Characterisation of AGATA detectors

B. Birkenbach, B. Bruyneel, J. Eberth, H. Hess, D. Lersch, G. Pascovici, P. Reiter, A. Wiens
Institut für Kernphysik der Universität zu Köln, Zülpicher Straße 77, 50937 Köln, Deutschland

17th Euroschool on exotic beams 2010 - Santiago de Compostela, Spain

AGATA - Advanced GAmma Tracking Array

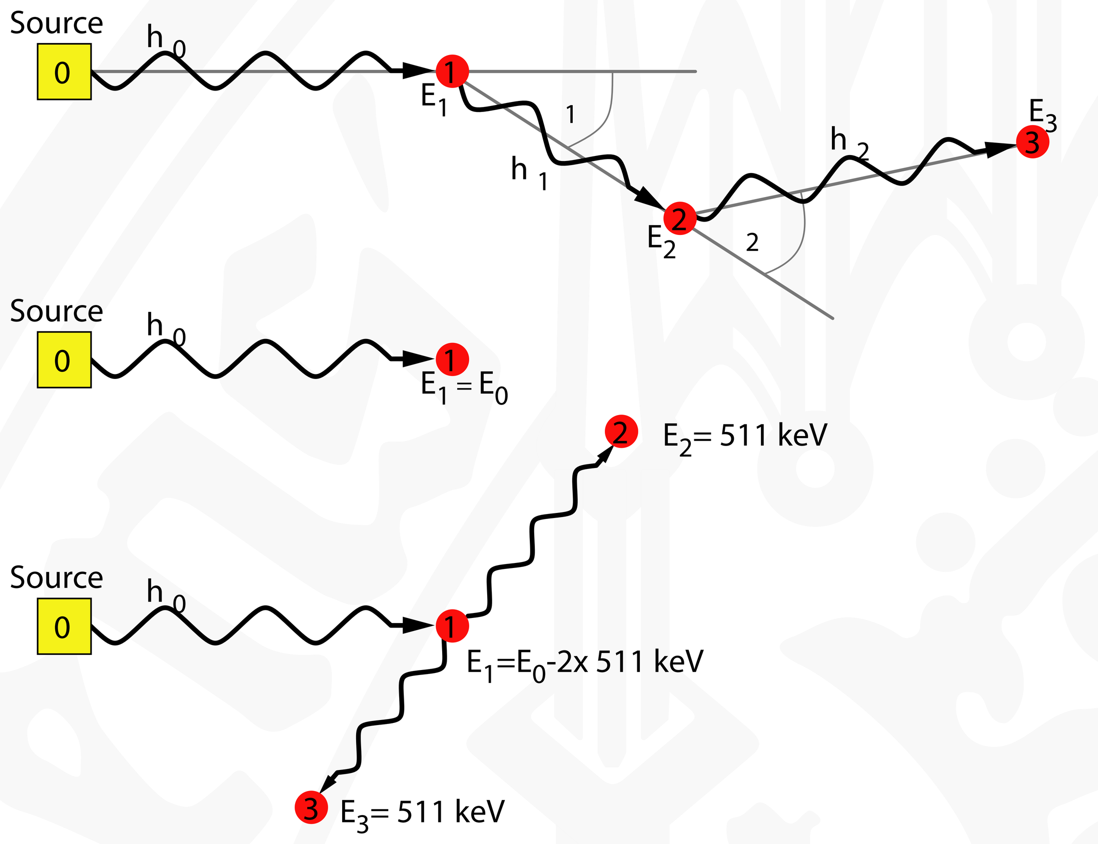
Basics of γ-ray tracking [1, 2]

Point like interactions of γ-rays in Germanium

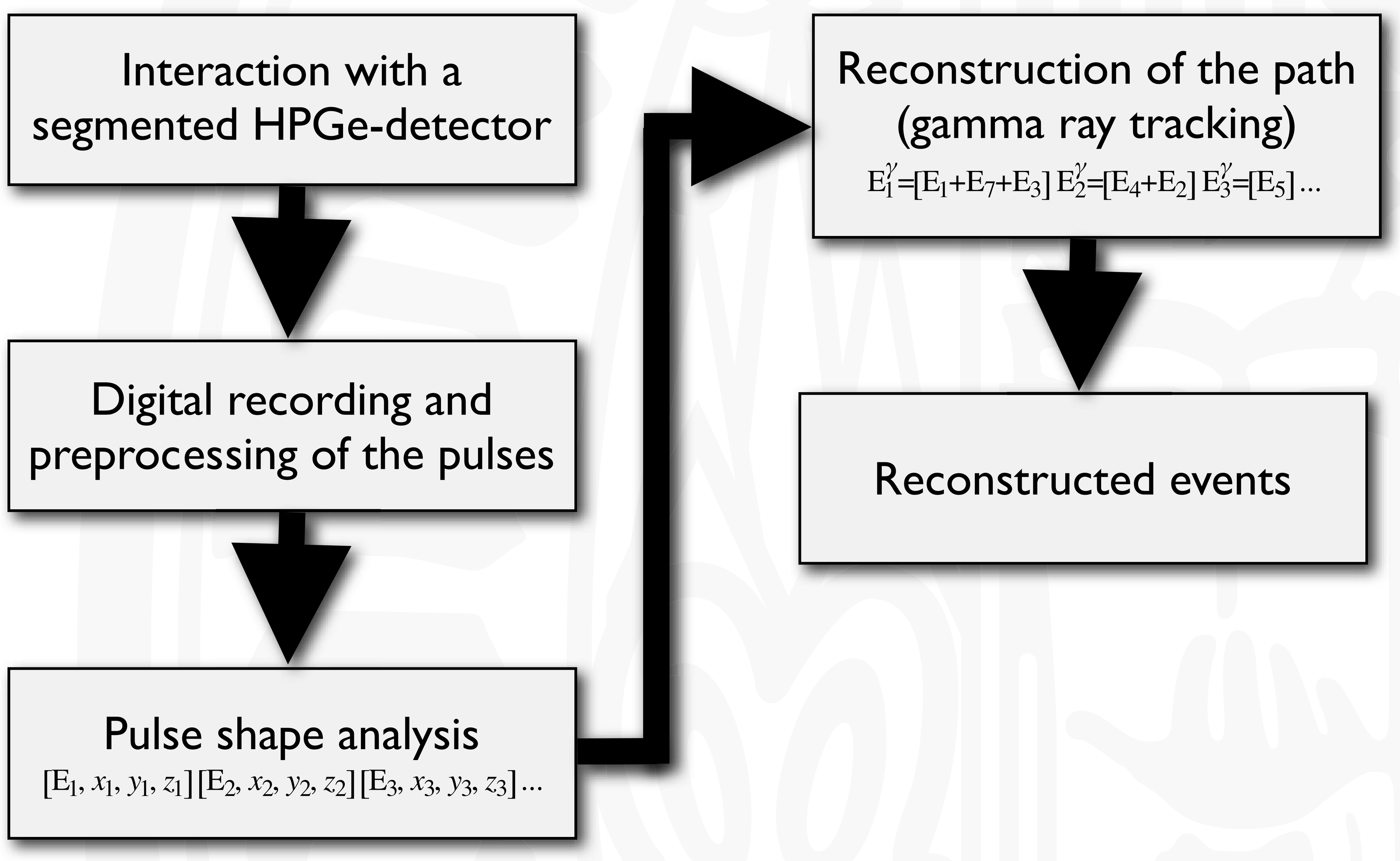
Compton scattering
(0.18 - 8 MeV)

Photo effect
(< 0.18 MeV)

Pair production
(> 8 MeV)



Data processing of AGATA for γ-ray tracking



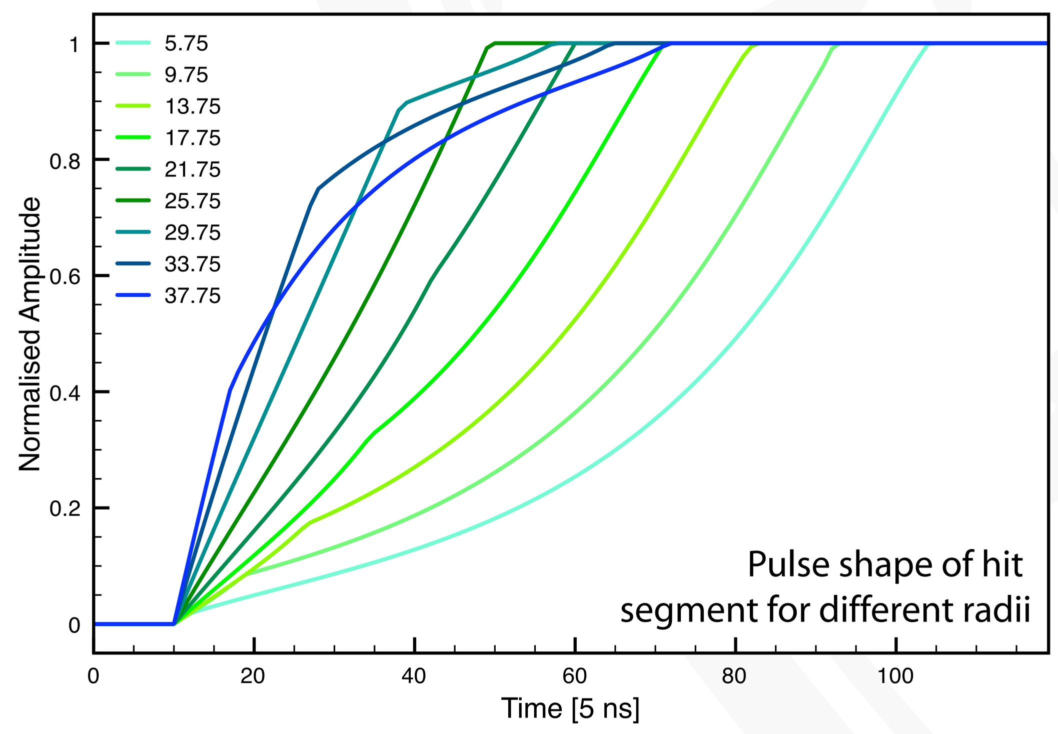
[1] *The Official AGATA homepage, http://www-w2k.gsi.de/agata*
[2] *Eberth, Simpson, From Ge(Li) detectors to gamma-ray tracking arrays - 50 years of gamma spectroscopy with Germanium detectors, Progress in Particle and Nuclear Physics 60 (2008), 283-337*

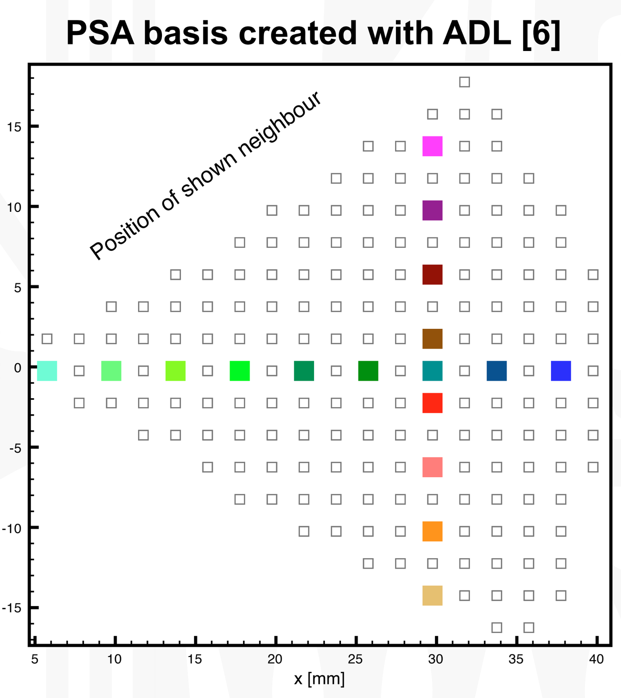
Pulse shape analysis (PSA)

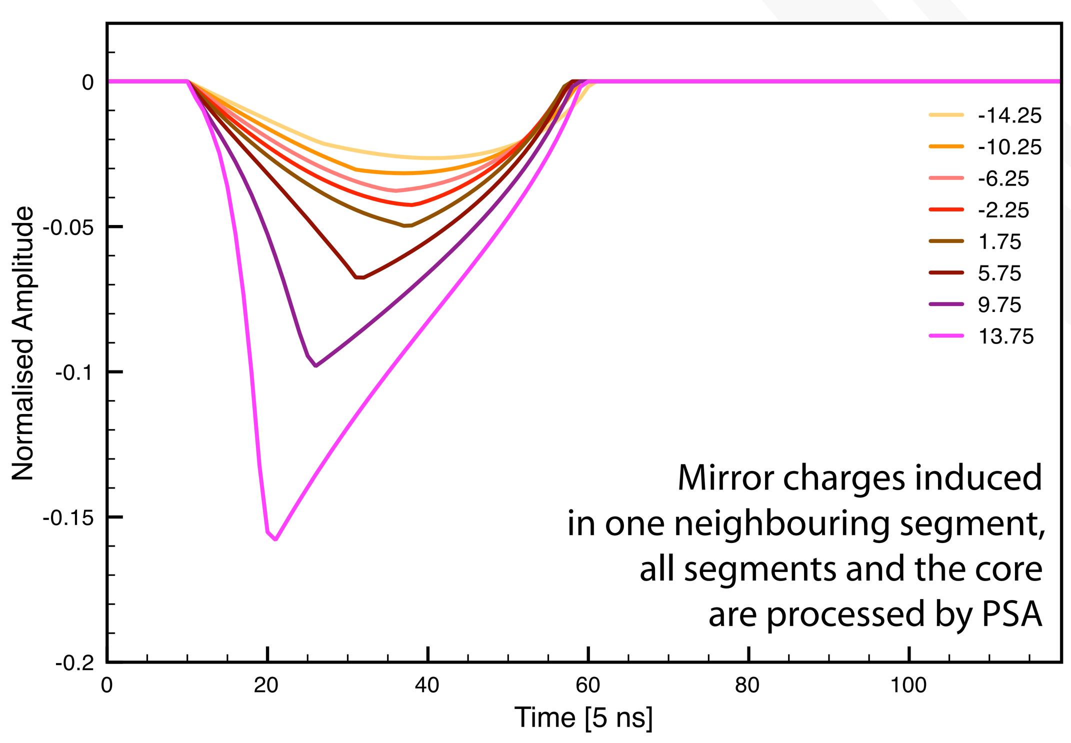
Parameters forming the pulse shape

Crystal
- Electron and hole drift velocities
- Geometry of the detector
- Orientation of the crystal axis
- Impurity concentration

Detector and Electronics
- Crosstalk
- Response functions







[3] *Bruyneel, et al., Characterization of large volume HPGe detectors. Part II: Experimental Results. NIM A (2006), 569, 764-773*
[4] *Wiens, et al., The AGATA triple cluster detector. NIM A (2010), 618, 223-233*
[5] *Bruyneel, et al., Crosstalk properties of 36-fold segmented symmetric hexagonal HPGe detectors, NIM A (2009), 569, 764-773*
[6] *AGATA Detector Library, http://www.ikp.uni-koeln.de/agata*

Crosstalk of segmented HPGe detectors

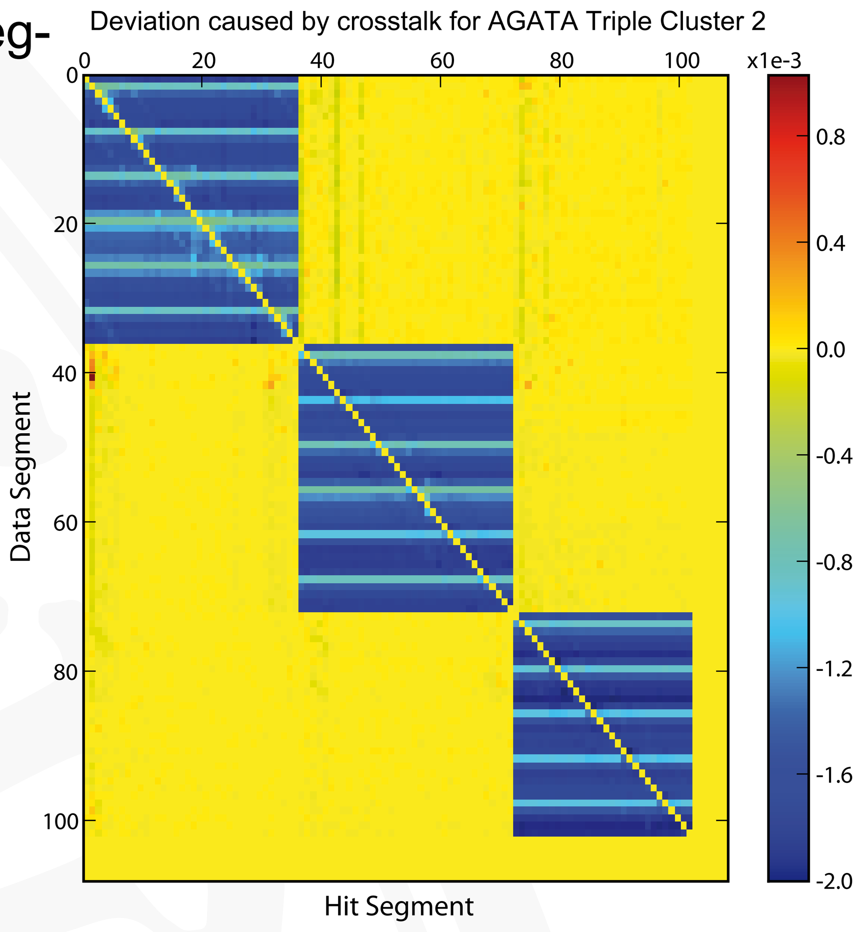
- Crosstalk caused by coupling of segments and core on 10^{-3} level
- Parameters measured with high accuracy
- Online correction of crosstalk implemented [7]

Ideal detector

$$\begin{pmatrix} E_{core} \\ E_{seg_1} \\ E_{seg_2} \\ \vdots \\ E_{seg_n} \end{pmatrix}_{meas} = \begin{pmatrix} 1 & 1 & \dots & 1 \\ 1 & 0 & \dots & 0 \\ 0 & 1 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & 1 \end{pmatrix} \cdot \begin{pmatrix} E_{seg_1} \\ E_{seg_2} \\ \vdots \\ E_{seg_n} \end{pmatrix}_{true}$$

Realistic detector

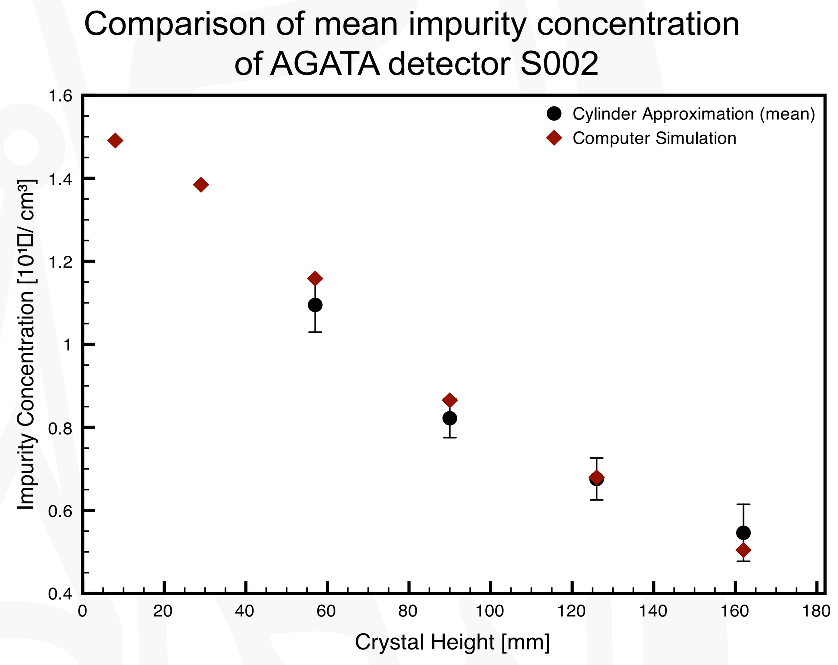
$$\begin{pmatrix} E_{core} \\ E_{seg_1} \\ E_{seg_2} \\ \vdots \\ E_{seg_n} \end{pmatrix}_{meas} = \begin{pmatrix} 1+\delta_{01} & 1+\delta_{02} & \dots & 1+\delta_{0n} \\ 1 & \delta_{12} & \dots & \delta_{1n} \\ \delta_{21} & 1 & \dots & \delta_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \delta_{n1} & \delta_{n2} & \dots & 1 \end{pmatrix} \cdot \begin{pmatrix} E_{seg_1} \\ E_{seg_2} \\ \vdots \\ E_{seg_n} \end{pmatrix}_{true}$$



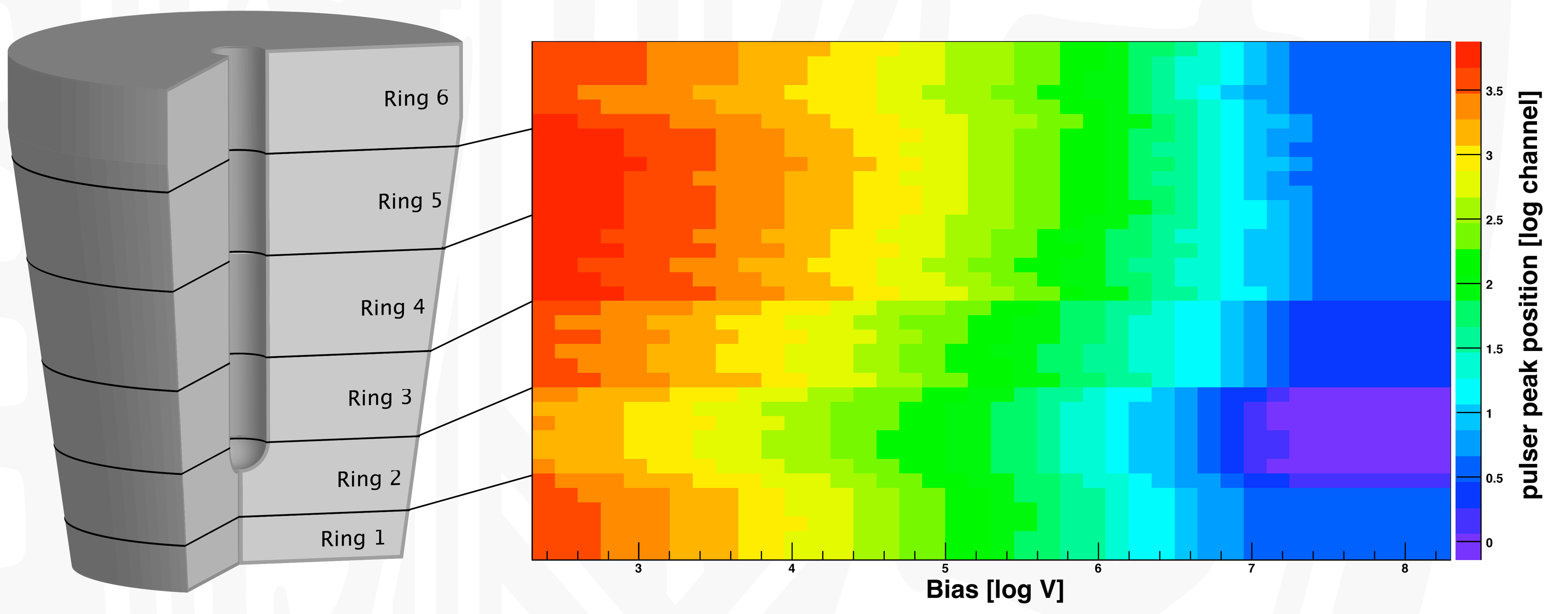
[7] *Bruyneel et al., Crosstalk corrections for improved energy resolution with highly segmented HPGe-detectors, NIM A (2009), 99-106*

Impurity concentration of AGATA detectors

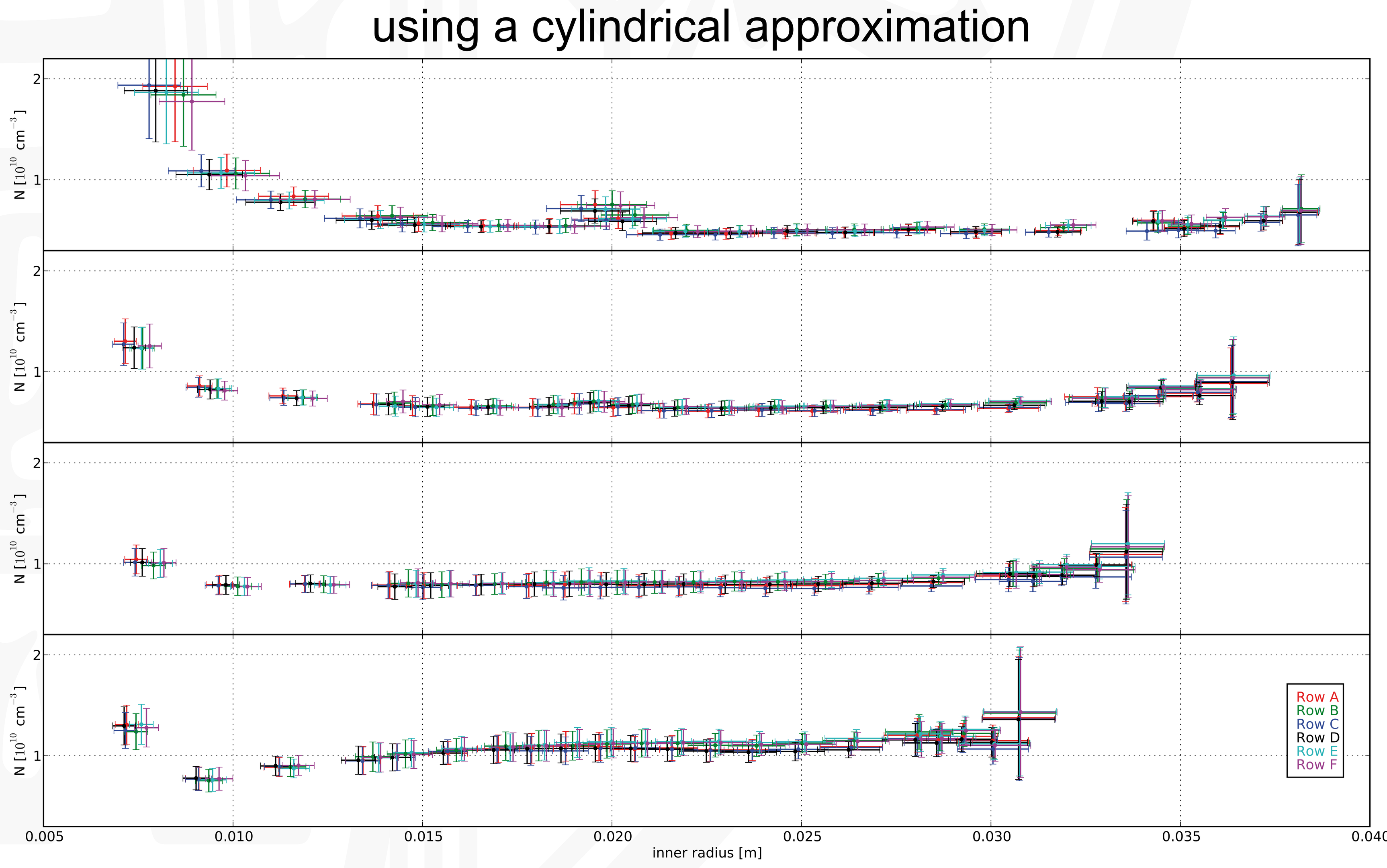
- New method to determine impurity concentration
- Based on capacitance voltage analysis
- Pulser of AGATA preamplifier used to measure capacitance of core and segments
- Fast reliable method
- Feasible with standard configuration
- Agreement with computer simulations in cylindrical segments
- Simulations needed for hexagonal part



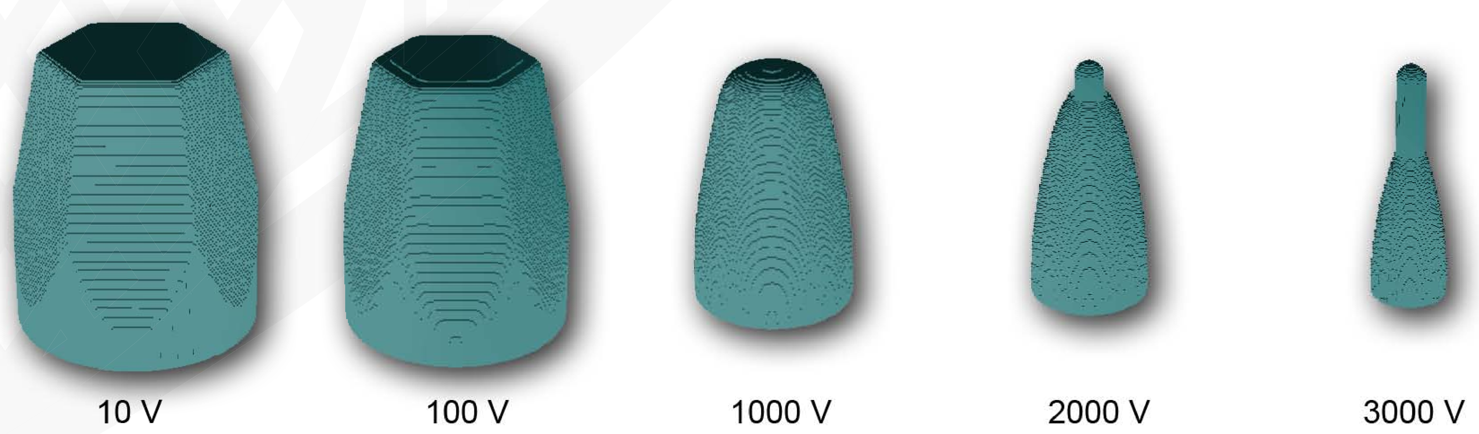
Pulser peak position for different voltages of detector C006



Impurity concentration of last four rings of AGATA detector S002 using a cylindrical approximation



Computer simulations using AGATA Detector Library [6]



Depletion boundary and core electrode