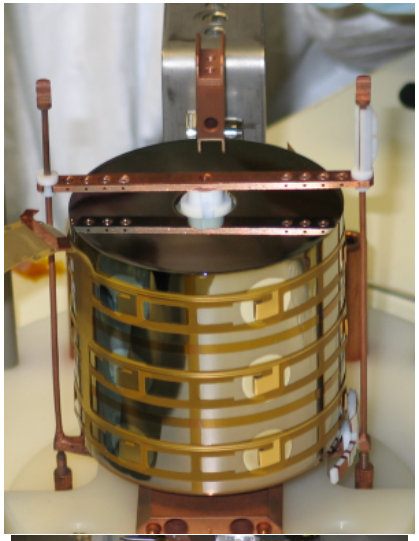
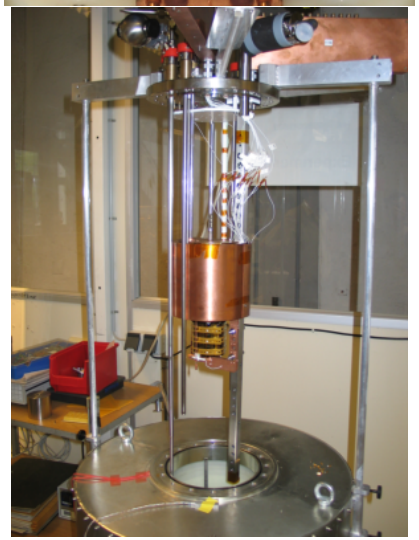
Phase II prototype detectors
(Segmented, n-type)

Outline

- Gerdalinchen II teststand filled with LN:
  - Latest run with SiegfriedII
  - validation of the PS simulation
- Vacuum cryostat:
  - SiegfriedII running in vacuum
  - Scan with collimated Eu152
  - Th228 data
- Gerdalinchen II teststand filled with LAr
  - Siegfried I in LAr
  - Long term leakage current measurement
  - Capacity measurements

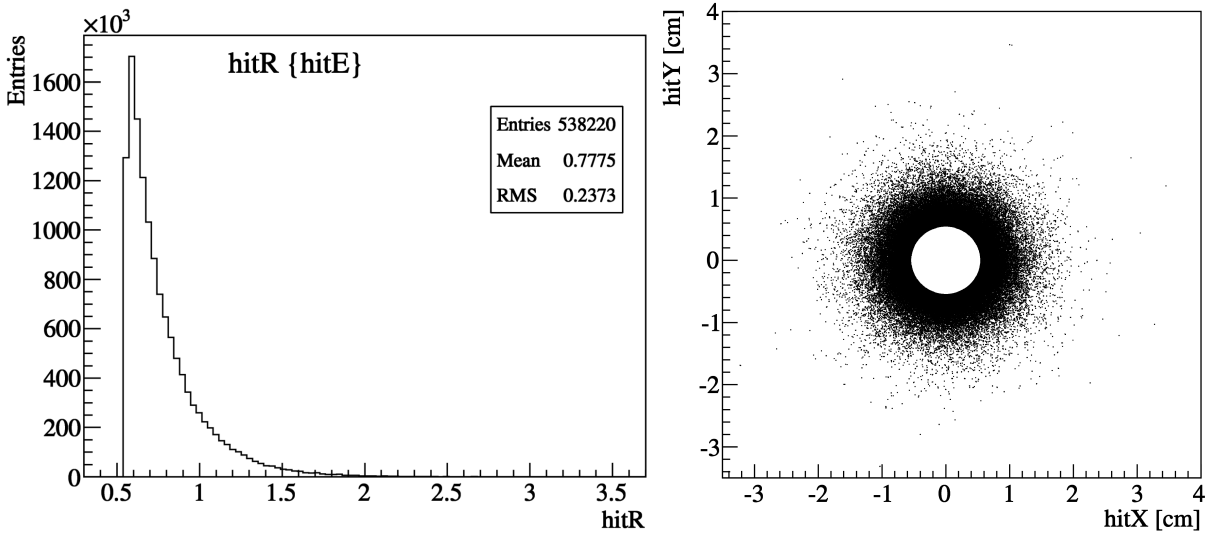
SiegfriedII in LN





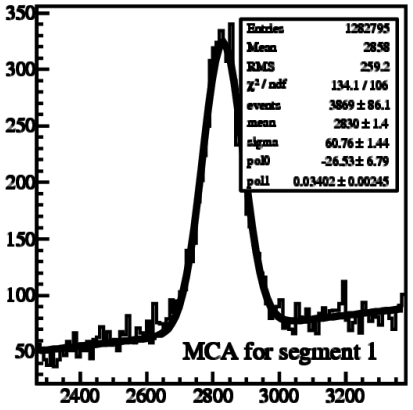
- SiegfriedII was running in LN from 24.03.09 to 29.04.09
- Cadmium-109 source was placed inside the borehole in the crystal
- The 88keV line seen only in the ”top“ segments
- Pulse shapes were recorded to validate PS simulation

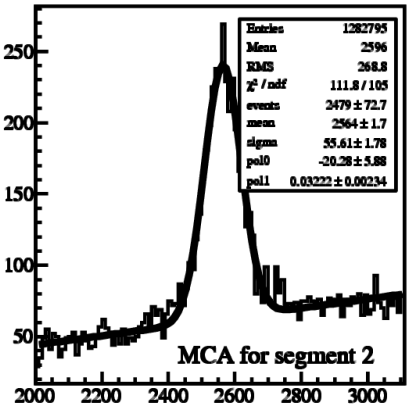
Cd109 - Simulation

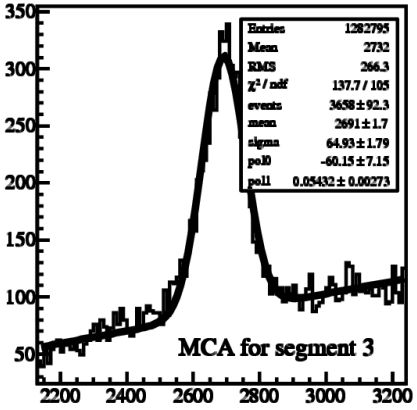


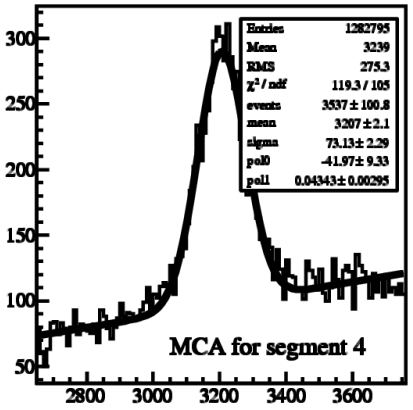
Hits are distributed close to the core, the pulse-shapes are mainly defined by the hole drift

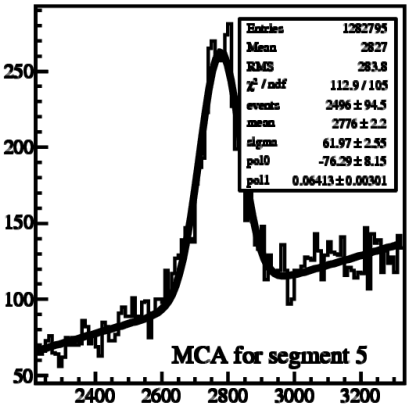
88keV line

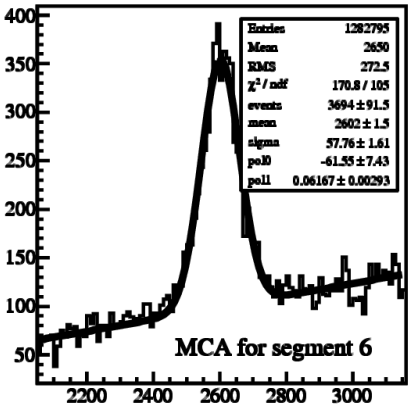

Entries 1282795
Mean 2858
RMS 259.2
χ²/ndf 134.1 / 106
events 3869 ± 86.1
mean 2830 ± 1.4
sigma 60.76 ± 1.44
pol0 -26.53 ± 6.79
pol1 0.03402 ± 0.00245
MCA for segment 1


Entries 1282795
Mean 2596
RMS 268.8
χ²/ndf 111.8 / 105
events 2479 ± 72.7
mean 2564 ± 1.7
sigma 55.61 ± 1.78
pol0 -20.28 ± 5.88
pol1 0.03222 ± 0.00234
MCA for segment 2

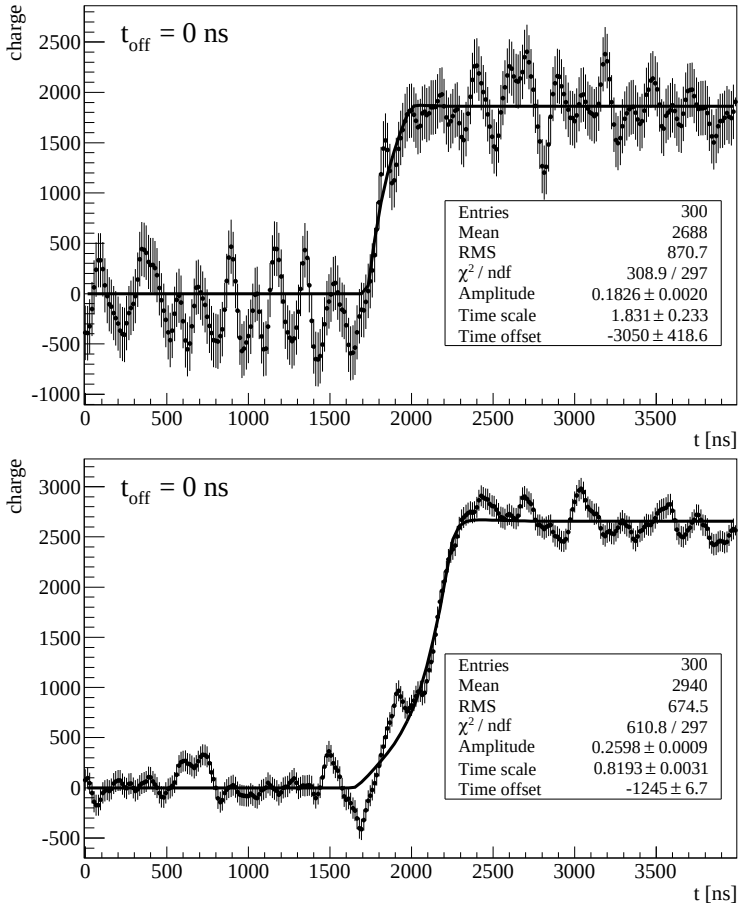

Entries 1282795
Mean 2732
RMS 266.3
χ²/ndf 137.7 / 105
events 3658 ± 92.3
mean 2691 ± 1.7
sigma 64.93 ± 1.79
pol0 -60.15 ± 7.15
pol1 0.05432 ± 0.00273
MCA for segment 3


Entries 1282795
Mean 3239
RMS 275.3
χ²/ndf 119.3 / 105
events 3537 ± 100.8
mean 3207 ± 2.1
sigma 73.13 ± 2.29
pol0 -41.97 ± 9.33
pol1 0.04343 ± 0.00295
MCA for segment 4


Entries 1282795
Mean 2827
RMS 283.8
χ²/ndf 112.9 / 105
events 2496 ± 94.5
mean 2776 ± 2.2
sigma 61.97 ± 2.55
pol0 -76.29 ± 8.15
pol1 0.06413 ± 0.00301
MCA for segment 5

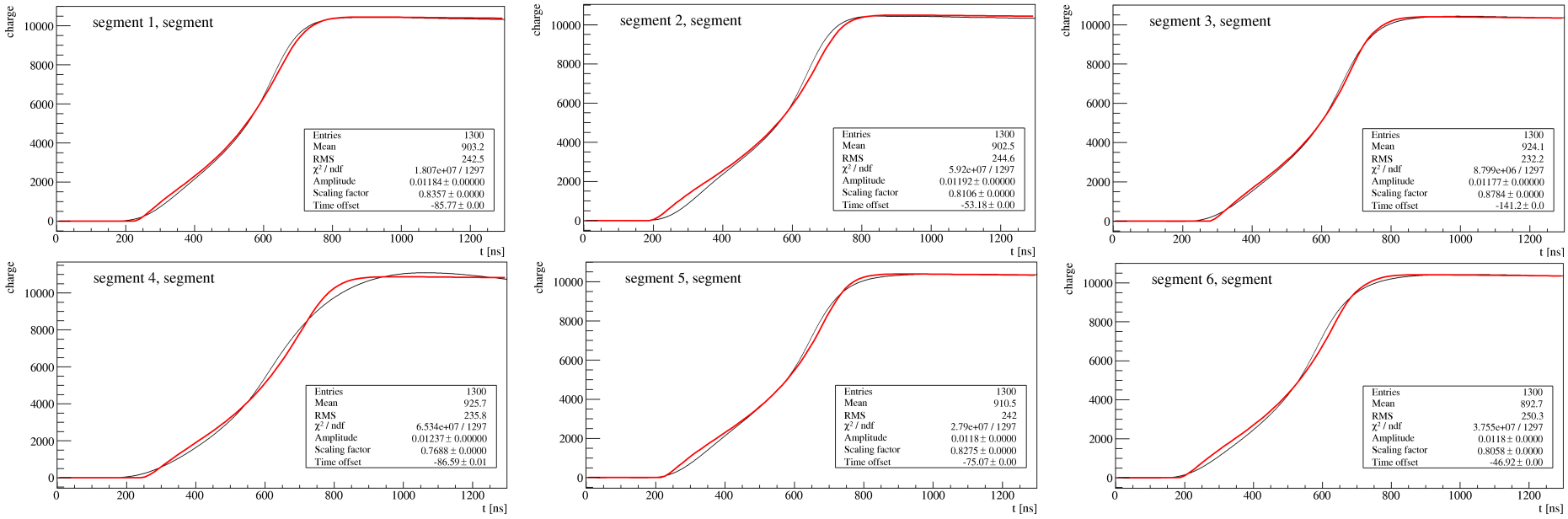

Entries 1282795
Mean 2650
RMS 272.5
χ²/ndf 170.8 / 105
events 3694 ± 91.5
mean 2602 ± 1.5
sigma 57.76 ± 1.61
pol0 -61.55 ± 7.43
pol1 0.06167 ± 0.00293
MCA for segment 6

Real pulses + simulation



To reduce the noise average pulses were used

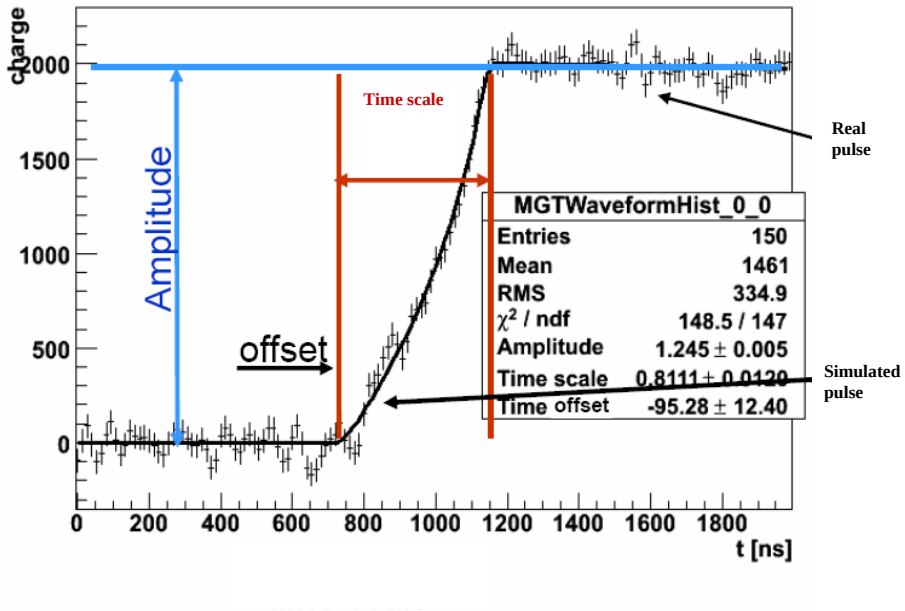
Average pulses (black) for all the top 6 segments with the simulated pulses (red)

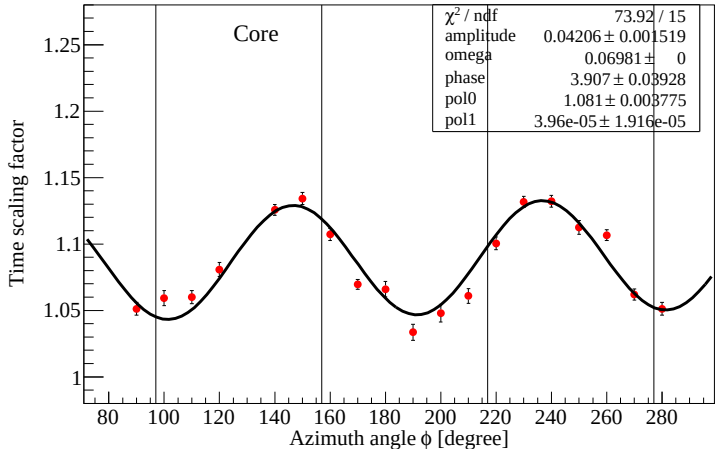


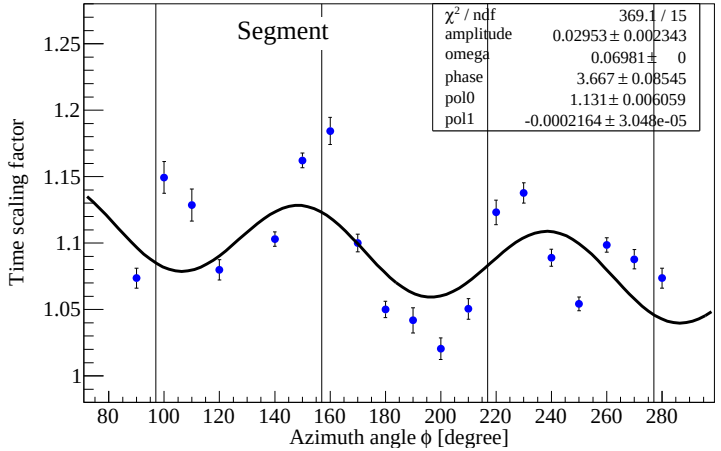
good agreement with the simulation

SigfriedII in Vacuum cryostat, PS analysis

The simulated pulse is scaled vertically and horizontally to fit the real pulse. Horizontal stretching = ”time scaling”

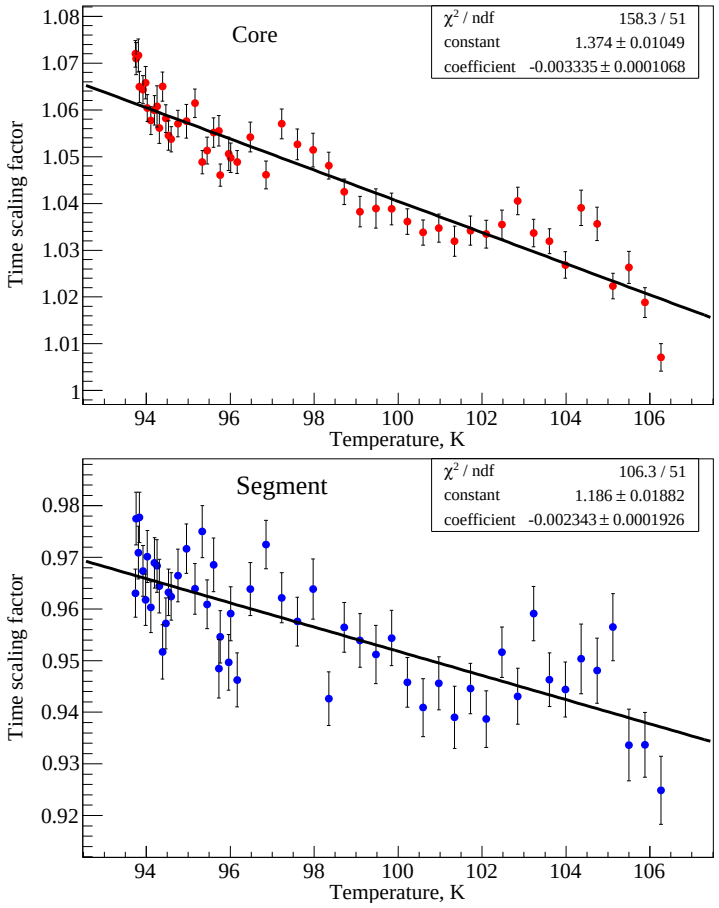






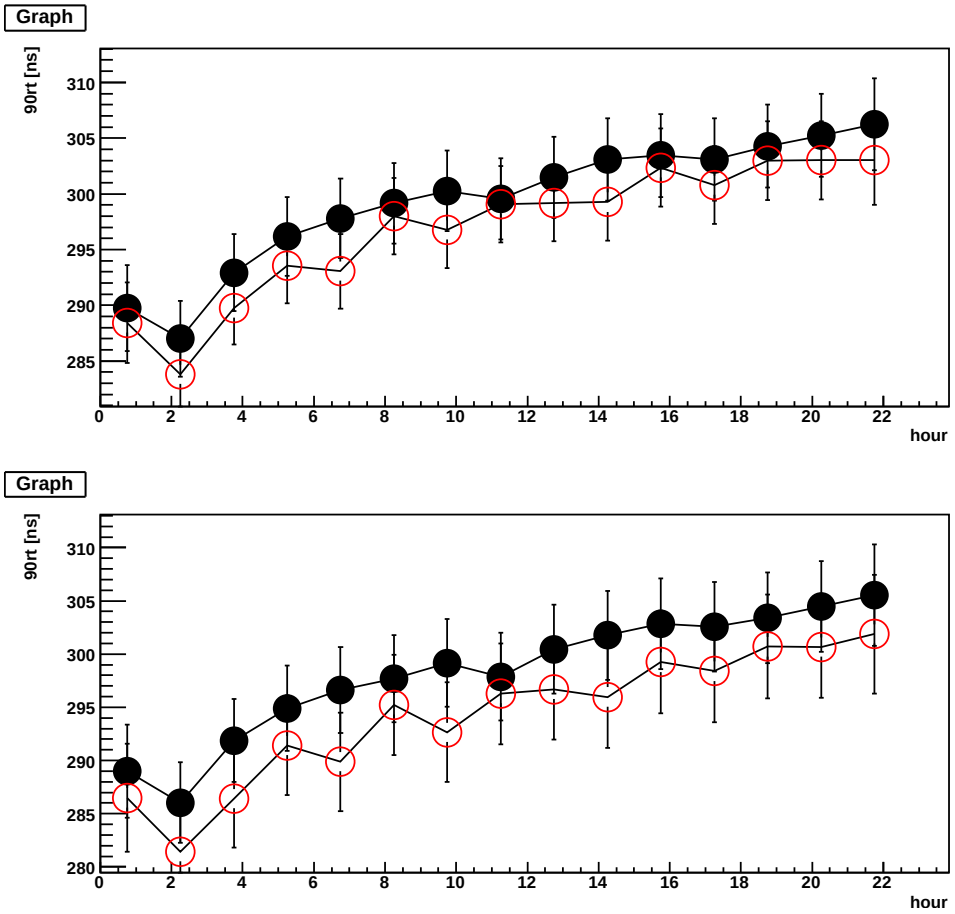
- Angular scan with collimated Eu152 source
- Crystal axes clearly visible

Temperature dependence



- Temperature continuously increases between refills
- Rise time changes with time
  $\longrightarrow$ Temperature dependent
- Consequences on the PS analysis

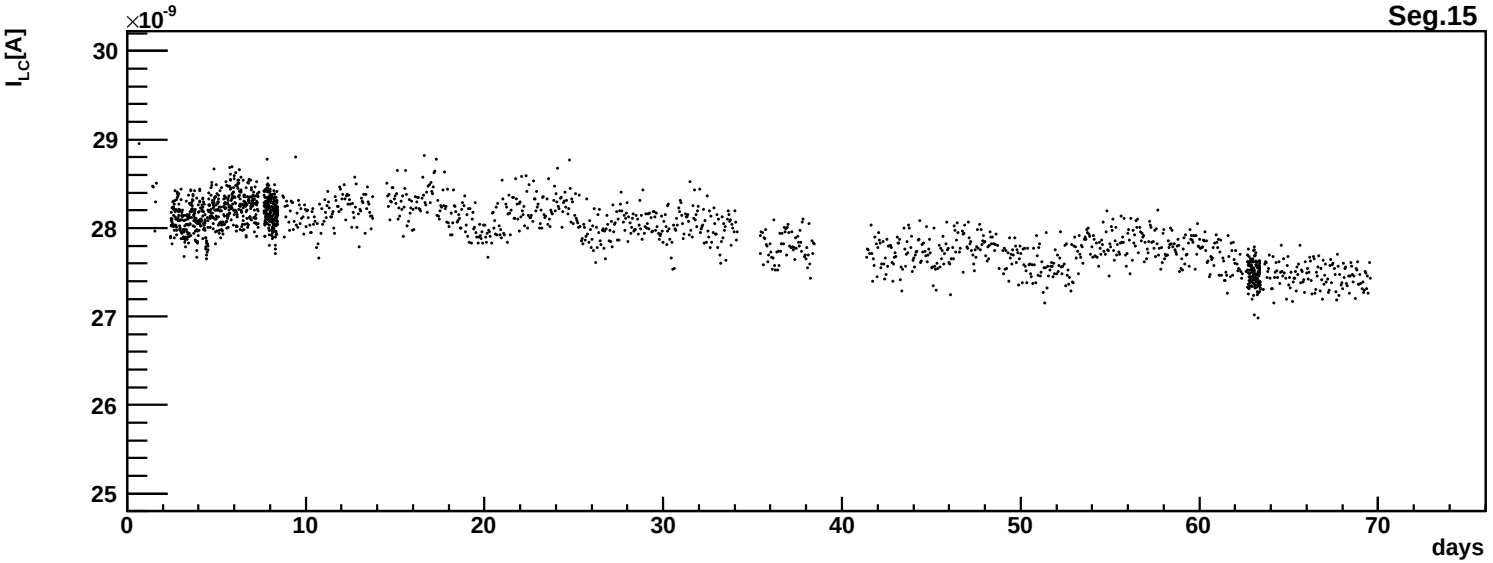
PS analysis



- Th228 data
- black dots: DEP peak
- open dots: 1620keV peak
- upper plot all events
- lower plot single-segment events.

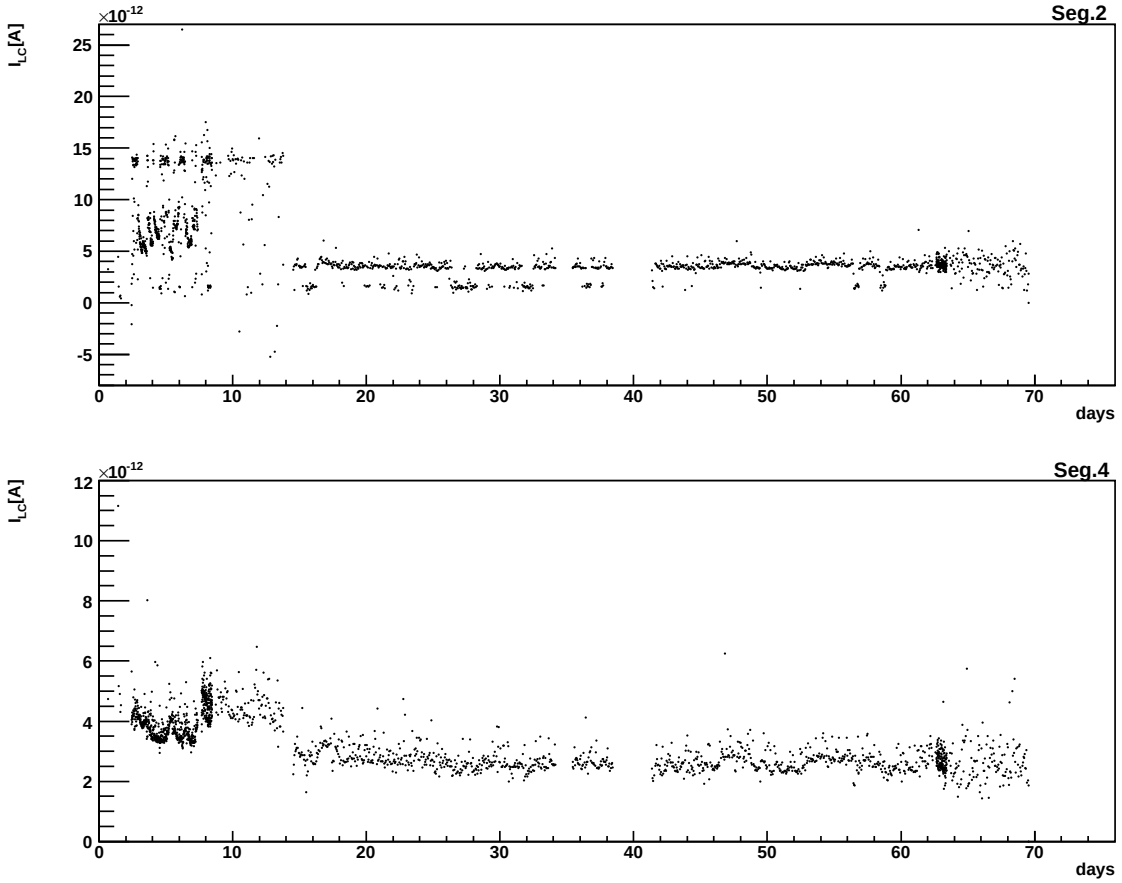
Siegfriedl in LAr

Siegfried I in LAr since (almost) 4 month (started on 29.05.09)
Automatic measurement: LabView + Keithley pico amp. meter
Leakage current measured every hour for all 18 segments.
One broken segment $I_{LC} = 28nA$



SI in LAr

Stable for more than 3 month, examples:



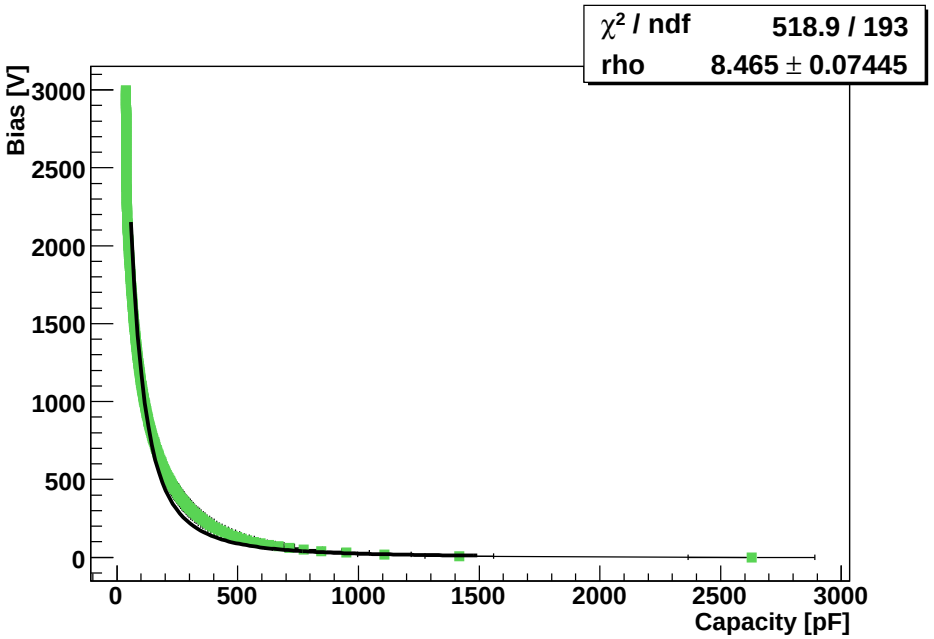
Capacity measurements

- We measured the capacities of SI as a function of bias voltage, core and all the segments one by one
- The C(V) curve can be fitted with:

$$V_d = \frac{\rho}{2\epsilon}\left[r_1^2 \ln\left(\frac{r_2}{r_1}\right) - \frac{1}{2}(r_2^2 - r_1^2)\right] \quad (1)$$

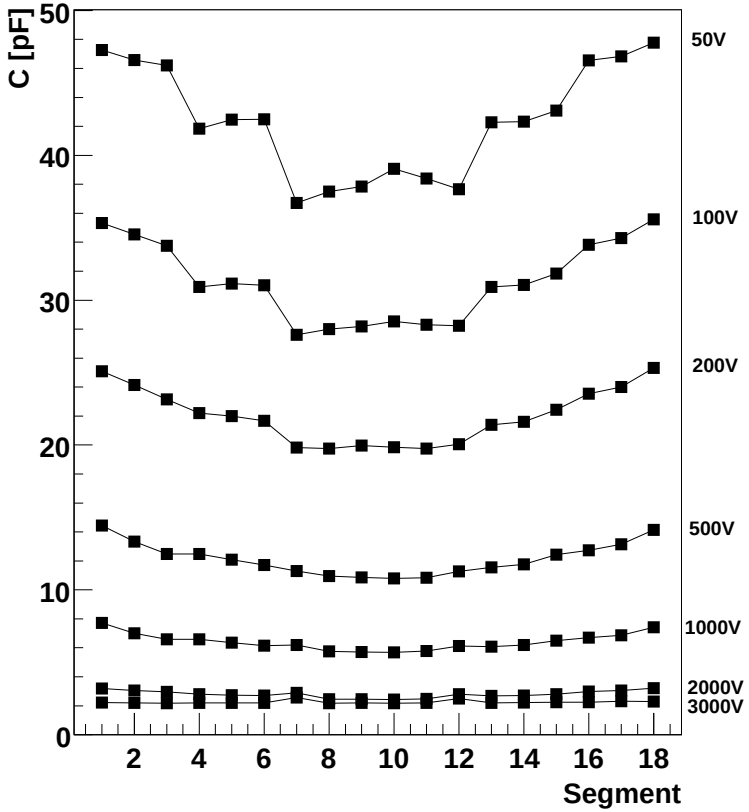
- Impurity concentration can be determined
- From the resistance, resistivity and mobility can be calculated

Core capacity



Bias voltage v. core capacity fitted with the formula. From the fit the donnor concentration is $8.5 \times 10^9/cm^3$ Good agreement with the values given by Canberra

Segment capacities



From the segment capacities (as function of bias voltage) the vertical gradient can be reconstructed

Impurity concentrations

	Resistance kΩ	Resistivity Ωcm	Capacity pF	Impurity conc. 10^9/cm^3	Mobility m^2/VS
Core	1.021	24494.6	37.76	8.23	3.09
Top	2.675	21394.0	12.64	9.08	3.21
Middle	3.094	24742.4	12.44	8.14	3.09
Bottom	3.525	28193.5	13.01	7.61	2.90
Seg.1	15.76	21010.2	2.23	9.94	2.98
Seg.2	15.97	21290.3	2.20	9.24	3.17
Seg.3	16.36	21809.1	2.17	8.79	3.25
Seg.4	18.40	24529.7	2.20	8.72	2.91
Seg.5	18.37	24492.7	2.18	8.42	3.02
Seg.6	18.63	24840.4	2.20	8.24	3.04
Seg.7	21.34	28448.3	2.57	8.15	2.69
Seg.8	21.32	28425.1	2.17	7.63	2.87
Seg.9	20.88	27835.3	2.18	7.57	2.96
Seg.10	21.03	28031.5	2.18	7.52	2.96
Seg.11	21.00	27986.3	2.20	7.64	2.91
Seg.12	20.92	27889.0	2.49	8.06	2.77
Seg.13	18.53	24700.7	2.20	8.13	3.10
Seg.14	18.63	24831.3	2.21	8.27	3.03
Seg.15	18.04	24054.1	2.24	8.66	2.99
Seg.16	16.16	21546.7	2.25	8.92	3.24
Seg.17	15.95	21263.0	2.30	9.11	3.22
Seg.18	15.45	20596.1	2.28	9.76	3.10

Summary

- PS simulation was validated with real data also for segment pulses dominated by the hole drift.
- Temperature dependence of the rise time observed in vacuum cryostat
- We don't see an increase of the leakage current in LAr after more than 3 month continuous measurement
- Impurity concentration and it's spatial distribution was estimated from capacity measurement for SI.