delta\alpha$ up to α_{max}=f(number of interaction points nb_int)
- cluster_evaluation: using the Compton scattering formula, compute the figure of merit for each sequence of points in every cluster and determine the best sequence of points in each cluster. The comparison between geometrical angles and energy angles depends on the position uncertainties through sigma_theta
- cluster_sort_flag: sort the clusters according to the figure of merit and flags clusters, which have common points with better clusters
- cluster_validation: accept clusters if figure of merit > threshold_track

process_event returns tracked multiplicity (mult), total energy of track (etot), 1st (xfirst,yfirst,zfirst) and 2nd (xsecond,ysecond,zsecond) positions in track, number of points in track (nbtot) and figure of merit of track (probtot)

! single_interaction: single interaction point clusters are treated separately. They must be isolated (distance to closest point > 4cm) and the product of the depth and interaction probabilities must be > threshold_single

Different tests

- in-beam (week 12, 2009):
  - reaction: $^{30}Si + ^{12}C$
  - transition of interest: ^{40}K line at 1823 keV
  - 1 ATC

  optimized kinematic parameters:
  - $(x_0,y_0,z_0)=(0, 66.11, -156.22)$ mm
  - $v/c= 4.85\%$
  - $(v_x,v_y,v_z)=(0, 0.9664, 0.2571)$ i.e 75.1° in the yz plane
- source (august 2009)

- ^{60}Co
- transition of interest: 1173 and 1332 keV
- 2 ATC

different triggering conditions and source positions:

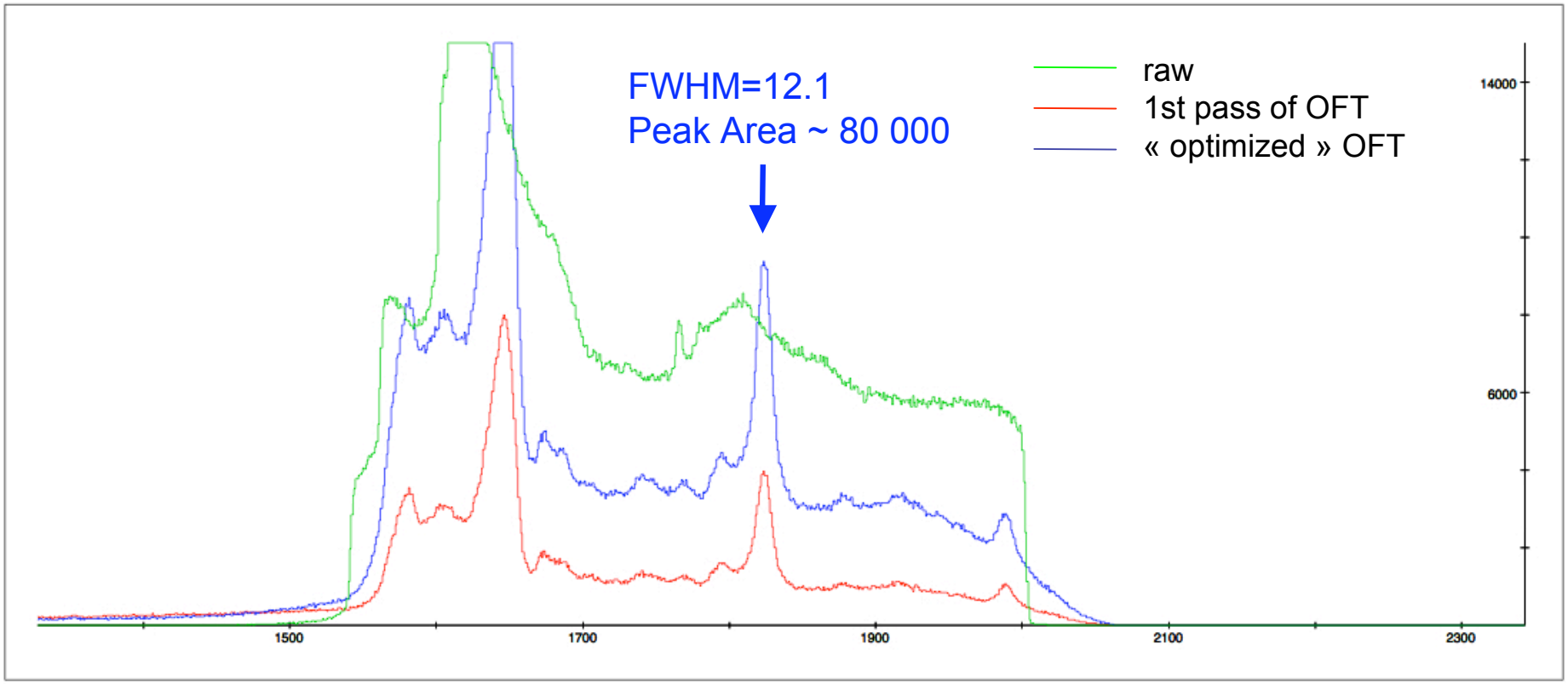
Source 1: trigger = single crystal : $(x_0,y_0,z_0)=(0,0,-115)$ mm

Source 2: trigger = crystal multiplicity ≥2 : $(x_0,y_0,z_0)=(0\ 0\ 0)$

Week 12 - mgt


Untitled - TkT
File Edit View Settings Actions Help
2693 4465 0 12654 mgt-spec_orig0.dat 30 L 64
1.2e+004
1.0e+004
8.0e+003
6.0e+003
4.0e+003
2.0e+003
1400 1500 1600 1700 1800 1900 2000 2100 2200
FWHM ~ 12.5
Peak Area ~ 100 000
13 Xcal 0.000000 0.500000
14 mgt-spec_orig0.dat 30 L 64 (F:\tdata\week12\sort13-JASS-30\mgt-
15 GFit 2822.863 0.00000 0.15993 0.000 0.000 & 2.23
0 99529.277 3647.738 24.914 1823.869 12.457 | 927.61

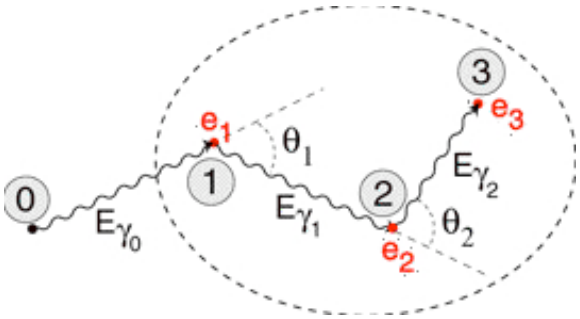
Week 12 - OFT


FWHM=12.1
Peak Area ~ 80 000
raw
1st pass of OFT
« optimized » OFT
14000
6000
1500
1700
1900
2100
2300

Week 12 - OFT optimization

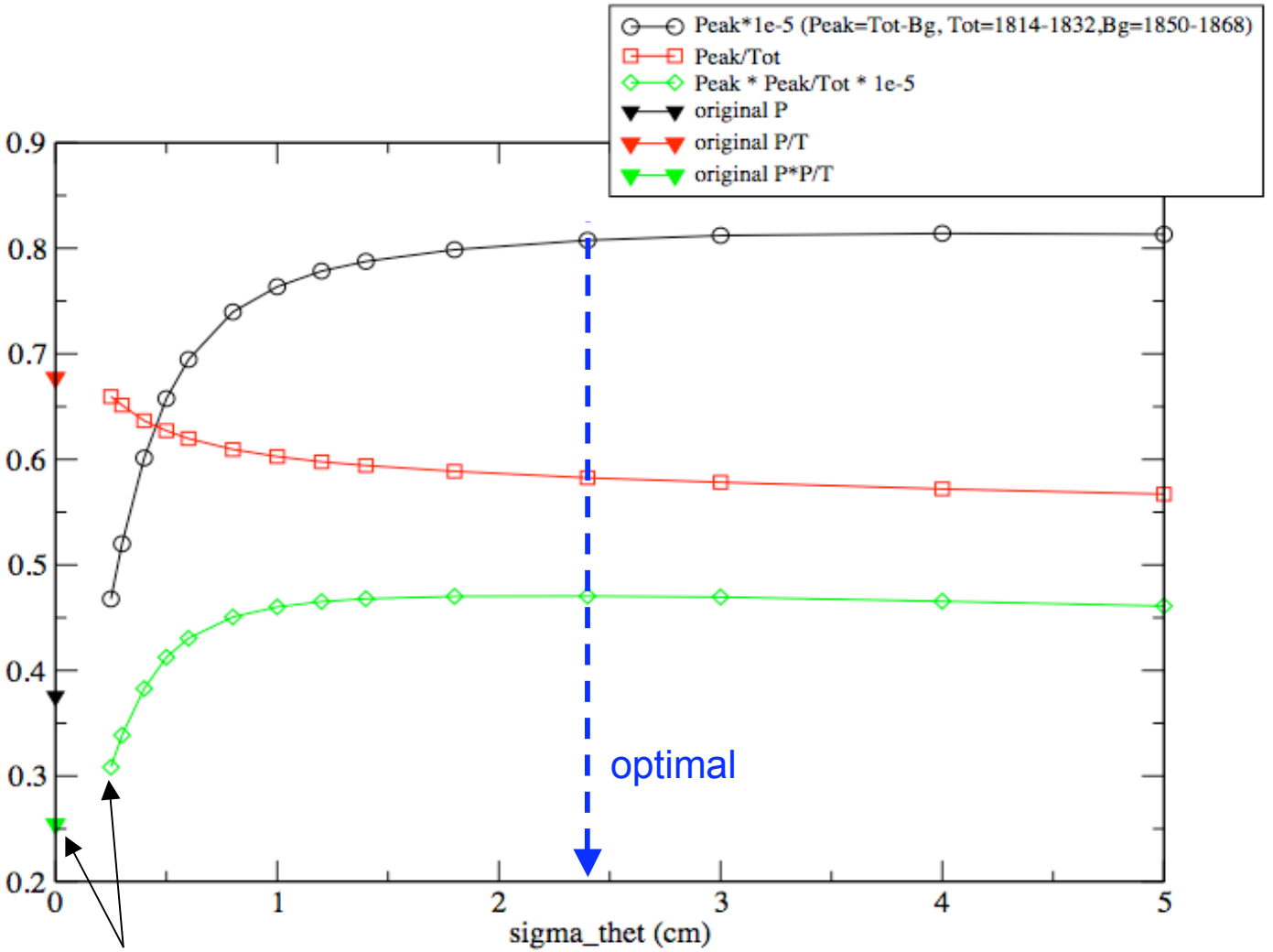
-no gain in changing threshold_track

-big effect when sigma_theta is varied, i.e the position uncertainty needs to be deteriorated



$$\sigma_{\cos\theta_1} = \sigma_\theta \sqrt{\left(\frac{\partial\cos\theta_1}{\partial x_0}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial y_0}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial z_0}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial x_1}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial y_1}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial z_1}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial x_2}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial y_2}\right)^2 + \left(\frac{\partial\cos\theta_1}{\partial z_2}\right)^2}$$

Week 12 - OFT optimization



increase due to a relaxed incident angle (=1st angle) probability: exp(-2...) changed to exp(-...)

Week 12- Conclusions

- improved efficiency of online tracking algorithm by deteriorating position resolution from σ=2.5 mm to σ=2.4 cm ! (although the parameter has probably no meaning above a certain value)

- single interaction issue:

OFT DOES NOT reconstruct any 1823 single-interaction-point events

! these represent ~22 000 photopeak events and account for 21% of the reconstructed peak with mgt

- blind tuning of parameters:

Need a source run

Source 1

Comparison to GEANT4 simulations to understand:

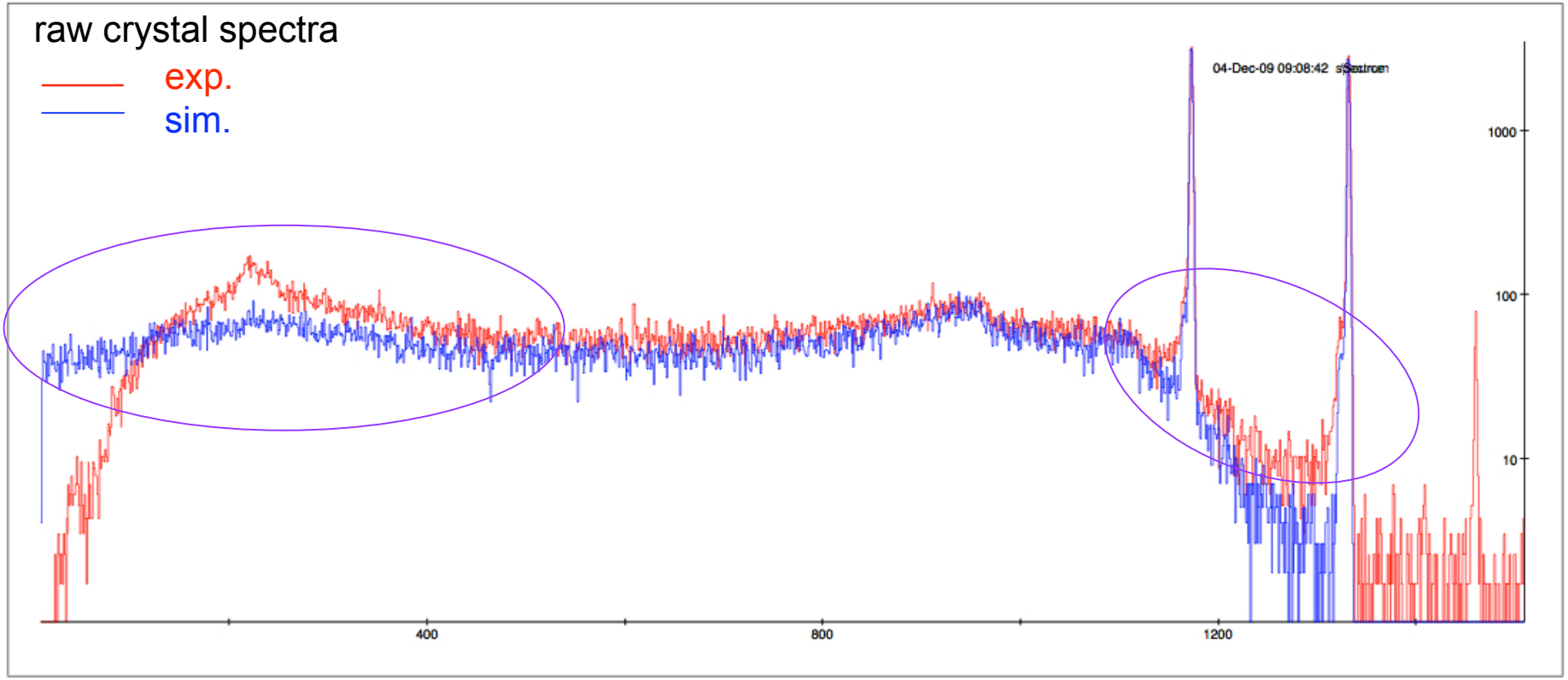
- the response of the 2 ATC
- the problems of the tracking algorithm

Simulation ingredients:

- 2 ATC with capsules and passivated areas
- 2mm thick Al chamber of 150 mm radius
- point source at z=-11.5 cm and x=0,y=0
- segment packing
- 10 keV threshold on the energy of interaction points (after packing)
- standard tracking parameters (threshold_track=0.05, threshold_single=0.15, sigmat_theta=0.25)
- emitted multiplicity for tracking: 2

Source 1 - 2ATC response

-normalisation to same raw crystal photopeak area (sum of hits in individual crystals)

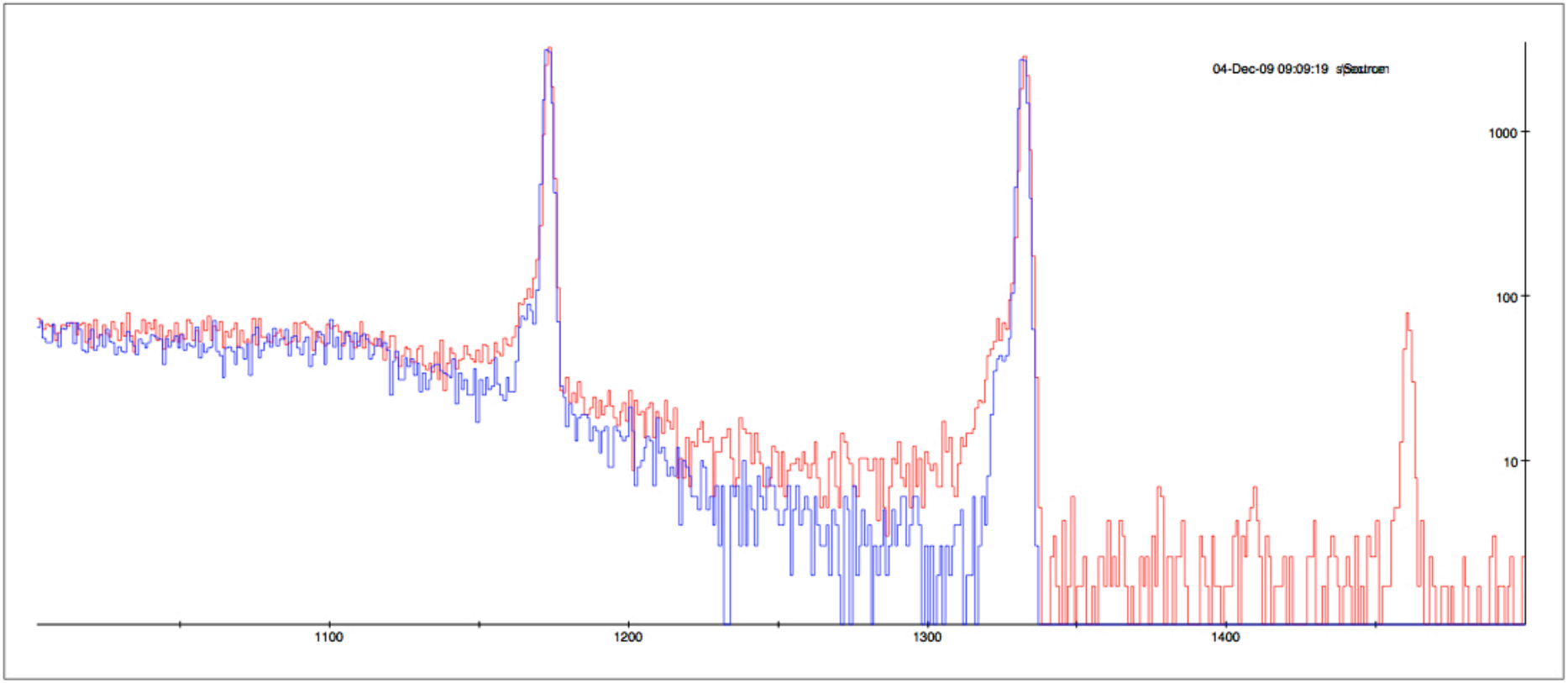


P/T_{exp} = 21%
proportion of single int. photopeak events: 22%

P/T_{sim}= 25%
prop. of sing. int peak events: 21%

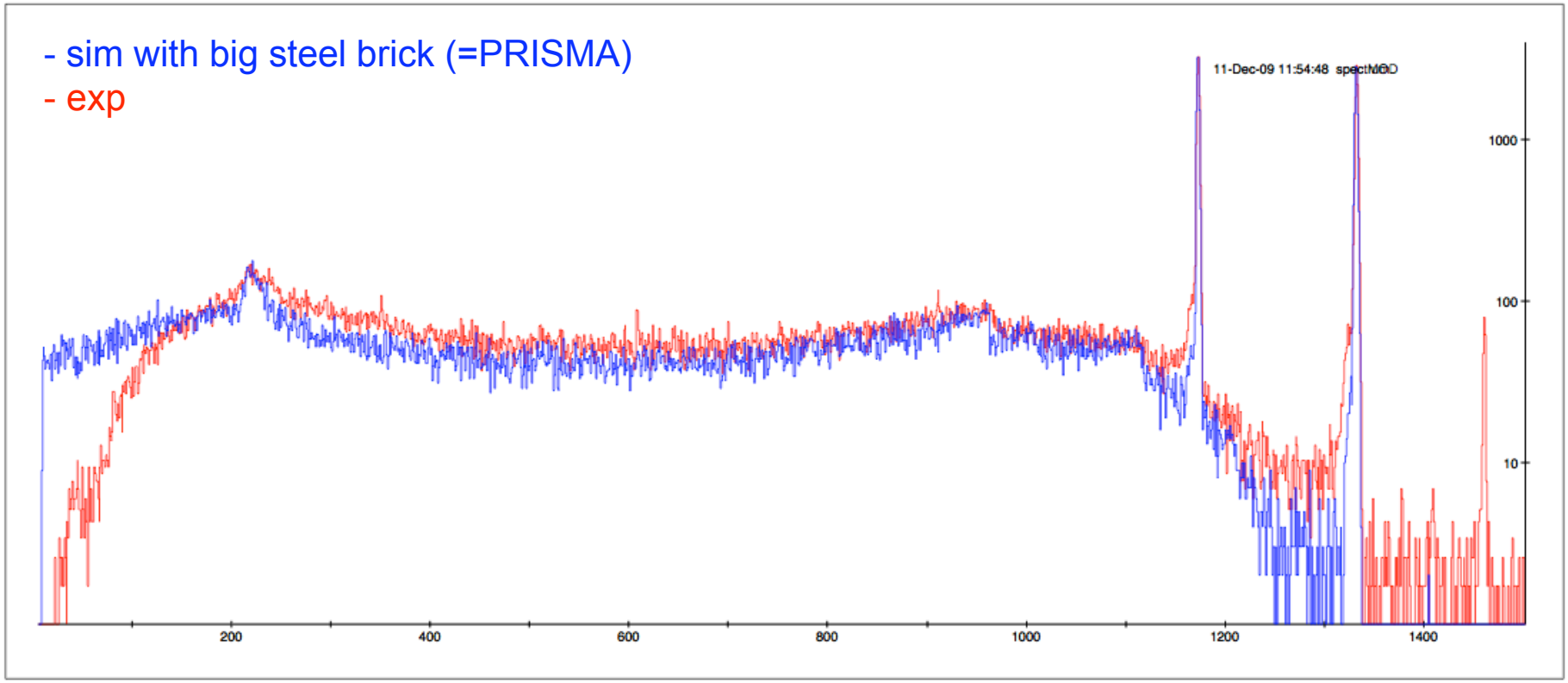
Source 1 - problems

- low-energy tails extend further than 10 keV

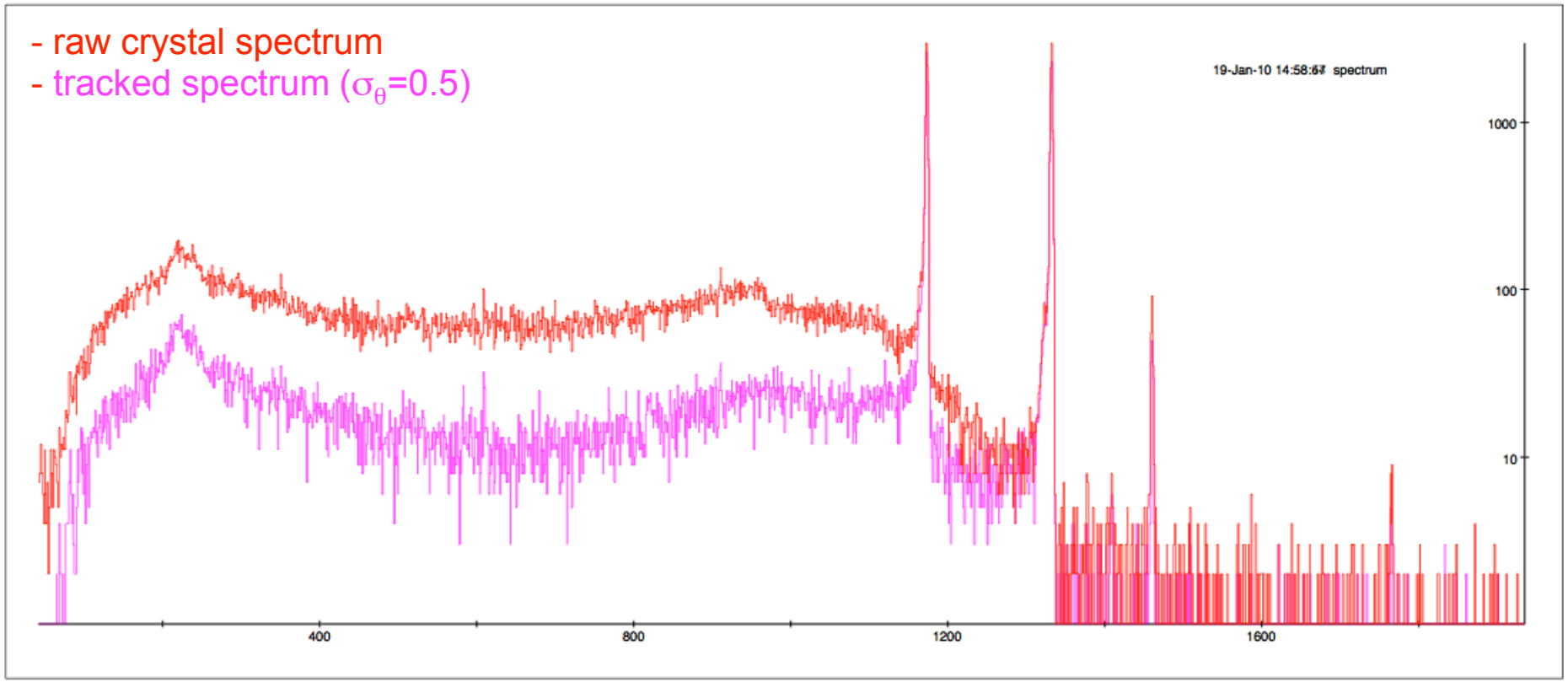


Source 1 - problems

- origin of packscatter peak : PRISMA
- energy threshsold on the core signal is quite high (~100-150 keV)

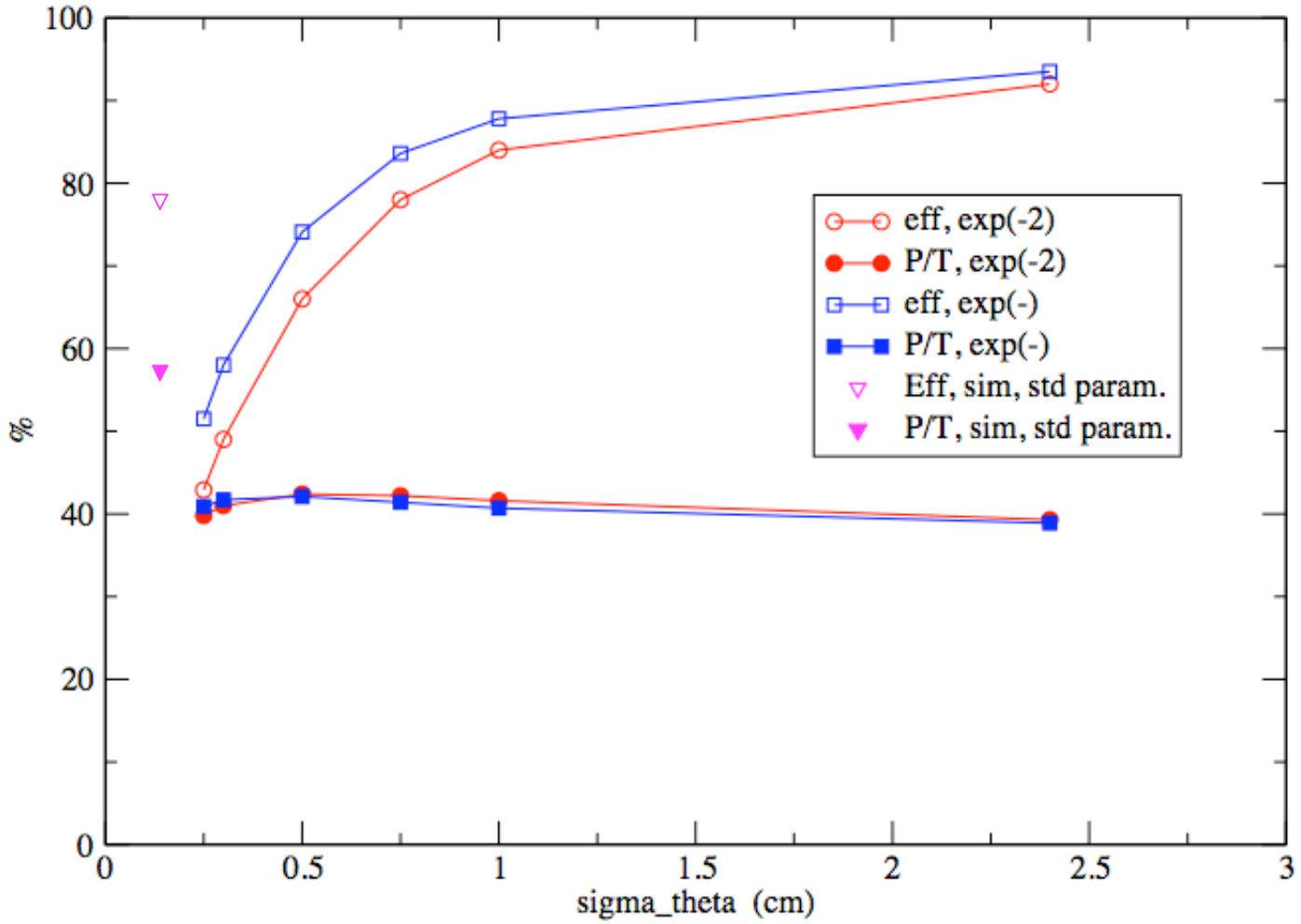


Source 1 - Tracking



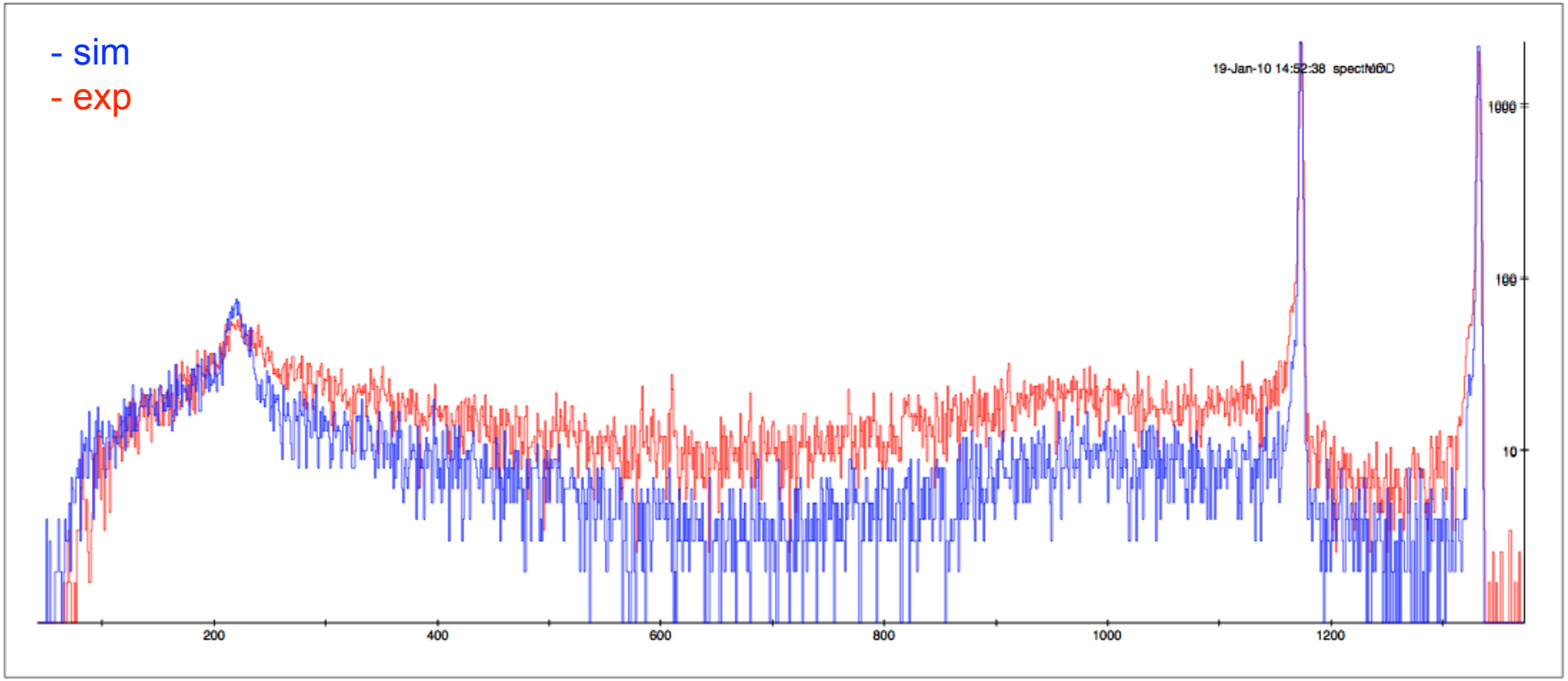
Source 1 - tracking performance

efficiency = (photopeak area)$_{\text{tracked spectra}}$/(photopeak area)$_{\text{raw crystal spectrum}}$



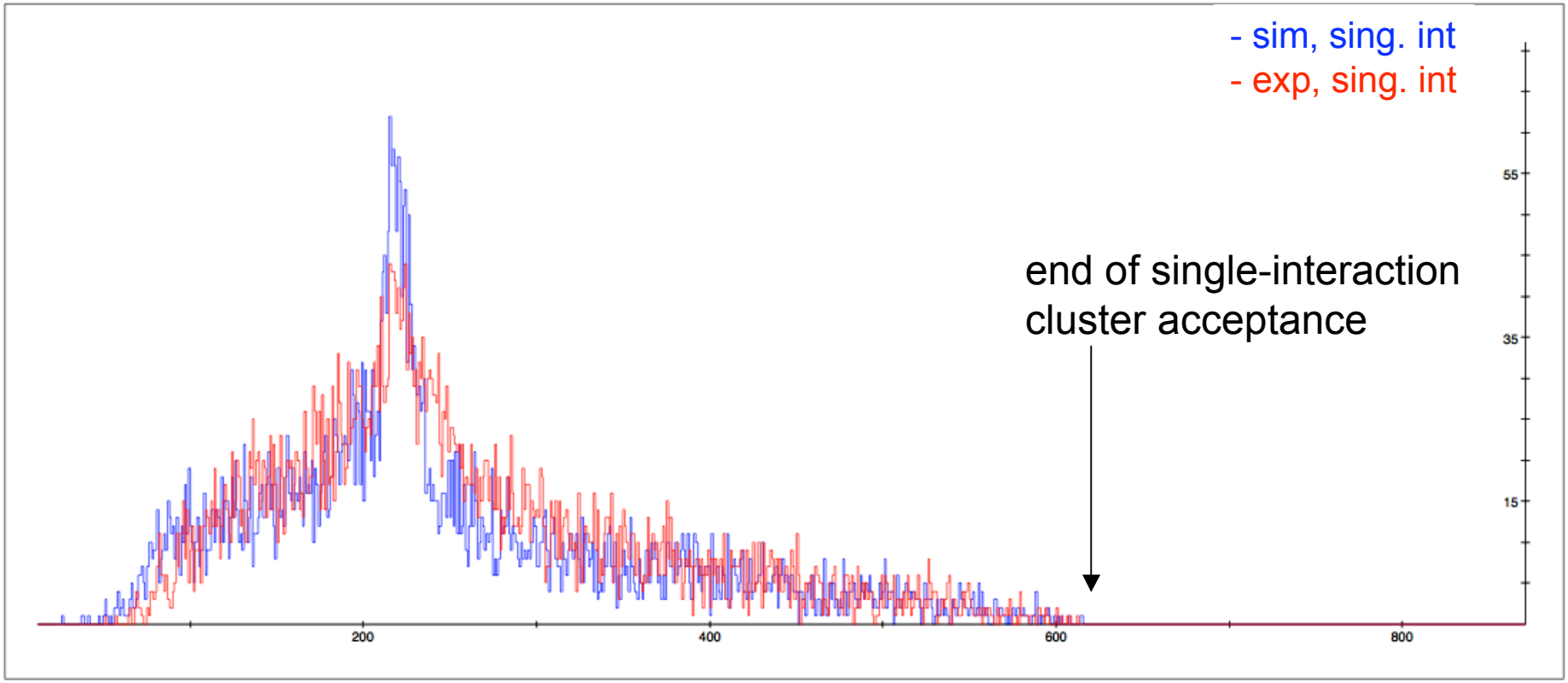
Source 1 - background

- origin of increased experimental tracked background ?



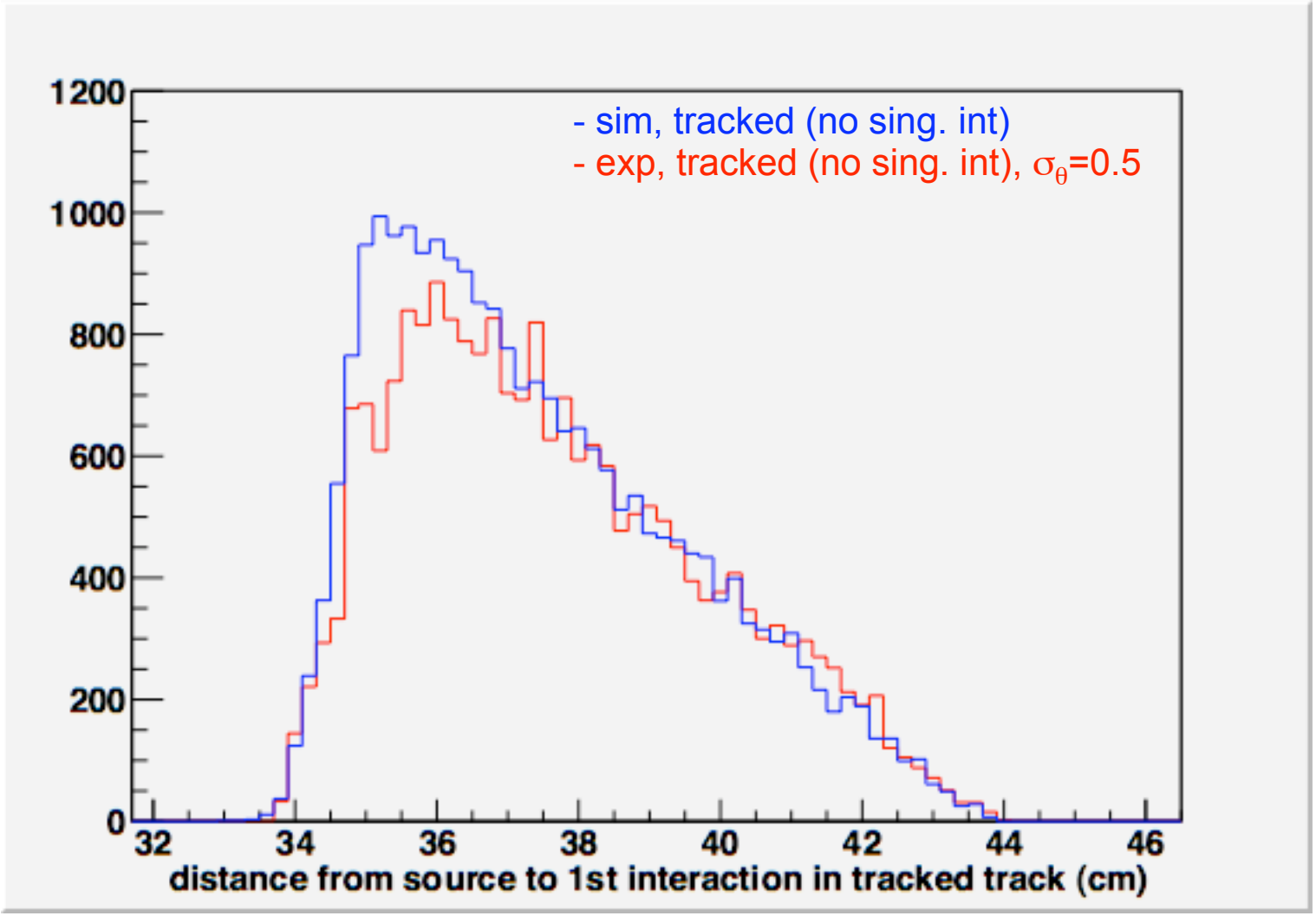
Source 1 - background

- No extra background coming from the single interaction point treatment

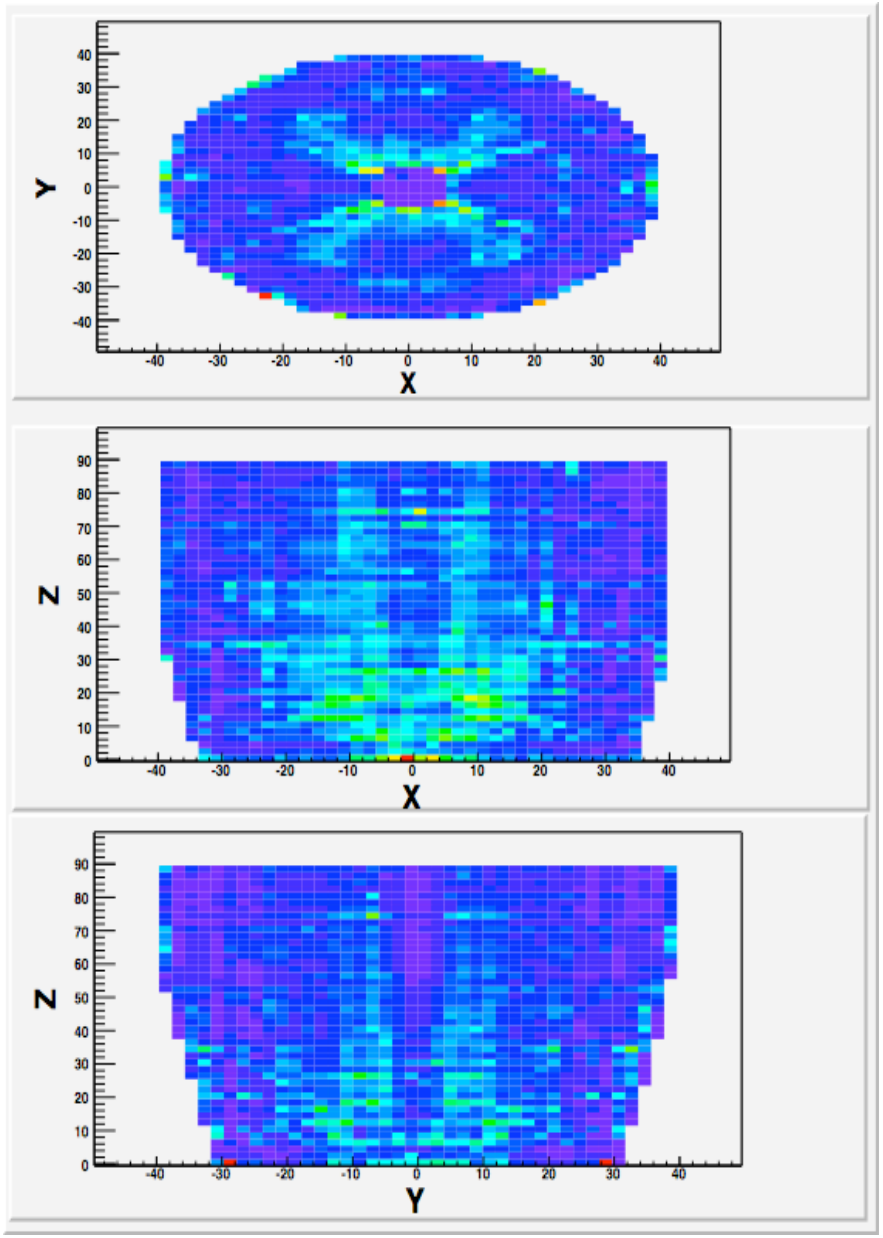


Source 1 -peak

missing photopeak intensity comes from tracks originating in the front of the detector : bad PSA position determination (quantization in z)



PSA position distributions



-distribution of hits is far from being smooth

-concentration of counts in regions of the crystal

⇨need to simulate these effects

Conclusion Source 1

- large backscatter peak due to PRISMA

- need to investigate the origin of the bad tracked P/T (~42% instead of simulated 57% with PRISMA): is it localised ? Is it related to PSA problems ?

- need to modify treatment of single interactions to recuperate some peak at high energy

- need to run with low-medium energy sources to check tracking parameters and investigate multiplicity effects

- re-test tracking with improved PSA