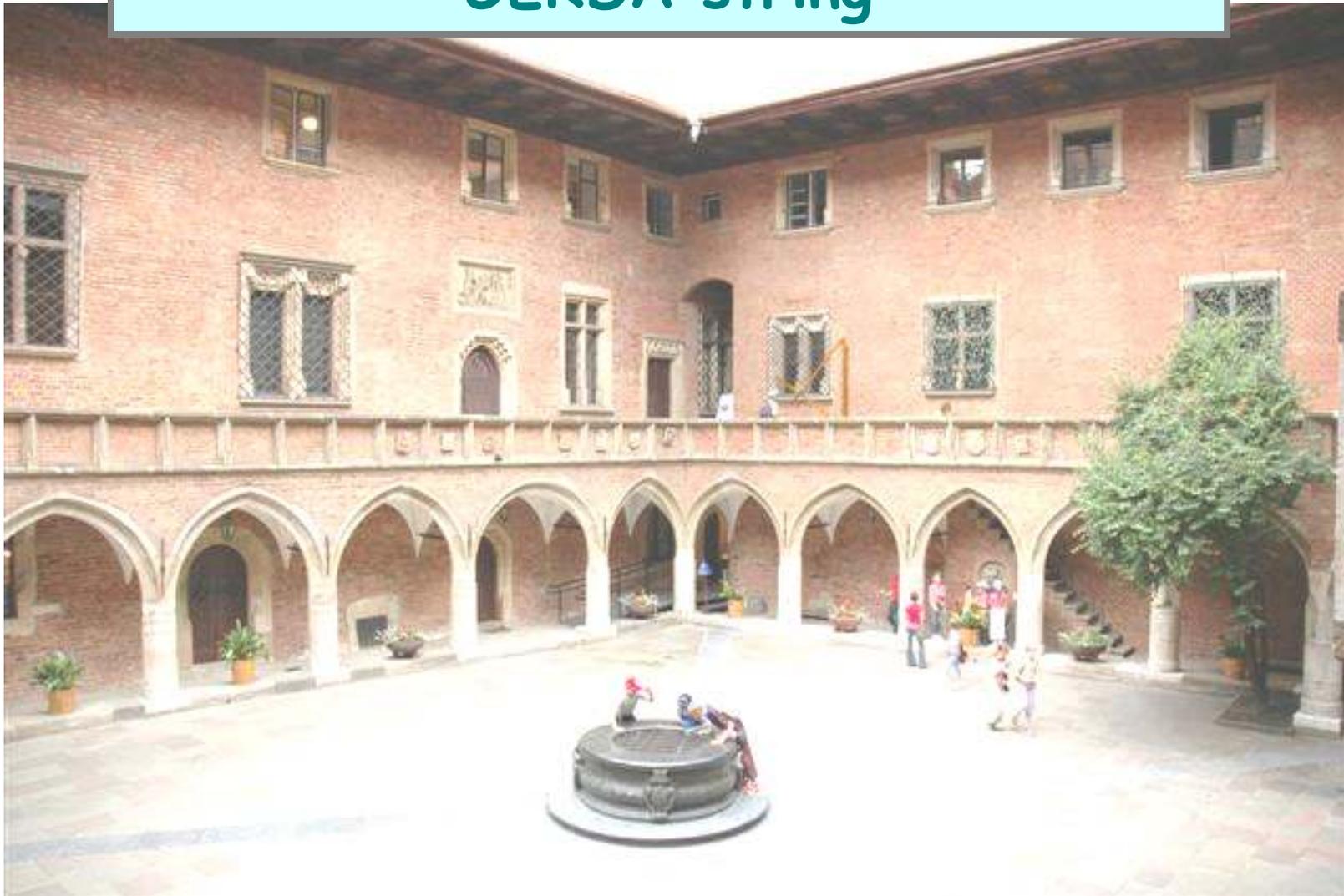




Test of Signal Transmission for a GERDA string





GERDA Signal Transmission Schematically:

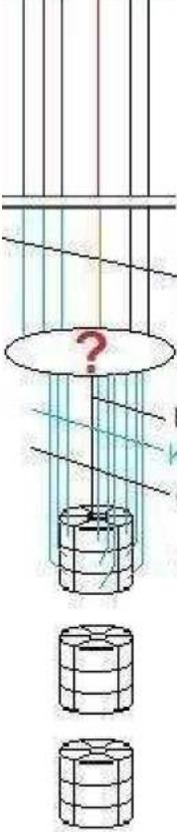


Habia Teflon coated coaxial cable SM50

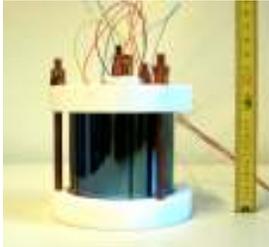
"Köln" type Preamp procured by DSG



Copper Pin Plus Pogo Pin matrix on sled



6-fold segmented p-type DSG detector Roland II



Flexible Printed Circuit Copper on Kapton

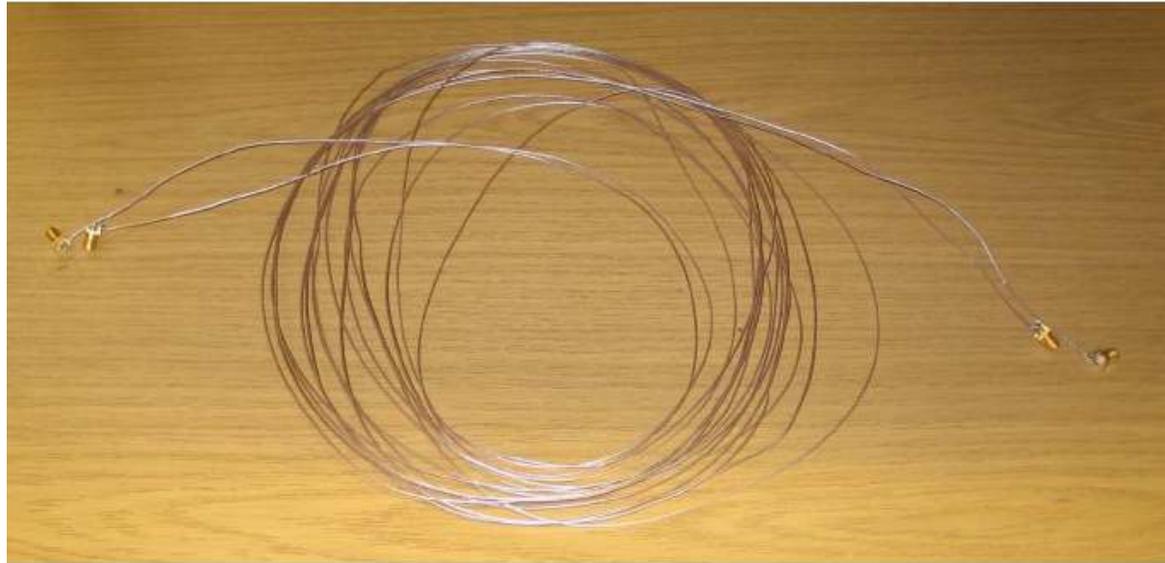


The Habia Coaxial Teflon Cable:

Sample: coax cable MPI-Munich
 weight: 3158.3 g
 live time: 164.8883 h (for
 Radon daughters: 91.1092 h)
 detector: GeMPI
 radioactive contaminants:

Th-232:
 Ra-228: < 6.9 mBq/kg
 Th-228: < 4.7 mBq/kg
 U-238:
 Ra-226 (Pb&Bi) < 1.8 mBq/kg
 Pa-234m < 59 mBq/kg
 U-235: < 1.4 mBq/kg
 K-40: (0.40 +/- 0.04)
 Bq/kg
 Cs-137: < 0.45 mBq/kg
 Co-60: < 0.83 mBq/kg
 Ag-108m:(0.78+/-0.24) mBq/kg
 Ag-110m:(1.3 +/- 0.3) mBq/kg
 Be-7: < 7.7 mBq/kg
 upper limits 90% CL,
 expanded uncertainties are with
 k=1 (approx. 68% CL);

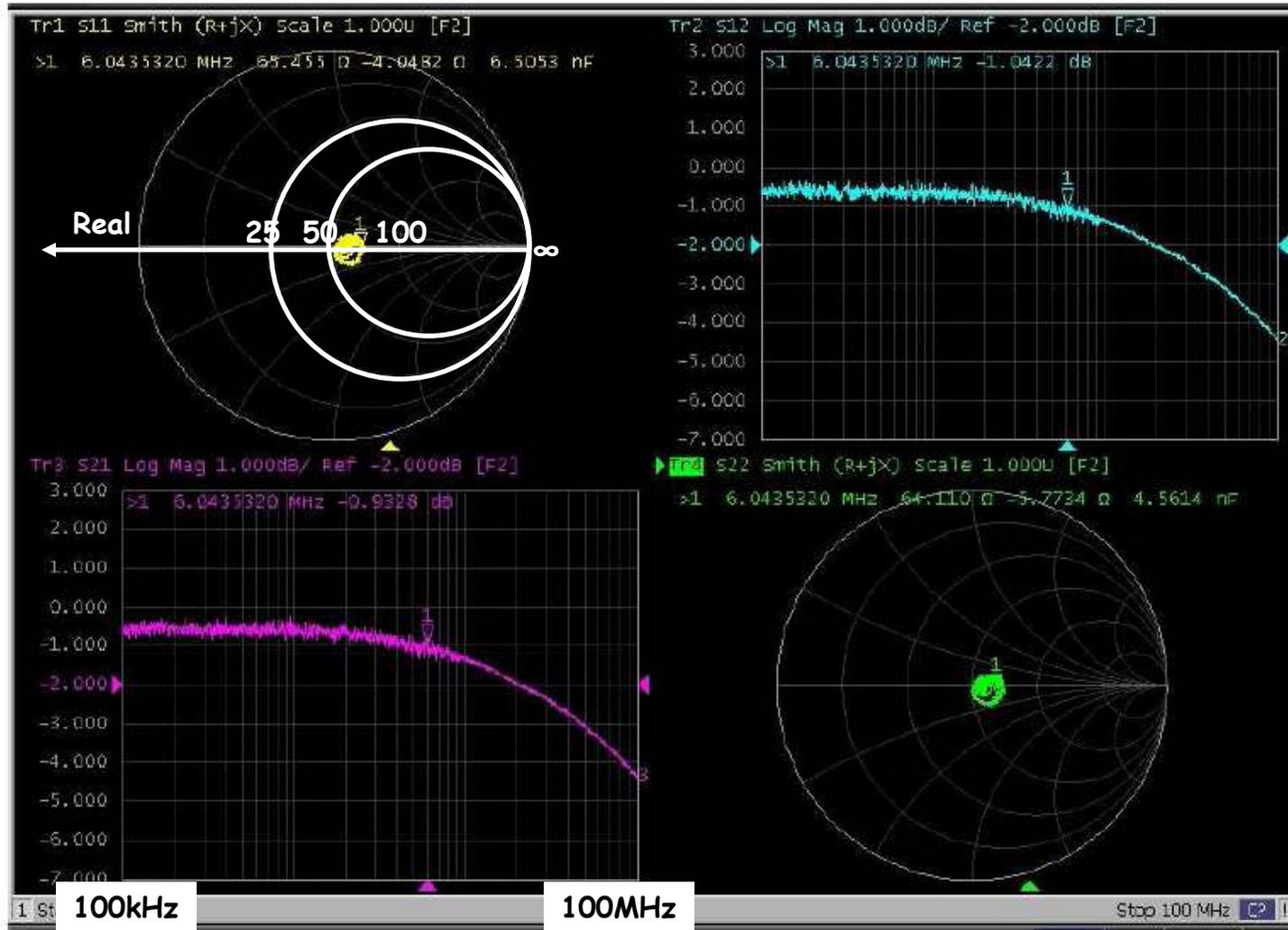
Radon Emanation:
 (0.35 +/- 0.08) mBq/kg



| Frequency [MHz] | Attenuation[dB] | Attenuation[%] |
|-----------------|-----------------|----------------|
| 10 | 1,3±0,1 | 13,9±1,0 |
| 20 | 1,95±0,05 | 20,1±0,5 |
| 30 | 2,3±0,05 | 23,2±0,5 |
| 40 | 2,65±0,05 | 26,3±0,4 |
| 50 | 3,05±0,05 | 29,6±0,4 |
| 60 | 3,30±0,05 | 31,6±0,4 |



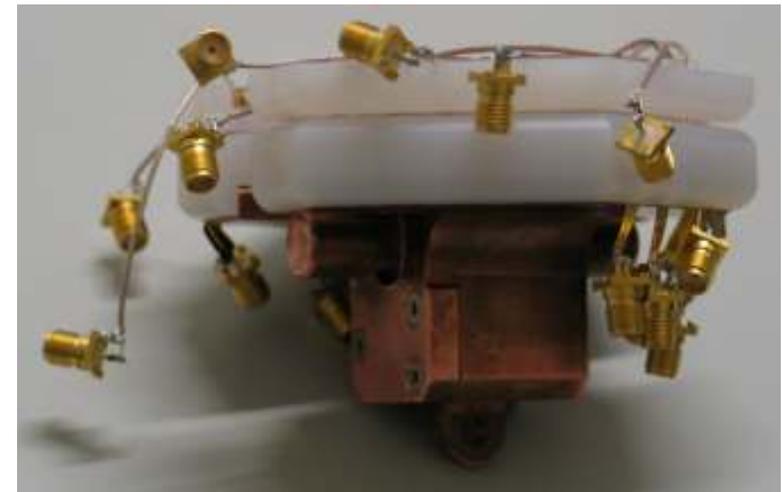
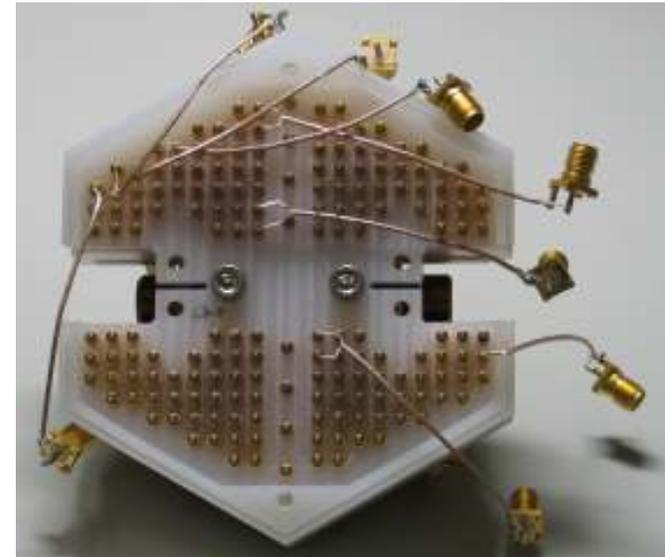
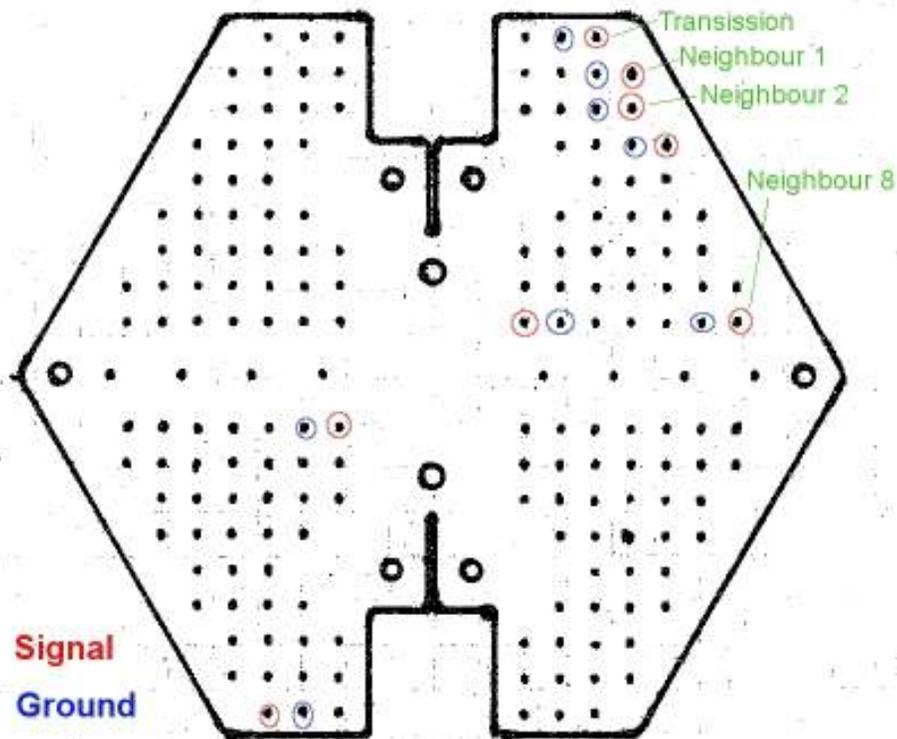
Impedance and Transmission:





The Copper Pin and Pogo Pin Matrix:

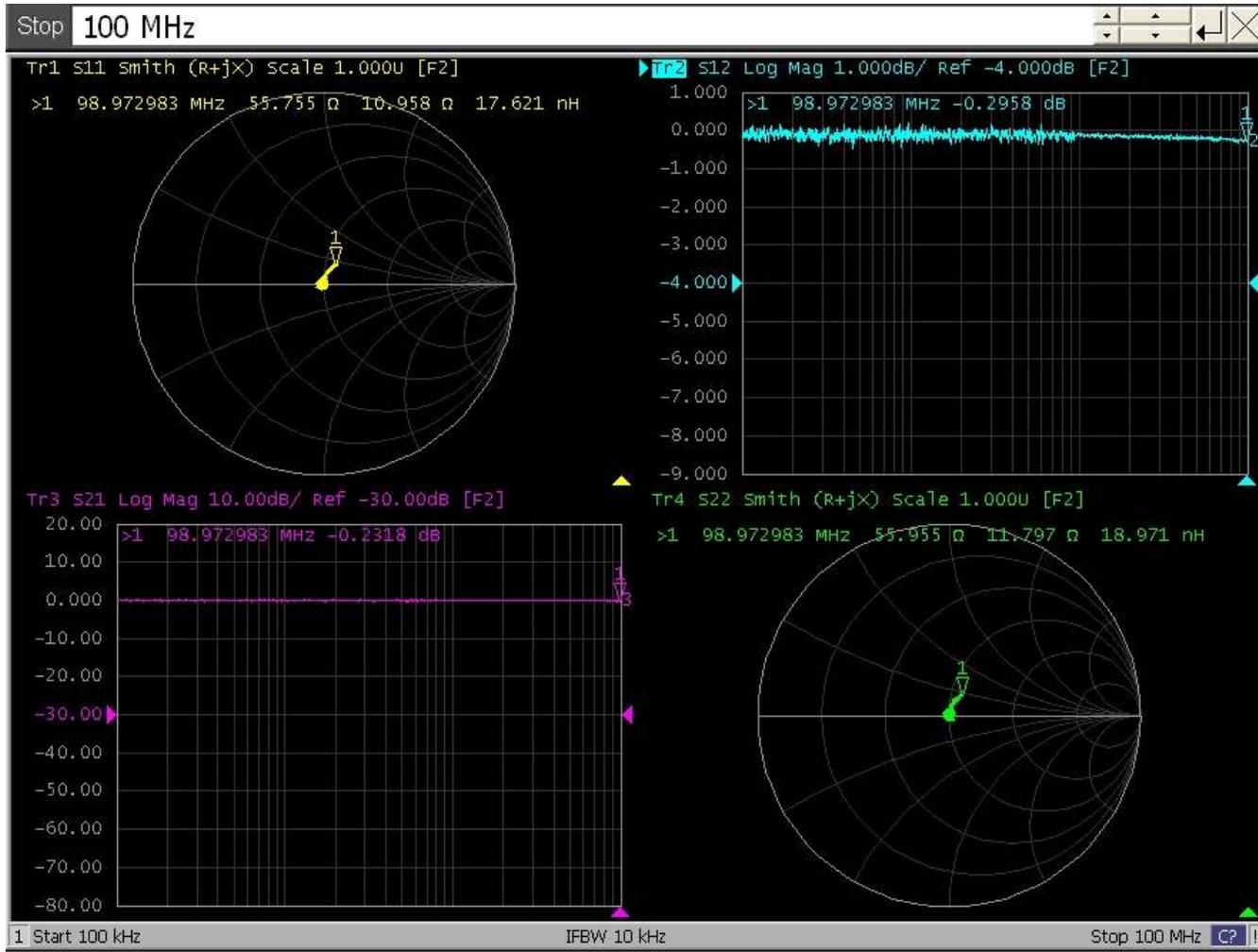
Transmission and Cross talk measured at different neighbour pins





Copper Pin and Pogo Pin Matrix Transmission:

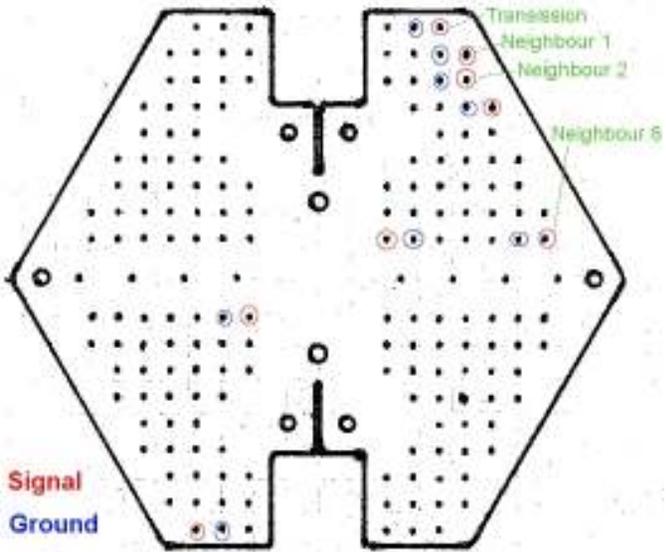
Attenuation at 100 MHz: 0,30 dB = 3,4 %



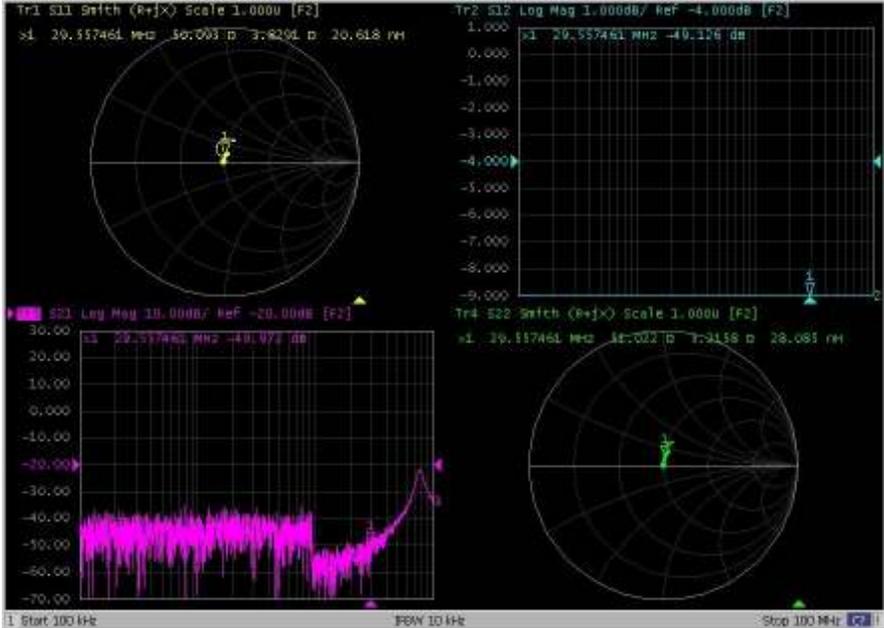


Copper Pin and Pogo Pin Matrix Cross-Talk:

| Nr. | Cross-Talk at 30MHz | Cross-Talk II |
|-----|---|---|
| 1 | $-(43,5 \pm 0,8) \text{ dB} = (0,67 \pm 0,06) \%$ | $(-22 \pm 2) \text{ dB} = (7,9 \pm 1,6) \%$ at 62 MHz |
| 2 | $-(49,5 \pm 0,5) \text{ dB} = (0,33 \pm 0,02) \%$ | $(-23 \pm 2) \text{ dB} = (7,1 \pm 1,5) \%$ at 75 MHz |
| 8 | $(-50,4 \pm 3,2) \text{ dB} = (0,30 \pm 0,09) \%$ | $(-22 \pm 2) \text{ dB} = (7,9 \pm 1,6) \%$ at 80 MHz |



Cross-Talk in the system, not in Matrix!

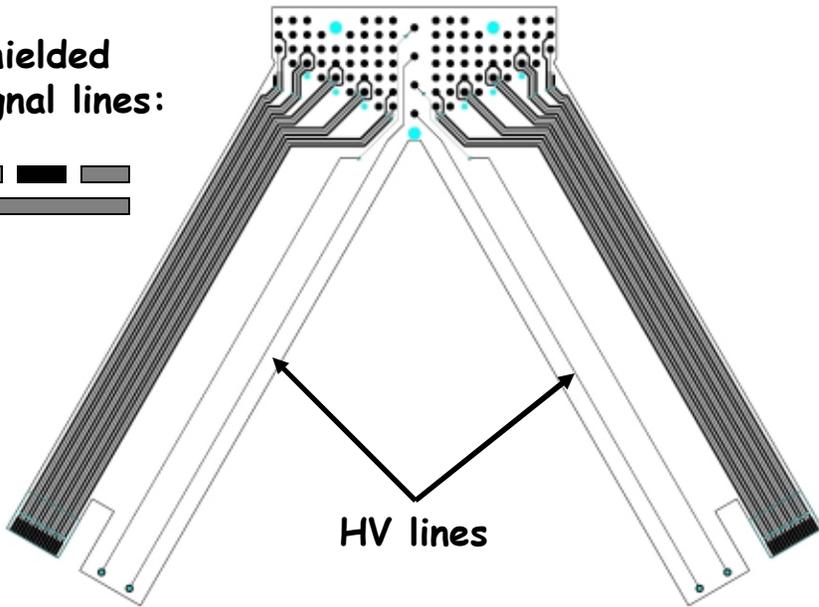




Flexible Printed Circuit:

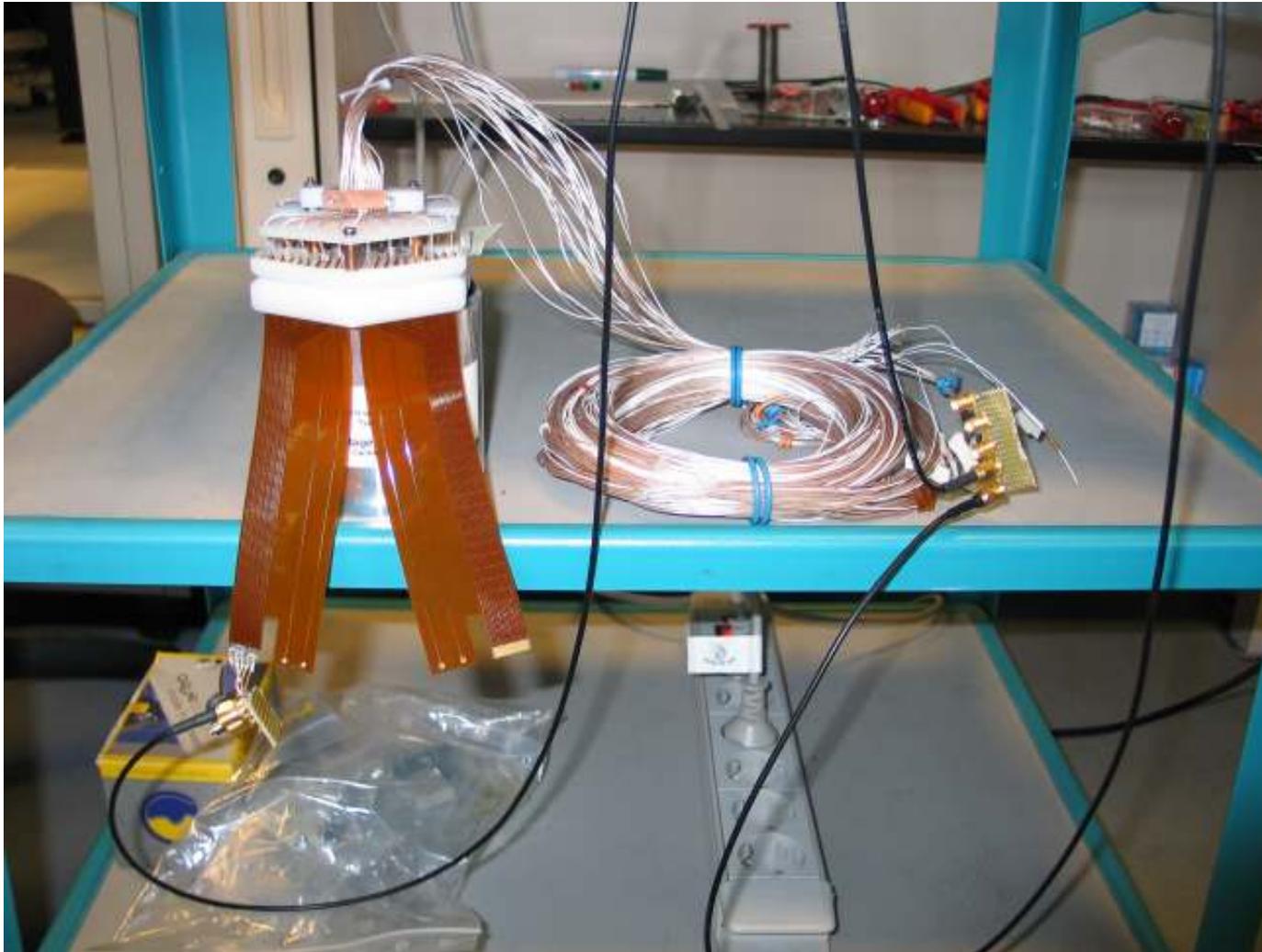
Test Circuit: Multilayer Copper on Kapton with Pogo Pin Contacts Nickel-Gold plated. Designed for 50 Ohm impedance
On Order: Cufion version
Ideally: Front-End Electronics implemented on extension of Flexible Circuit.

Shielded signal lines:





The Tested GERDA Signal Transmission Line:



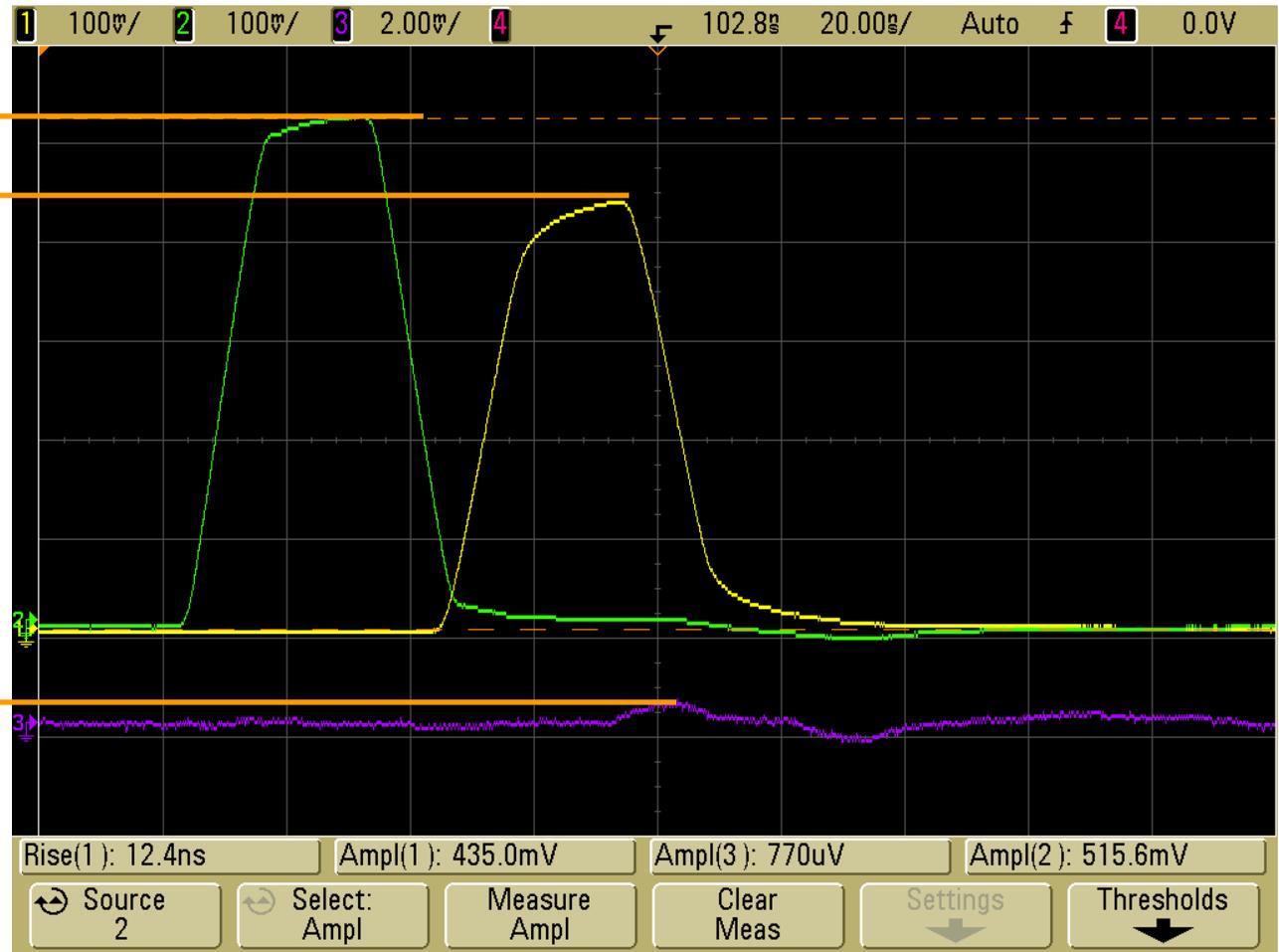


Signal Transmission:

Test Pulse
Rise time: 10ns
Flat: 20ns
Fall time: 10ns
Amplitude: 516 mV

Transmitted Signal:
Rise time: 12.4ns
Amplitude: 435 mV

Cross-talk Signal:
Amplitude: 0.77 mV
1.8‰ → ok

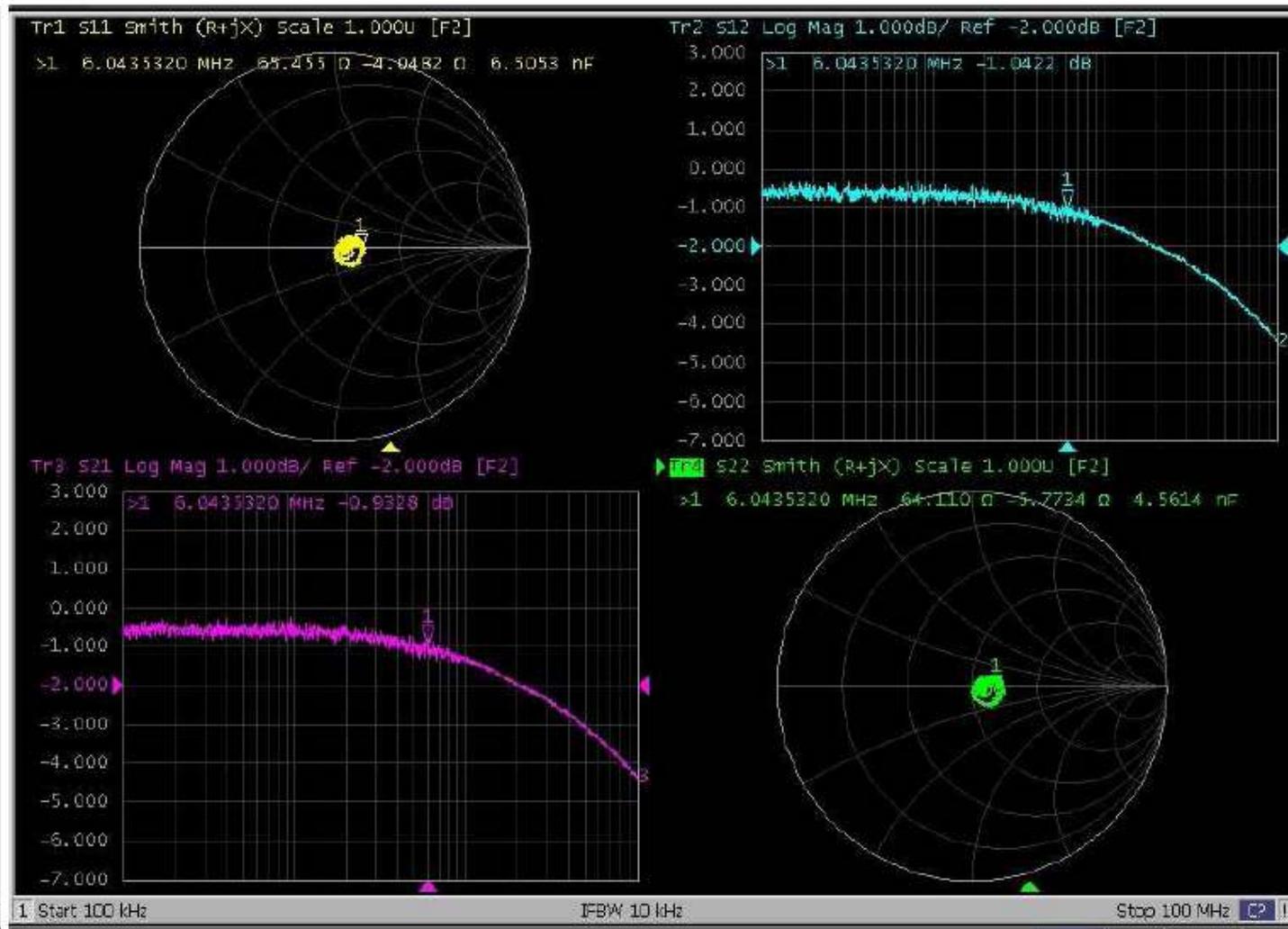


Timing Information: Rise time increase (10%-90%) by 2ns → ok



Signal Attenuation:

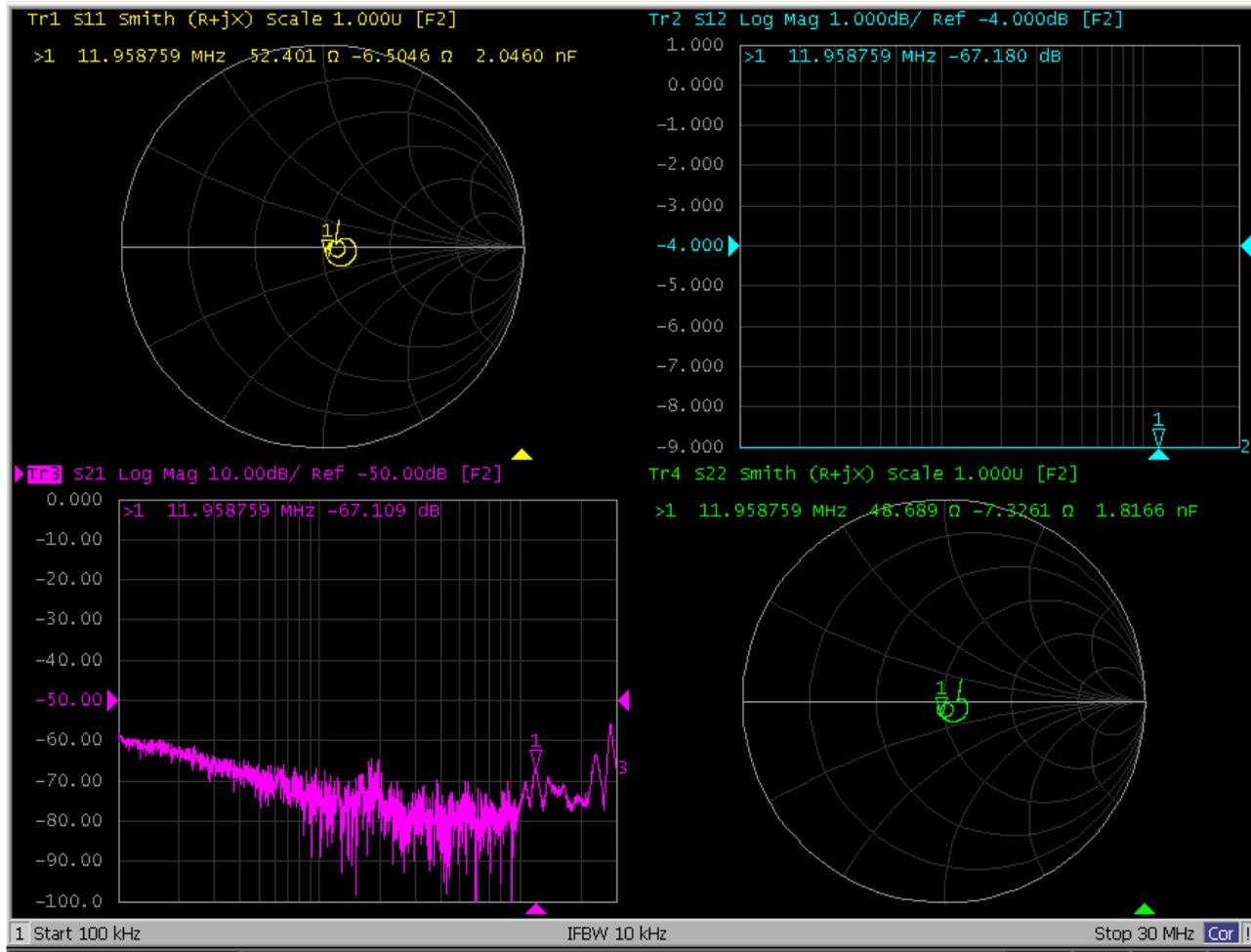
Basically the same as with cable only → ok





Cross Talk with SMA Shields Connected:

Cross-talk Signal < -60dB (1‰) below 25MHz

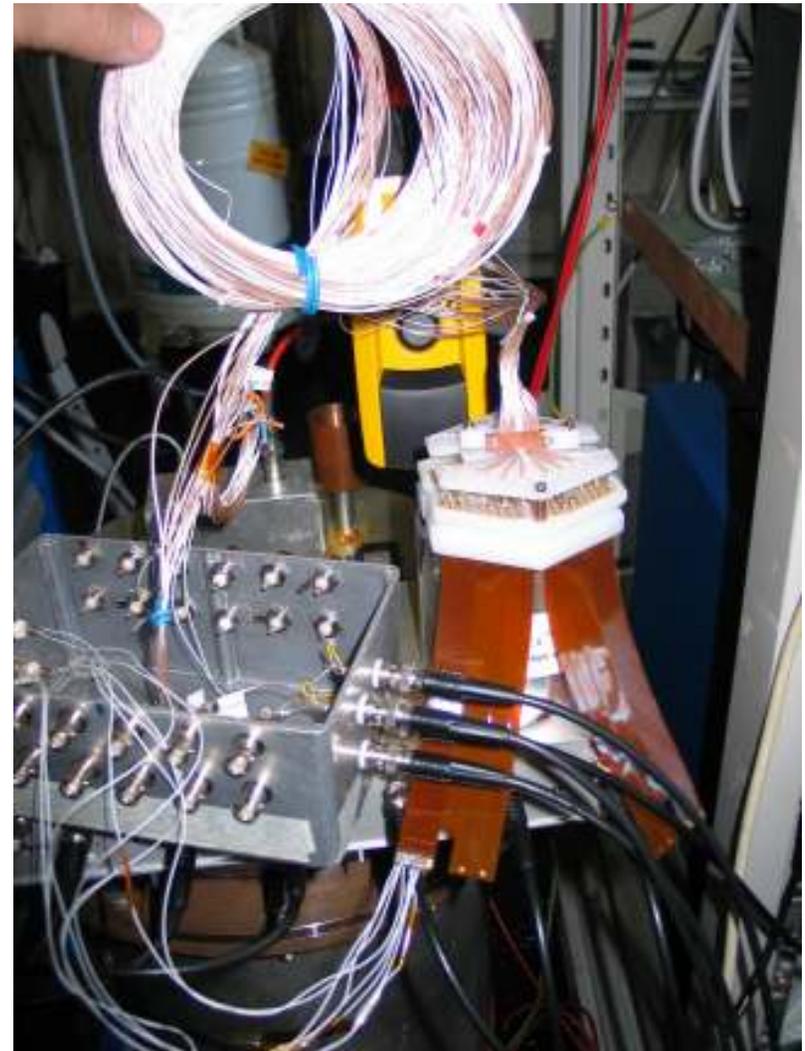
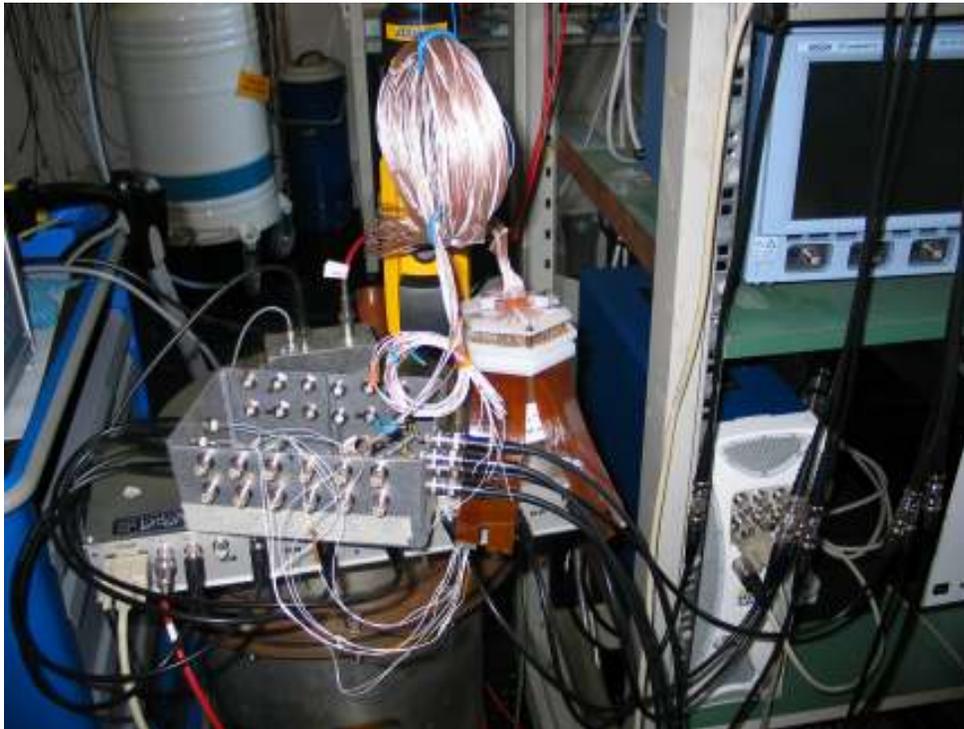




Signal Transmission Tests:

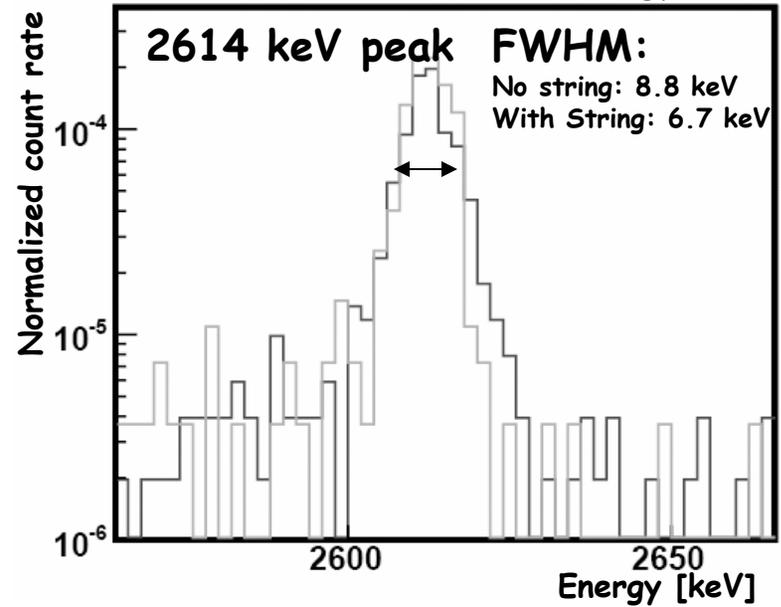
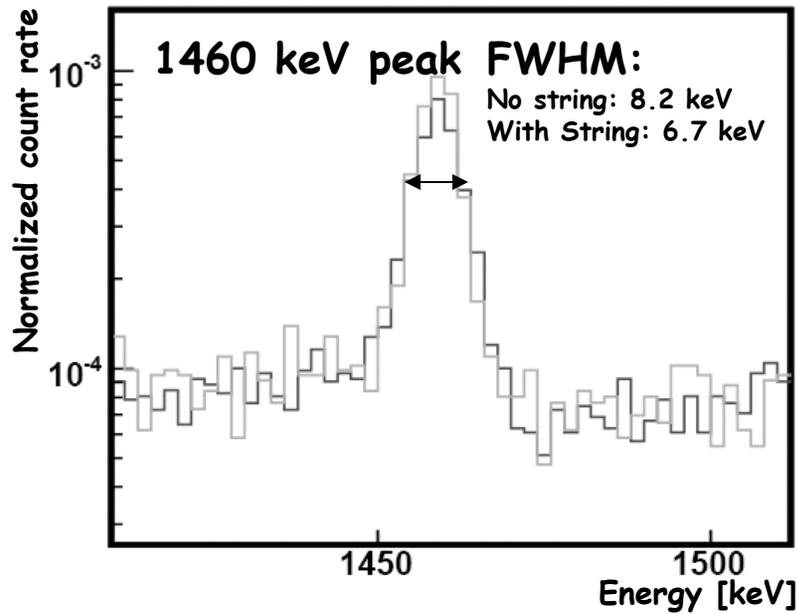
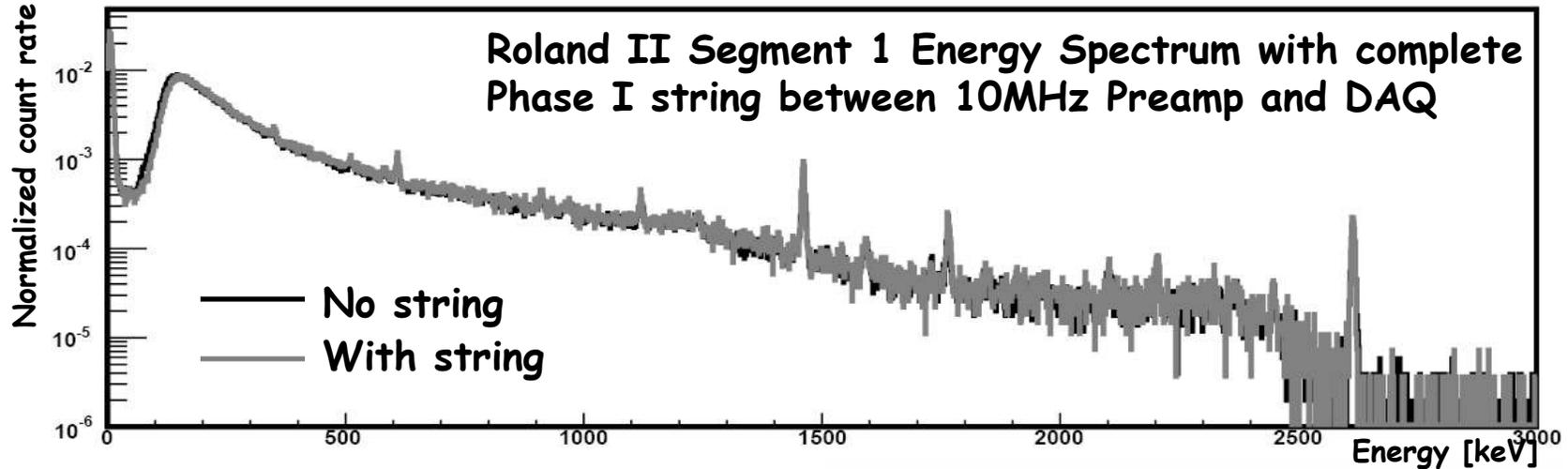
Full Cable Chain tested with HPGe detector:

- 7m of Coaxial signal cable and HV chain
- Cables laser welded to Copper Pin Matrix
- Copper Pin Matrix
- Pogo Pin Matrix
- Flexible Kapton Circuit Board





Signal Transmission Segment 1:





Signal Transmisison Cross Talk:

Segment 1 over Core Energy ratio

Full Energy in Segment:
Ratio = 1

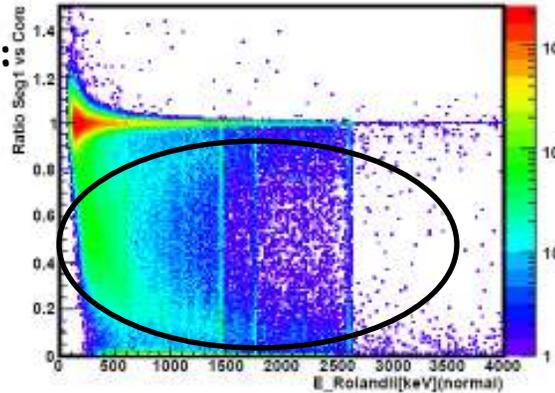
Multi Segment Events:
 $0 < \text{Ratio} < 1$

Zero Energy in Segment:

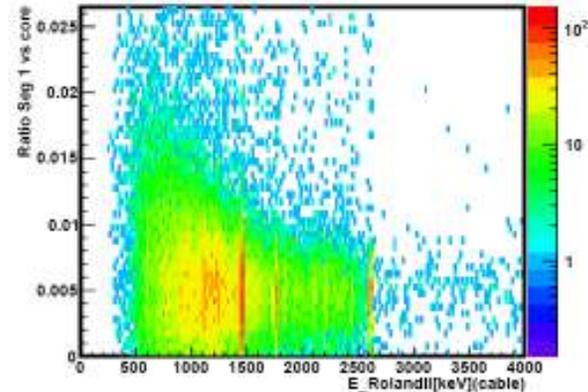
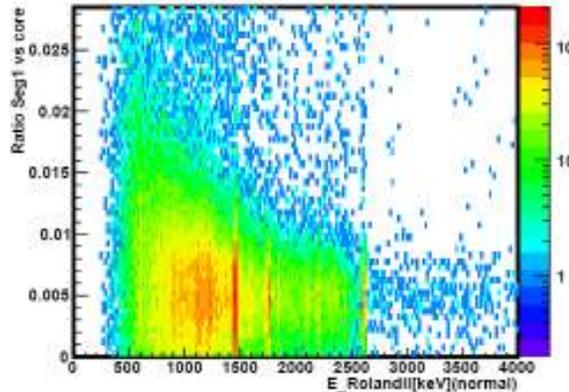
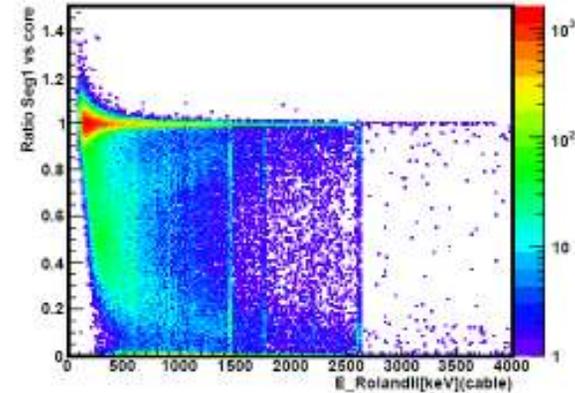
Crosstalk:

$E_{\text{Seg}} = X * E_{\text{core}}$
→ $E_{\text{Seg}} / E_{\text{core}} = X$
→ Crosstalk will be visible as line

No string



With string

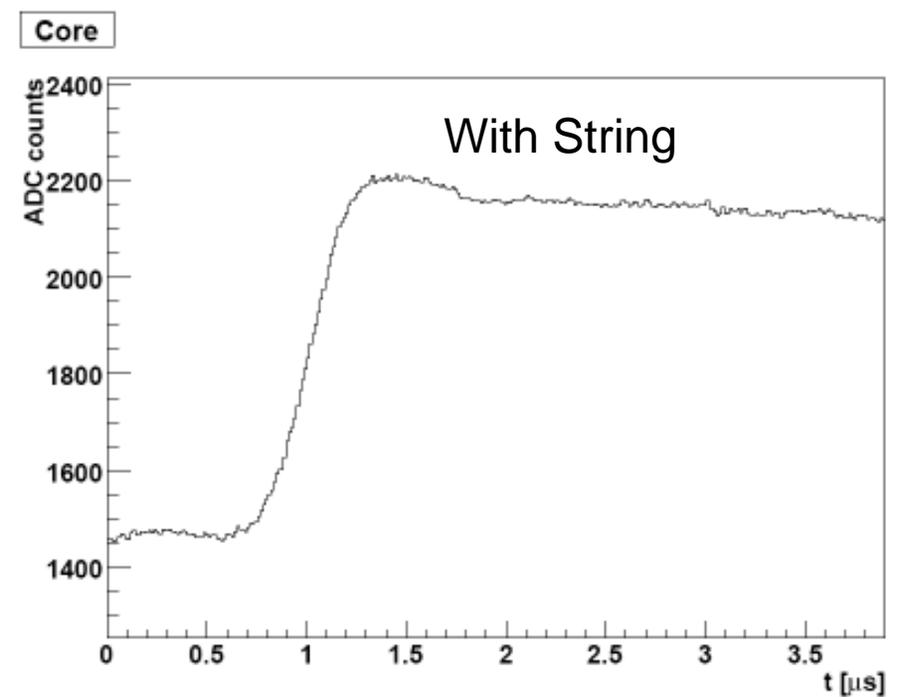
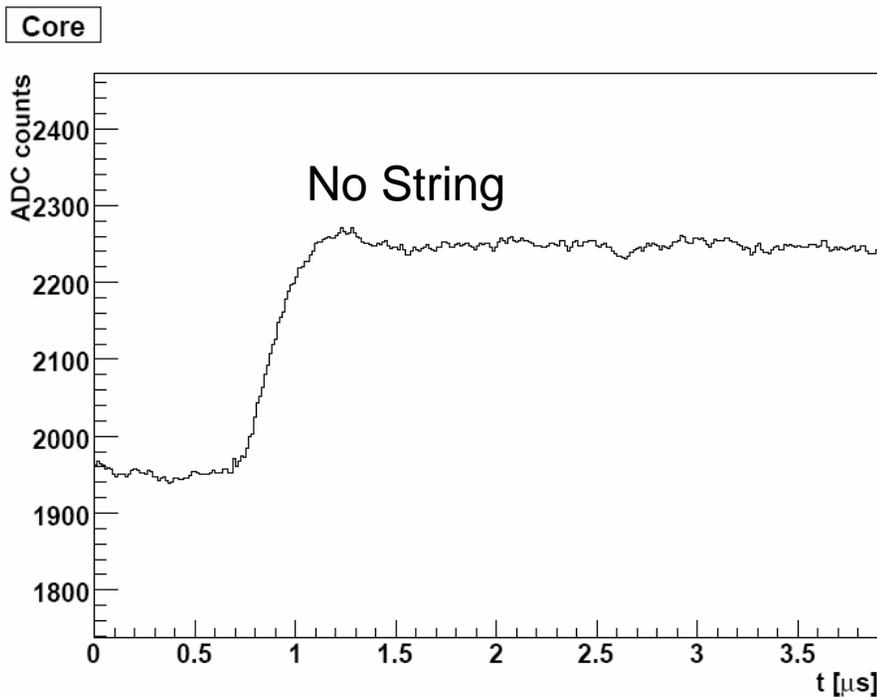


Crosstalk visible at the 5‰ level, but it is in the system, not in the string! No firm analysis yet!



Signal Transmisison Pulse Shapes:

On first sight no deterioration of Pulse Shape seen. No firm analysis yet!



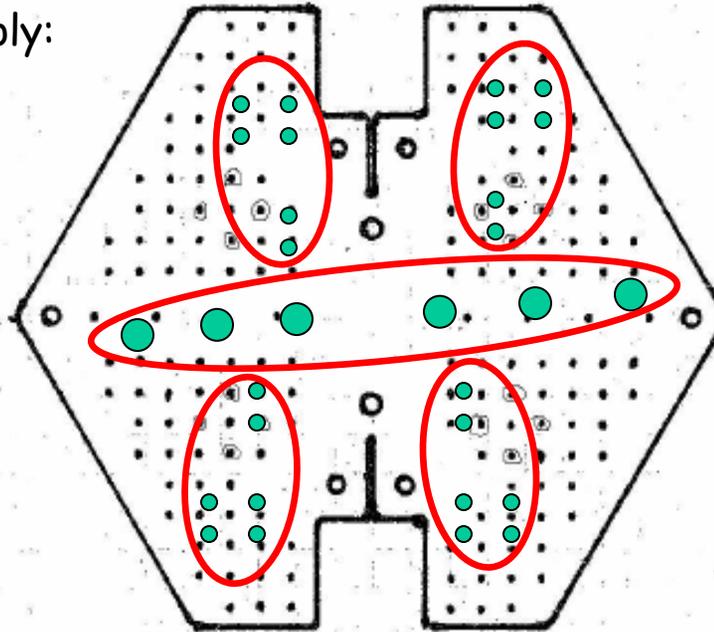


Phase I Matrix Pin:

Phase I matrix will be designed for differential read out.
Exact pin positions yet to be defined

4. Quadrant: FE Supply:
3 LV for Preamps
2 GND
1 Spare

3 (HV plus GND)



I. Quadrant: Detector 1
1 (Signal Out plus GND)
1 (Signal In plus GND)
1 (Signal Out diff plus GND)

For Phase I:
 $5 \times 6 = 30$ Pogo pins
→ 0.75g material
→ 40mBq/kg (measured)
→ 1.7×10^{-5} Cts/(kg keV y)
(according to GSTR-08-10)

We still need to do the LAr test!

III. Quadrant: Detector 3
1 (Signal Out plus GND)
1 (Signal In plus GND)
1 (Signal Out diff plus GND)

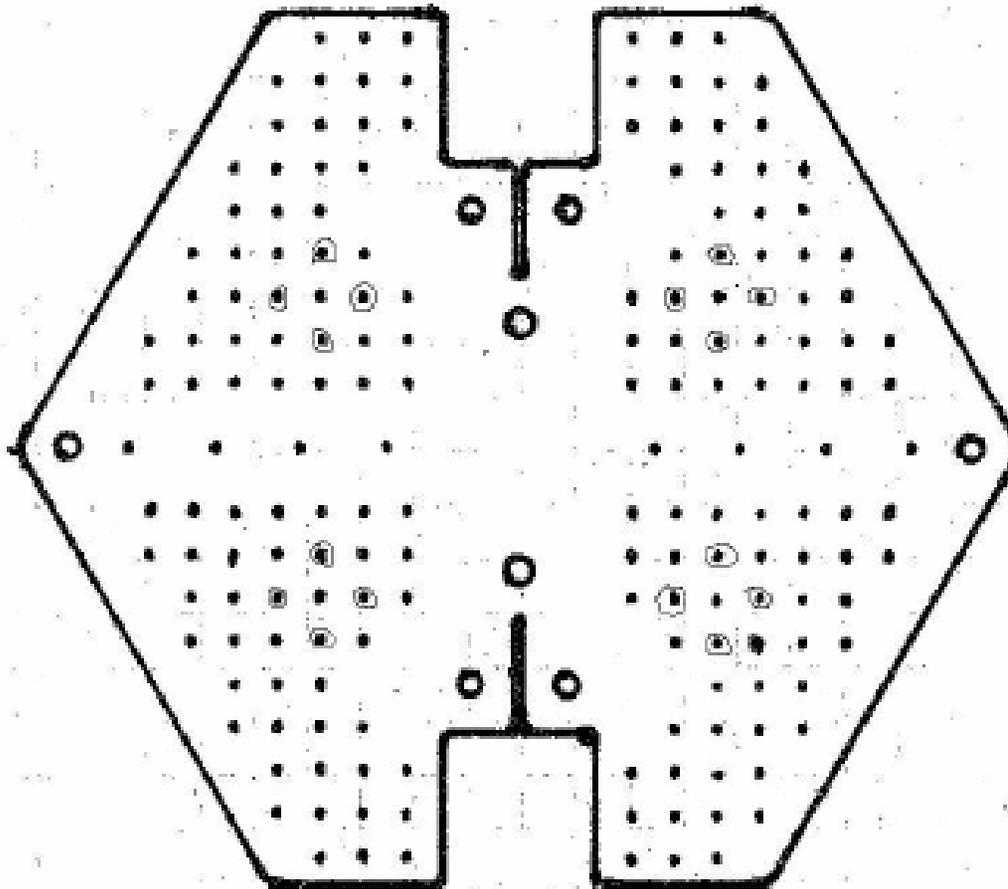
II. Quadrant: Detector 2
1 (Signal Out plus GND)
1 (Signal In plus GND)
1 (Signal Out diff plus GND)



Phase II Matrix Pin Positions:

Phase II matrix will be a real challenge

With isolated lines:
Only 13 single ended
But remember: Crosstalk
only tested for single
read out! Situation is
better for Differential
Read-Out



Example:
for Diagonal
reads: Place for 12
trial signals per
row
You will have to think
about this!

Close cooperation

Béla Majorovits

necessary!

Test of Signal Transmission for a GERDA string 18