BEGe project

Results from detector operations and outlook

MPI für Kernphysik • Heidelberg
LNGS • Gran Sasso

1. BEGe in LAr test results
2. Constraints on front-end bandwidth

   Marik Barnabé Heider • Dušan Budjáš • Stefan Schönert

3. Upcoming characterisation of ^{dep}Ge BEGe detectors

   Matteo Agostini • Enrico Bellotti • Dušan Budjáš • Carla Cattadori • Alexander Hegai • Stefan Schönert • Michal Tarka • Assunta di Vacri

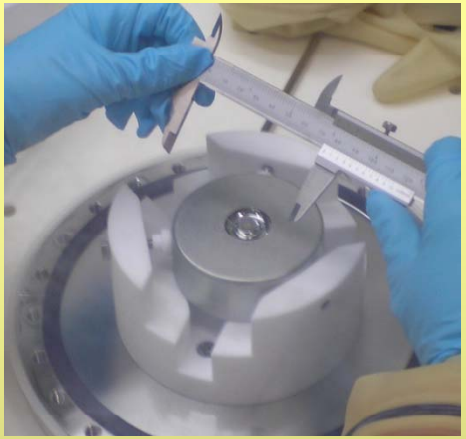
Max-Planck-Institut für Kernphysik

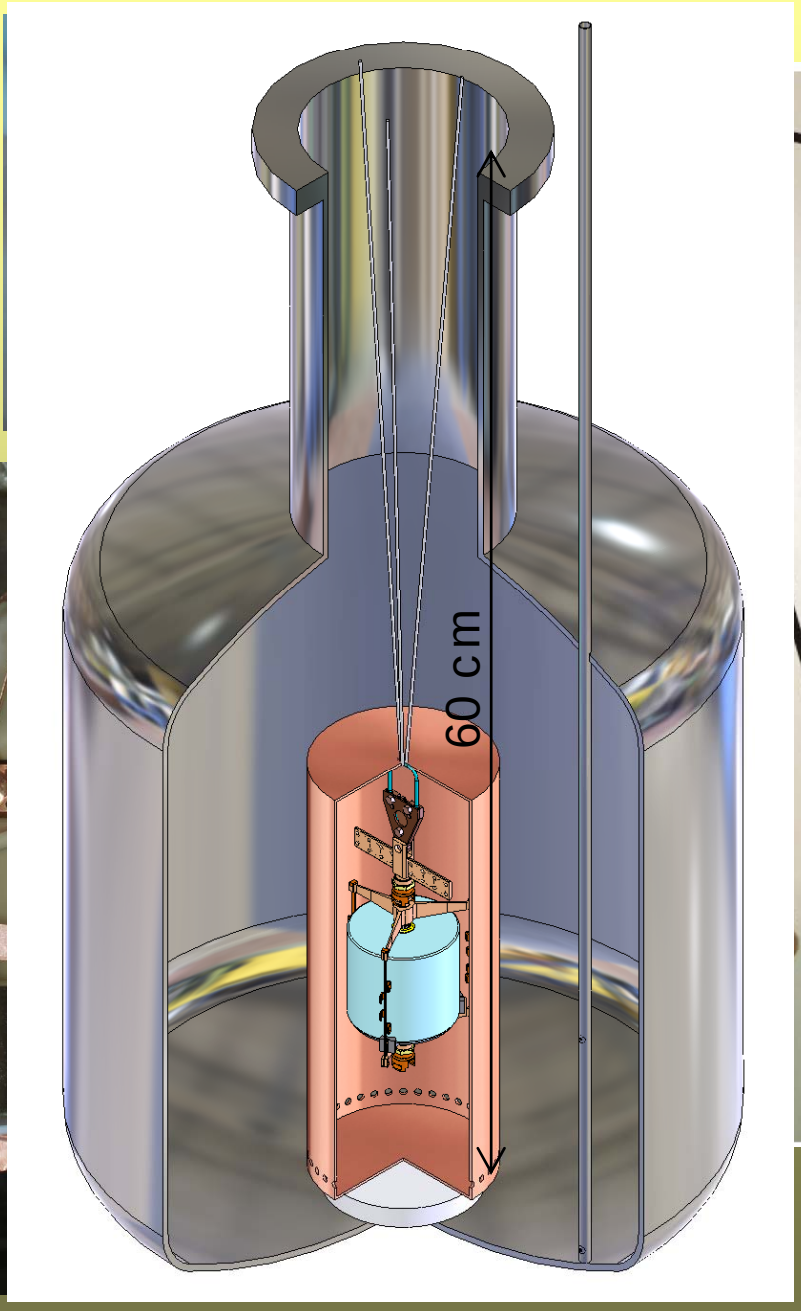
1. **BEGe in LAr test results**

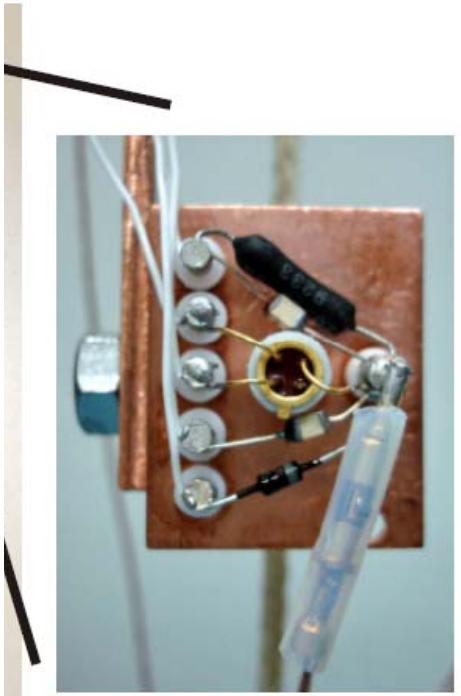
2. **Constraints on front-end bandwidth**

3. **Upcoming characterisation of ^{dep}Ge BEGe detectors**

BEGe in LAr: GDL test bench







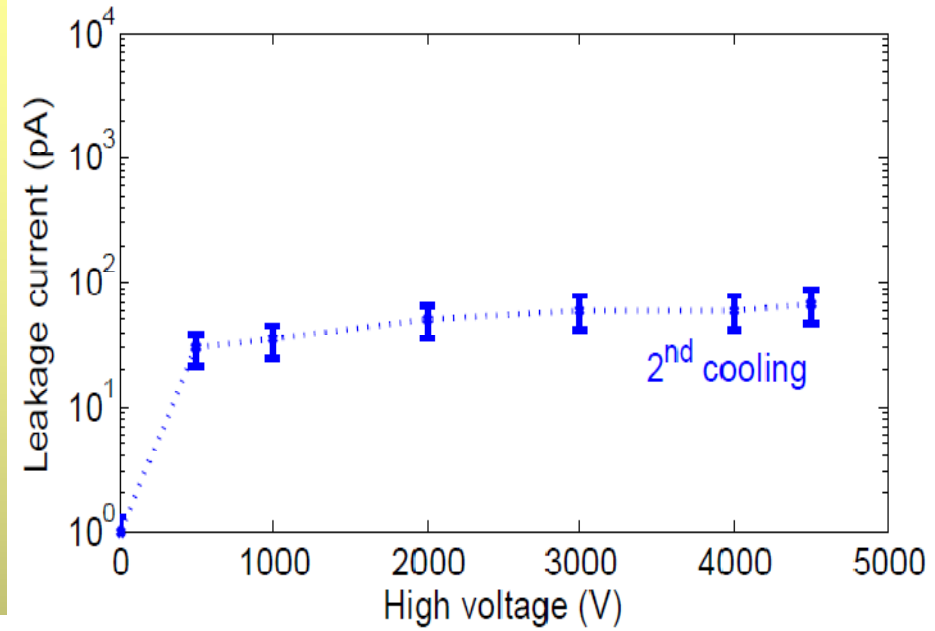
- 1st stage preamp from HdM (in Ar gas in dewar neck)
- warm 2nd stage
- 30 ns rise time

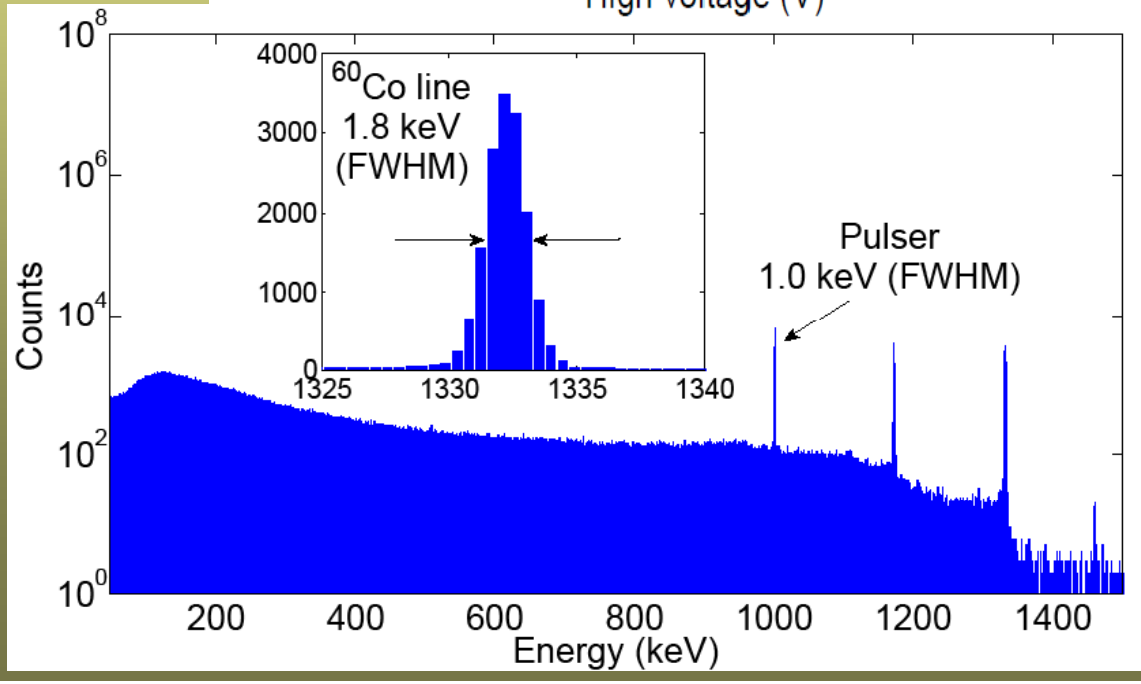
BEGe in LAr: short term test 12. 2009

- Goals:
  - working in LAr?
  - HV scan

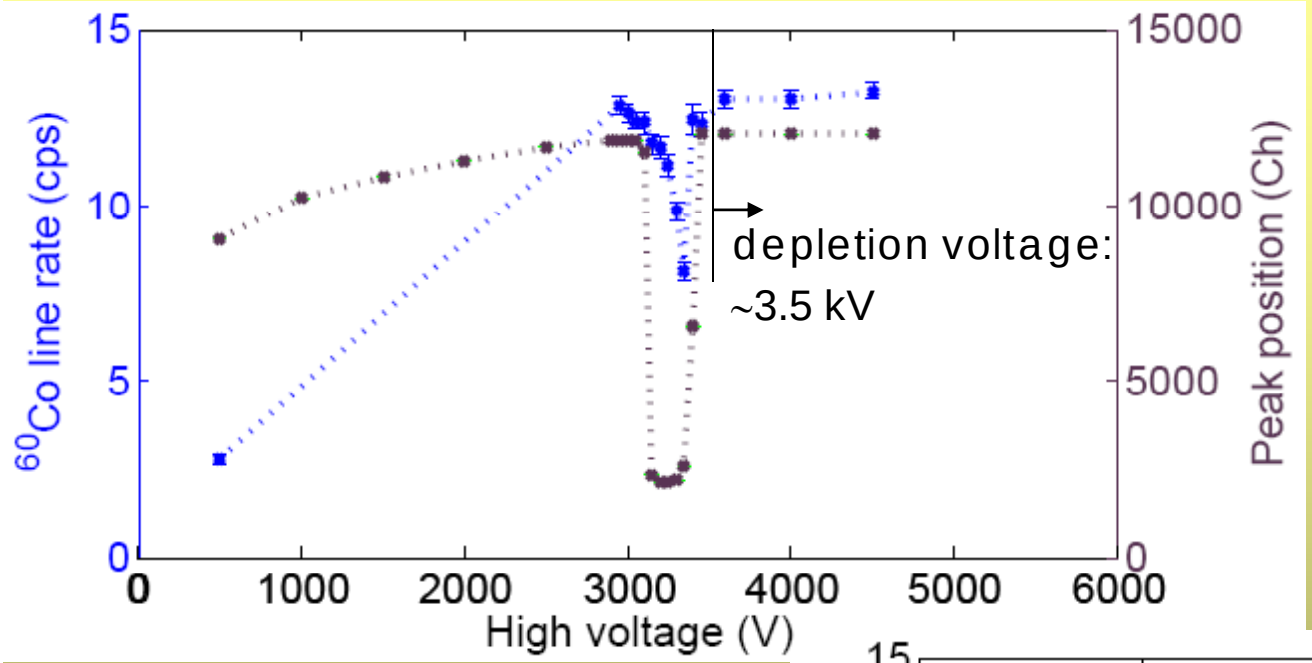
- 1st cooling:
  high LC, some visible signals,
  but no spectrum
  → cure: 3 × methanol bath

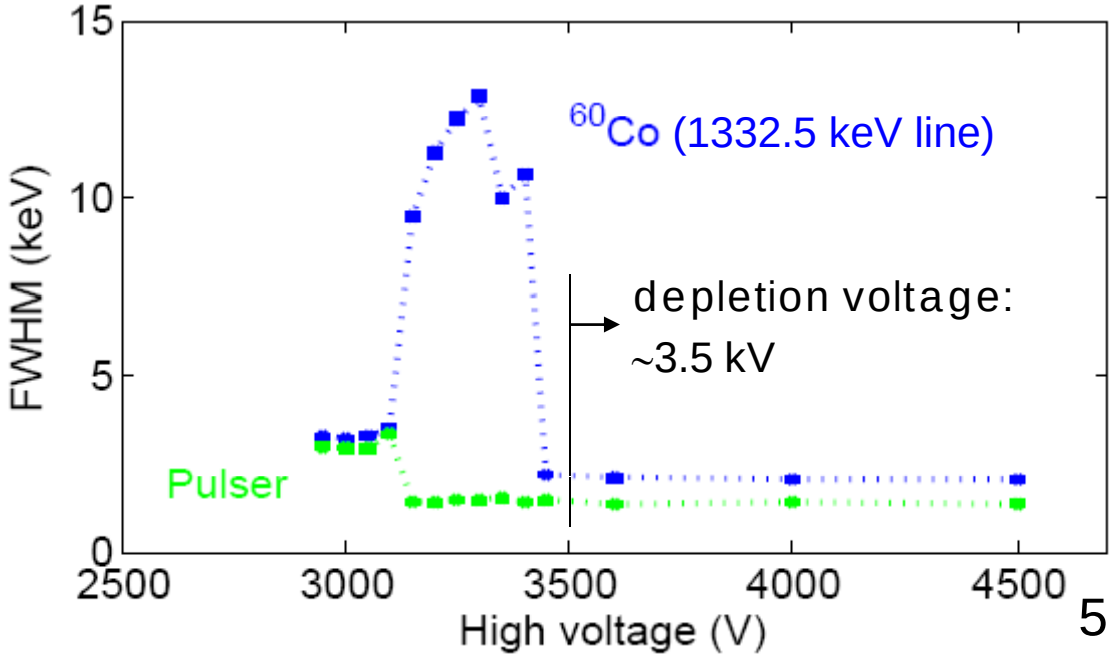
- 2nd cooling:
  LC~50 pA
  FWHM ~1.8 keV



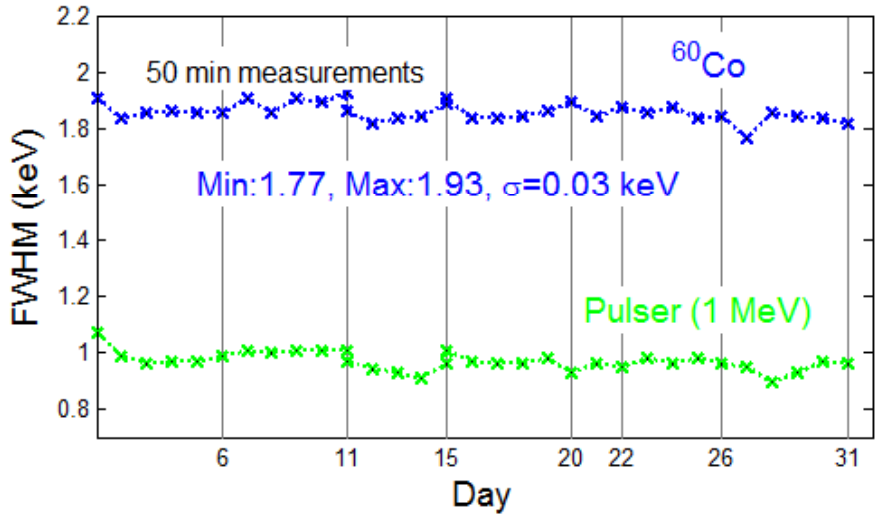


BEGe in LAr: short term test 12. 2009

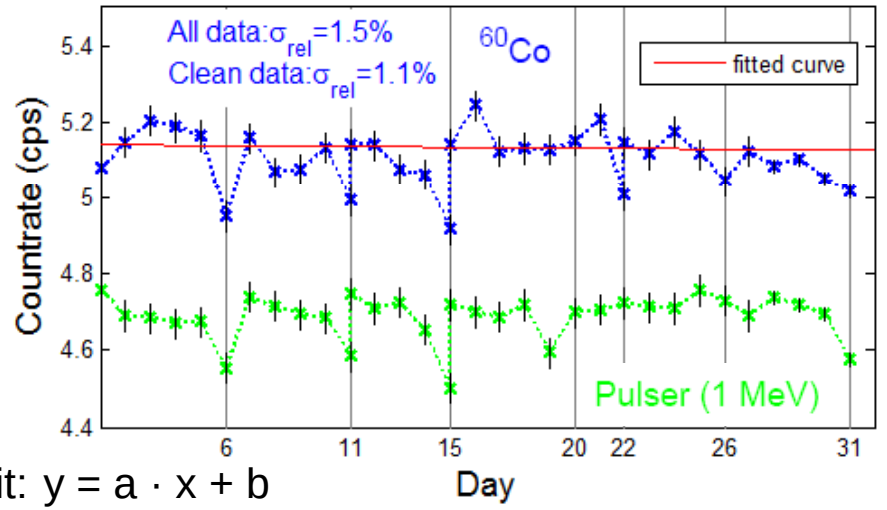




BEGe in LAr: long term test 2. 2010



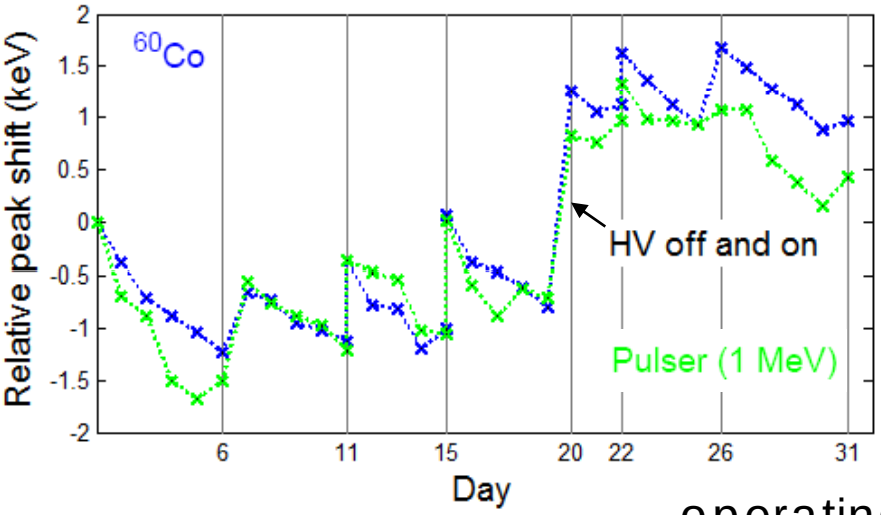
LAr refillings

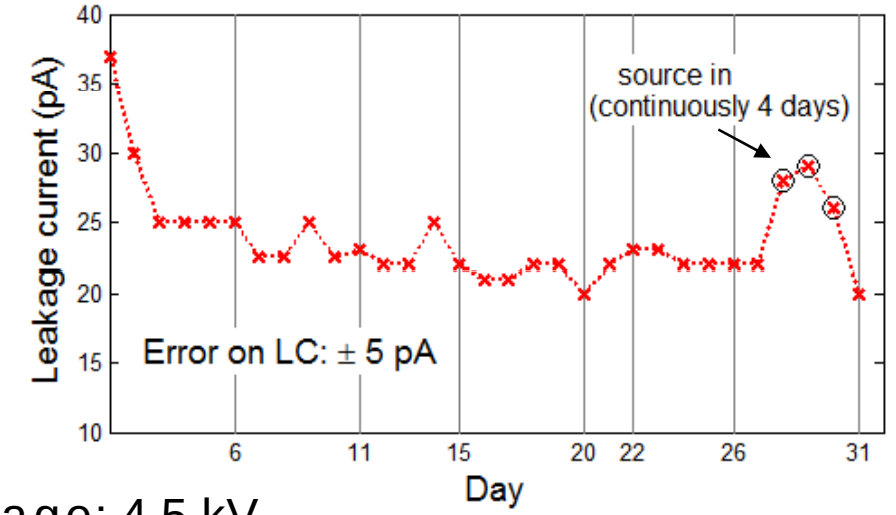


Fit: $y = a \cdot x + b$

$a = (-0.5 \pm 2.5) \cdot 10^{-3}$

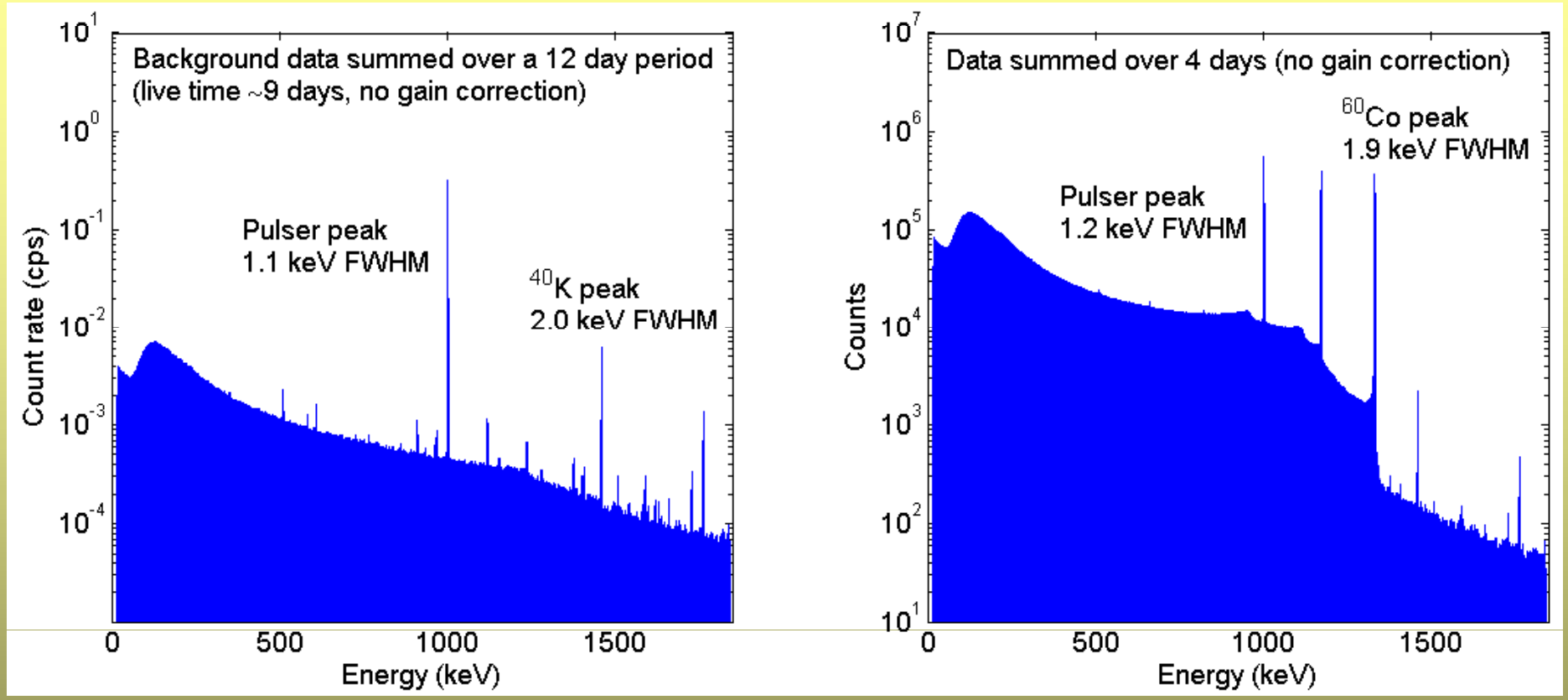
$b = 5.14 \pm 0.04$

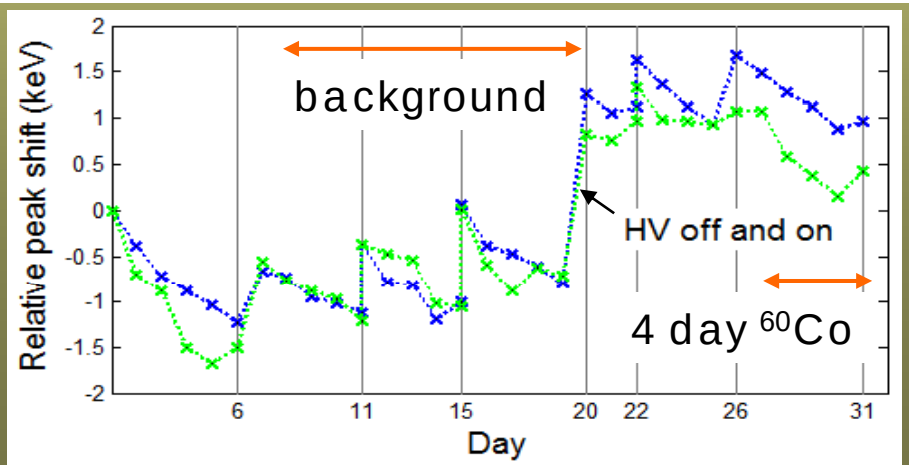




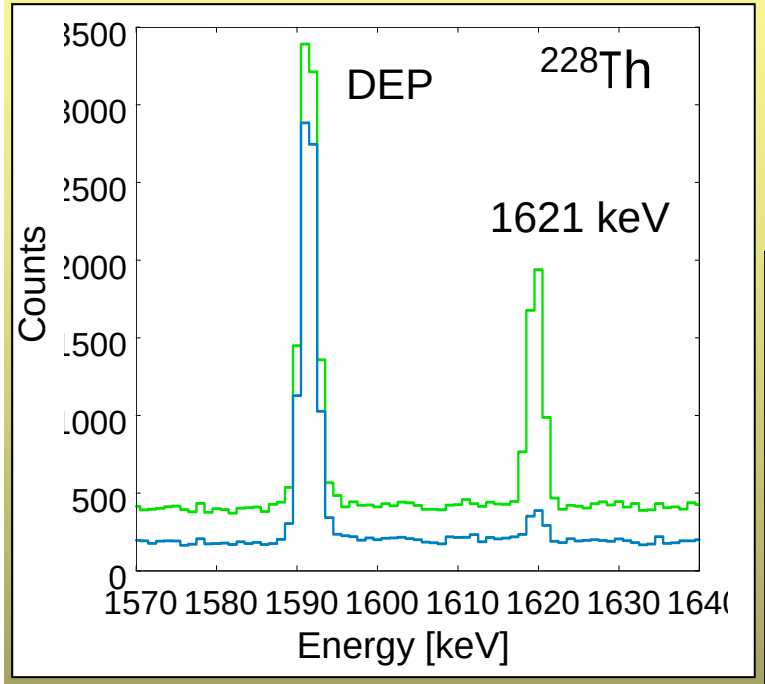
operating voltage: 4.5 kV

BEGe in LAr: overall system stability

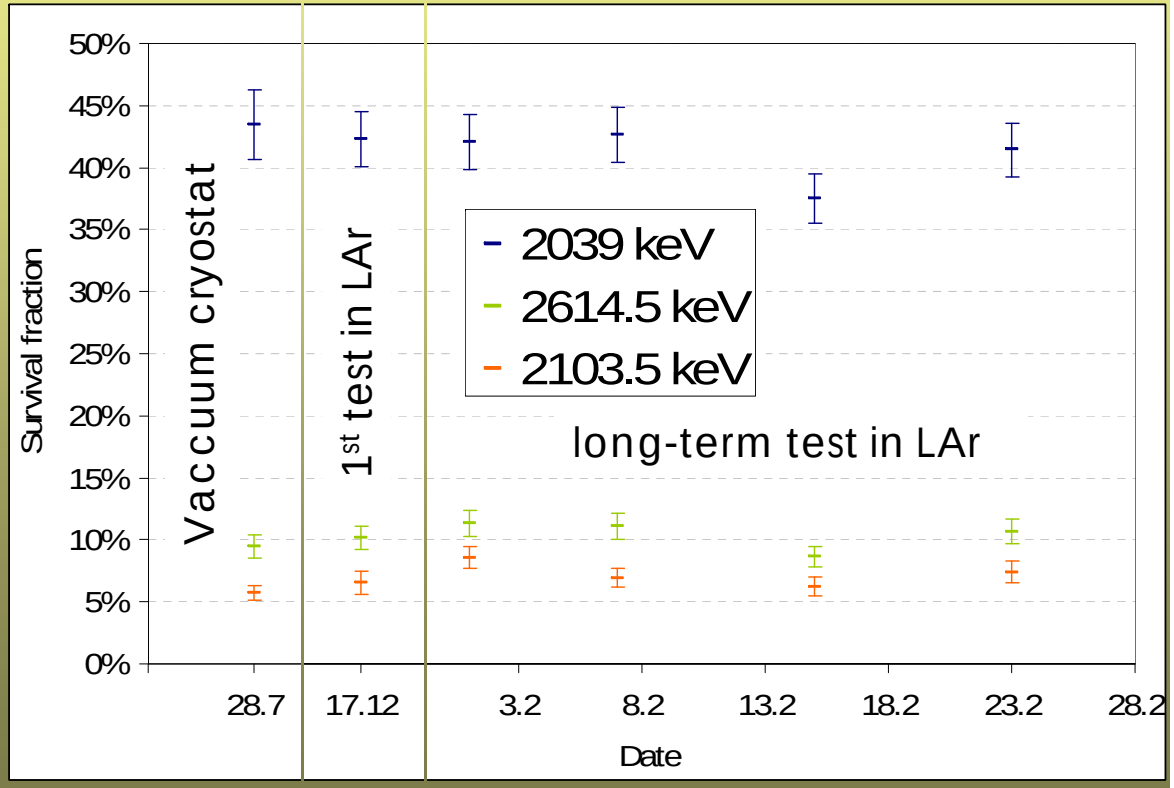




BEGe in LAr: pulse-shape discrimination results



DEP acceptance fixed at 90%



Error bars include systematic uncertainty of PSD calibration

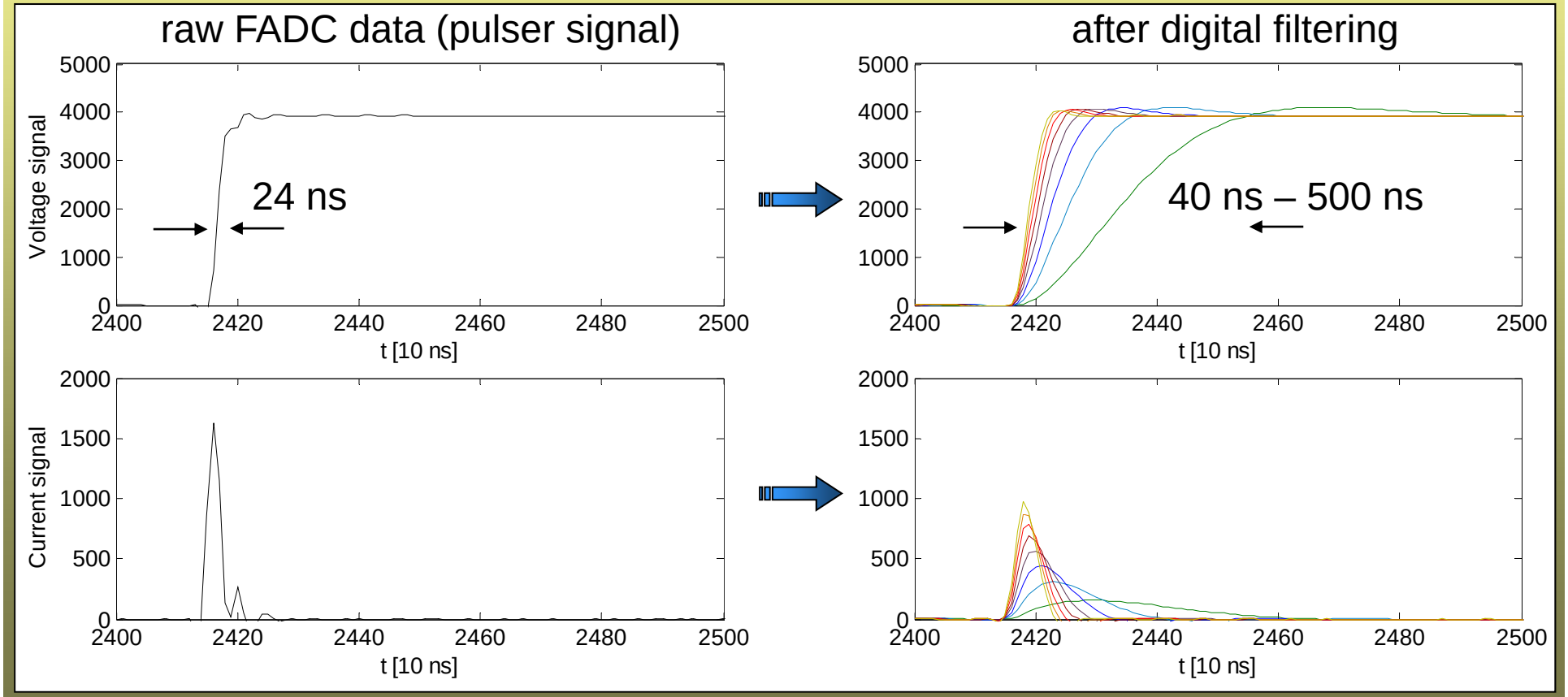
1. BEGe in LAr test results

2. **Constraints on front-end bandwidth**

3. Upcoming characterisation of ^{dep}Ge BEGe detectors

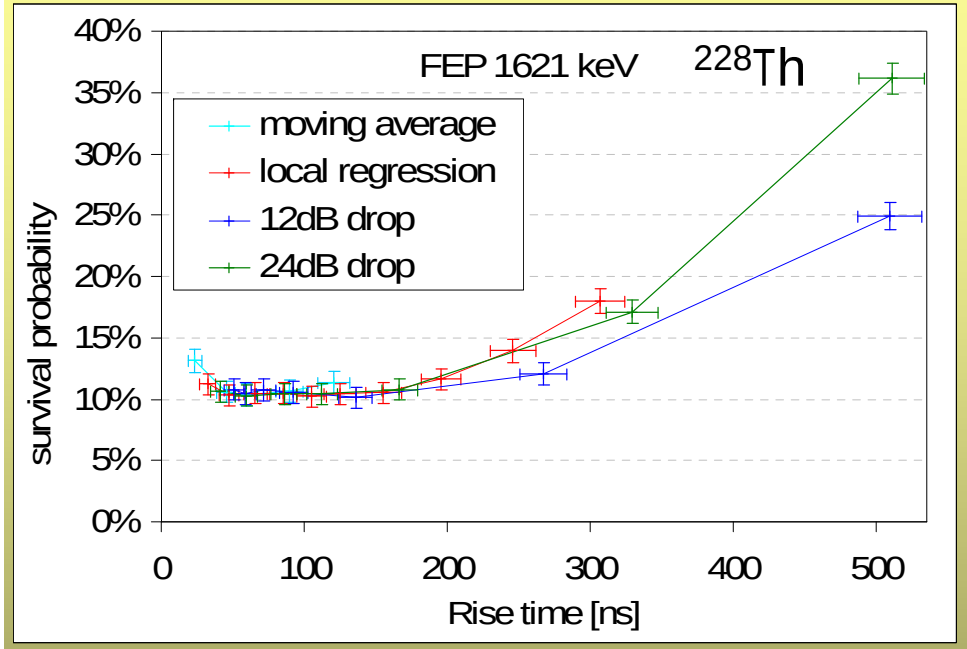
BEGe PSA constraints on front-end bandwidth

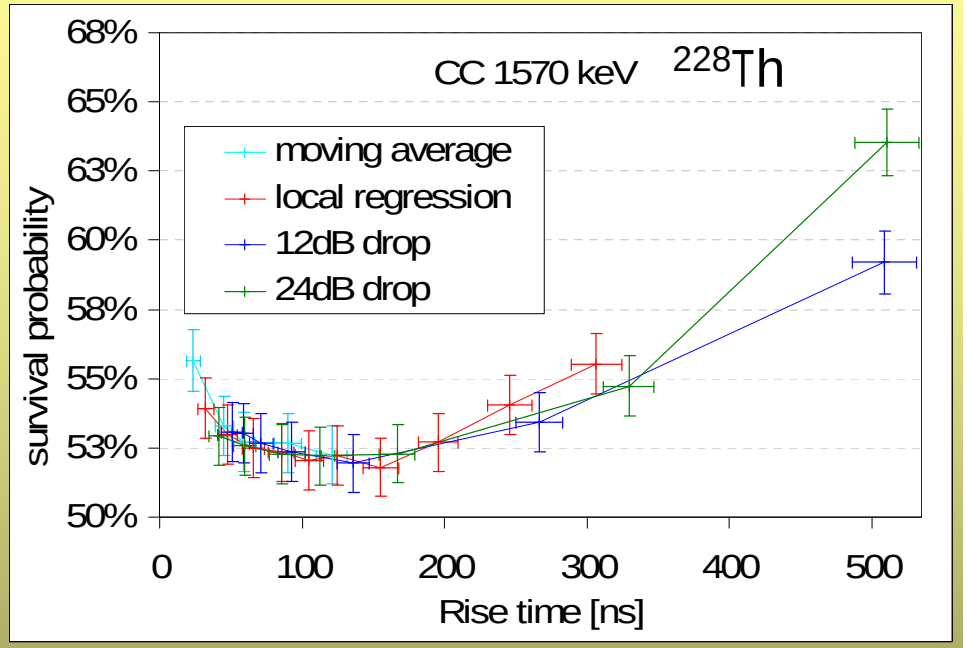
- test of PSD performance in dependence on signal bandwidth
- using recorded experimental pulse-data
- step 1: FE bandwidth restriction simulated by various filter methods

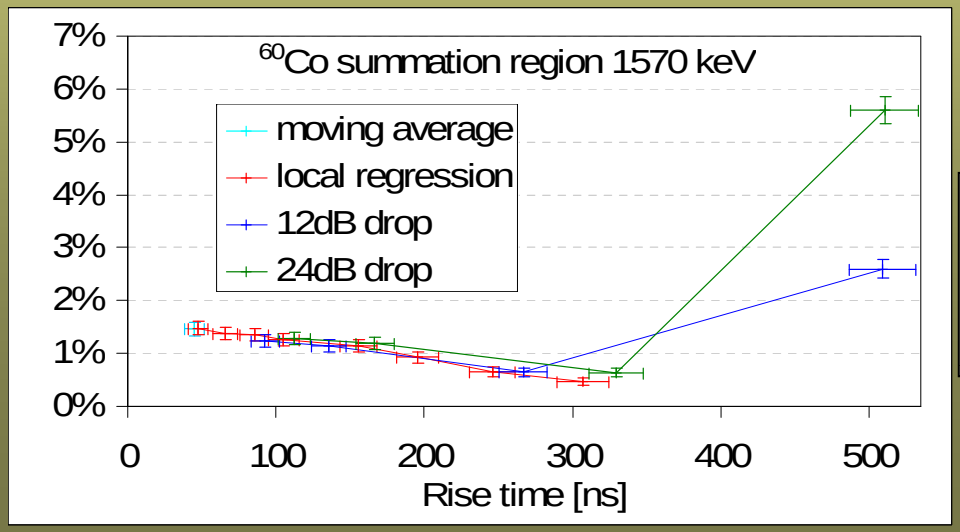


BEGe PSA constraints on FE bandwidth

- step 2: PSD on filtered pulses (DEP acceptance always fixed at 90%)







⇒ possibility for improved PSD rejection with optimised shaping

1. BEGe in LAr test results

2. Constraints on front-end bandwidth

3. **Upcoming characterisation of ^{dep}Ge BEGe detectors**

Characterisation of ^{dep}Ge BEGe detectors

Coordinators: Dušan, Assunta

- Participants from several GERDA institutes
- **Goal**: characterise spectroscopic, charge collection and PSD performance of the new BEGe detectors
- **Work plan**:
  - high-voltage scanning
  - energy resolution measurements
  - dead-layer and active volume determination
  - PSD performance tests
  - stability measurement
- **Place**: LNGS, laboratory at Autorimessa 2 (above ground)
- **First detector arrival**: in the next days

Characterisation of ^{dep}Ge BEGe detectors

- Schedule: under review (permanently...)

week	W 1 (GERDA meeting)					W 2					W 3 (DPG Bonn)					W 4				
day	1.3.	2.3.	3.3.	4.3.	5.3.	8.3.	9.3.	10.3.	11.3.	12.3.	15.3.	16.3.	17.3.	18.3.	19.3.	22.3.	23.3.	24.3.	25.3.	26.3.
task1	equipment and lab preparation			1aMCoAm	1dMCoAm	1eMBa		1fMCo	1dFCoAm	1gFTh	1hF(M)Am_c				1gFCo + Th + background?				1bFAm_c	1cFCs
task2	MCA system check with LNGS BEGe				FADC check with LNGS BEGe (incl. 228Th PSD)															
Dusan																				
Assunta																				
Matteo																				
Michal																				
Alexander																				

Notes:
tasks should include time for measurement analysis

code of the task: detector number; measurement code (small letter, see .doc file); DAQ system (FADC or MCA, F or M); source (with _c when collimated)

week	W 5			Easter				W 6			W 7					W 8				
day	29.3.	30.3.	31.3.	1.4.	2.4.	5.4.	6.4.	7.4.	8.4.	9.4.	12.4.	13.4.	14.4.	15.4.	16.4.	19.4.	20.4.	21.4.	22.4.	23.4.
task1	---------- 1jMCoAm (stability 1 month) ----------																			
task2								2aMCoAm	2dMCoAm	2eMBa	2fMCo	2dFCoAm	2gFTh + Co + background						2cFCs	2bFAm_c
Dusan																				
Assunta																				
Matteo																				
Michal	?	?	?																	
Alexander																				

week	W 9					W 10					W 11					....
day	28.4.	29.4.	30.4.	1.5.	2.5.	5.5.	6.5.	7.5.	8.5.	9.5.	12.5.	13.5.	14.5.	15.5.	16.5.	
task1	1iFTh_c															
task2	2hMAm_c ?			---------- 2jMCoAm (stability) ----------											2iFTh_c	
Dusan																
Assunta																
Matteo																
Michal																
Alexander																

Summary and conclusions

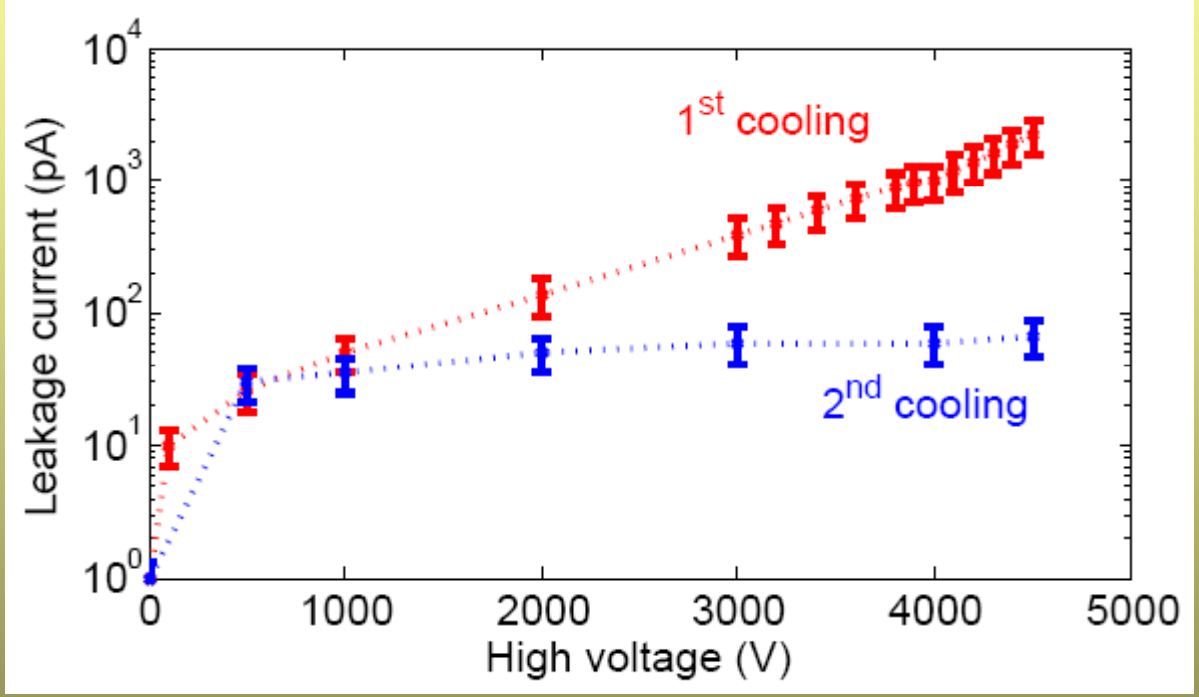
- BEGe detector succesfully operated in LAr:
  1.8 keV FWHM, stable operation,
  PSD performance same as in vac. cryostat

- PSD requirements on front-end bandwidth not very demanding: ~100 ns risetime sufficient

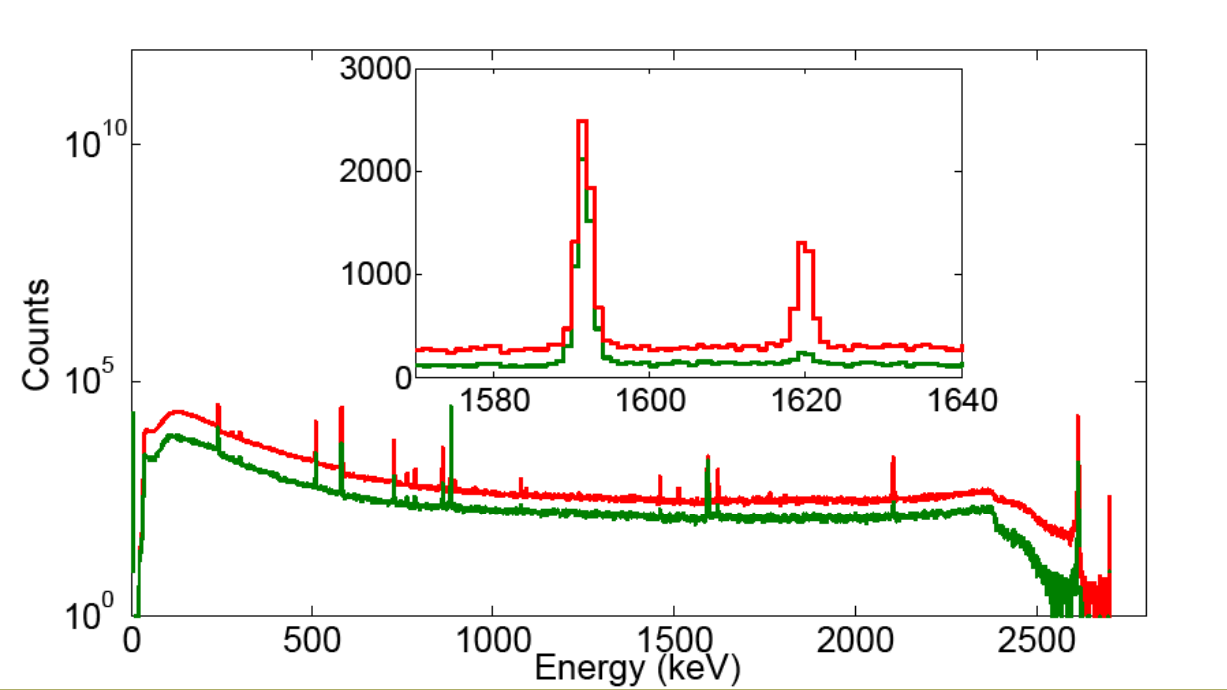
- Ready for acceptance testing campaign of the new ^{dep}Ge BEGe detectors,
  characterisation of the 1st detector starting after the meeting

Backup slides

BEGe in LAr: short term test 12. 2009



BEGe in LAr: short term test 12. 2009

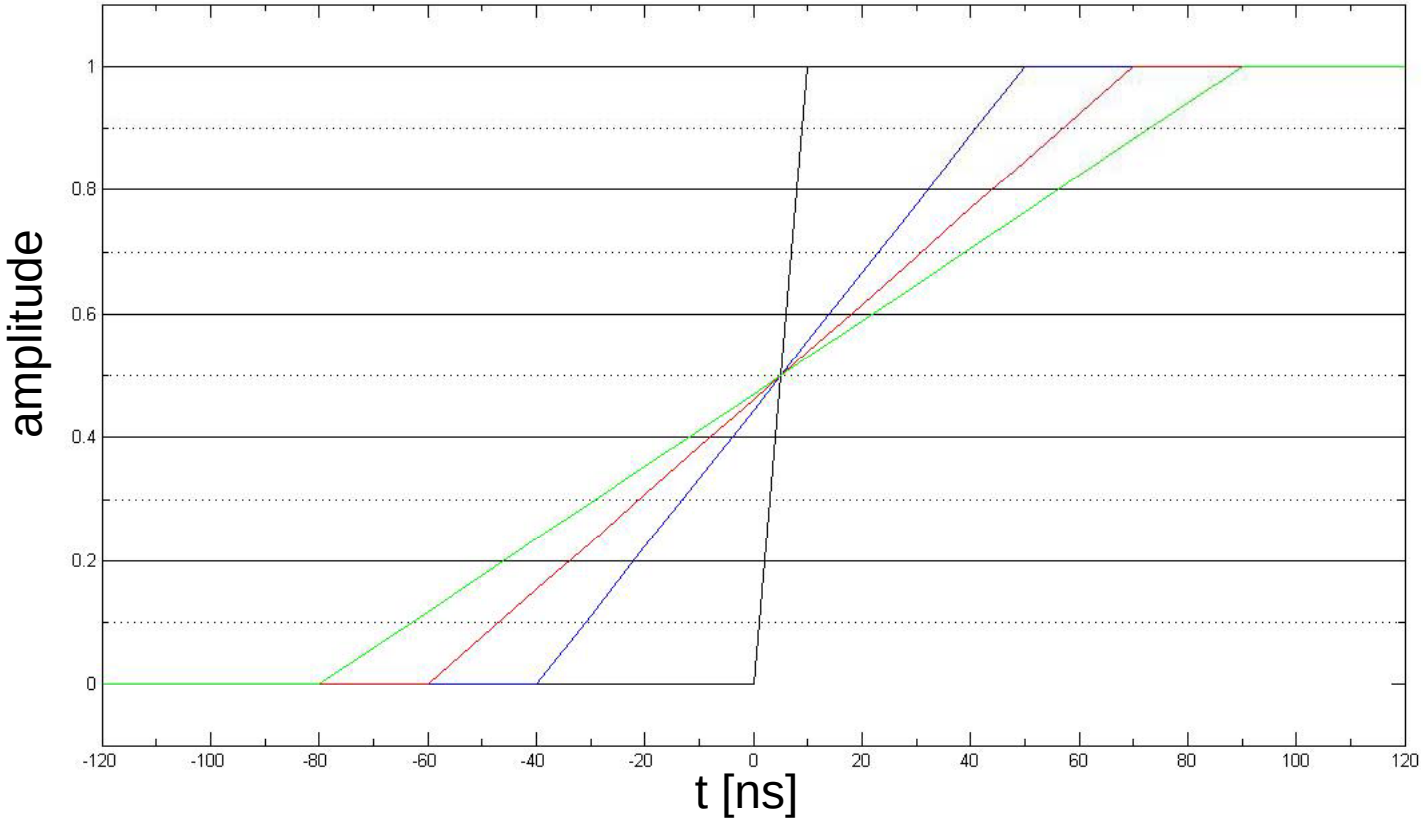


Region	LAr/GDL	Vacuum/Hd
DEP	0.90 ± 0.02	0.90 ± 0.02
1621 keV	0.12 ± 0.02	0.11 ± 0.01
SEP	0.07 ± 0.01	0.06 ± 0.01
2614 keV	0.102 ± 0.001	0.095 ± 0.001
$Q_{\beta\beta}$	0.42 ± 0.03	0.42 ± 0.02

BEGe PSA constraints on FE bandwidth

moving-average smoothing

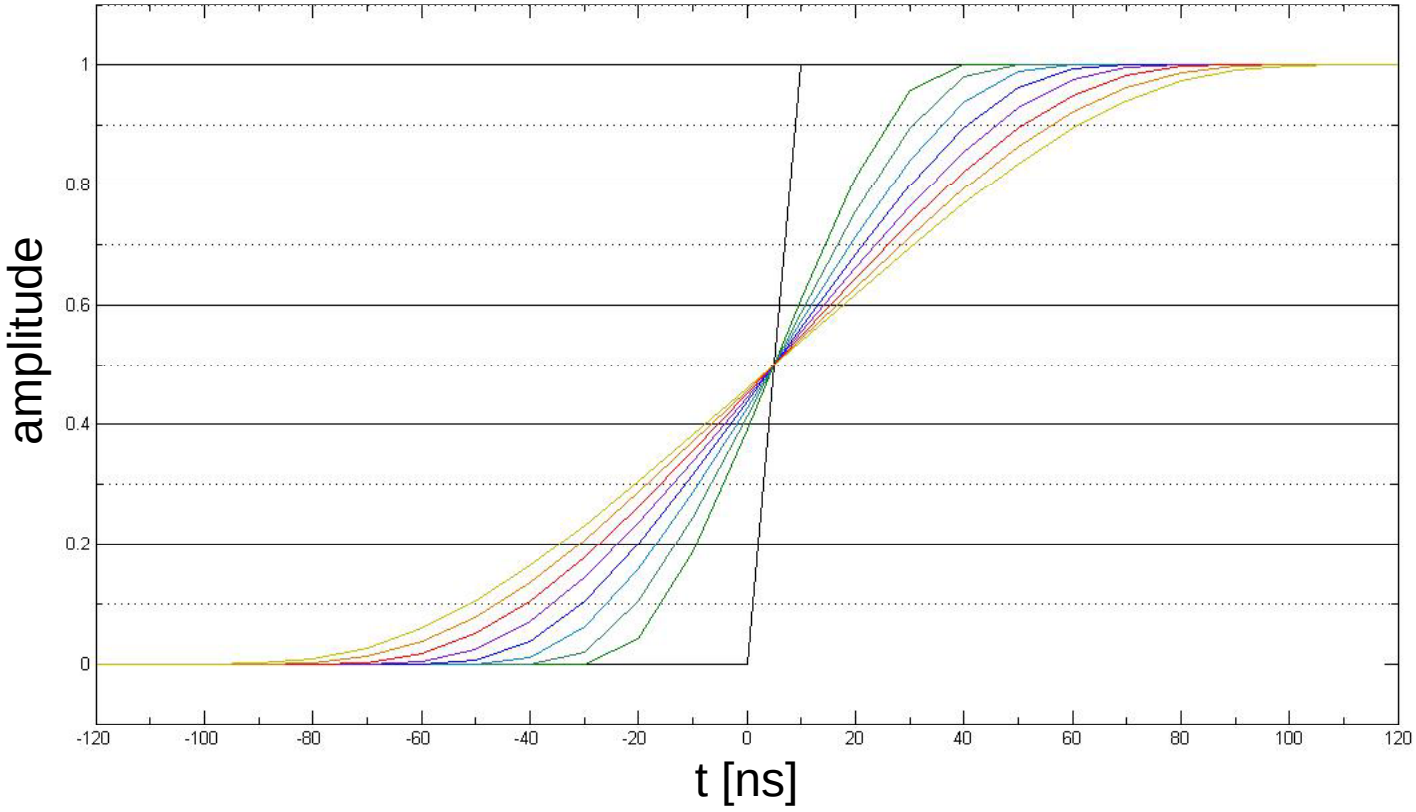
smoothing span [points]: 5, 7, 9, 13, 17 ...



BEGe PSA constraints on FE bandwidth

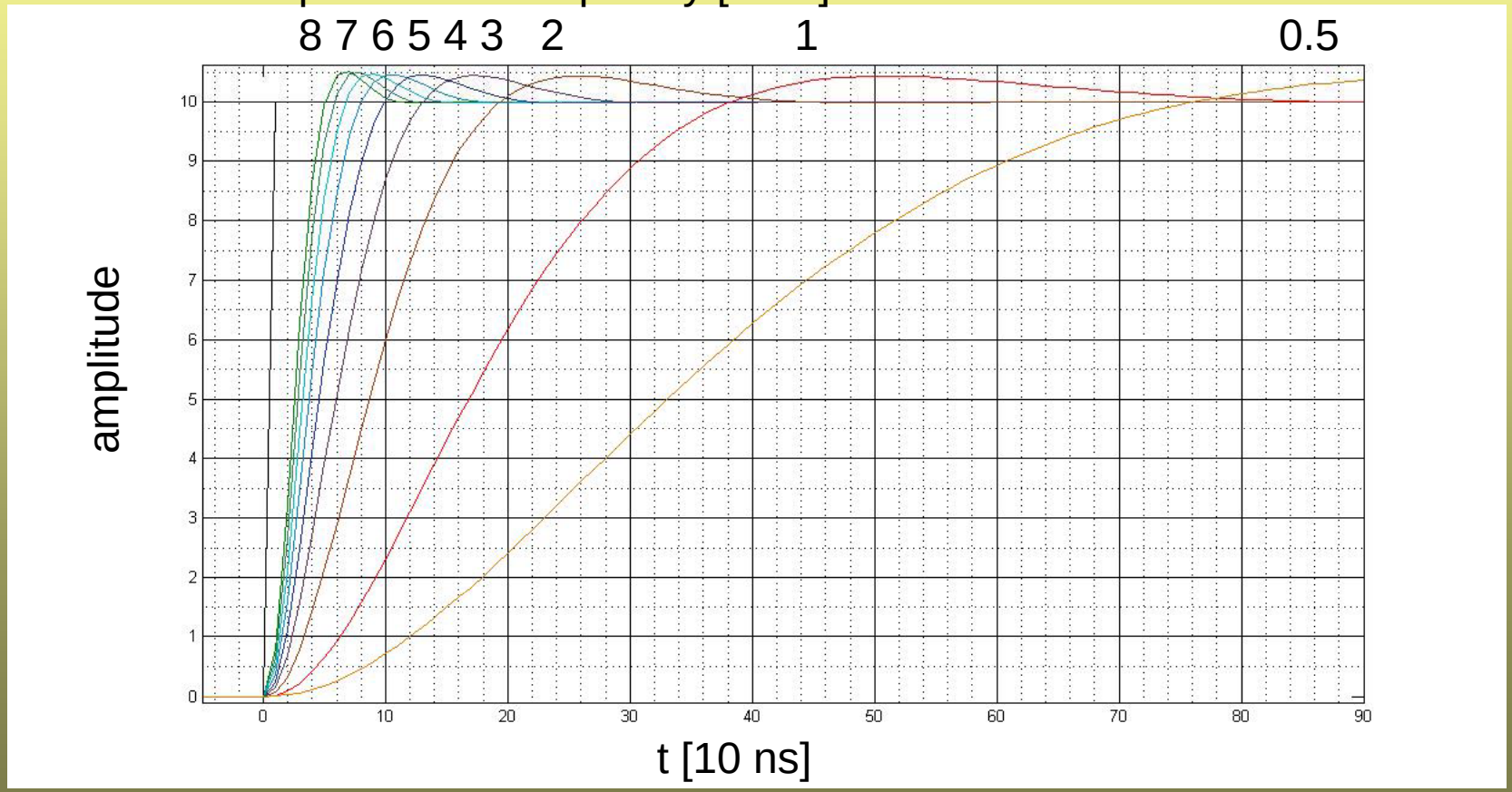
smoothing via local regression using weigthed least squares

smoothing span [points]: 9, 11, 13, 15, 17, 19, 21, 23, ...



BEGe PSA constraints on FE bandwidth

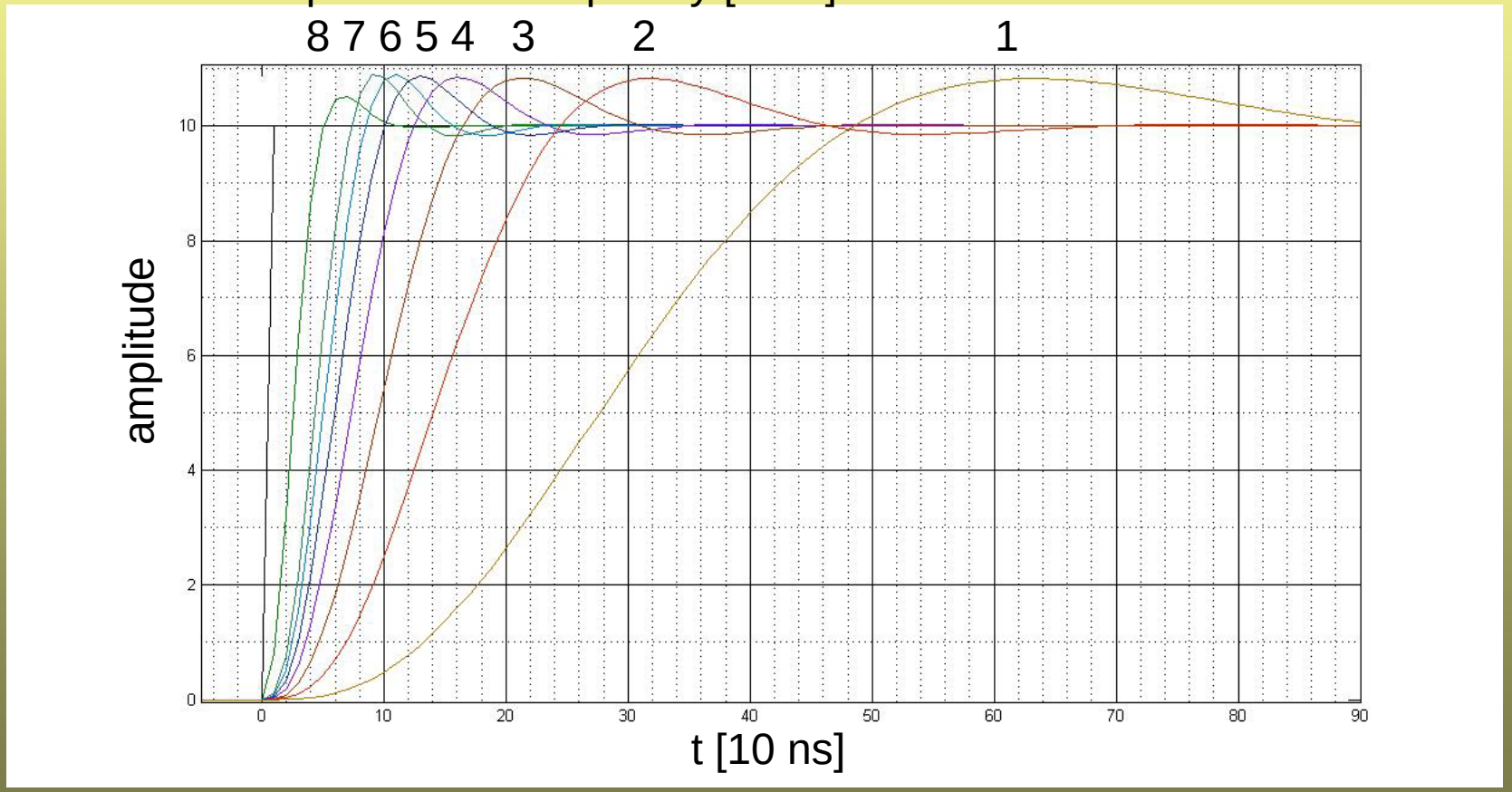
IIR Butterworth filter, 12 dB drop



BEGe PSA constraints on FE bandwidth

IIR Butterworth filter, 24 dB drop

pass-band frequency [MHz]:



Characterisation of ^{dep}Ge BEGe detectors

Measurements list

Measurement	Source	DAQ
a. high voltage scanning (incl. "bathtub region")	^{60}Co (+ ^{241}Am) + pulser	MCA
b. high voltage scanning for average PS check	collimated ^{241}Am	FADC
c. high voltage scanning with a single-peak source	^{137}Cs	FADC or MCA
d. energy resolution, peak tails, etc. check (shaping constant scan, predetermined number of events)	^{60}Co (+ ^{241}Am) + pulser	MCA and FADC
e. dead layer determination	^{133}Ba (or ^{241}Am)	MCA
f. active volume determination	^{60}Co	MCA
g. PS discrimination (PSD) performance tests	^{228}Th, ^{60}Co + background	FADC
h. charge collection and dead layer variation; lateral and front surface scan	collimated ^{241}Am + positioning device	MCA and FADC
i. check of PSD sensitivity loss near n+ electrode	collim. ^{228}Th, background	FADC
j. long-term performance stability test	^{60}Co (+ ^{241}Am) + pulser	MCA