Segmentation Options for GERDA Phase II Detectors

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The need for segmentation

- Background rejection through segmentation is necessary for GERDA Phase II in order to reach the goal on the background index. The physical process under study suggests segments with size of at least 1 cm.

- Different choices of segmentation (4-fold, 36-fold) have been studied by the Majorana and AGATA experiments

- For GERDA, very good results on the background suppression have been obtained for a 18-fold segmentation ($6\phi,3z$) which fulfills the requirement of GERDA Phase II
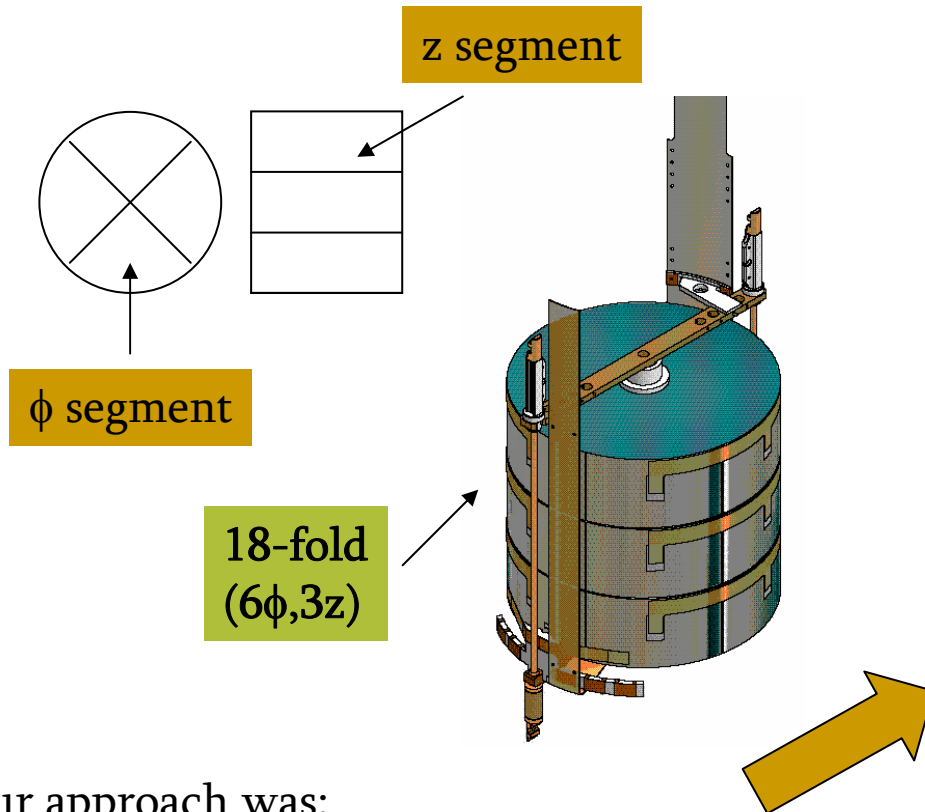
  But there are other things to consider when choosing the segmentation scheme:

- Technical feasibility

- Complexity of the signal read-out and analysis

- Induced background

For this reason we have studied with MaGe different segmentation options from the point of view of the background rejection capability

Segmentation options

z segment

φ segment

18-fold
(6φ,3z)

φ	z	Tot	φ size	z size
1	2	2	24 cm	4 cm
1	3	3	24 cm	2.5 cm
1	4	4	24 cm	1.8 cm
2	2	4	12.6 cm	4 cm
2	3	6	12.6 cm	2.5 cm
3	2	6	8.4 cm	4 cm
4	2	8	6.3 cm	4 cm
3	3	9	8.4 cm	2.5 cm
4	3	12	6.3 cm	2.5 cm
4	4	16	6.3 cm	1.8 cm
6	3	18	4.2 cm	2.5 cm

Our approach was:
· to study many different options with a simplified
geometry (only 1 GERDA detector)
· to focus on 2/3 realistic options and investigate the background suppression factor
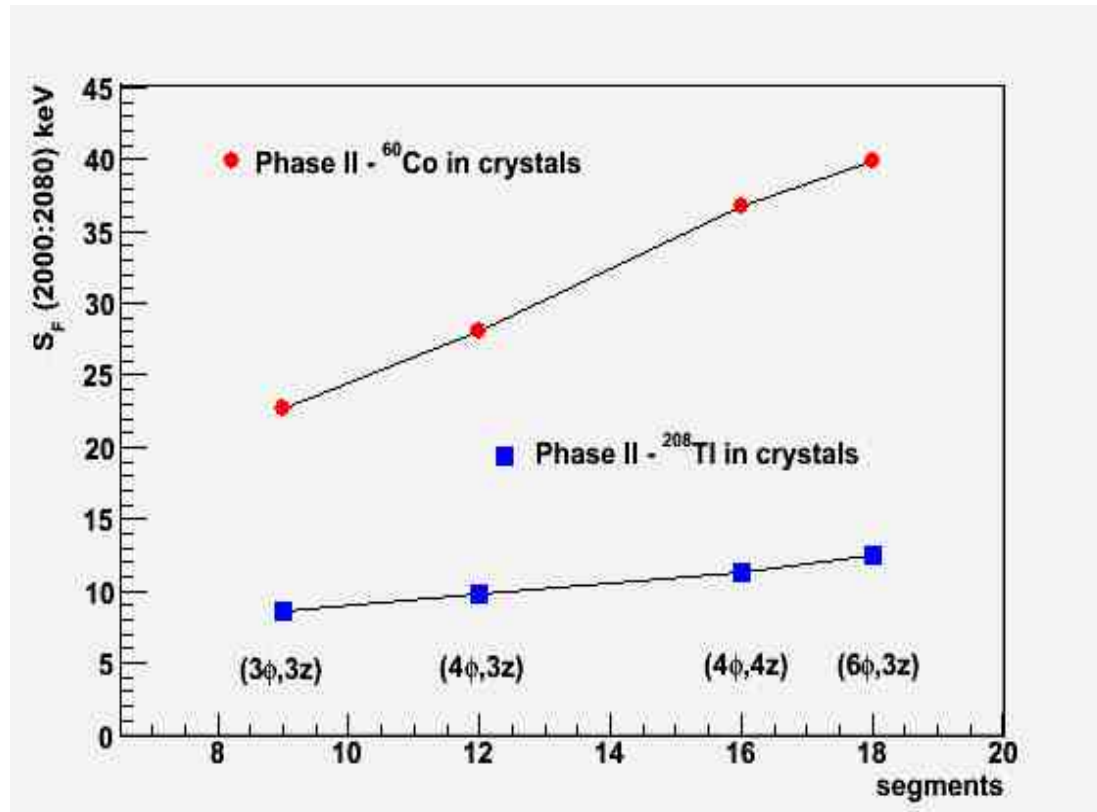for GERDA Phase II (21 detectors, full geometry)

Background Suppression for 1 Detector

10^6 simulated events for each configuration - Ge threshold: 50 keV
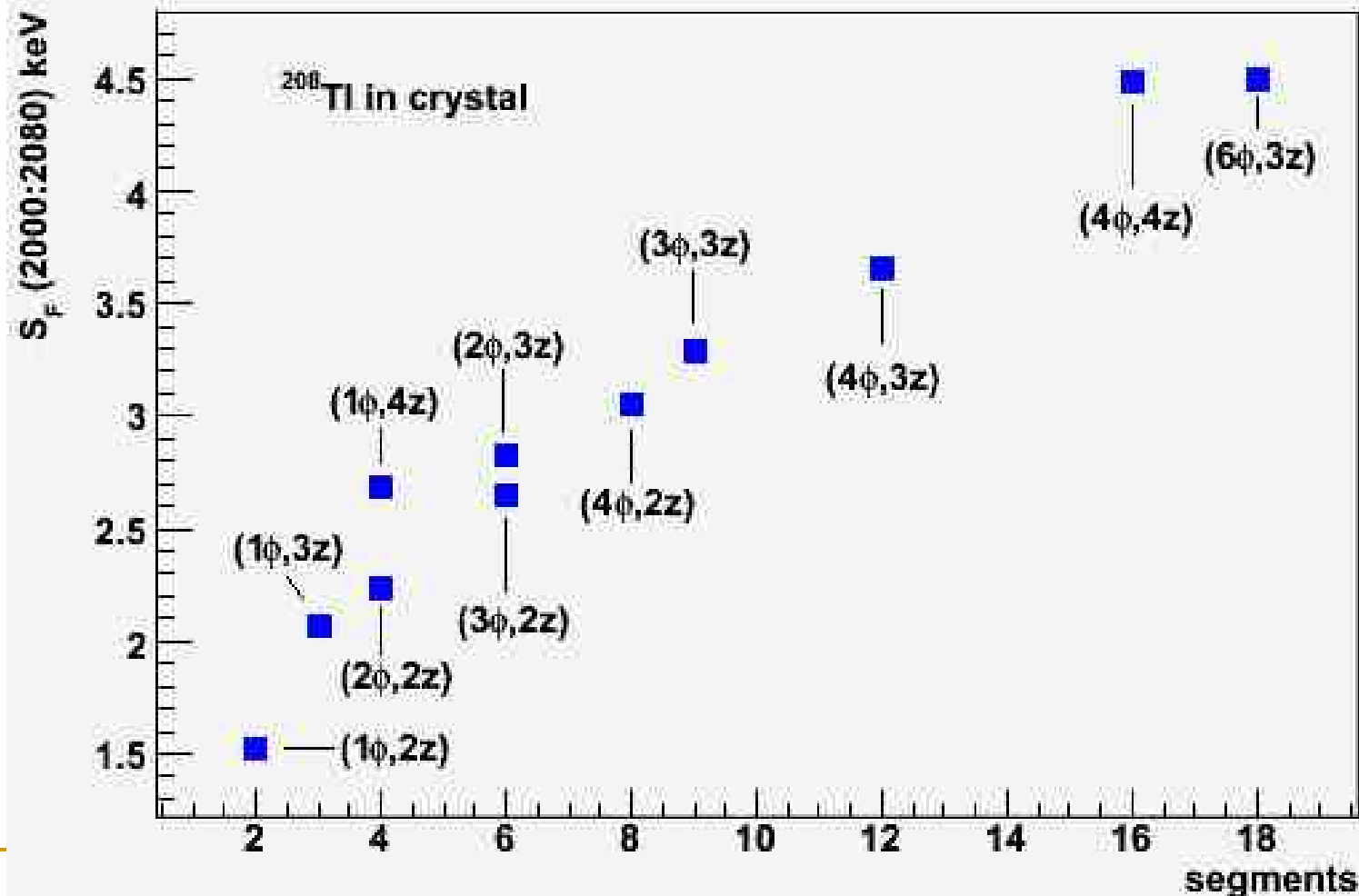
Background Suppression for Phase II

^{208}Tl and ^{60}Co inside crystals

Seg.	S_F ^{60}Co	S_F ^{208}Tl
$(3\phi,3z)$	22.6	8.6
$(4\phi,3z)$	28.0	9.8
$(4\phi,4z)$	36.8	11.2
$(6\phi,3z)$	39.9	12.5

Liquid Argon

Seg.	S_F ^{60}Co	S_F ^{208}Tl
$(3\phi,3z)$	19.3	8.2
$(4\phi,3z)$	24.6	9.4
$(4\phi,4z)$	34.7	11.2
$(6\phi,3z)$	34.8	11.2

Factor 2 difference in S_F when going from $(6\phi,3z)$ to $(3\phi,3z)$

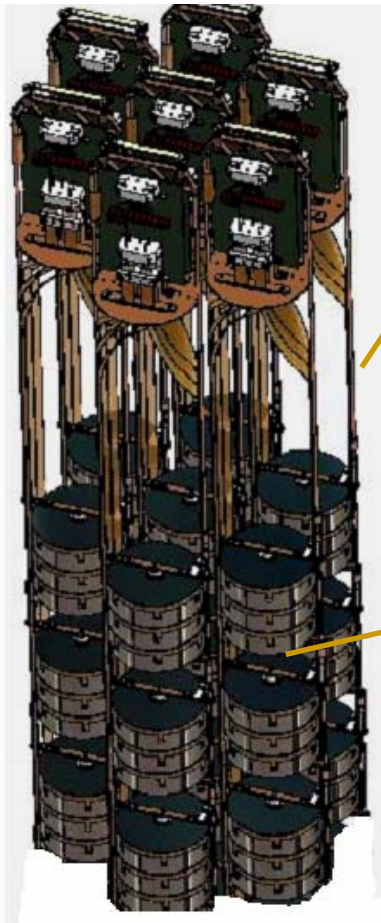Factor 1.4 difference in S_F when going from $(6\phi,3z)$ to $(3\phi,3z)$
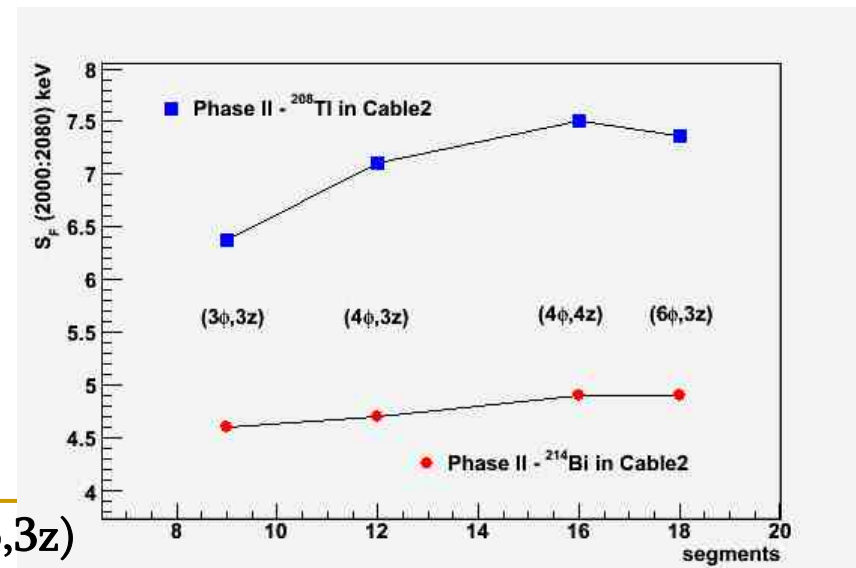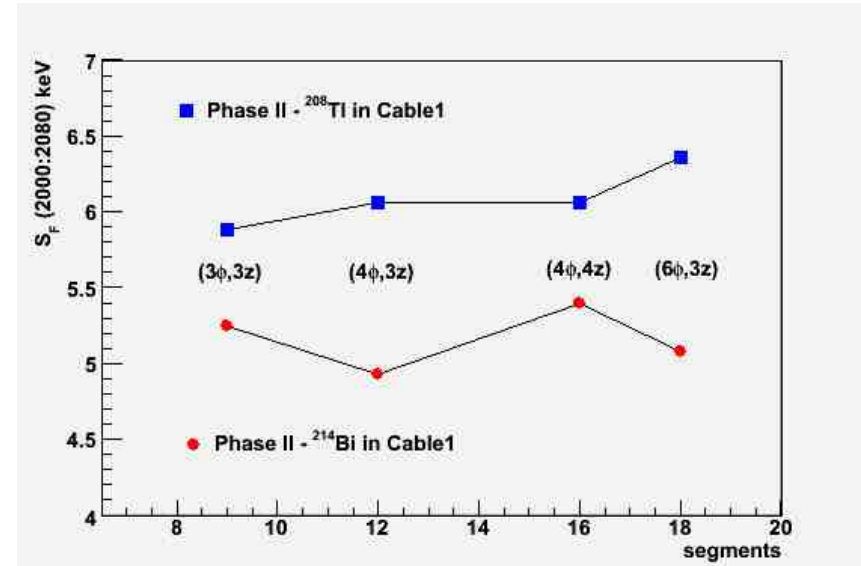
Background Suppression for Phase II

^{208}Tl and ^{214}Bi impurities in Cables

Cable 1:
one for each crystal
copper,
56.4 cm long
50μ thick, 6g

Cable 2:
one for each z segment
copper,
5 cm high
50μ thick, 0.44g

^{214}Bi: S_F compatible within the error
^{208}Tl: S_F compatible within the error except for (3ϕ,3z)

Background Suppression for Phase II

^{208}Tl and ^{214}Bi impurities in Electronics

EBoard:
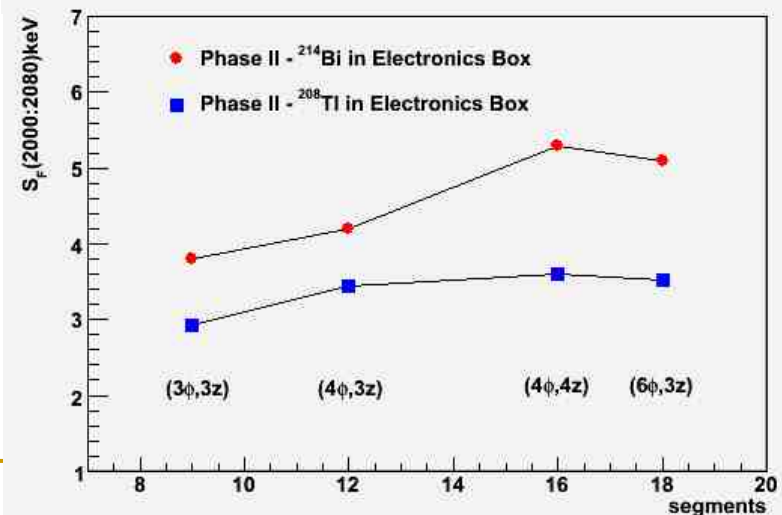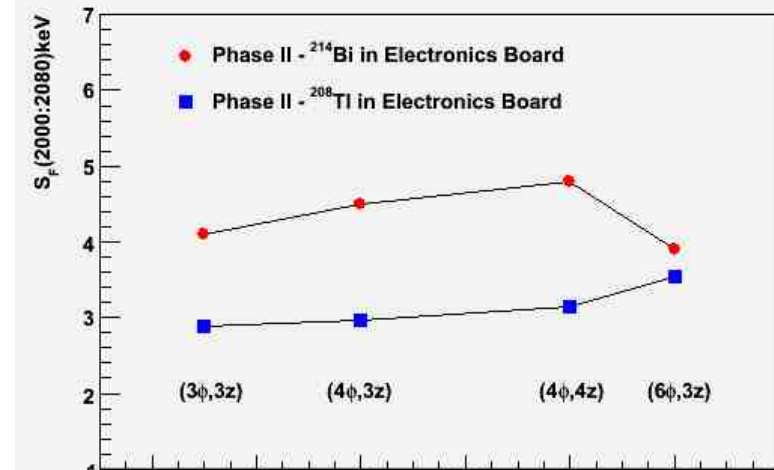4 for each column copper,
9 cm diameter
1 mm thick, 54g

EBox:
4 for each column copper,
2.25 x 2.25 cm^2
4 mm thick, 17g

^{214}Bi: S_F compatible within the error
^{208}Tl: S_F compatible within the error except for (3ϕ,3z)

Conclusions

- GERDA has already a working option for the Ge segmented detectors (18-fold, 6f-3z) which fulfills the requirements in terms of background suppression and induced background

- We think that is nevertheless important to show that we have studied in detail the possibility of other segmentation options which have a lower background suppression factor but are maybe easier to build and require less cabling/electronics.

- From our preliminary results on some of the background sources we show that the decrease in the background suppression power is relevant only for intrinsic impurities

- We plan to continue the investigation for at least 1/2 segmentation backup options