



Max-Planck-Institut für Physik  
(Werner-Heisenberg-Institut)



EBERHARD KARLS  
UNIVERSITÄT  
TÜBINGEN



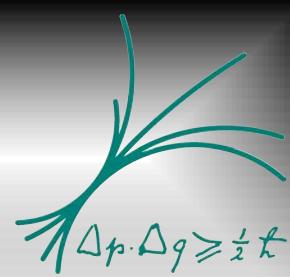
# Deutsch-Chinesische-Kooperationsgruppe

## Development of High Purity Germanium Detector Techniques for Applications in Fundamental Research

Finanziell unterstützt durch: Chinesisch-Deutsches Zentrum für Wissenschaftsförderung Peking, China

中德合作研究小组  
应用于基础研究的高纯锗探测器技术研发

资助者:中德科学中心 / 中国 北京



# Segmented coaxial detectors:

## effect of metallization

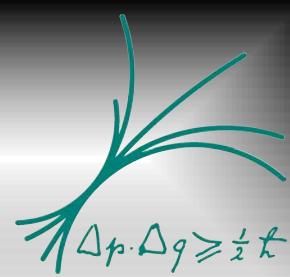
**Matteo Palermo**

**Sino-German GDT Cooperation  
Symposium 2015, Ringberg Castle**

On behalf of the GeDet group  
Max-Planck-Institut für Physik, München



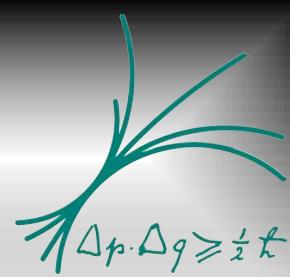
# Disclaimer



This is a  
**VERY** preliminary  
qualitative study.  
  
**(Started last week)**



# Outline



- **The goal**
- Fully and partially metallized 19-fold segmented detector(s) comparison
  - The first attempted analysis
  - A 18-fold segmented detector with different metallization on segments
  - The Ba-133 scan
- Summary & Conclusions



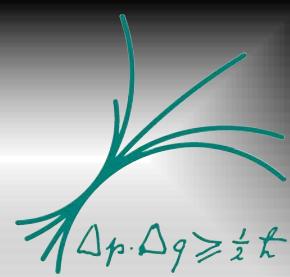
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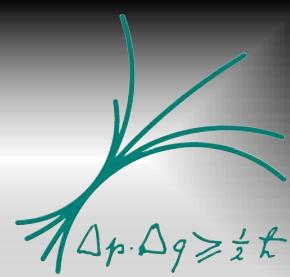
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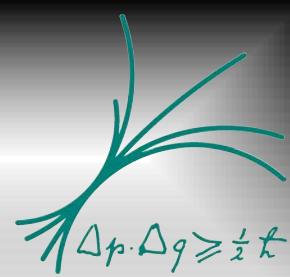
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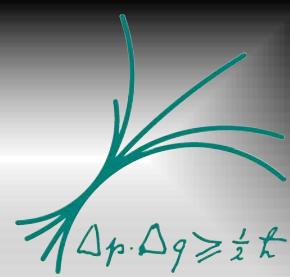
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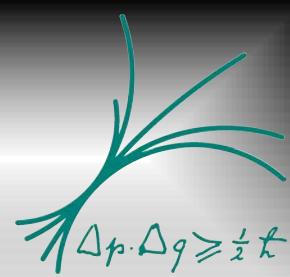
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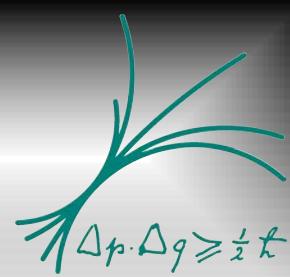
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# The Goal



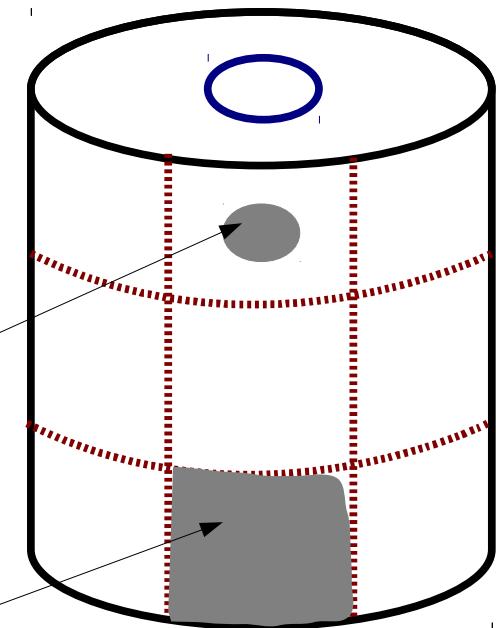
- Effect of metallization for segmented coaxial detectors on:

Alu = bkg?

- Energy resolution
- Charge trapping events

NOT fully

fully





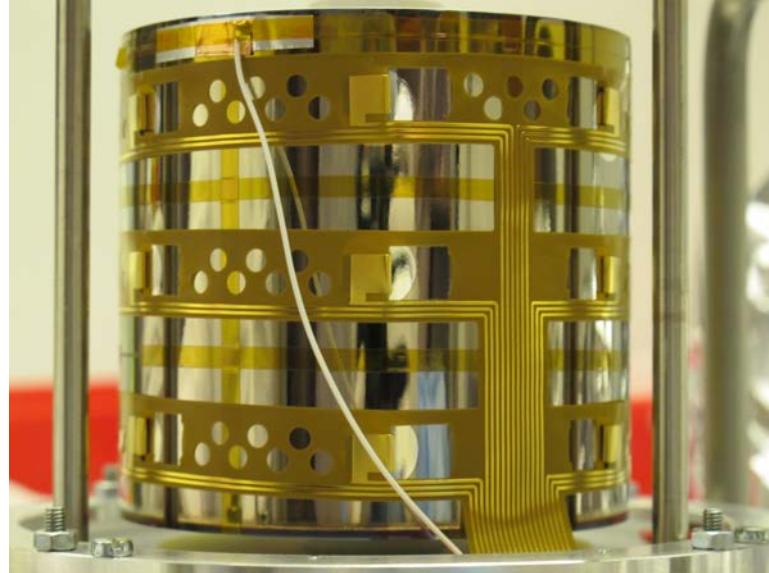
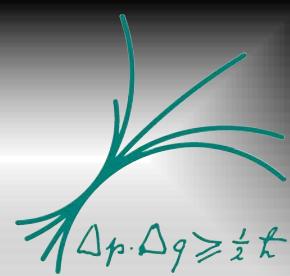
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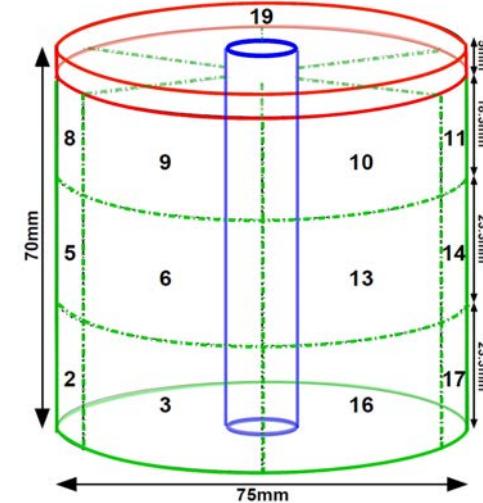
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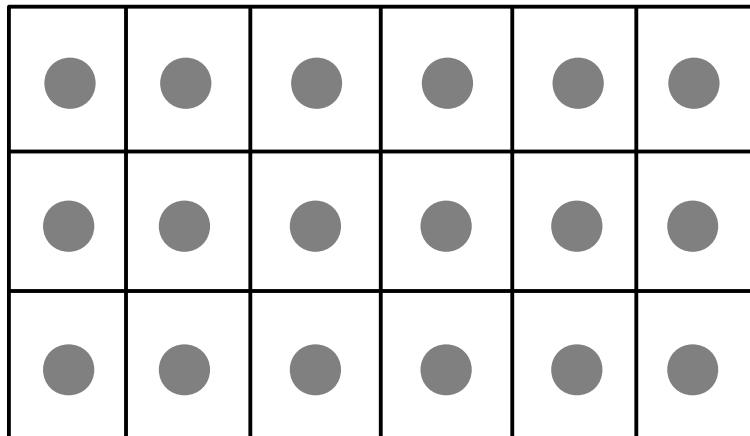
# SuperSiegfried



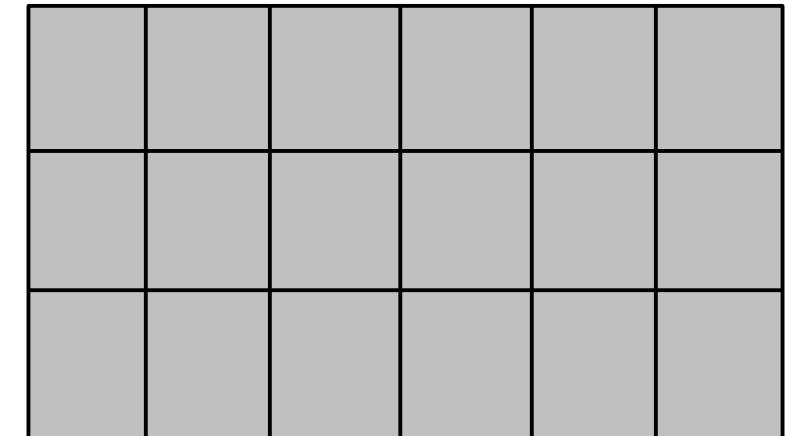
- 19-fold (1+3 z, 6  $\Phi$ ) segmented coaxial detector
- n-type



**BEFORE:** NON-fully metallized seg.



**AFTER:** Fully metallized seg.





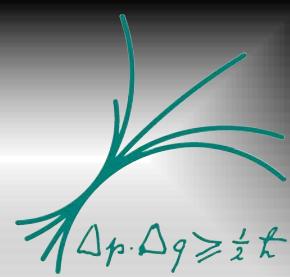
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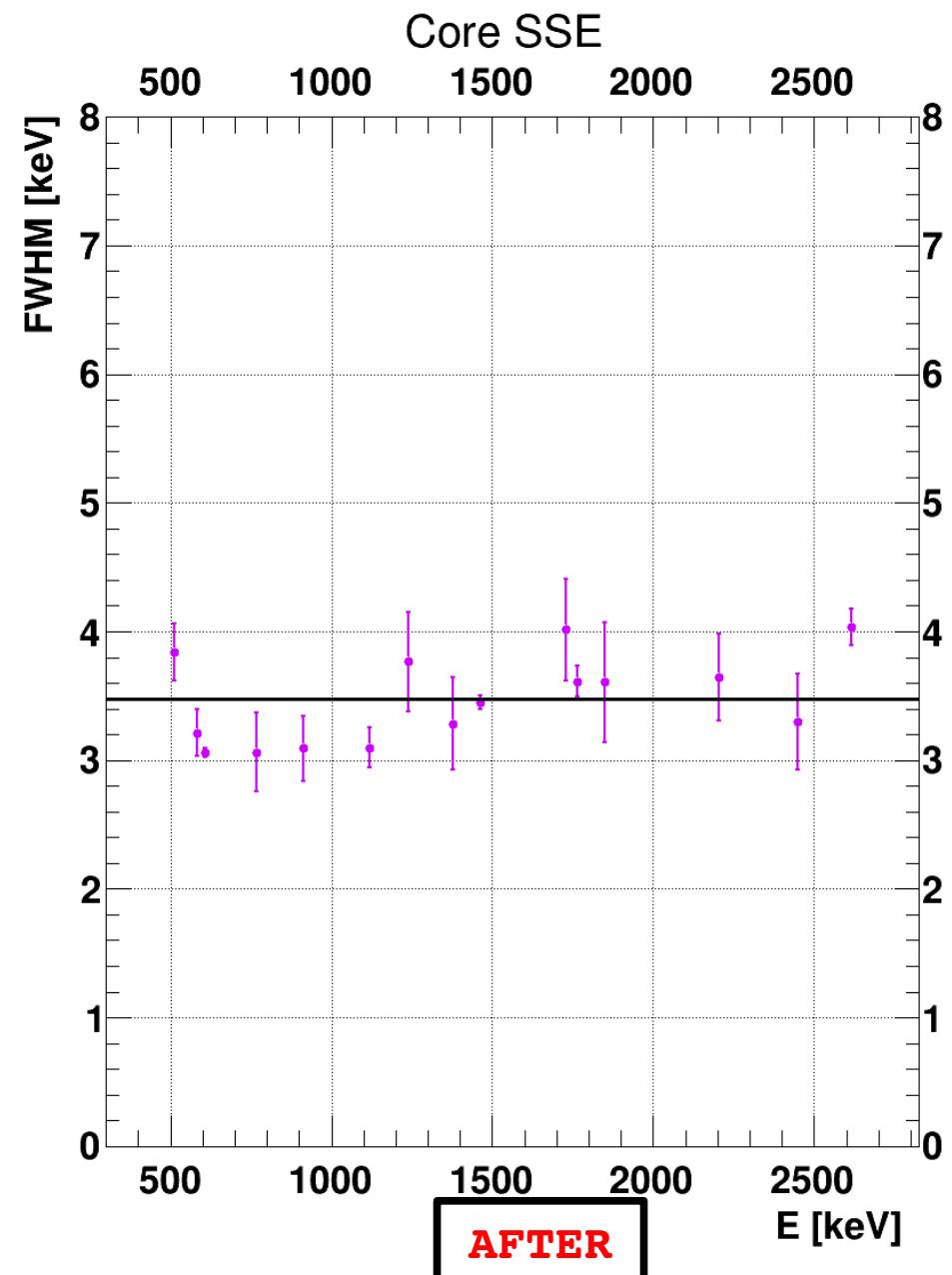
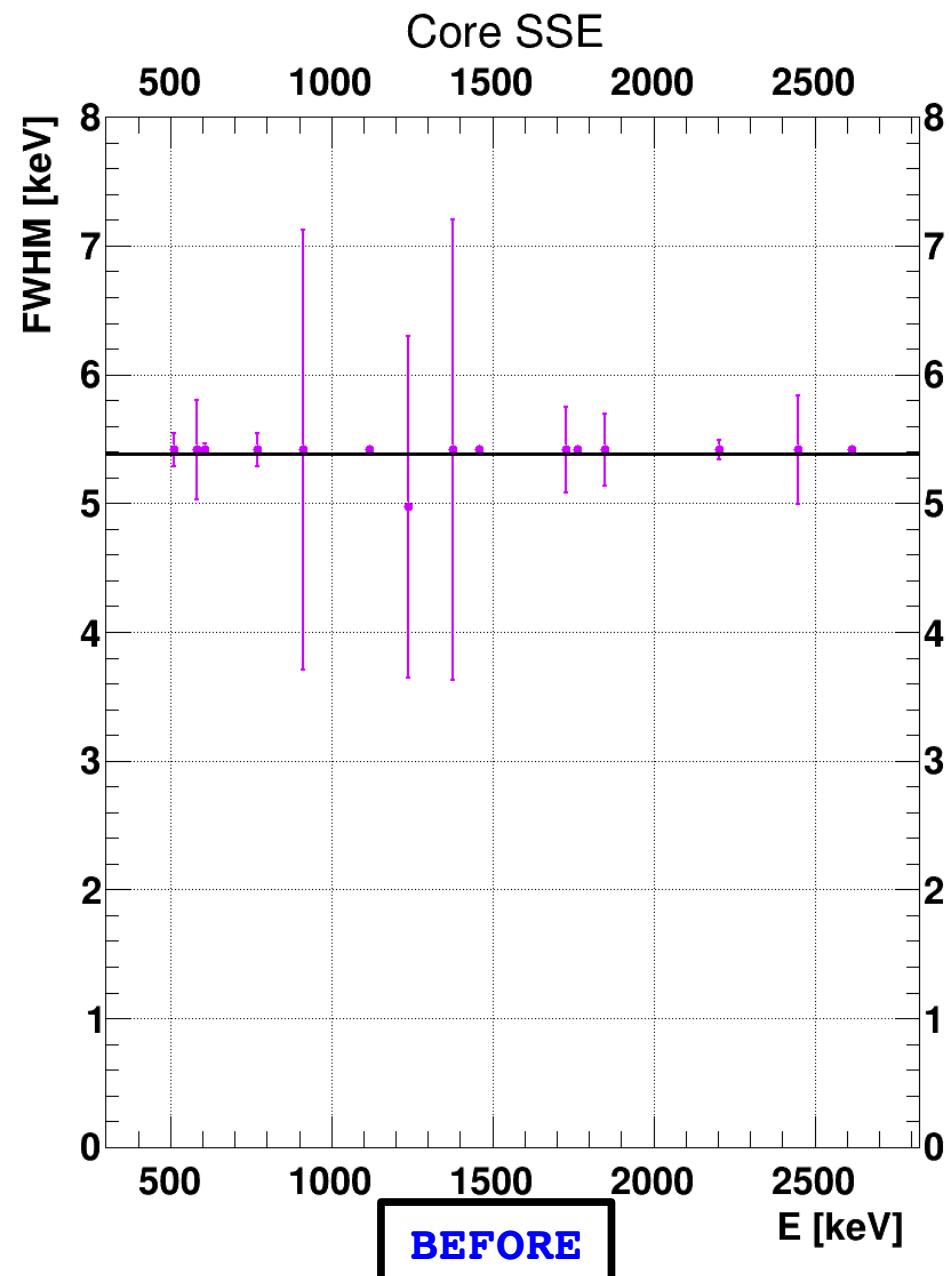
# First Attempted Analysis



- Choose ~15 peaks (bkg in this case)
- Select Single Segments Events (**SSE**)
- Fit them with a **Gaus + poll** using an **automatic(!!)** routine
- Get the energy resolution (**FWHM**)
  - Compare **BEFORE** and **AFTER**
- For each segment:
  - Fraction of ev. With **Eseg < Ecore-1\*FWHM**
  - Fraction of ev. With **Eseg > Ecore+1\*FWHM**

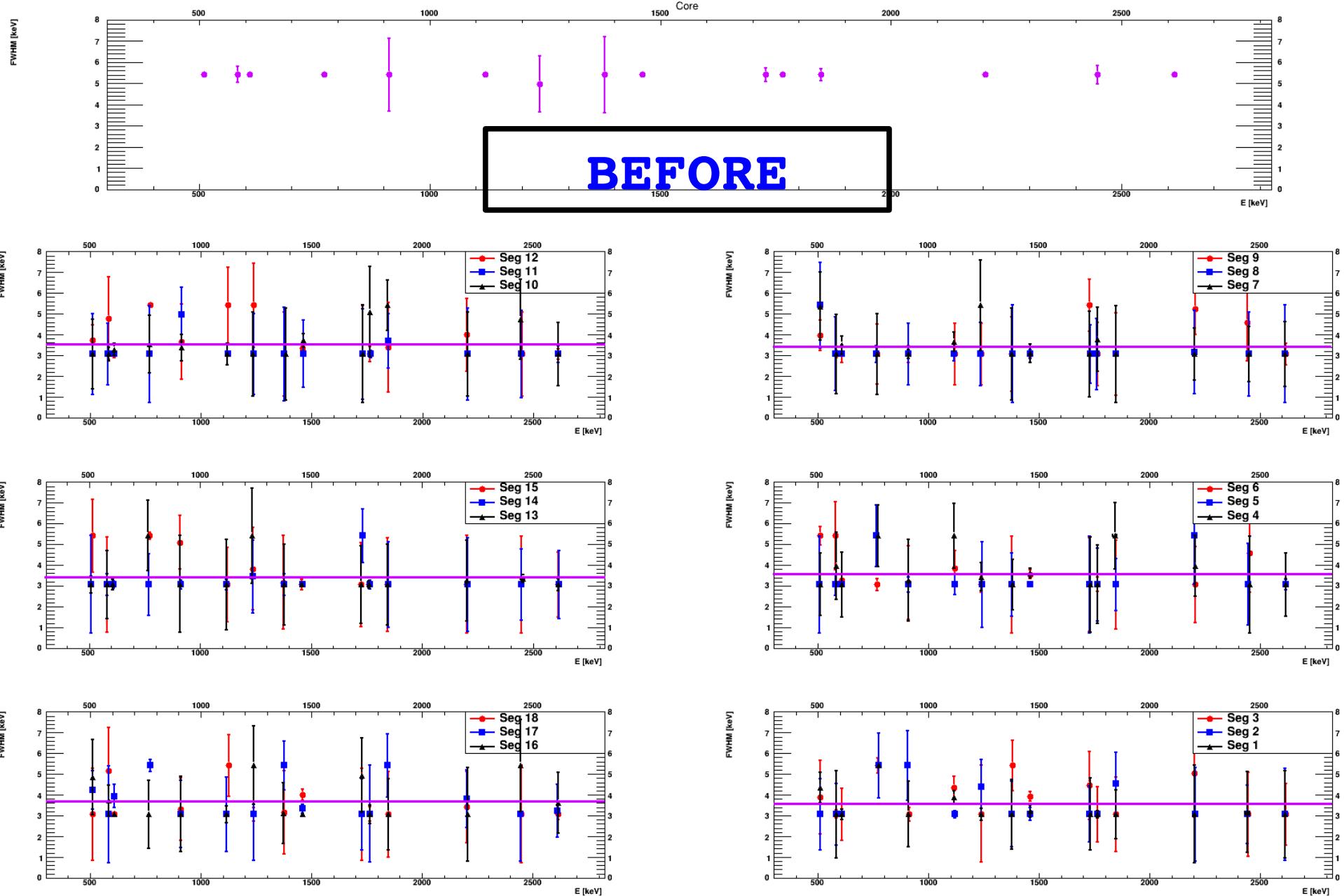


# FWHM Core SSE



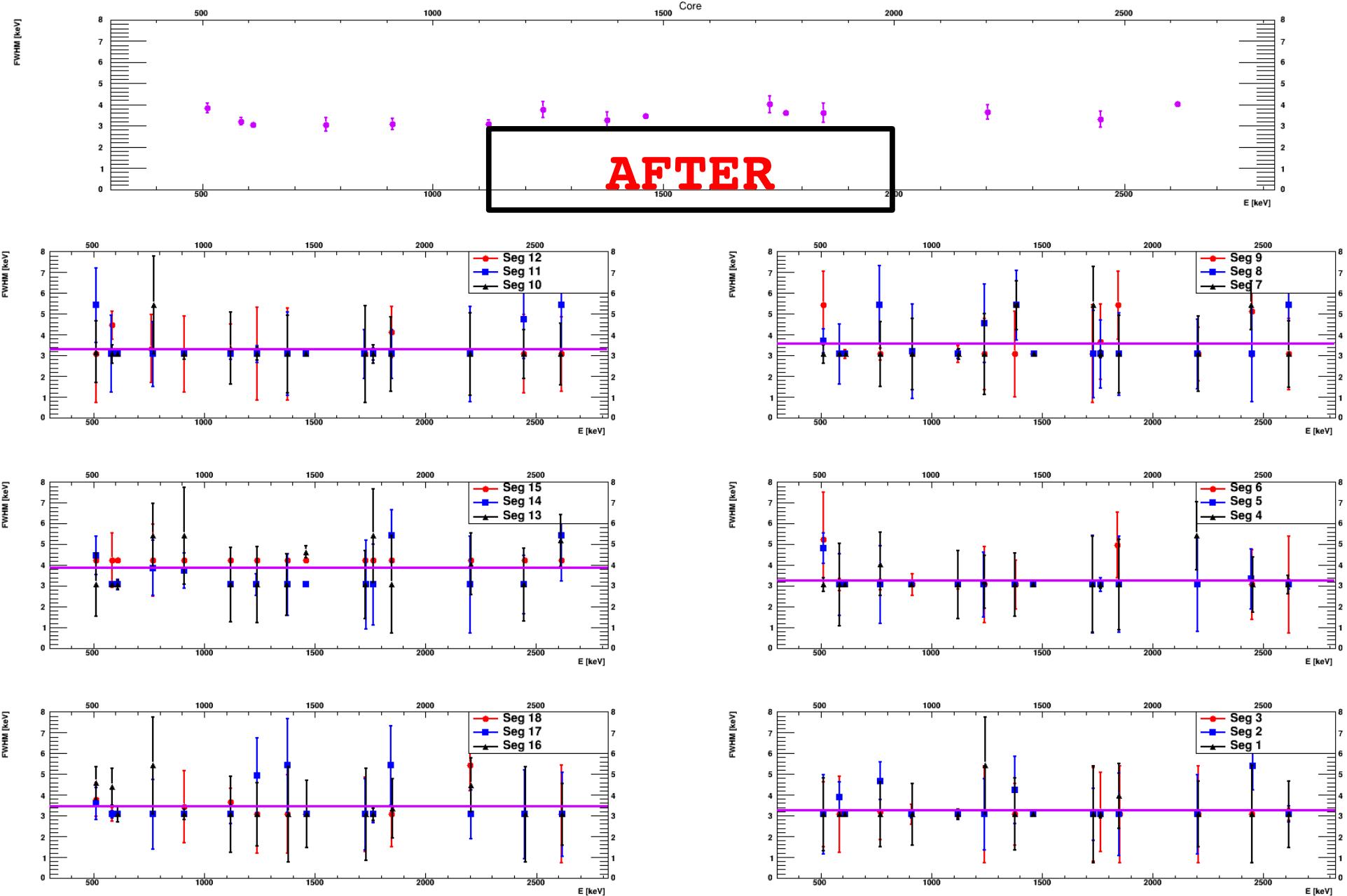


# FWHM seg. SSE



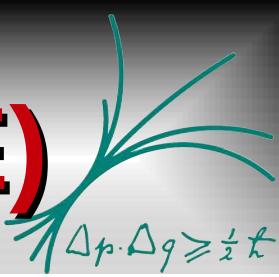


# FWHM seg. SSE

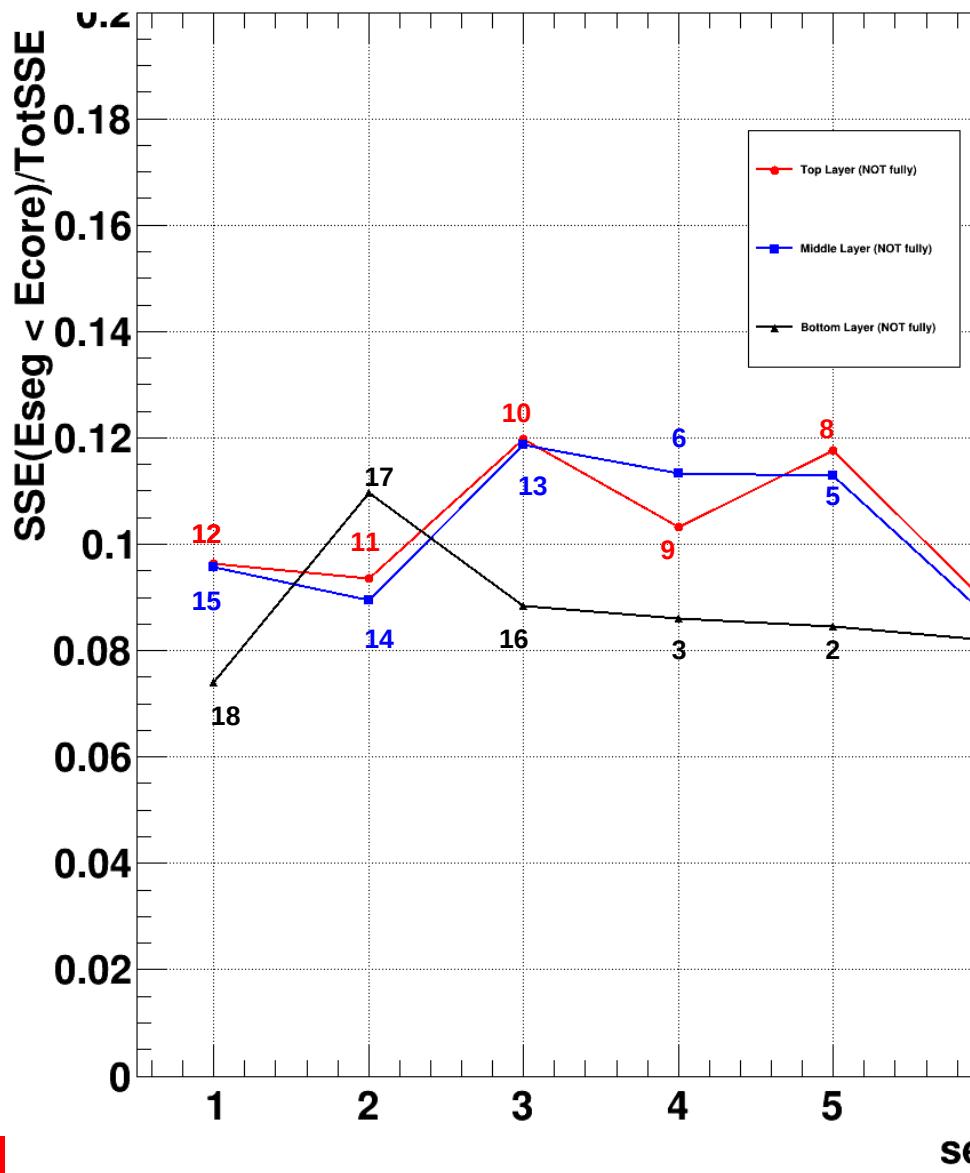




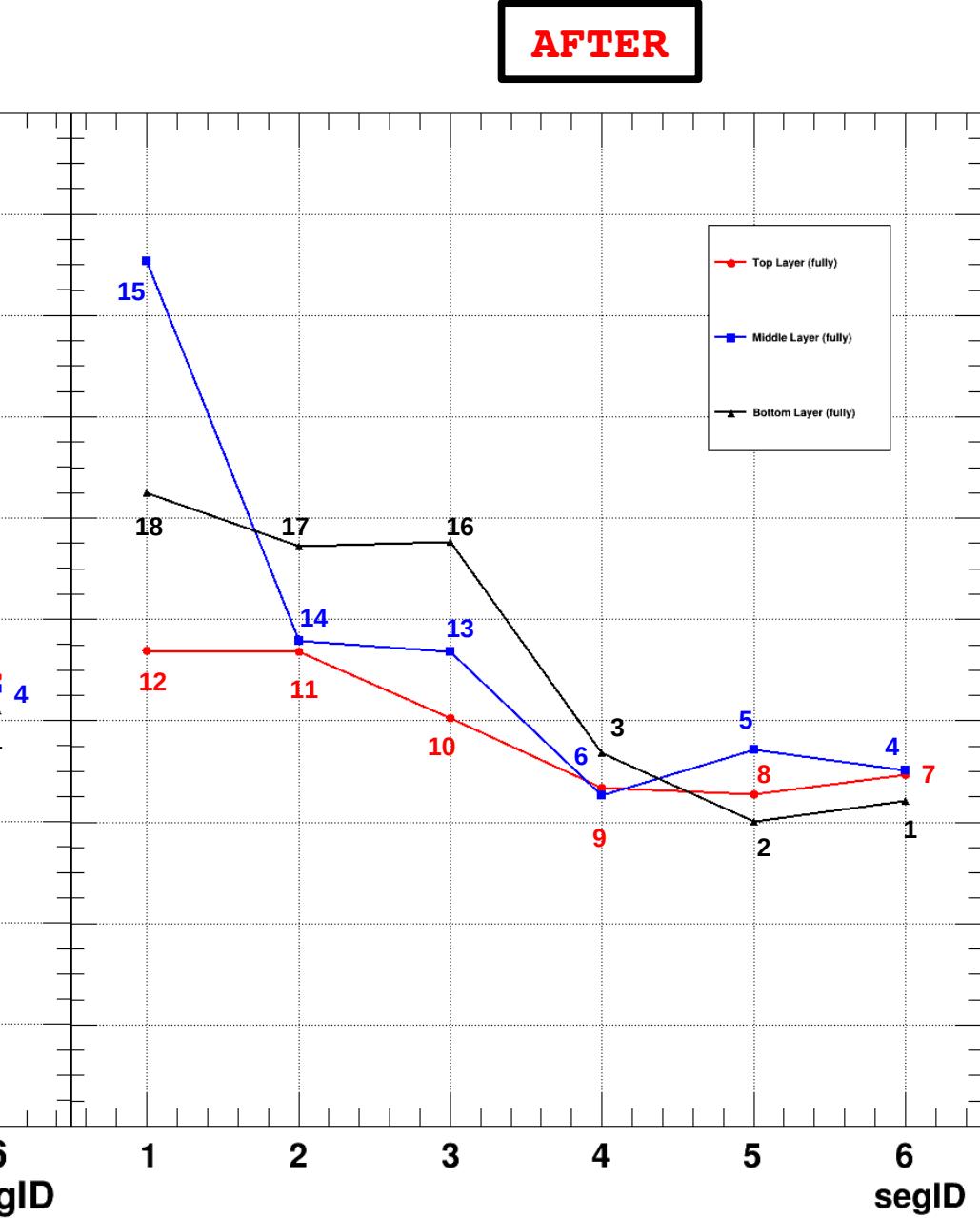
# Eseg < Ecore-1\*FWHM (SSE)



BEFORE



AFTER



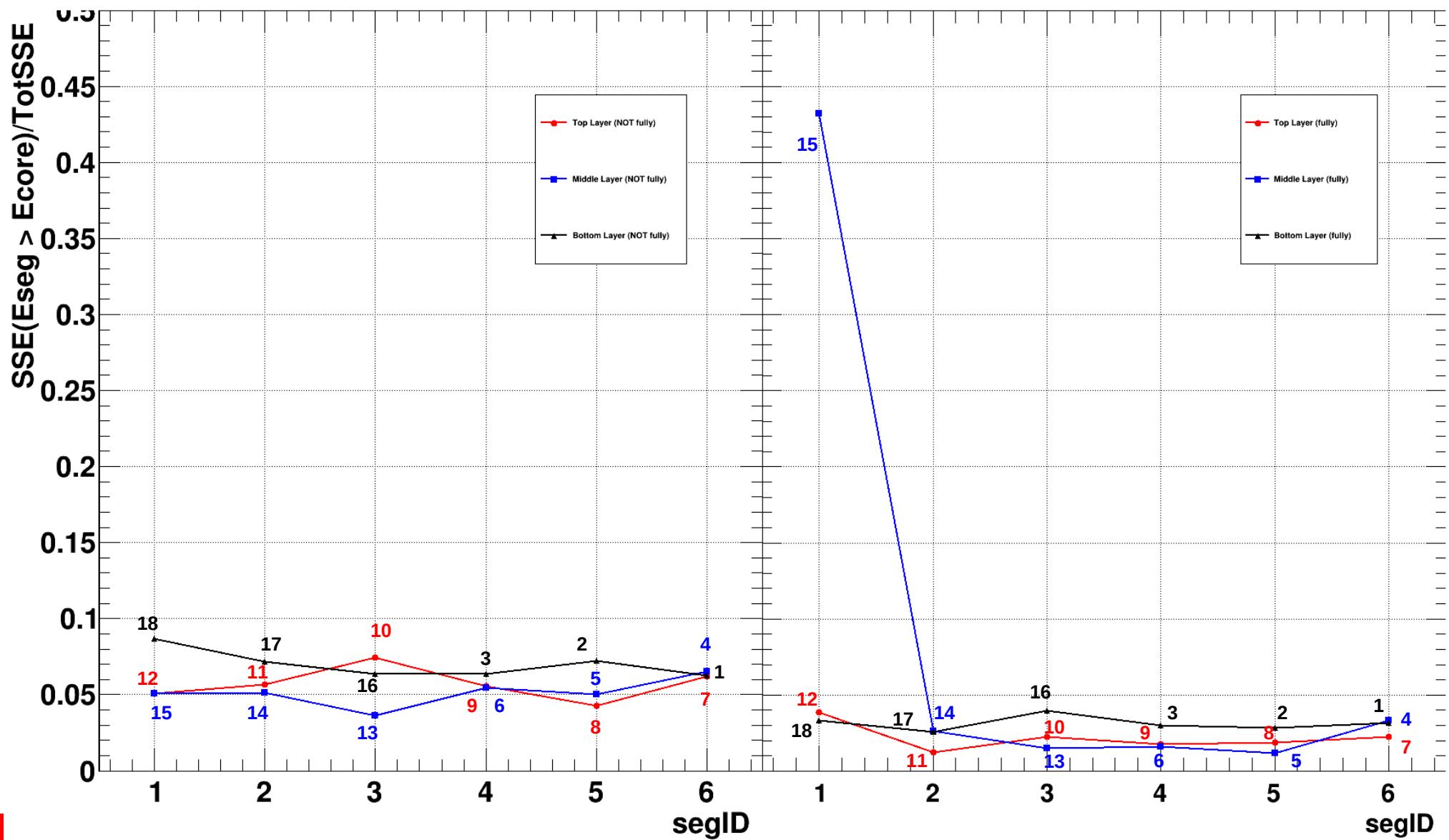


# Eseg > Ecore+1\*FWHM (SSE)

$$\Delta_p \cdot \Delta_q \geq \frac{1}{2} k$$

BEFORE

AFTER

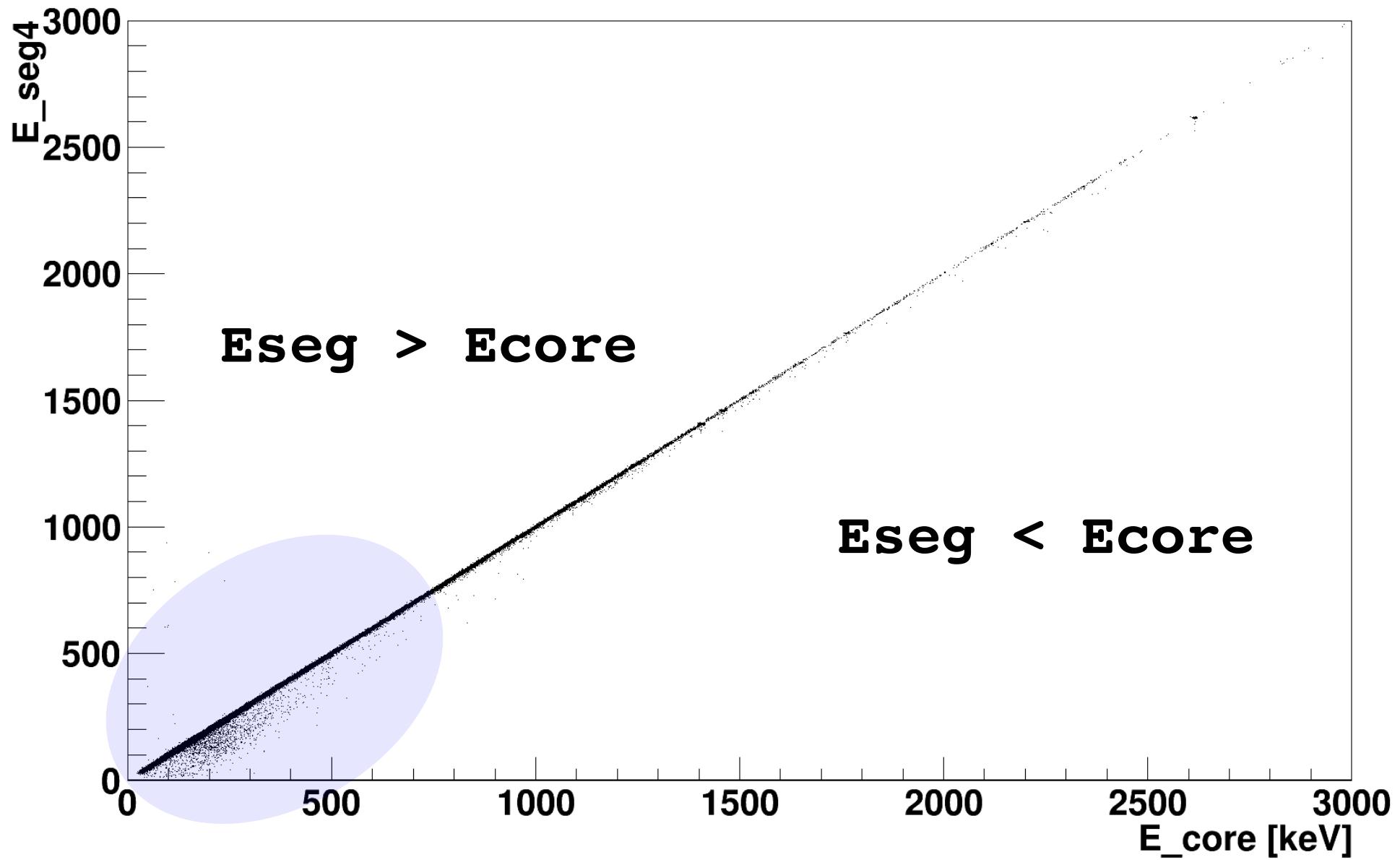




# BEFORE



Eseg\_4 vs Ecore (SSE)

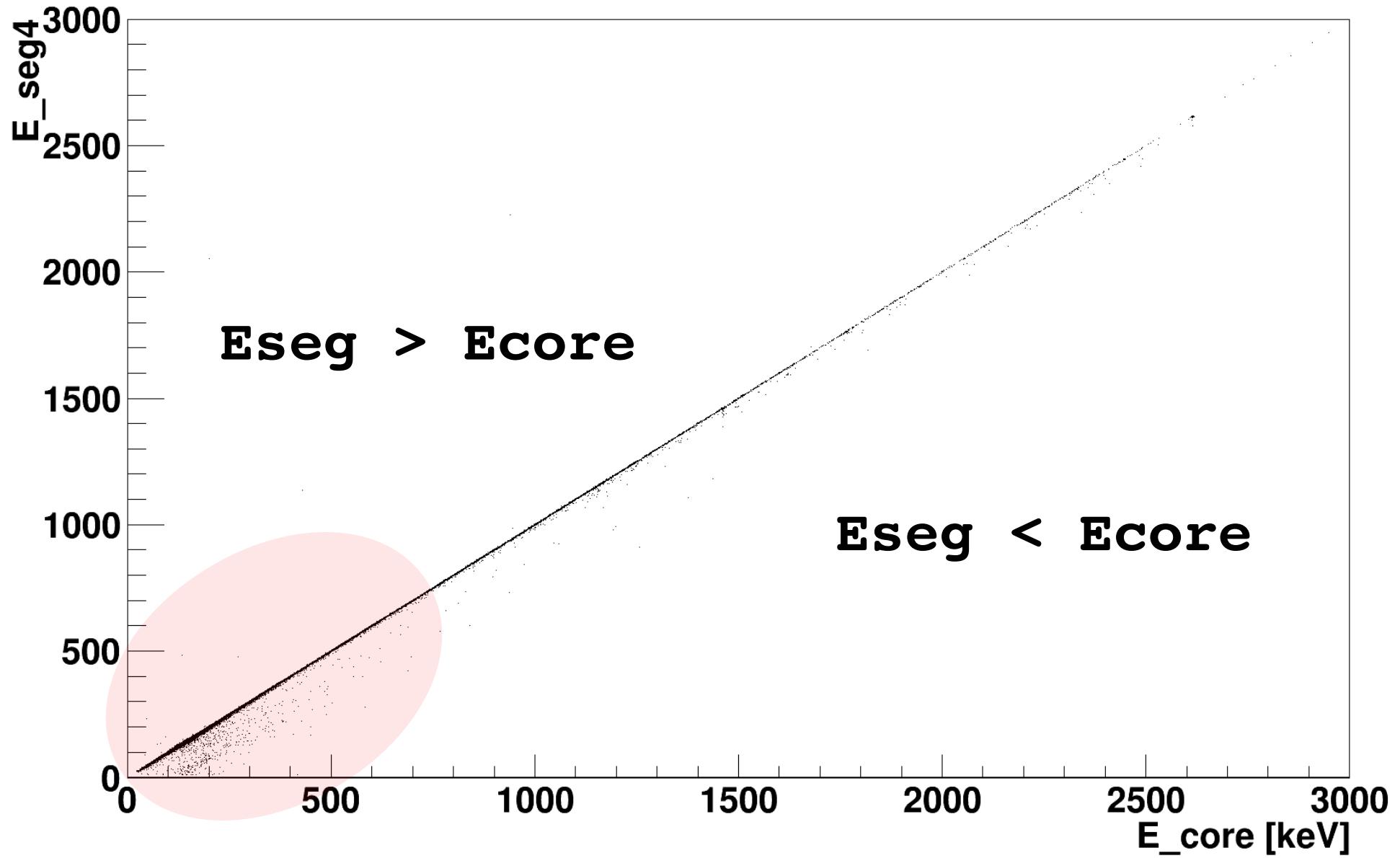




# AFTER



## Eseg\_4 vs Ecore (SSE)

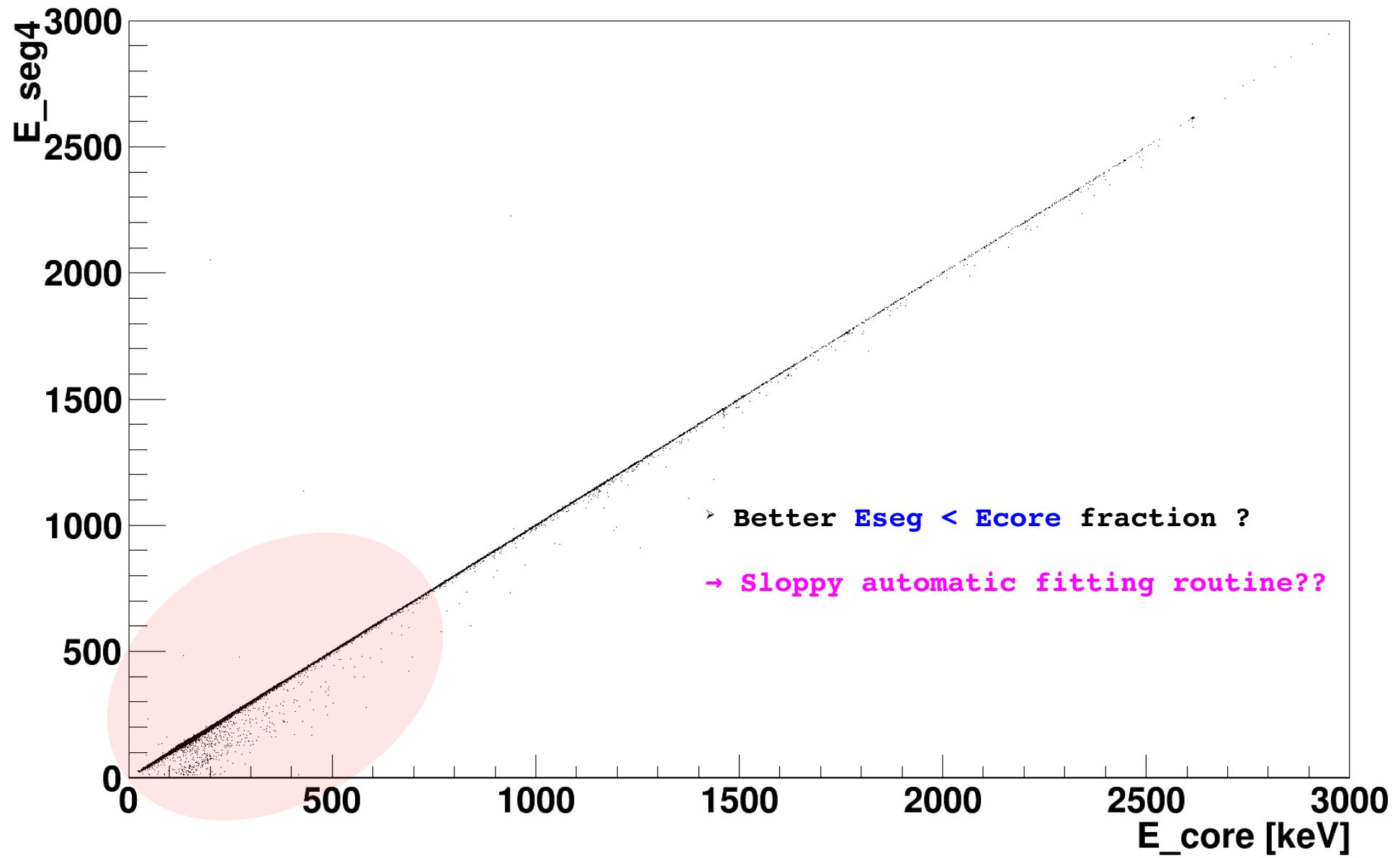




# AFTER

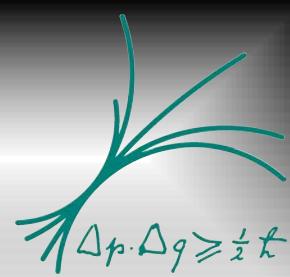


## Eseg\_4 vs Ecore (SSE)





# Outline



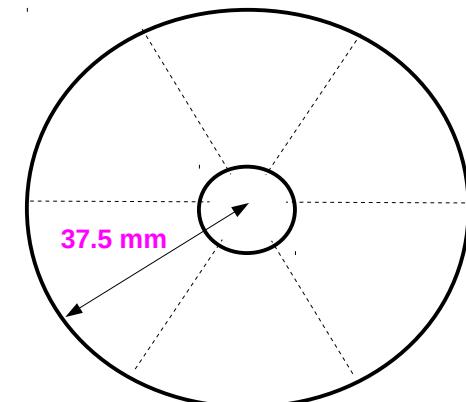
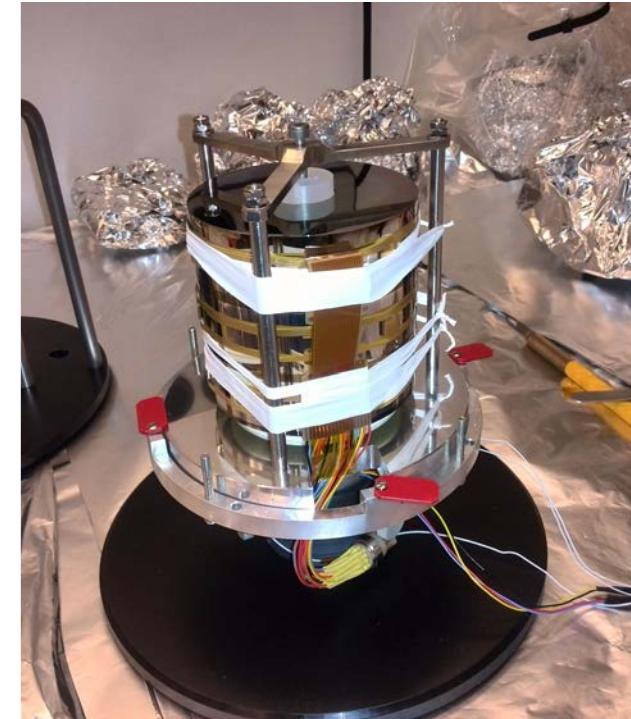
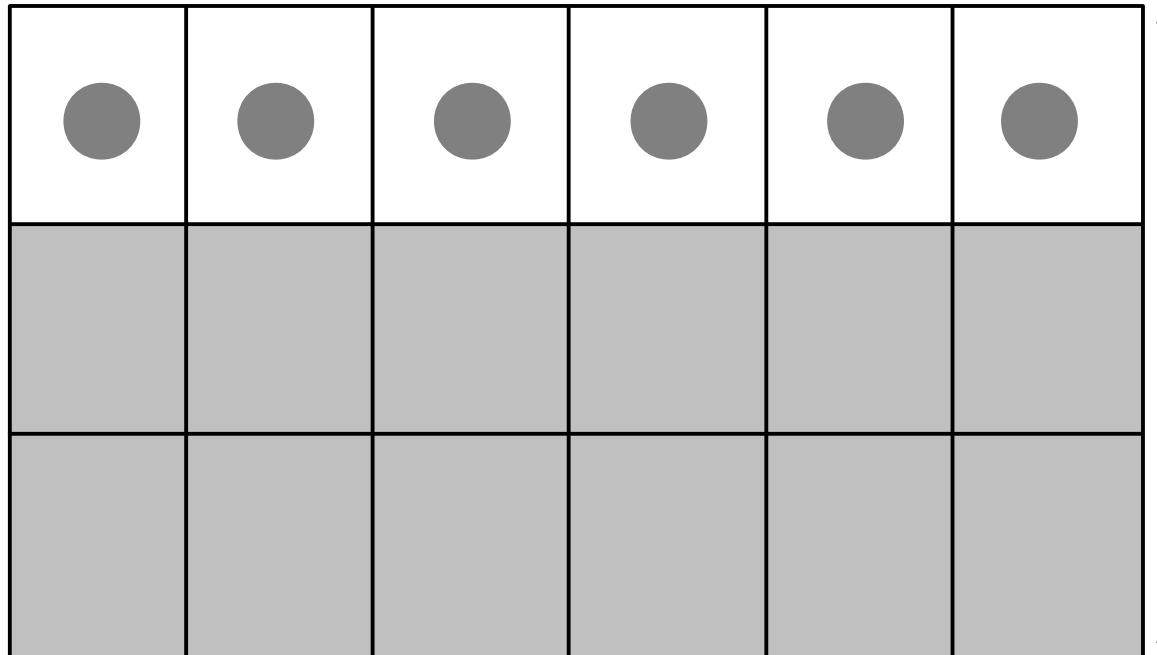
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# Siegfried III

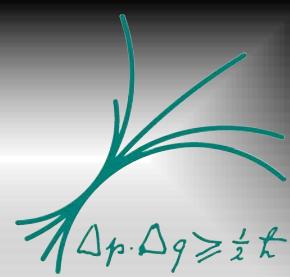


- 18-fold (3 z, 6 φ) segmented coaxial detector
- n-type
- **Top Layer NOT-fully metalized**  
The rest is **fully** metalized





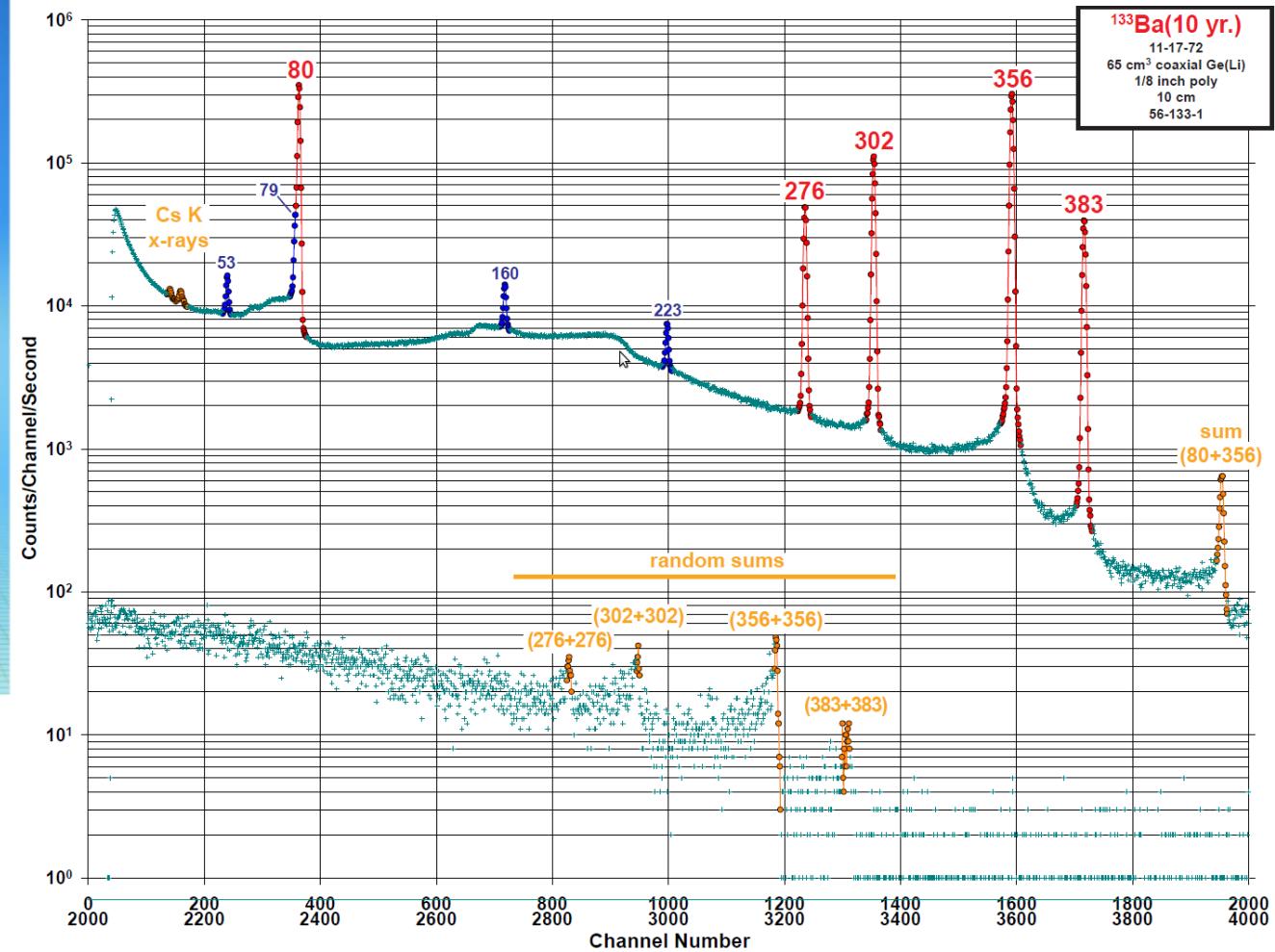
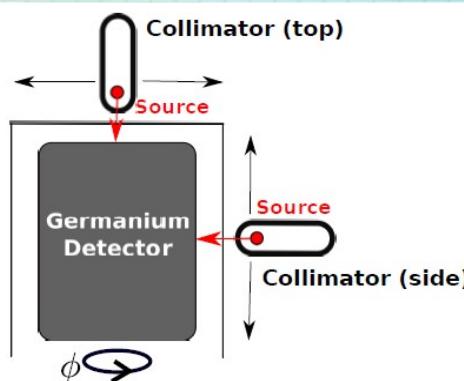
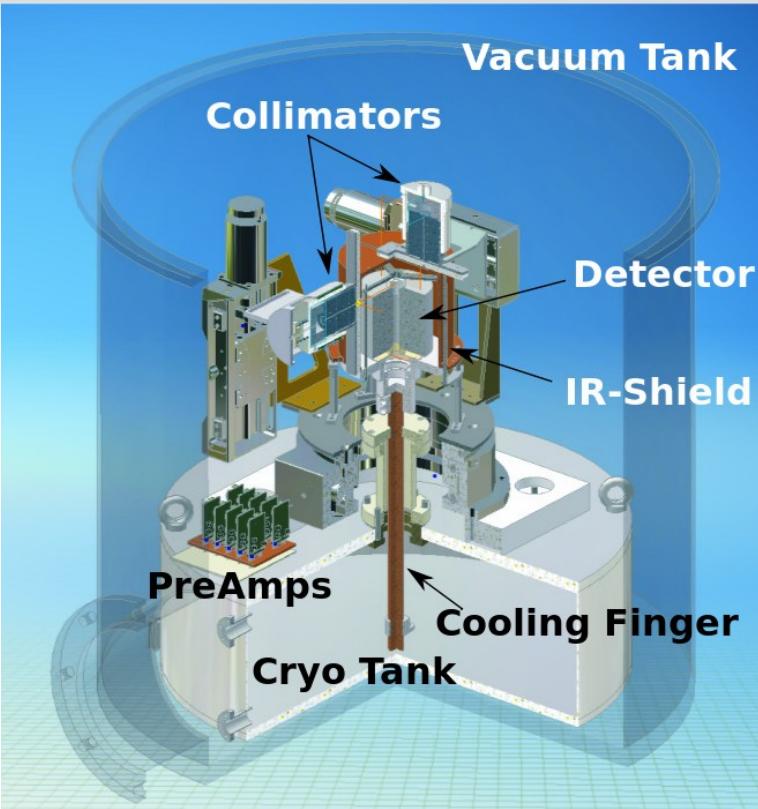
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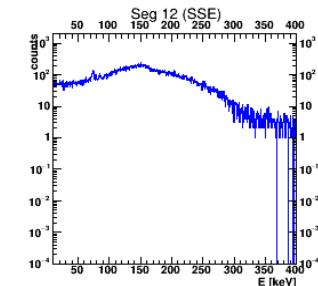
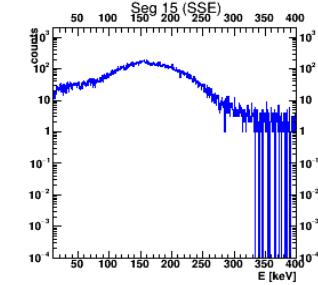
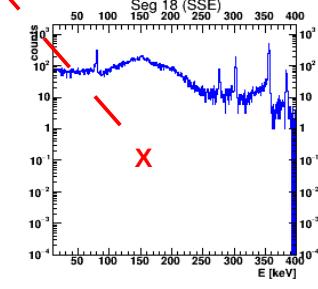
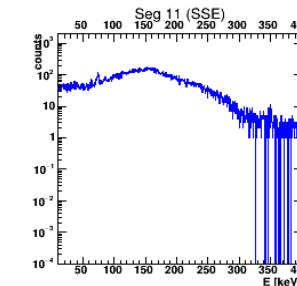
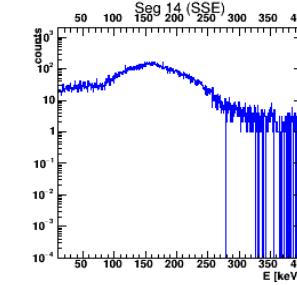
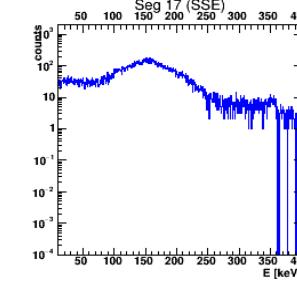
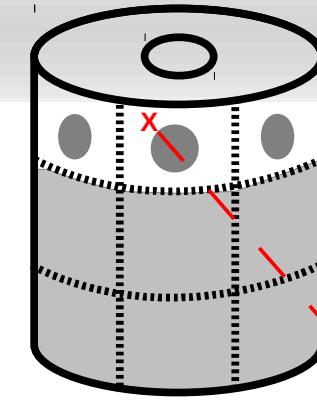
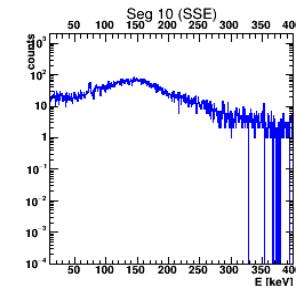
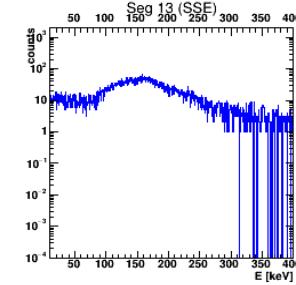
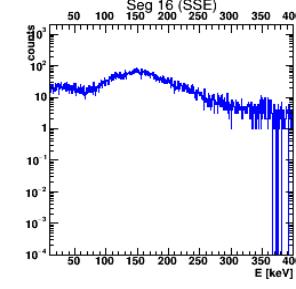
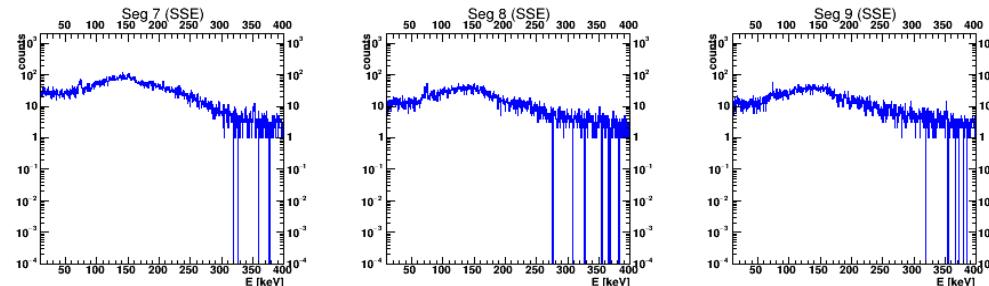
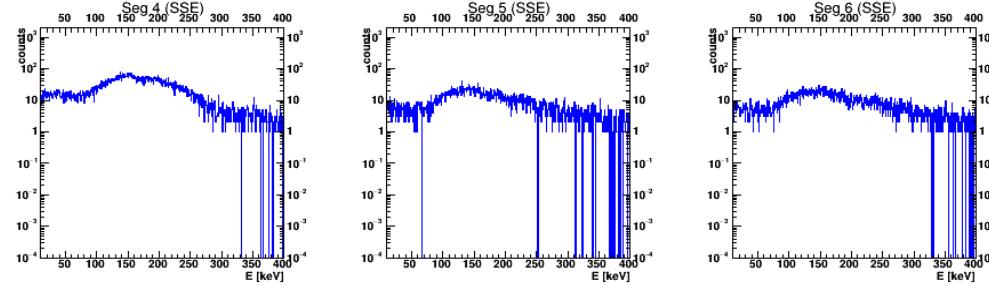
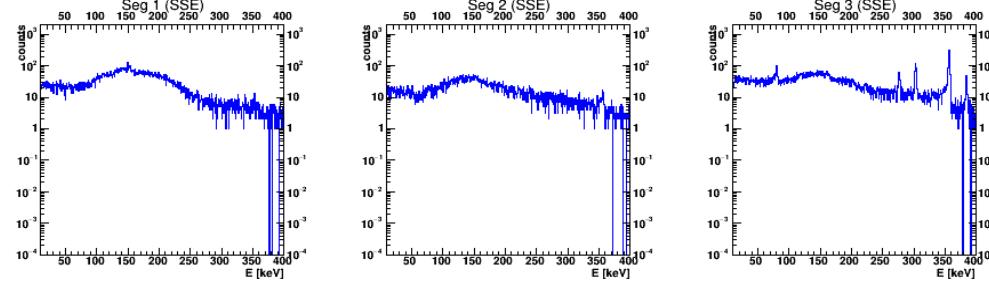
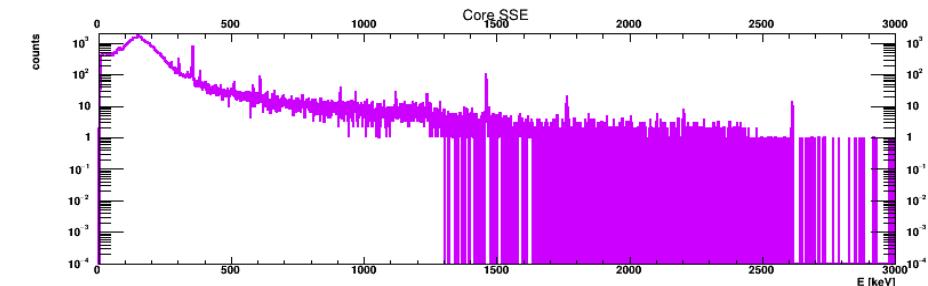
# Ba-133 Side Scan





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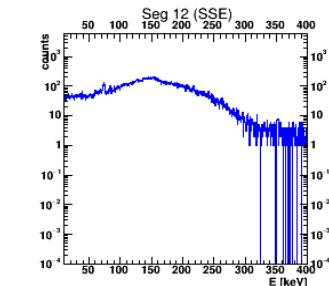
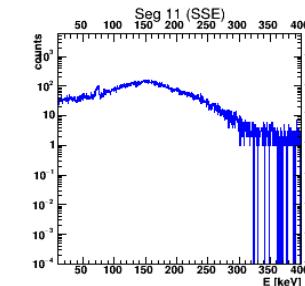
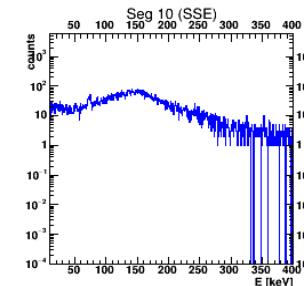
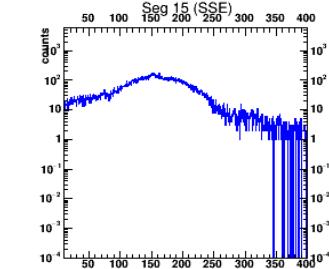
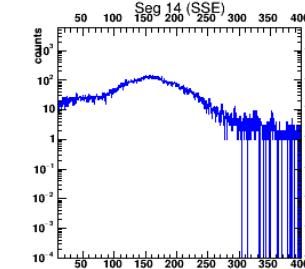
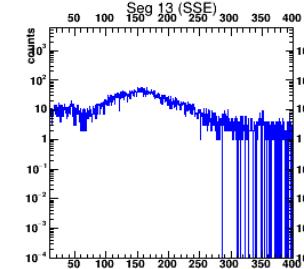
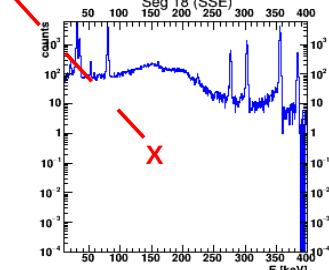
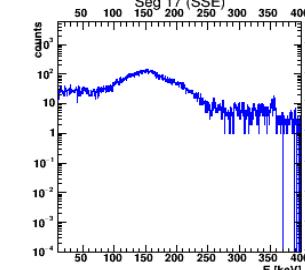
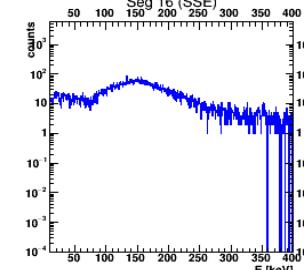
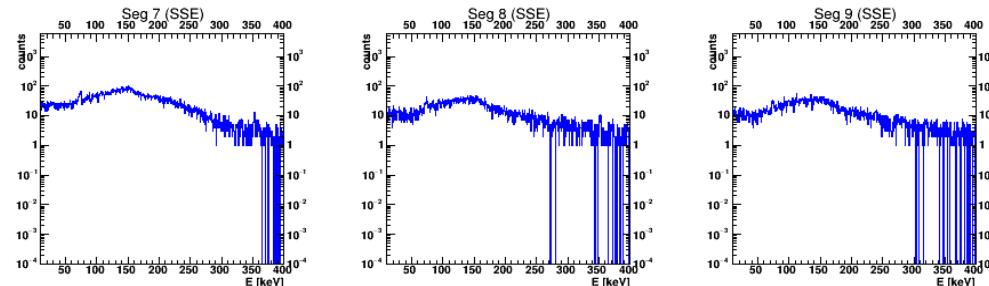
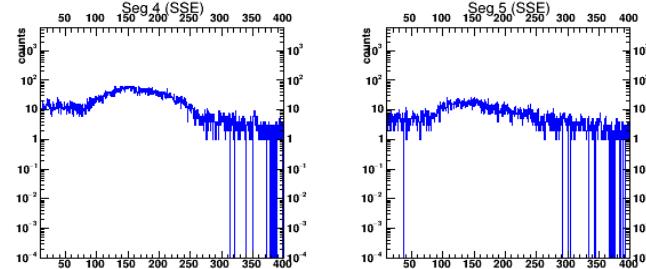
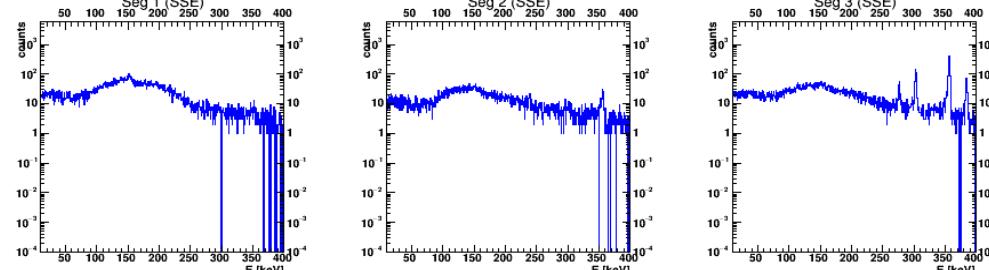
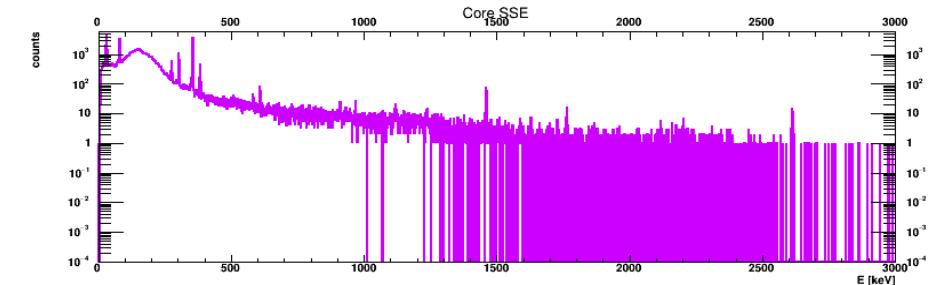
$$\Delta p \cdot \Delta q \geq \frac{1}{2} \hbar$$





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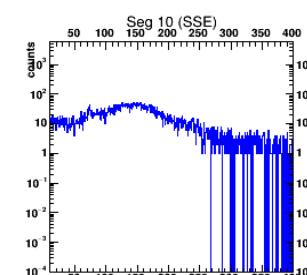
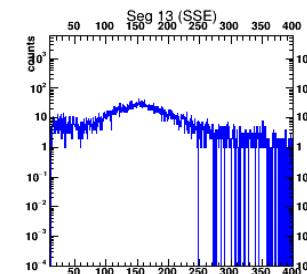
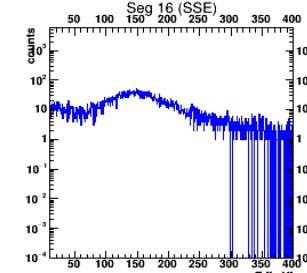
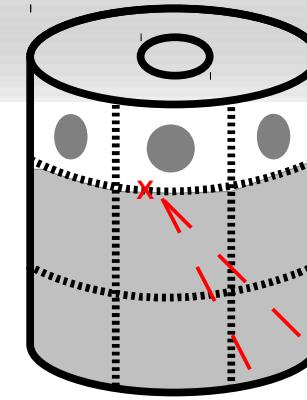
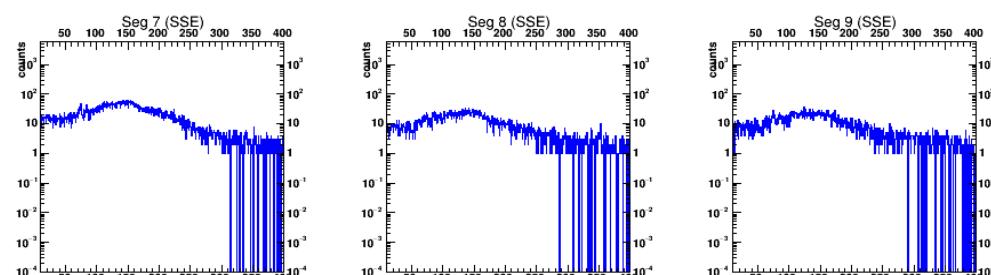
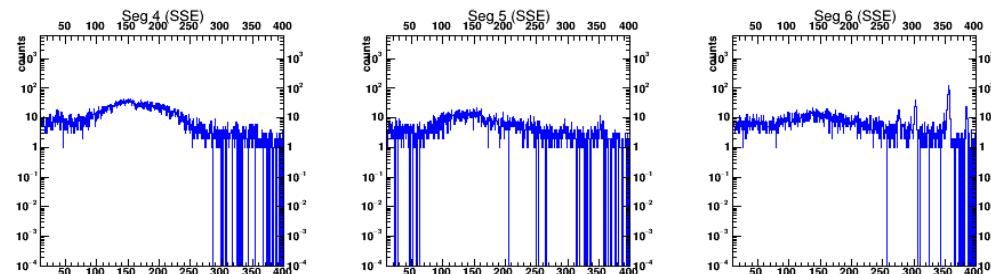
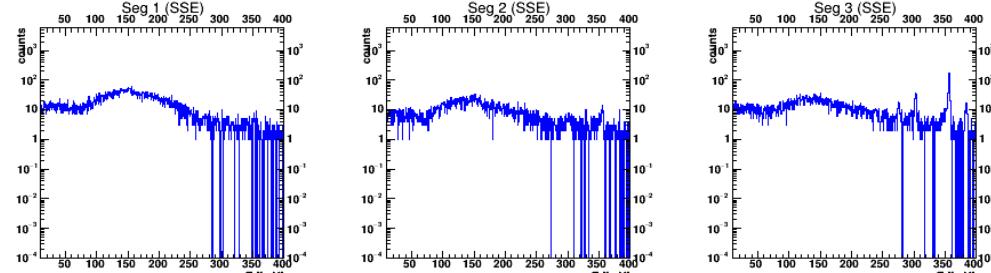
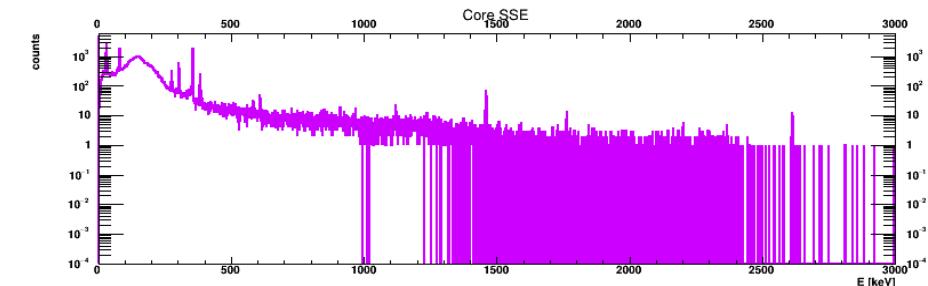
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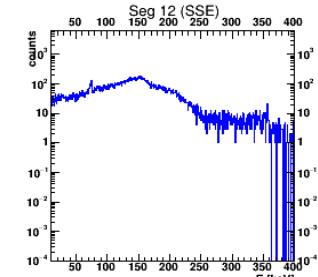
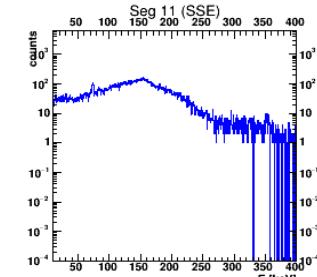
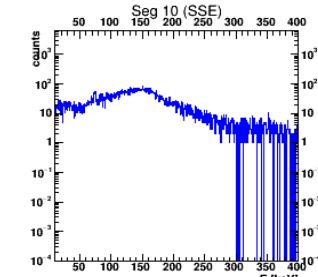
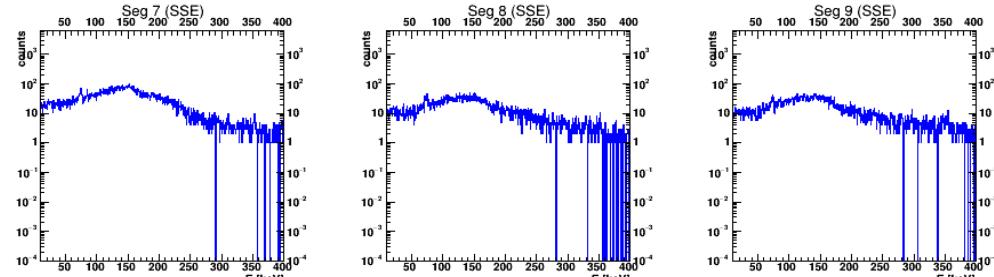
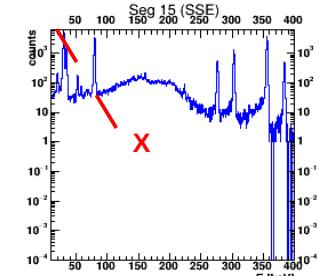
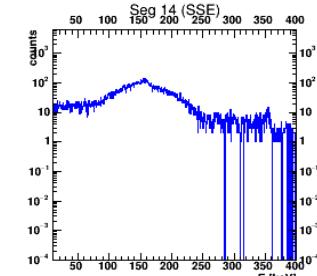
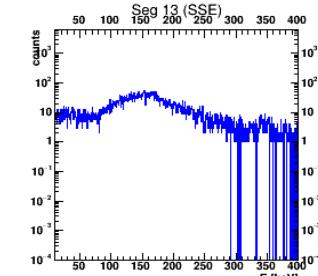
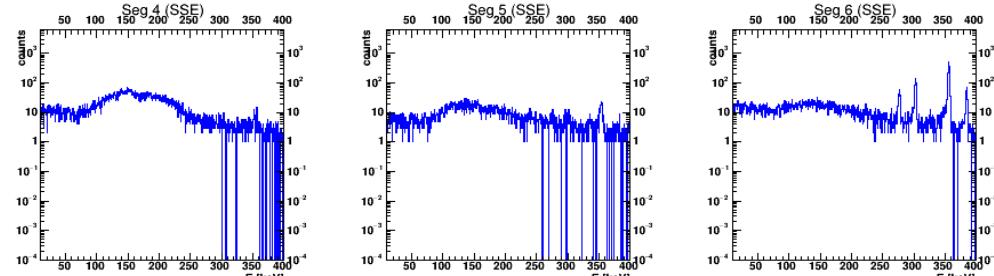
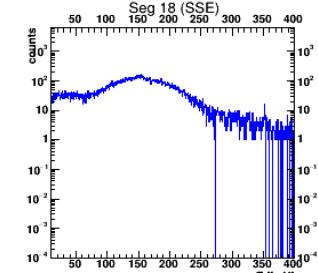
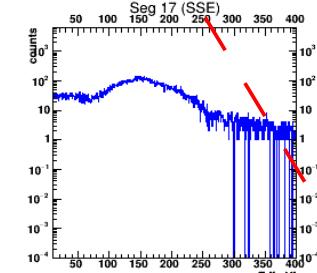
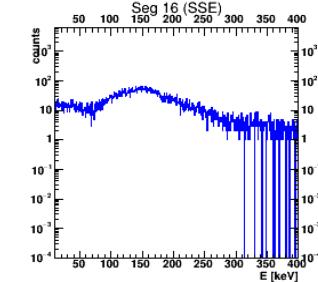
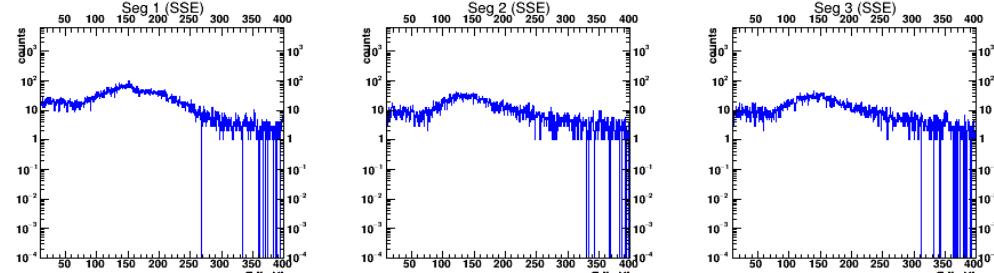
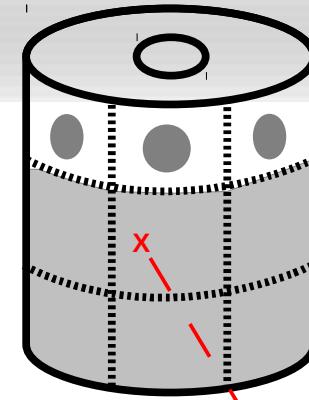
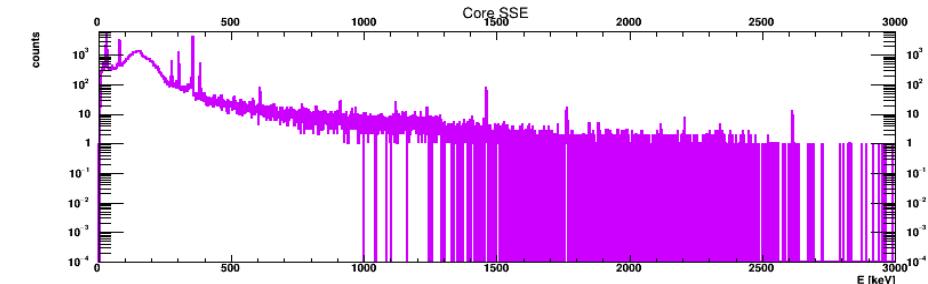
$$\Delta p \cdot \Delta q \geq \frac{1}{2} \hbar$$





# Ba-133 Side Scan

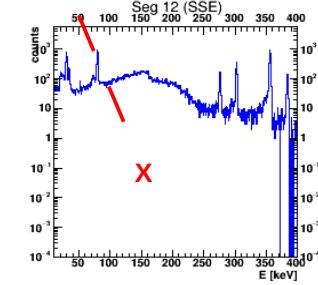
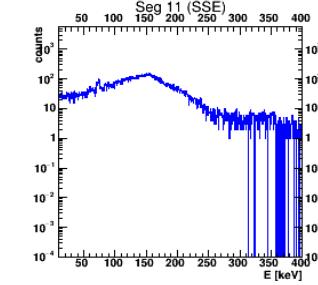
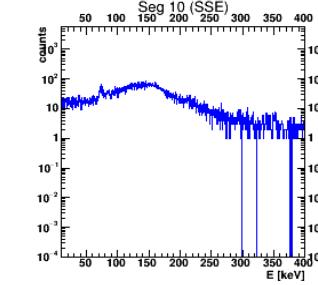
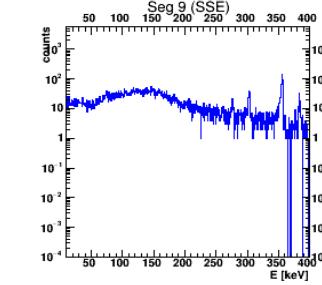
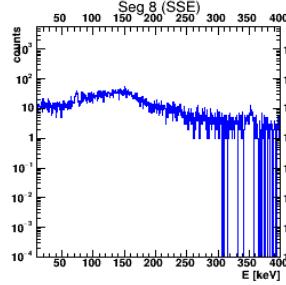
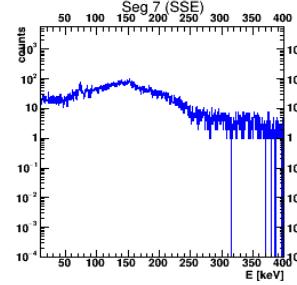
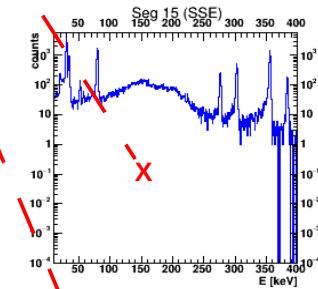
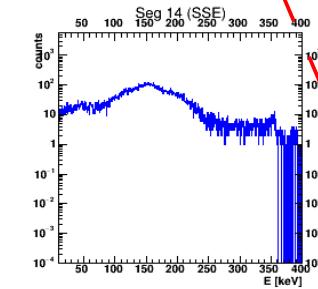
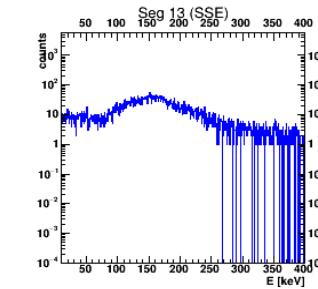
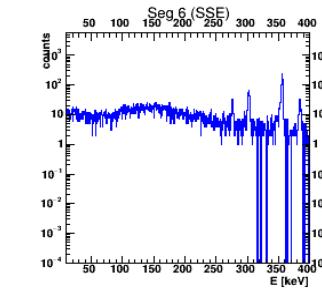
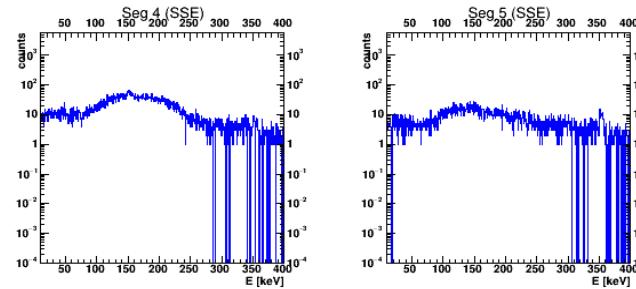
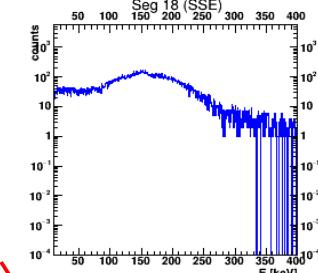
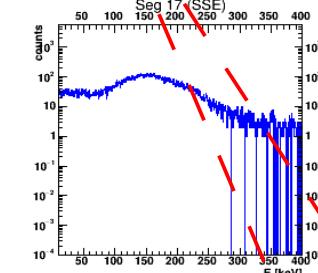
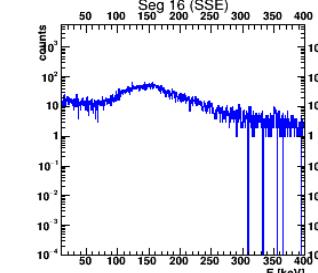
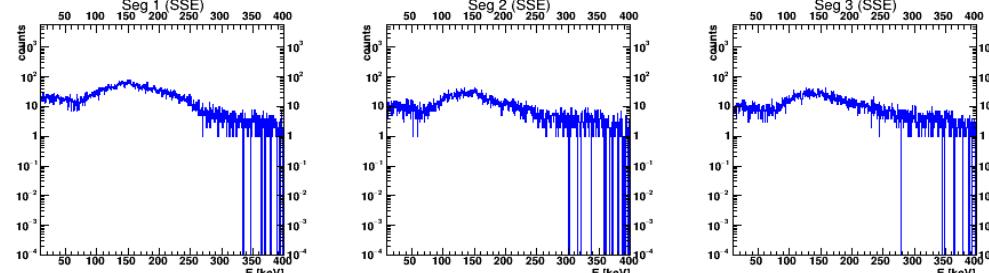
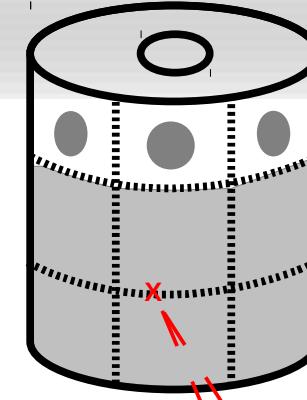
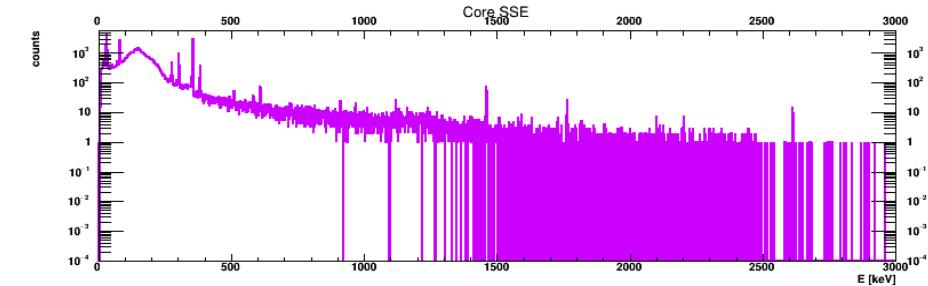
$$\Delta p \cdot \Delta q \geq \frac{1}{2} \hbar$$





# Ba-133 Side Scan

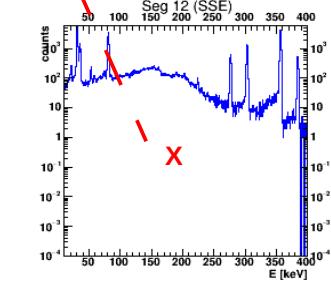
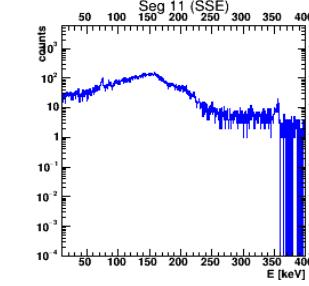
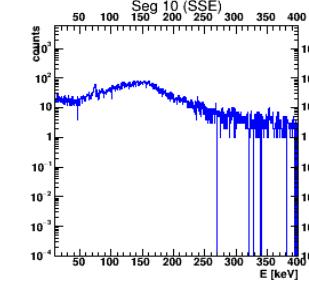
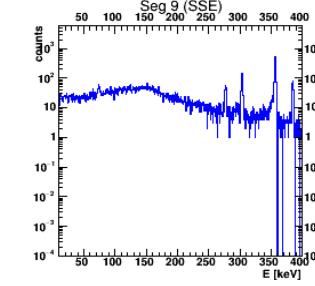
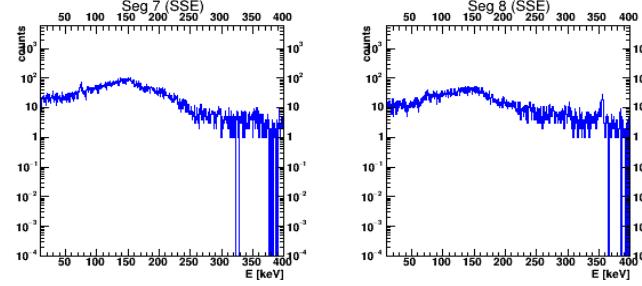
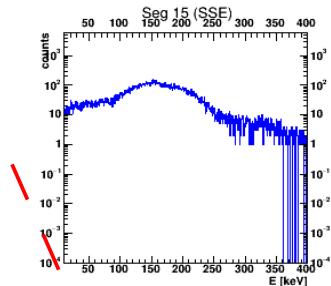
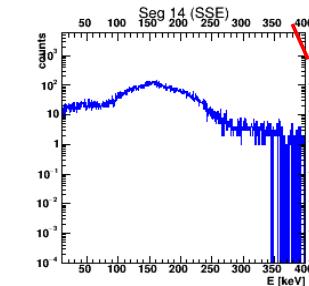
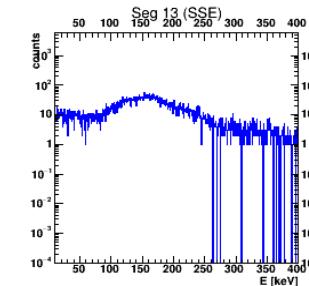
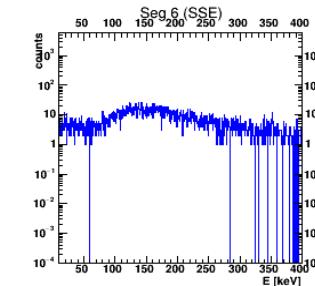
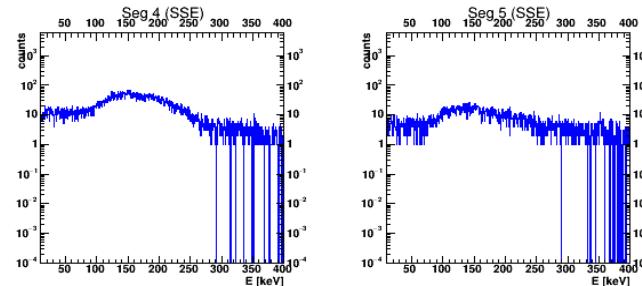
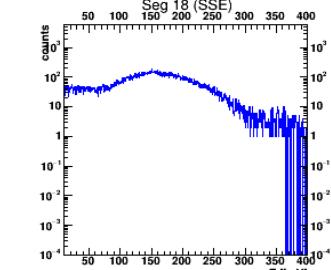
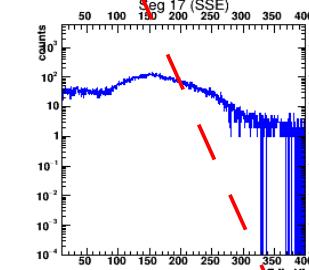
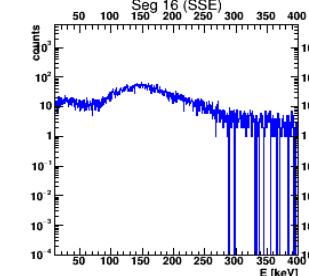
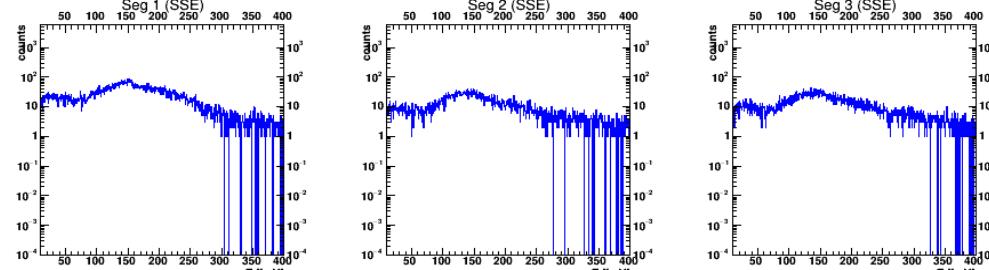
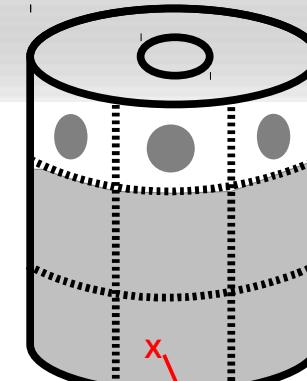
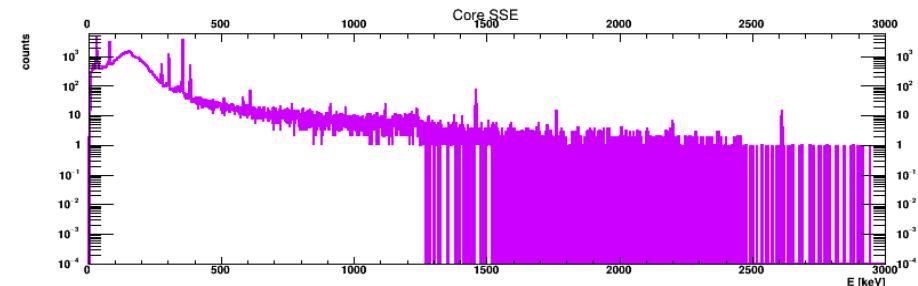
$$\Delta p \cdot \Delta q \geq \frac{1}{2} \hbar$$





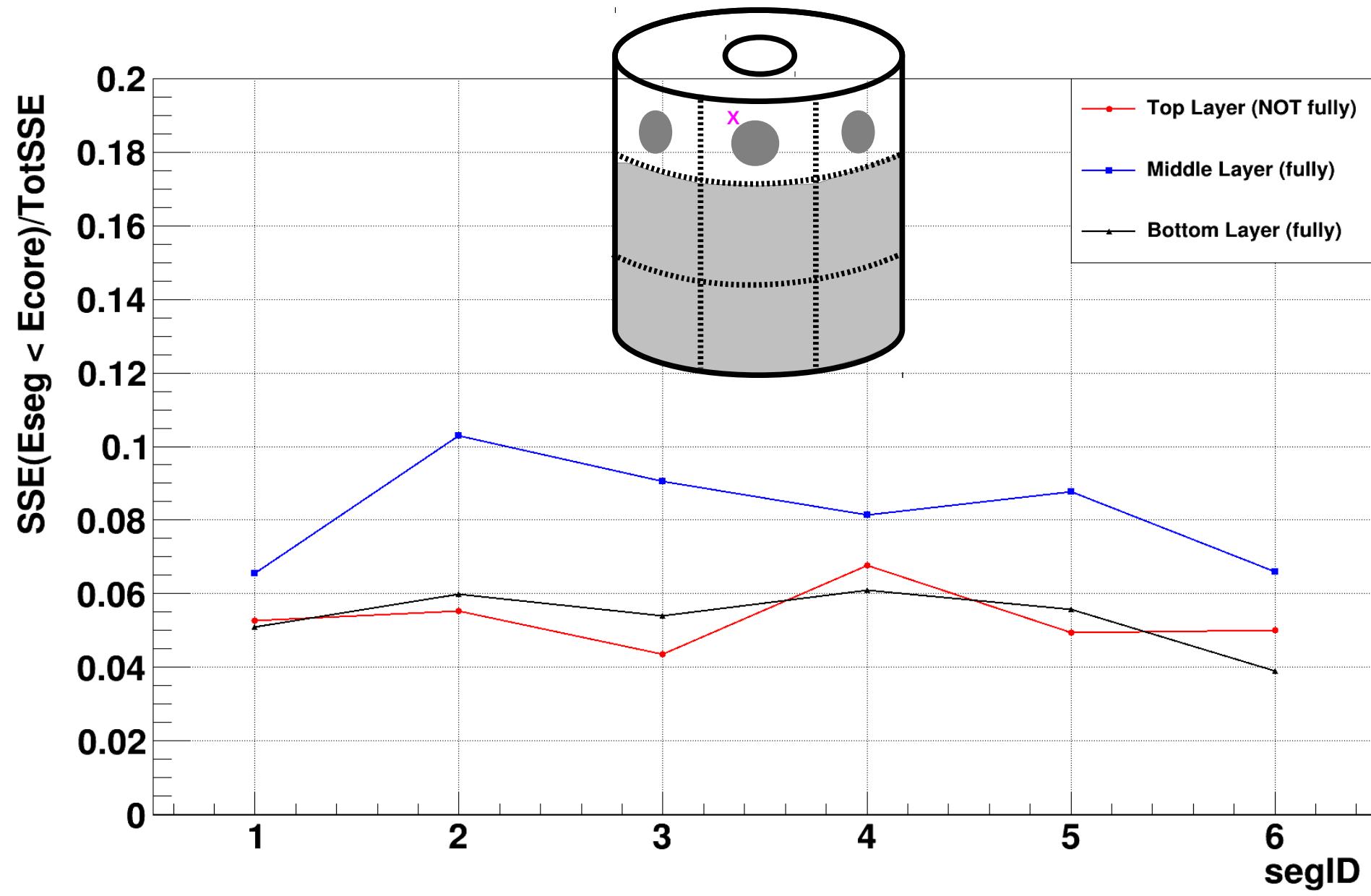
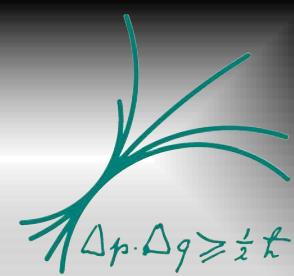
# Ba-133 Side Scan

$$\Delta p \cdot \Delta q \geq \frac{1}{2} \hbar$$



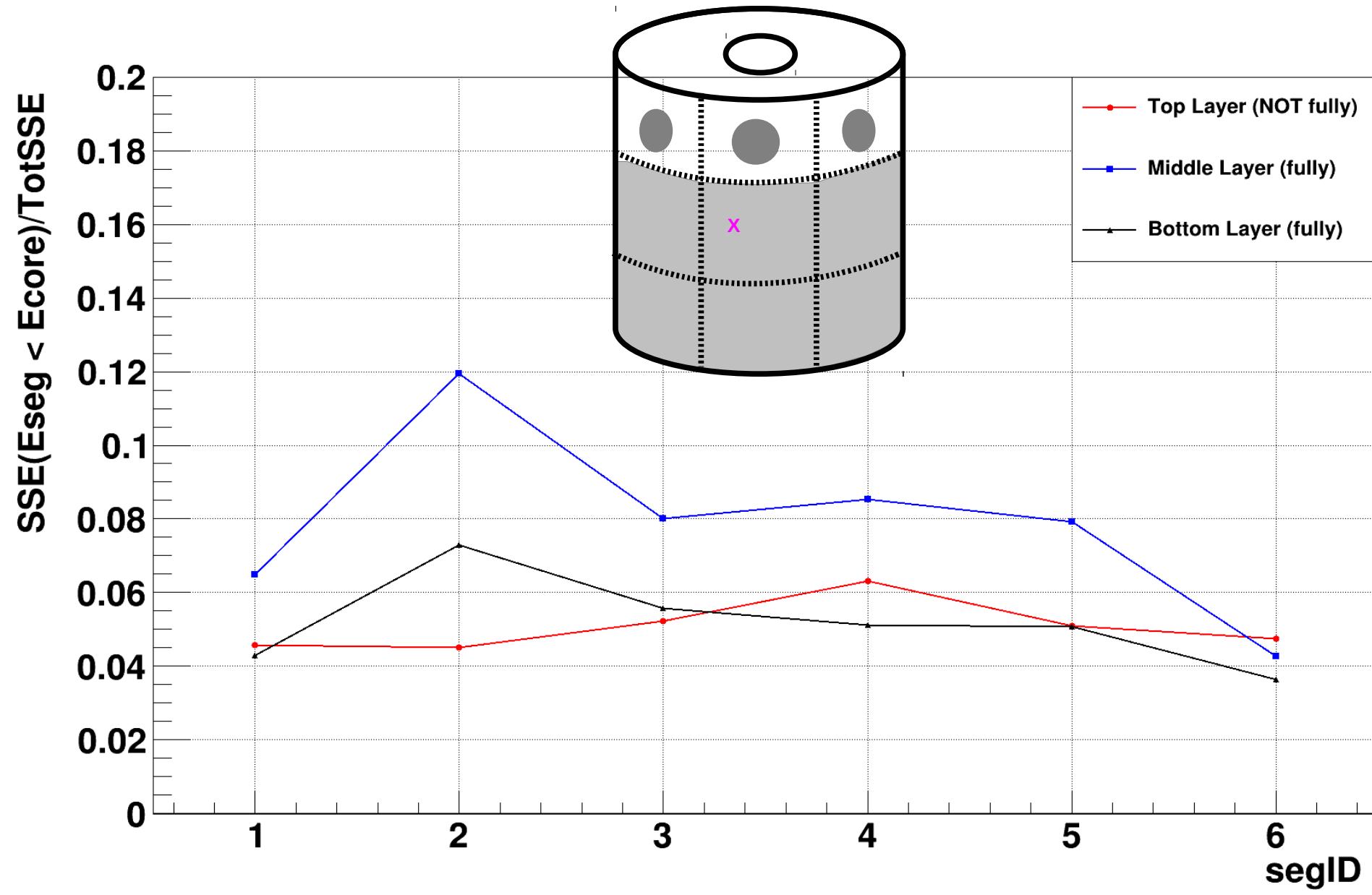
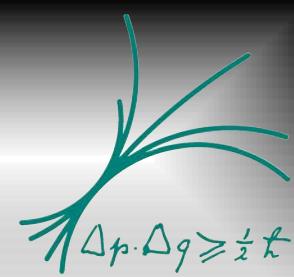


# Ba-133 Side Scan



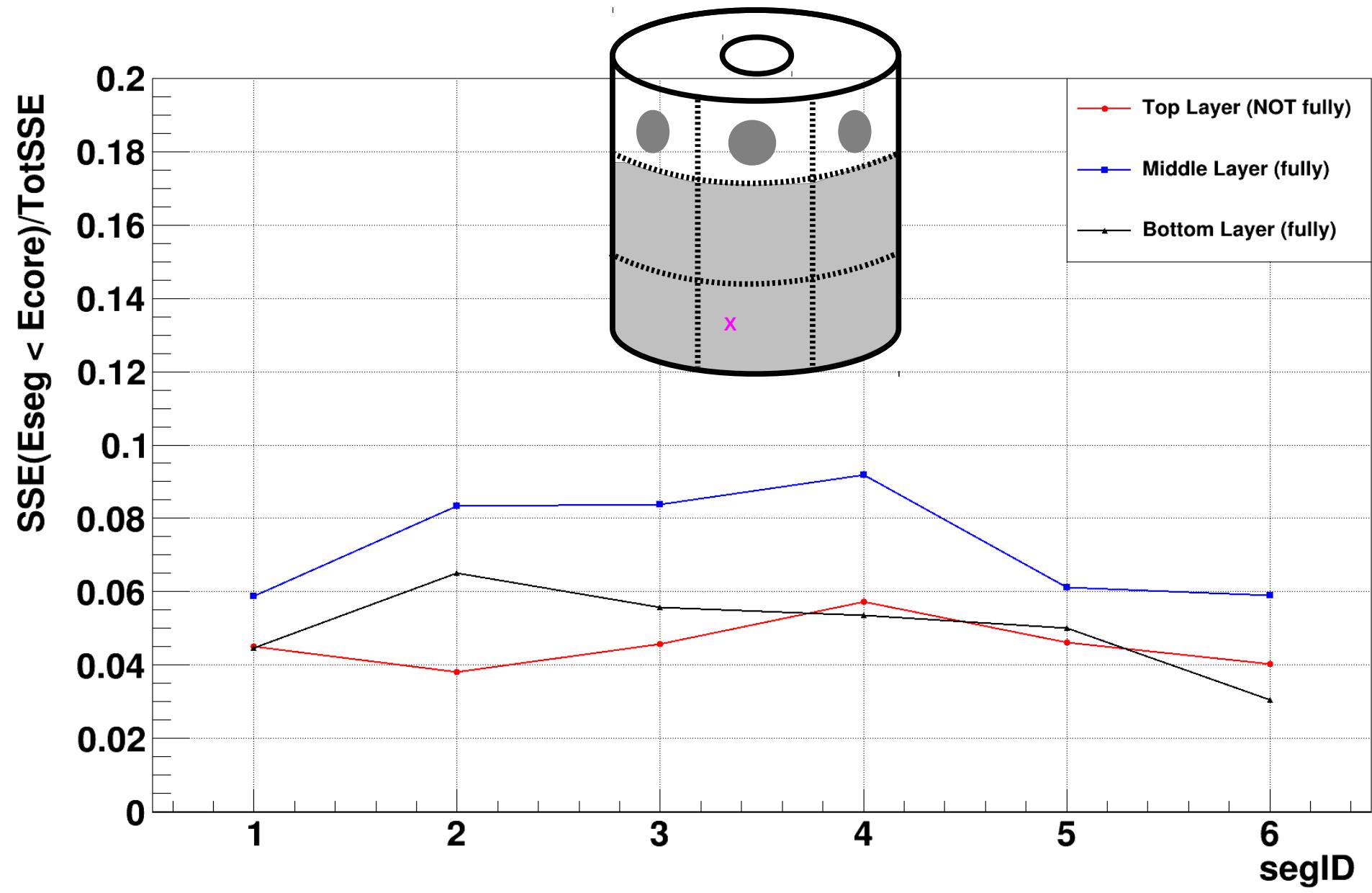
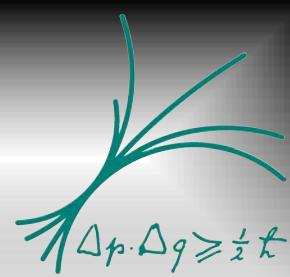


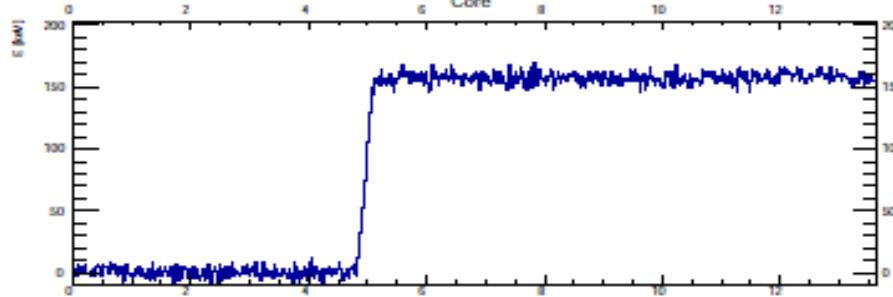
# Ba-133 Side Scan



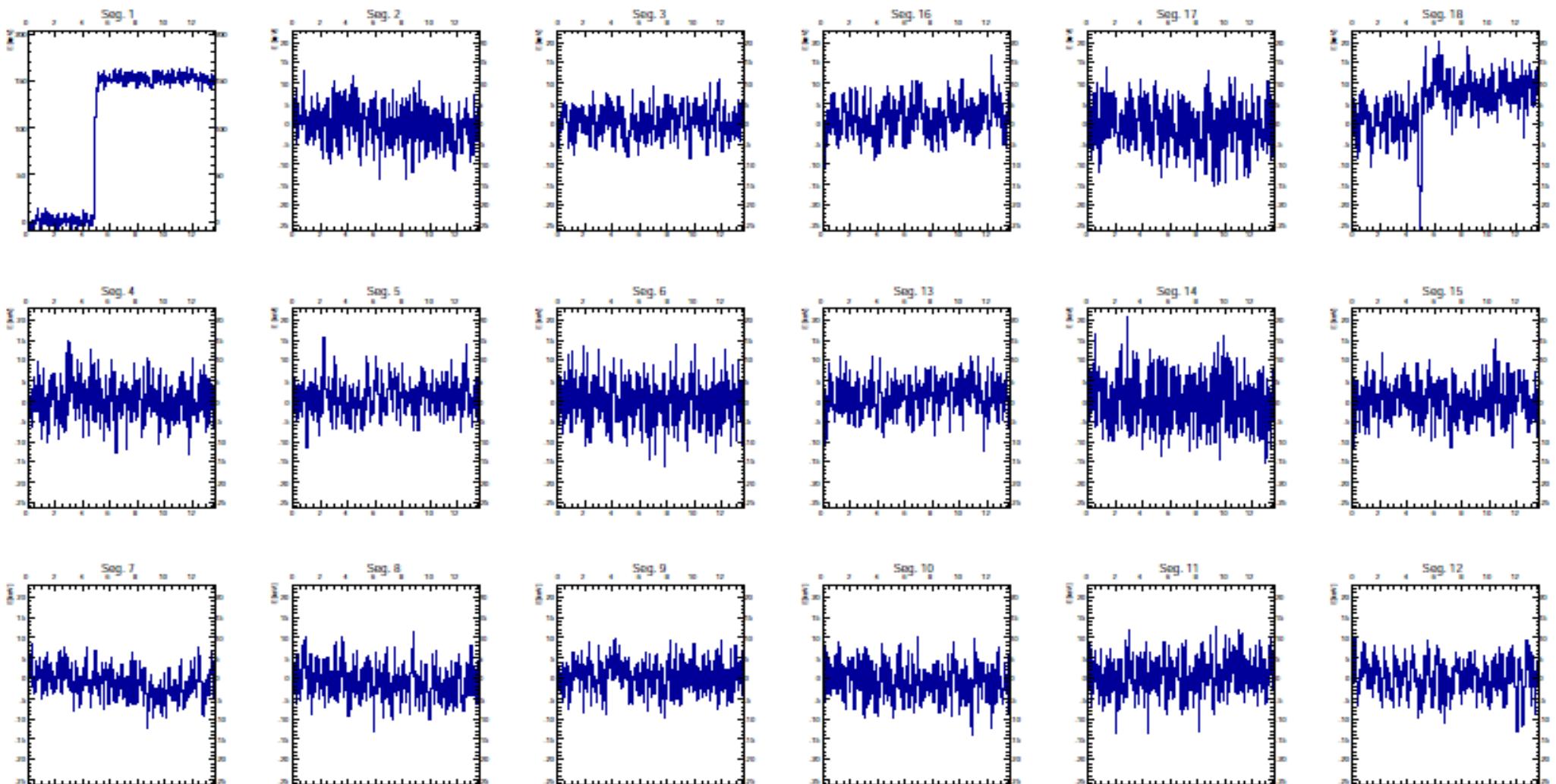


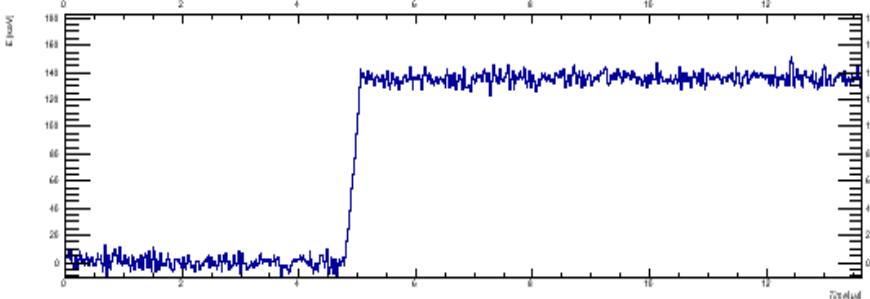
# Ba-133 Side Scan





**SSE with Eseg < Ecore**  
**Event ID 2141**  
**Ecore = 154.09 keV**

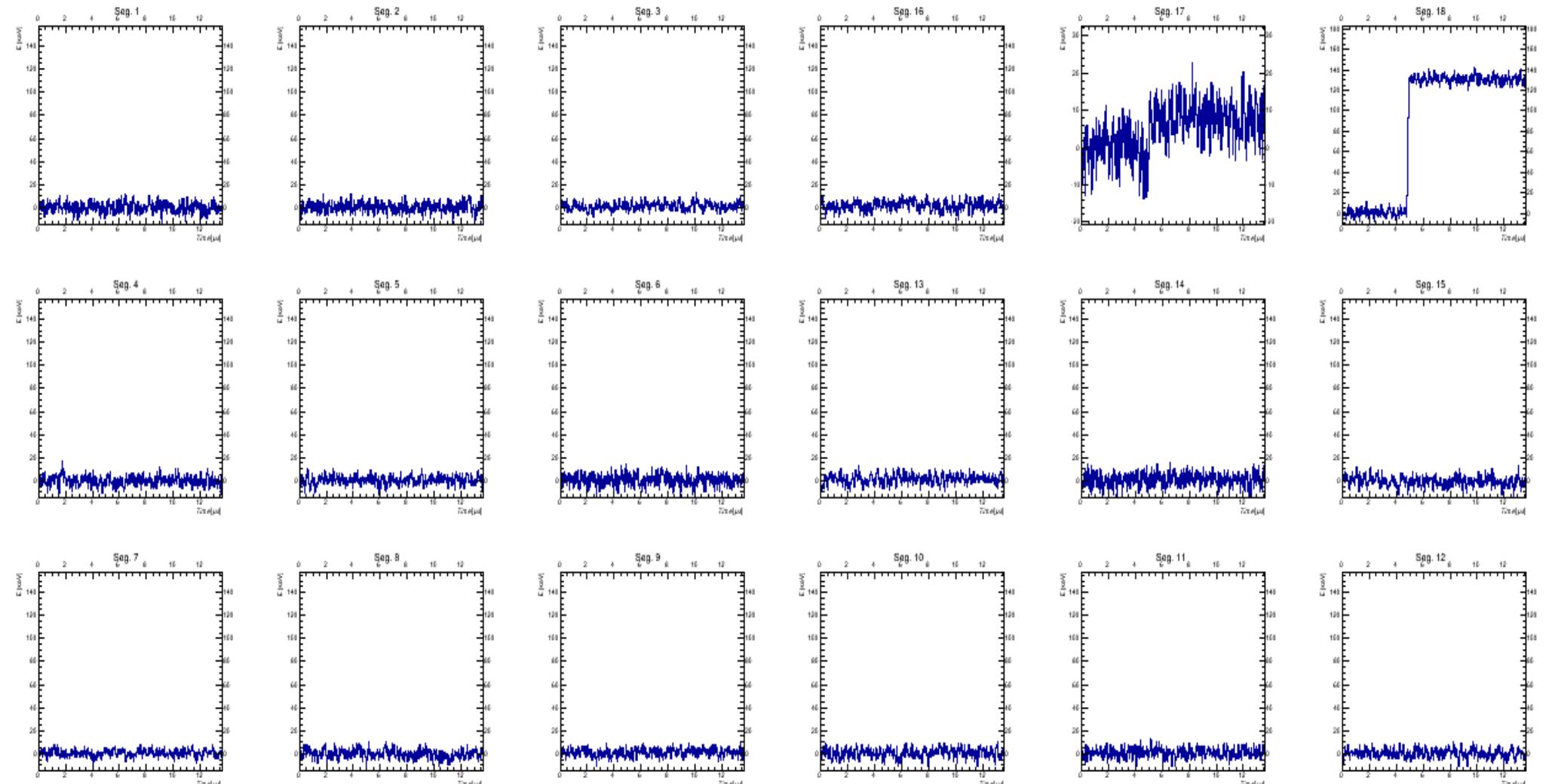


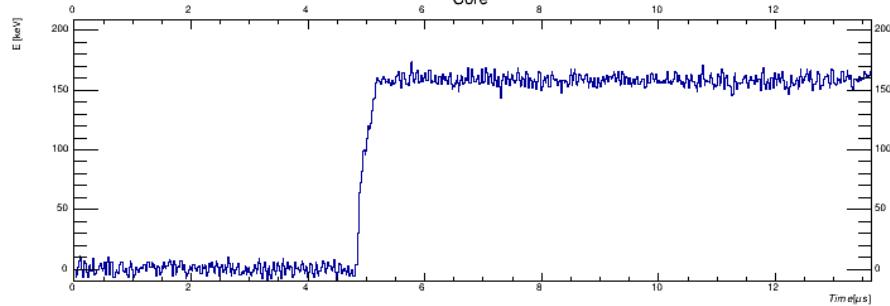


# SSE with Eseg < Ecore

## Event ID 3100

### Ecore = 133.43 keV

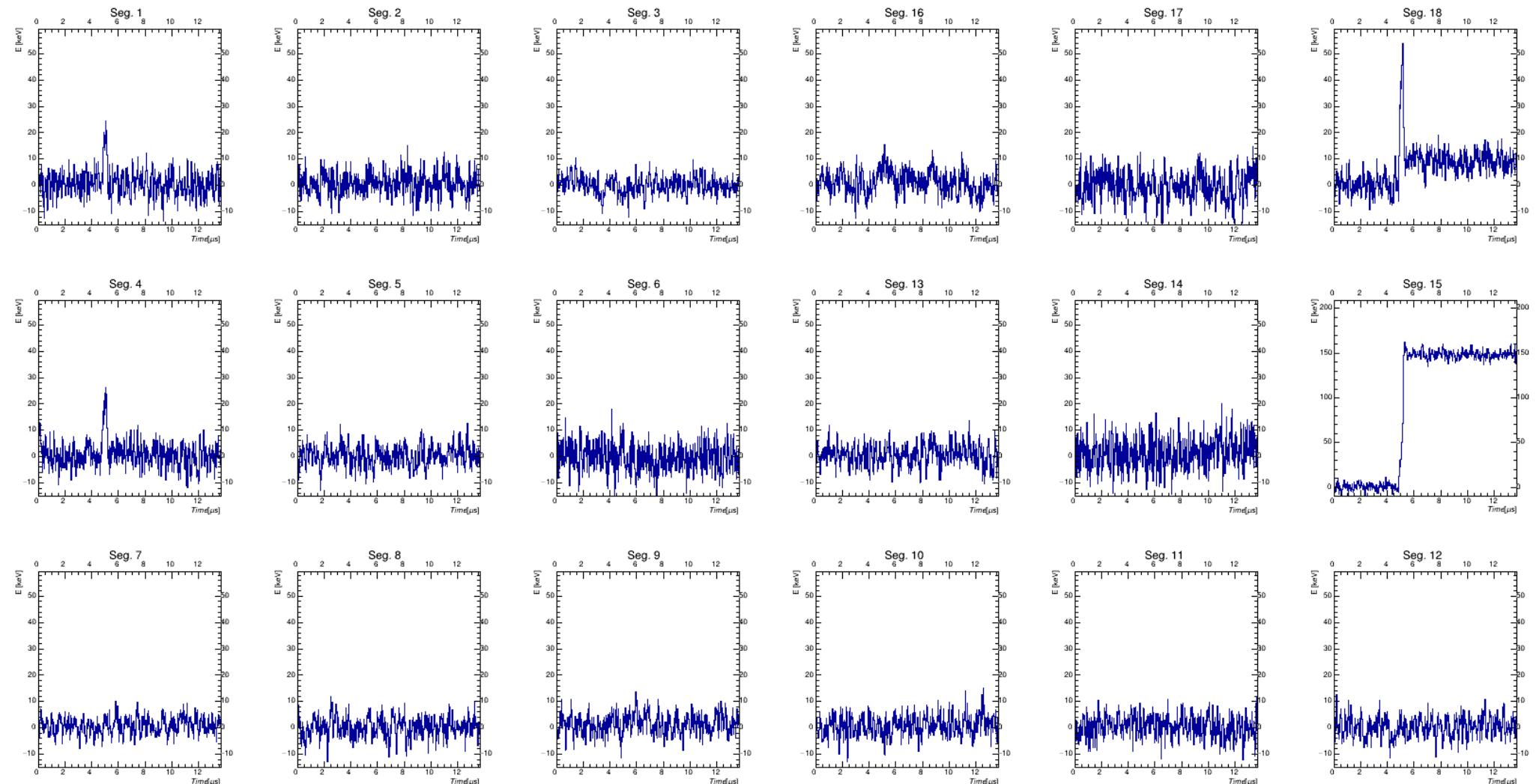




# SSE with Eseg < Ecore

## Event ID 2007

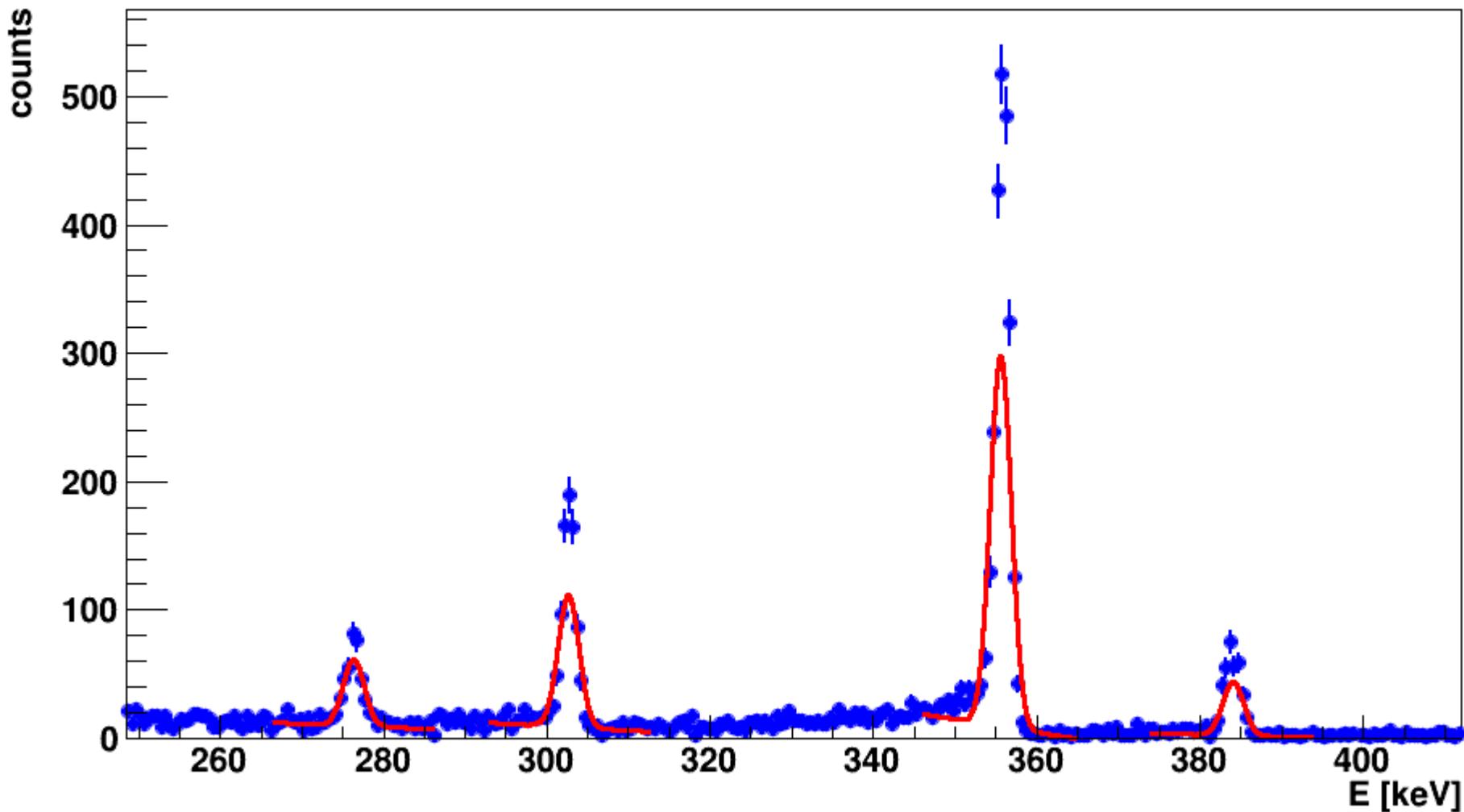
### Ecore = 155.53 keV





# Ba-133 Side Scan Fit Examples (Seg. SSE 18)

$$\Delta_P \cdot \Delta_Q \geq \frac{1}{2} k$$

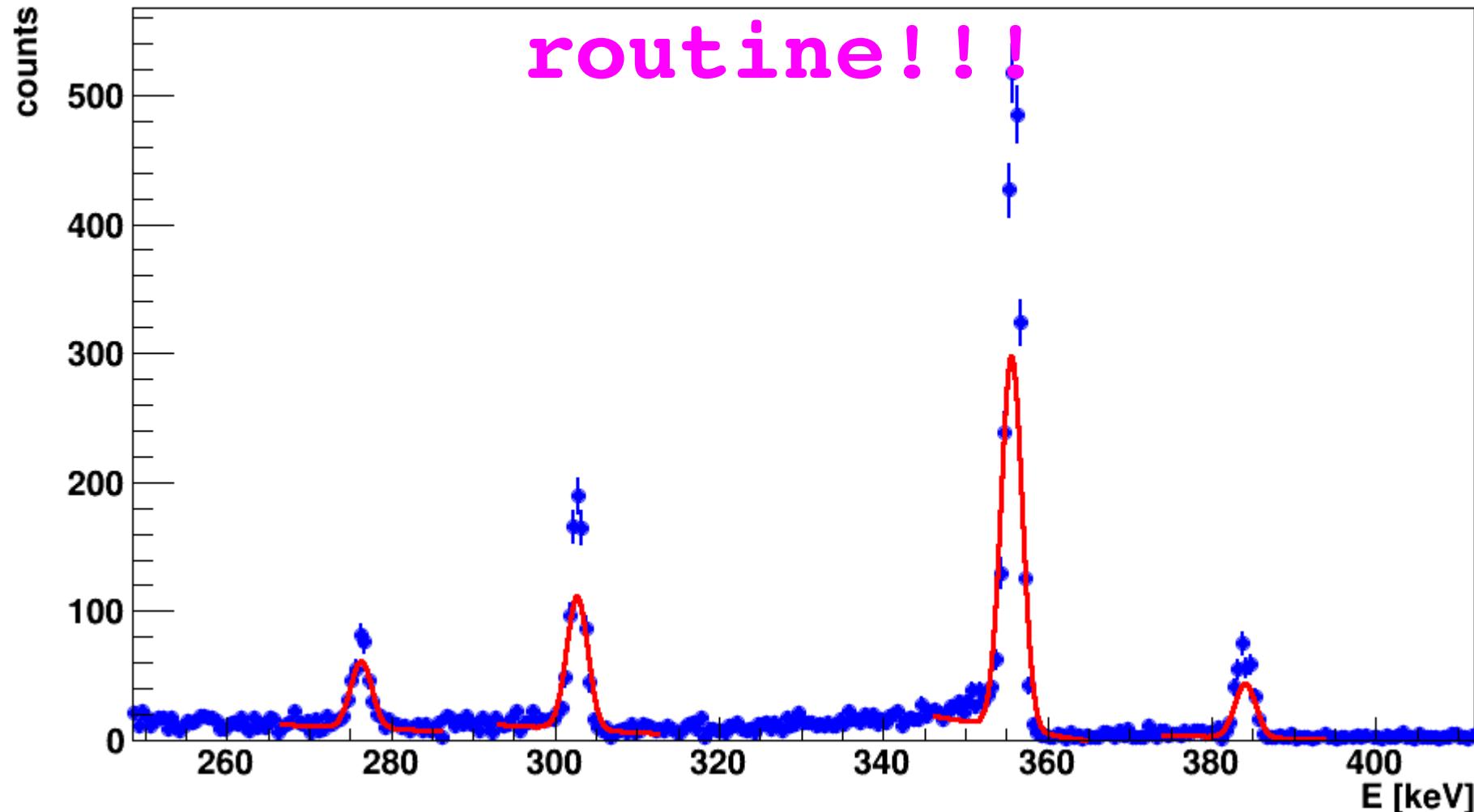




# Ba-133 Side Scan Fit Examples (Seg. SSE 18)

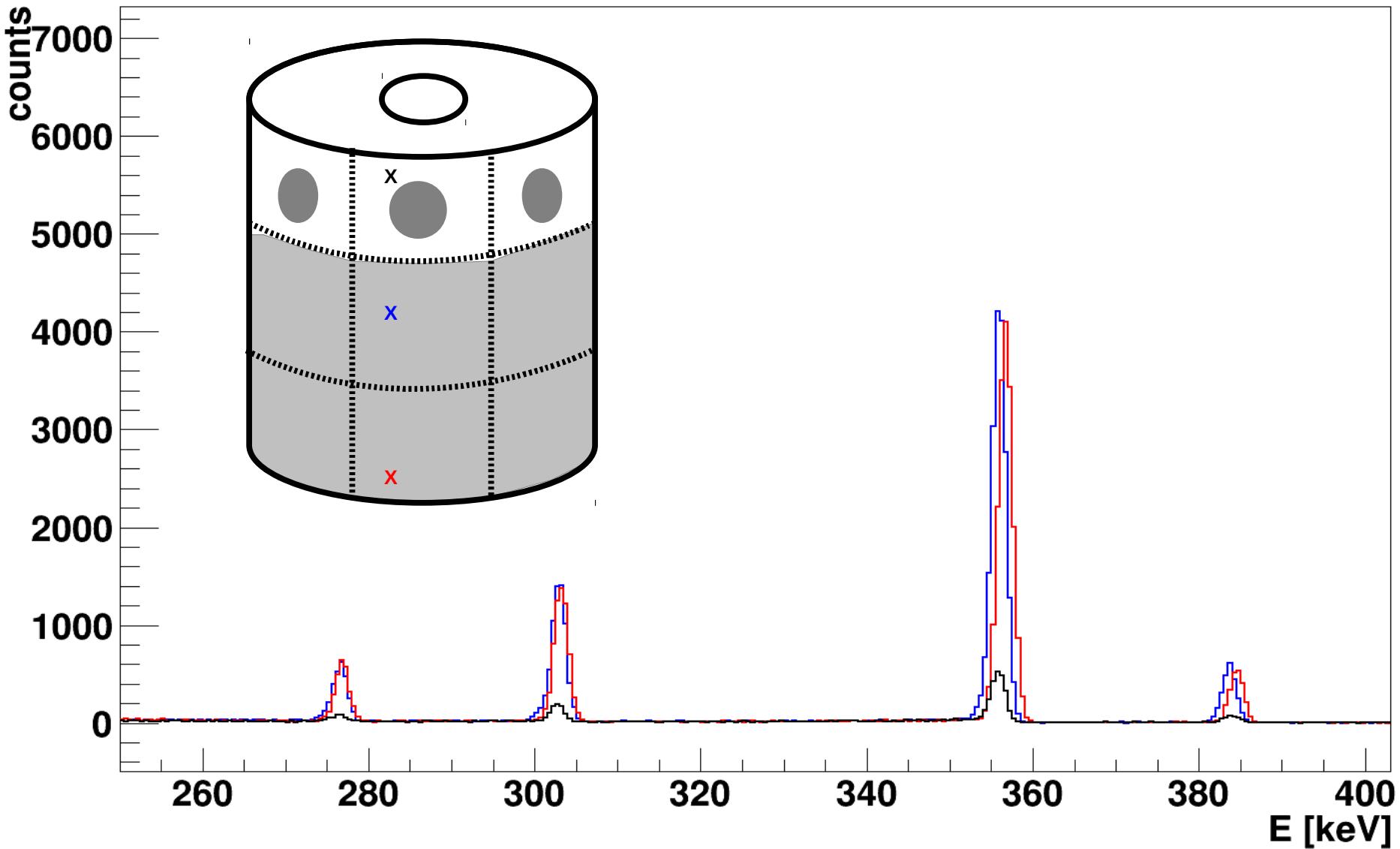
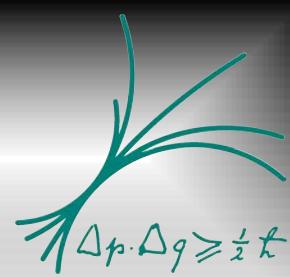


→ Sloppy automatic fitting



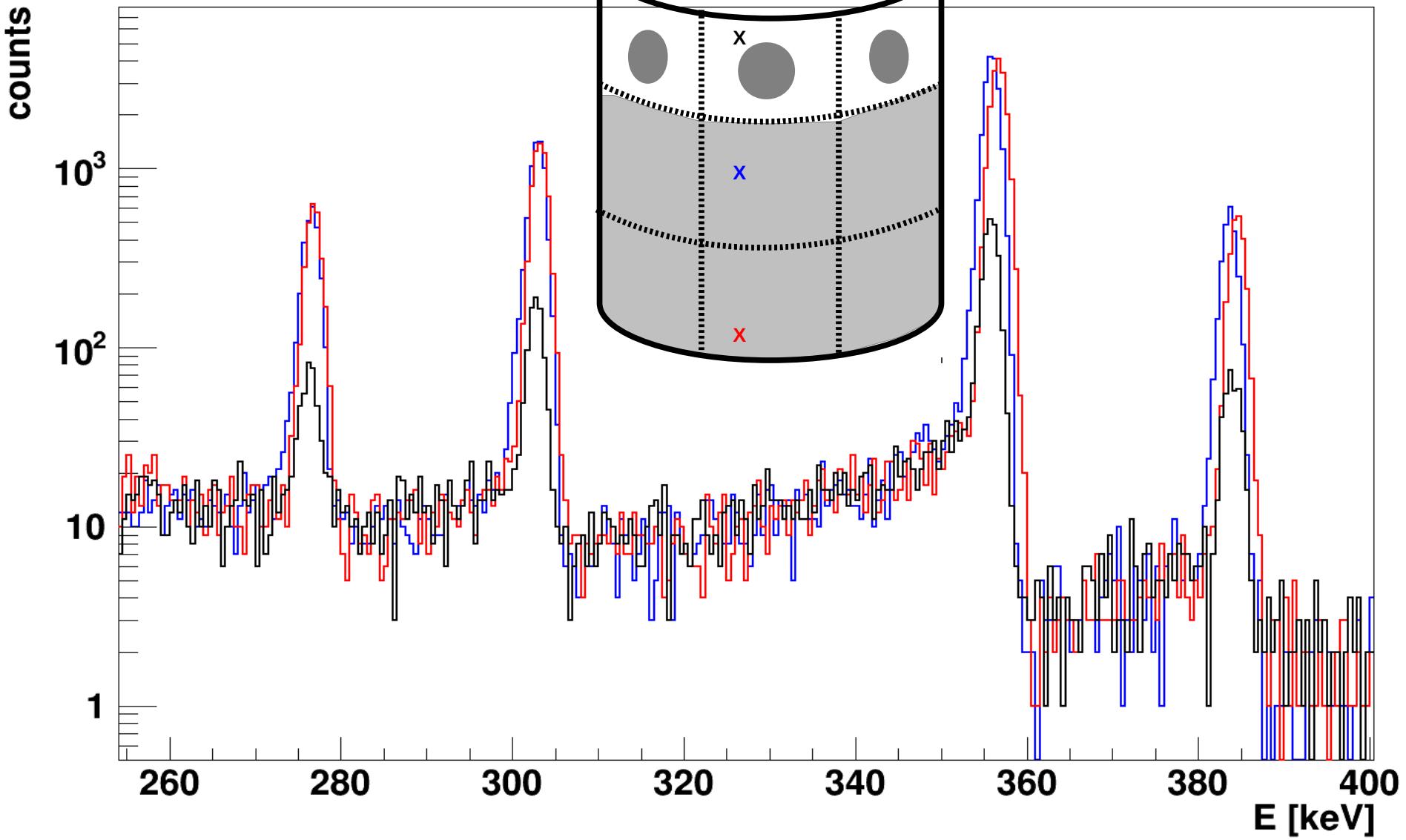
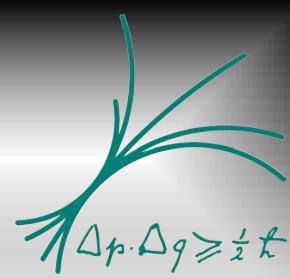


# Ba-133 Side Scan SSE spectra comparison



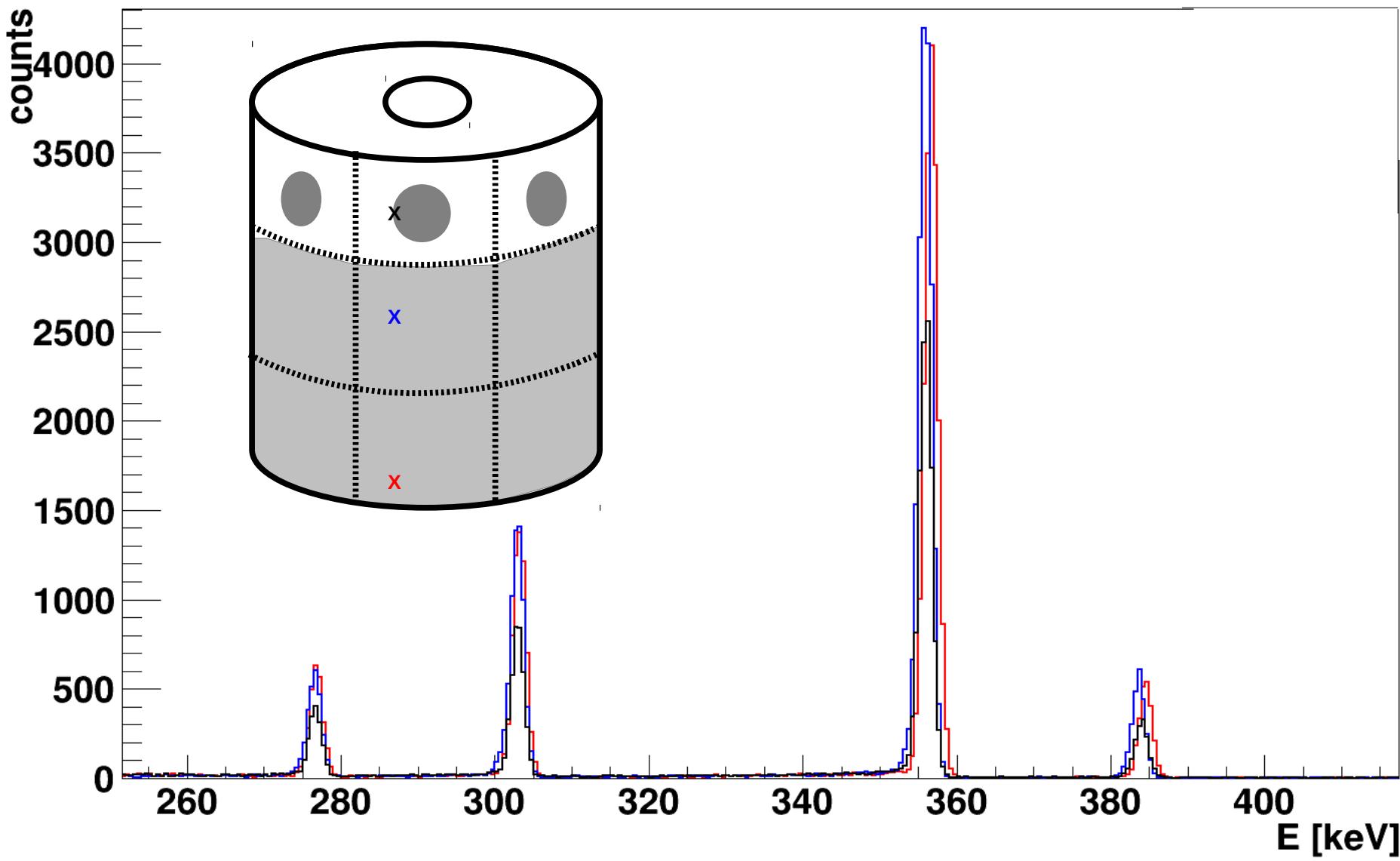
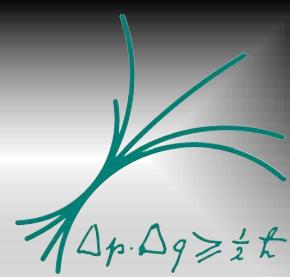


# Ba-133 Side Scan SSE spectra comparison



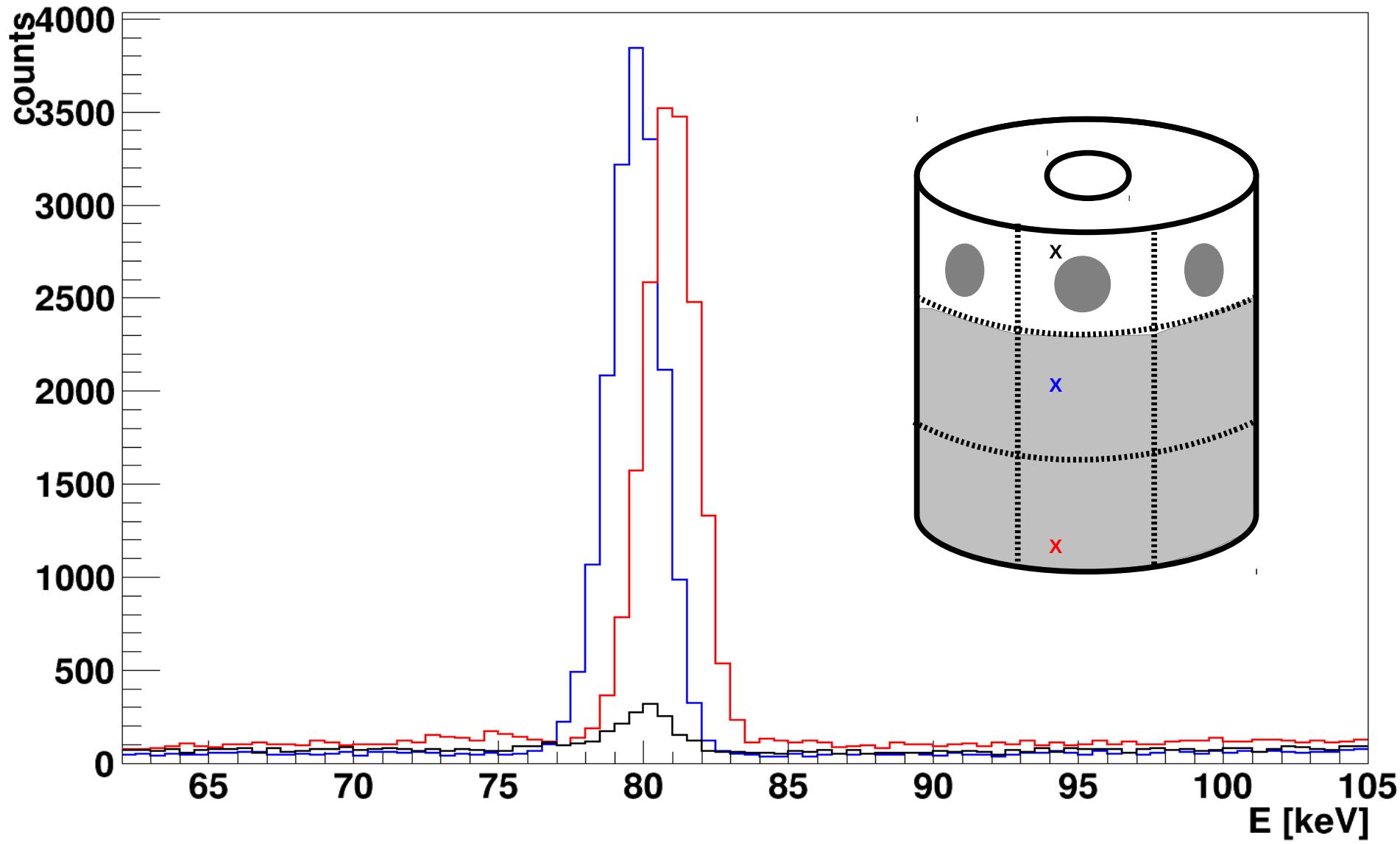
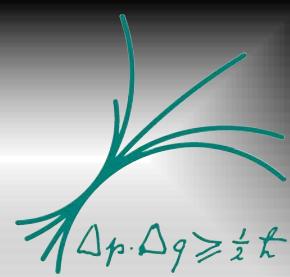


# Ba-133 Side Scan SSE spectra comparison



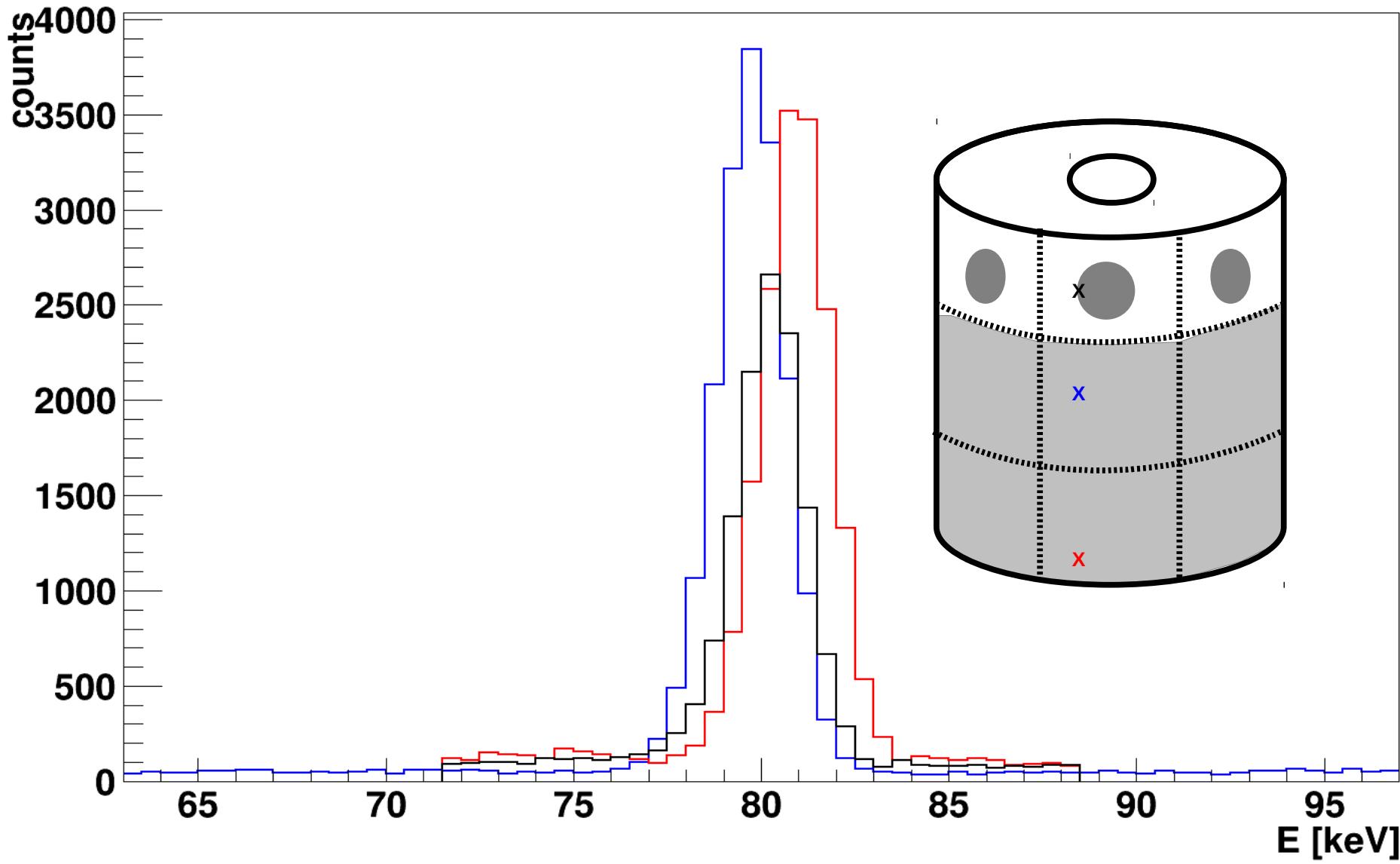
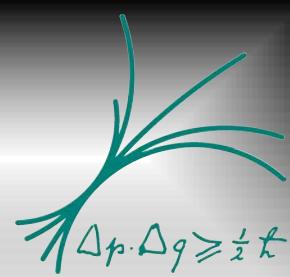


# Ba-133 Side Scan SSE spectra comparison



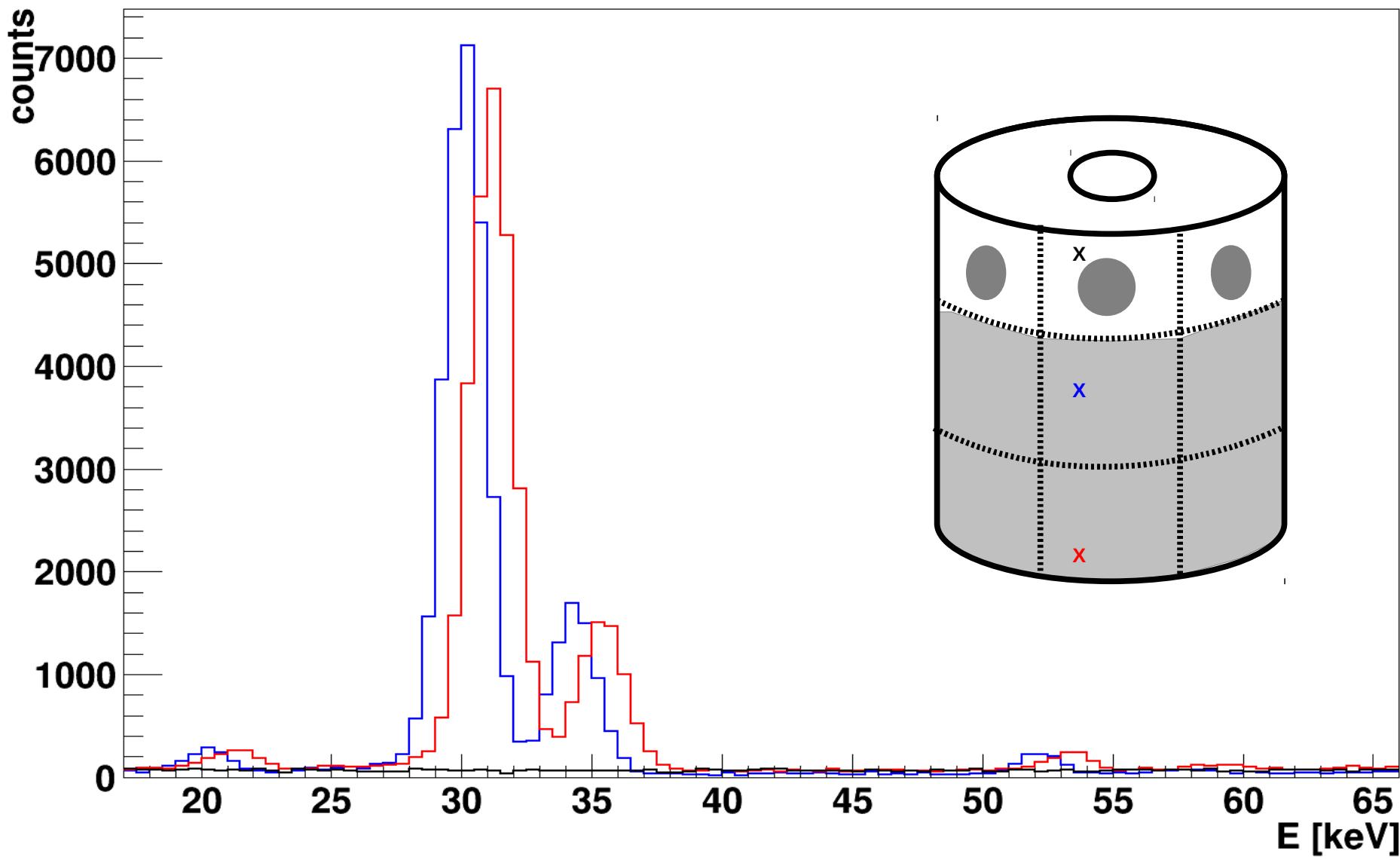
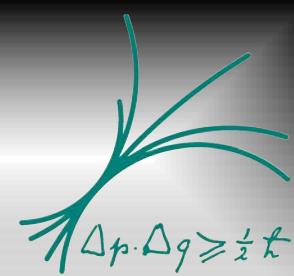


# Ba-133 Side Scan SSE spectra comparison



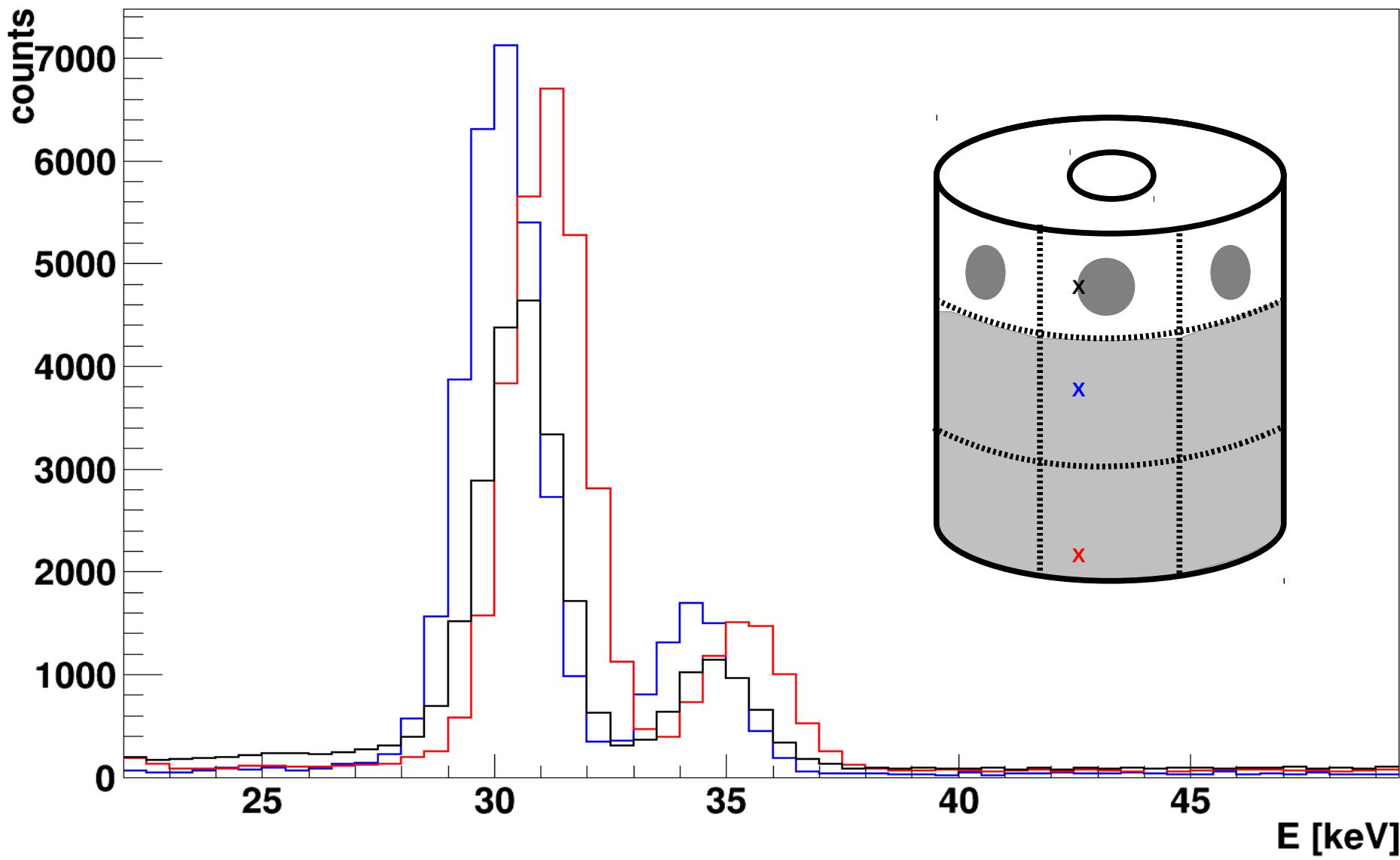
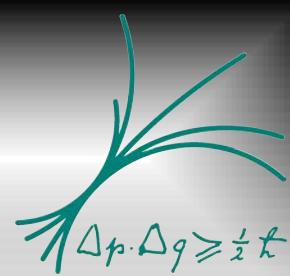


# Ba-133 Side Scan SSE spectra comparison



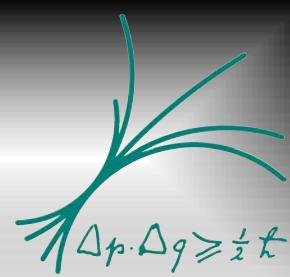


# Ba-133 Side Scan SSE spectra comparison





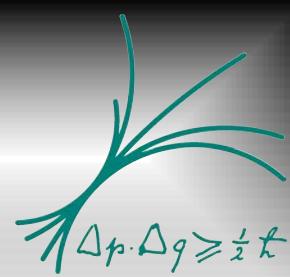
# Outline



- The goal
- Fully and partially metallized 19-fold segmented detector(s) comparison
  - The first attempted analysis
  - A 18-fold segmented detector with different metallization on segments
  - The Ba-133 scan
- Summary & Conclusions



# Summary & Conclusions



- Clear effect of the metallization on the **CORE fwhm**
- Closer look at the **seg.** Spectra → clear **hints** of effect
- The method used is **too sloppy** to fit the seg.
  - The **fits** need to be **tuned**
  - Re-look at the Eseg < Ecore fraction
  - Look at the **%-age** of ev. with **TRUNCATED MIRROR pulses**
- **Better to fully metallize your segmented detector**



Max-Planck-Institut für Physik  
(Werner-Heisenberg-Institut)



EBERHARD KARLS  
UNIVERSITÄT  
TÜBINGEN



# Deutsch-Chinesische-Kooperationsgruppe

## Development of High Purity Germanium Detector Techniques for Applications in Fundamental Research

Finanziell unterstützt durch: Chinesisch-Deutsches Zentrum für Wissenschaftsförderung Peking, China

中德合作研究小组  
应用于基础研究的高纯锗探测器技术研发

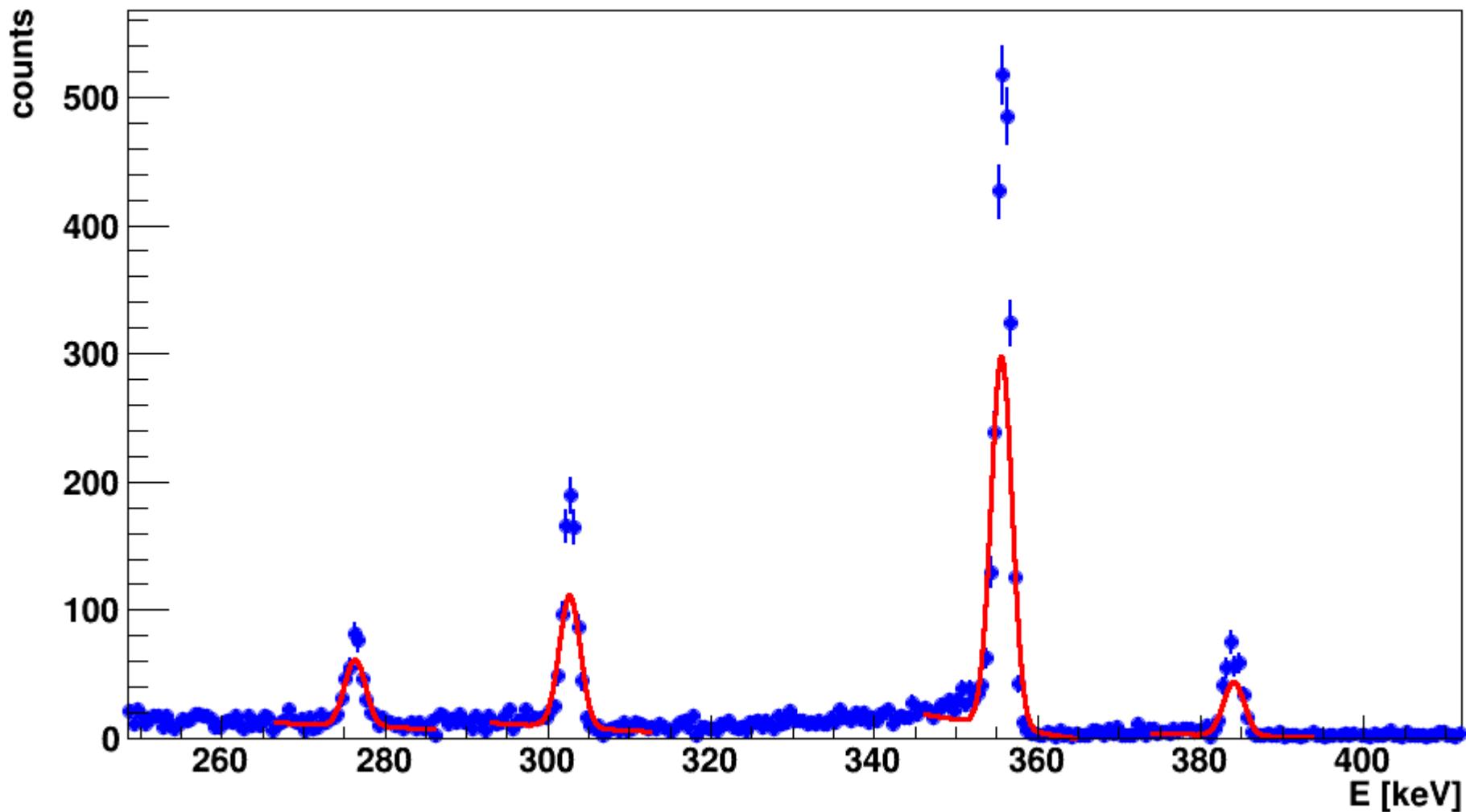
资助者:中德科学中心 / 中国 北京

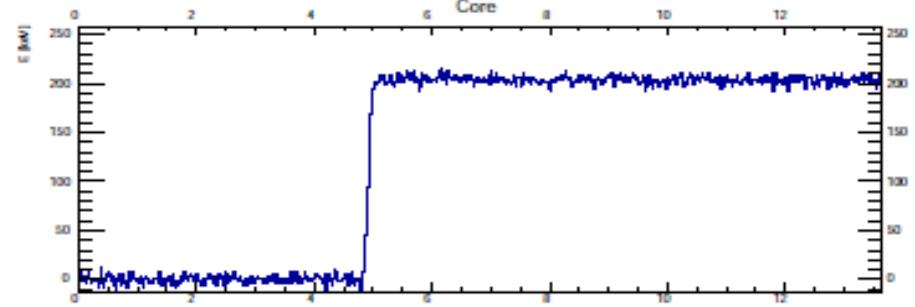


# Backup



$$\Delta_P \cdot \Delta_Q \geq \frac{1}{2} k$$

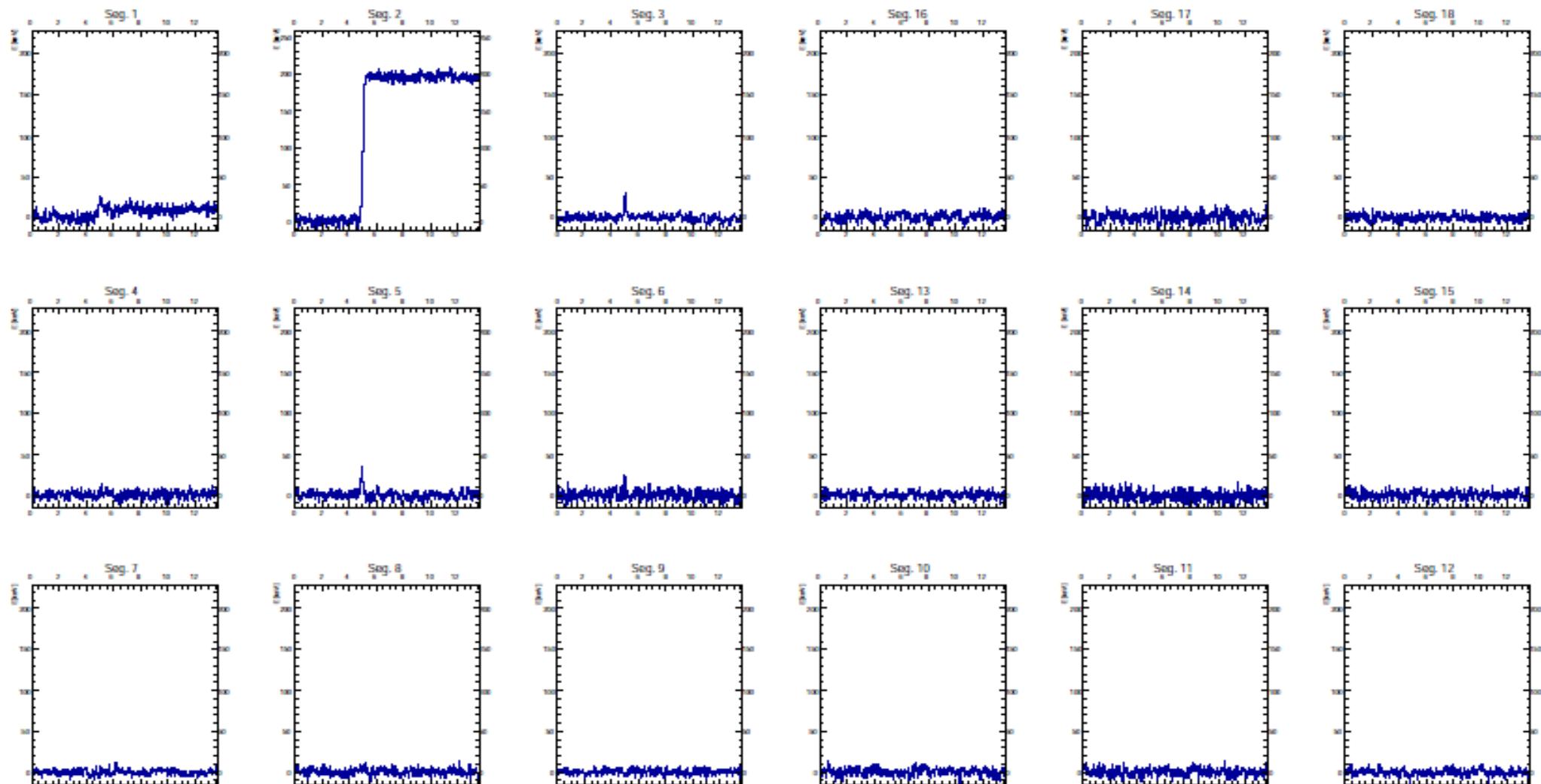




# SSE with Eseg < Ecore

## Event ID 1727

### Ecore = 200.47 keV

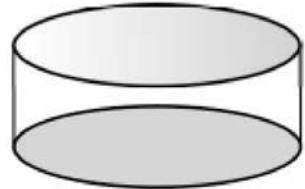




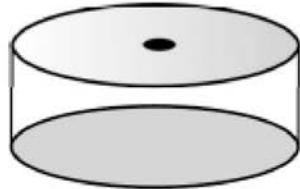
# Germanium Detectors



## Detector configurations:



Planar



Point-contact



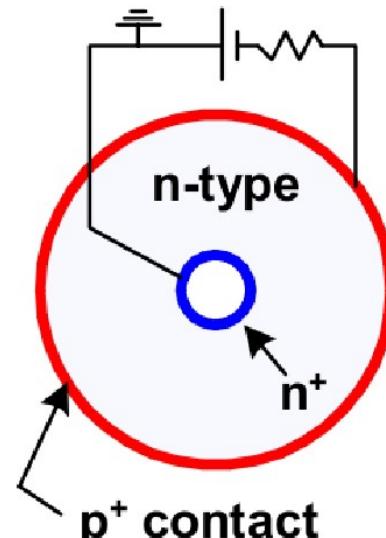
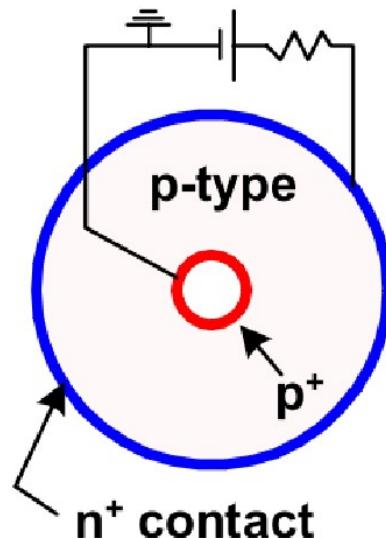
Closed-ended  
coaxial



True-coaxial

## Electrode configurations for coaxial detectors:

Lithium  
Diffusion  
Layer  
(~mm)



Boron  
Implantation  
(~μm)