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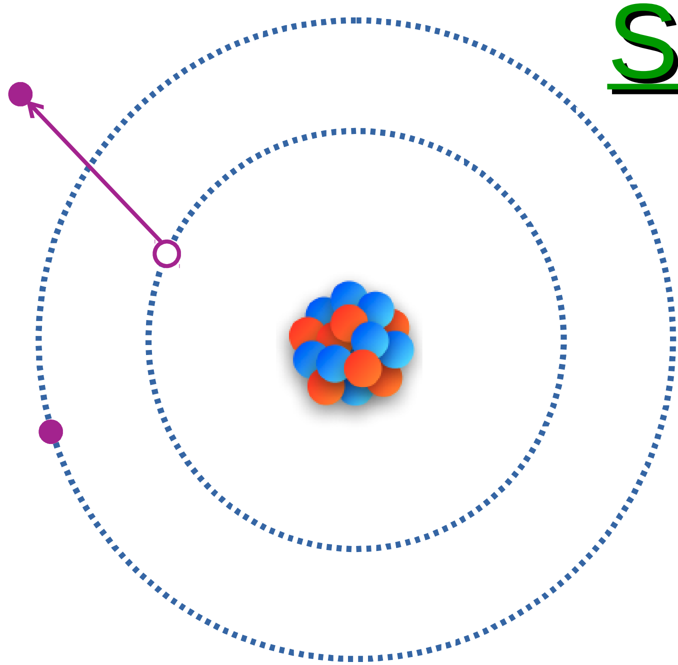
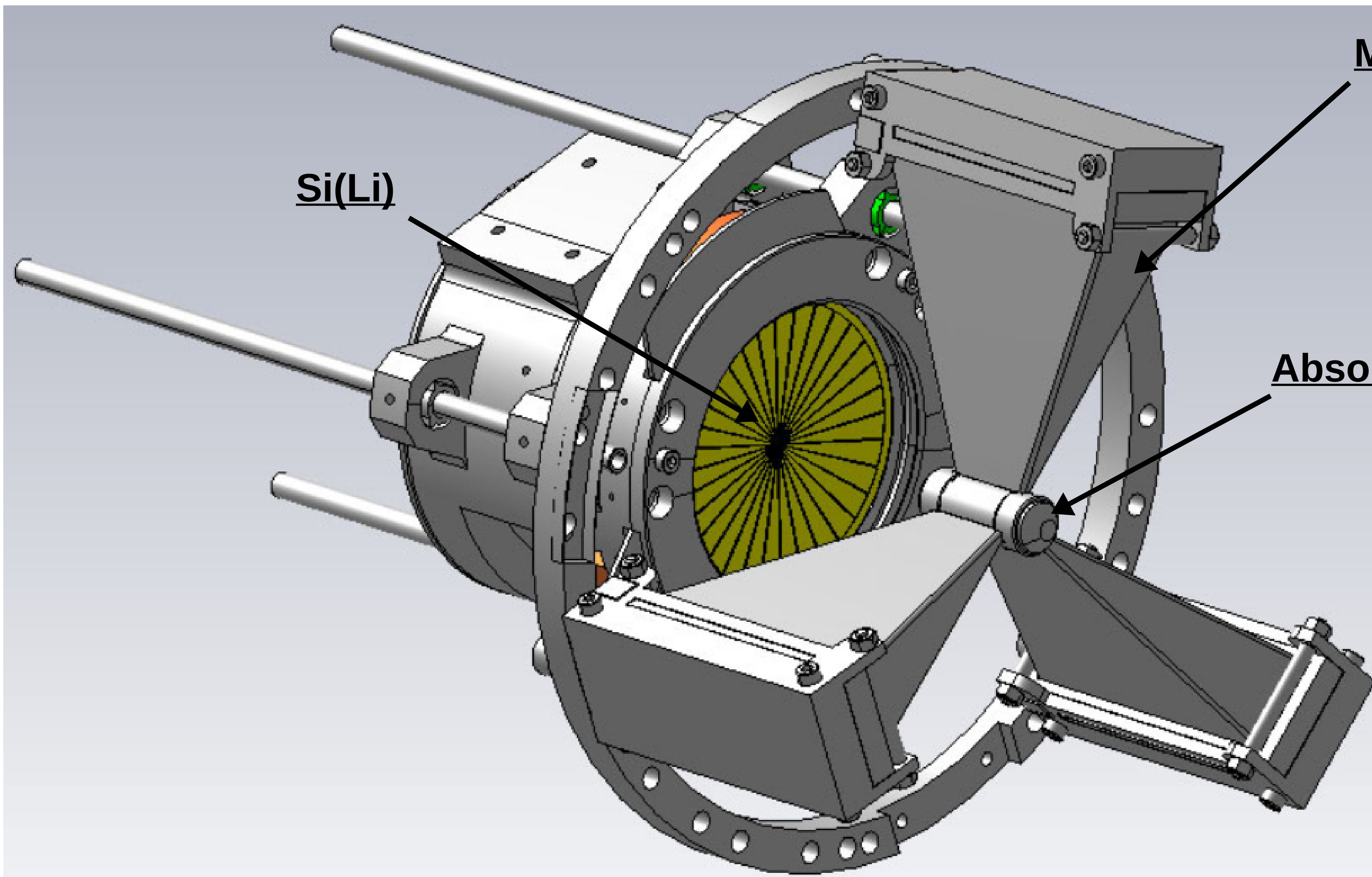
Università di Camerino and INFN Sezione di Firenze

Internal Conversion Electron Spectroscopy @LNL

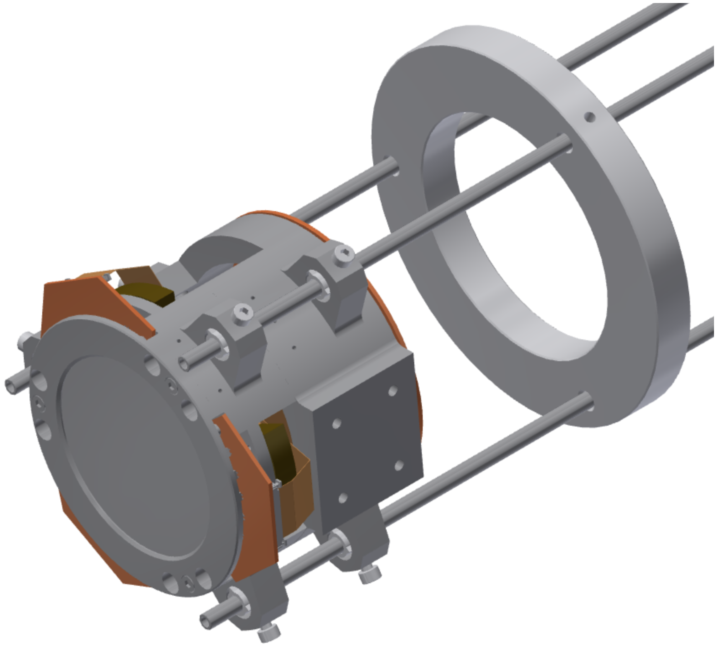


SLICES (Spes Low-energy Internal Conversion Electrons Spectrometer)

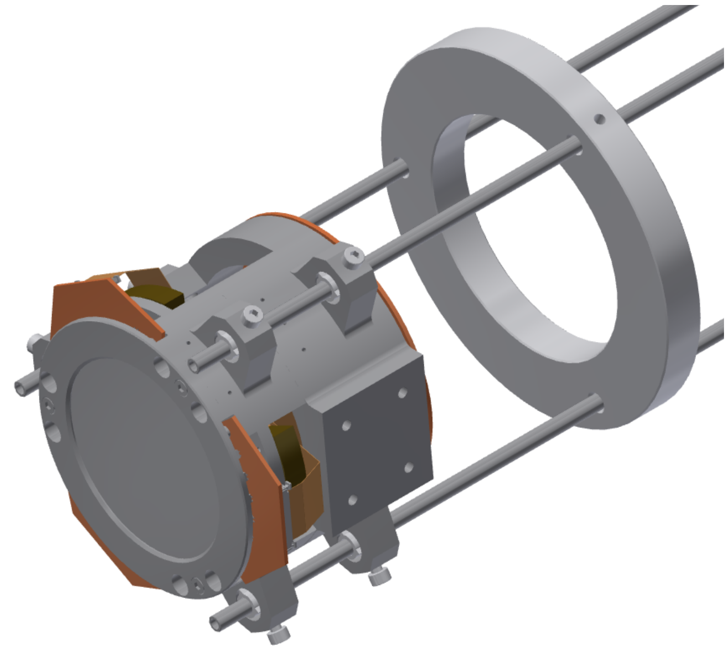


SLICES Si(Li) detector

- Development in collaboration with the Jülich (Germany) research center
- Diameter = 70 mm (active area ~ 3900 mm^2)
- Thickness = 6.8 mm
- Segmented in 32 independent sectors
- Requested FWHM(@~1MeV) ~ 3 keV

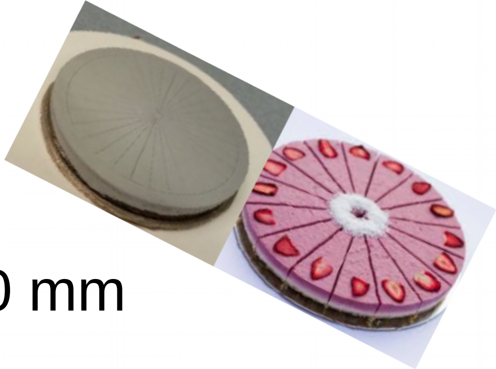


SLICES Si(Li) detector

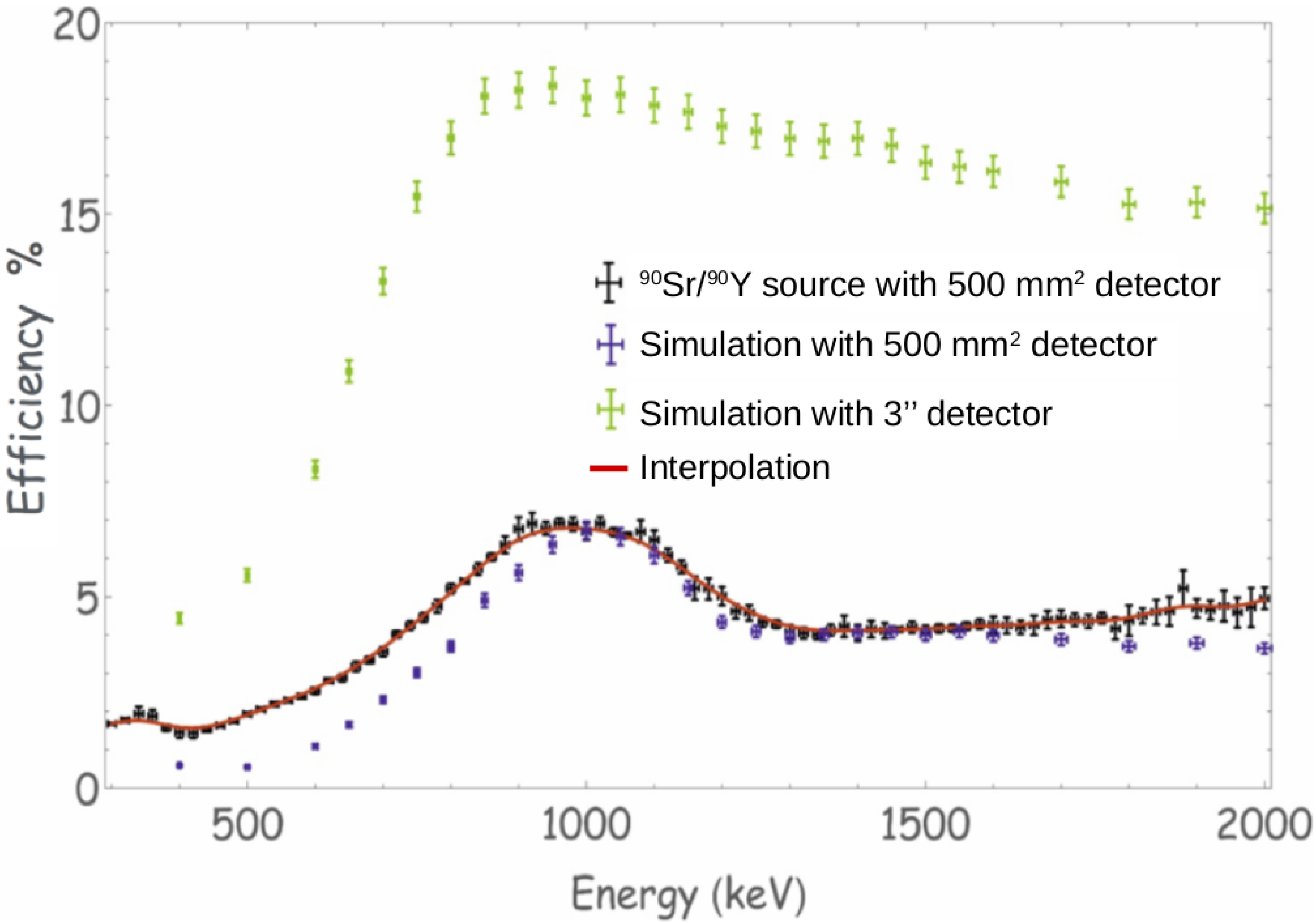


- Develop ülich (Germar
- Diamete mm^2)
- Thickne
- Segmen
- Request

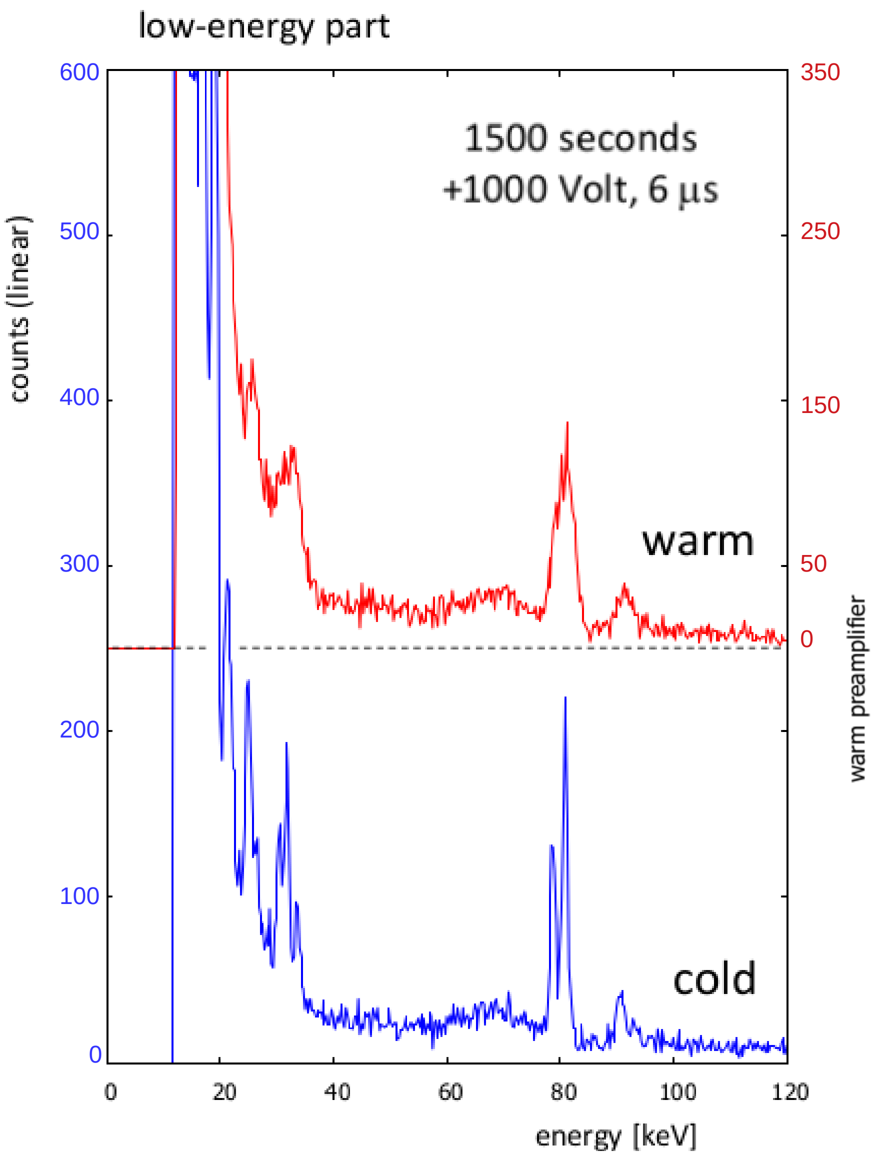
SLICES Efficiency

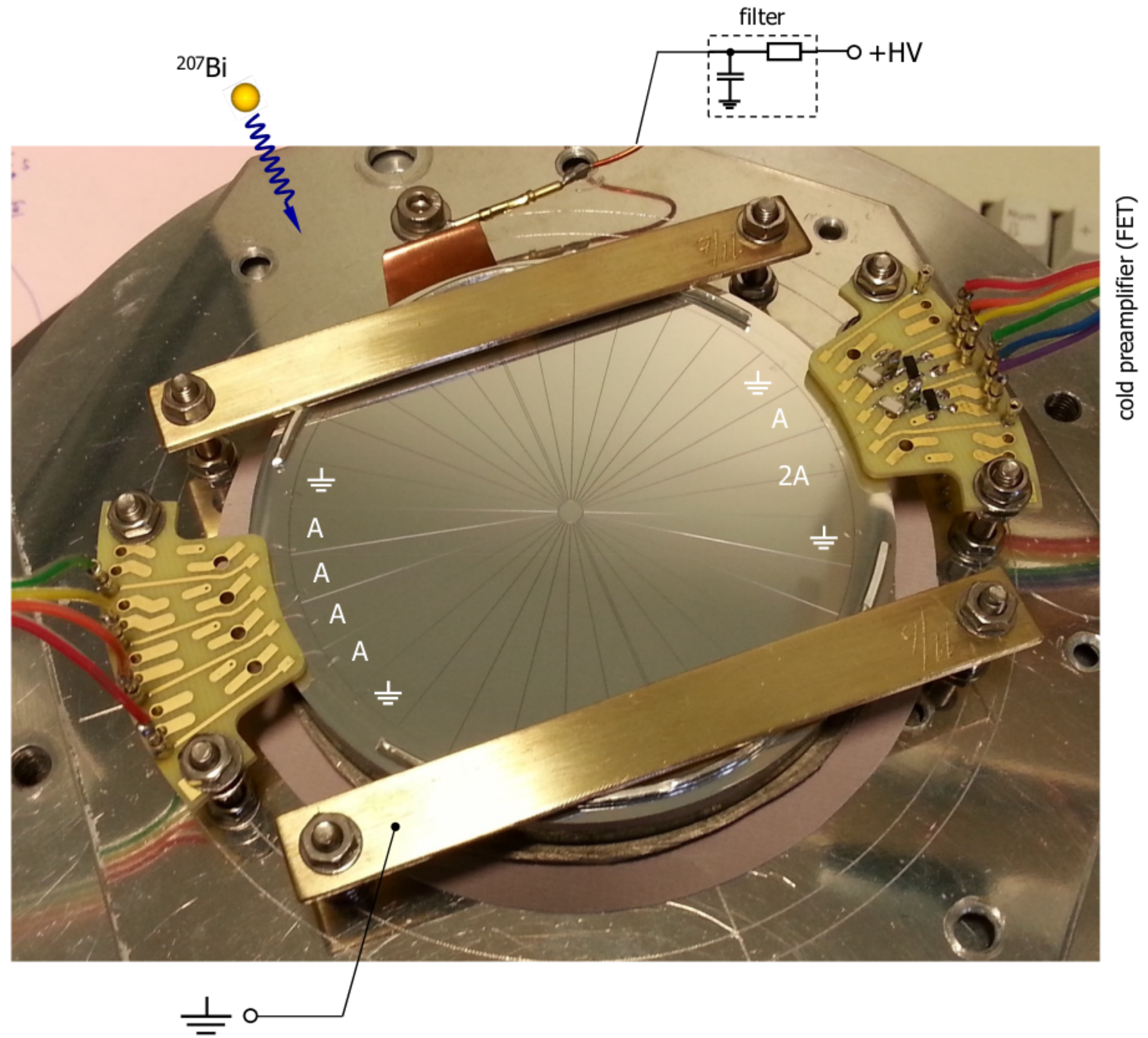


Distances: Source-Magnets = 50 mm, Magnets-Detector = 40 mm

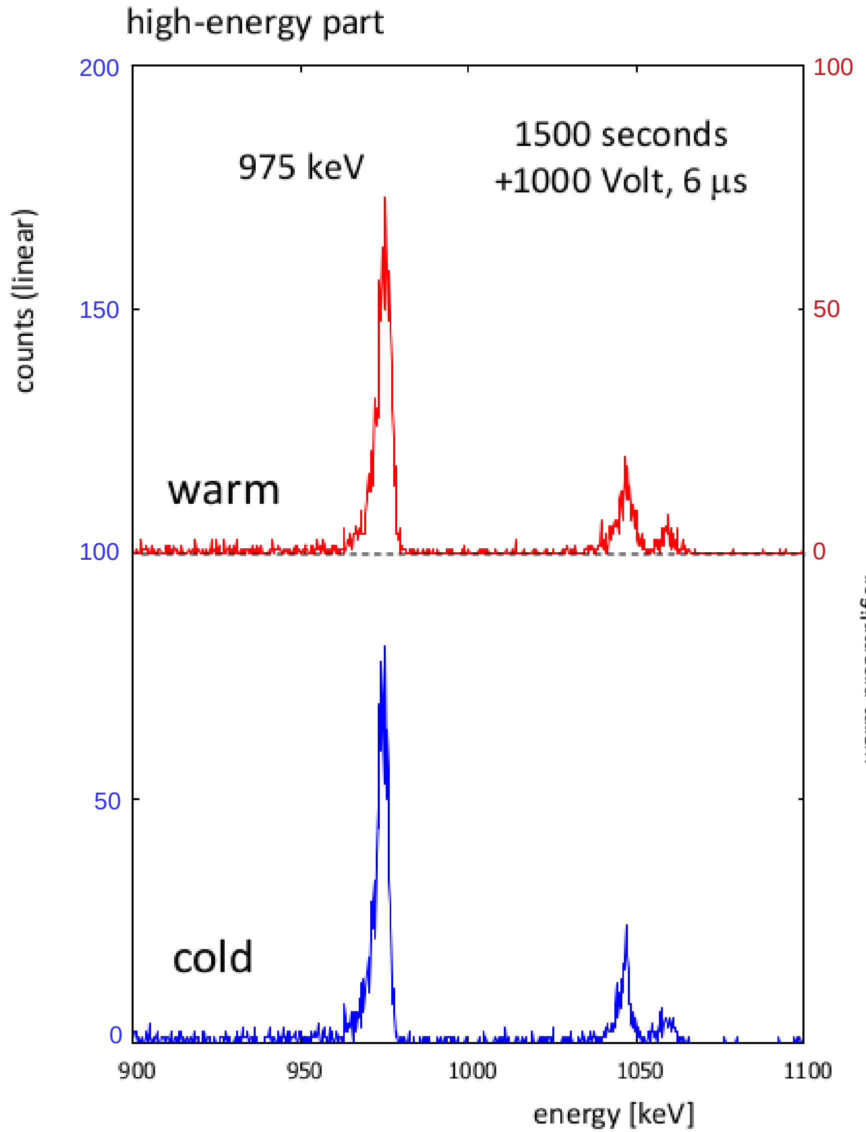


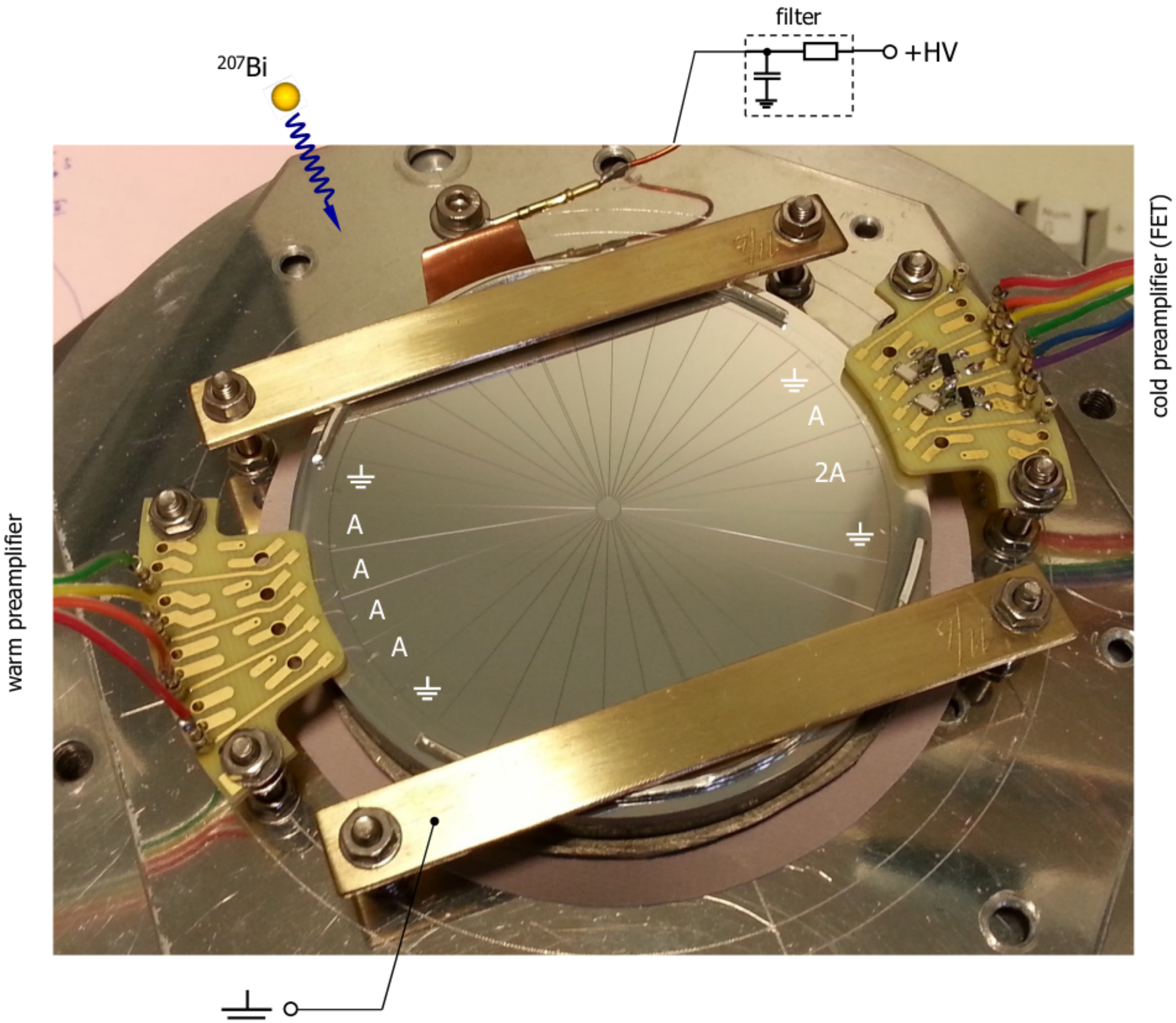
SLICES Resolution Test



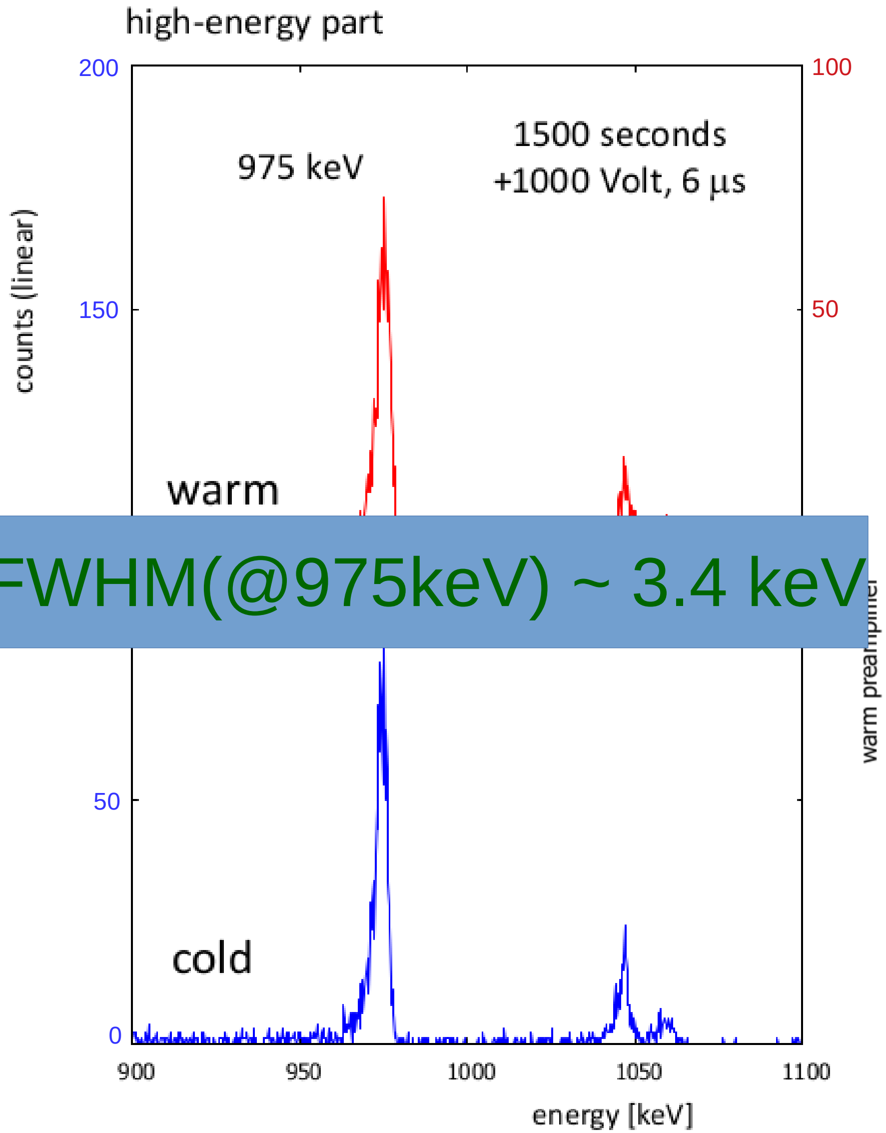


SLICES Resolution Test

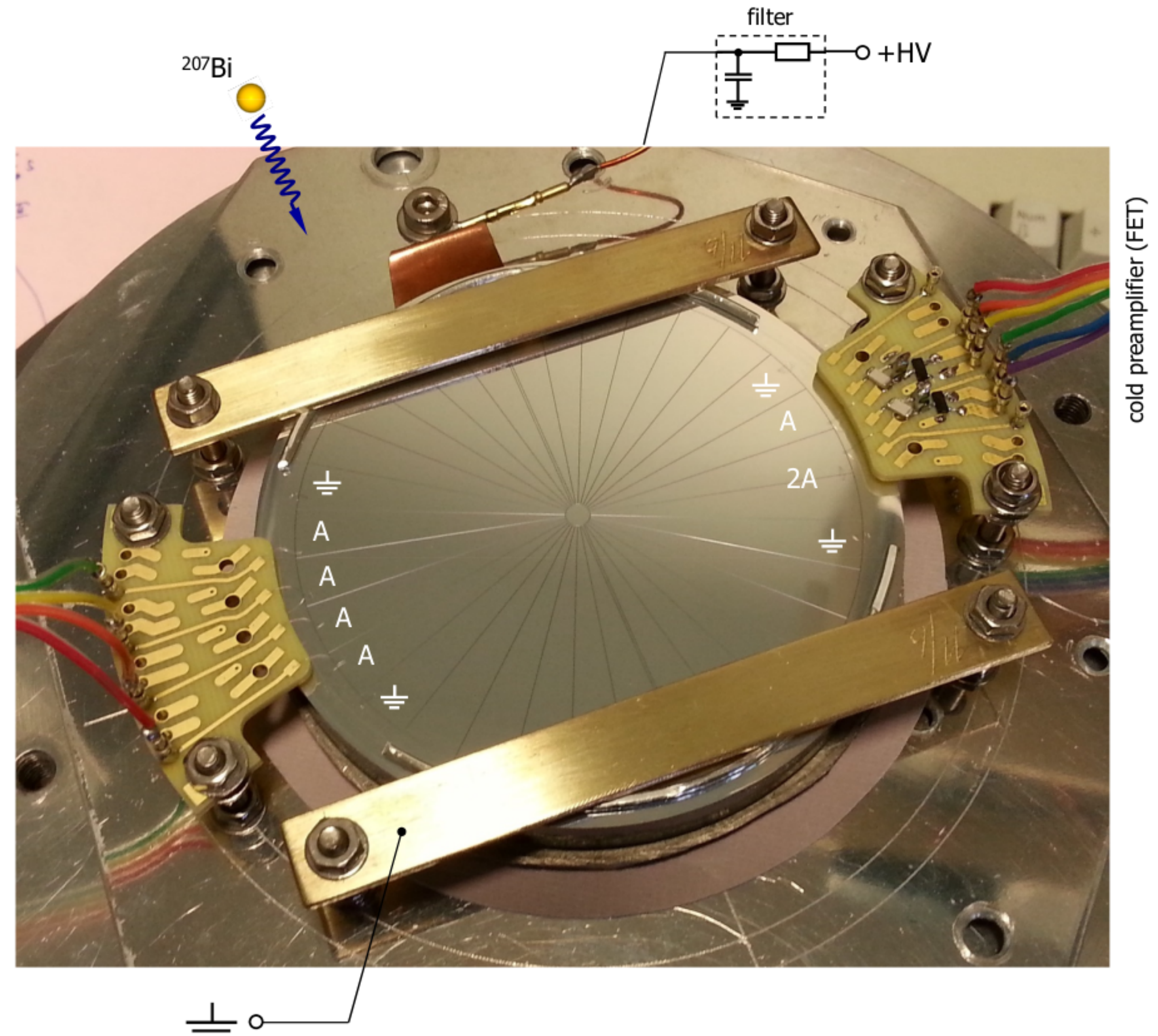




SLICES Resolution Test

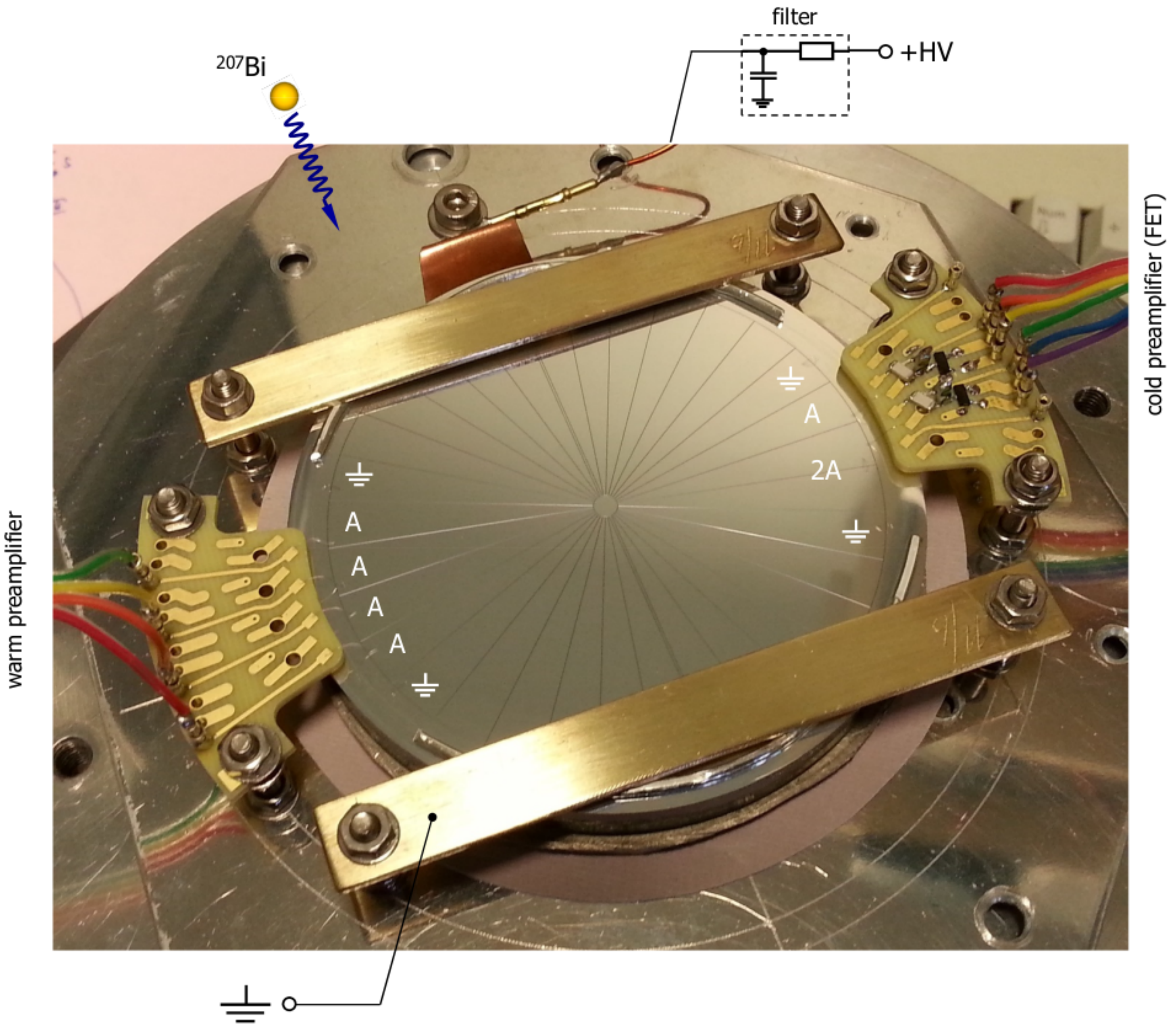


FWHM(@975keV) ~ 3.4 keV

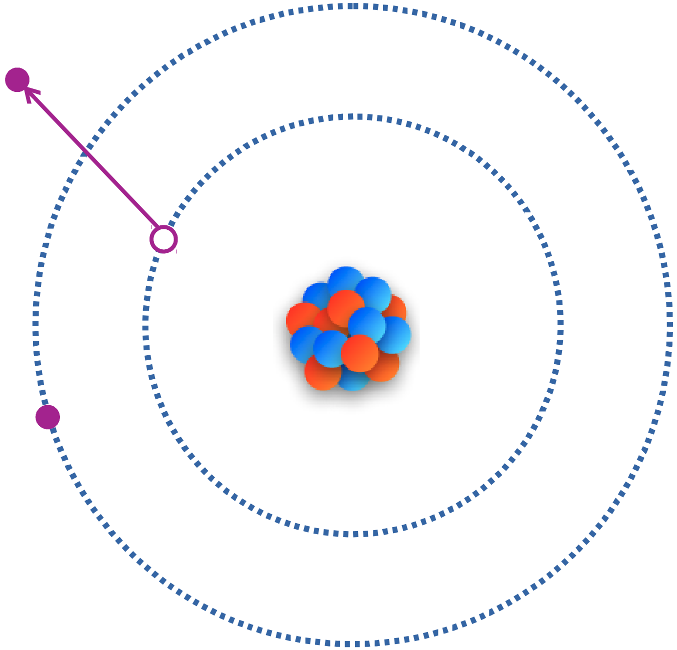


SLICES Resolution Test

Strips	Live Time	τ	FWHM (@975 keV)
2A	1500s	6μs	3.4keV
A	1500s	6μs	3.7keV
A	1500s	3μs	2.4keV

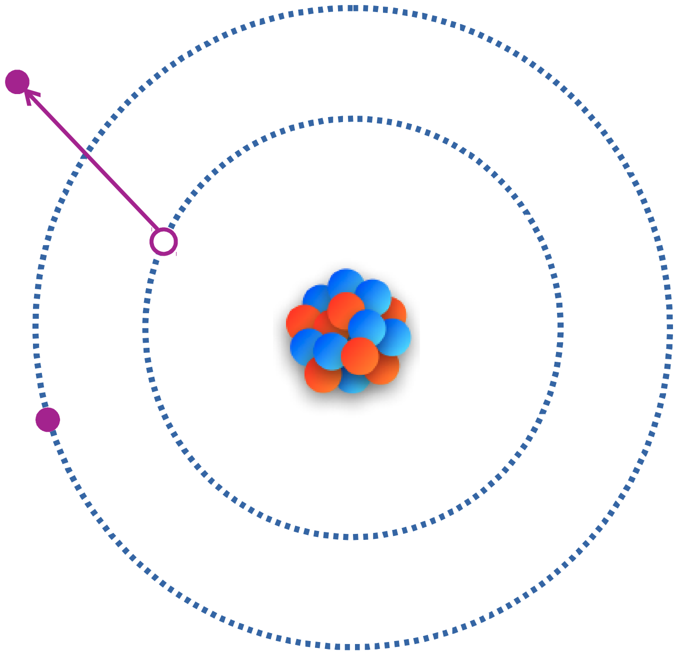


Why Internal Conversion Electron Spectroscopy ???



Why Internal Conversion Electron Spectroscopy ???

- Measure the internal conversion coefficients
- Study the electric monopole transitions

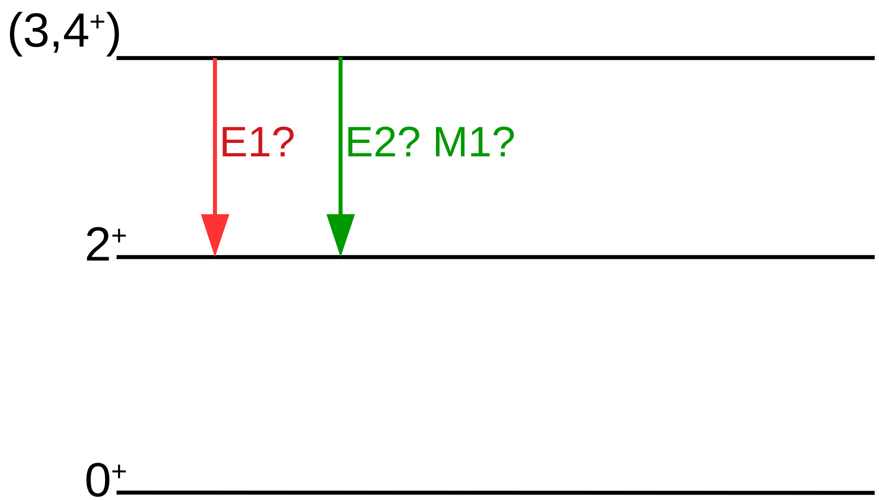


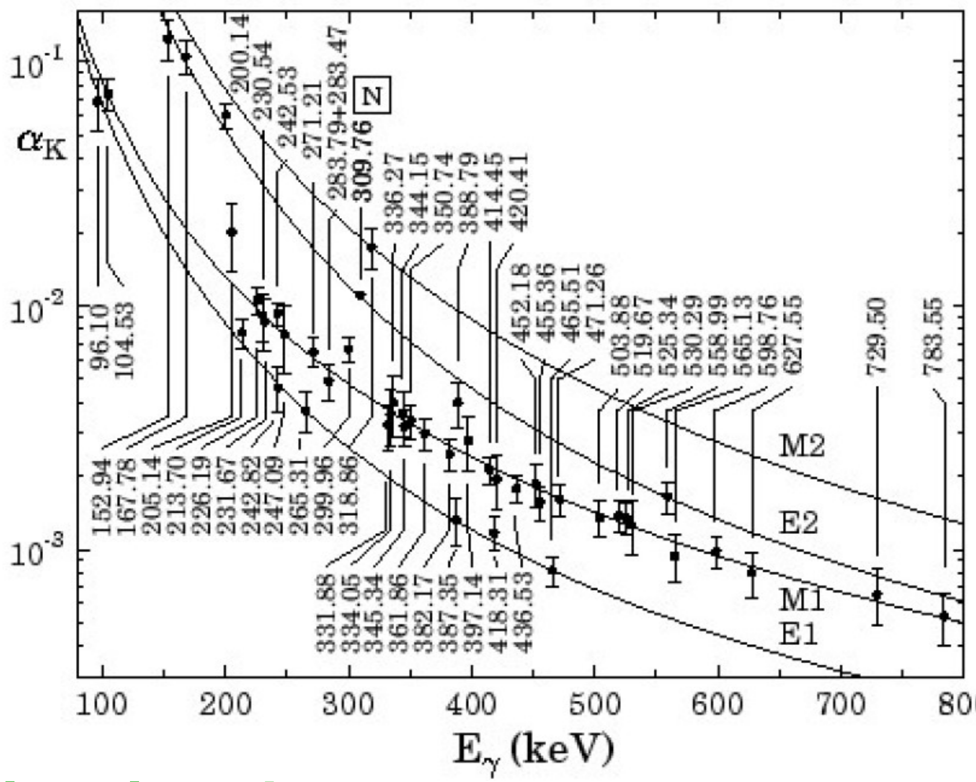
Internal Conversion Coefficients

- Experimentally we obtain:

$$\alpha_K(\Omega L) = \frac{I_K(\Omega L)}{I_\gamma(\Omega L)} \cdot \frac{\eta_\gamma^{abs}}{\eta_e^{abs}}$$

- Compare the experimental $\alpha_K(\Omega L)$ value with the theoretical $\alpha_K(\Omega L)$ values for different multipolarities to find a correct parity of the level





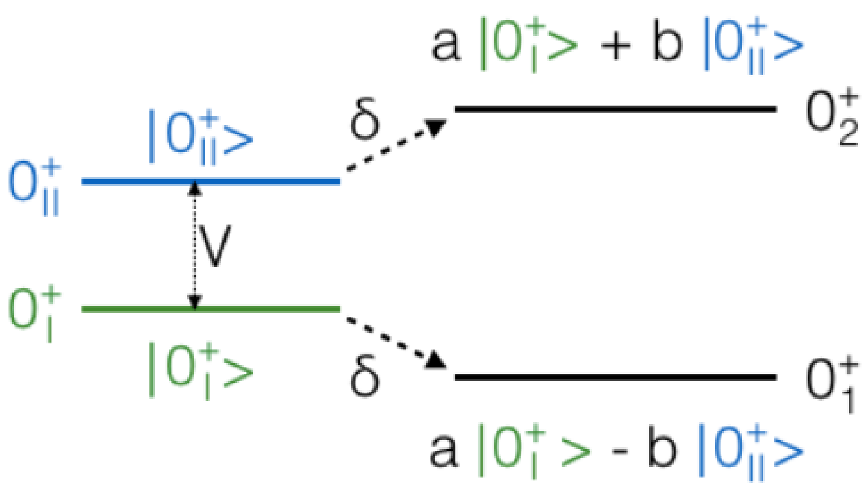
Assign level parity

Electric Monopole Transitions (E0) ΔJ=0

- E0 Transition Probability: $$B\left(E0; J \longrightarrow J'\right) = \frac{1}{2J+1} \left|\left\langle J' \left|\left|E0\right|\right| J\right\rangle\right|^2$$

- Monopole Transition Strength: $$\rho^2\left(E0; J \longrightarrow J'\right) = \frac{\left|\left\langle J' \left|\left|E0\right|\right| J\right\rangle\right|^2}{e^2 R^4}$$

Simple two levels model:

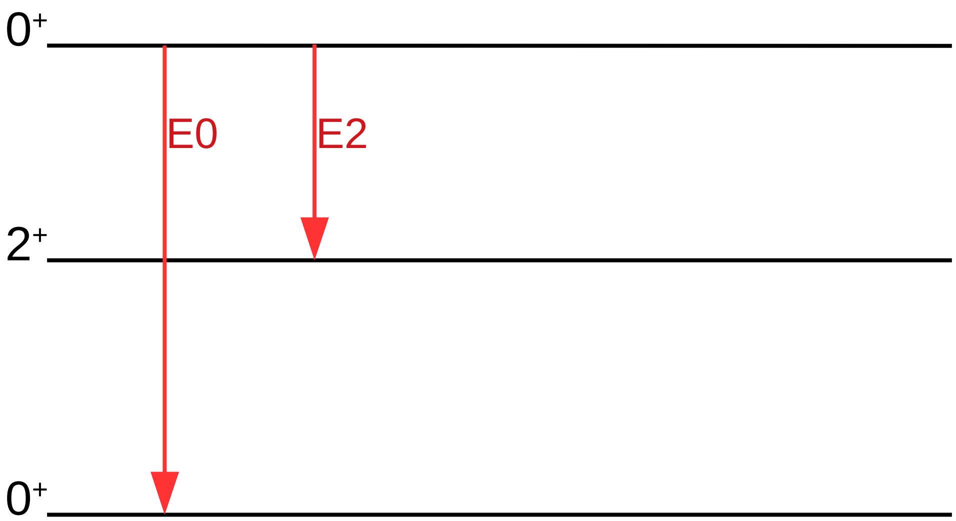


$$\rho^2(E0) = \frac{Z^2}{R^4} a^2 b^2 \left(\Delta \left\langle r^2 \right\rangle\right)^2$$

Shape of excited states and mixing between them

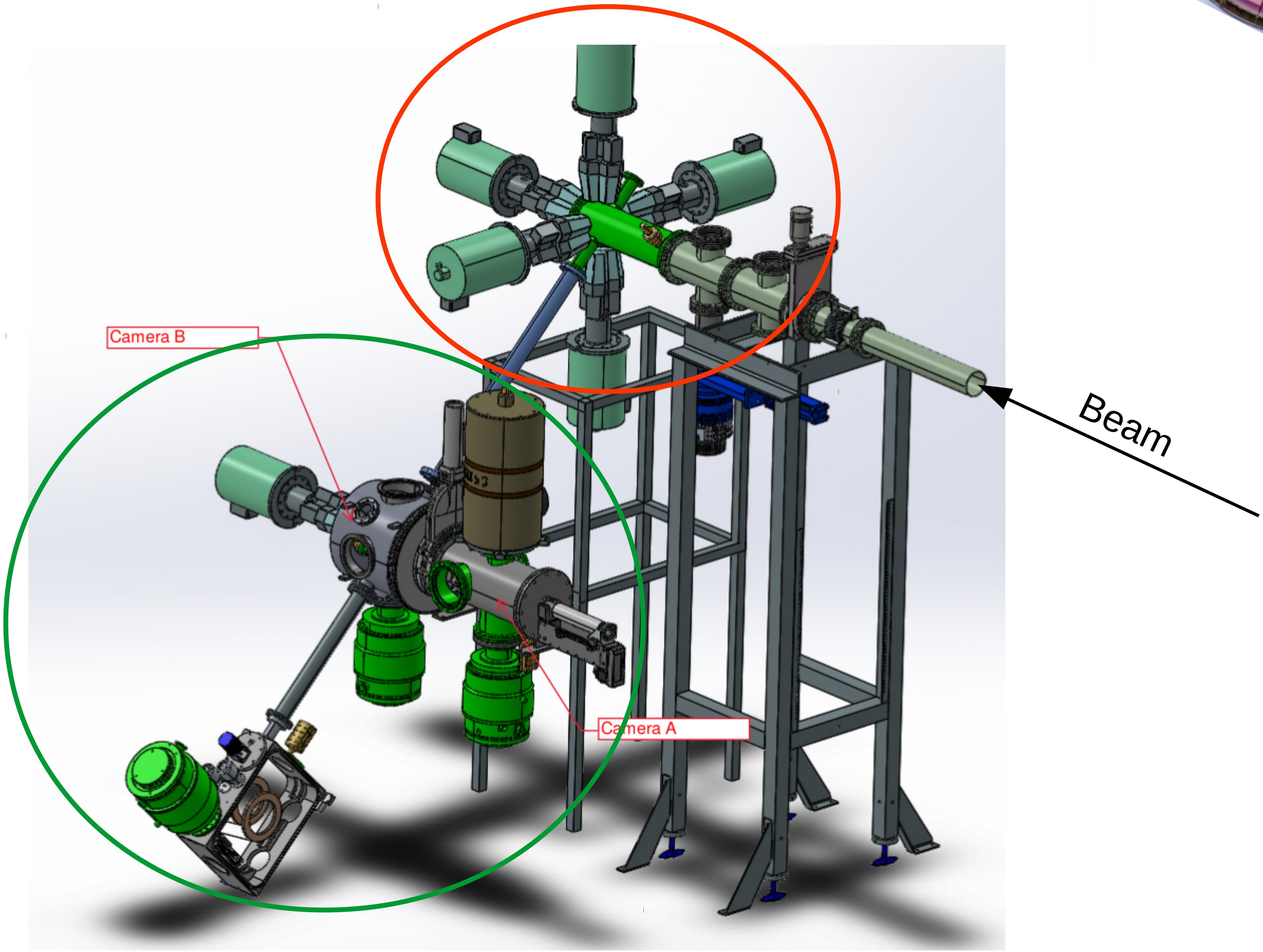
Electric Monopole Transitions (E0) ΔJ=0

- Experimentally we obtain: $$q_K^2(\mathrm{E0/E2}) = \frac{I_K(\mathrm{E0})}{I_K(\mathrm{E2})}$$



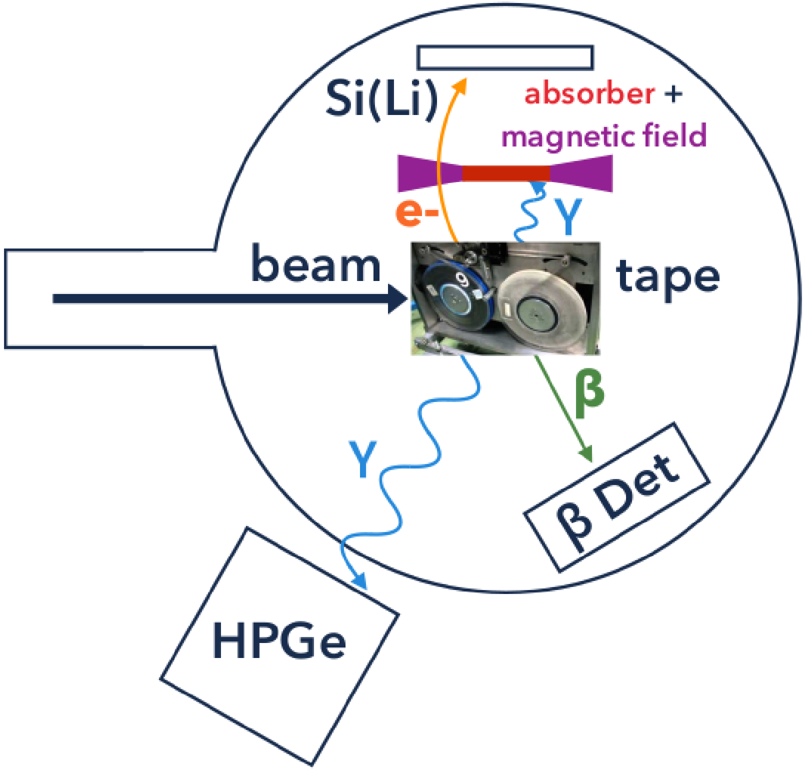
- If the E2 transition rate is known: $$\rho^2(\mathrm{E0}) = q_K^2(\mathrm{E0/E2}) \times \frac{\alpha_K(\mathrm{E2})}{\Omega_K(\mathrm{E0})} \times W_\gamma(\mathrm{E2})$$

SLICES @SPES low-energy beam line



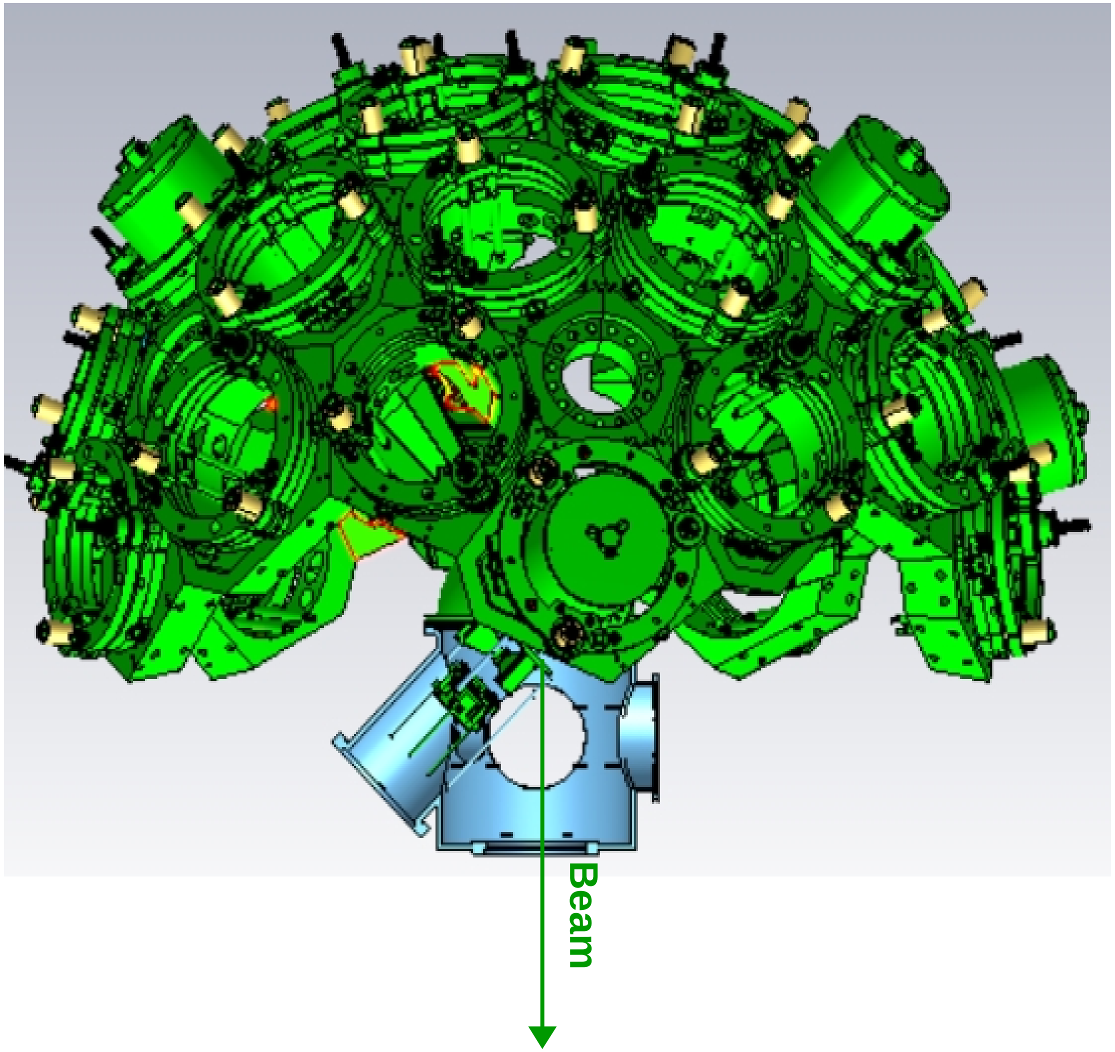
SLICES @SPES low-energy beam line

- Si(Li) detector + Magnetic transport system
- HPGe detector
- Plastic Scintillator
- Complete DAQ (takes advantage of the developments made for AGATA) :
  - Trigger-less mode
  - Common clock synchronization

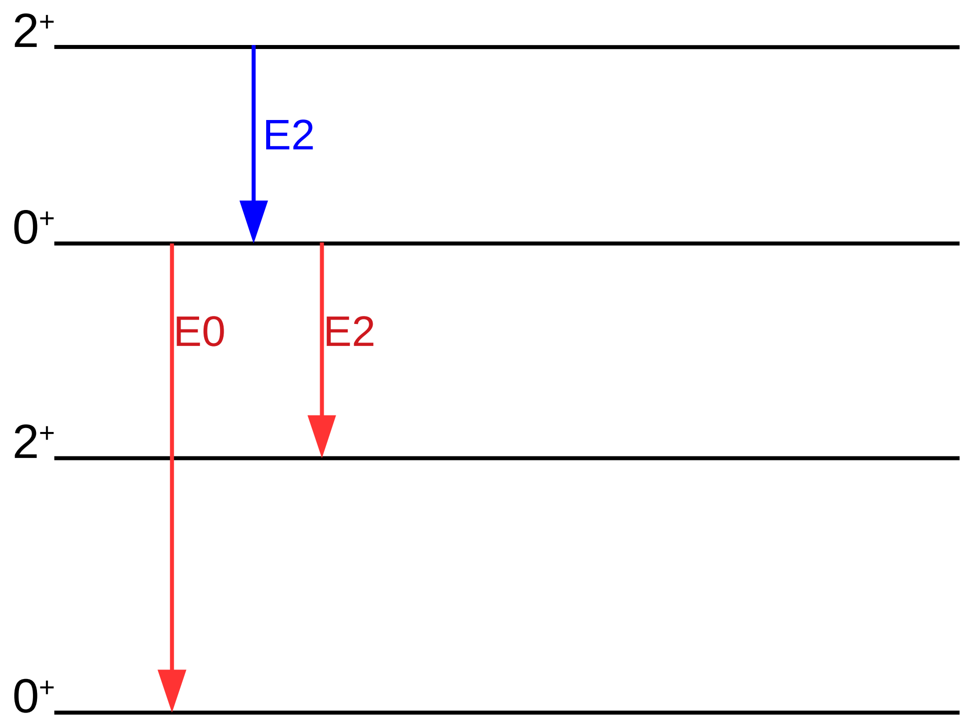


β – tagged electron and gamma spectra

SLICES with AGATA



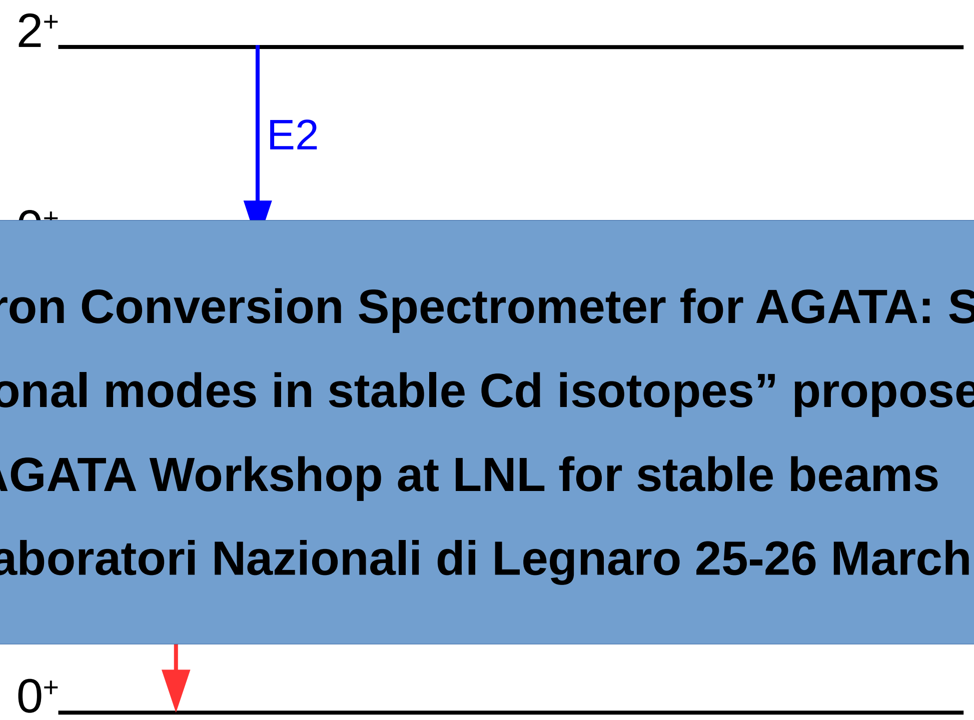
SLICES with AGATA



Electron-Gamma coincidence measurements

- Efficiency of AGATA: 10% at 1.3 MeV
- Efficiency of ES: 18% from 600 keV to 1600 keV

SLICES with AGATA



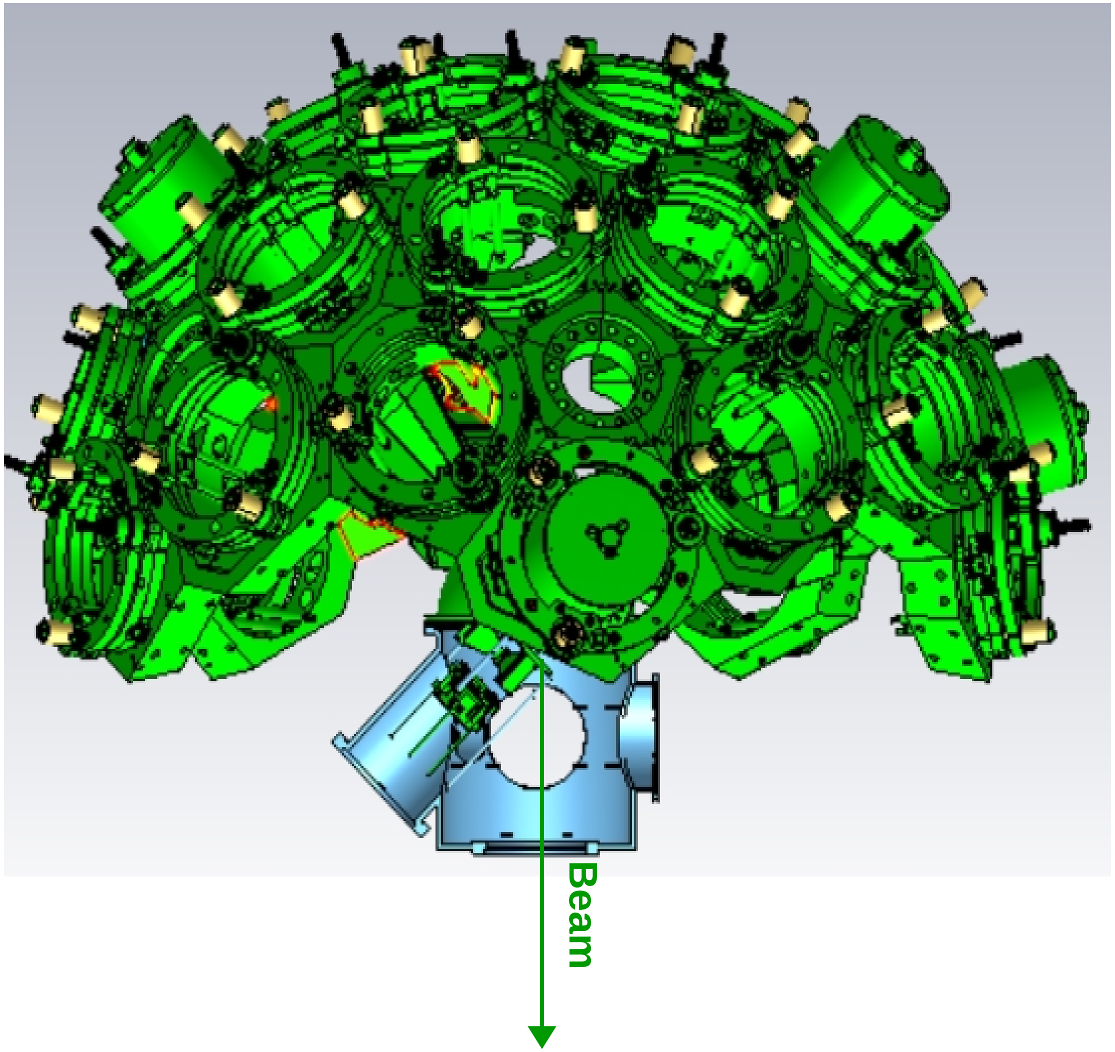
LoI "An Electron Conversion Spectrometer for AGATA: Study of the vibrational modes in stable Cd isotopes" proposed at AGATA Workshop at LNL for stable beams

INFN, Laboratori Nazionali di Legnaro 25-26 March 2019

Electron-Gamma coincidence measurements

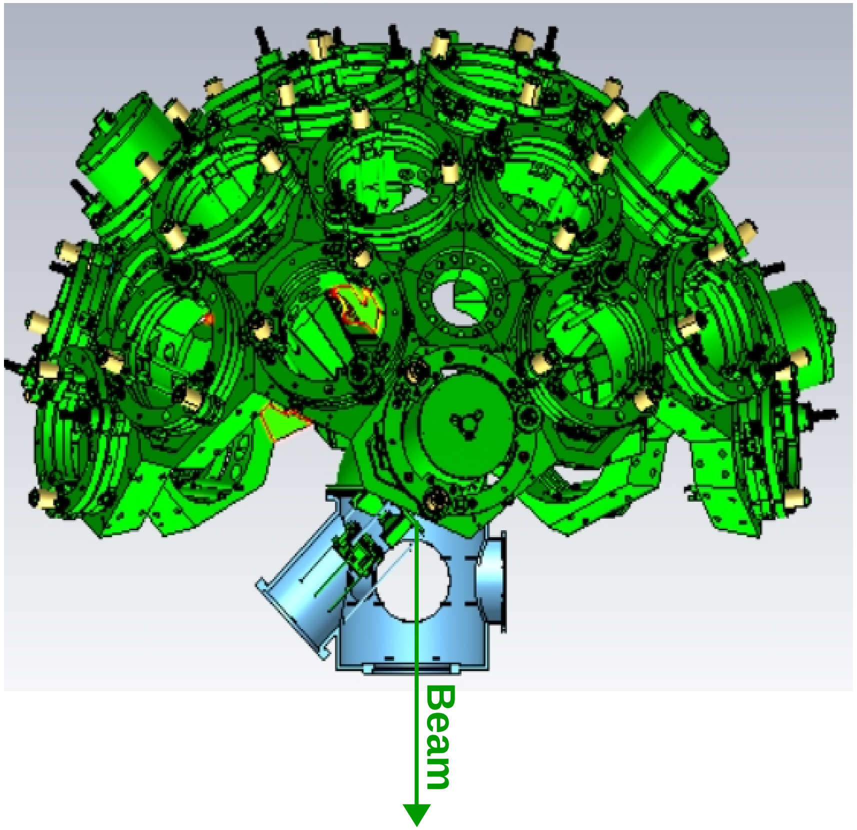
- Efficiency of AGATA: 10% at 1.3 MeV
- Efficiency of ES: 18% from 600 keV to 1600 keV

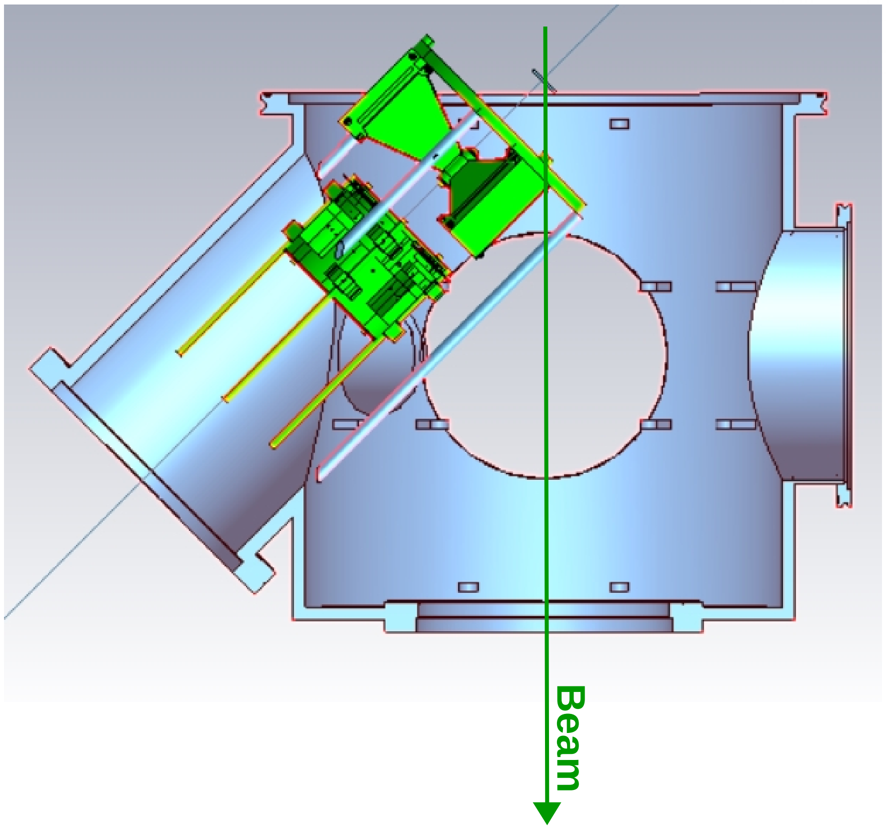
SLICES with AGATA: Configuration



- AGATA at 0° with respect of the beam direction
- SLICES at ~ 50° from beam direction

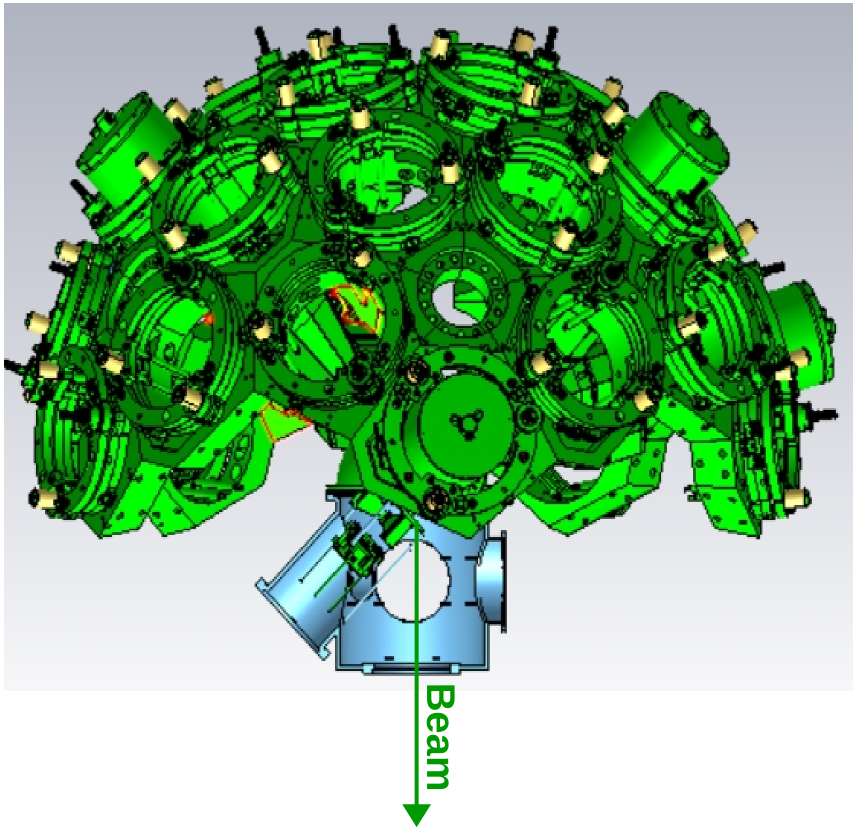
SLICES with AGATA: Target

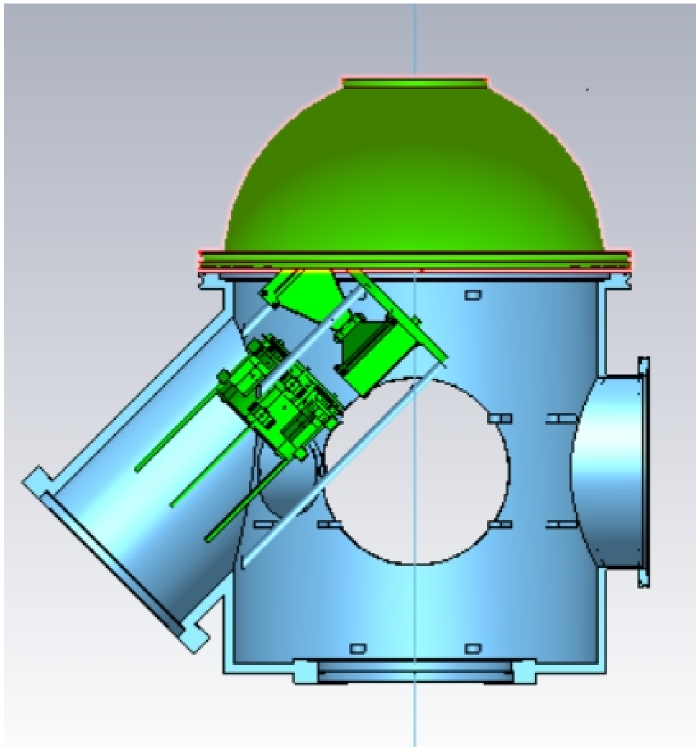




- Target orthogonal to the detector axis
- Particular care for the target preparation

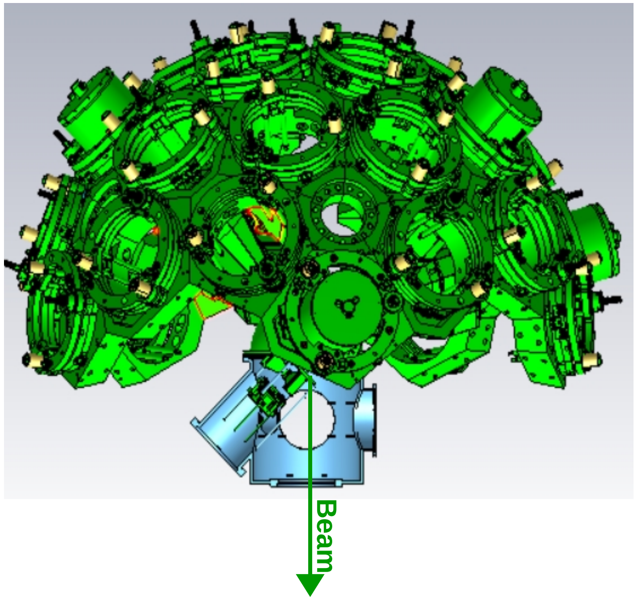
SLICES with AGATA: TO DO





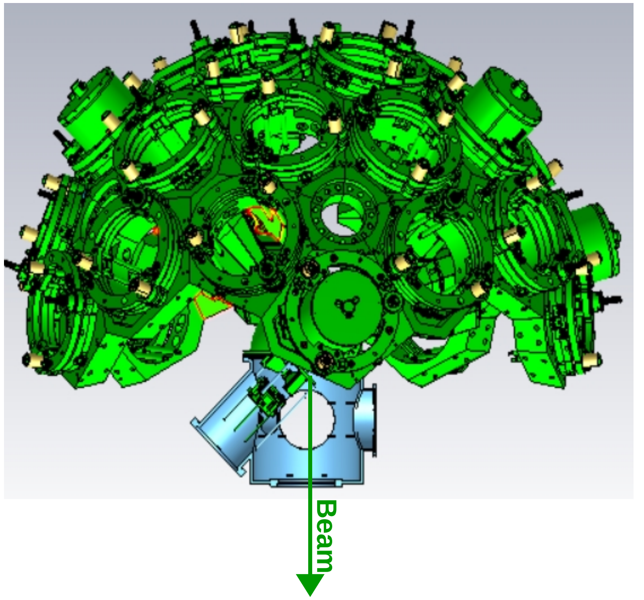
- Mechanical structure to be developed
- Cooling system for the Si(Li) detector
- Automatic target changing
- Acquisition system (See Alain talk)

SLICES with AGATA: Conclusions



- Use the same detector and magnetic transport system planned for the SPES low-energy beam line
- Use the same acquisition system planned for the SPES low-energy beam line (See Alain talk)
- LoI already proposed at AGATA Workshop at LNL for stable beams INFN, Laboratori Nazionali di Legnaro 25-26 March 2019

SLICES with AGATA: Conclusions



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Collaboration is opened to a new members

Thank you for the attention

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[5] *University of Padova*

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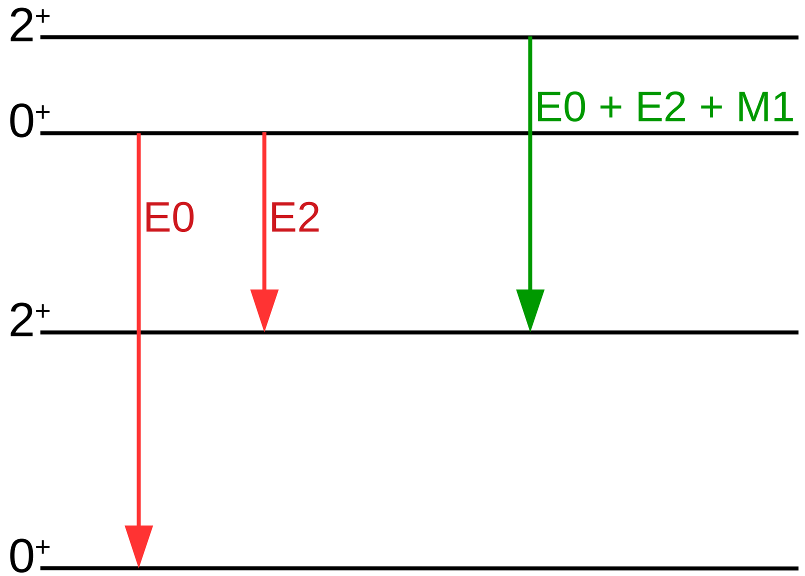
[7] *INFN, LNL Division*

Electric Monopole Transitions (E0) ΔJ=0

- Experimentally we obtain: $$q_K^2(\mathrm{E0/E2}) = \frac{I_K(\mathrm{E0})}{I_K(\mathrm{E2})}$$



- For $J_i=J_f=0$

$$q_K^2(\mathrm{E0/E2}) = \frac{I_K(\mathrm{E0})}{I_K(\mathrm{E2})}$$

- For $J_i=J_f\neq0$

$$\alpha_K = \frac{\alpha_K^{th}(M1) + (1+q_j{}^2{}_{if}) \cdot \delta^2 \cdot \alpha_K^{th}(E2)}{(1+\delta^2)}$$

- If the E2 transition rate is known: $$\rho^2(\mathrm{E0}) = q_K^2(\mathrm{E0/E2}) \times \frac{\alpha_K(\mathrm{E2})}{\Omega_K(\mathrm{E0})} \times W_\gamma(\mathrm{E2})$$

Why Electron Spectroscopy?

- Obtain the $\alpha_K(\Omega L)$ Internal Conversion Coefficients

$\downarrow$

Assign level Parity

- Study of Electric Monopole Transitions (E0)

$\downarrow$

Study the possible Shape Coexistence
and level Mixing