Opportunity for next generation experiments with the new ALBEGA multi-coincidence detector

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und Forschung

The ALBEGA Collaboration

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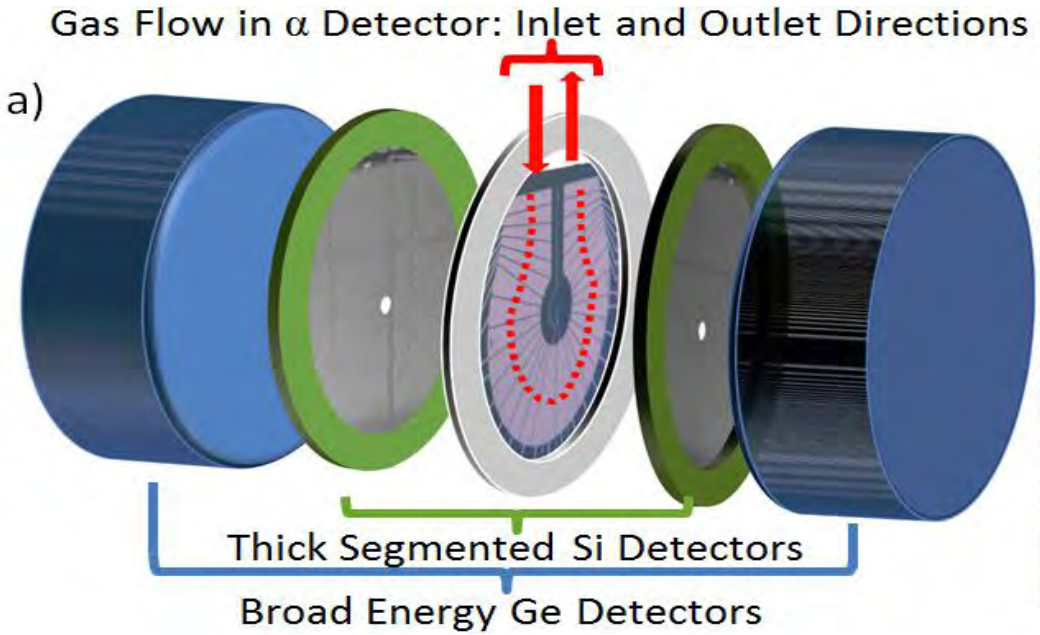
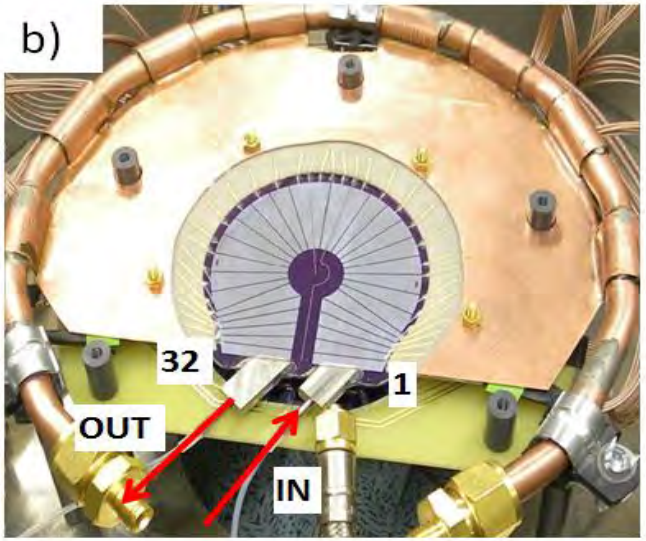
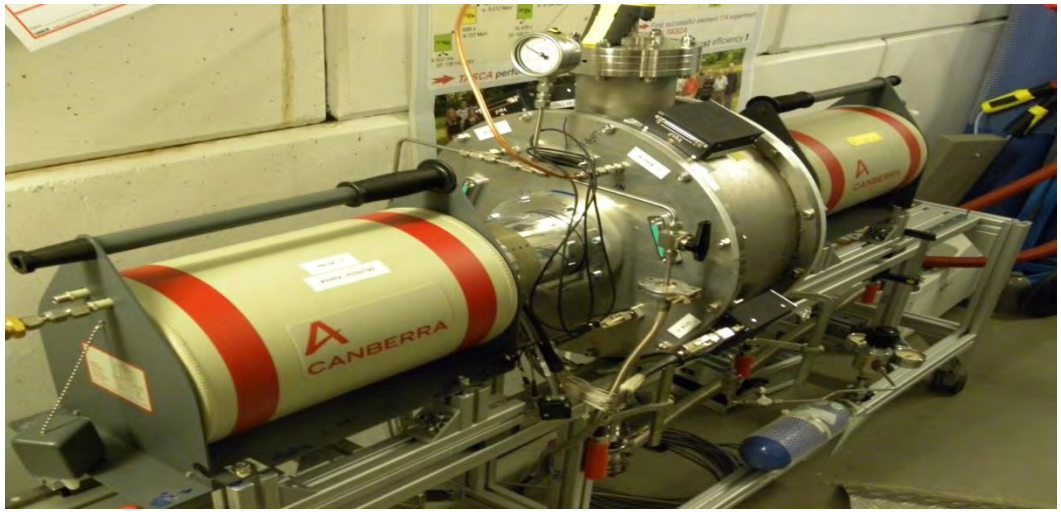
Outline

- The data collection modes and efficiency
- The GEANT4 simulations
- The measurement at TRIGA Mainz
- Future developments

ALBEGA







Cupper cooling frame Si det at -80° C

CANBERRA BEGe 6530:
3cm thickness and 9cm diameter

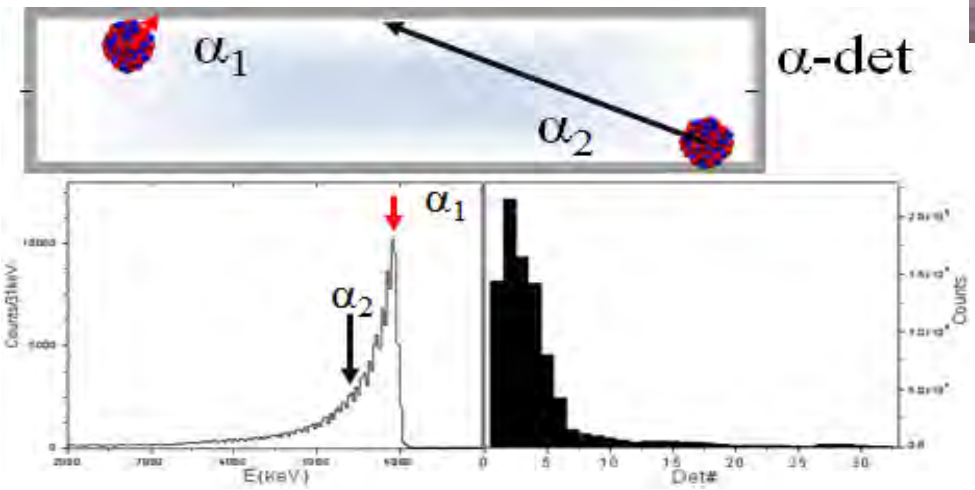
A. Di Nitto et al., GSI Annual report 2014
M. Wegrzecki et al., SPIE Proc. 9291 (2014)

α-Detector

gas flow→drift velocity
diffusion → collision on the channel boundary

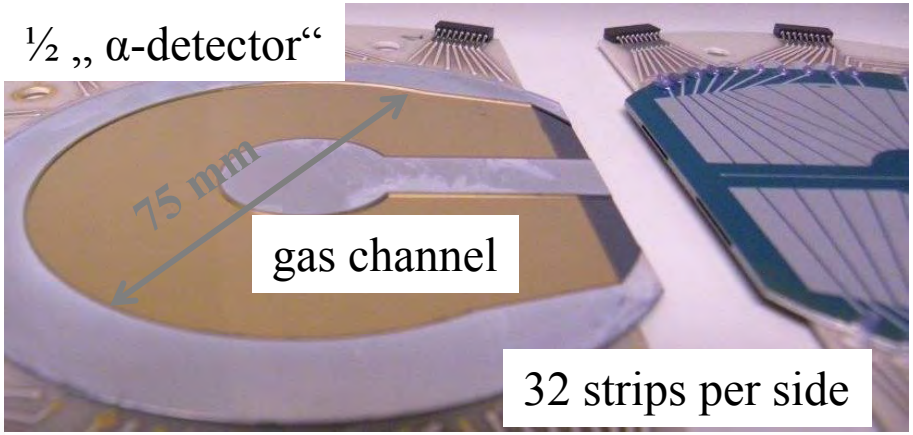
$^{140}Ce(^{50}Ti,\ 7\text{-}8n)^{183,182}Hg$

The Hg atoms are adsorbed on the surface of the detector, covered with a thin gold layer



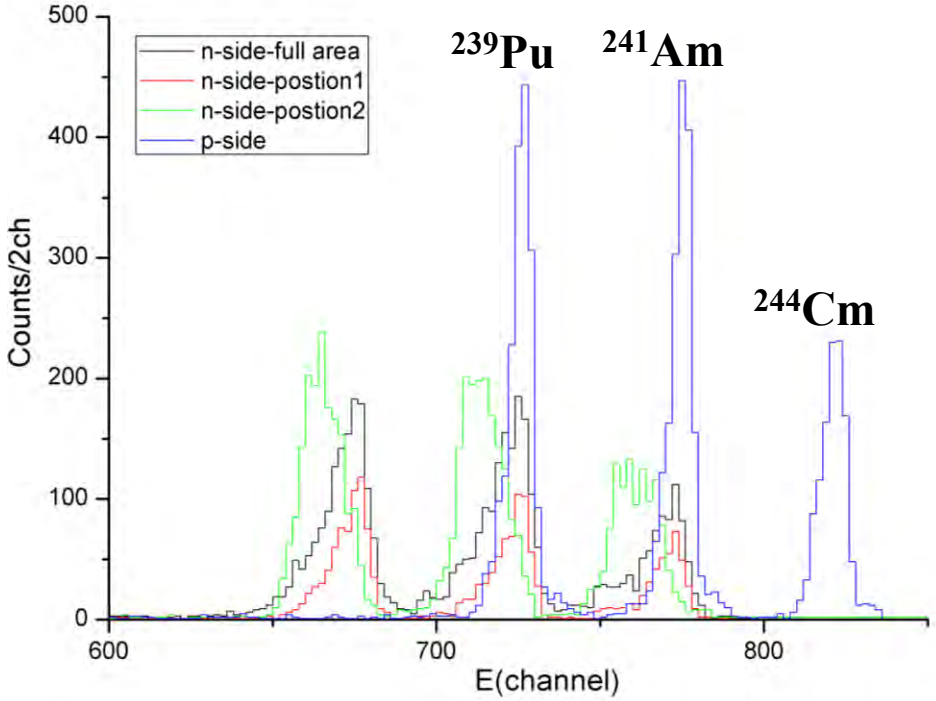
The large tail at low energy is due to the use of Ar as gas carrier at high pressure (1 bar) and the Si dead-layer.

½ „ α-detector“



Distribution pattern has a narrow peak located in the first segments → demonstrate the retention properties, which are essential for future studies

Dead-Layer measurements

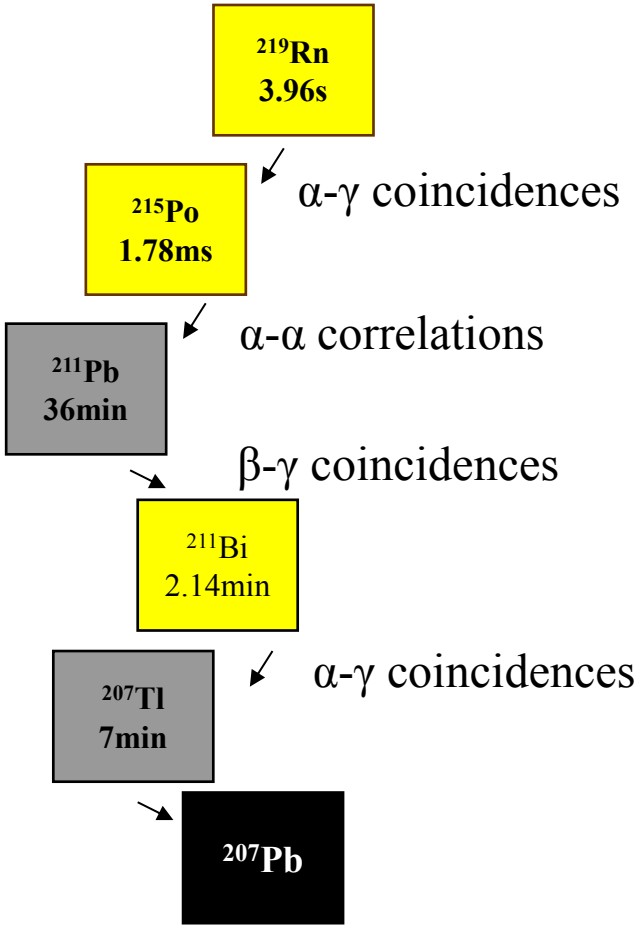


Point mixed source
^{239}Pu = 5148 keV
^{241}Am = 5480 keV
^{244}Cm = 5795 keV

Mask with 1 mm in diameter to map the detector surface

n-side Dead-layer ≈ **2.6 μm**
In agreement with manufacturing characteristics

Calibration Source

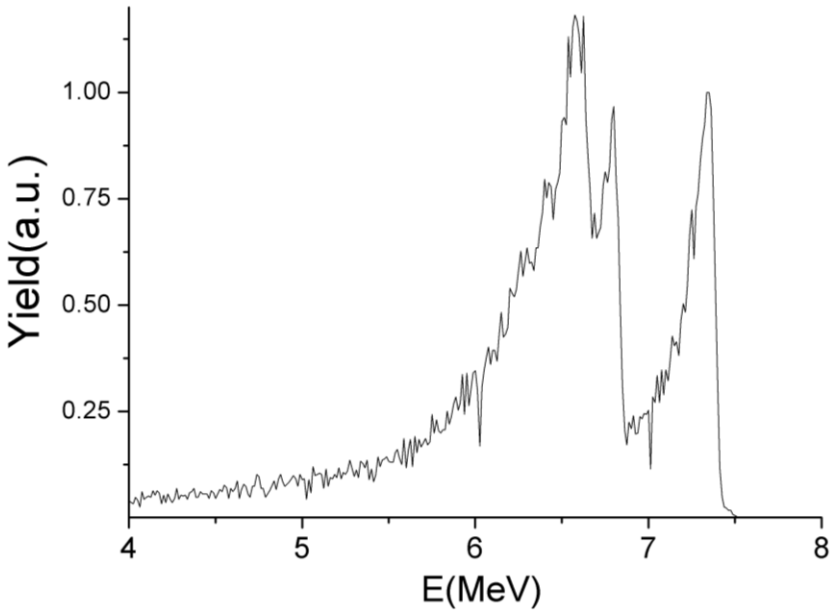


Flushing the ^{227}Ac source, the radioactive and volatile ^{219}Rn is transported through the gas system to the ALBEGA.

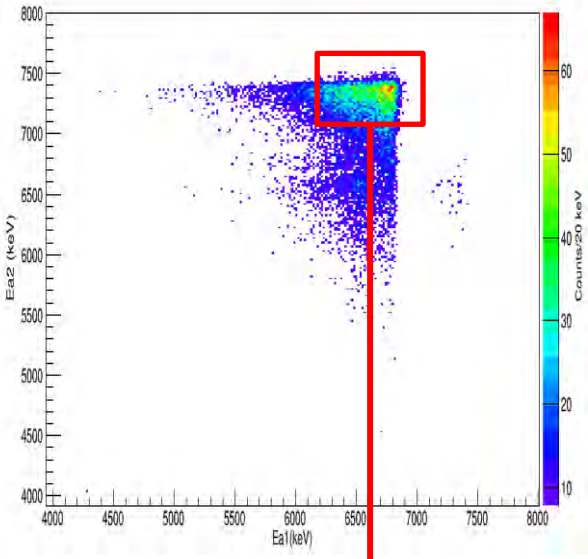
- the α-particles energy → α-detector calibration;
- the gamma → BEGe calibration;
- α-γ coincidences → γ-efficiency;
- α-α correlations → α-efficiency.

ALBEGA work conditions with Rn Source

Energy Spectrum



Alpha-Alpha Correlations
(2 α-particles registered in neighbouring segments)



Rn-219

6.4-6.8 MeV

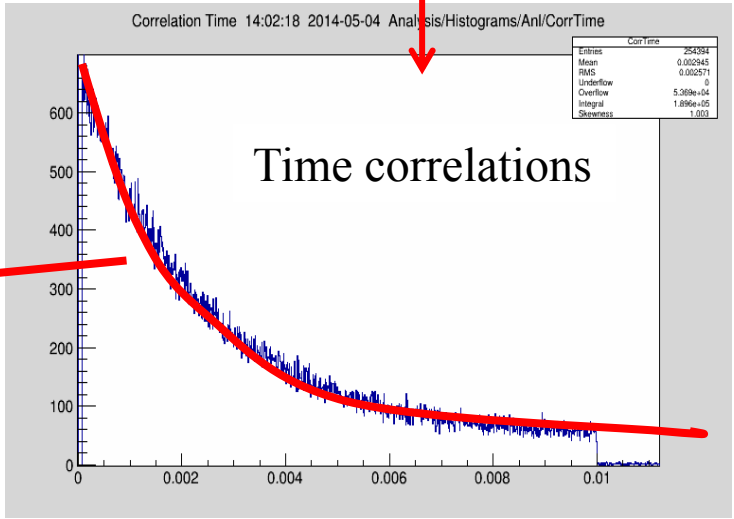
Po-215

$t_{1/2}$=1.78ms

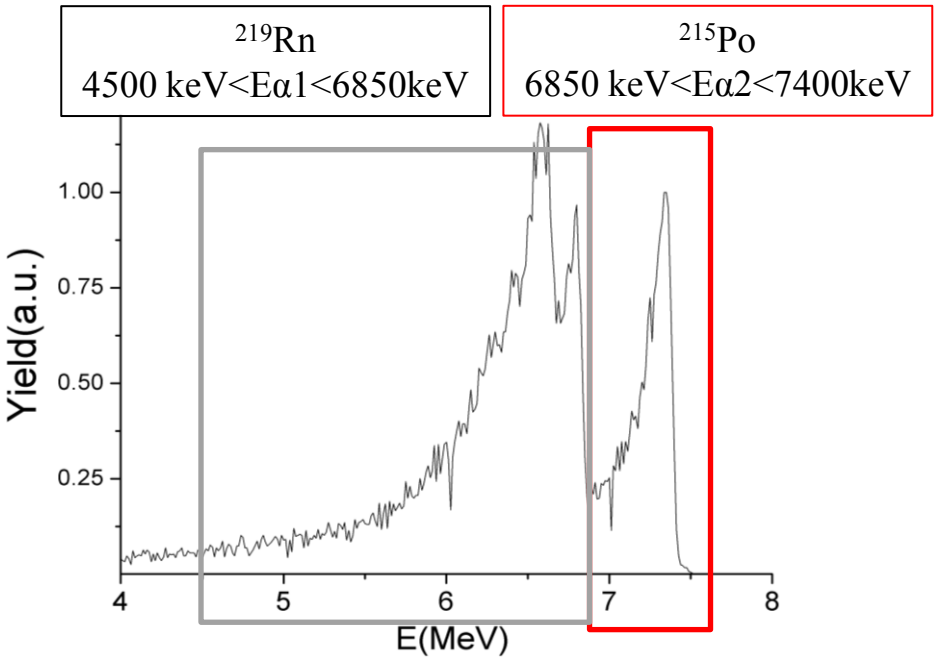
7.4 Mev

Pb-211

slope



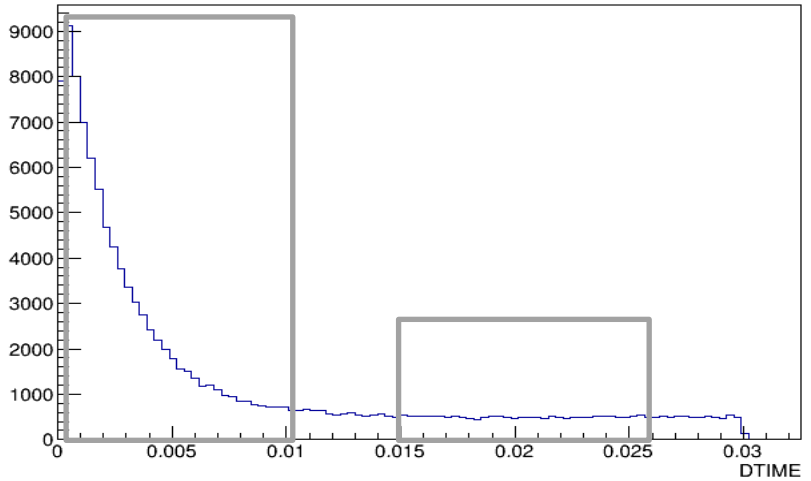
α-Efficiency



Time correlation (^{215}Po $T_{1/2}$=1.78ms)

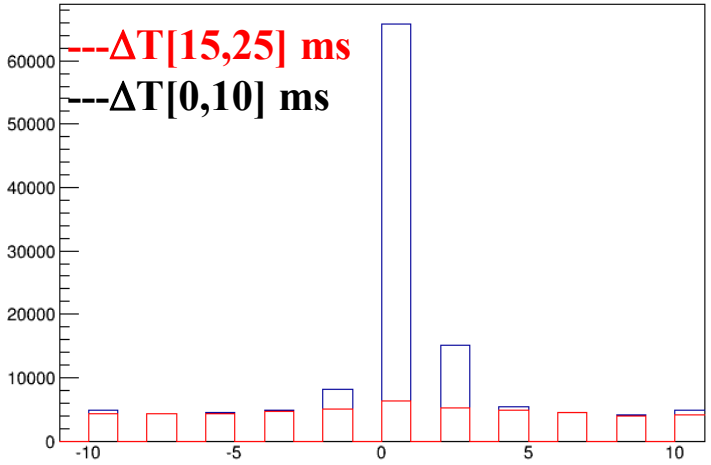
I_1=[0,10]ms — Real + Random corr

I_2=[15,25] ms — Random corr



ΔT(s)

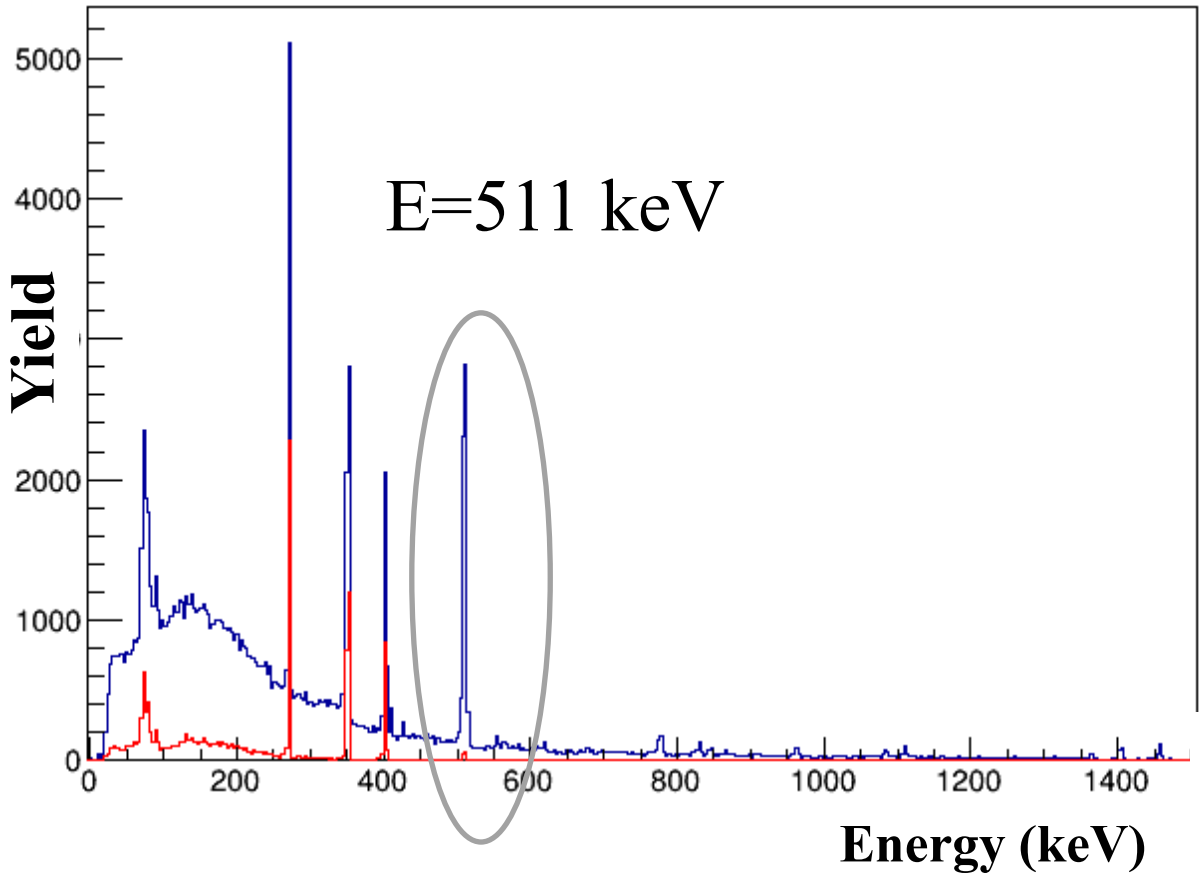
Spatial correlation



PRELIMINARY

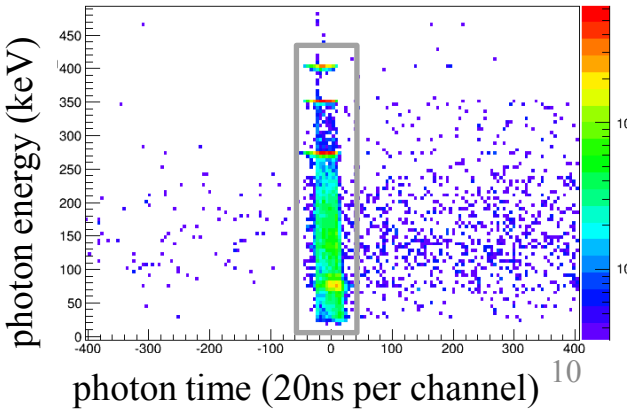
$\varepsilon_\alpha = 72 \pm 8\%$

α-γ coincidence MODE

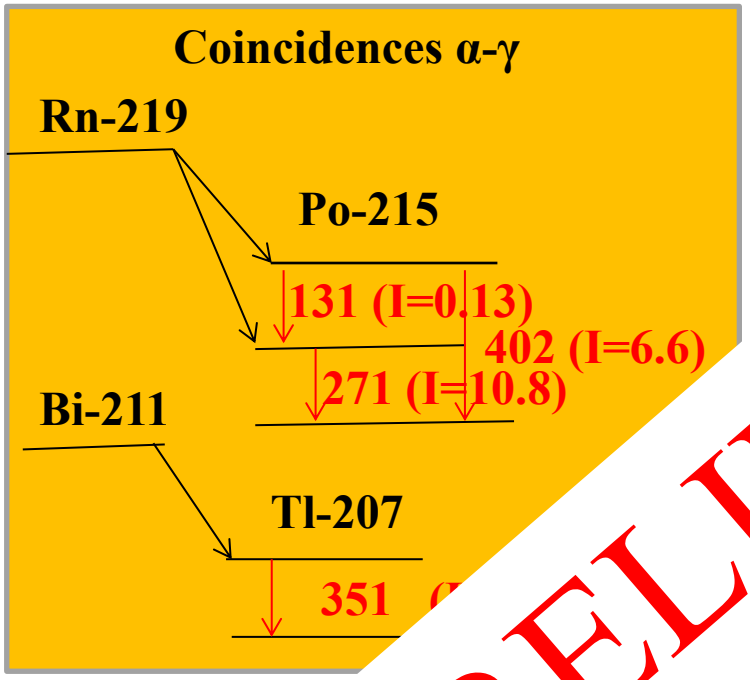


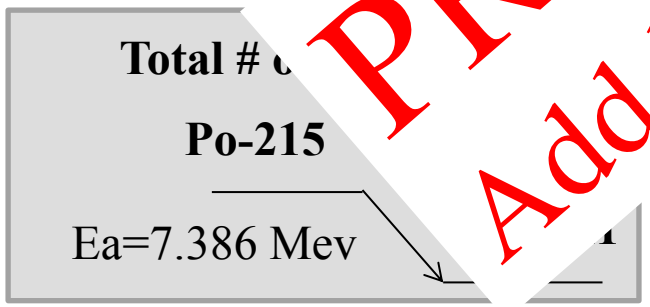
Slave Mode:
Any trigger produced by α-detector

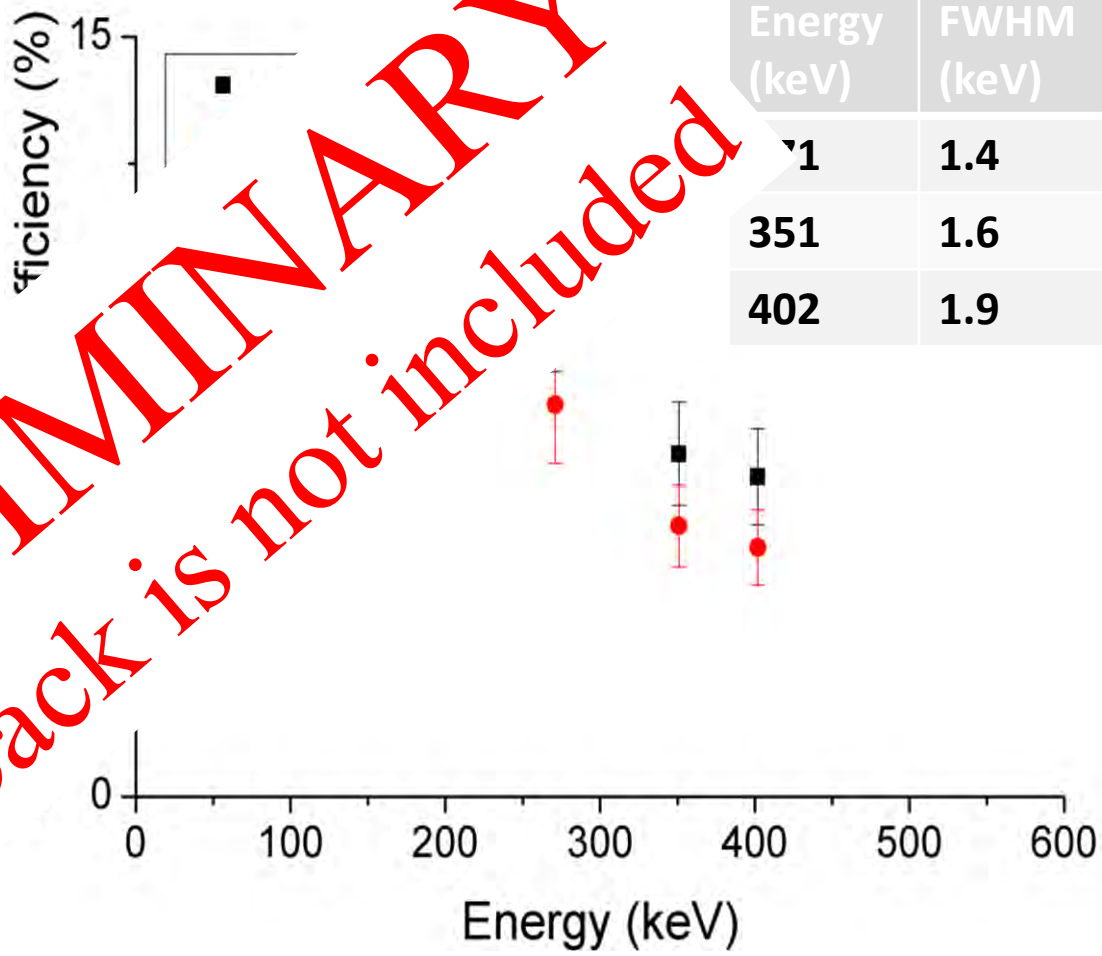
Coincidence conditions:
ΔT(α-γ)<800 ns
Eα>2.5 MeV
1 side of α-detector



γ- Efficiency and resolution





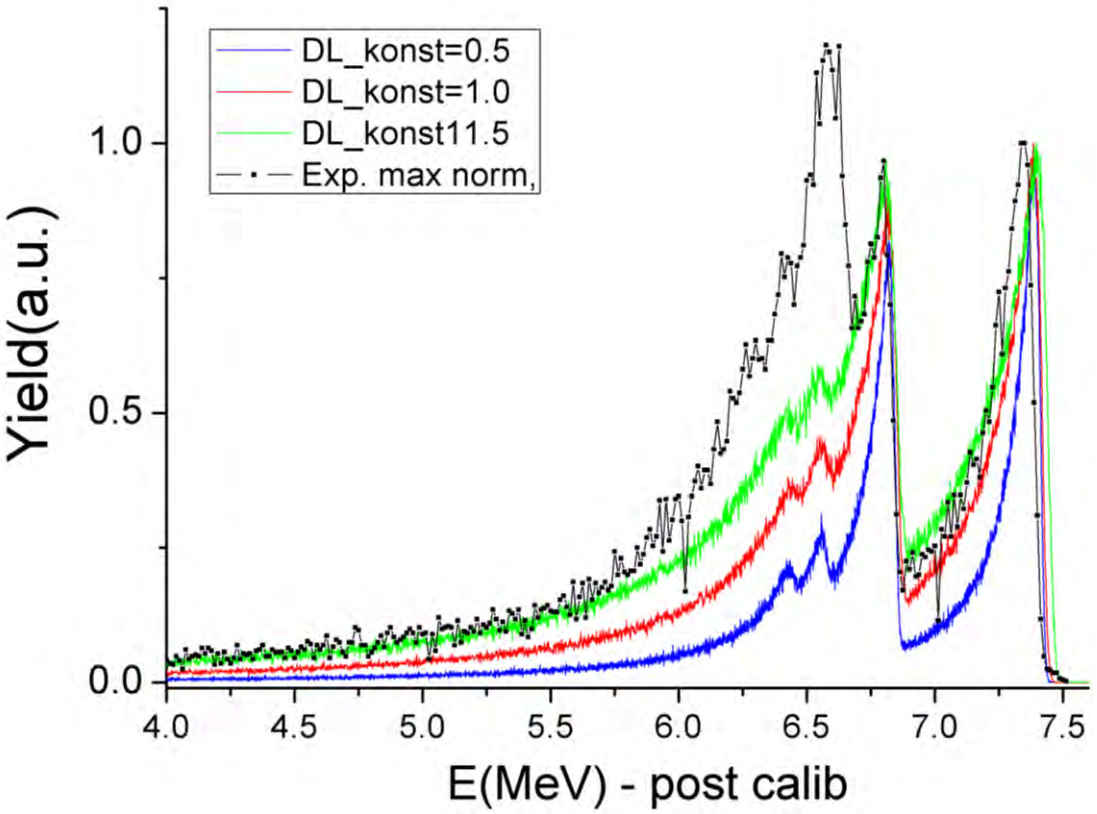


Energy (keV)	FWHM (keV)
71	1.4
351	1.6
402	1.9

Det2 is placed 4 mm farer than Det1 from the source

ALBEGA Geant4

GEANT4: Alpha Spectrum and efficiency



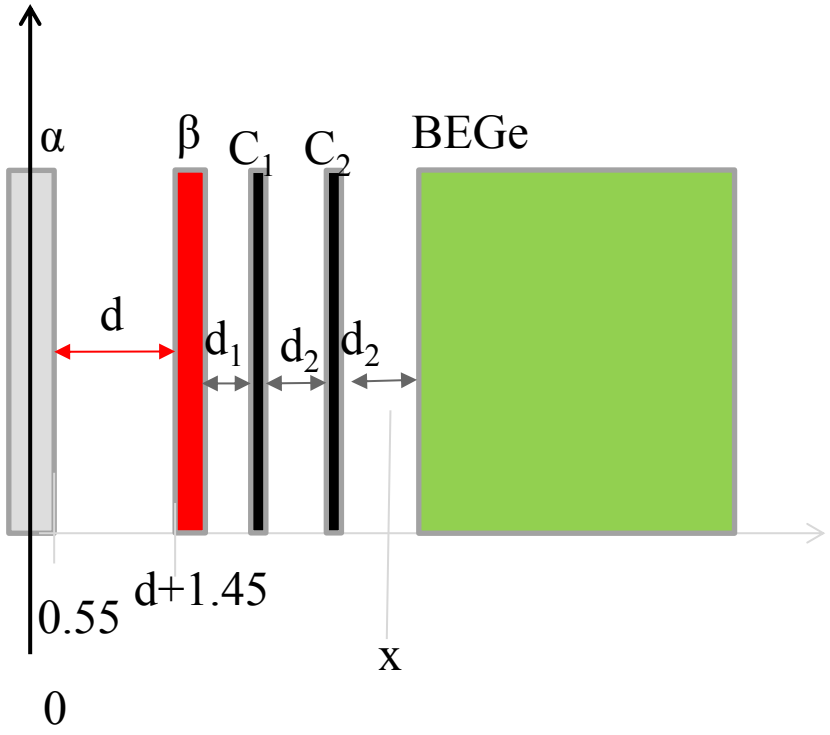
Conditions	Efficiency (%)
Exp.	72±8
Sim (DL*0.5)	90.8
Sim (DL*1.0)	84.6
Sim (DL*1.5)	78.8

Energy lost:

- Carrier gas (Pressure and composition from the exp. Cond.);
- Si dead layer (2.6 μm *DL_konst meas. with α-source).

Reduction of the detection resolution and efficiency

Ge Efficiency: Experimental conditions



Current configuration

d1 = 3 mm

d2 = 2 mm

C_{thick} = 0.6mm

β1: d=11.45 → X=**20.2**

β1: d=15.45 → X=**24.2**

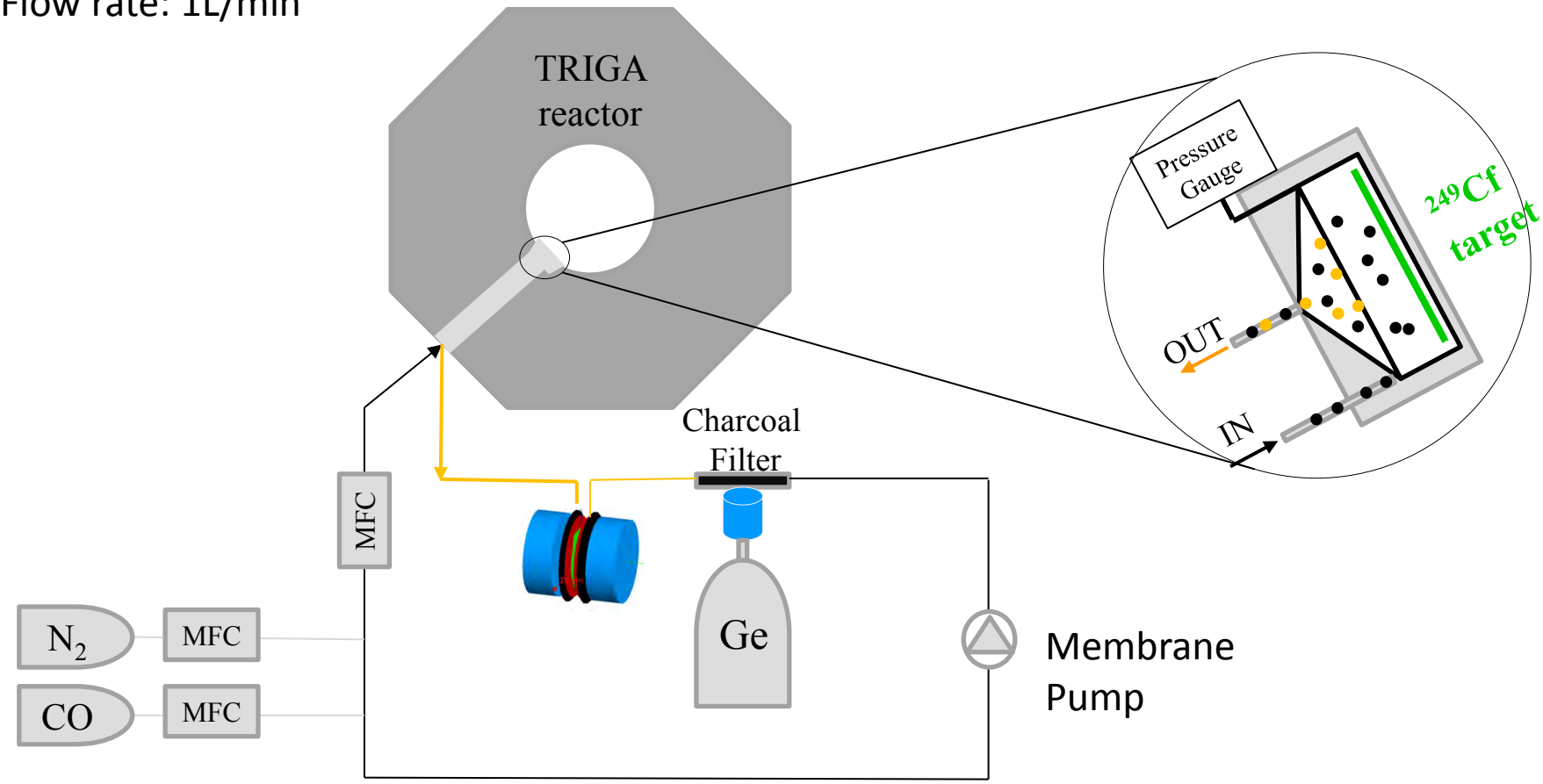
E_γ (keV)	Det1 Exp.	sim 20 mm	Det2 Exp.	ε_sim 24 mm
271	9.9+1.5	12	7.74±1.2	9.5
351	6.8+1.0	--	5.35±0.8	--
402	6.3+0.9	8.5	4.92+0.7	7.5

x (mm)	Total ε (%) (Eg=271 keV)	Total ε (%) (Eg=402 keV)
12	31	22
20	24	17
24.25	19	15

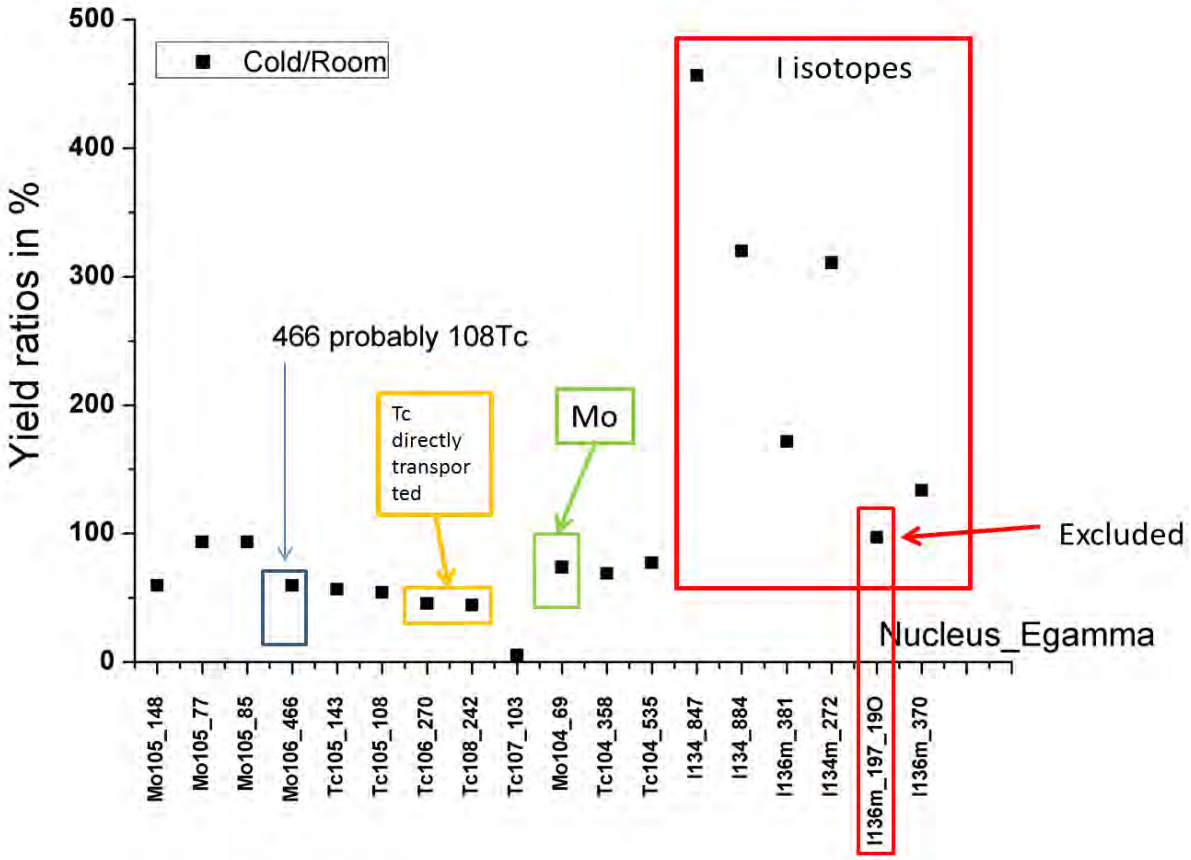
Future Core detector (under study):
d<4 mm → ε >30%

ALBEGA@TRIGA Mainz

Gas flow composition: CO:N2=1:1
Flow rate: 1L/min



Mo/Tc/I adsorbed on ALBEGA surface



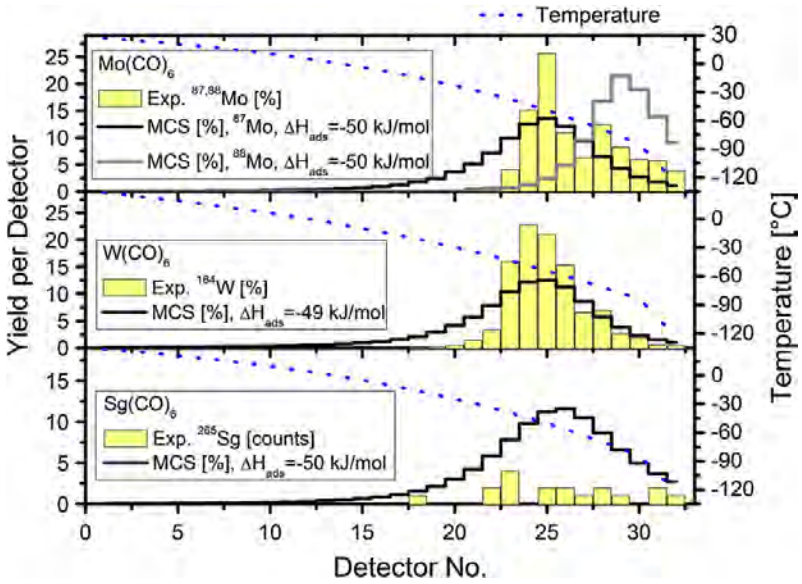
The Core detector connected with a Chiller at -80°

^{106}Tc ($T_{1/2}$=36 s): I excluded the presence of ^{106}Mo therefore this peak can be considered as Tc directly transported. It disappears in the decay files.

^{104}Mo ($T_{1/2}$=1m): produced by the Mo transported. This peak disappears in the decay files.

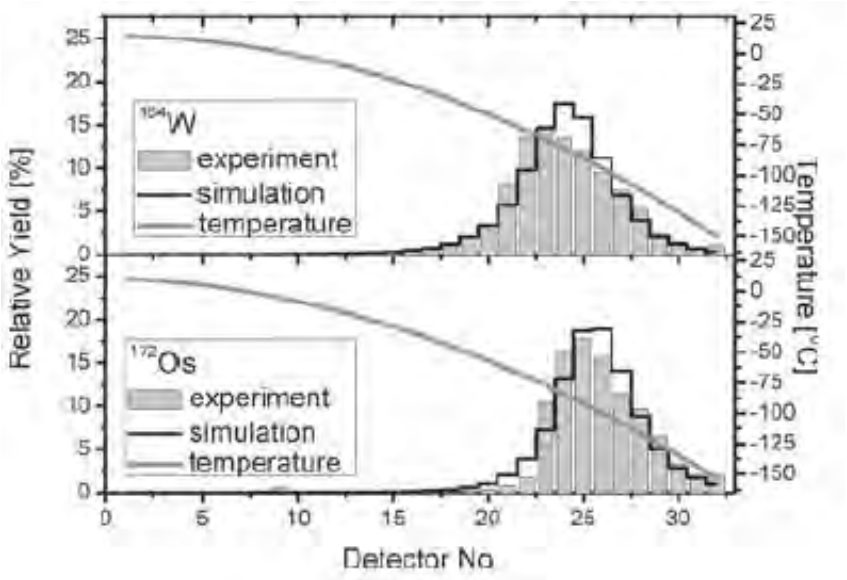
ALBEGA Temperature

COMPACT SiO_2

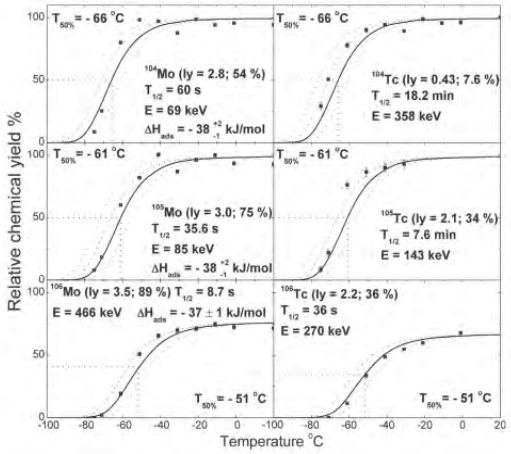


J.Even Radioanal Nucl Chem (2015) 303:2457–2466

COMPACT Au



J.Even Radichim. Acta (2014) 102:1093-1110



Breakthrough curves from literature obtained using Teflon or Quarz IC columns the temperature values are:

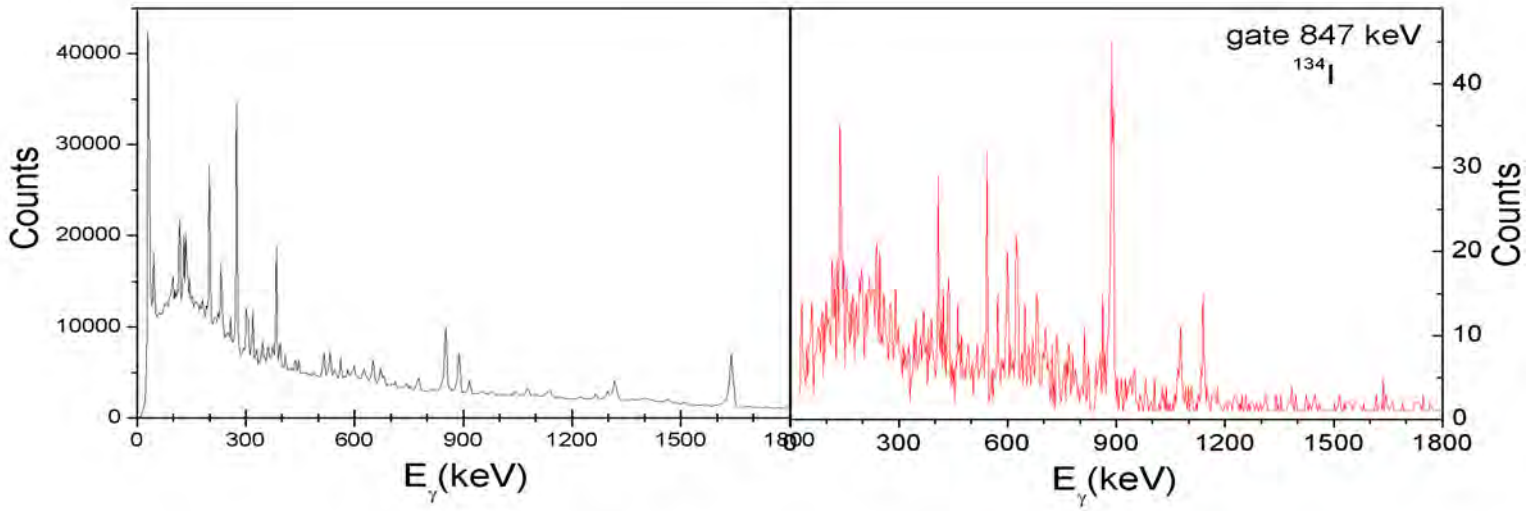
74% ^{104}Mo→**-58°C**

45% ^{106}Tc\$^{108}$Tc →**-40°C**

Y. Wang et al. ***Phys.Chem.Chem.Phys.***(2015)

γ-γ coincidences

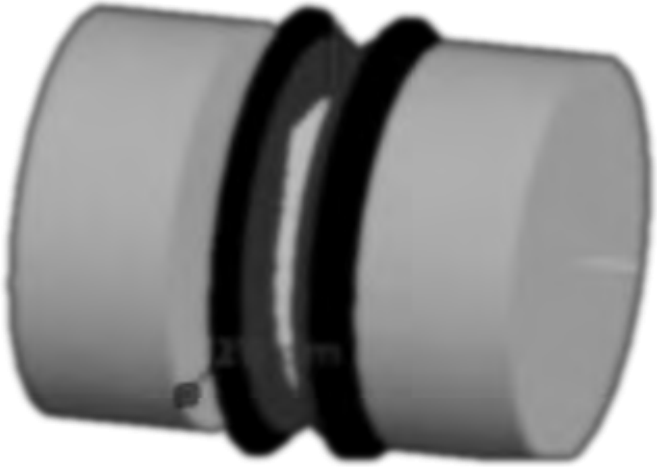
Case2→ γ-γ coincidences: TRIGA@Mainz



Outlook

Future developments and plans:

- Full implementation of ALBEGA in GEANT4;
- New core detector for optimization of α-particle detection efficiency and resolution (reduction of the dead-layer);
- Improving the mechanical stability;
- Increasing the Ge-detectors geometrical efficiency and optimize the resolution;



Thank you for your attention