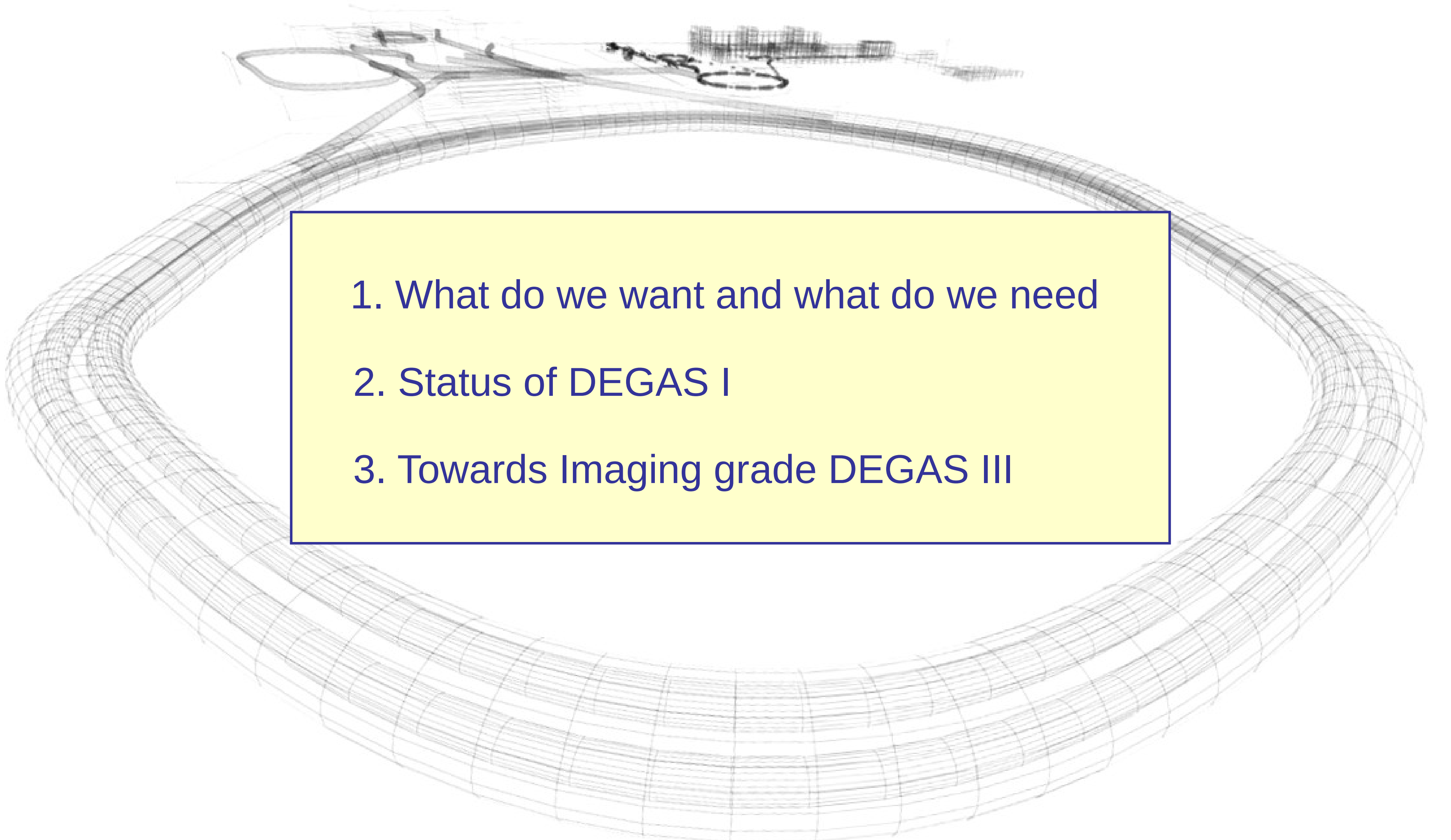
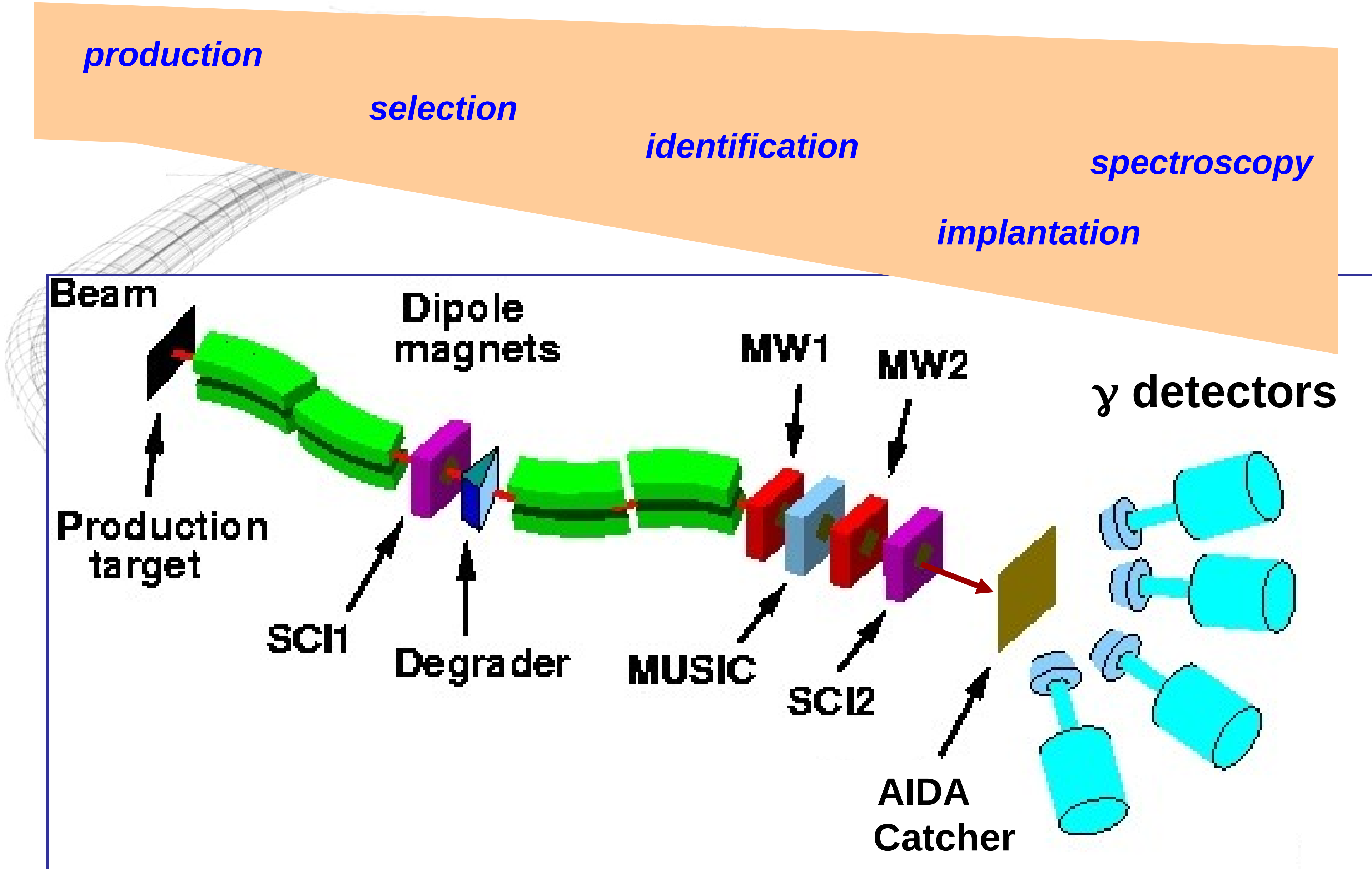
DEGAS



1. What do we want and what do we need
2. Status of DEGAS I
3. Towards Imaging grade DEGAS III

Decay Spectroscopy at FAIR



What is wanted?

α,β-decay experiments

-> AIDA active implanter defines time of decay -> very little chance background

-ε(DEGAS) ≥ ε(RISING) ≈ 15%

-P/T(DEGAS) ≥ P/T(RISING) ≈ 35%

Isomer-decay experiments

-> AIDA defines implantation points -> time of decay unknown

-> chance background depends on lifetime

-ε(DEGAS) ≥ ε(RISING)

-P/T(DEGAS) ≥ P/T(RISING)

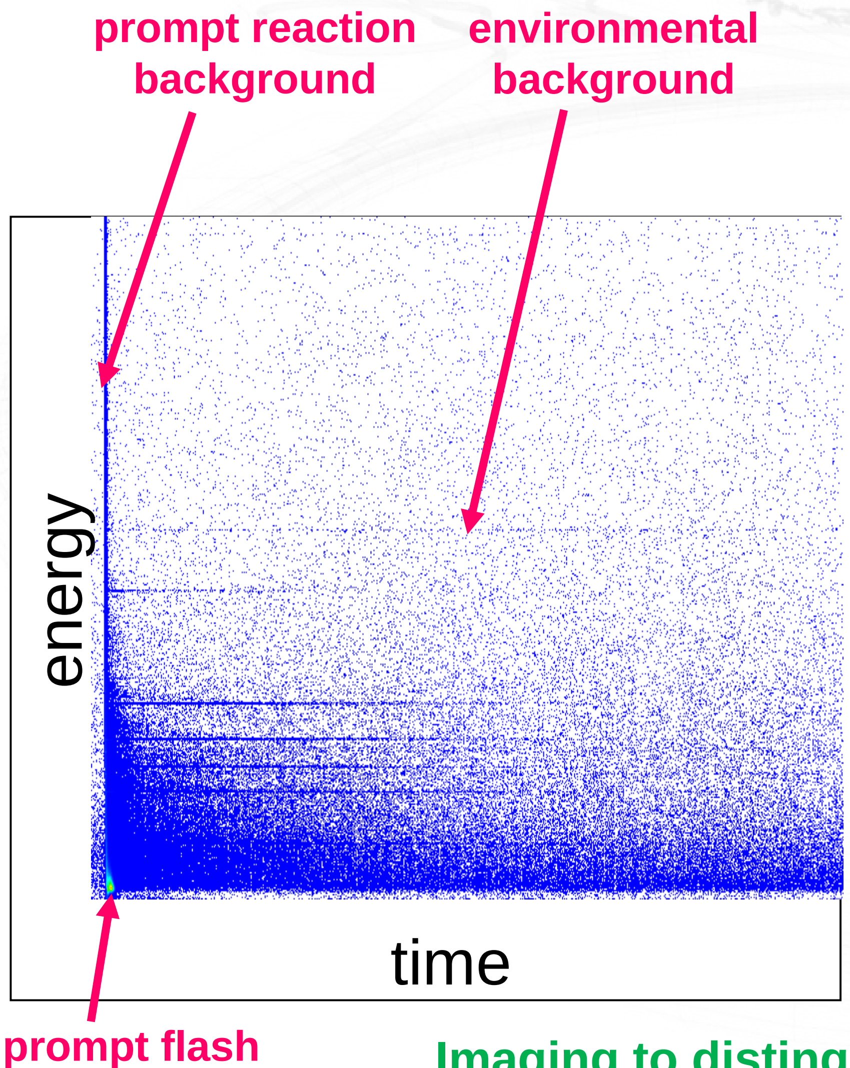
-τ_{max}(DEGAS) ≥ 100 ms !!! [RISING ≈ 100 μs]

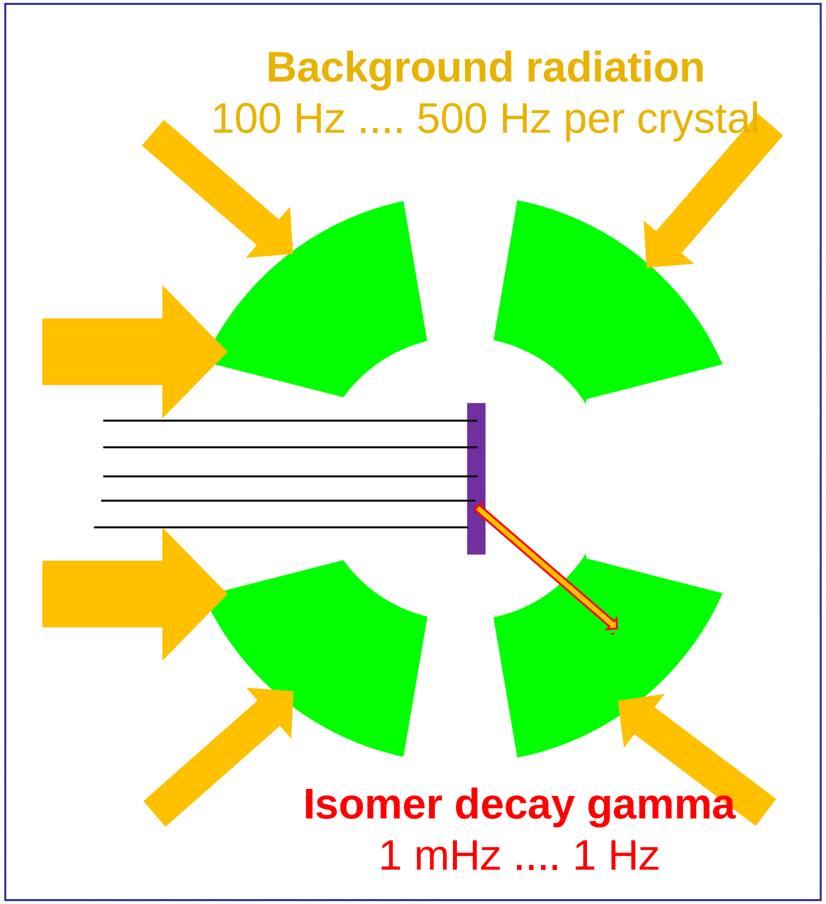
General

-Uses AIDA in 8x8 cm^2 and 24x8 cm^2 mode

-quasi-permanent set-up at FAIR

Challenge: Background supression

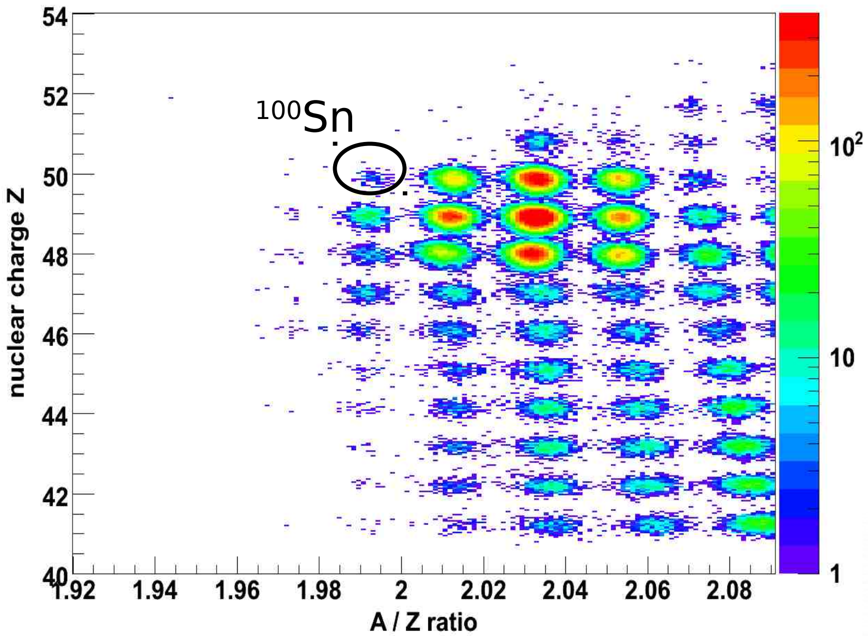




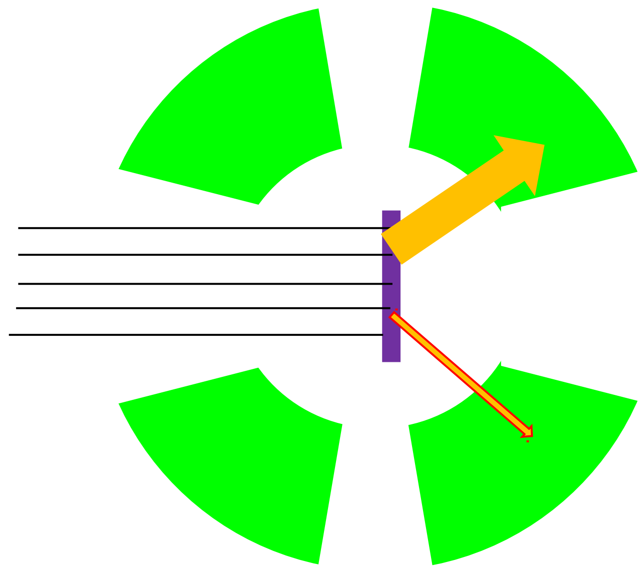
Imaging to distinguish isomeric from environmental γ rays

Challenge: Background supression

background from unwanted isotopes



Implantation rate
0.1 kHz .... 50 kHz



weak decay channel
1 mHz .... 1 Hz

Imaging to localize the respective implantation points

What is needed?

Phase 1

-Use RISING crystals

-Replace preamps and detector pcbs

-Change configuration to adopt to extended AIDA implantation zone and structure

-Go for triple detectors if efficiency is gained compared to 7-fold clusters

-add active/passive shielding to reduce background

Phase 2

-include AGATA type doubles and/or triple detectors (towards beam)

-replace digital electronics

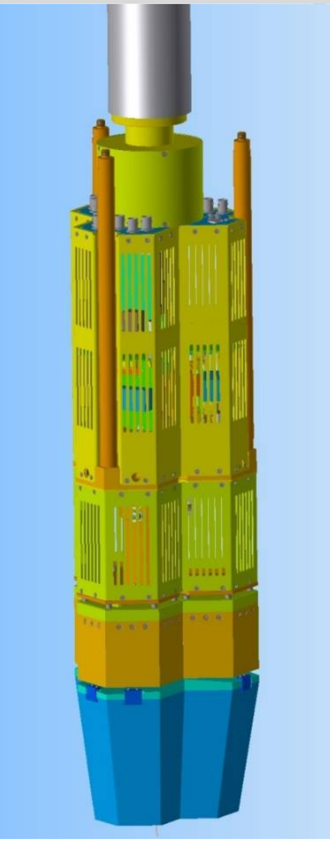
Phase 3

-develop imaging array

-develop Ge implanter

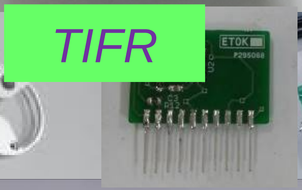
DESPEC – DEGAS I Detector

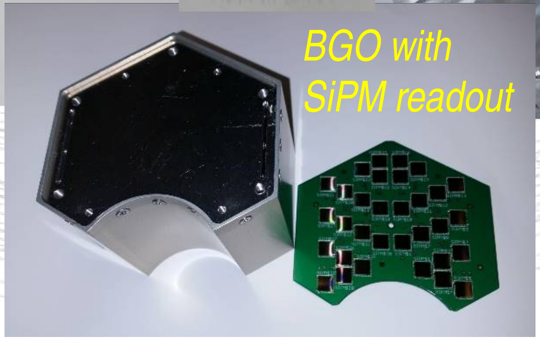
DEGAS γ-detector



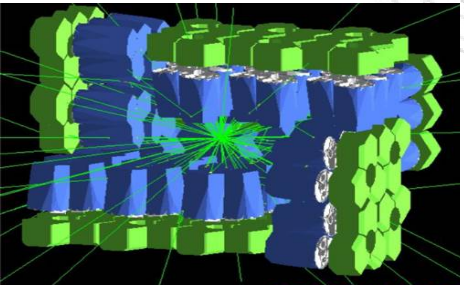
A very complex and complicated device

- Encapsulated HPGe crystals in a cryostat with electrical cooling.
- Minimal thermal losses
- High vacuum
- Integrated front-end and control electronics
- Imaging capability
- ...



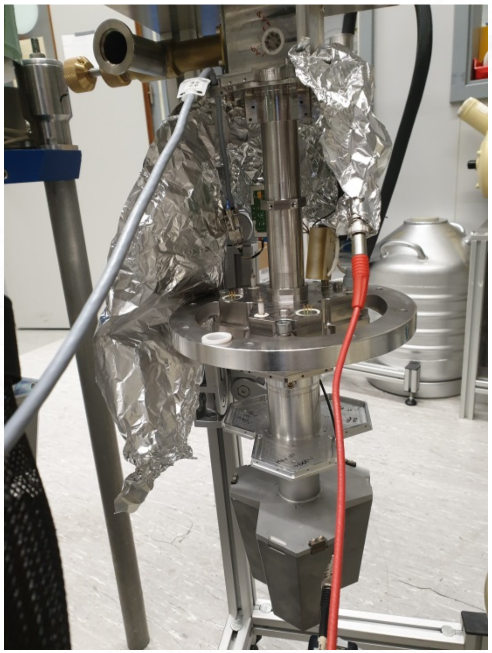


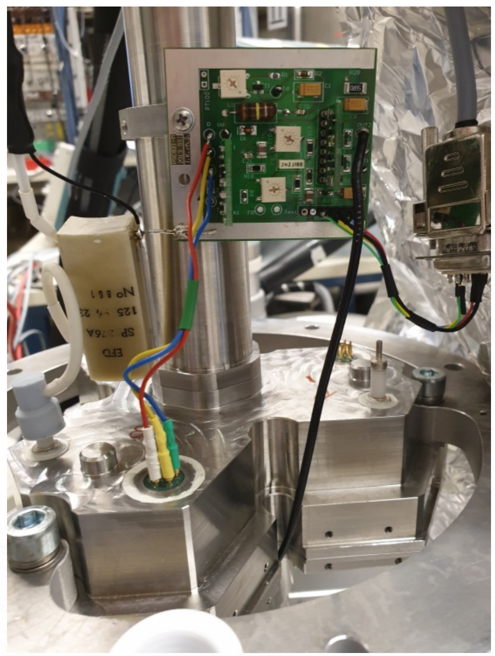
Commisioning of pre-series detector started

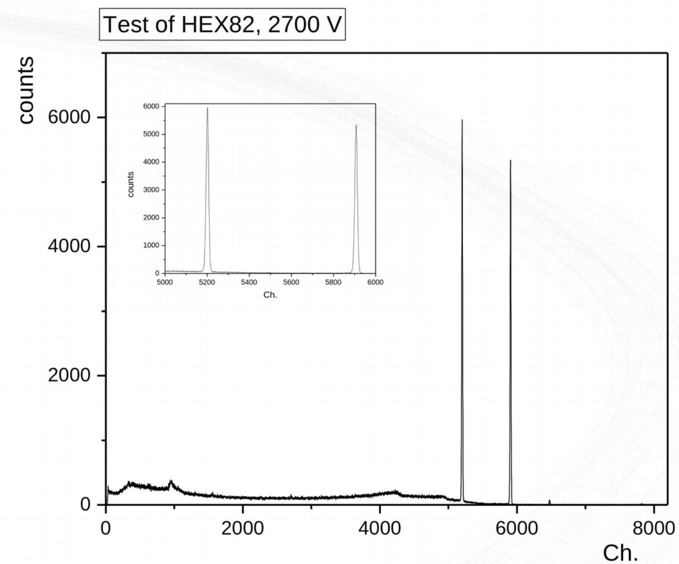


GSI - Germany
TIFR – India
ITÜ – Turkey
JSI - Slovenia

DEGAS test June 2019







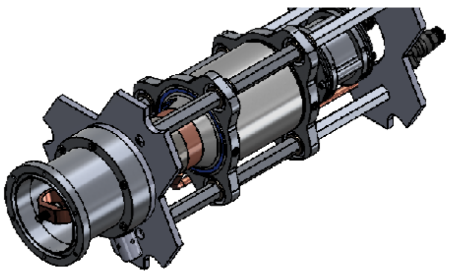
$\Delta E = 2.8$ keV

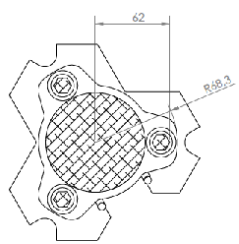
DEGAS I Critical Issues

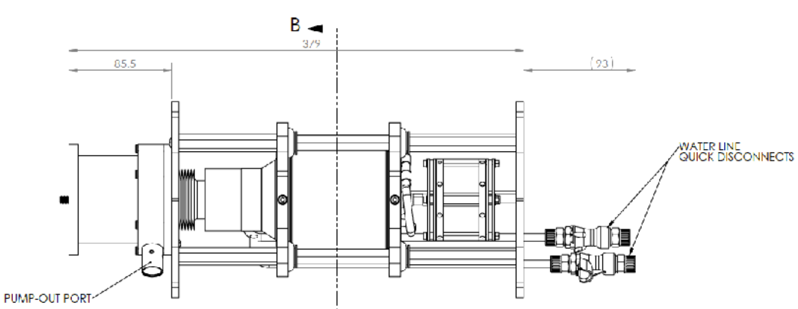
DEGAS Electrical cooling

X-Cooler production stopped!
Available X-Coolers are half-broken!!!
CT-cooler too noisy for Ge operation!

De-noising unit under development with ORTEC.





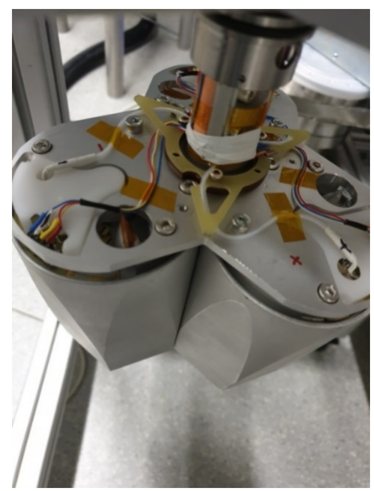


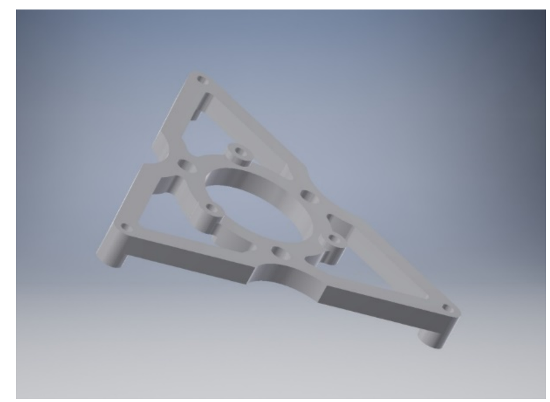
Delivery expected now

Remaining thermal losses

Thermal load of 10 W measured, while 7 W were expected from simulations and are needed to assure ≤ 155 °C at the crystals.

Reduced cold finger thickness and improved holding labyrinthin in preparation





Expected by end of October

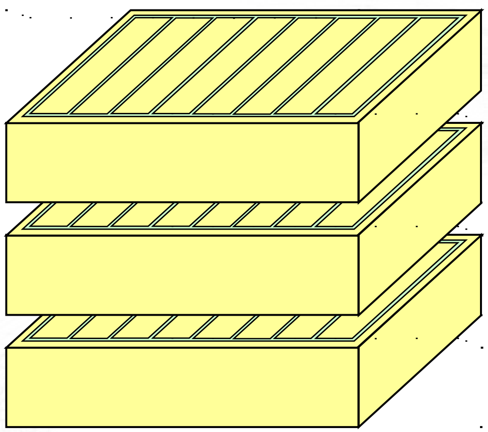
DEGAS I Time plan

2019 Test and improve prototype

2020 Assemble up to 5 Triples for runs in March-May
(*if e-cooling fails use LN2)*
Produce remaining 18 modules

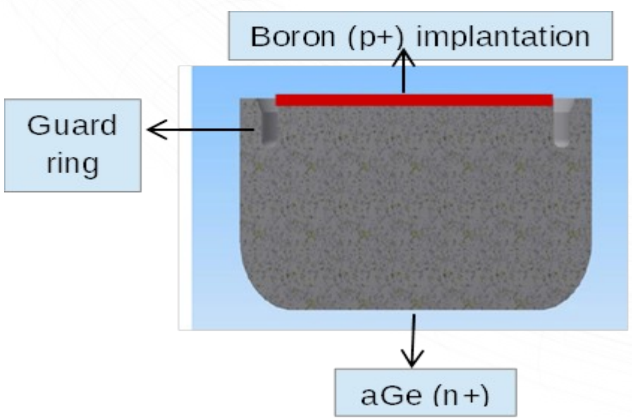
2021 Set up full DEGAS I for runs in Q2

DEGAS III Basic Idea



- Stack of 3 planar 2D stripe Ge detectors
- 68mm^2 x 68mm^2 x 20mm^2 + 2mm guard ring
- 6mm gap between crystals
- 8x8 segmentation
- 1 – 3 mm 3D position resolution with PSA
- Energy resolution: 0.2%

➡ **dead volume destroys performance**



Semi-planar structure

Amorphous Ge (aGe) blocking contact

➡ Negligible dead zone!

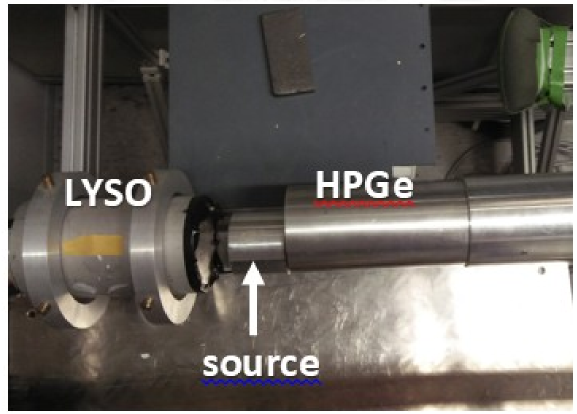
Semi-planar prototype

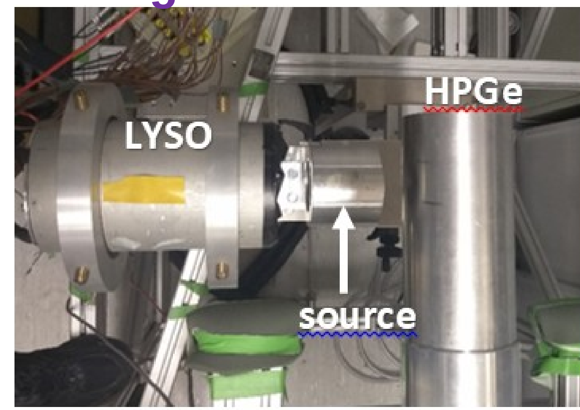
Non-segmented p-type HPGe crystal Volume: *33.2x33.2x15.5 mm³*

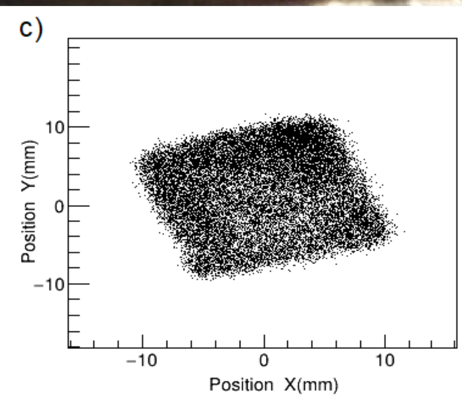
Carrier concentration 3.3x10⁹ *atom/cm³*

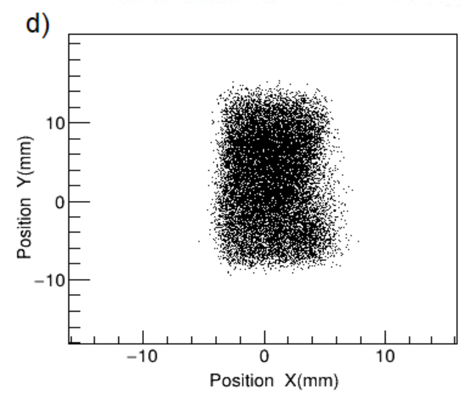
Crystal processed by SEMIKON FZ-Jülich

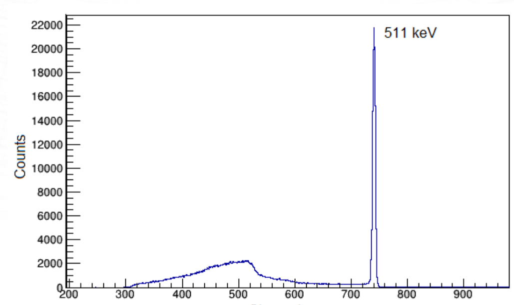
GSI Scanner investigations

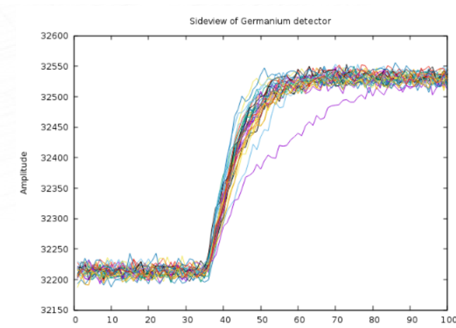




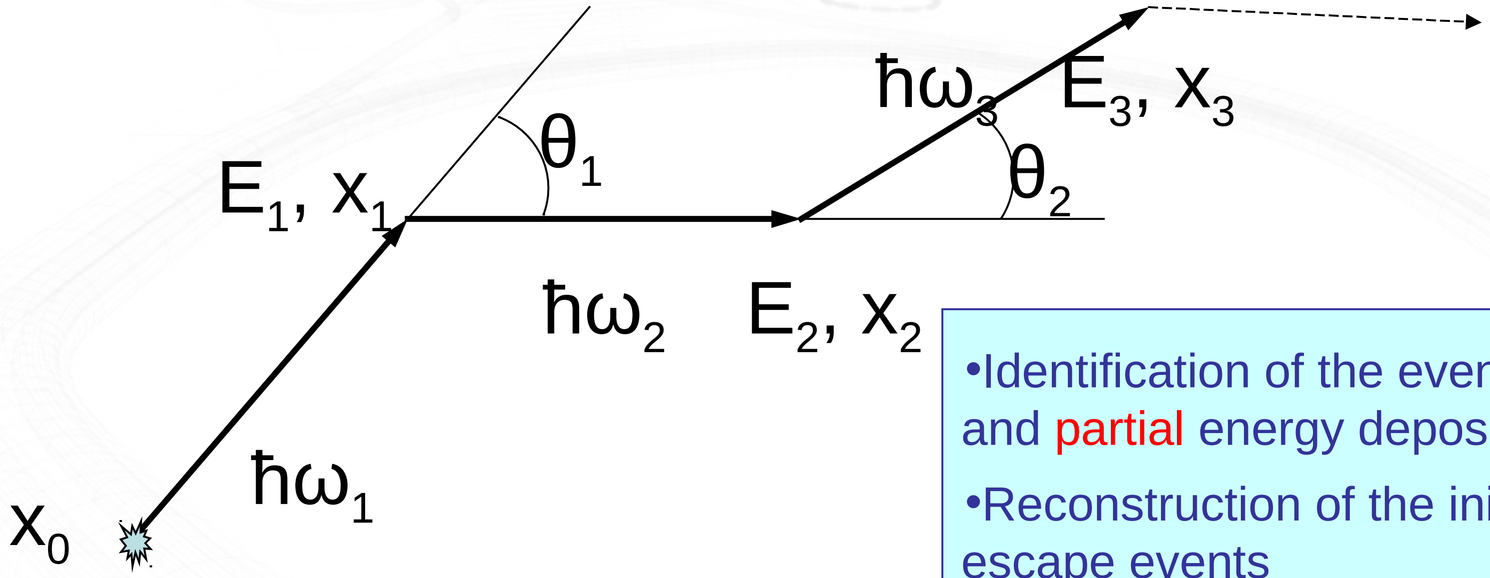








Tracking algorithm TANGO*



- Identification of the events with total and partial energy depositions
- Reconstruction of the initial energy for escape events
- Rejection of events from background sources

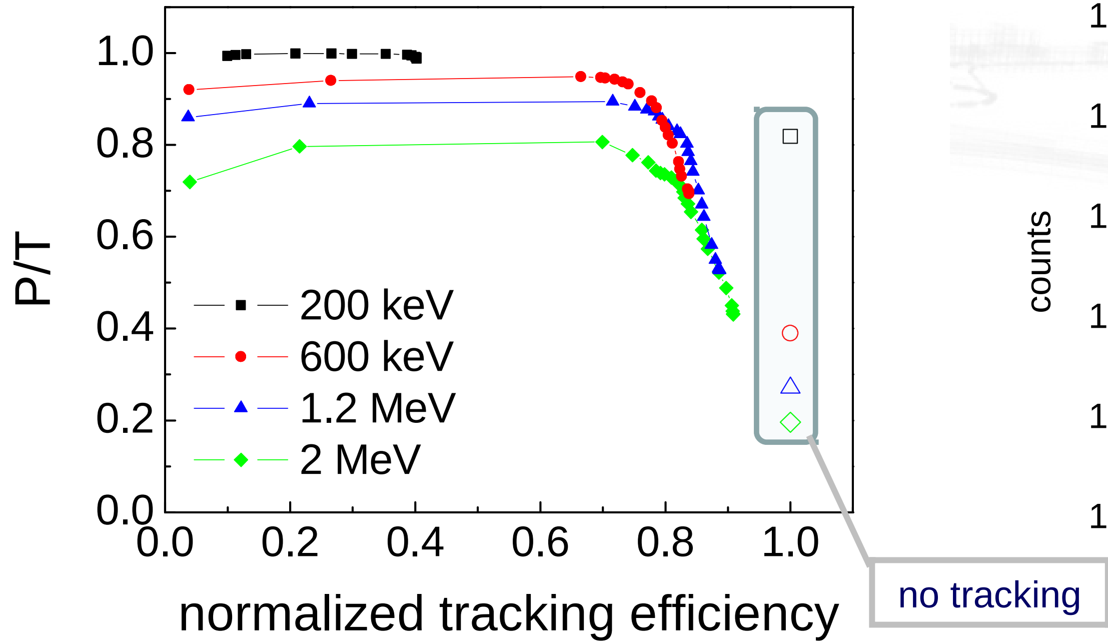
Construction of a “Figure of Merit”

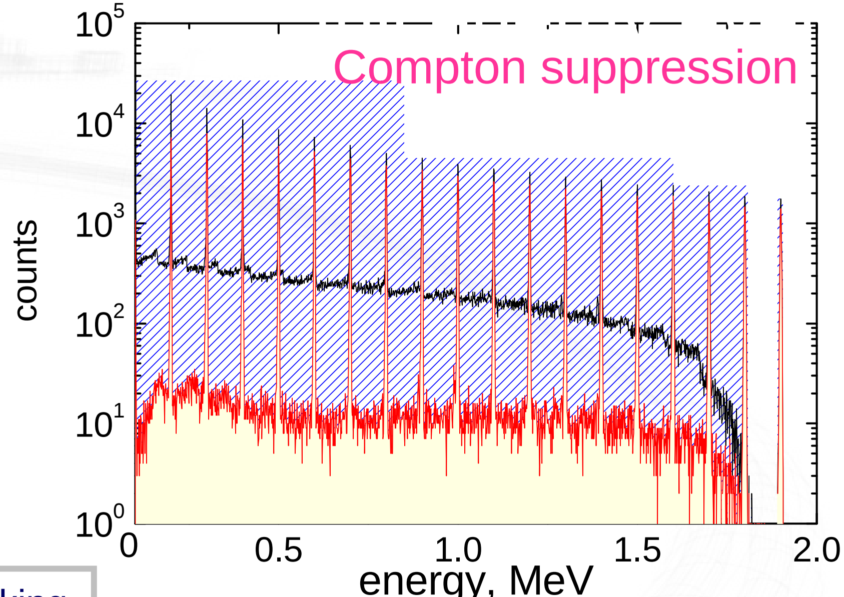
- for each possible order of interactions
- for the case of total and partial energy deposition
- probing the origin of the γ ray

Selecting the case with the maximum Figure of Merit

*S. Tashenov, J. Gerl, NIM A622 (2010) 592

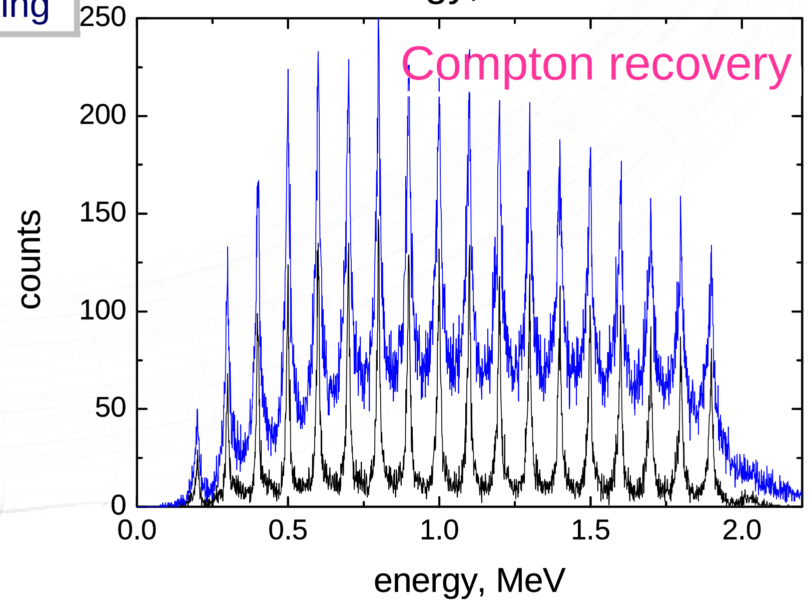
Tracking performance (@ 1mm res.)





Energy	**normalized** tracking efficiency		
MeV	full-energy	escapes	total
0.2	0.4	0.02	0.42
0.6	0.75	0.35	1.1
1.2	0.8	0.65	1.45
2	0.8	0.7	1.5

!!!



Conclusions

DEGAS I prototype is under testing

Remaining cooling issues need to be solved (urgently)

γ tracking/imaging is able to reduce the huge background in rare decay experiments

Efficient γ detector set-up with minimal dead volume is required

Semi-planar structure is under development for DEGAS III