Improving the Grid Search Algorithm

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- From Grid Search (GS) to Adaptive Grid Search (AGS)
- Results of the off-line data analysis for the W27_2009 commissioning experiment
- PSA analysis of experimental data to tune the signal basis

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from GS to AGS

The **GS method** is based on this hypothesis:
in case of multiple hits in a segment only the energetic barycentre is considered

This hypothesis can be assumed valid looking at :

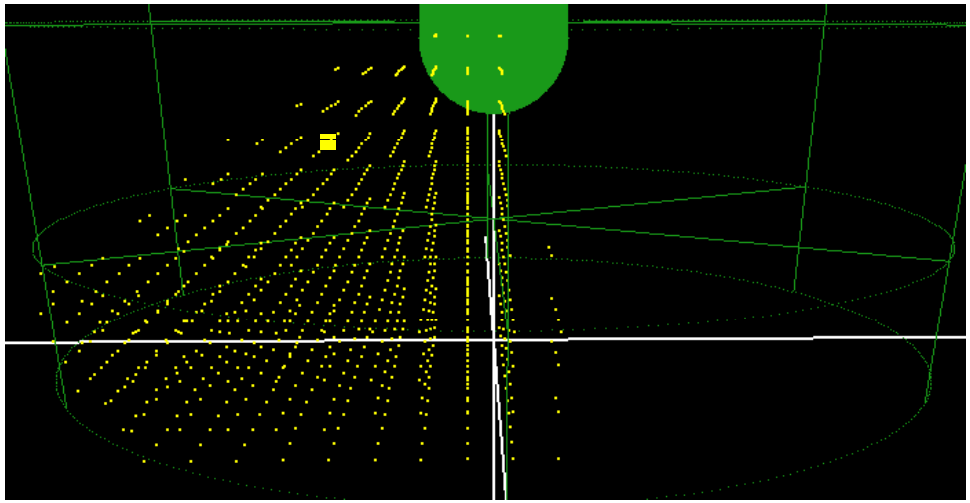
- the tracking simulations
- the results in experiments performed in the past and analyzed with this method

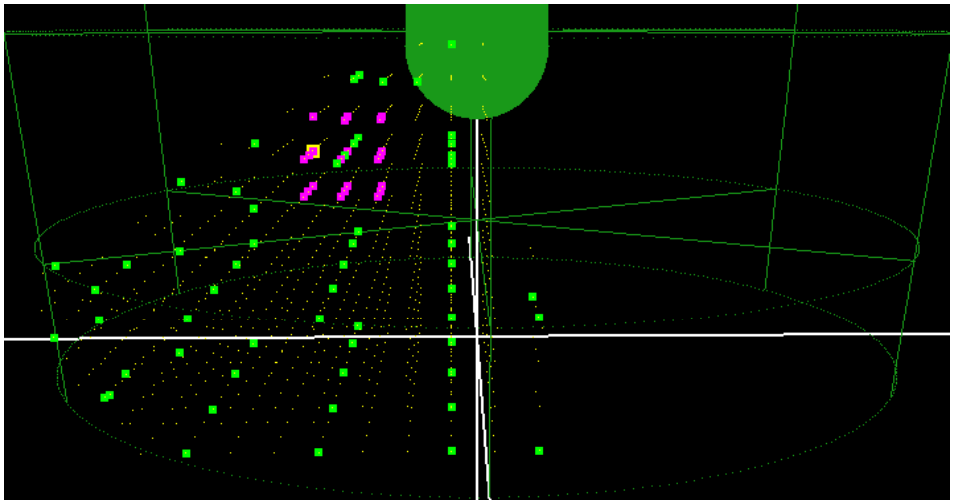
The **AGS method** performs two steps:

- a coarse grid search (step ~ 6 mm) to identify the best location;
- a fine grid search (step 2 mm) in a small volume around that location

PSA analysis rate: from 0.25 kHz with GS to 3.3 kHz with AGS

AGS improves the processing time preserving the quality of the position identification



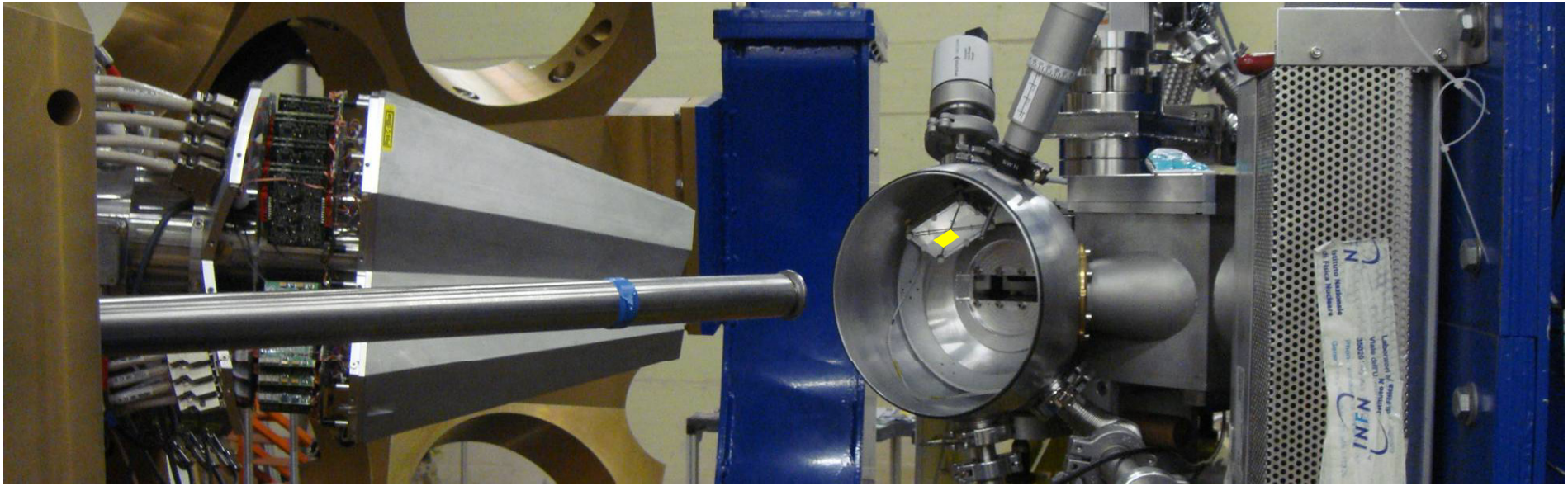


Commissioning experiment Week27 2009

The reaction : ^{56}Fe at 220 MeV → ^{197}Au recoils with $\beta \sim 8\%$ E_γ = 847 keV (^{56}Fe)

The detectors: γ detection with ATC1 in coincidence with DANTE for scattered ions

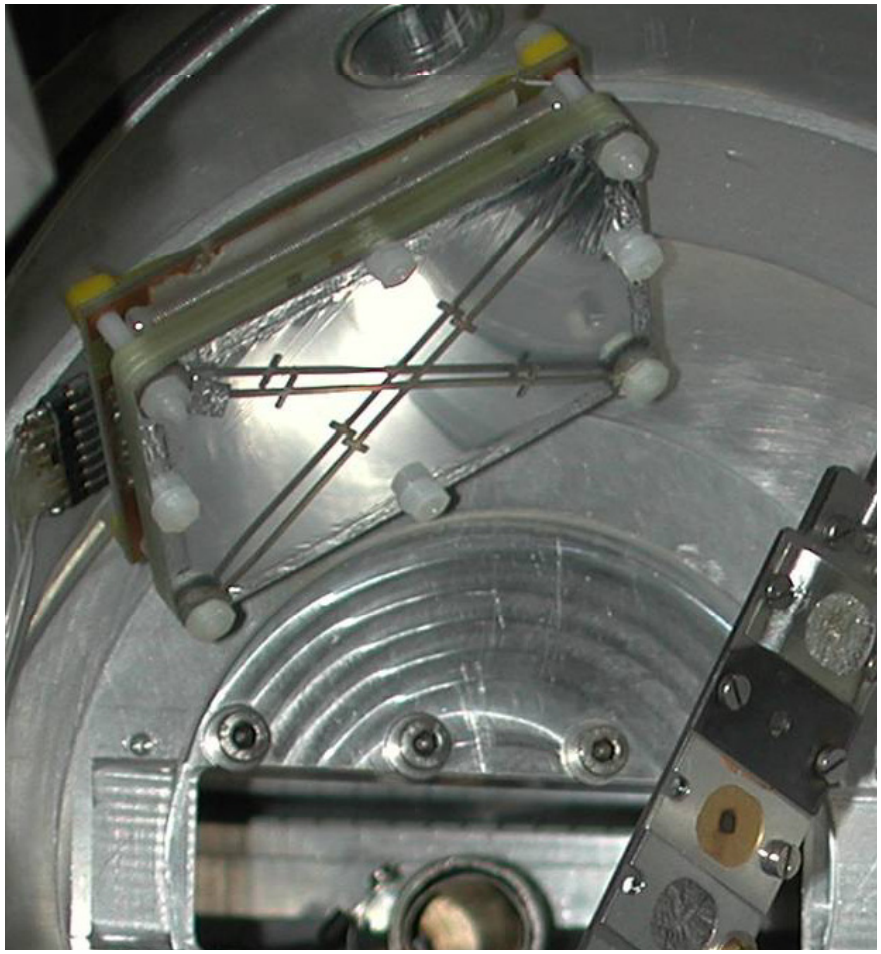
Experimental setup:



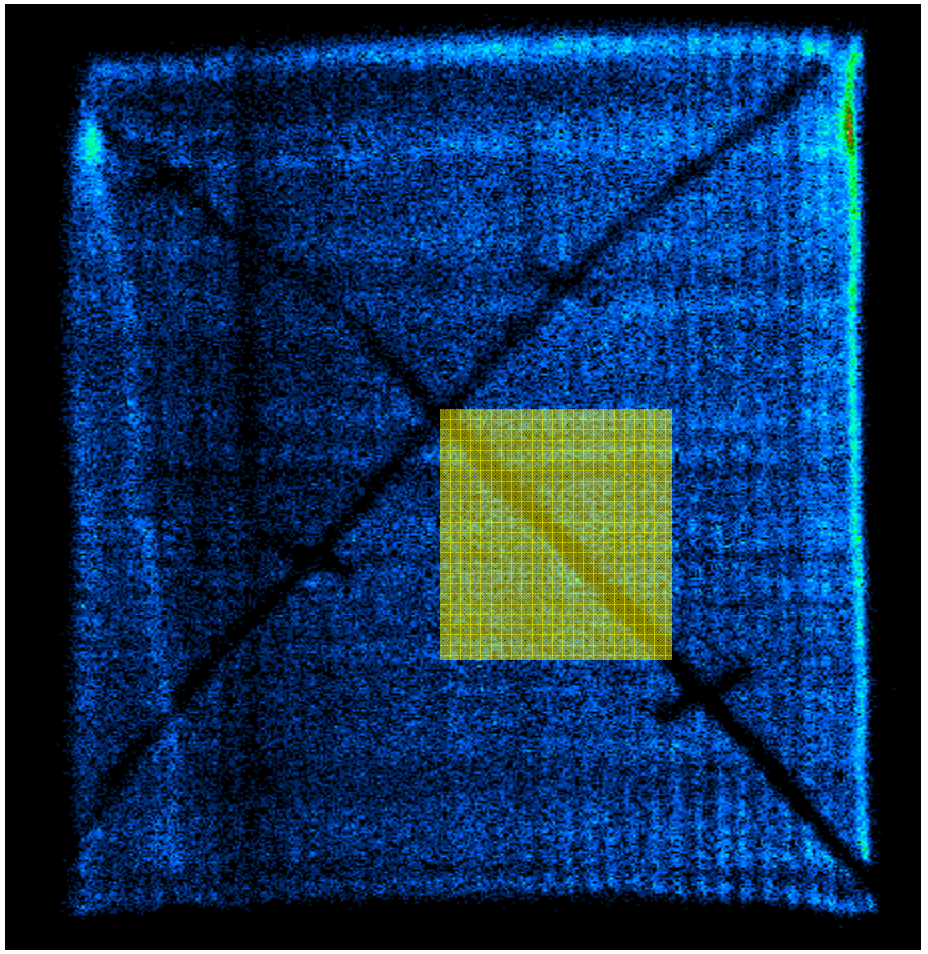
On-line event rate: 250 Hz of coincidences
Statistics: 150 Mevents for 2 Tbyte of saved traces
Off-line analysis: a subset of the statistics has been processed for PSA purpose (Red crystal, energy gate around the peak of interest, a window in the DANTE data to avoid the need of dealing with regions of nonlinear response inside the detector)

The Micro Channel Plate detector DANTE

Picture of the detector



Scattered ions detected



The non linearity in parts of the detector can be compensated.
For simplicity the analysis presented has been limited to the most linear region.

Commissioning experiment Week27 2009

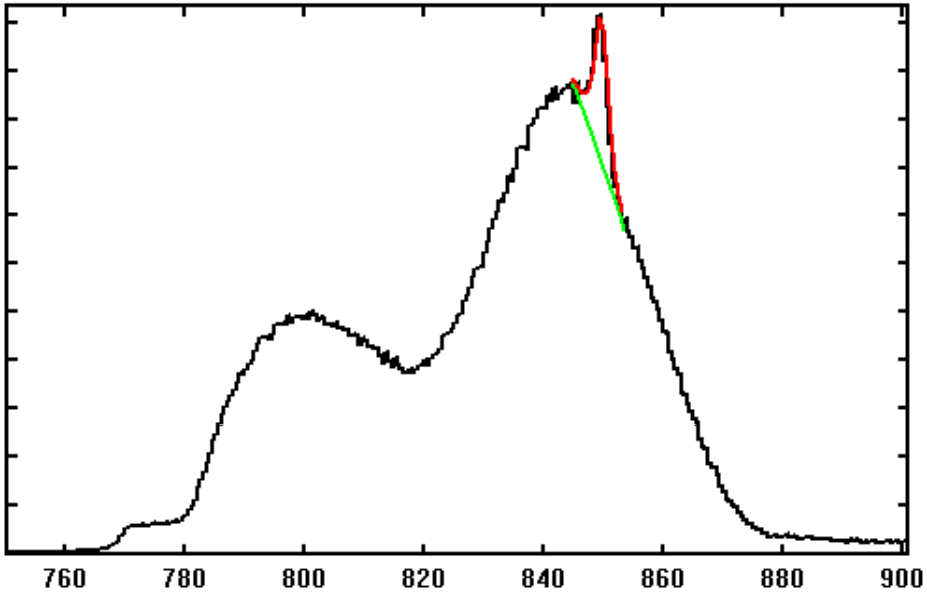
FWHM of Doppler corrected peak at 847 keV for RED crystal+DANTE

2.7 keV stopped peak: it's our goal !
3.2 keV PSA-AGS + DANTE* as photoelectric (segment multiplicity = 1)
3.8 keV PSA-AGS + DANTE* at every segment multiplicity
(photoelectric, Compton → tracking)
7.1 keV segment center + DANTE* at every segment multiplicity

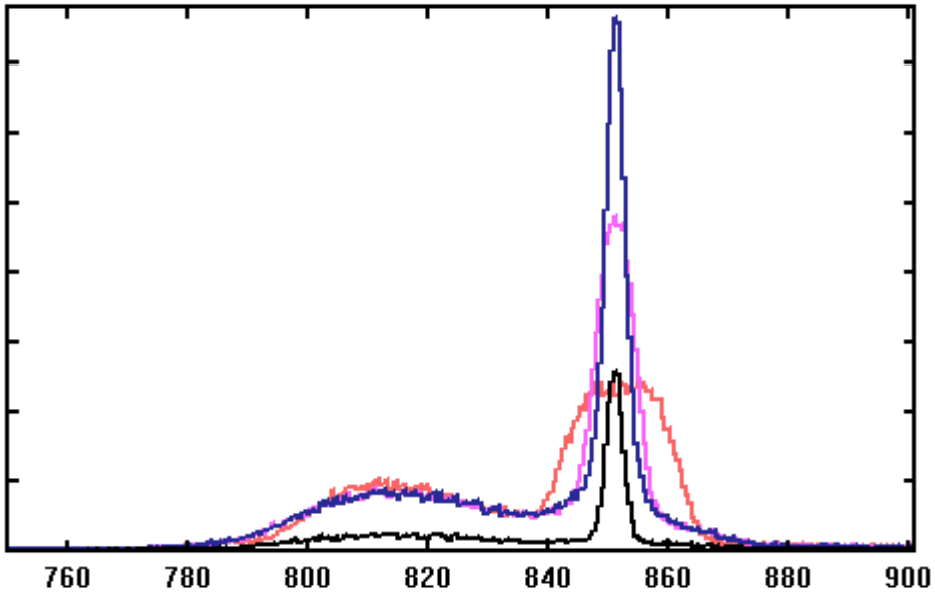
~19 keV crystal center + DANTE* at every segment multiplicity
~30 keV raw data

* $\frac{1}{16}$ of Dante

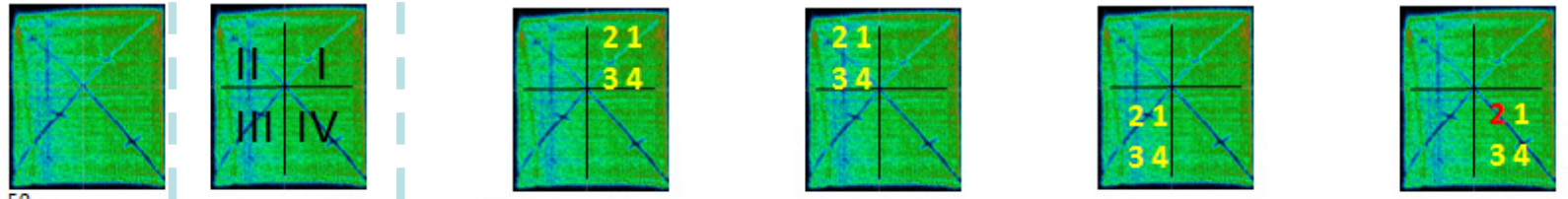
Spectra of Doppler broadening peak and peak of stopped ions from random coinc.

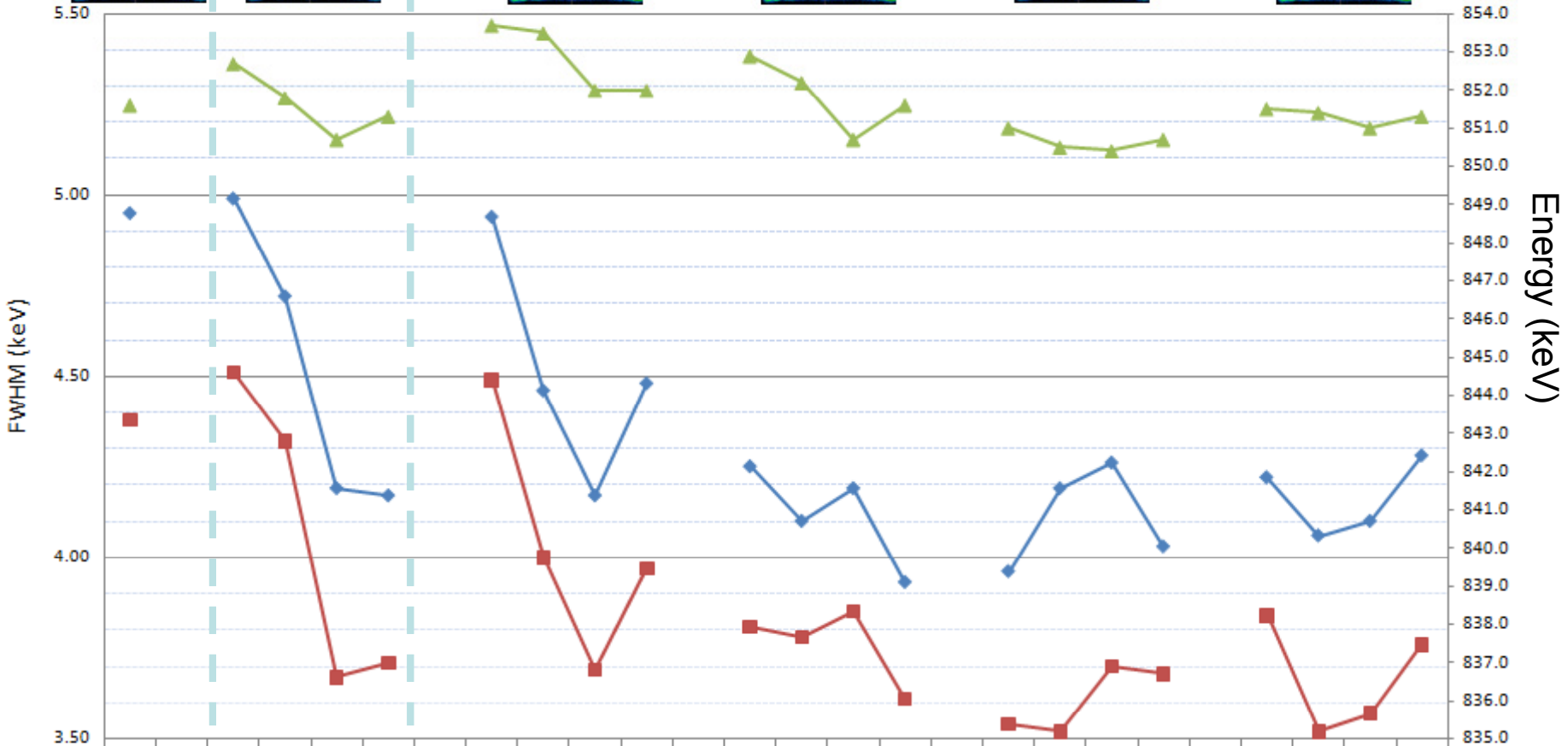


Spectra of Doppler corrected peak



Effects on FWHM and Peak-Position due to the response of DANTE





	FULL		I	II	III	IV		I1	I2	I3	I4		II1	II2	II3	II4		III1	III2	III3	III4		IV1	IV2	IV3	IV4
all mult.	4.95		4.99	4.72	4.19	4.17		4.94	4.46	4.17	4.48		4.25	4.10	4.19	3.93		3.96	4.19	4.26	4.03		4.22	4.06	4.10	4.28
segm.mult.=1	4.38		4.51	4.32	3.67	3.71		4.49	4.00	3.69	3.97		3.81	3.78	3.85	3.61		3.54	3.52	3.70	3.68		3.84	3.52	3.57	3.76
energy shifts	851.6		852.7	851.8	850.7	851.3		853.7	853.5	852.0	852.0		852.9	852.2	850.7	851.6		851.0	850.5	850.4	850.7		851.5	851.4	851.0	851.3

Other PSA considerations

GS vs AGS

method	GS	AGS
FWHM All segment mult.	3.7 keV	3.8 keV
FWHM segment mult.=1	3.2 keV	3.2 keV
Analysis rate*	.25 kHz	3.3 kHz

* Test on notebook single core

Grid Size

AGS	1mm	2mm
FWHM All segment mult.	3.7 keV	3.8 keV
FWHM segment mult.=1	3.2 keV	3.2 keV
Base dimension in RAM	2.8 Gbyte	345 Mbyte

Improved performance in processing time preserving the quality of position identification:
the real on-line rate is up to 10 kHz due to faster machine and parallelization given by NARVAL and threads

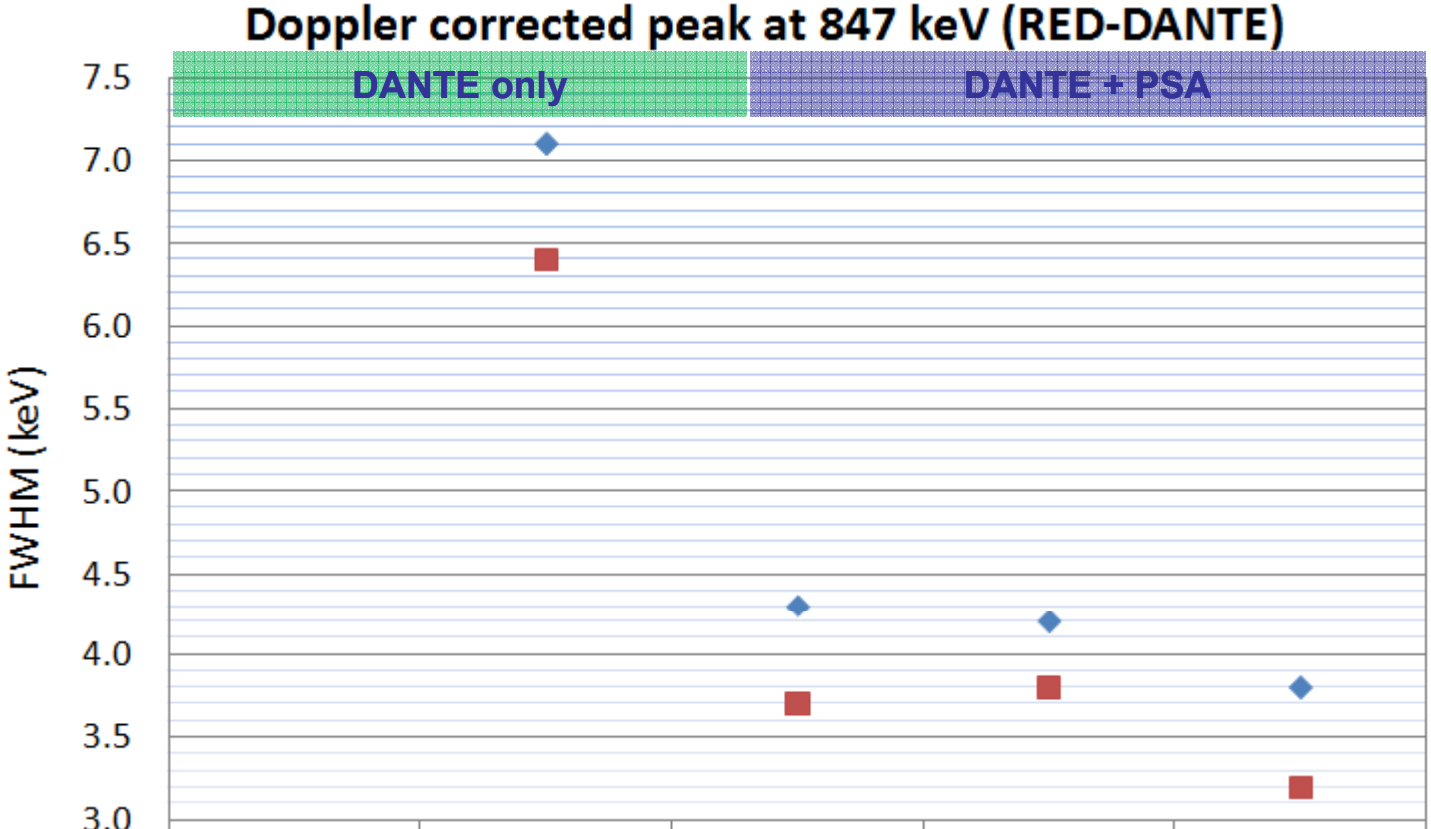
AGS speed opens at the possibility of search two hits per segment

From this single test, a basis with grid resolution of 1mm doesn't lead to significant improvements

Comparisons of different calculations

Bases prepared by the "simulators":

- **MGS**
- **JASS and 'BART' : same procedure but different implementation codes**

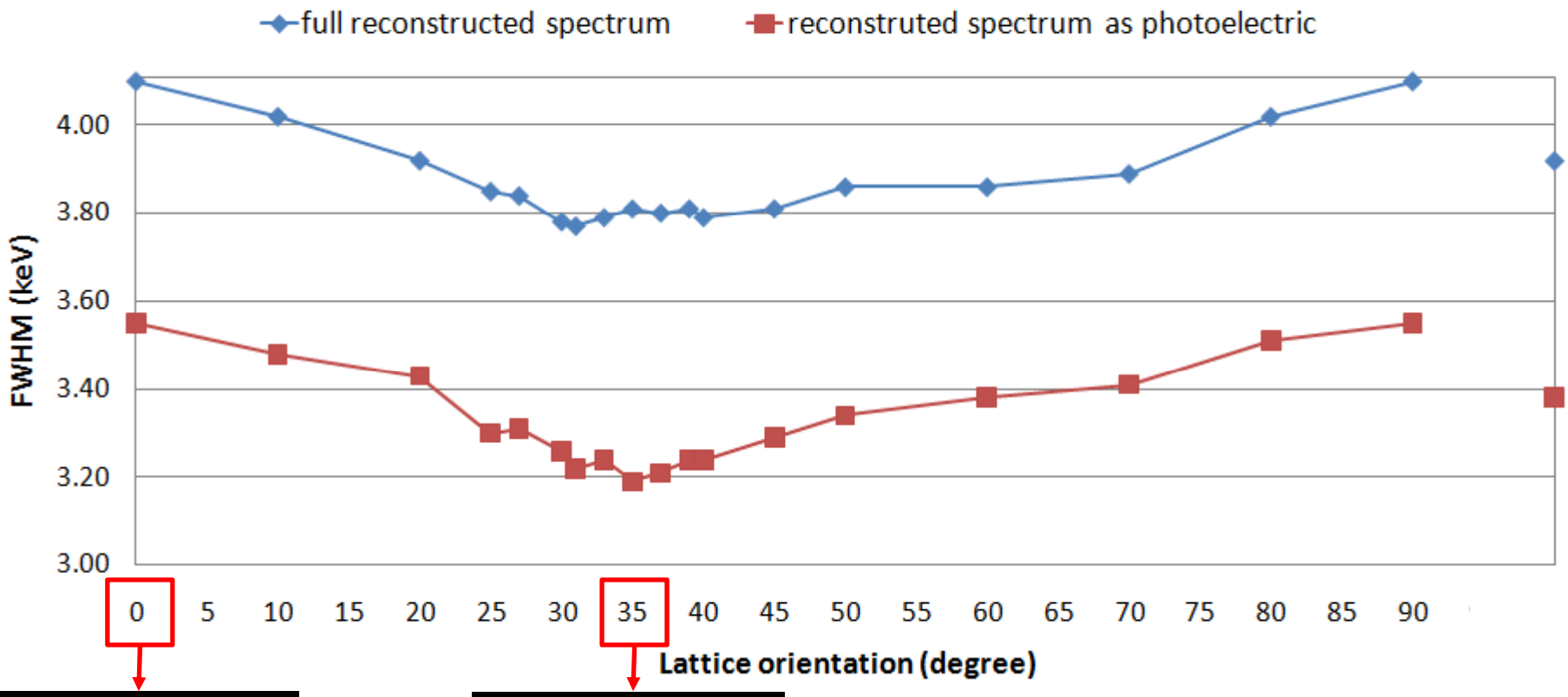


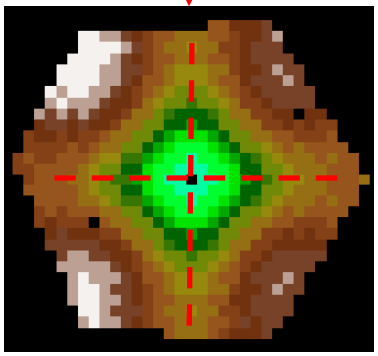
	hit put at crystal center	hit put at segment center	MGS-R	JASS-R	BART-R
◆ all segment multiplicity	19.0	7.1	4.3	4.2	3.8
■ segment multiplicity = 1		6.4	3.7	3.8	3.2

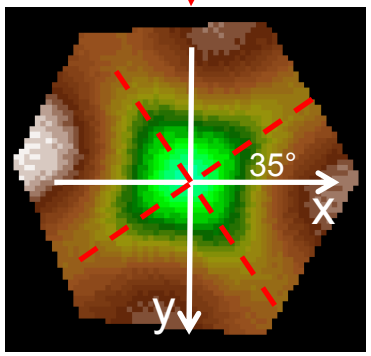
Differences don't depend only on the calculations but also from taking care of optimization, checking, tests, ... of the simulations

‘Bart’ calculation tuning

Optimization of the lattice orientation for RED (A001) looking at the FWHM of the Doppler corrected peak



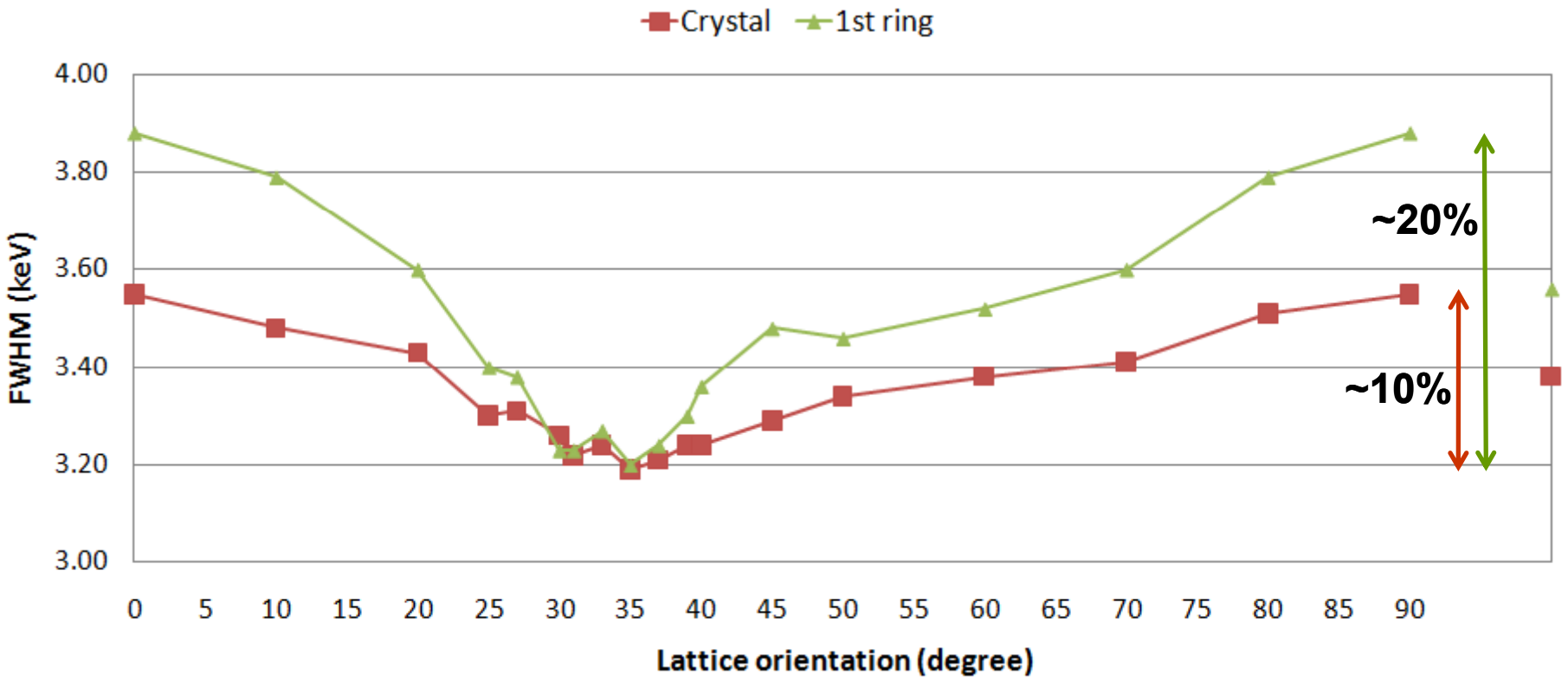




Front view of $T_{10\text{-}90}$ from simulations:
- 35° is respect the x axis
- this seems to be in agreement with the specifications for Eurisys (axis through the middle of one face)

‘Bart’ calculation tuning

Optimization of the lattice orientation for RED (A001) looking at the FWHM of the Doppler corrected peak

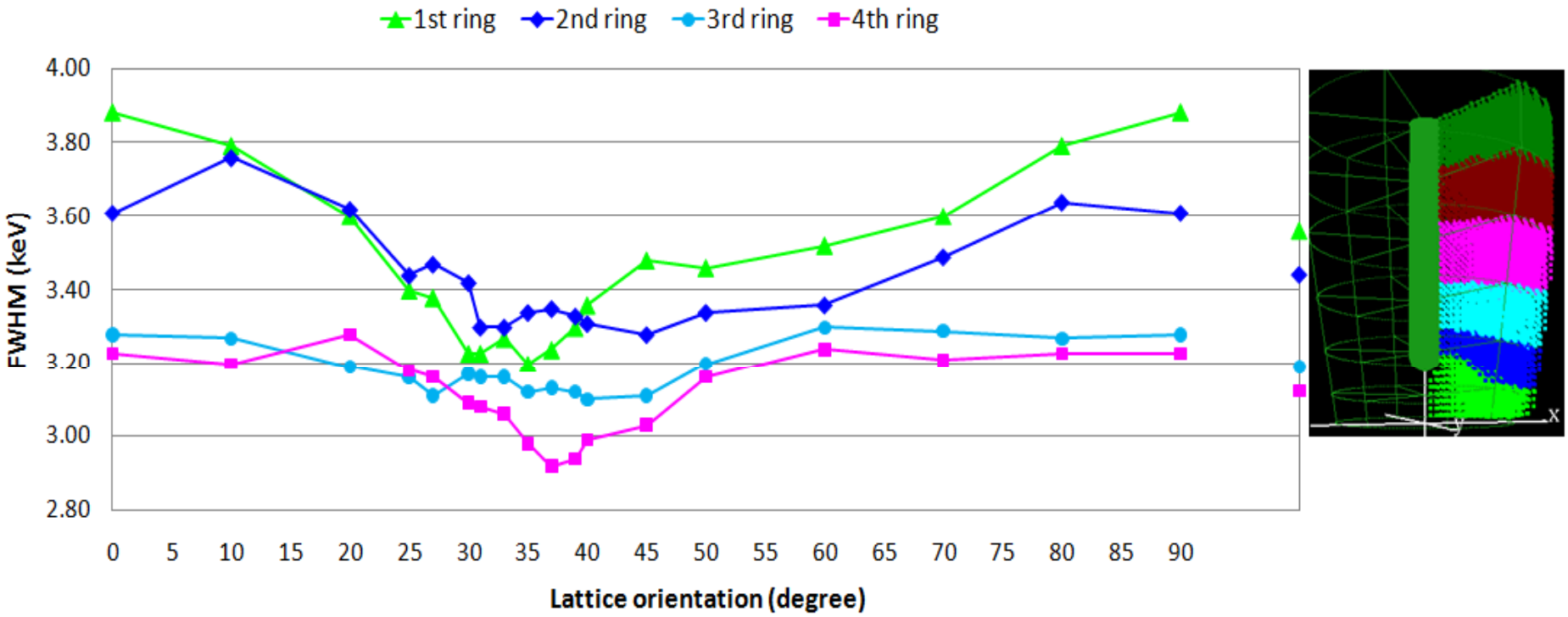


This optimization improves resolution of the peak by about 10%

The main contribution comes from the first ring where the effect of the crystallographic axis orientation is bigger

‘Bart’ calculation tuning

Optimization of the lattice orientation for RED (A001) looking at the FWHM of the Doppler corrected peak



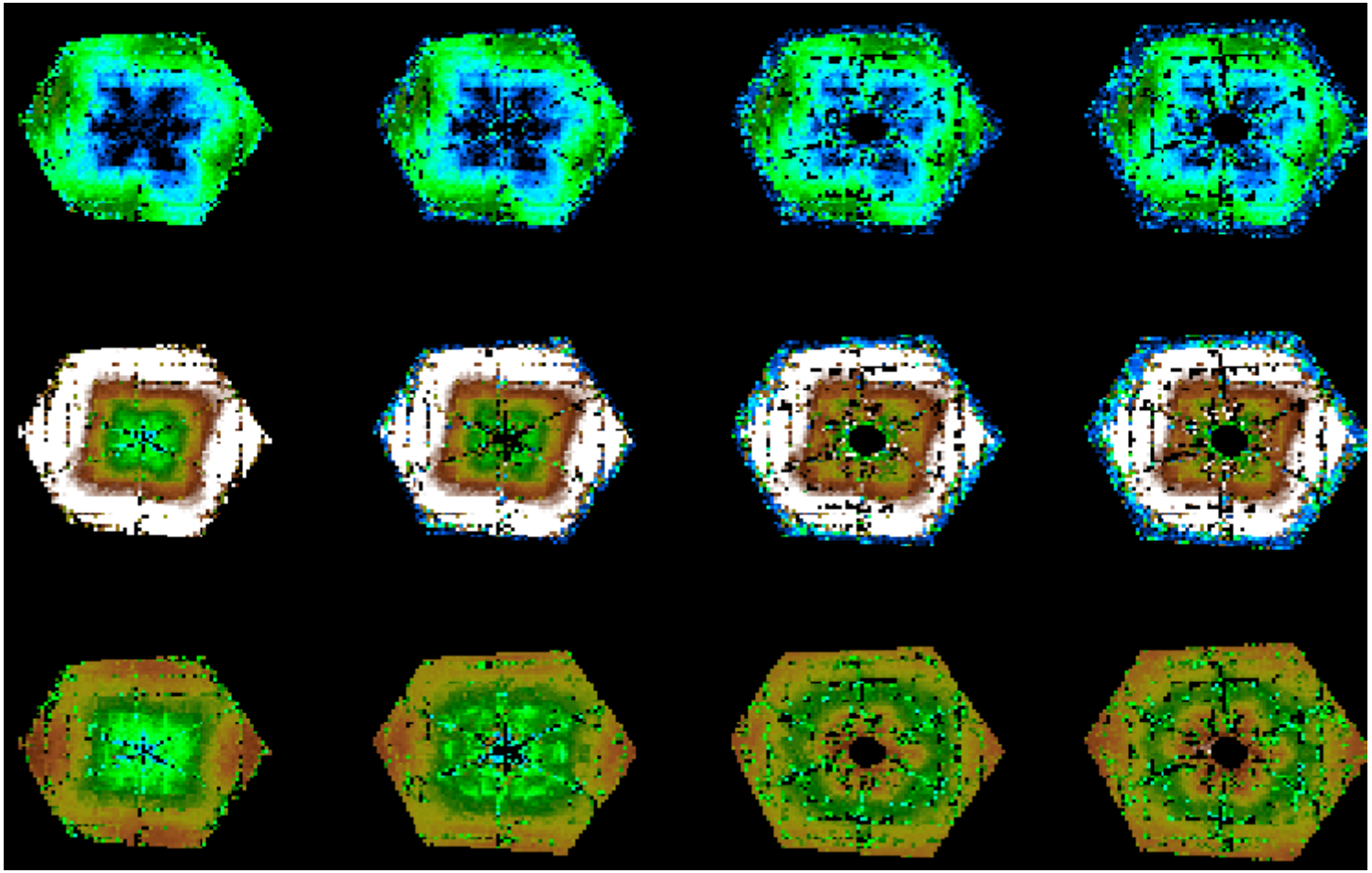
This improvement is present in all rings:

- **1st ring: 20%**
- **2nd ring: 14%**
- **3rd ring: 6%**
- **4th ring: 12%**

Due to the selection in Dante we are at the limit of statistics and cannot check the improvement on the individual segments

Core T10_90 calculated and measured

1 Average difference of measured and simulated
2 T10_90 matrix of simulated core signals
3 T10_90 matrix as average of the experimental values



Conclusions

The **Grid Search** algorithm implemented online has evolved into the **Adaptive Grid Search** preserving the quality of position identification and gaining ~one order of magnitude in speed

A partial analysis of the 2009_Week27 experiment has been done with good results that needs to be confirmed with the full analysis

This indirect method has been used to tune the signal basis; it should be repeated for other simulations and the other two crystals

So far, the PSA procedure is a delicate task not yet automatic;
it requires a particular attention to get reliable results