Istituto Nazionale di Fisica Nucleare
LABORATORI NAZIONALI DI LEGNARO

Simulation of a Germanium detector array coupled to a superconducting solenoid (and particle tracking) from an off-centre position

Second ISOLDE Solenoidal Spectrometer Workshop,

27.-28.08.2019

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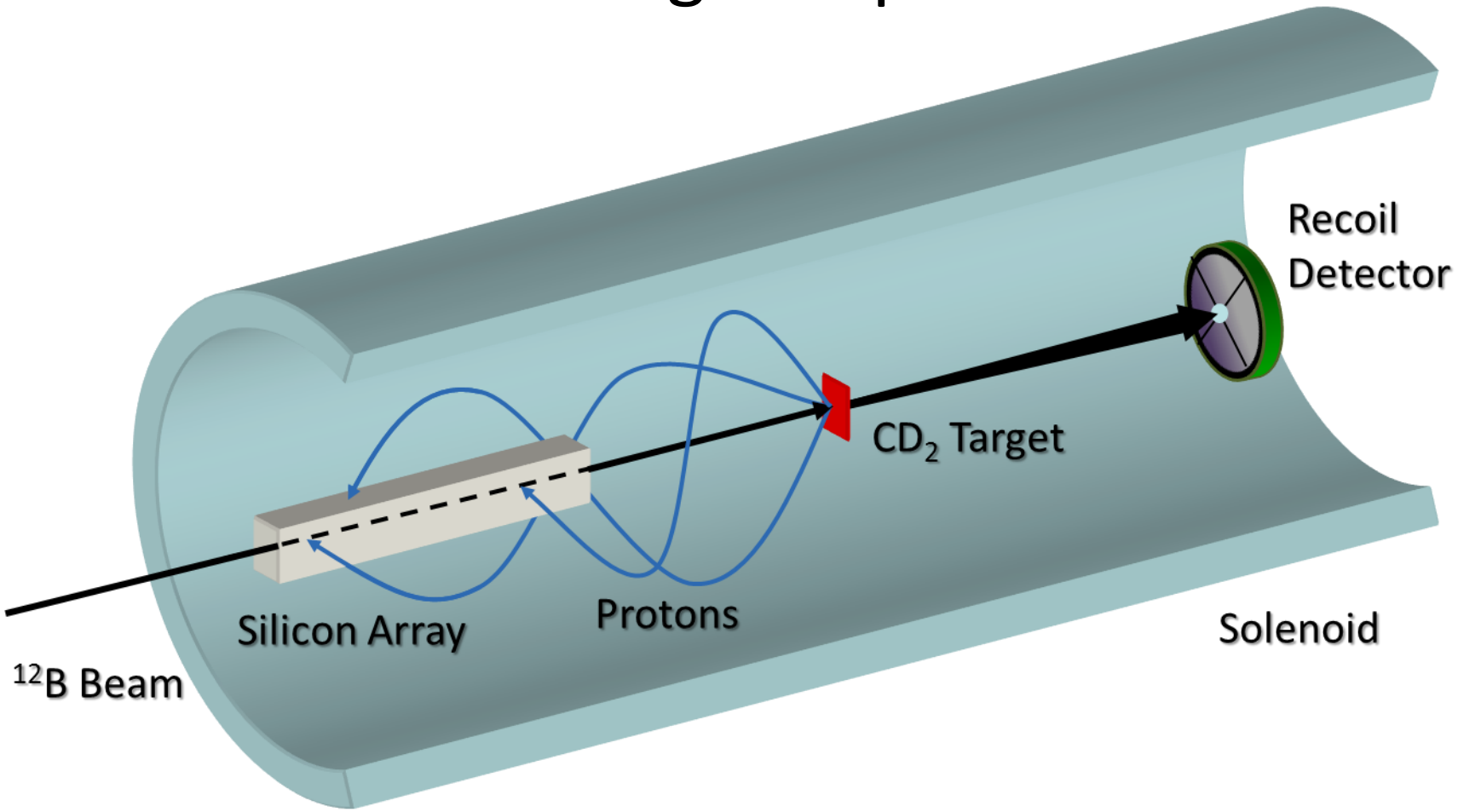
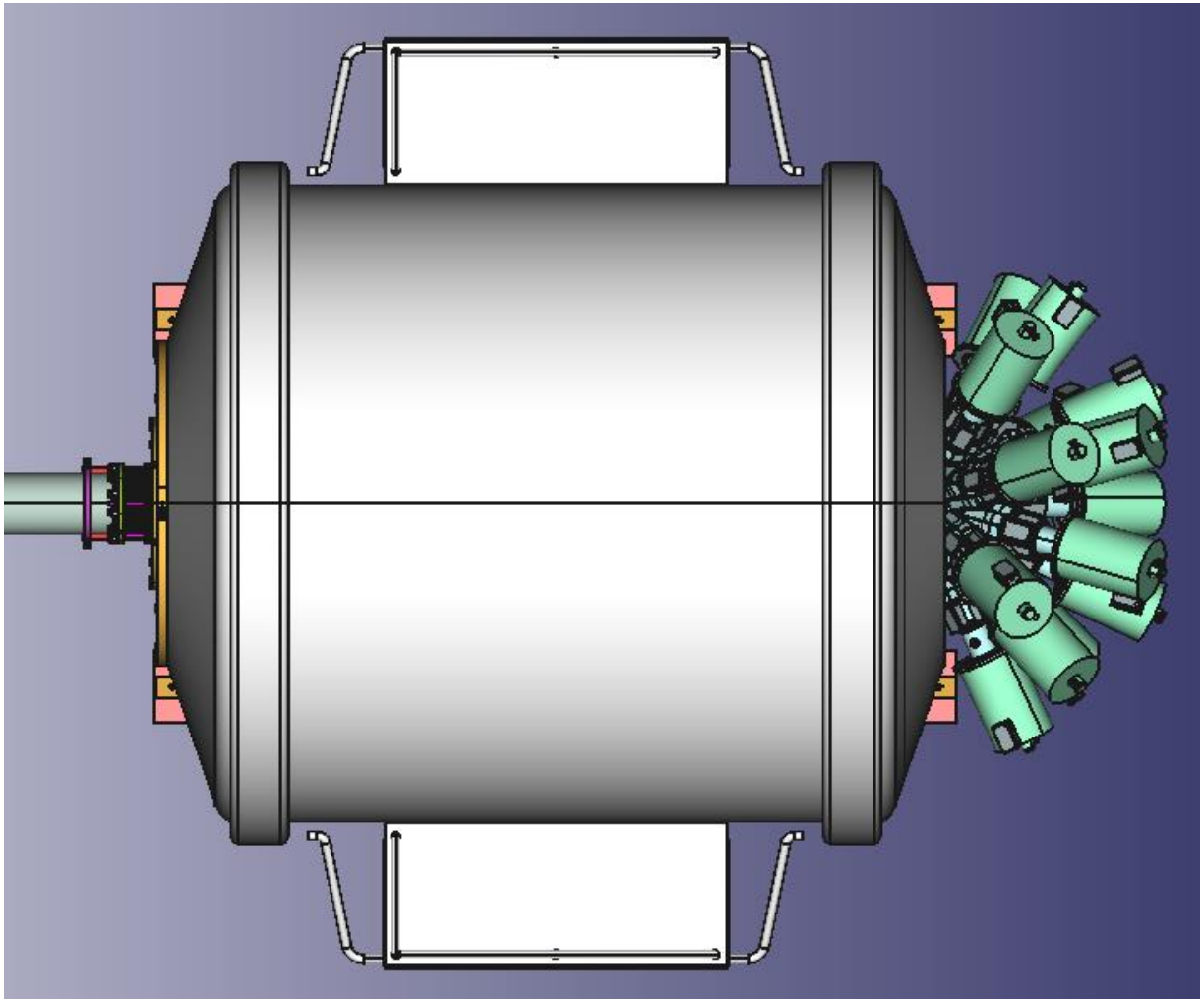
The Project
Solenoidal Magnet Spectrometer



Source: Results from HELIOS

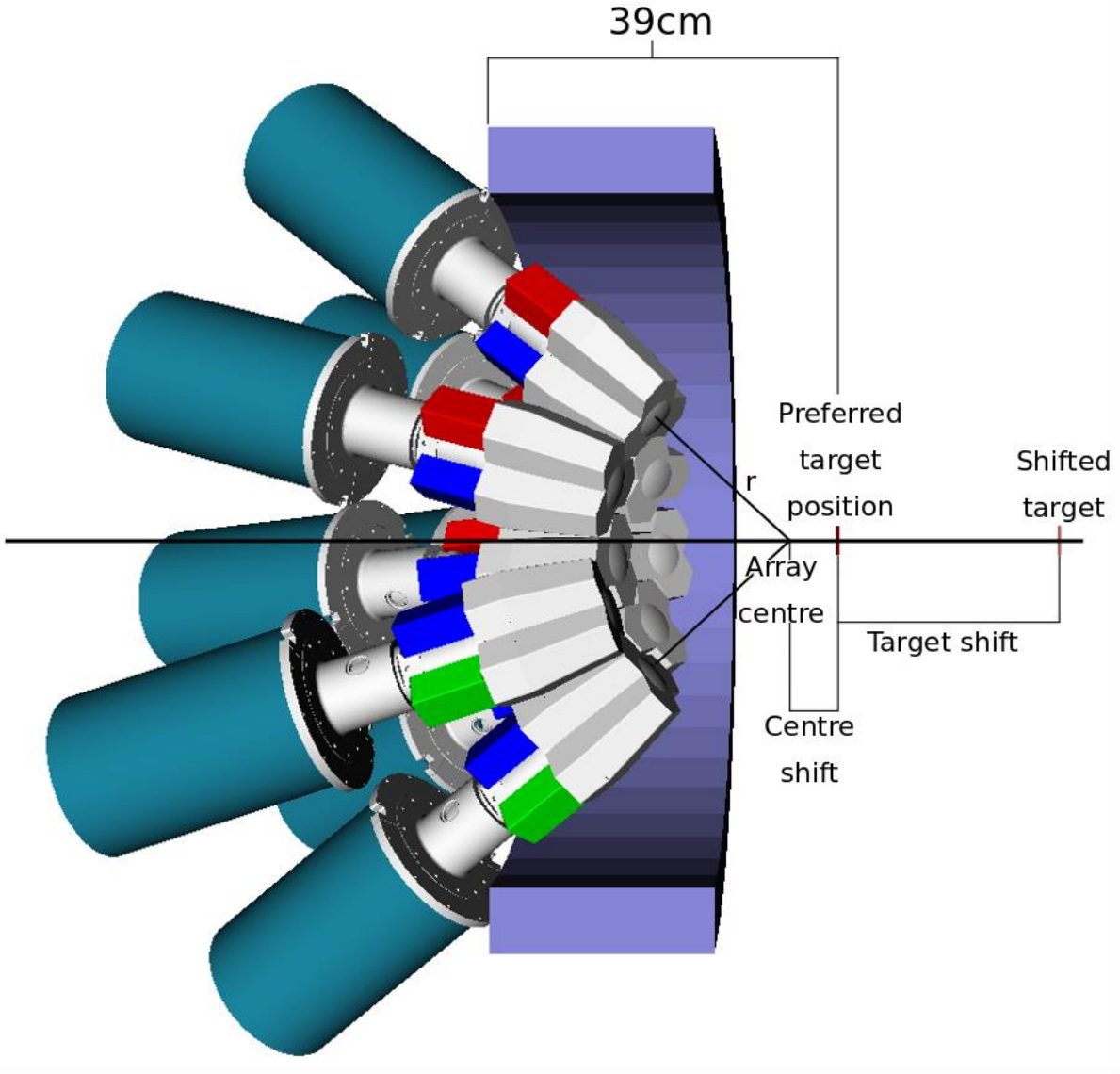
The Project
Basic setup



The setup
Basic setup

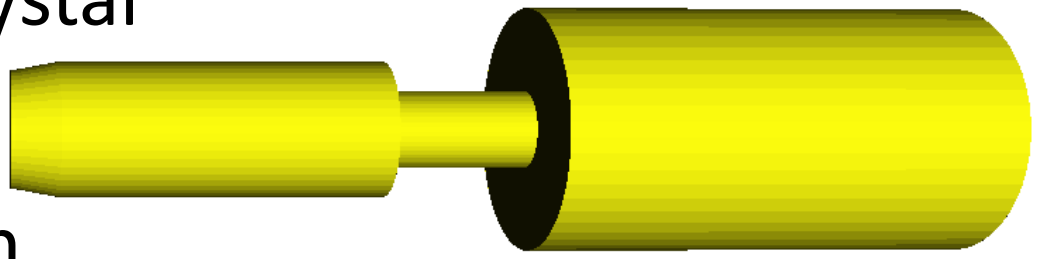
- GASP or TC detectors
- Try to keep the geometry flexible
- No Anti-Compton shields (size)
- Magnet inside diameter: 92.4cm
- Nominal limit of the uniform field: 39cm
  - Preferred target position

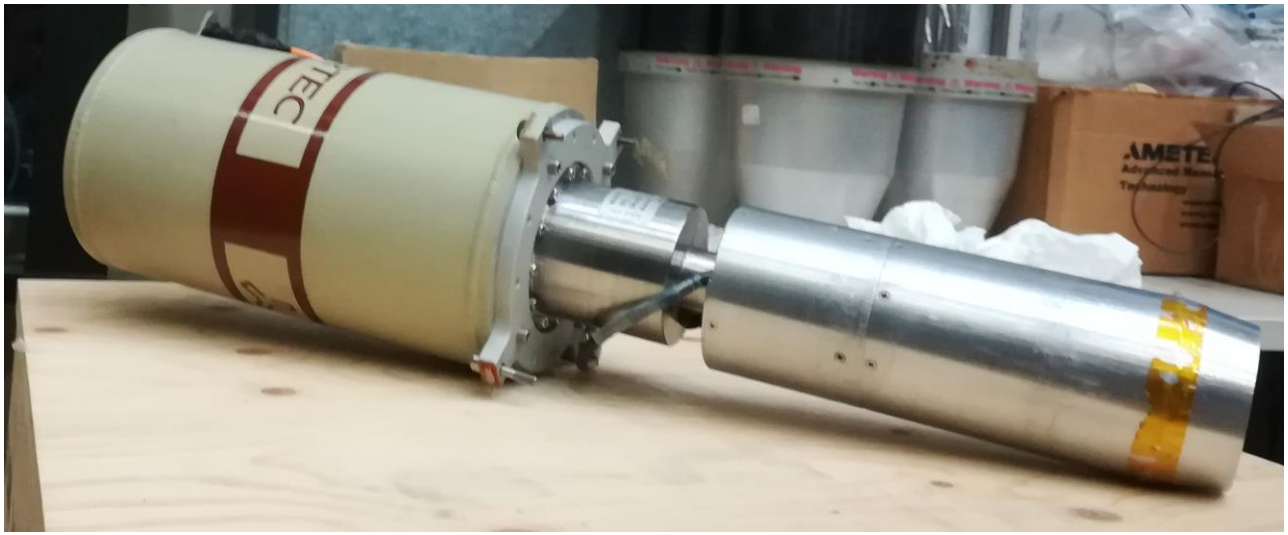
The Setup
Basic setup



The Project
GASP detectors

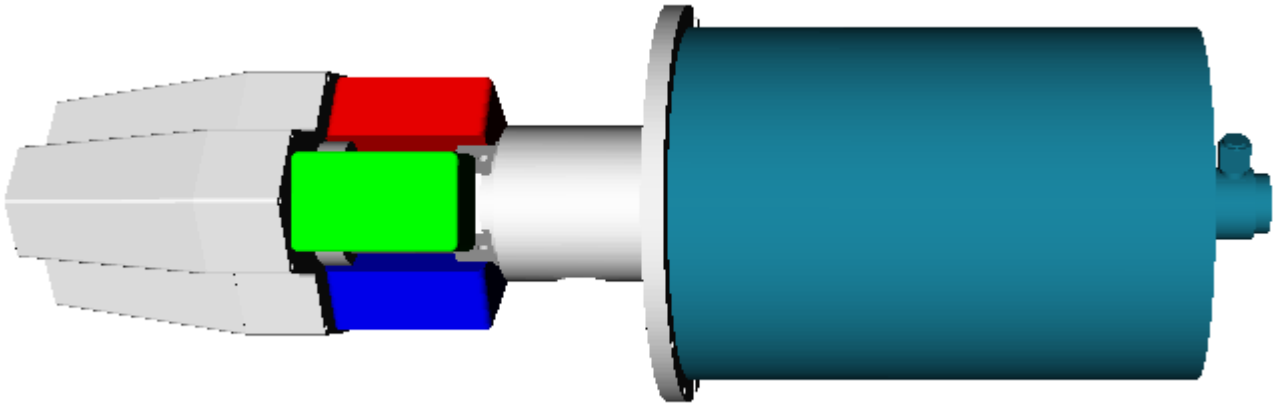
- Single cylindrical crystal
- Length: 82mm
- Diameter: 61-72mm



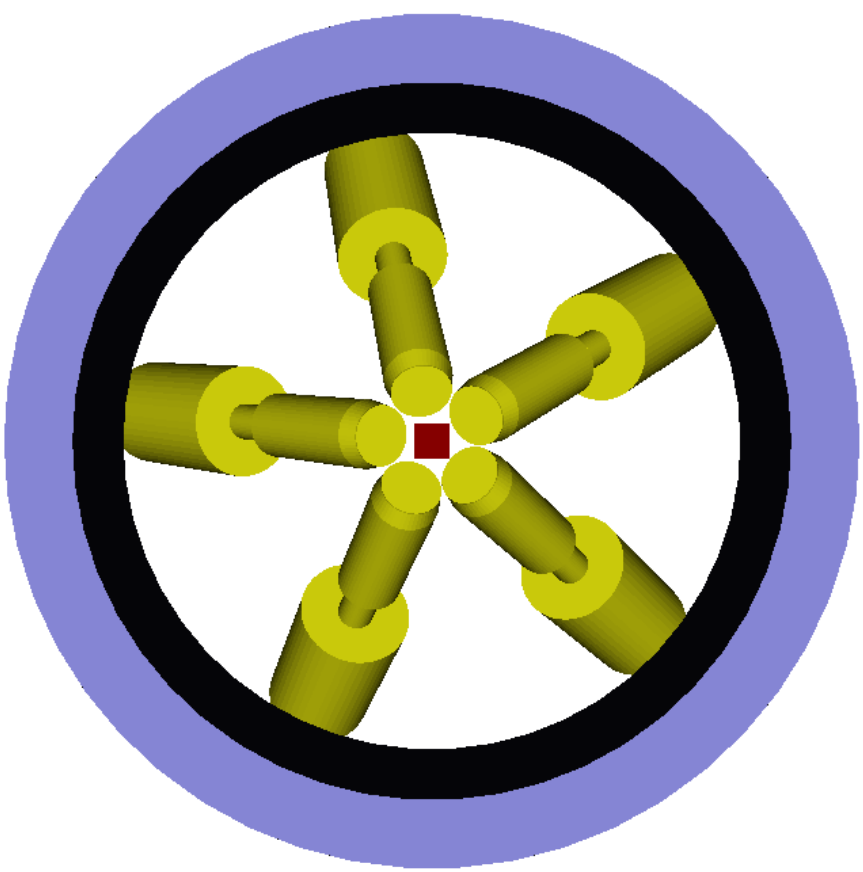


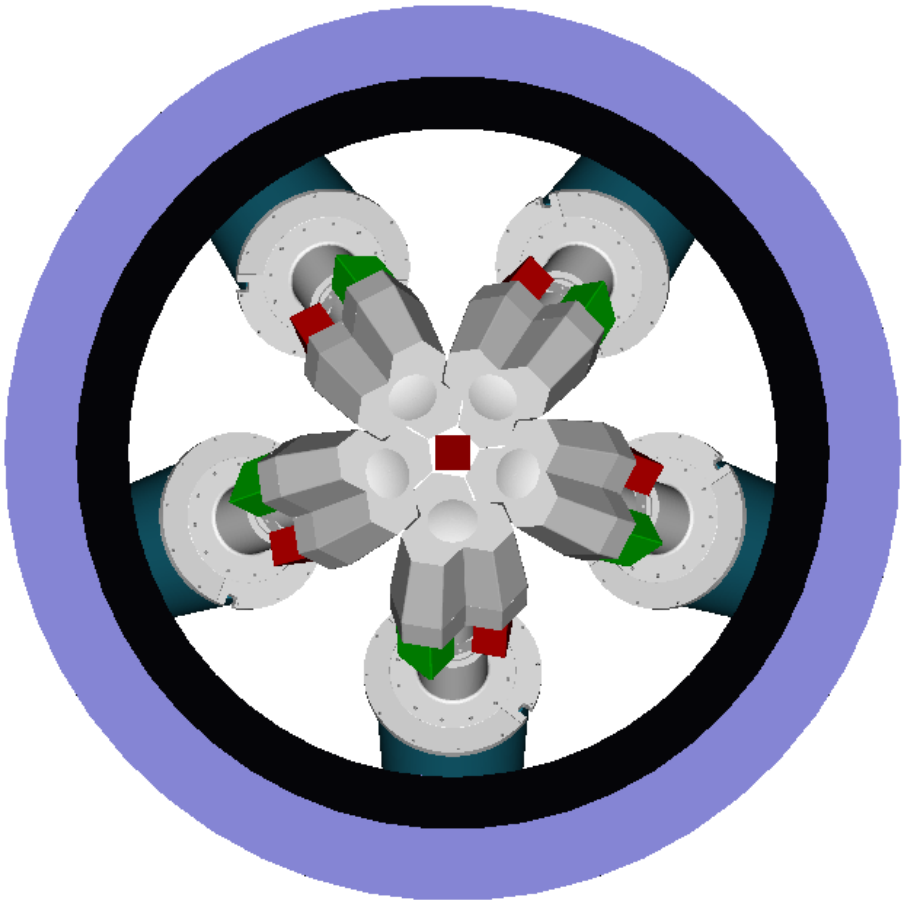
The Project
Triple cluster detectors

- Built from three EUROBALL crystals
- Hexagonal crystals
- Length: 68mm
- Diameter: 48.5-58.9mm

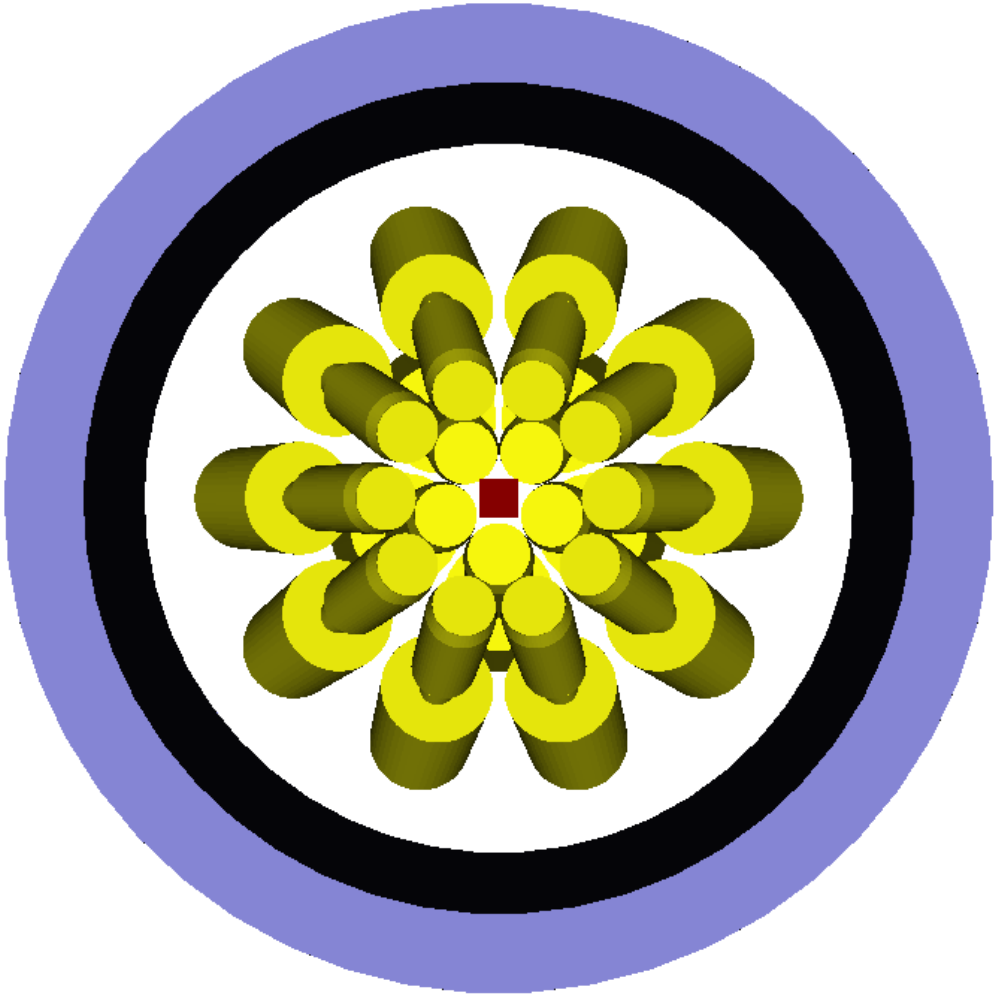


The Setup
5 detectors

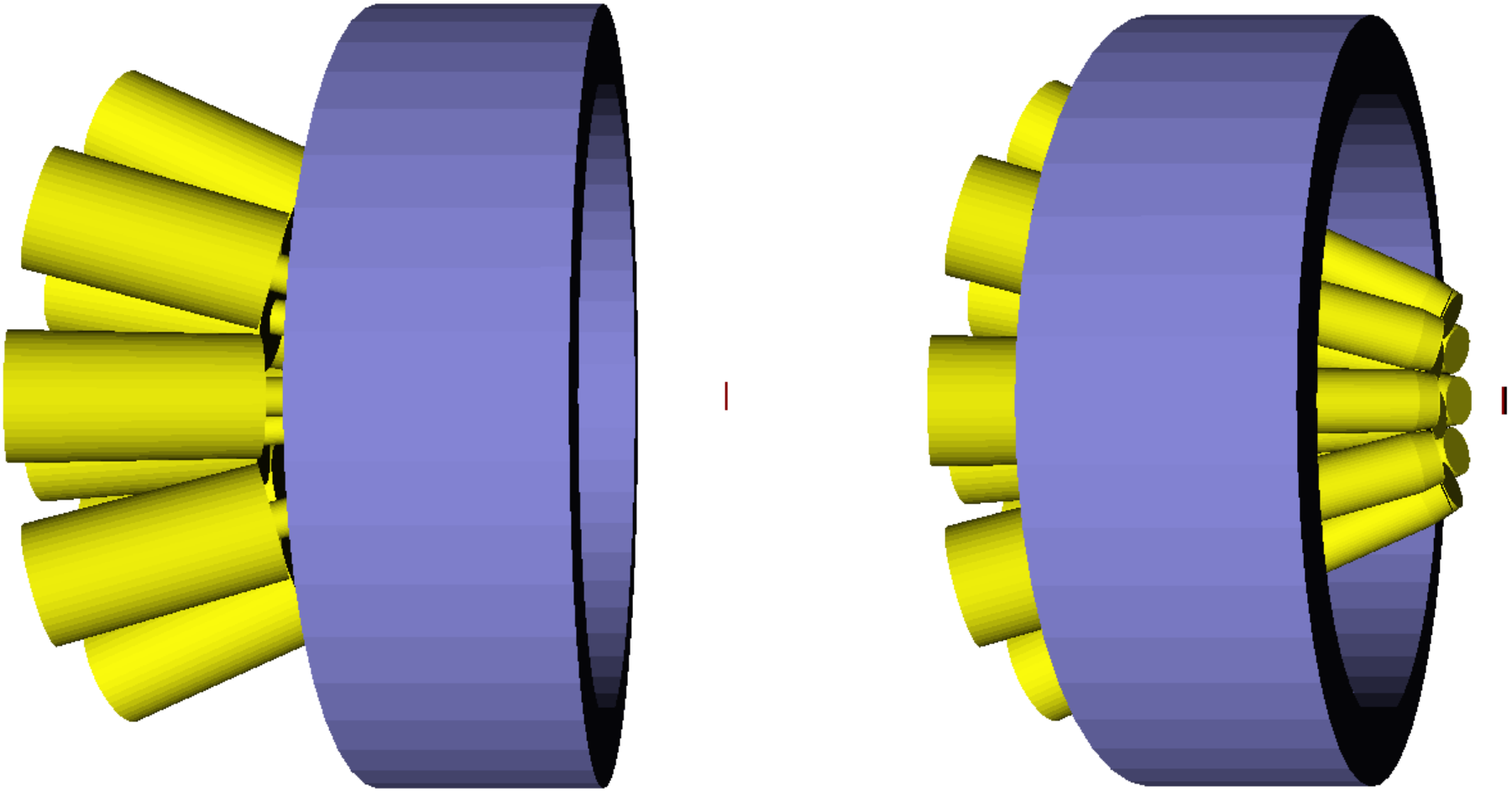




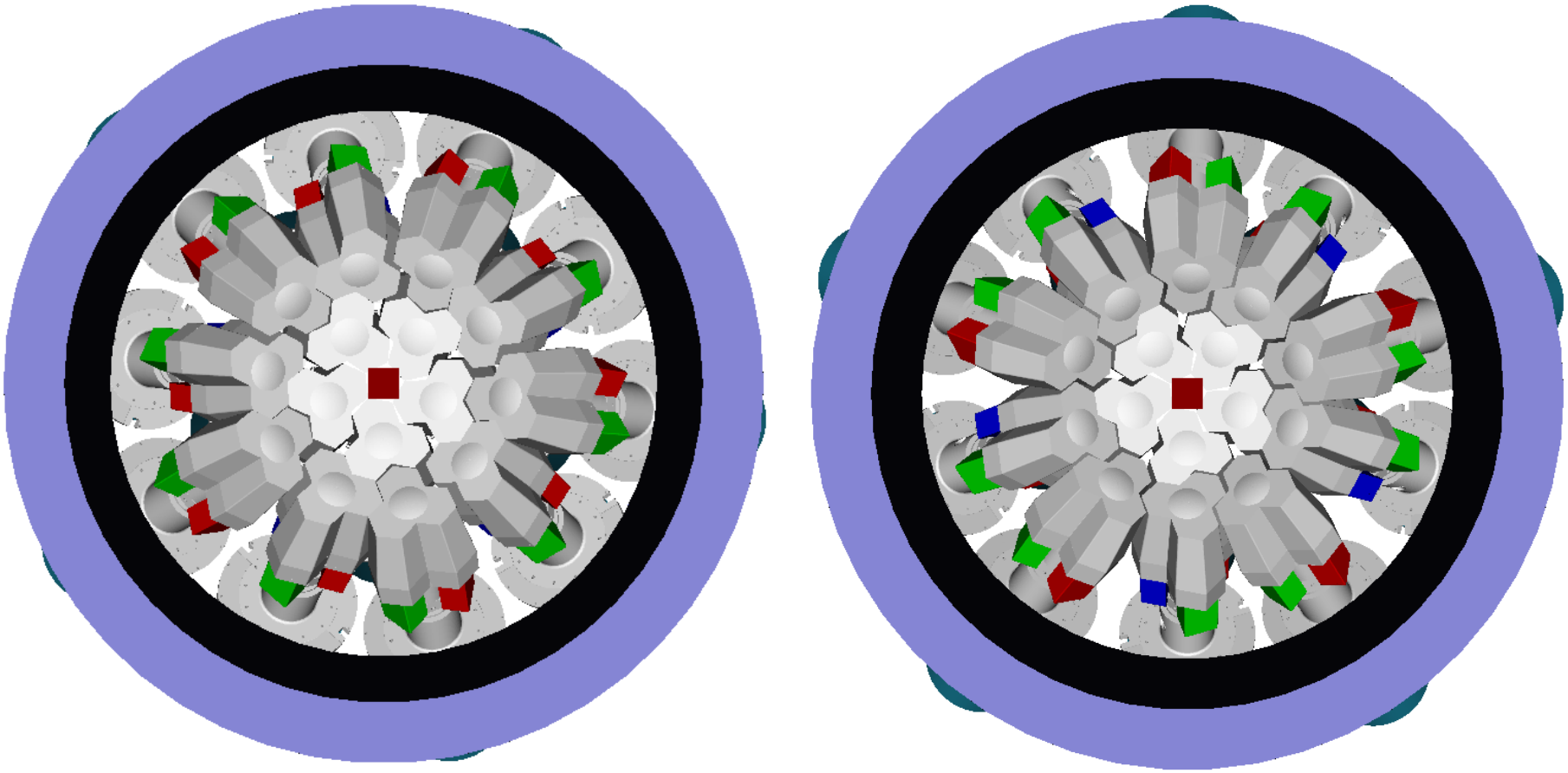
The Setup
15 GASP detectors



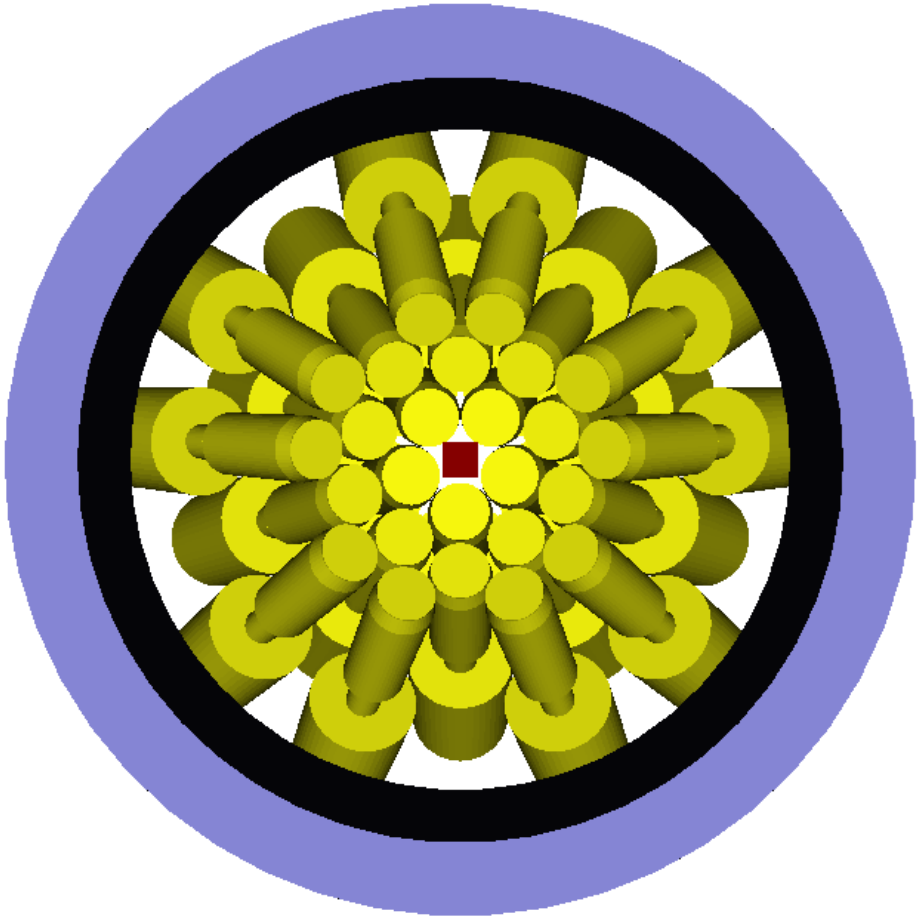
The Setup
15 GASP detectors

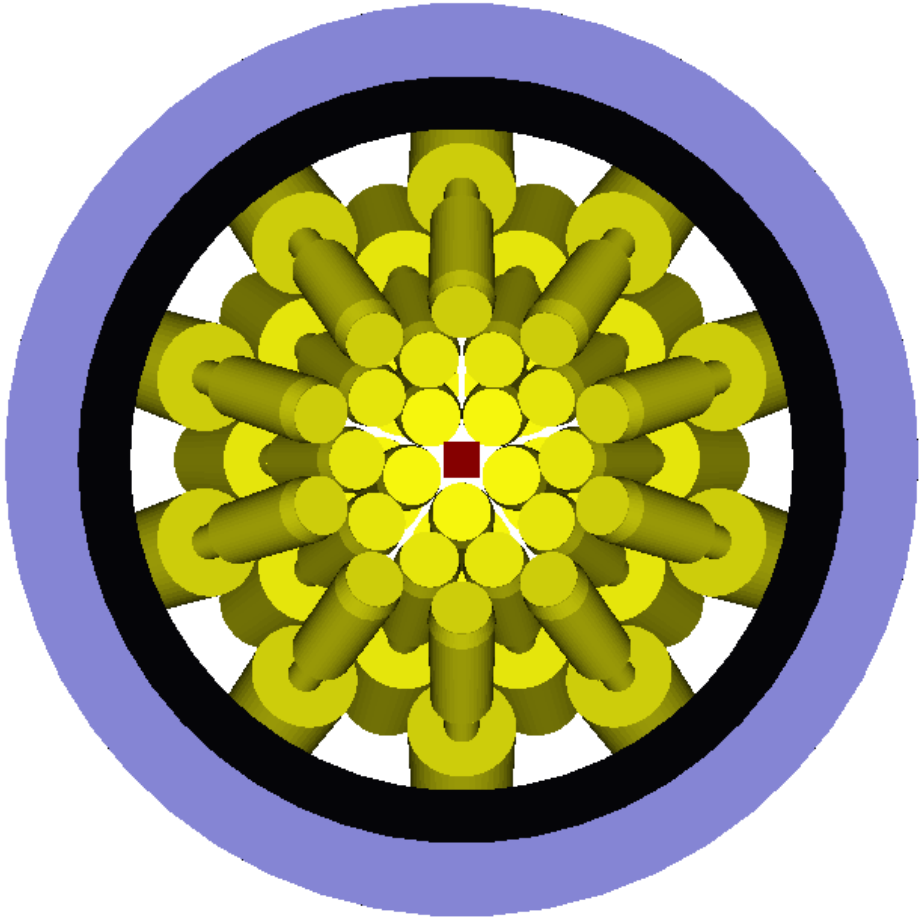


The Setup
15 TC detectors

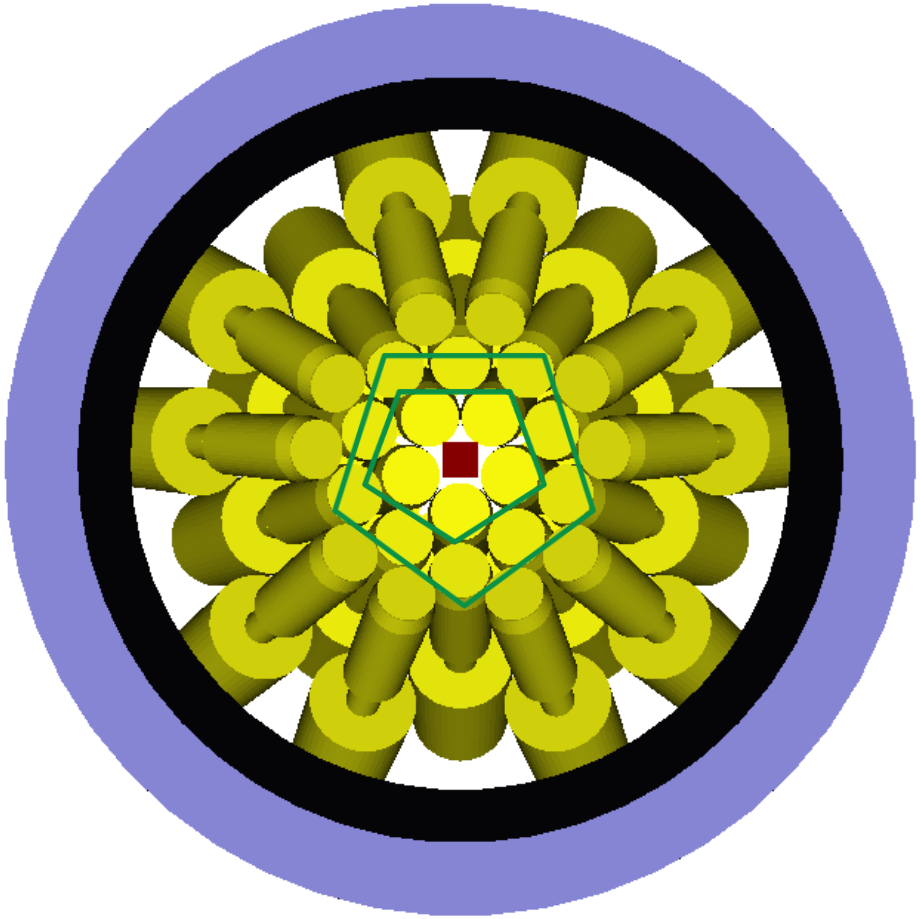


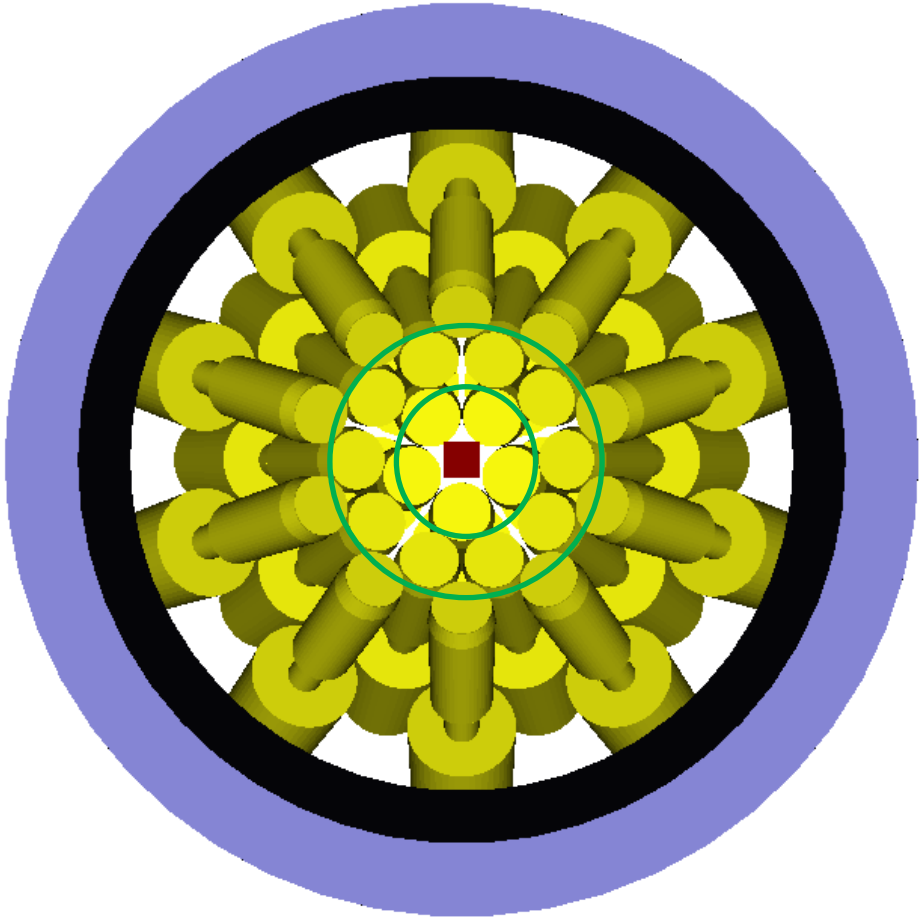
The Setup
25 GASP detectors





The Setup
25 GASP detectors



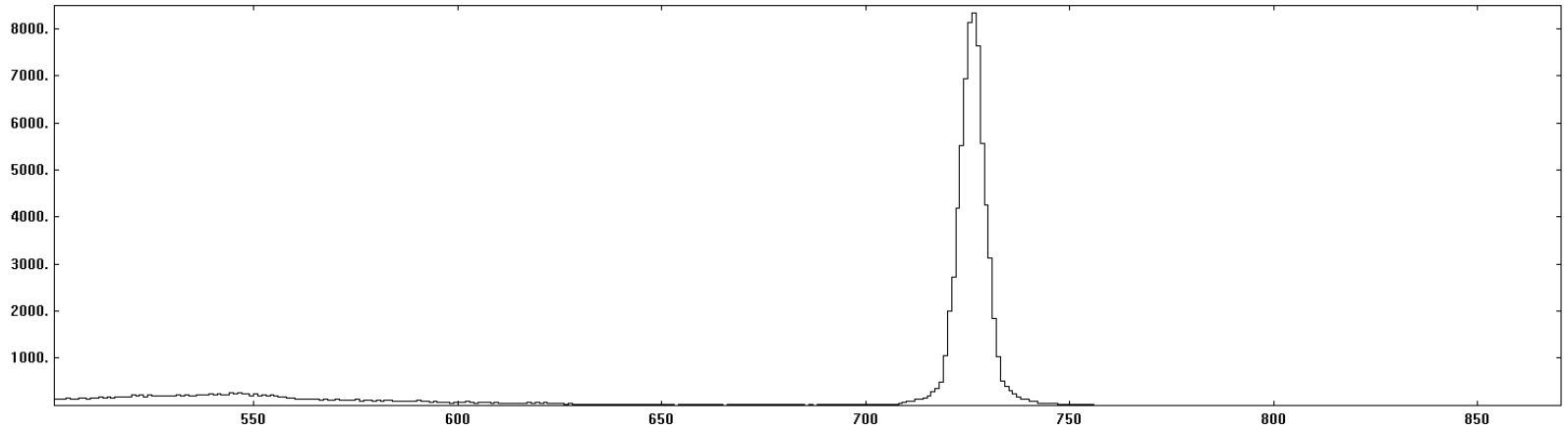


Performance simulation

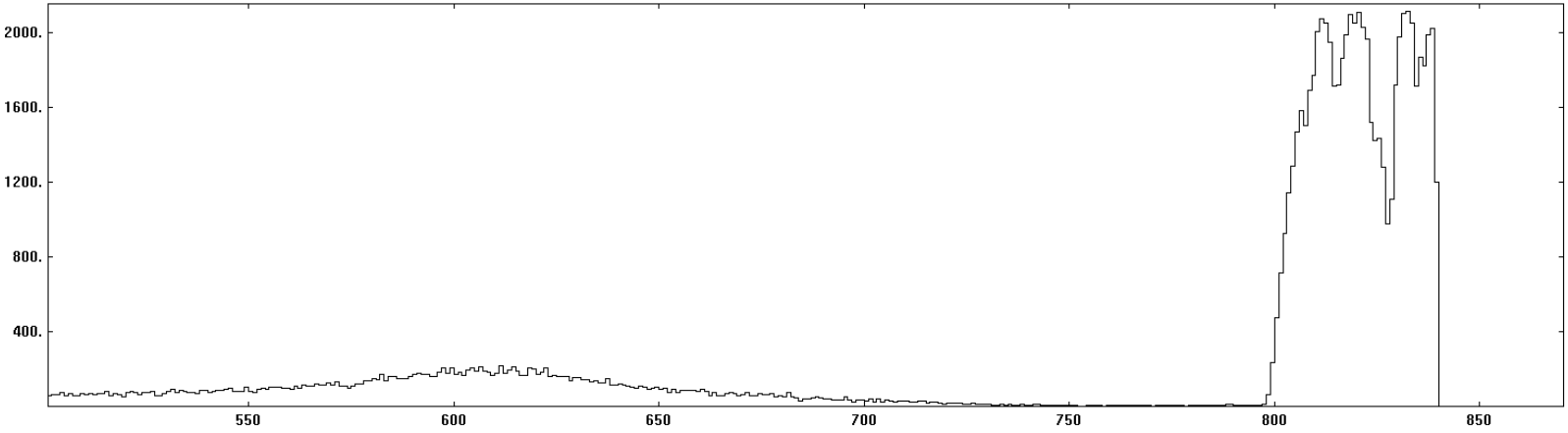
- Assuming a $^{133}Sn(d,p)^{134}Sn$ reaction as surrogate of (n,γ) in r-process
- First 2^+ in ^{134}Sn: 725.6 keV
- Beam energy: 10 MeV/u
- β=14.54%
- Efficiency and Doppler effect

Performance simulation

- Efficiency

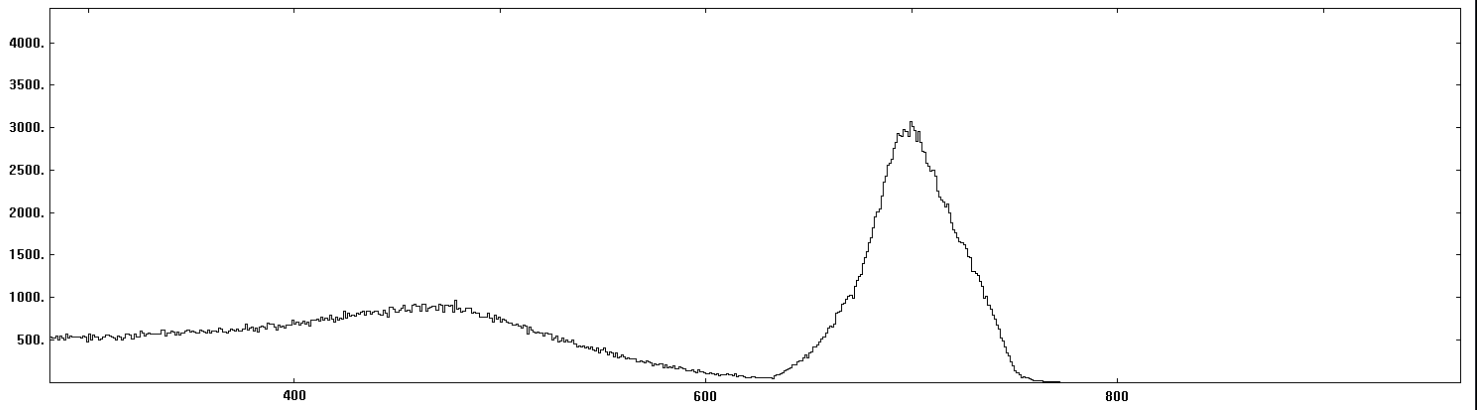


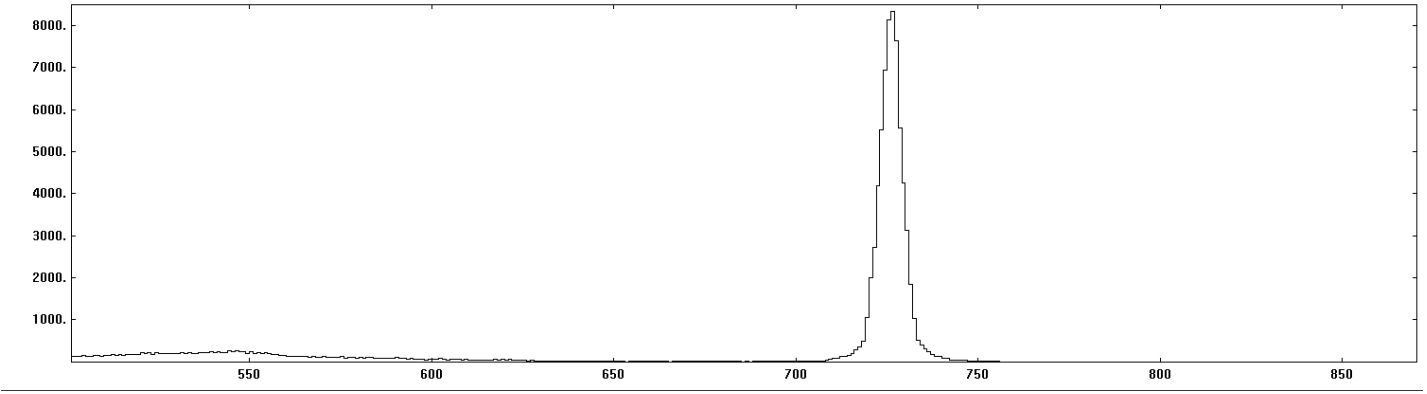
- Doppler effect



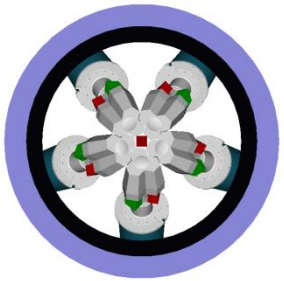
Performance simulation

- How close can to the detectors can the target be put before the resolution gets too bad?
  →Compromise between efficiency and resolution

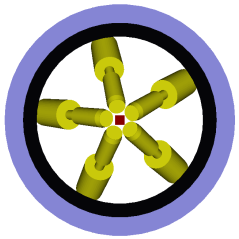




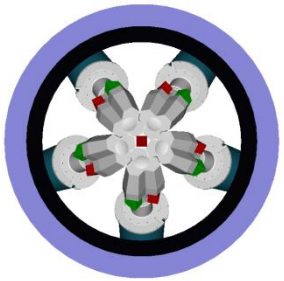
Results
5 detectors



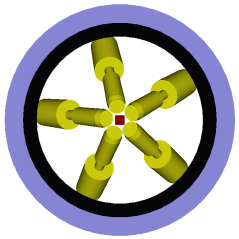
Geometry	Detectors used	Target position [cm]	Target shift [cm]	Efficiency [%]	Resolution [%]
5TC	TC			4.6	2.1
5GASP	GASP			3.7	3.7



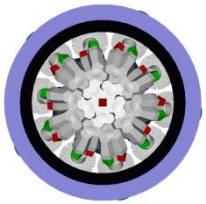
Results
5 detectors



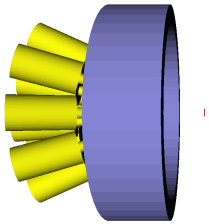
Geometry	Detectors used	Target position [cm]	Target shift [cm]	Efficiency [%]	Resolution [%]
5TC	TC			4.6	2.1
5TC	GASP	Preferred		6.0	6.1
5TC	GASP	Array centre	-5.0	3.3	3.3
5GASP	GASP			3.7	3.7
5GASP	TC	Preferred		4.7	1.5
5GASP	TC	Array centre	+5.0	7.3	2.6



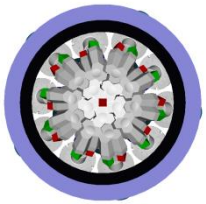
Results
15&25 detectors



Geometry	Detectors used	Target position [cm]	Target shift [cm]	Efficiency [%]	Resolution [%]
15TC	TC	Preferred		5.6	0.9
15TC	TC	Array centre	+3.0	6.3	1.0
15GASP	GASP			1.8	0.5

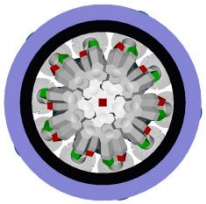


Results
15&25 detectors



Geometry	Detectors used	Target position [cm]	Target shift [cm]	Efficiency [%]	Resolution [%]
15TC	TC	Preferred		5.6	0.9
15TC	TC	Array centre	+3.0	6.3	1.0
15TC	GASP	Preferred		2.9	1.0
15TC	GASP	Array centre	+4.0	3.9	1.2
15GASP	GASP			1.8	0.5

Results
15&25 detectors



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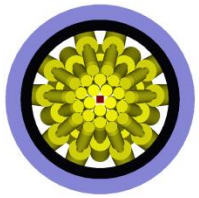
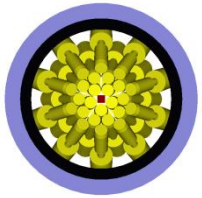
15TC	TC	Preferred		5.6	0.9
15TC	TC	Array centre	+3.0	6.3	1.0
15TC	GASP	Preferred		2.9	1.0
15TC	GASP	Array centre	+4.0	3.9	1.2
15GASP	GASP			1.8	0.5
25GASP-v1	GASP			3.1	0.8
25GASP-v2	GASP			3.2	0.8

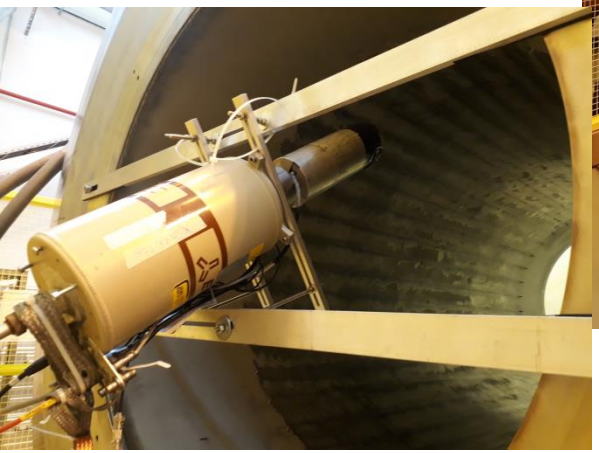
Results – 2% Resolution
5 detectors

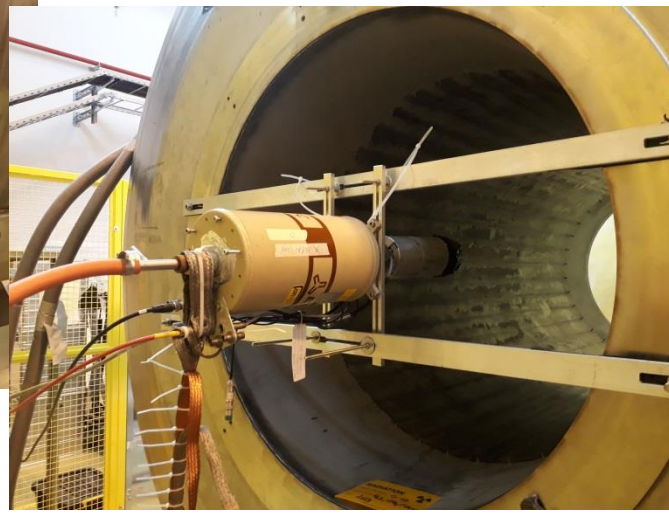
Geometry	Detectors used	Efficiency [%]	Target shift [cm]
5TC	TC	4.3	-1.0
5TC	GASP	2.0	-5.0
5GASP	GASP	2.0	-6.0
5GASP	TC	6.1	-2.0

Results – 2% Resolution 15&25 detectors

Geometry	Detectors used	Efficiency [%]	Target Shift [cm]
15TC	TC	8.3	+14.5
15TC	GASP	5.8	+9.5
15GASP	GASP	6.1	+17.5
25GASP-v1	GASP	8.1	+15.0
25GASP-v2	GASP	7.8	+15.0

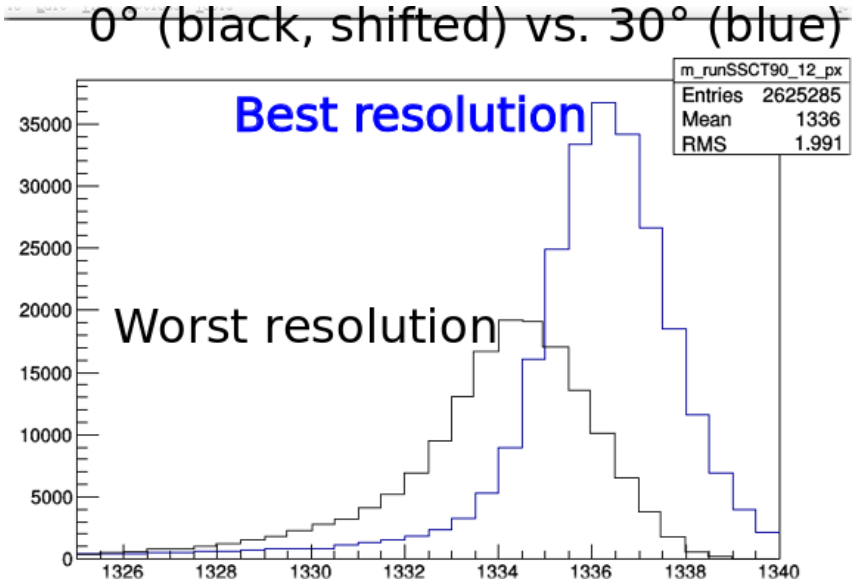
Detector Test





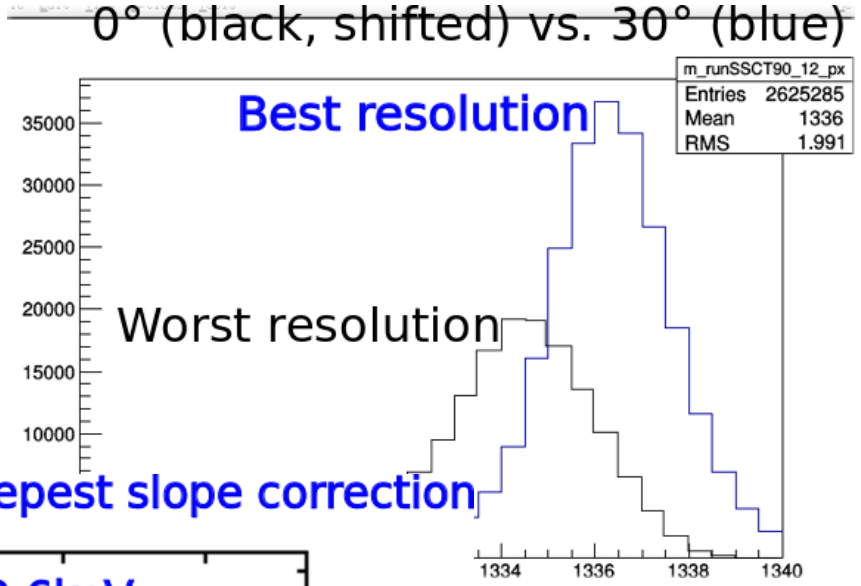
Detector Test

- Best case: 30°
- Worst case: 0°

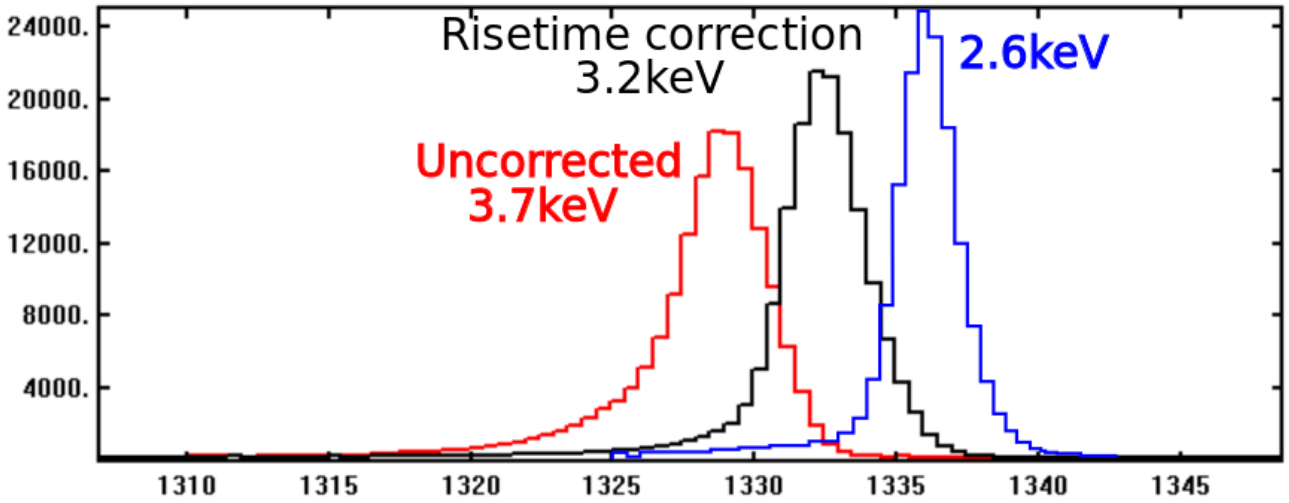


Detector Test

- Best case: 30°
- Worst case: 0°



Risetime and steepest slope correction

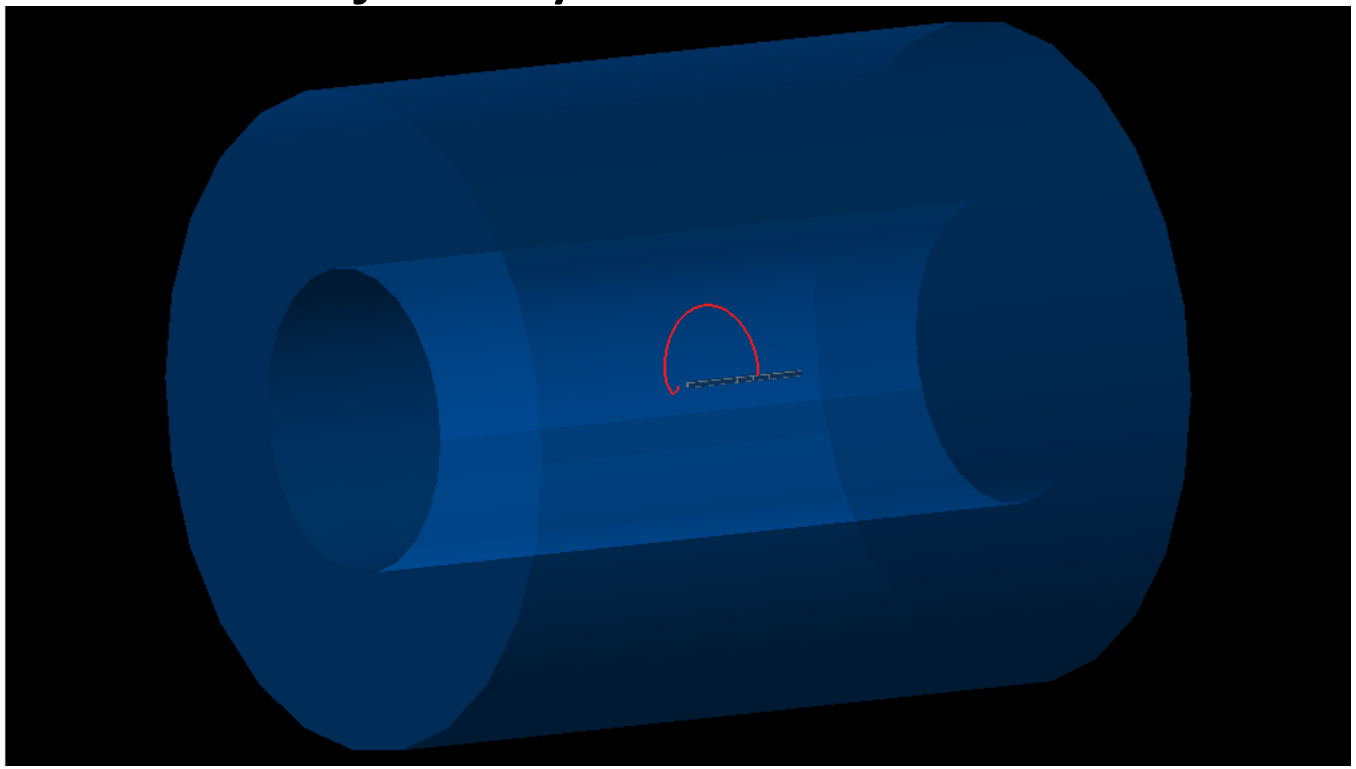


Summary

- Project: Combine a solenoidal spectrometer with a germanium detector array
- Geometries with 5, 15 and 25 GASP or TC detectors investigated
- Efficiency and Doppler effect simulations
- Suggests several geometries are usable
- GASP detector test promising

Outlook

- Particle trajectory simulations



  - Can the target even be moved further out?
    - Will the trajectories converge on the detectors?
    - What are the effects on the particle energy resolution?

Thank you for your attention!