Consistency check of Pulse Shape Discrimination for Broad Energy Germanium Detectors using double beta decay data

Outline:

- **Motivation**
- **Data Analysis**
- **Outlook & Summary**

Heng-Ye Liao

Max-Planck-Institut für Physik

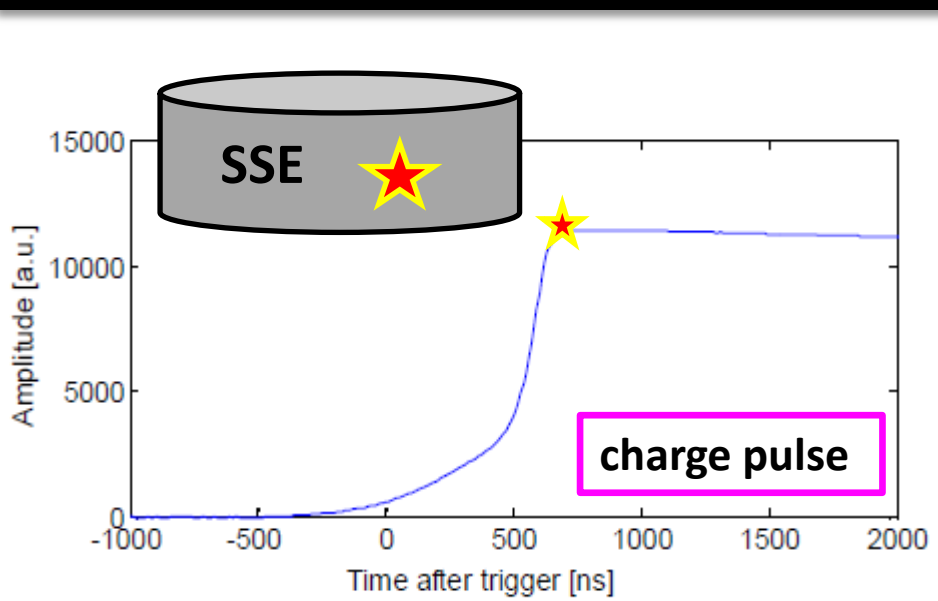
DPG-Frühjahrstagungen

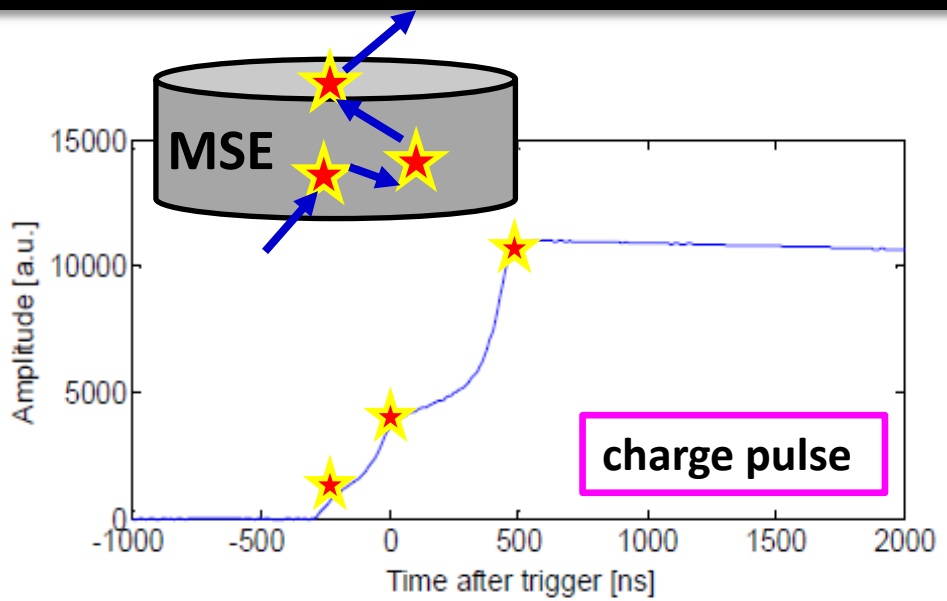
@ Dresden, Deutschland, 04/03/2013

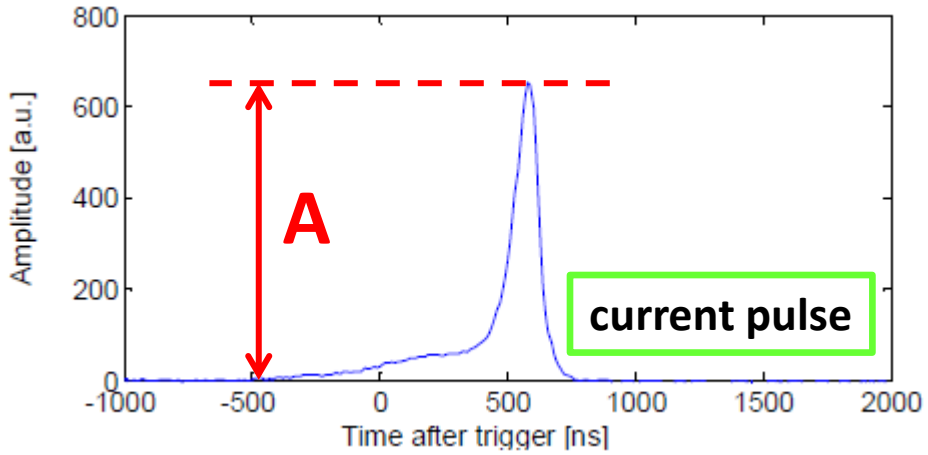
Motivation

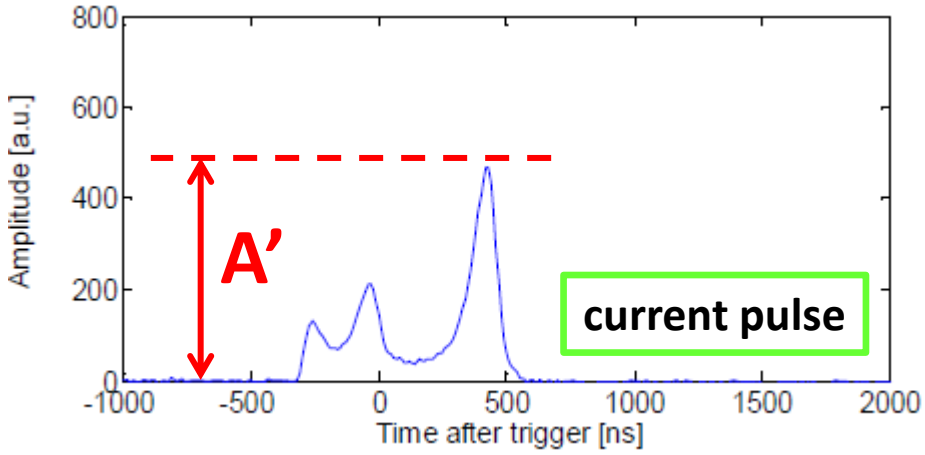
- GERDA: Searching for 0νββ decay
- Background recognition utilizing PSD method
- Define PSD parameters for SSE/MSE discrimination using calibration data
- Event topology & event location distribution :
  - 0νββ ≅ 2νββ except E dependence
  - Calibration ?= 0νββ
- Investigate systematic uncertainty due to event topology & event location on PSD
- The method:
  Comparison of PSD for 2νββ/calibration data

A/E : Pulse Shape Discrimination Method





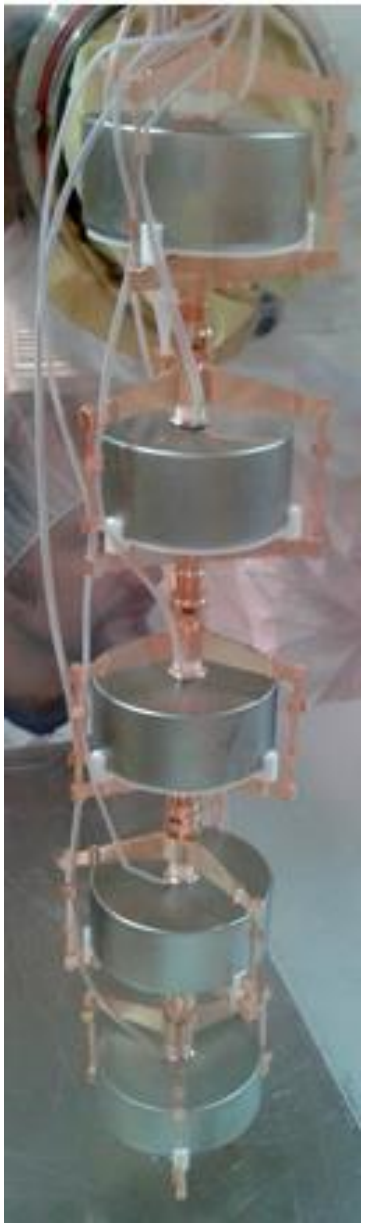




Dušan Budjaš et al, JINST 4 P10007, 2009

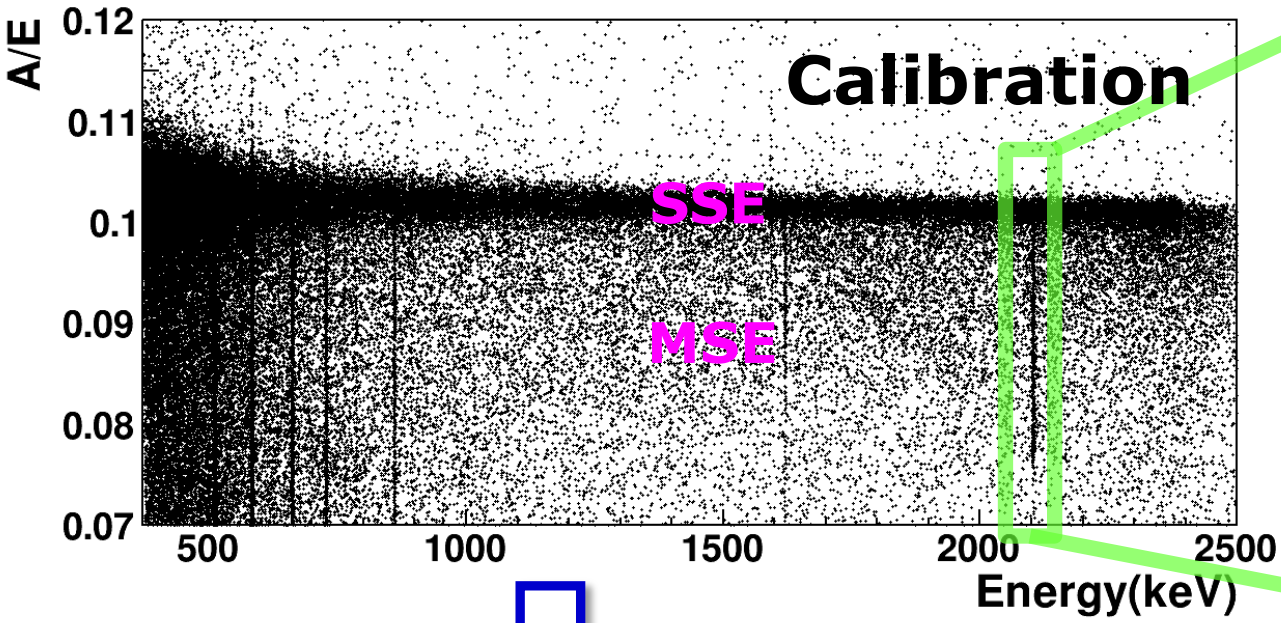
- **A/E PSD method:**
  Use "Ratio of Maximum Amplitude to Energy"
  for discriminating SSE/MSE

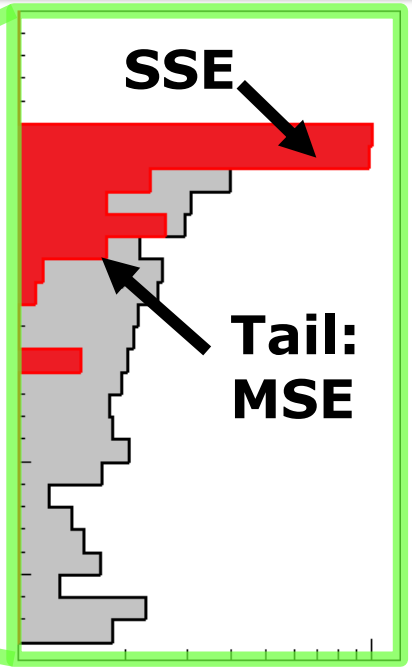
Pre-test mode for GERDA Phase-II

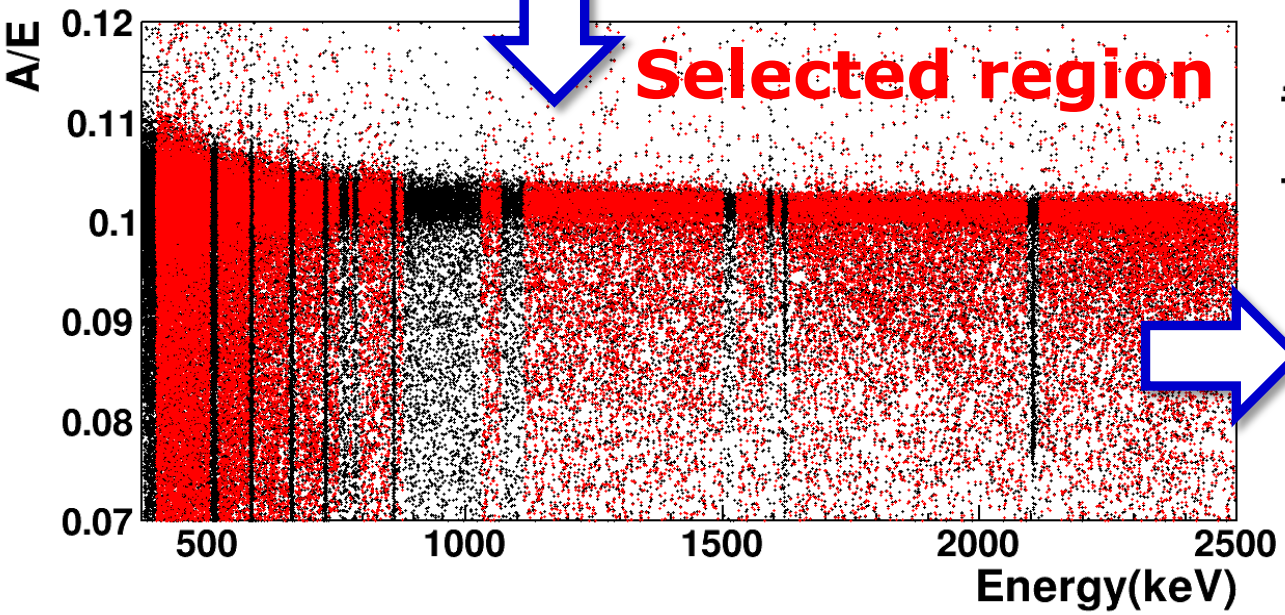


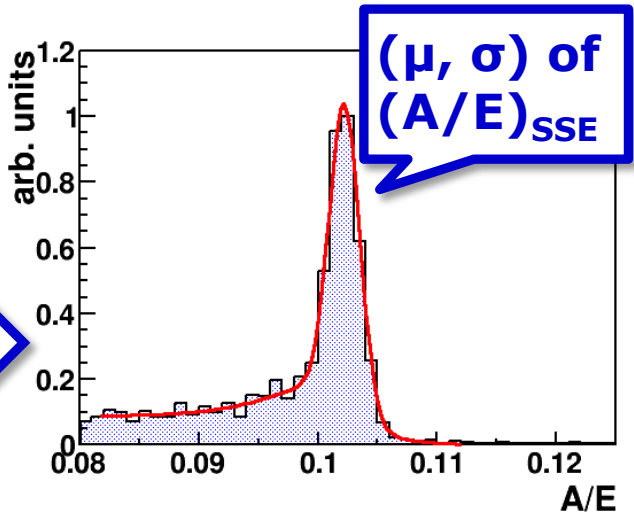
- GERDA Phase-I using 6 coaxial ^{enr}Ge detectors
- Pre-test mode for Phase-II: Additional 5 ^{enr}BEGe detectors
- Advantages of BEGe detectors:
  - ΔE < 3.0keV @ 2.6 MeV
  - Powerful PSD: A/E parameter
- Total mass of ^{enr}BEGe detectors:
  - 3.6 kg
- Data taking: Since July, 2012
- Exposure:
  - 2νββ: 1.51 kg·yr
  - Calibration: 88.04 kg·hr

SSE for calibration data

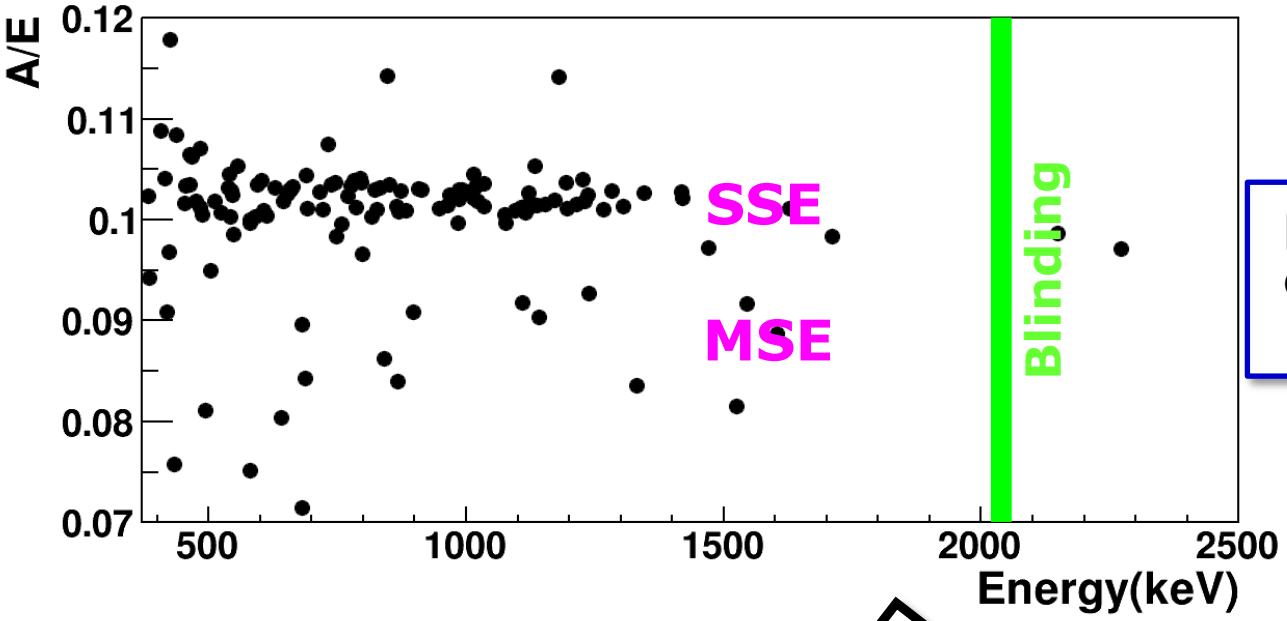




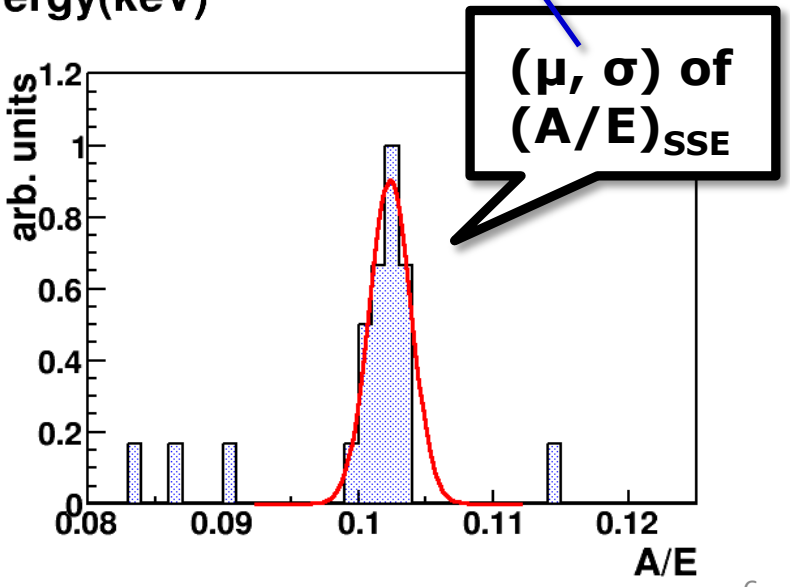




SSE for 2νββ data

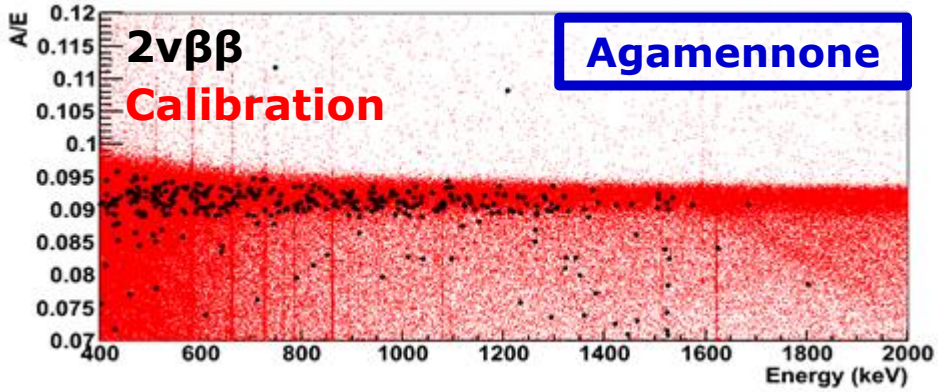


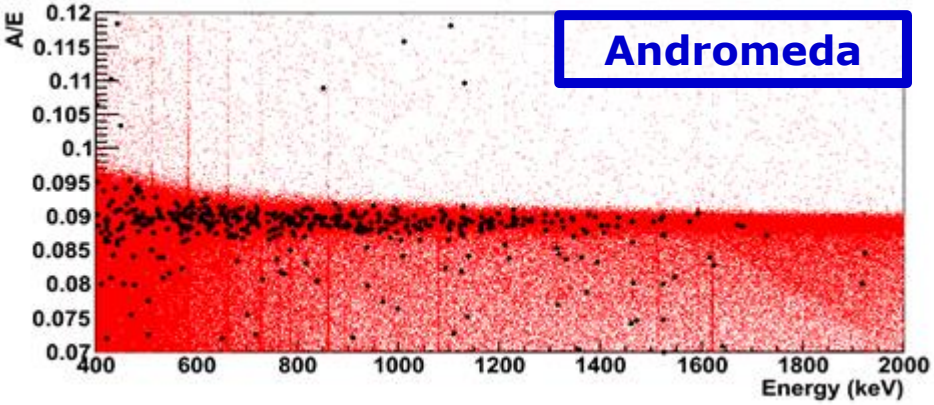
μ: mean value
σ: standard deviation of fitted Gaussian

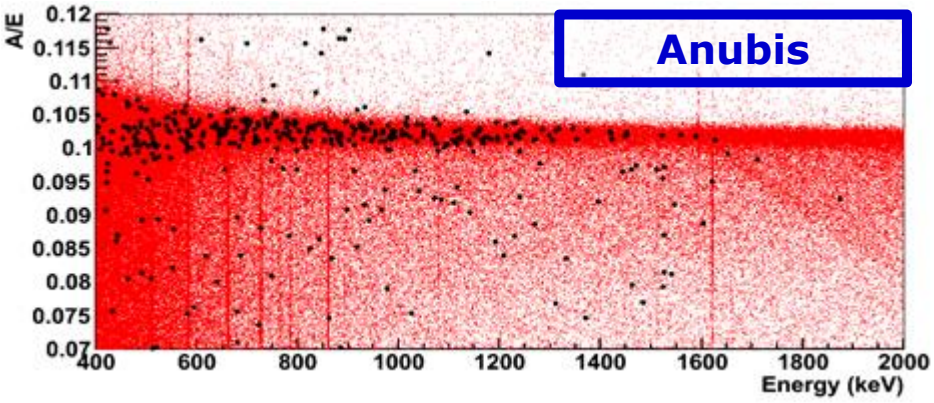


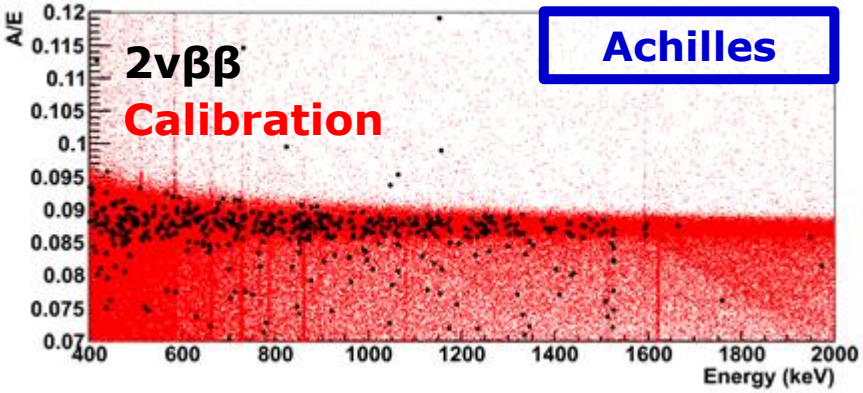
- **Energy region for consistency check : 600 keV - 1.2 MeV, ΔE = 200 keV**

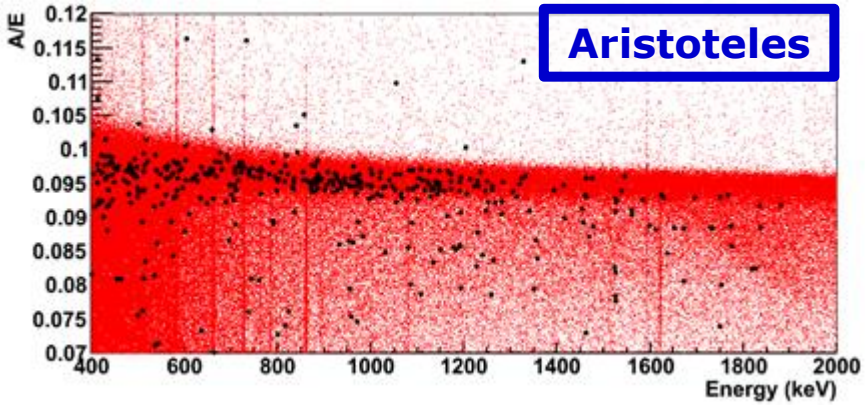
A/E-versus-E for 2νββ/calibration data



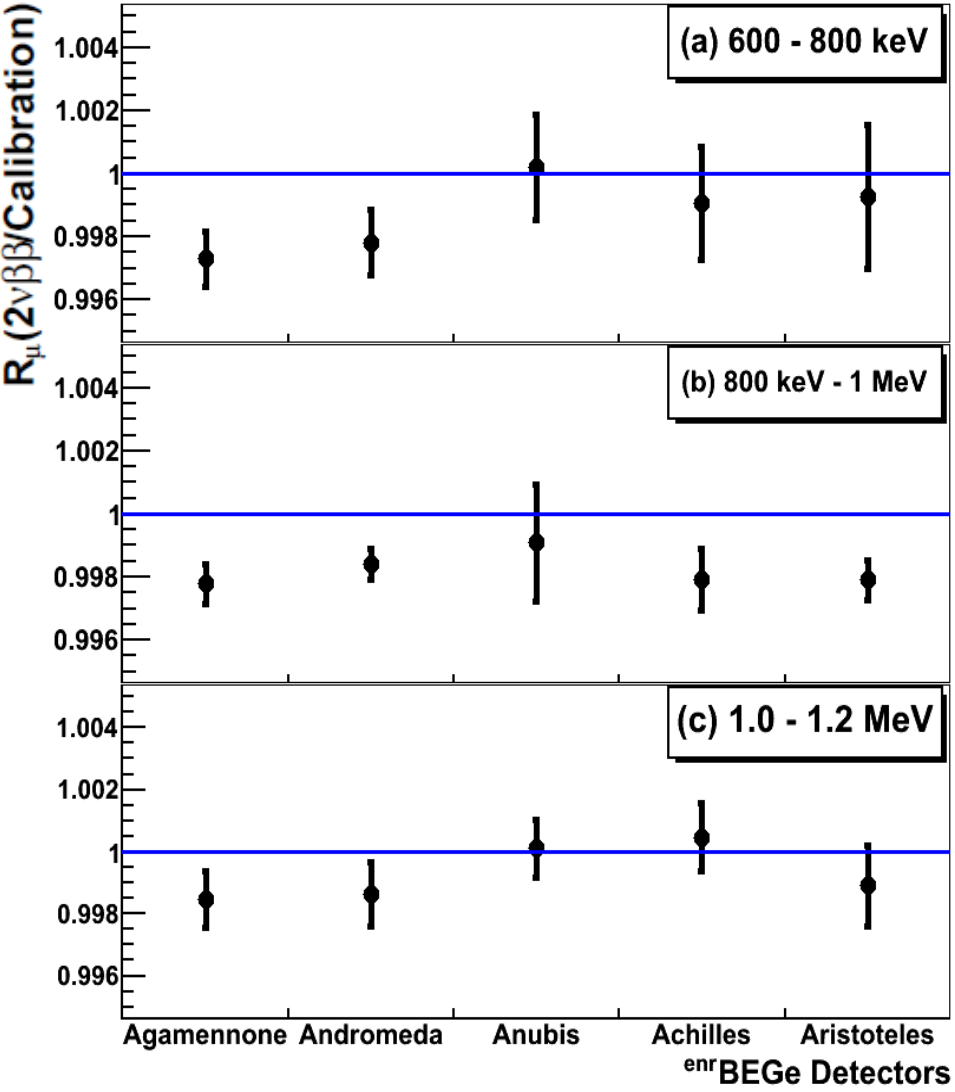


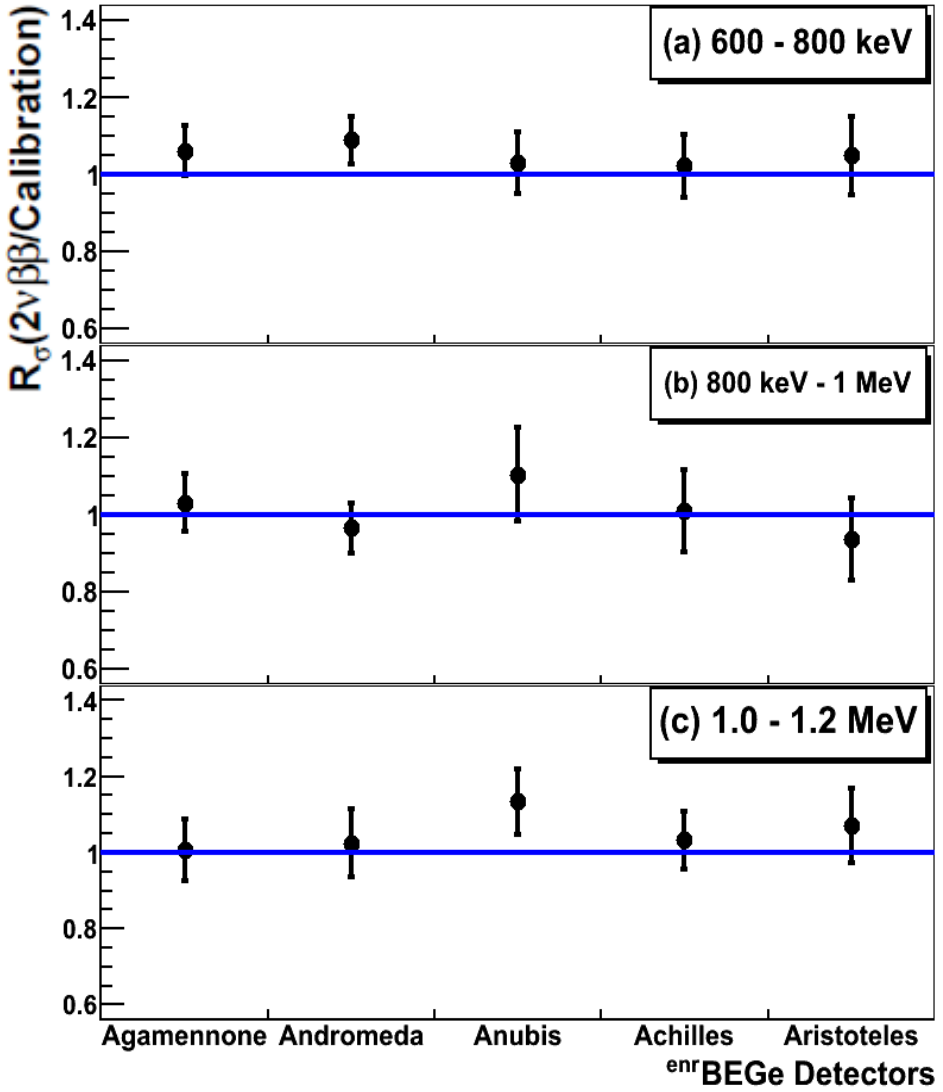






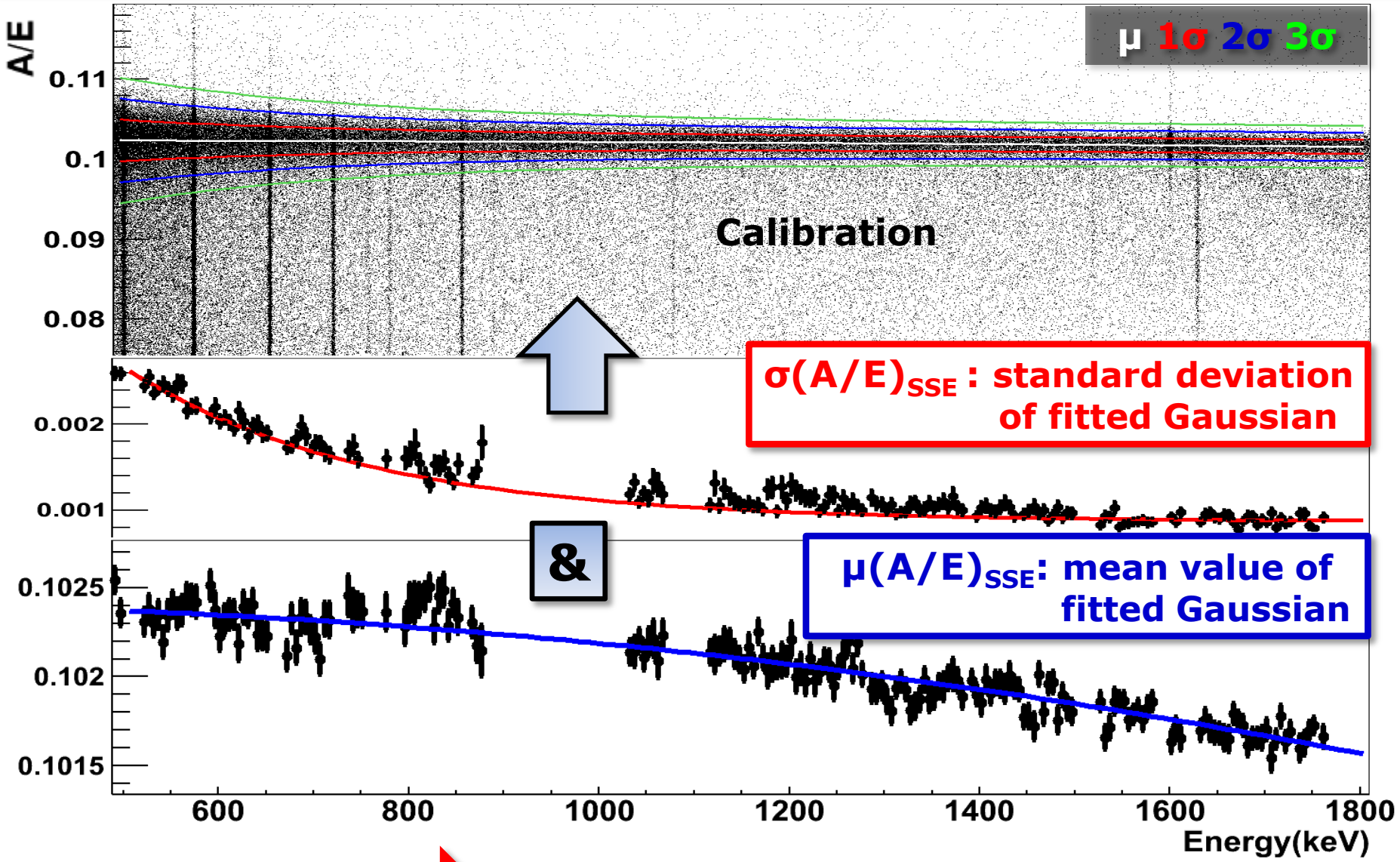
Consistency check for two methods





➢ **No systematic uncertainty of A/E was found!**

A/E Resolution as function of Energy



- A/E (E) ➡ Improvement in recognition efficiency of SSE/MSE

Outlook & Summary

- **PSD can reduce background & improve sensitivity for 0νββ experiments**
- **A/E for BEGe provides powerful SSE/MSE pulse shape recognition efficiency**
- **Topological & event location difference between 2νββ/calibration data**
- **Deviations between methods dominated by statistical uncertainties**
- **Possible improvement in recognition eff. of SSE/MSE by A/E(E)**