A new cryogenic target at LNL: CTADIR project

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Outline

- Scientific motivation
- Target design
- Performance
- Commissioning experiment

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Scientific motivation

- Direct reactions are used to study the single-particle structure and shell evolution
- Cross section angular distributions of single-particle transfer reactions provide the overlap between the initial and final states of the reaction
- Compare to (d,p), reaction with He can populate both single-particle and core-coupled states
- Inelastic scattering of the beam on a ^{4}He target allows one to study the Pygmy Dipole Resonance isoscalar component
- ISOL facilities - impinging the radioactive ion beam on the light target
- Requirements: high purity He with desired thickness 10^{20} at/cm^{2}
- Cryogenic TArget for DIrect Reaction (CTADIR) project has been developed with the idea of coupling it to detector arrays like AGATA and GRIT
- Path for the study of direct reactions with exotic nuclei and inelastic scattering studies at LNL

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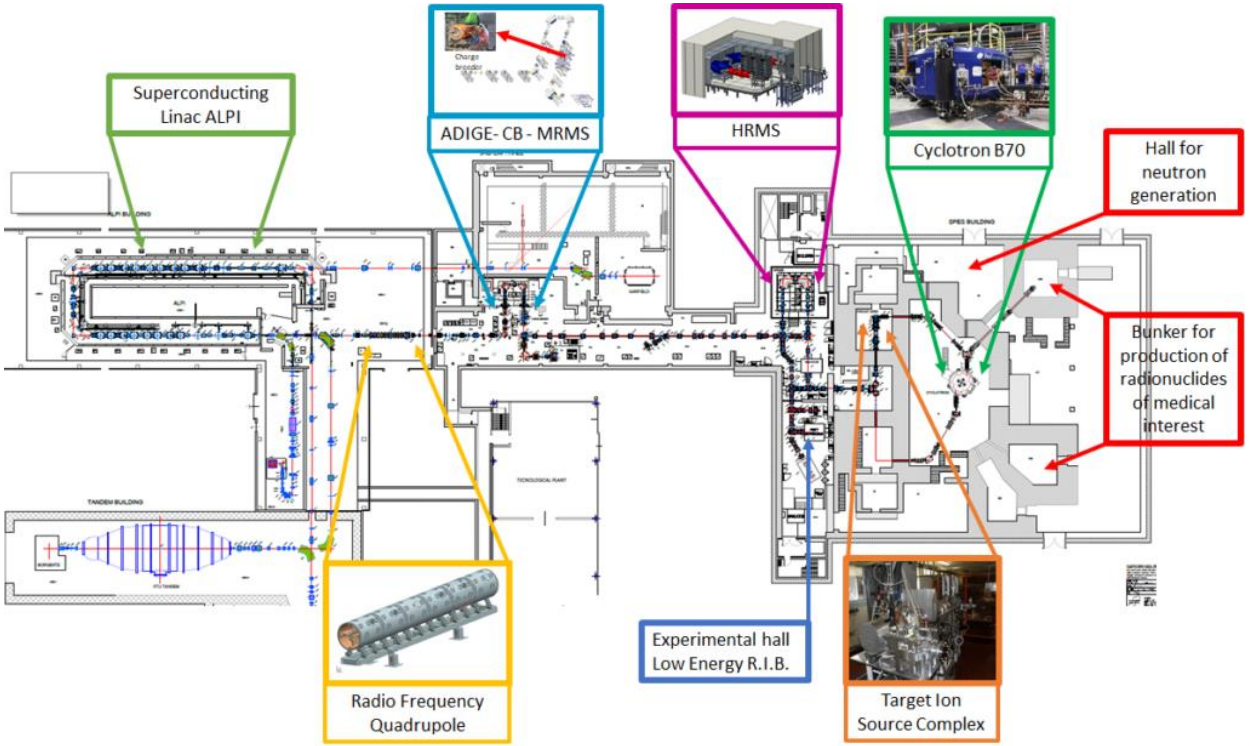
SPES@LNL

- **S**elective **P**roduction of **E**xotic **S**pecies
- Second generation ISOL system - neutron rich beams
- Post acceleration to 10-15 MeV/u

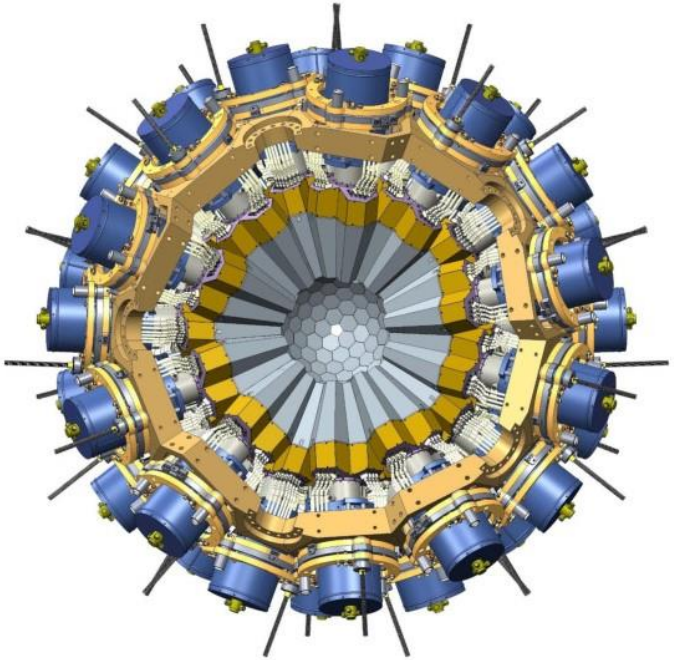
- The SPES project is divided into the following 4 phases:
- SPES-alpha: production and delivery to the target of Cyclotron proton beams
- SPES-beta: production and acceleration of radioactive ion beams with the ISOL technique
- SPES-gamma: production of radionuclides of medical interest
- SPES-delta: generation of neutron sources

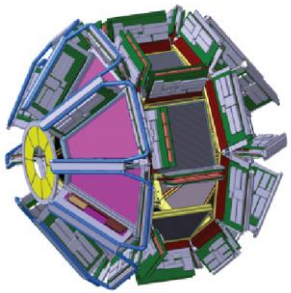
SPES@LNL

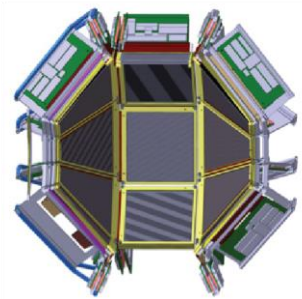


AGATA + GRIT

- **A**dvanced **GA**mma **T**racking **A**rray
- **G**ranularity, **R**esolution, **I**dentification, **T**ransparency
- A new generation silicon array
- ~2000 strips
- Limited space







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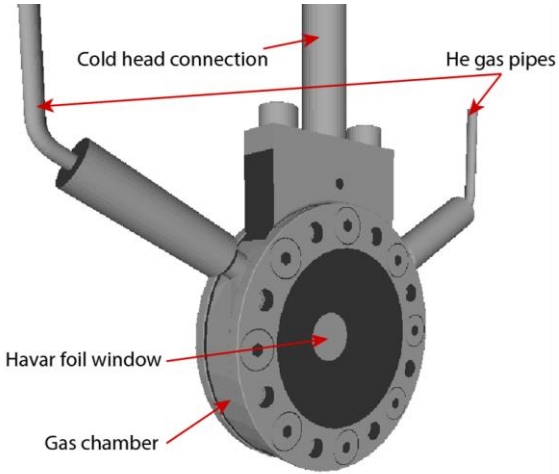
Target design

- CT body made out of Al alloy
- 2x 3.8 μm thick Havar windows - 10 mm diameter
- Anchored to a copper cold finger
- Two-stage Gifford-McMahon cryocooler connected to a 7 kW water-cooled compressor unit
- Copper thermal shield attached to the first stage of the cryocooler - reduce radiation heat load from the detectors
- Designed to allow detection of the reaction products in the total angle of 140° on both sides
- Operational temperature 8-10 K
- Window to window distance is 4 mm



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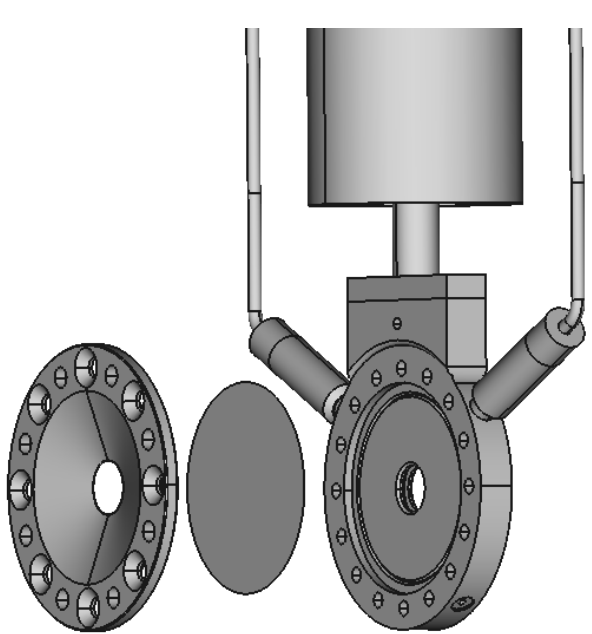

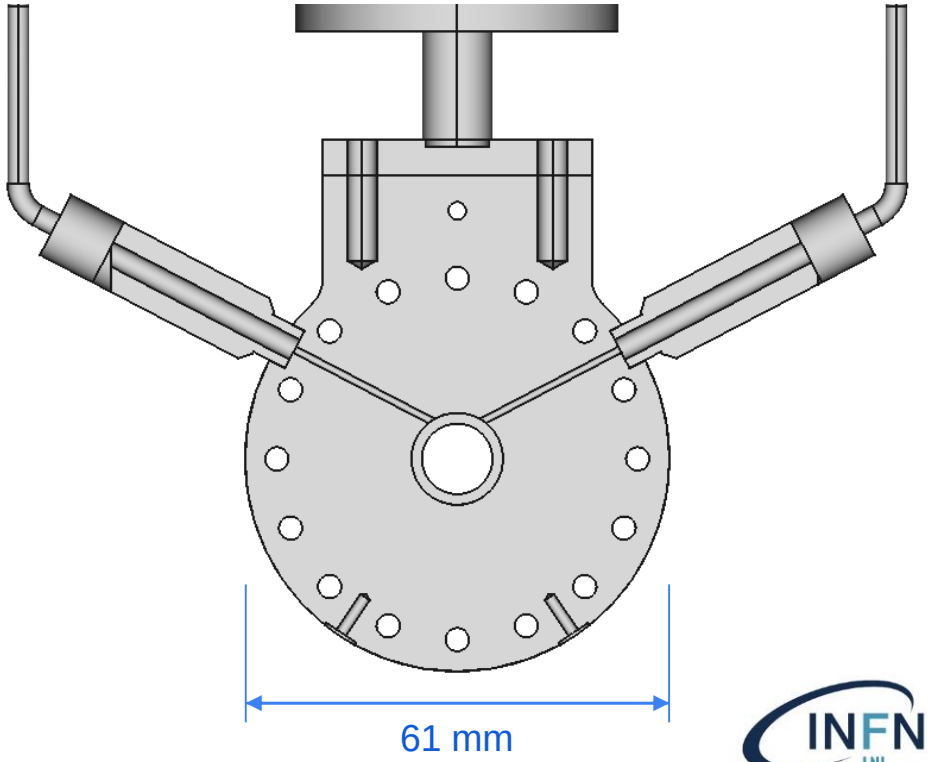

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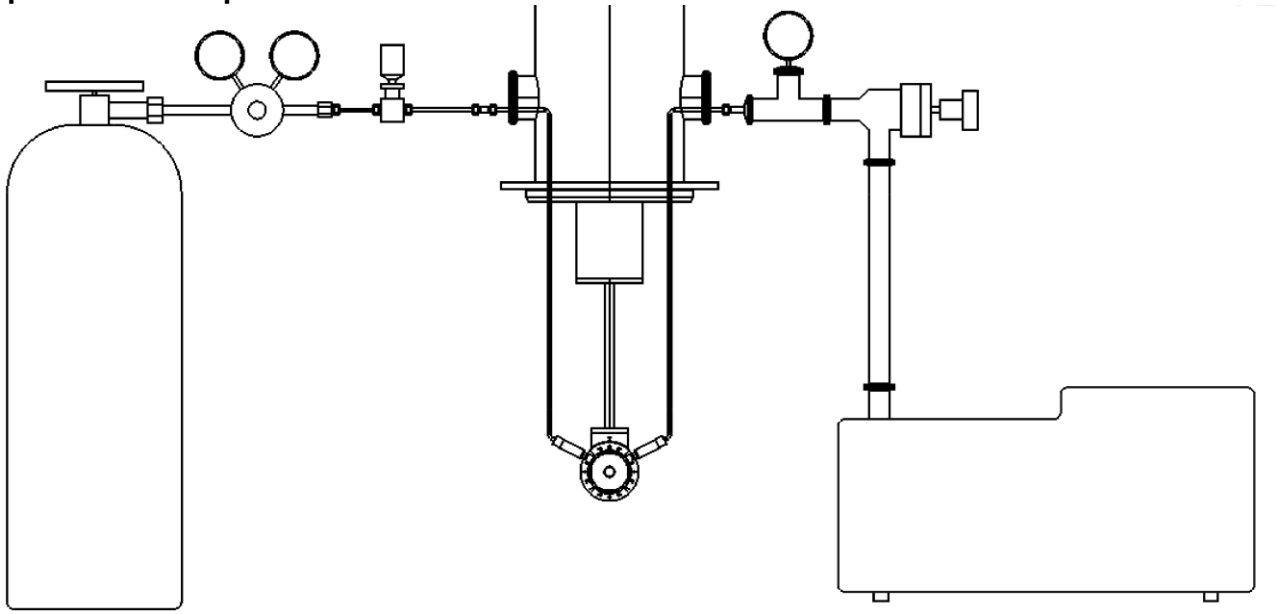
Target design

- Static gas – closed valves during operation
- Up to 1 bar pressure



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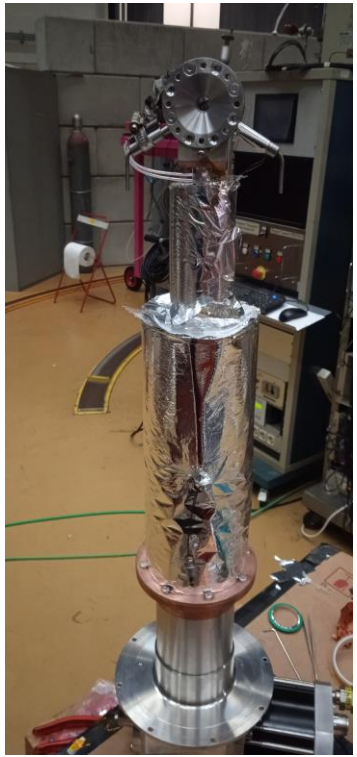

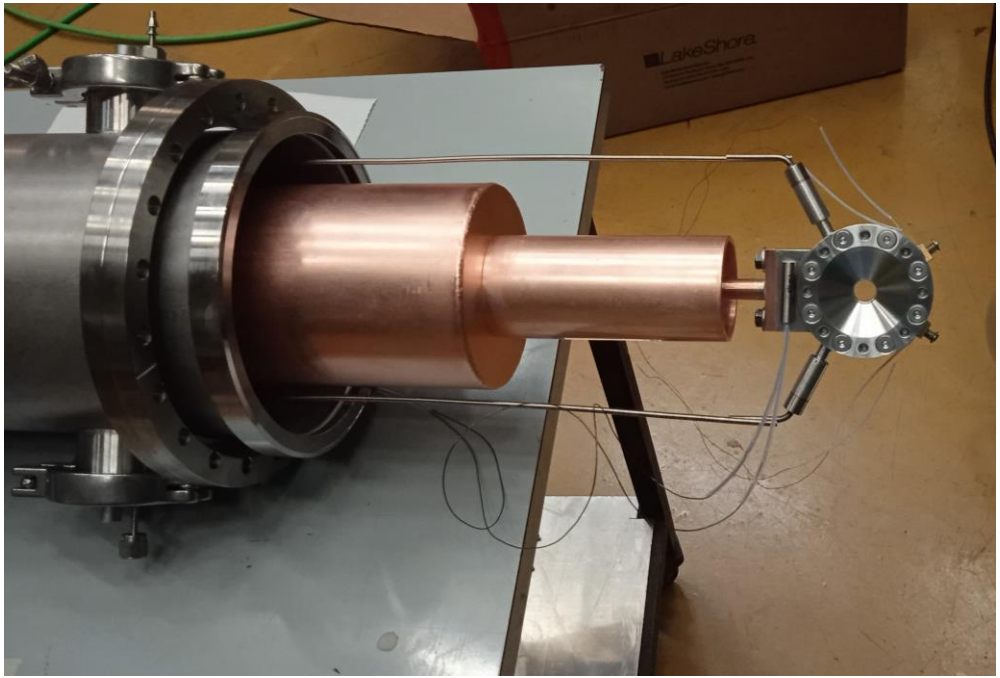

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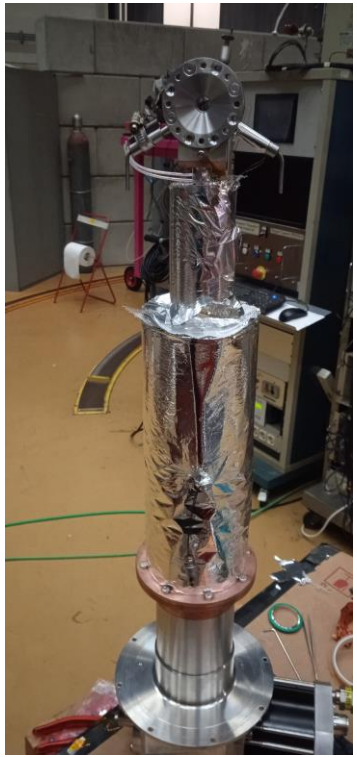

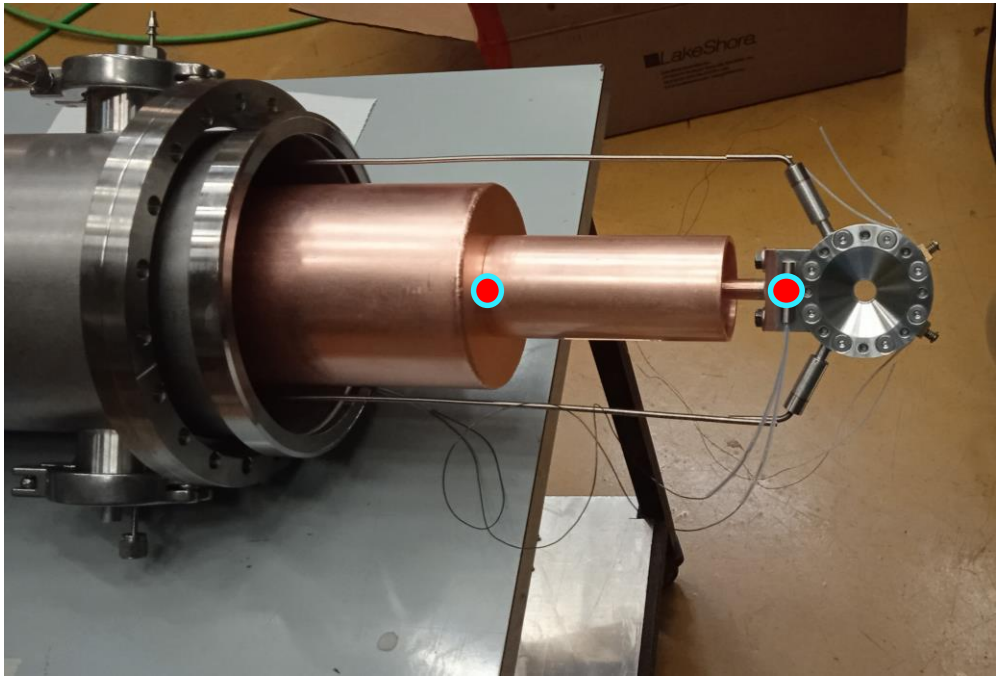

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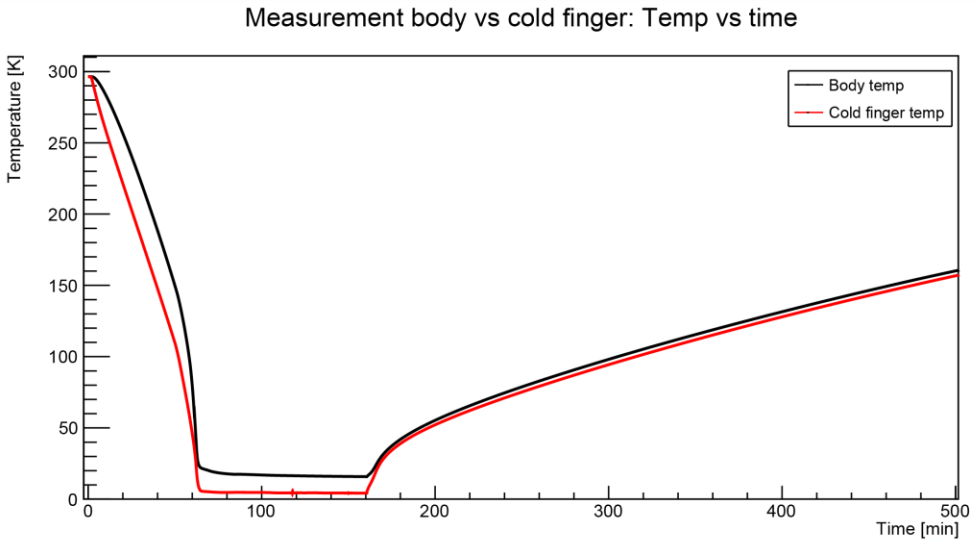
Performance

- Diode and CERNOX sensors
- Cool-down ~1 hour
- Warm-up >18 hours
- 3.4 K cold-head alone
- 4.8 K cold finger base
- 8.9/17 K target body



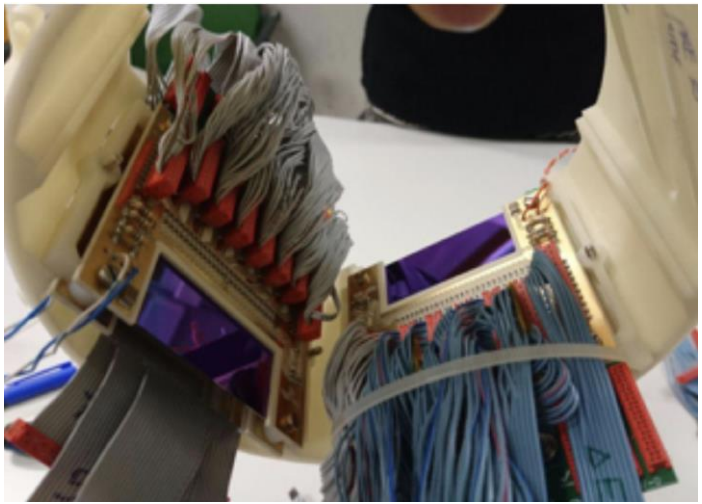
Commissioning experiment

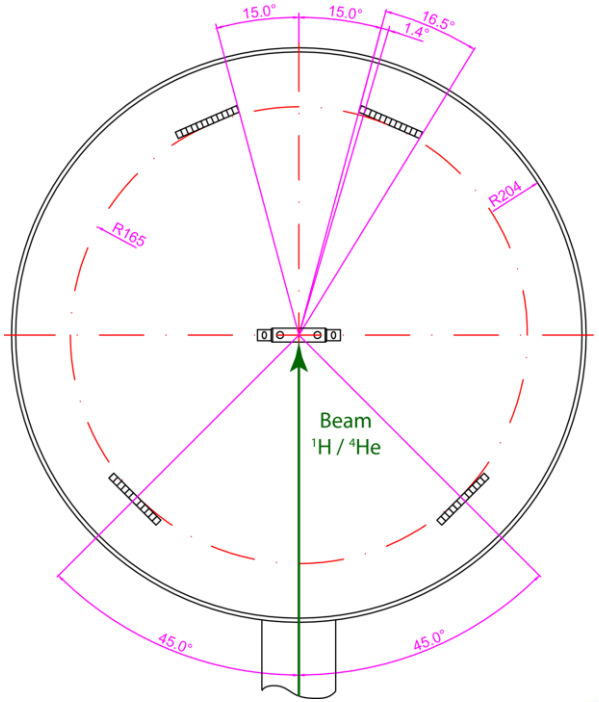
- Characterisation of the target homogeneity:
  - ^{1}H @ 4 MeV and intensity of 1 pnA
  - Beam will be focused to different points of the CTADIR Havar window
  - Performed in 3 conditions of the gas cell: empty at room temperature, filled with ^{4}He gas at pressure of 1 bar and room temperature and filled with pressurised ^{4}He gas to 1 bar at temperature of 9 K
  - Silicon detectors will be placed at forward and backward angles

- Mott scattering measurement:
  - ^{4}He @ 10 MeV and intensity of 1 pnA
  - CT filled with ^{4}He gas @ 0.5 bar and temperature of 9 K.
  - GalTRACE and target distance set to 16.5 cm -> each segment will cover an angle of 1.4°
  - Angular coverage of detectors will be from 15° to 31.5°
  - Obtained experimental results will be compared to the published calculated and measured values
  - We will perform a run with the empty target also to subtract the scattering on Havar windows

Experimental setup

- GalTRACE, silicon-detector array
- Each detector has 12 × 5 segments of 4 × 4 mm^2
- Placed in our 40 cm wide reaction chamber





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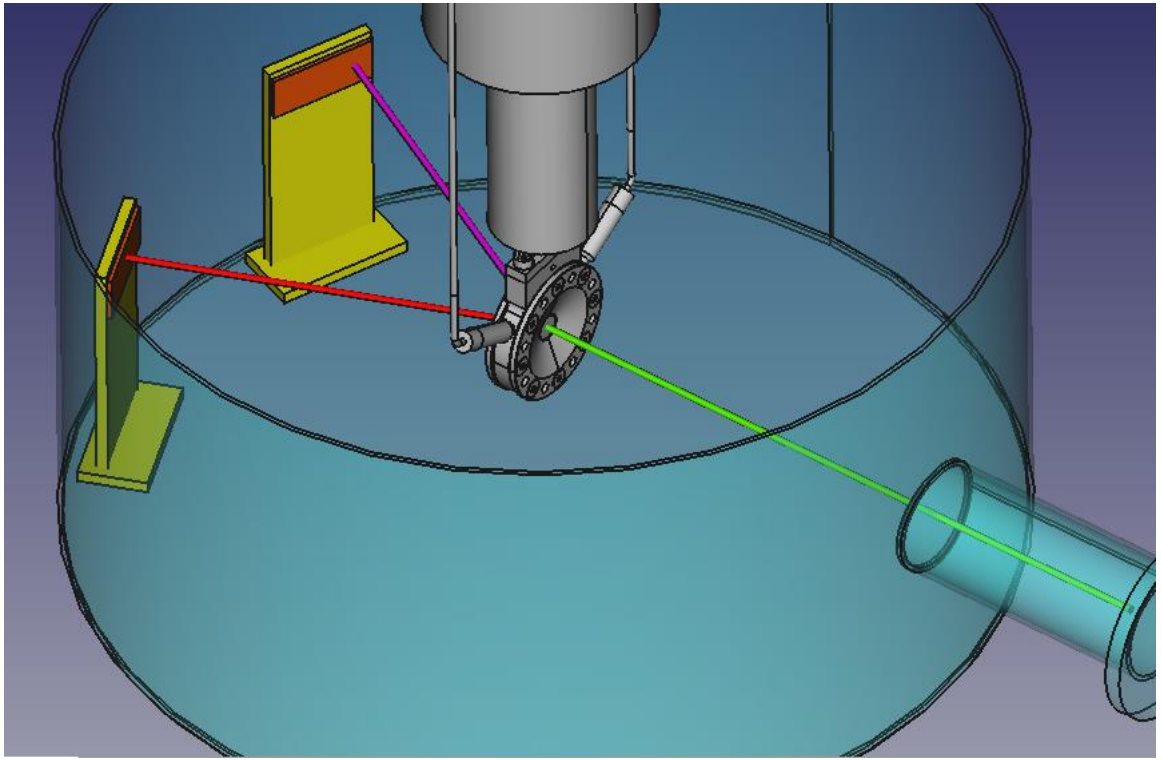

Thank you for your attention

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