Marco Rocchini

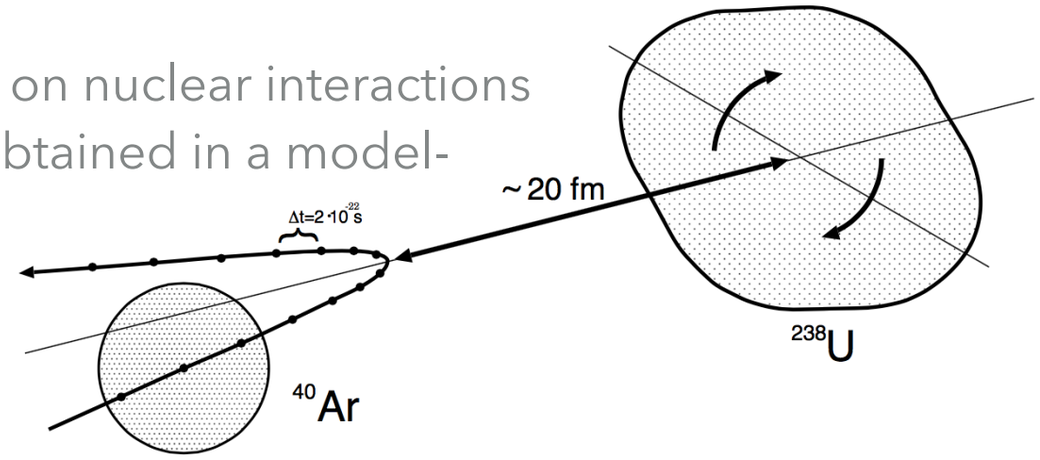
Università degli Studi di Firenze and INFN Sezione di Firenze

SPIDER: DEVELOPING THE COULOMB EXCITATION TECHNIQUE @LNL

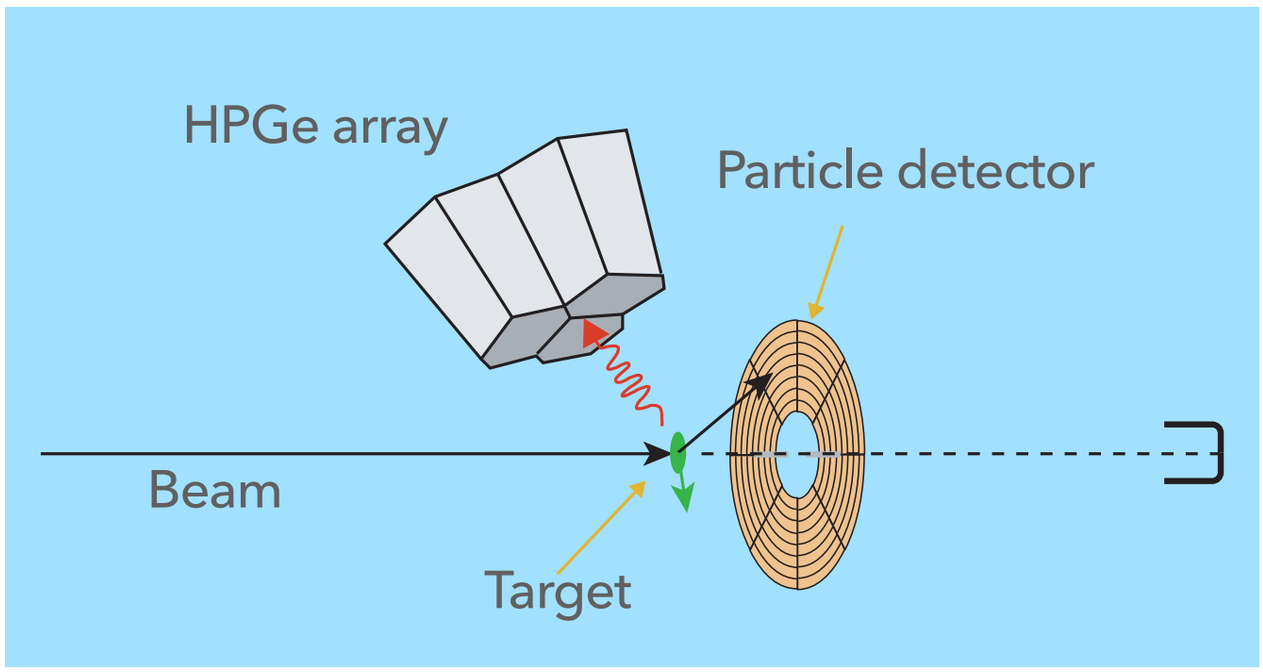
- SPIDER as ancillary device for GALILEO @LNL
- Recent results of ^{7}Li Coulomb excitation @LABEC in Florence
- Coulomb excitation with radioactive beams from SPES

LOW-ENERGY COULOMB EXCITATION (COULEX)

- Electromagnetic interaction, no hypothesis on nuclear interactions are required: experimental values can be obtained in a model-independent way
- Collective excitations: B(E2), Q



- Typical set-up: HPGe array to detect gamma rays and a particle detector

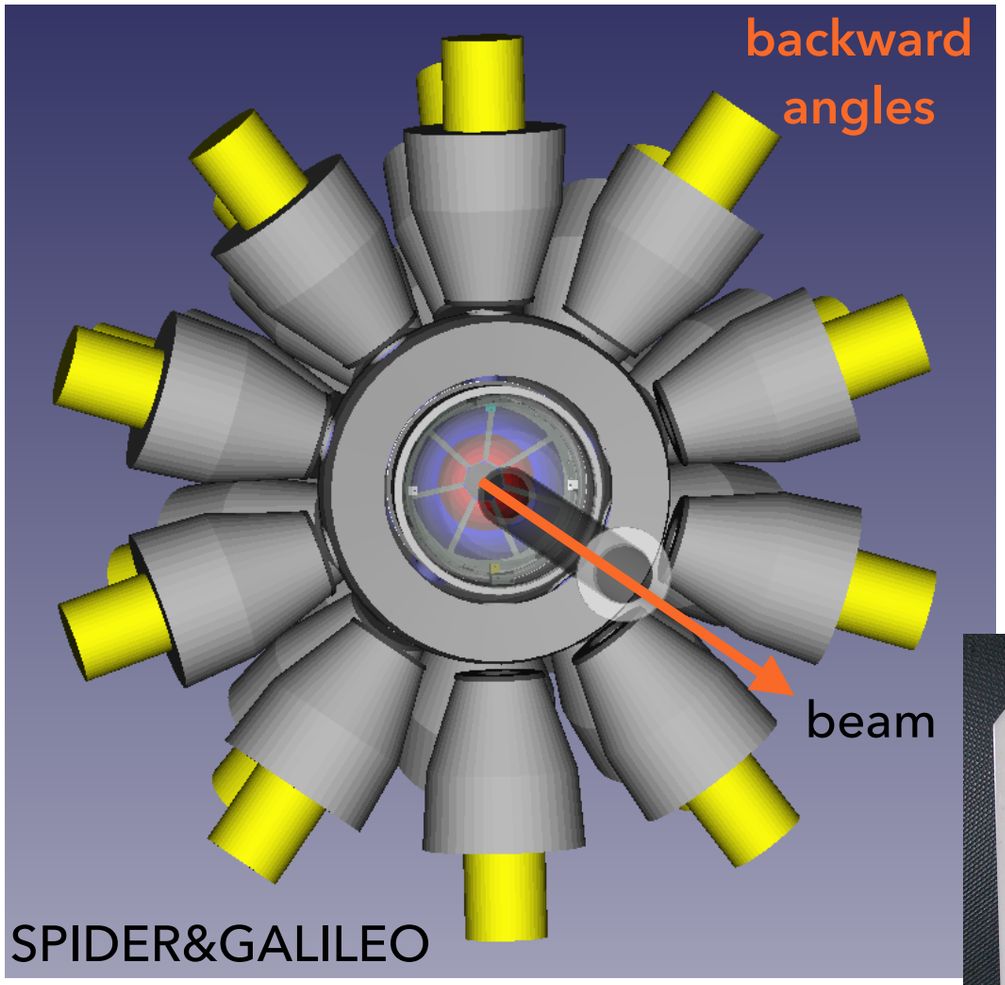


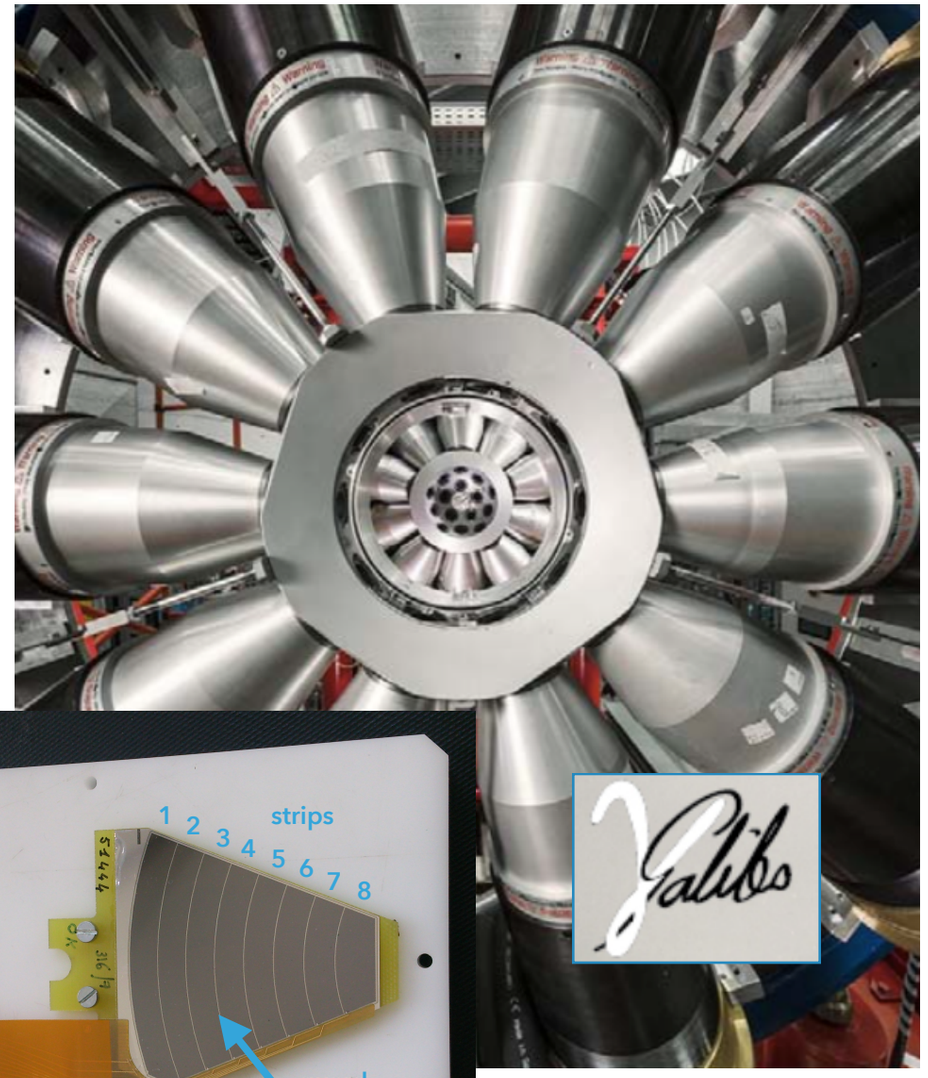
Particle detector (SPIDER)

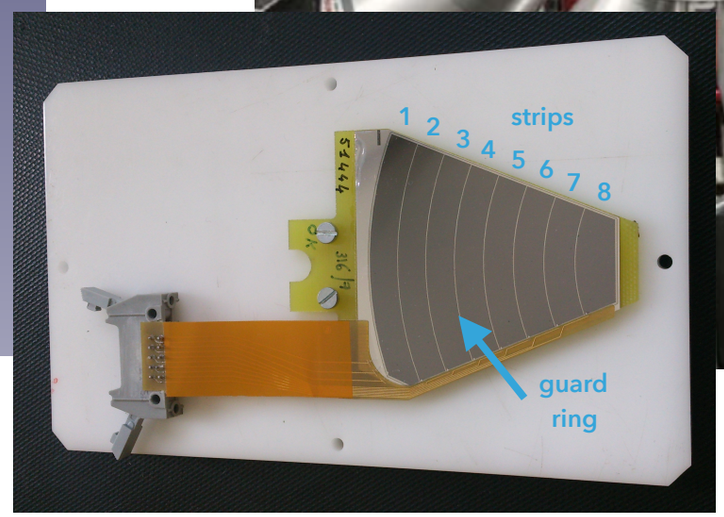
- to have a clean trigger
- to perform the Doppler correction
- to study the angular dependence of the cross section -> Q

SPIDER & GALILEO @LNL

- Developing Coulomb excitation technique at LNL: new possibilities with GALILEO and stable beams, priority for radioactive beams from SPES

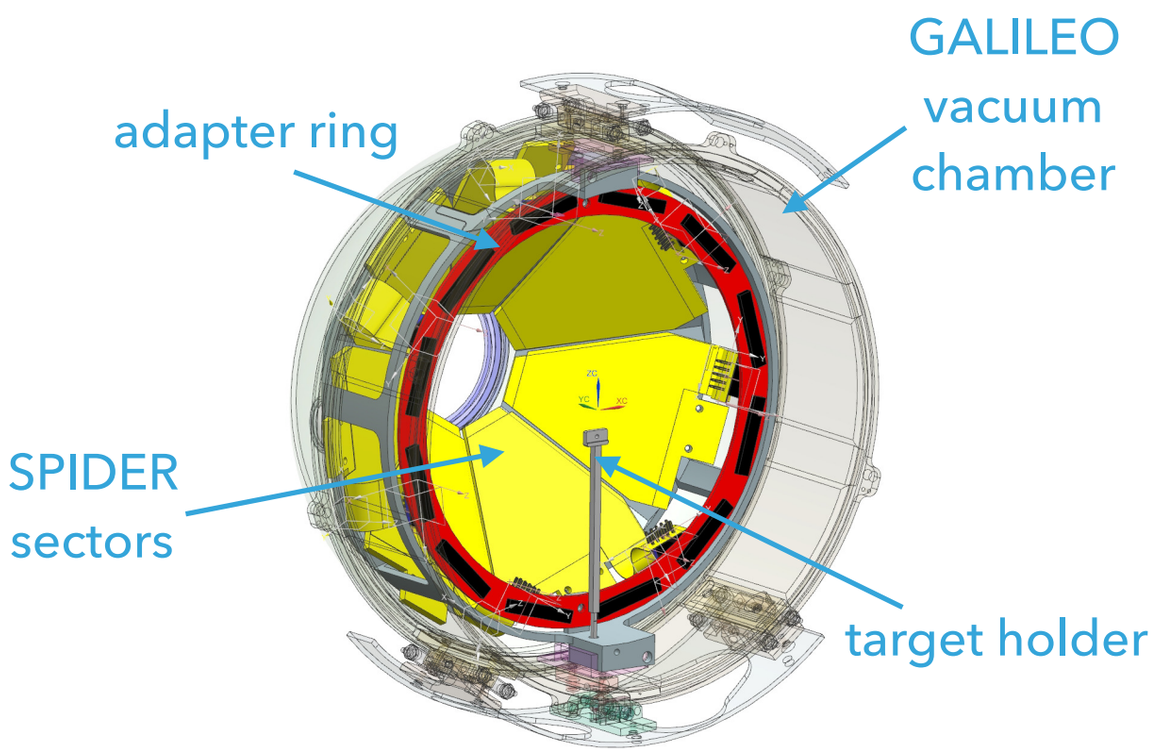




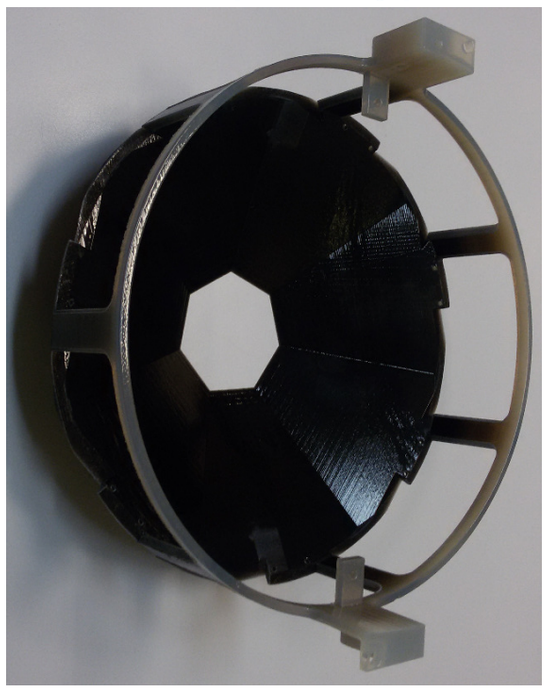


SPIDER & GALILEO @LNL

- Cone configuration to fit the GALILEO vacuum chamber
- Same acquisition system of EUCLIDES: 56 electronic channels can be used as trigger signals -> 56 needed for SPIDER (8 strips for 7 sectors)
- New mechanical frame and electronic adapter to connect SPIDER



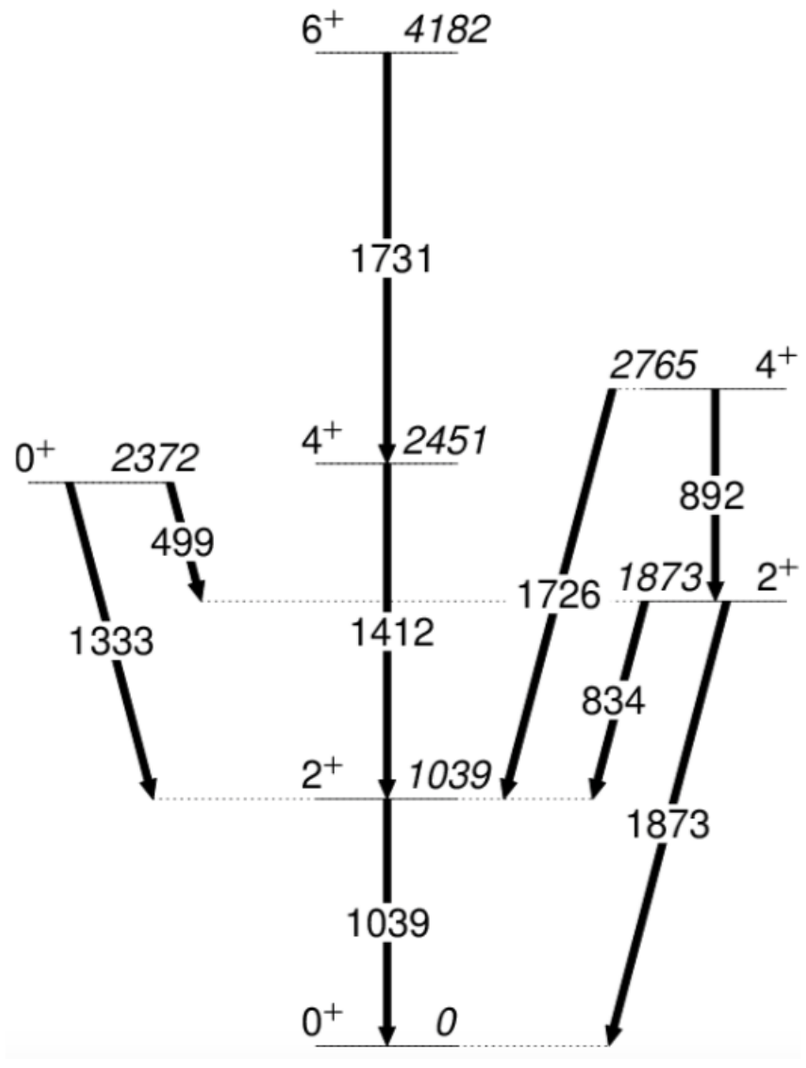
frame prototype



SPIDER & GALILEO @LNL

- First commissioning with GALILEO: from 11/07/2016 to 14/07/2016 @LNL
- ^{66}Zn @ 240 MeV on 1mg/cm^2 ^{208}Pb target, 4 days obtained
- High populated states (test), physics behind
- GOSIA estimations:

Transition	Energy [keV]	N/day x1000	N total x1000
$2_1 \rightarrow 0_1$	1040	1500	7500
$4_1 \rightarrow 2_1$	1411	10	50
$(6_1) \rightarrow 4_1$	1734	0.013	0.6
$2_2 \rightarrow 2_1$	834	145	780
$2_2 \rightarrow 0_1$	1872	0.15	0.7
$0_2 \rightarrow 2_1$	1333	16	80
$0_2 \rightarrow 2_2$	500	0.1	0.5
$4_2 \rightarrow 2_1$	893	0.2	1
$4_2 \rightarrow 2_2$	1726	0.2	1



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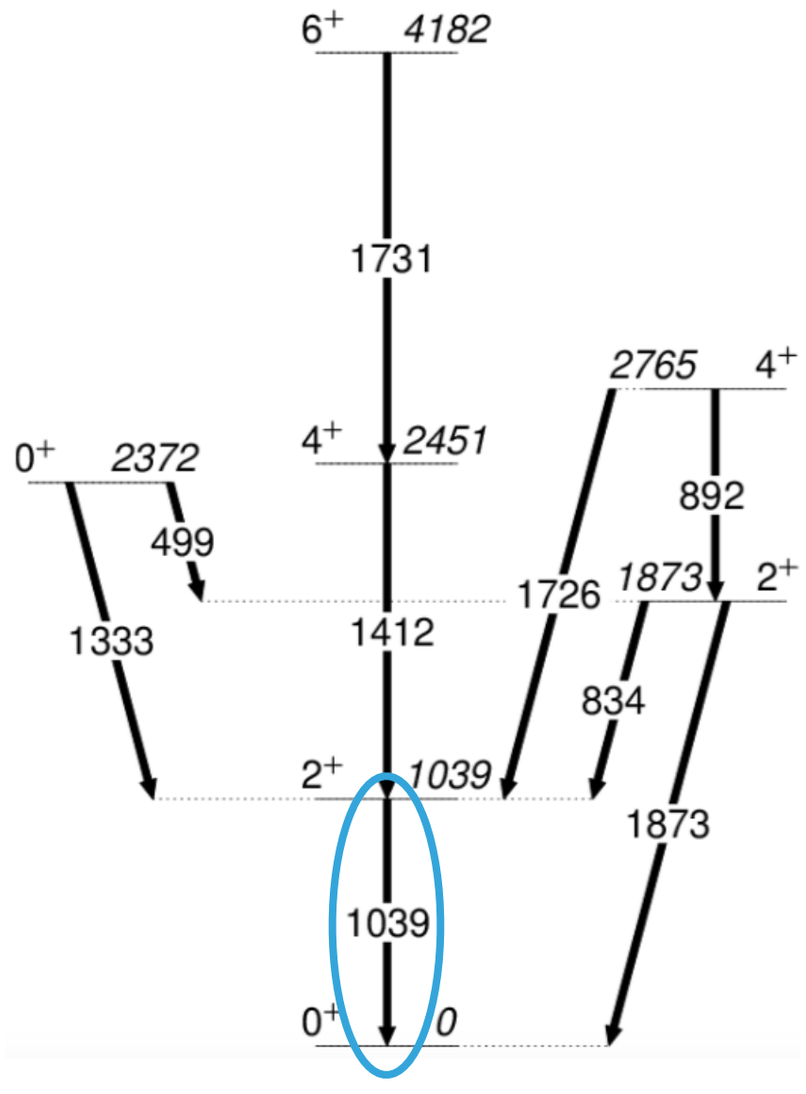

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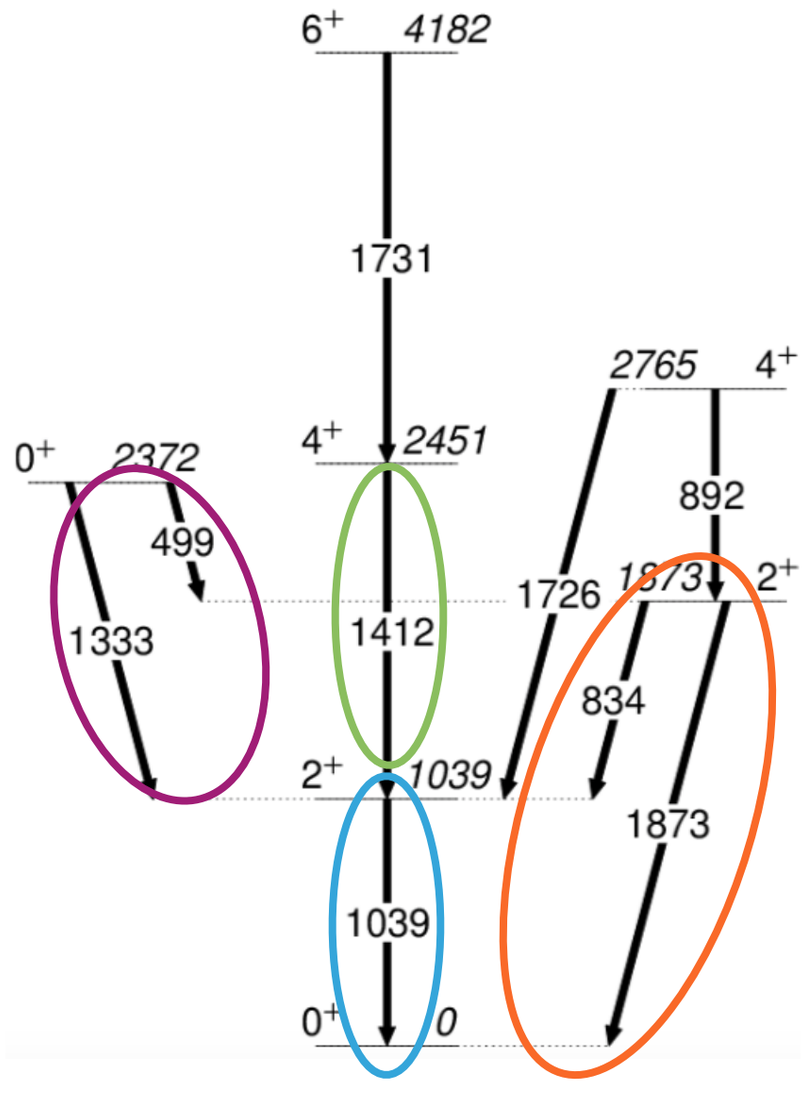

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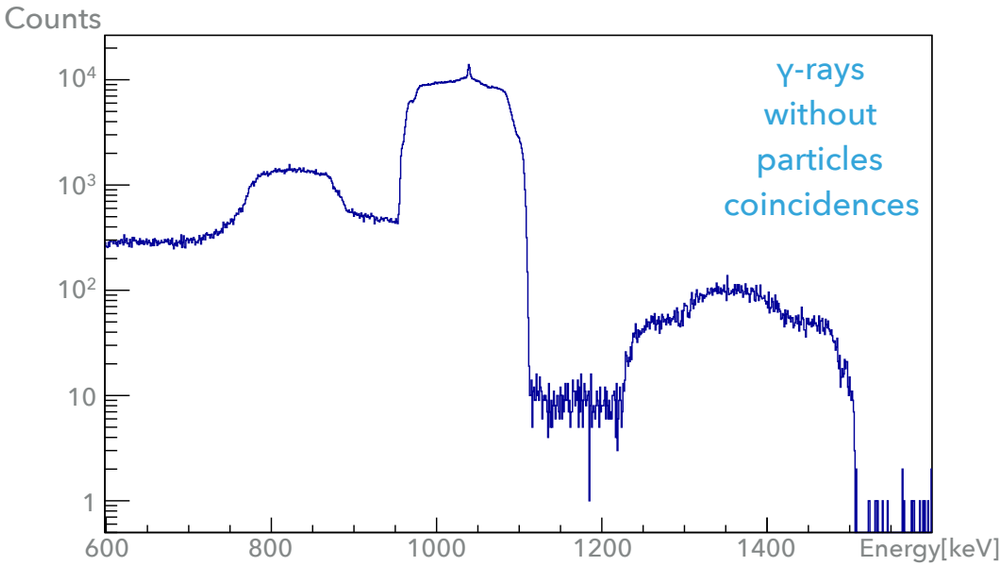
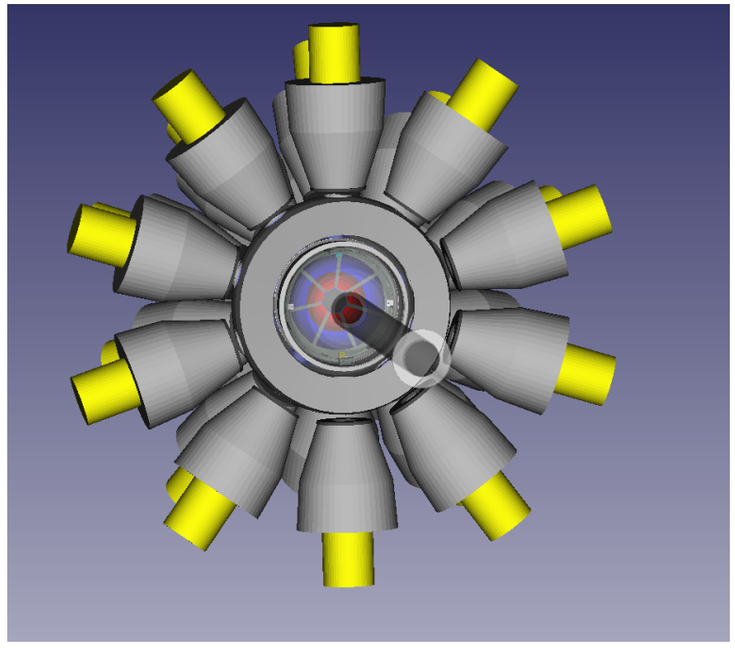
- GEANT4 simulations: ^{66}Zn





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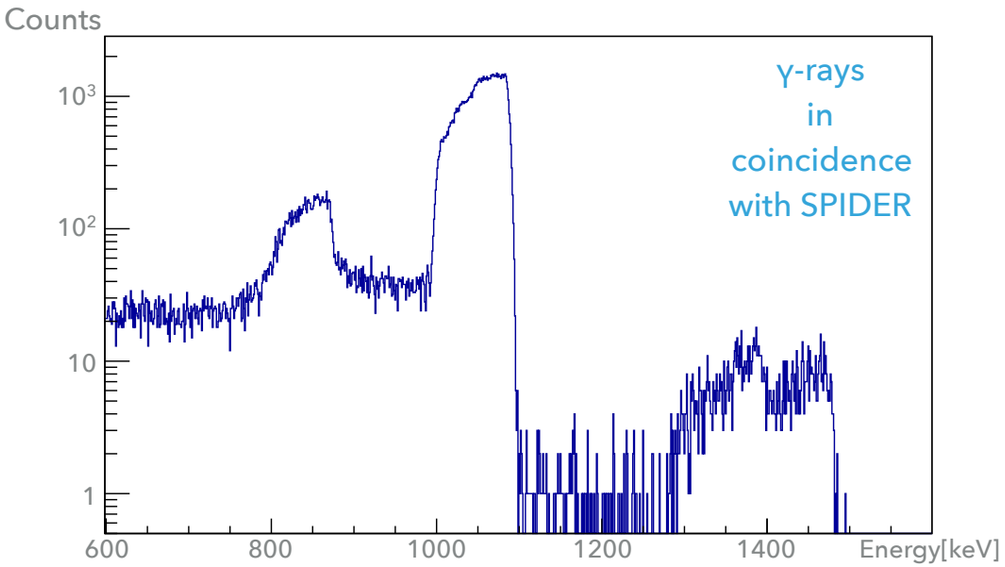

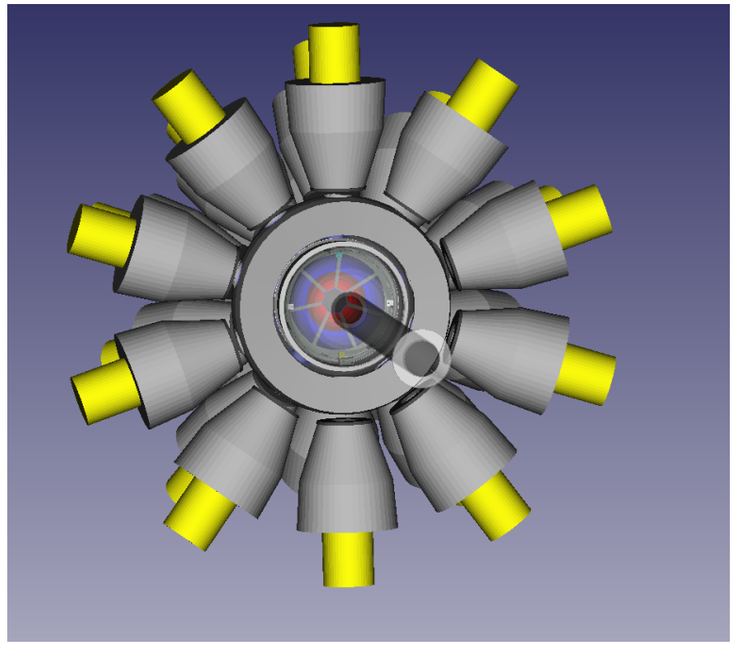

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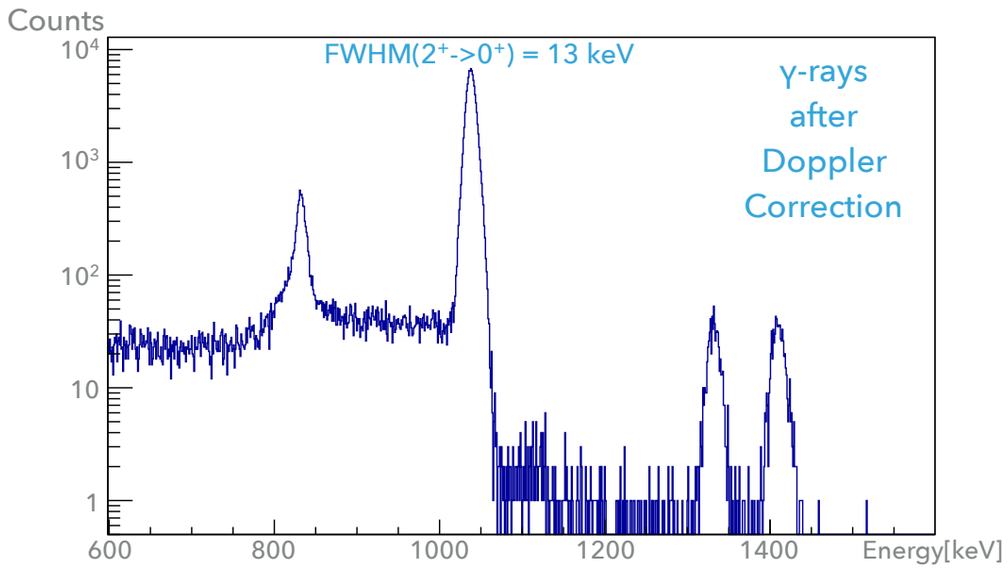

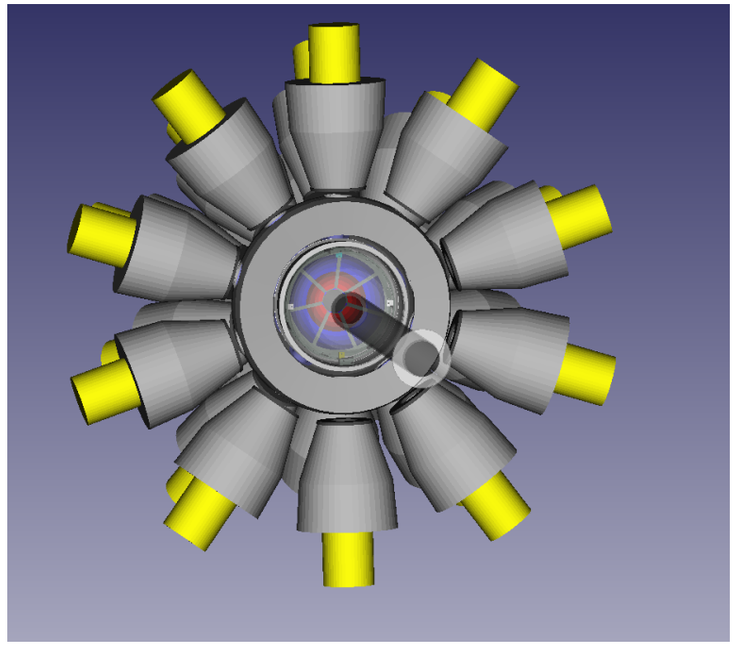

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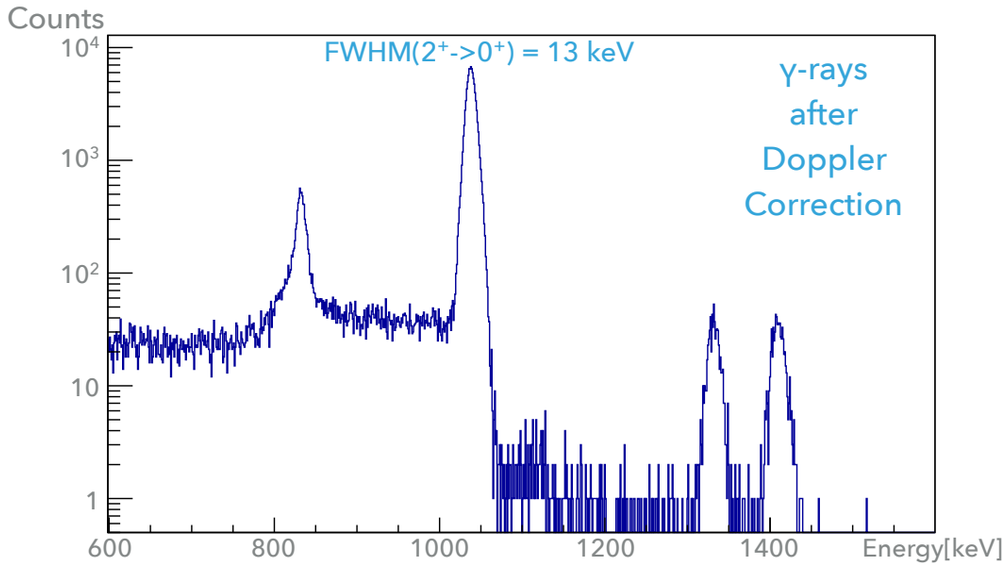
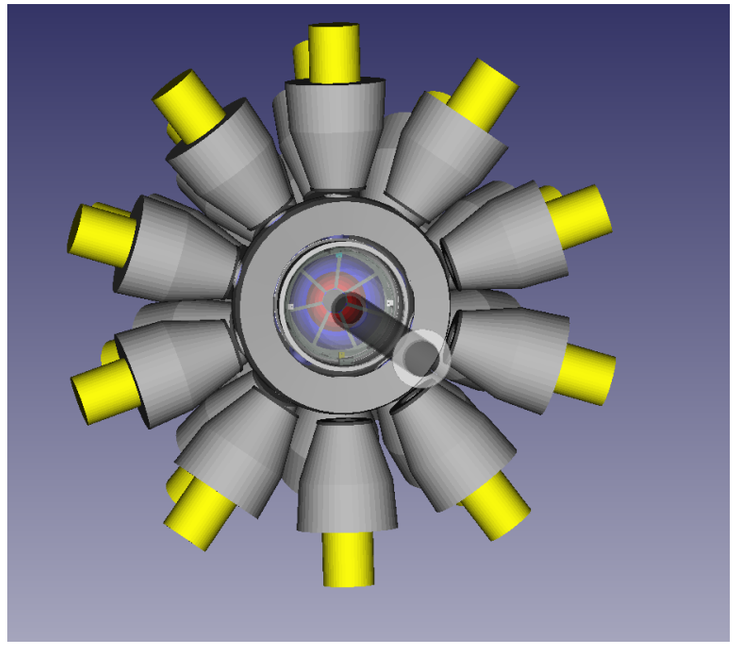
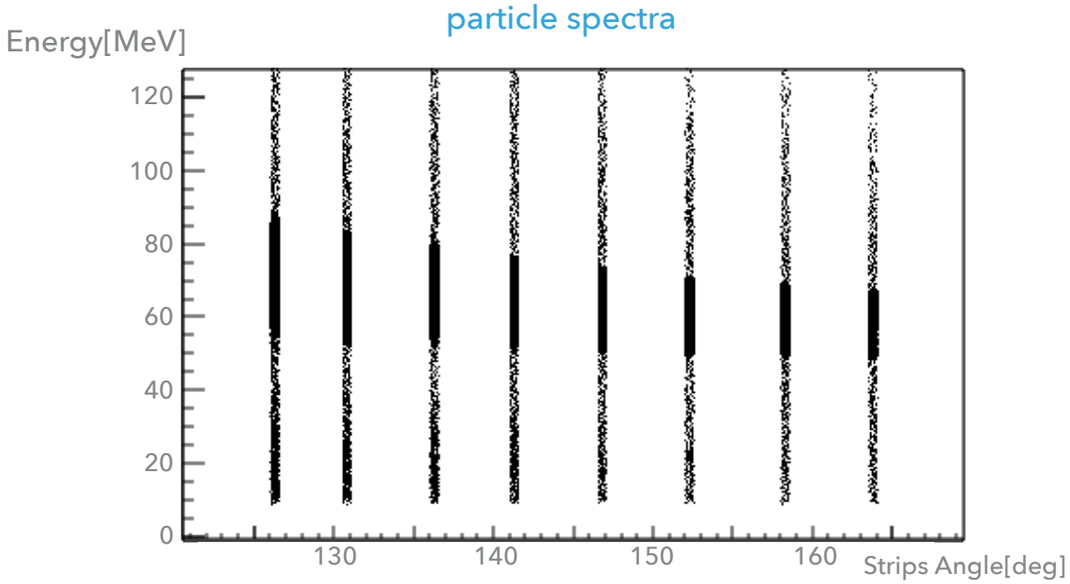




particle spectra



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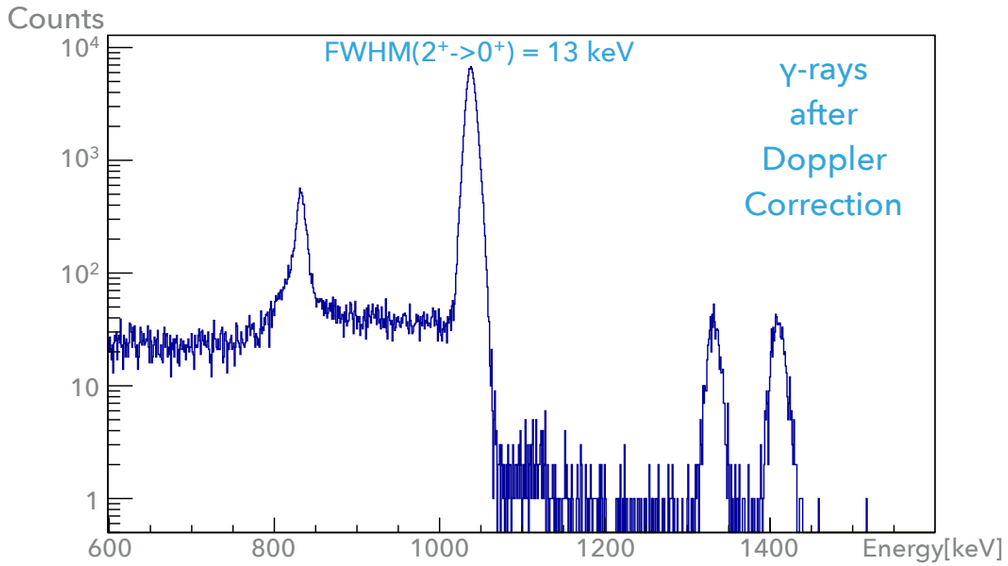

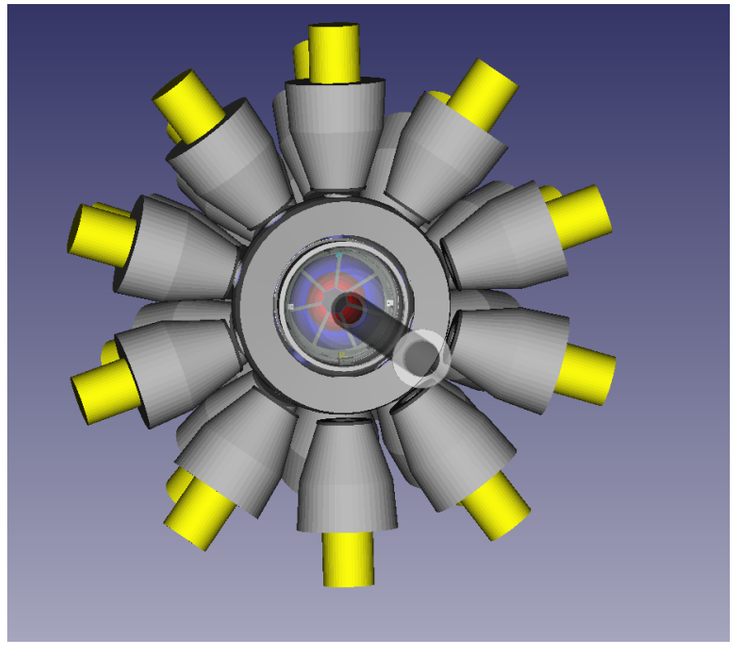

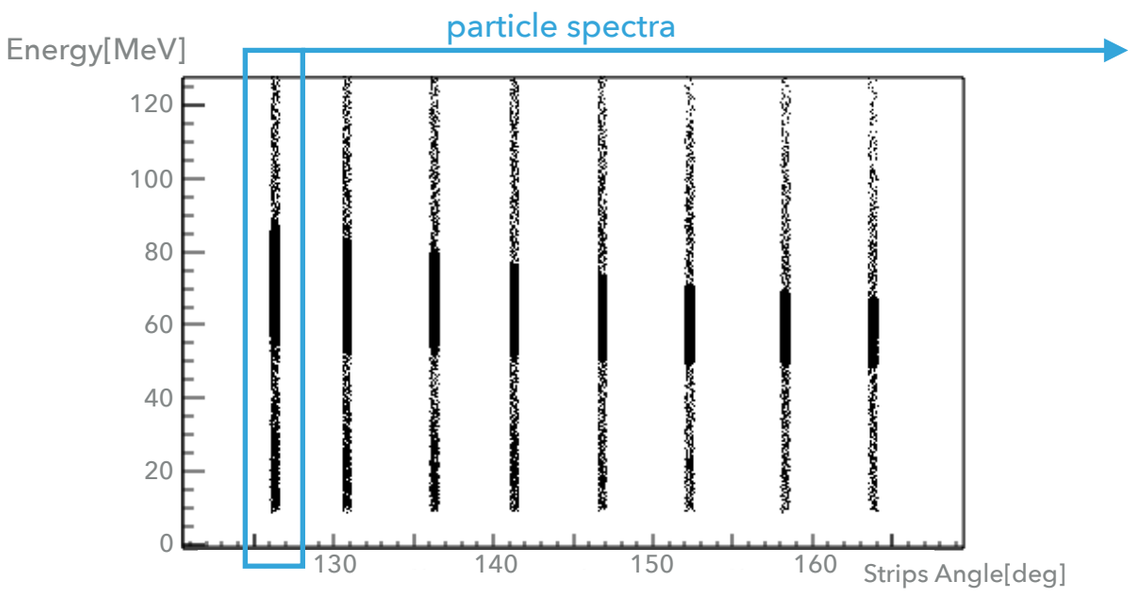

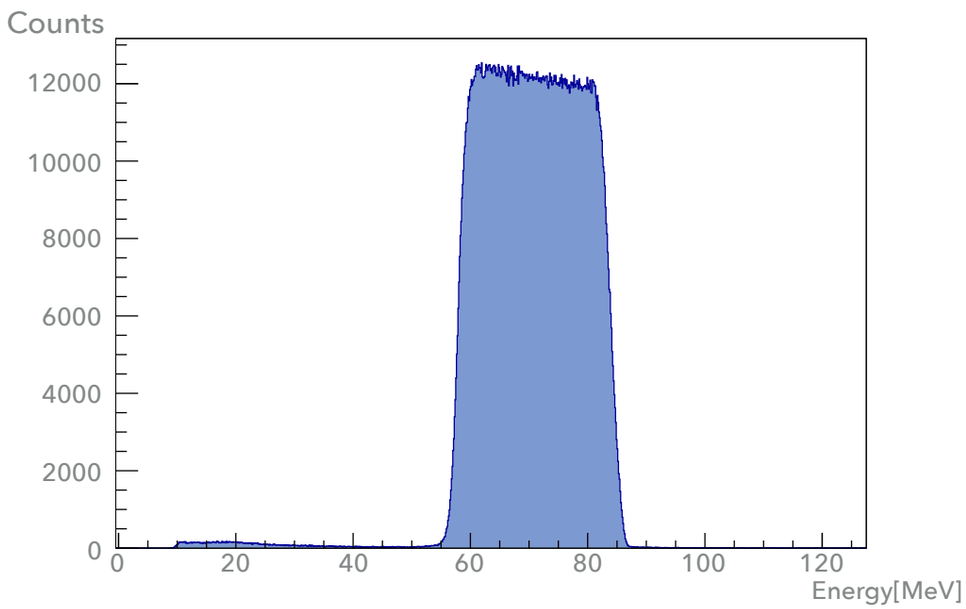

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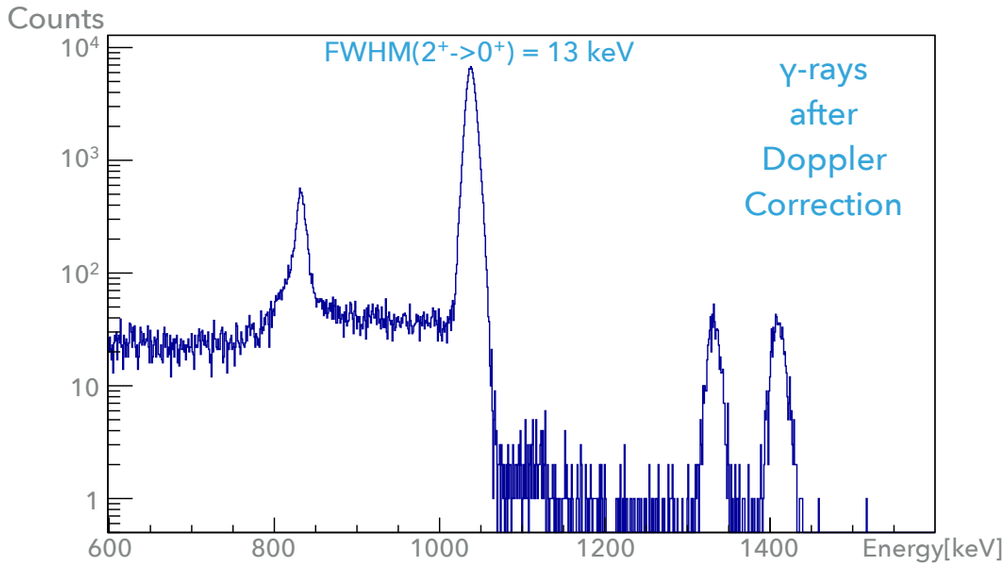

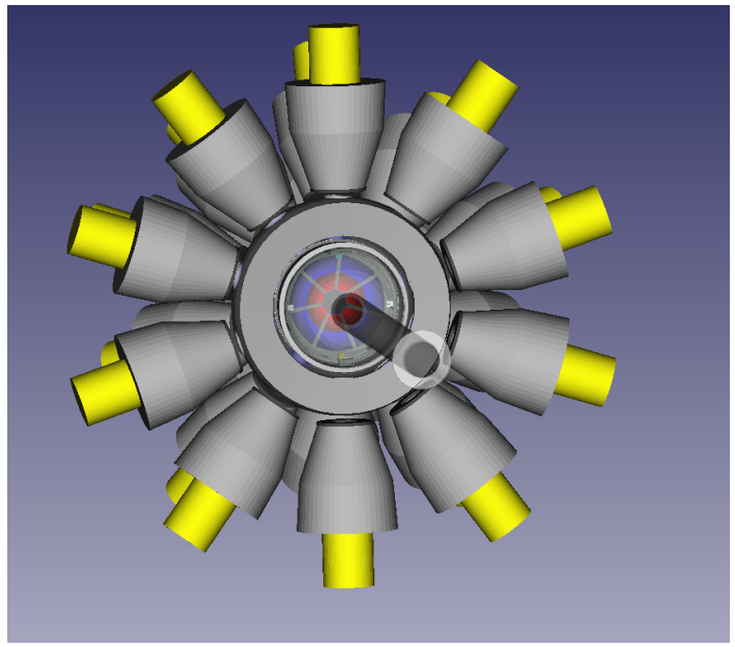

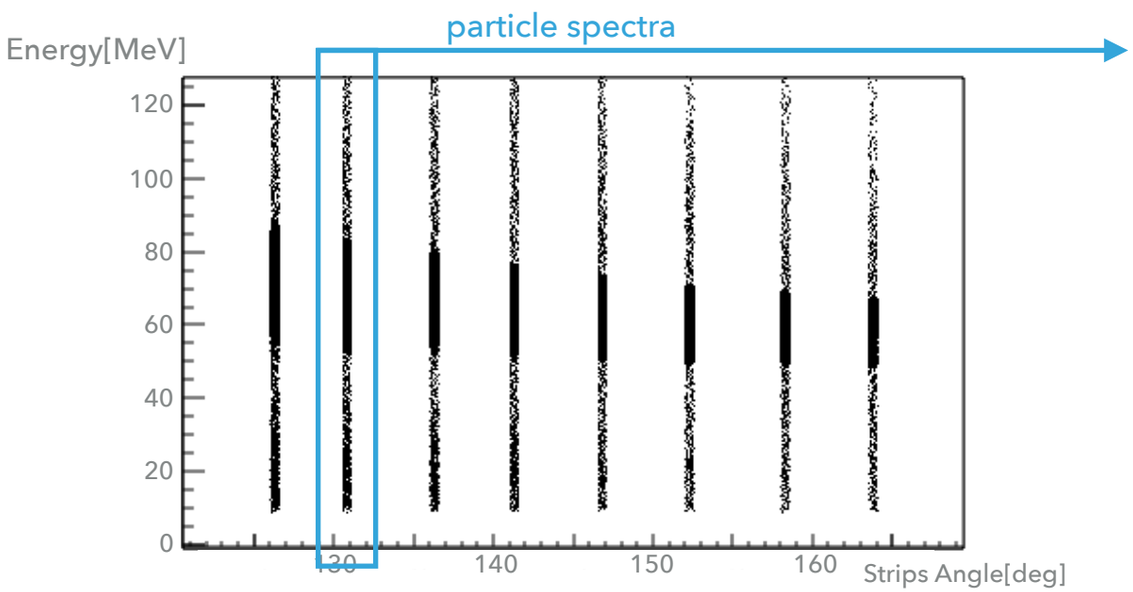

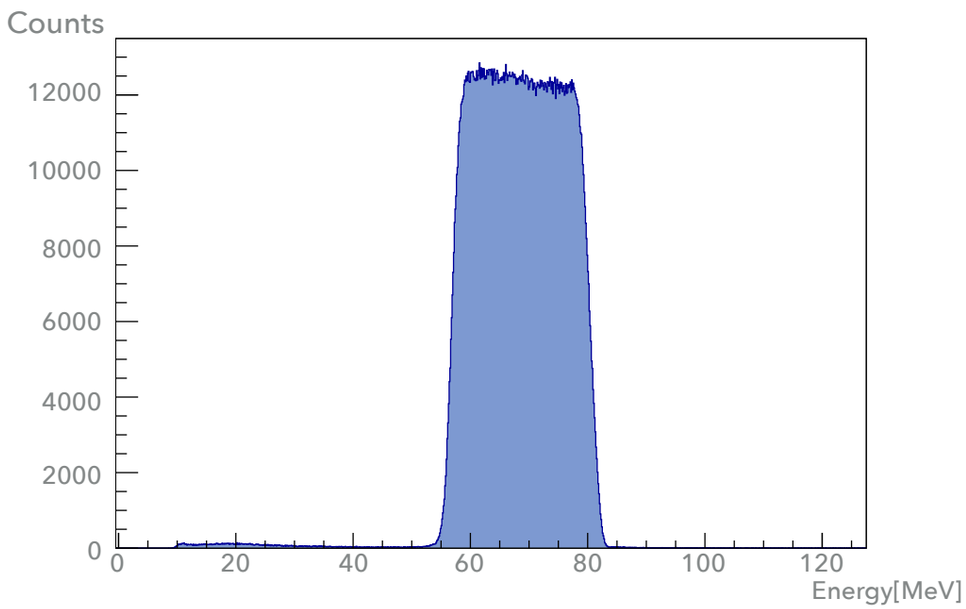

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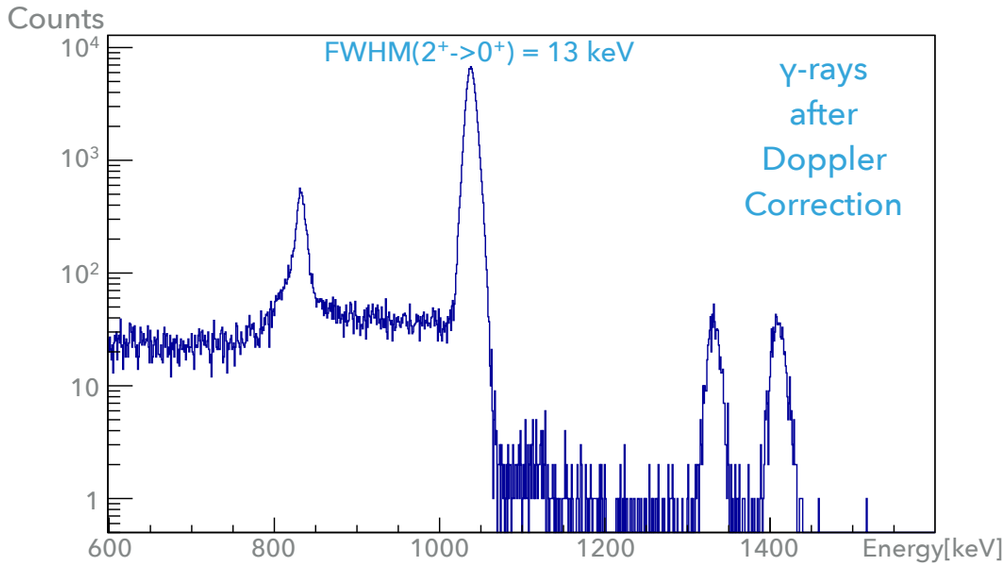

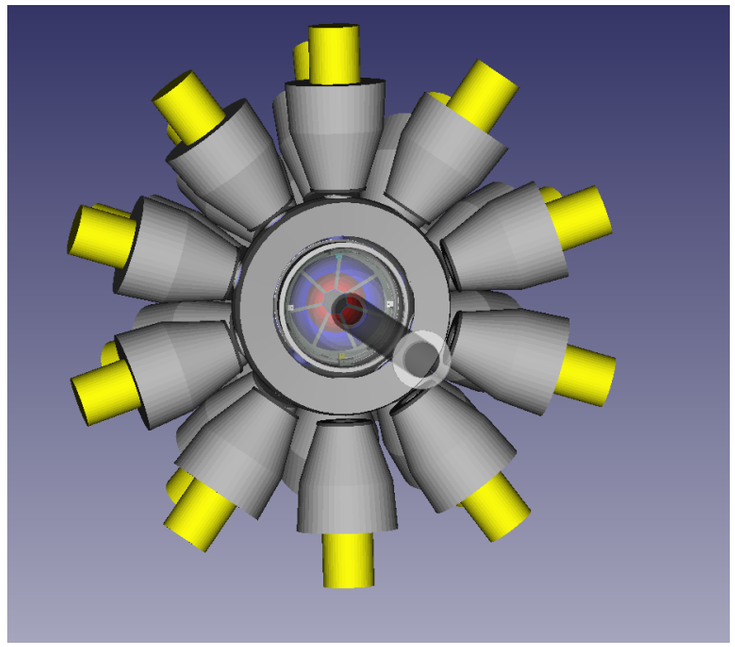

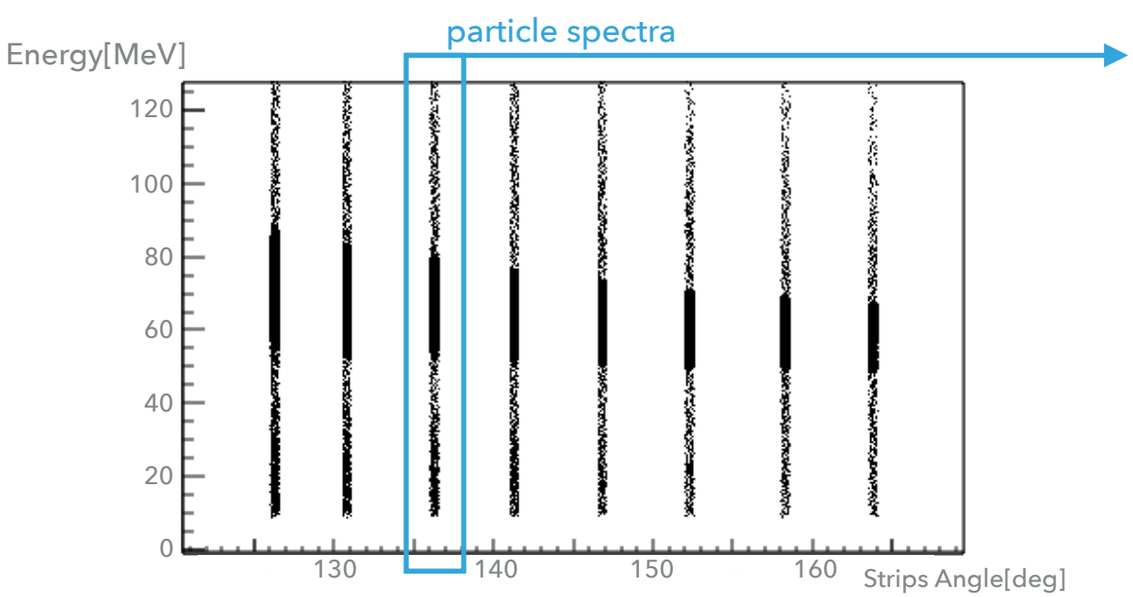

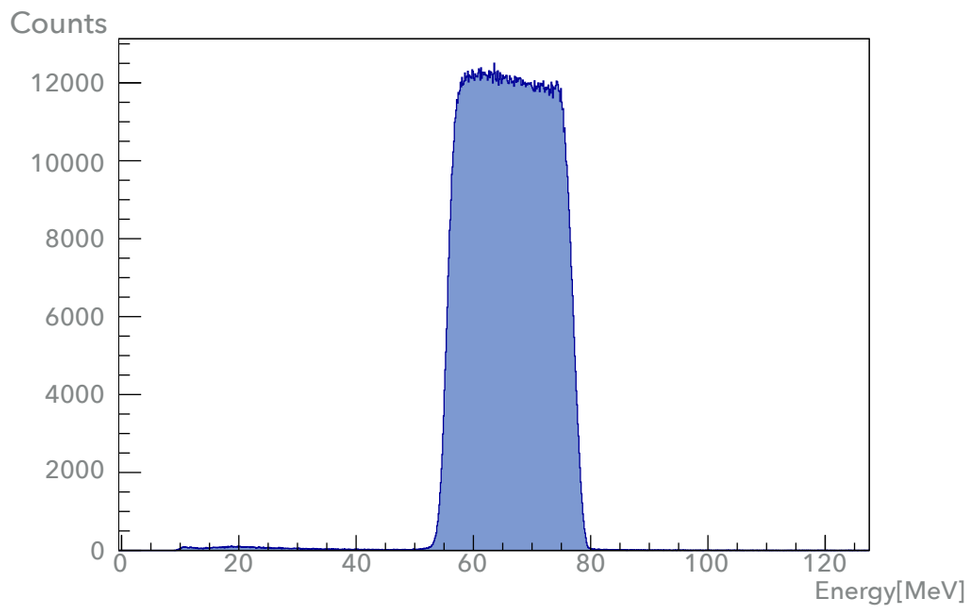

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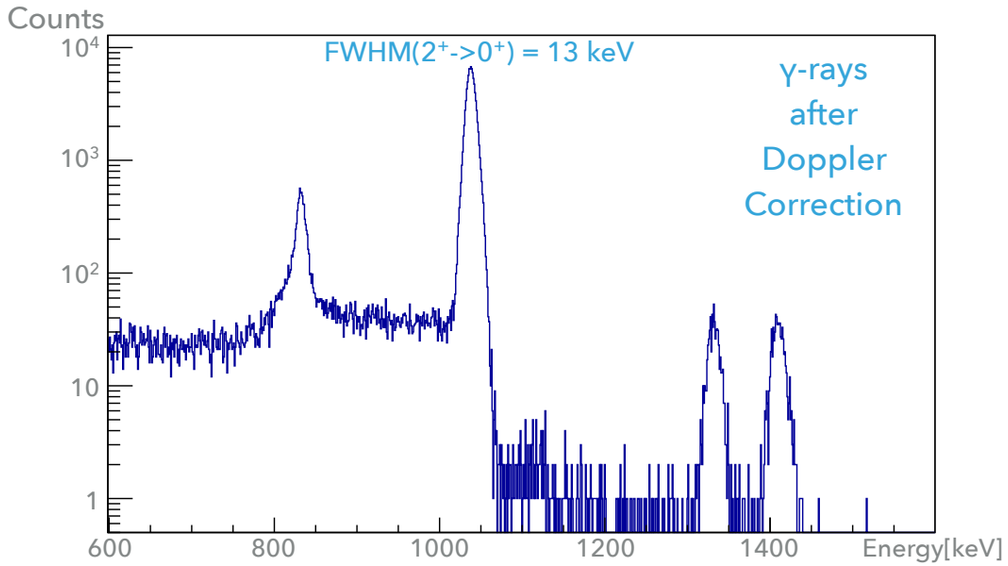

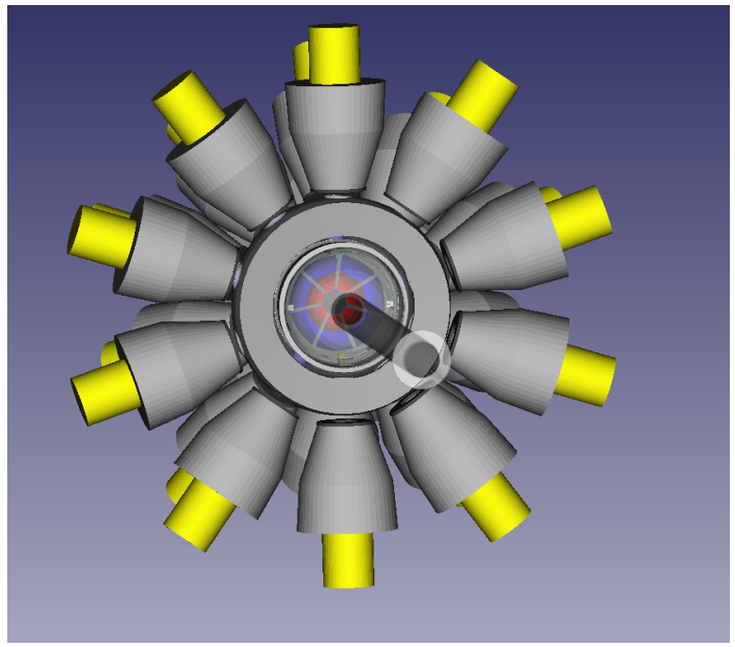

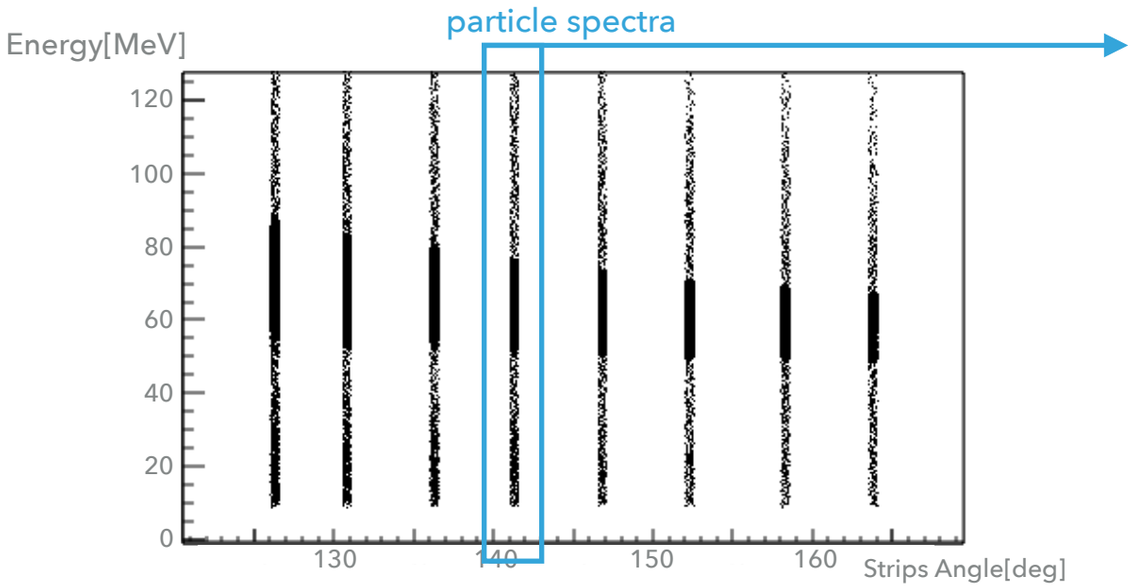

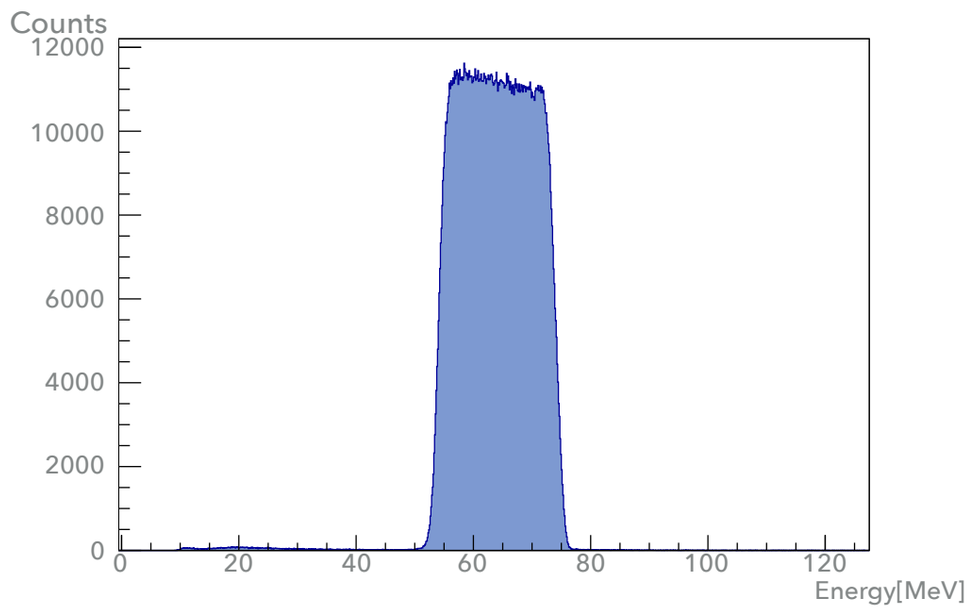

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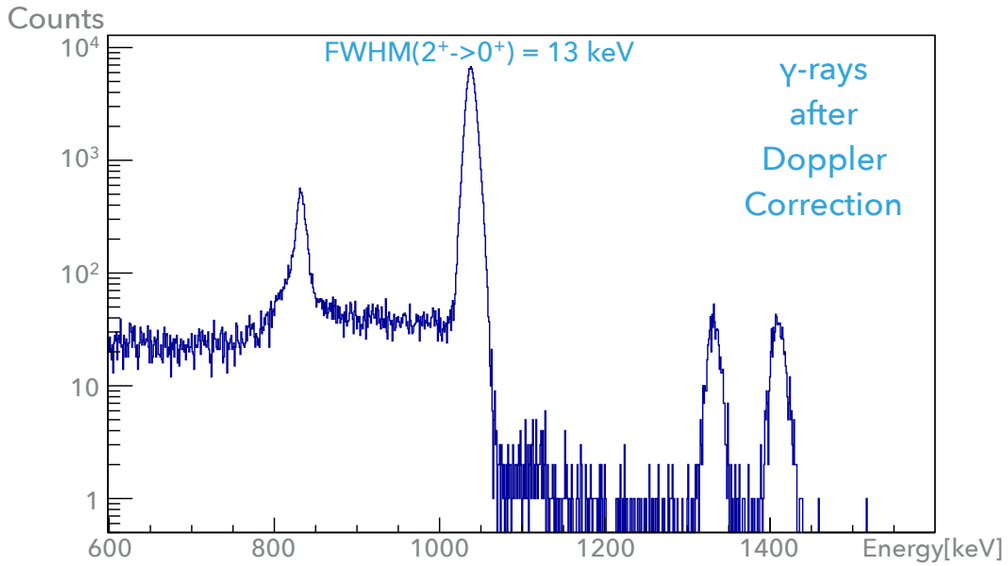

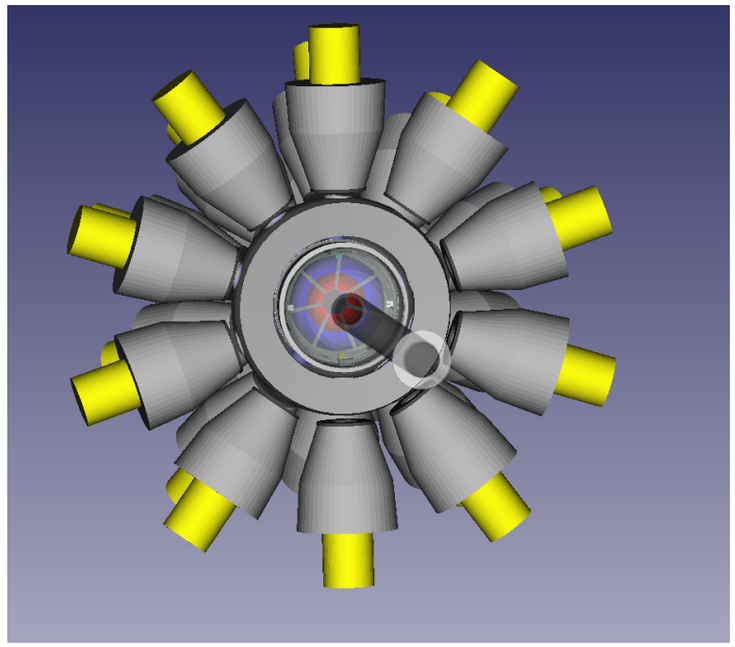

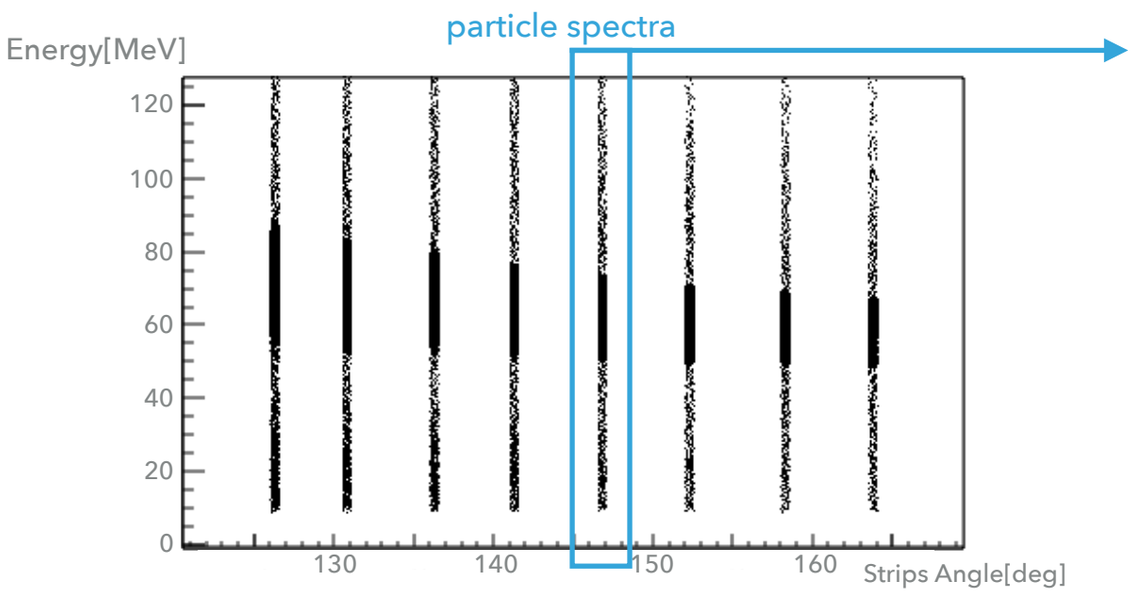

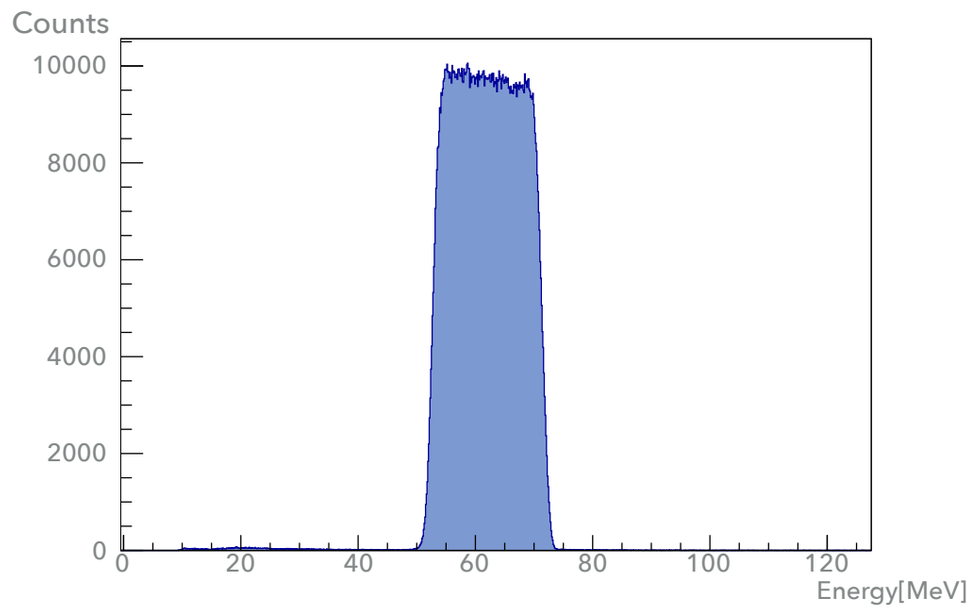

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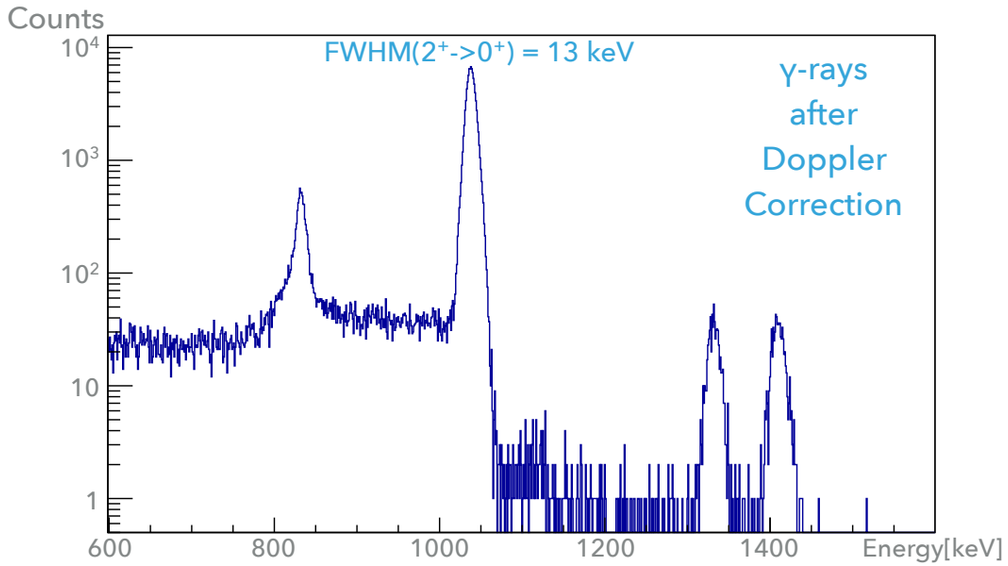

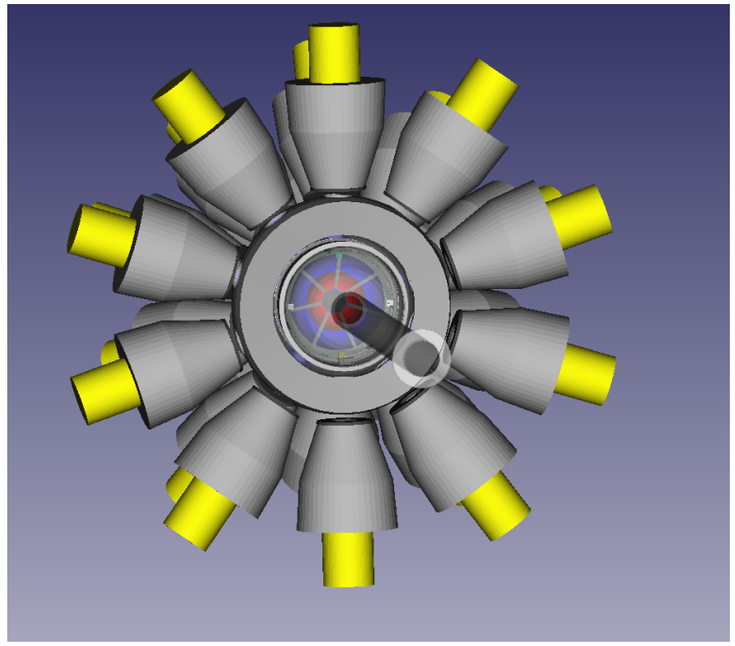

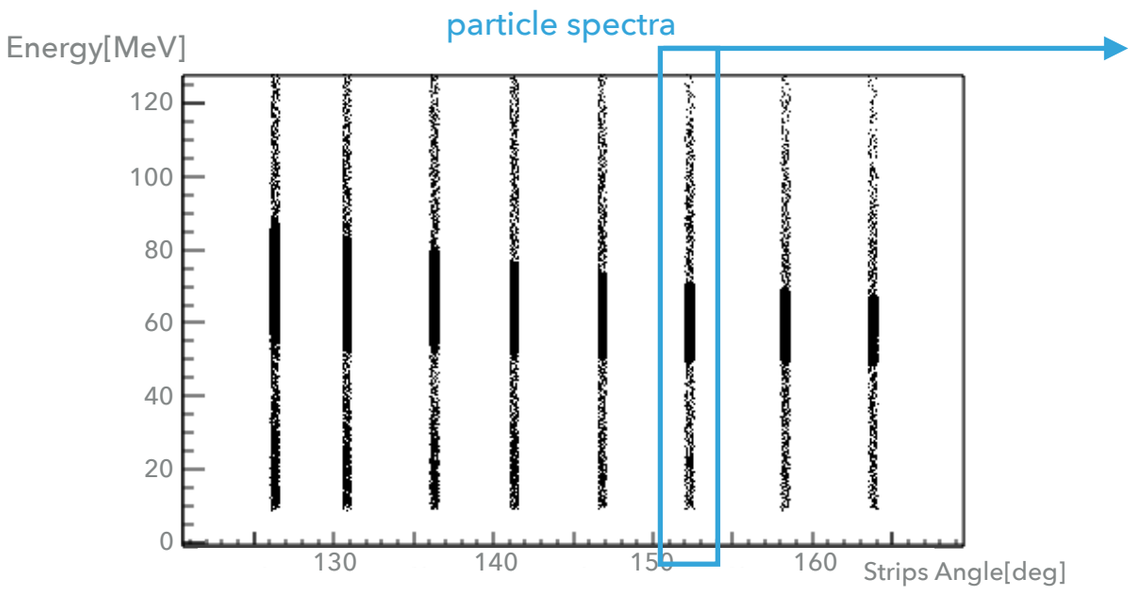

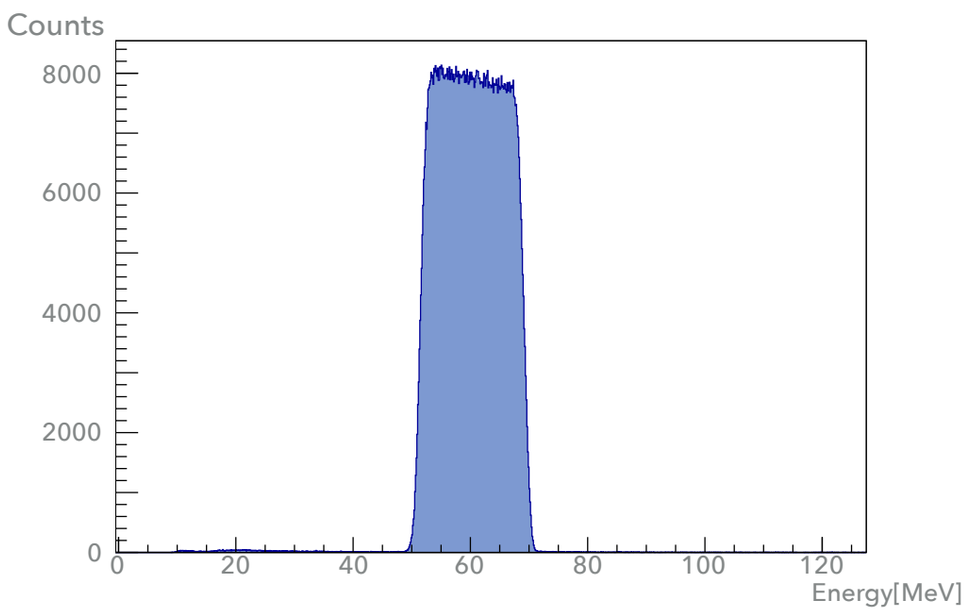

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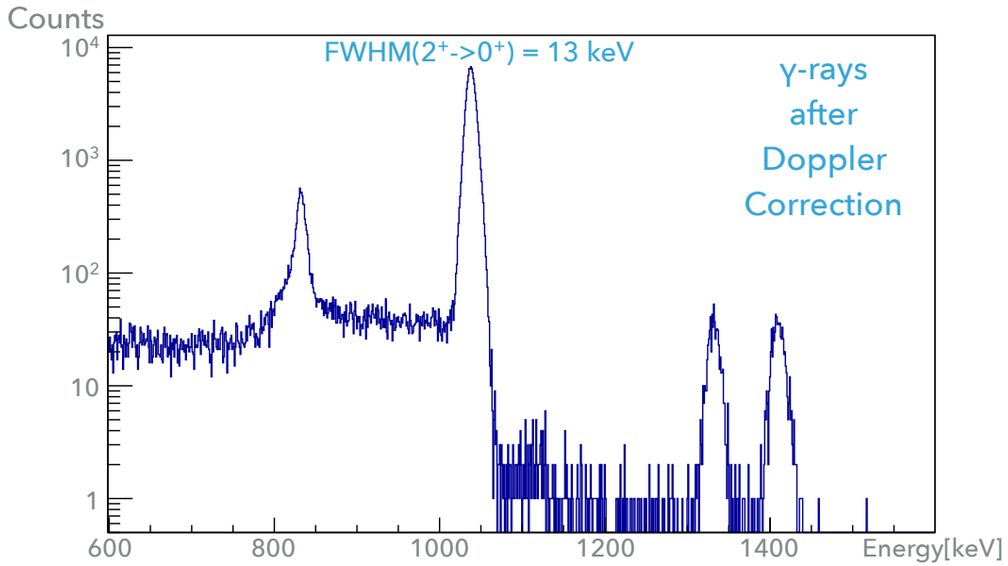

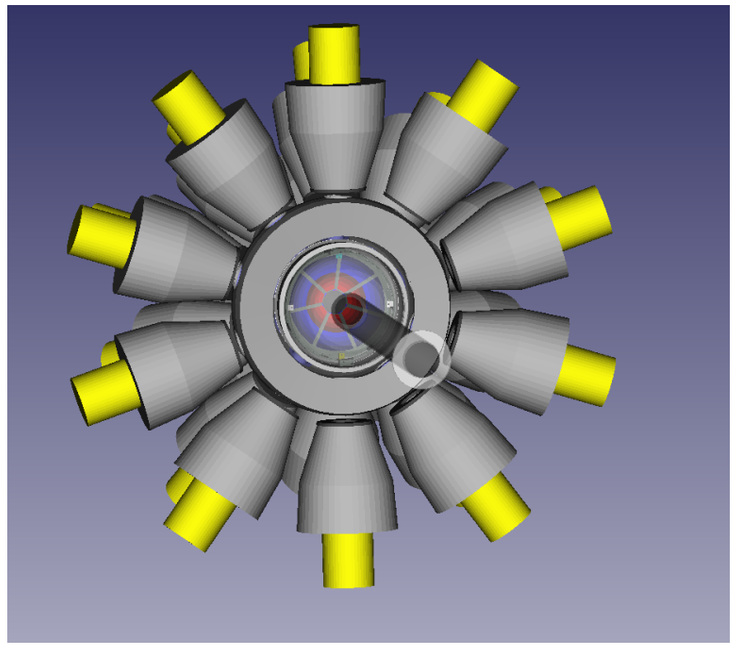

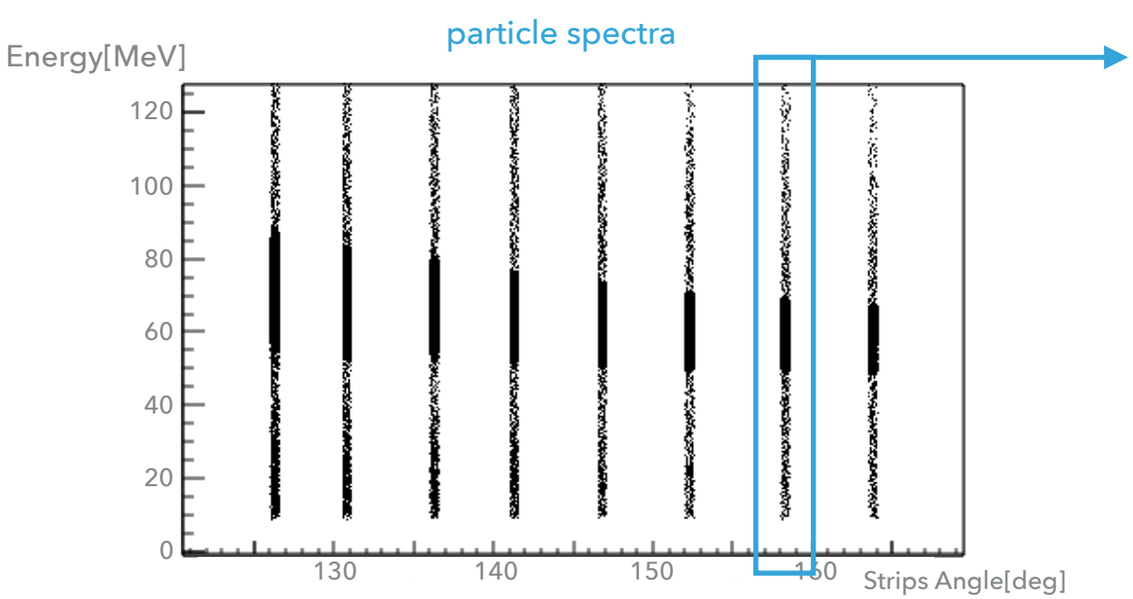

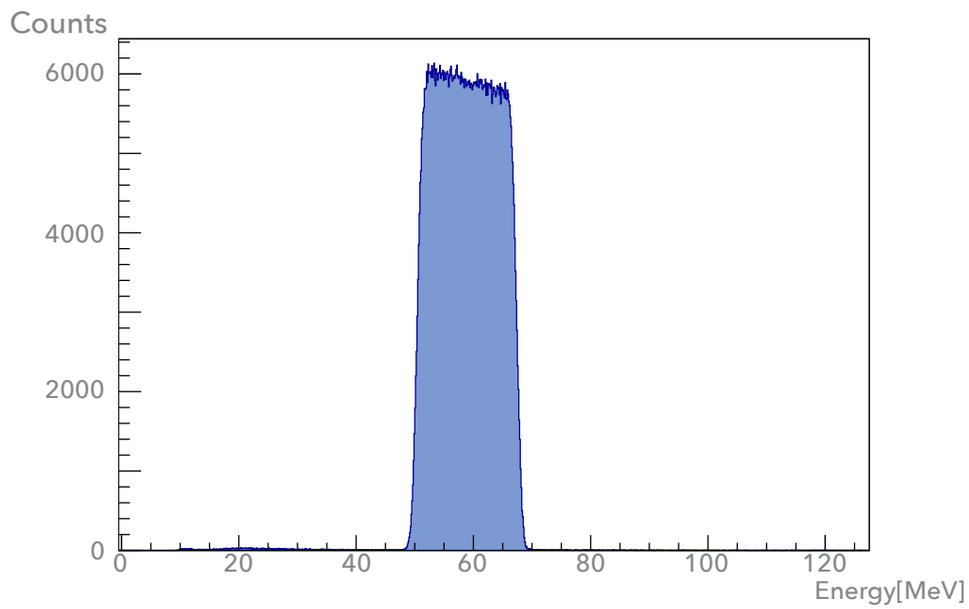

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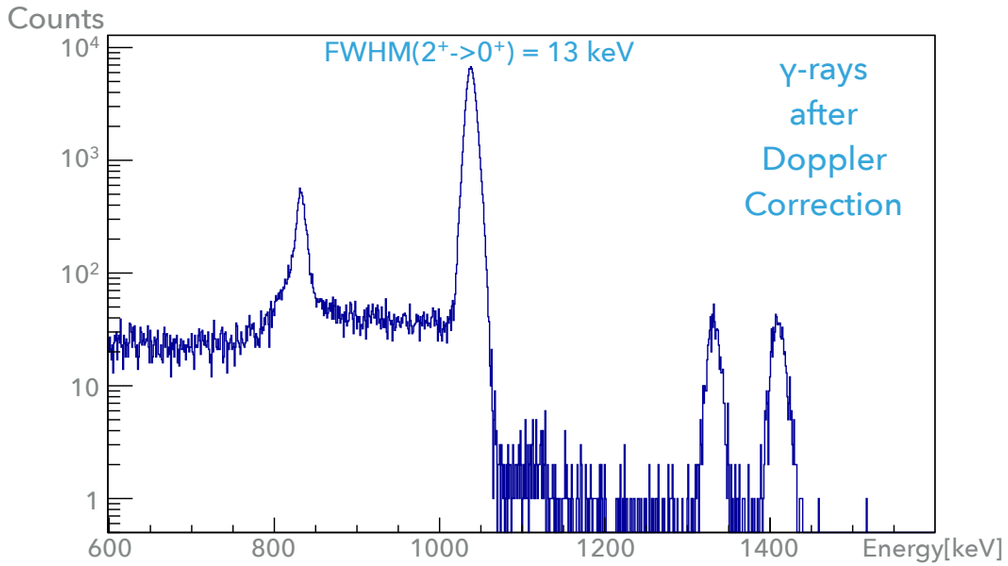
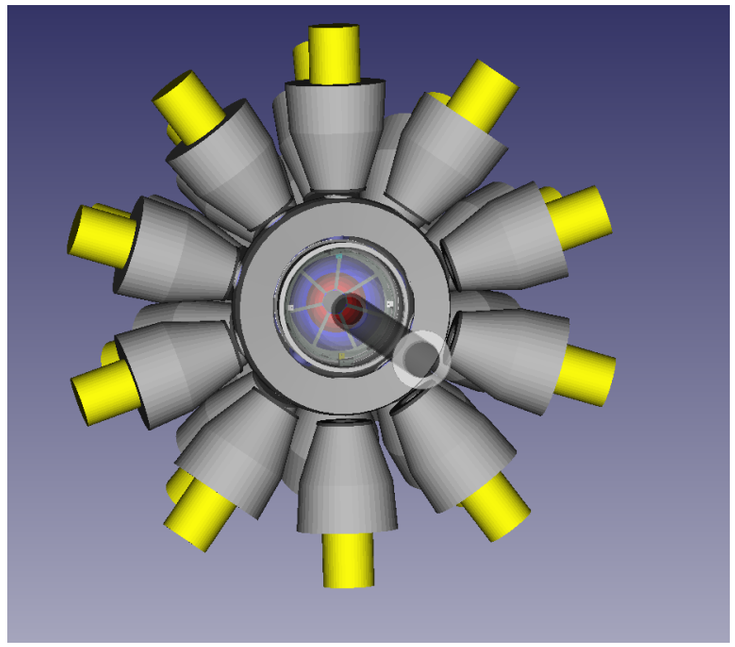
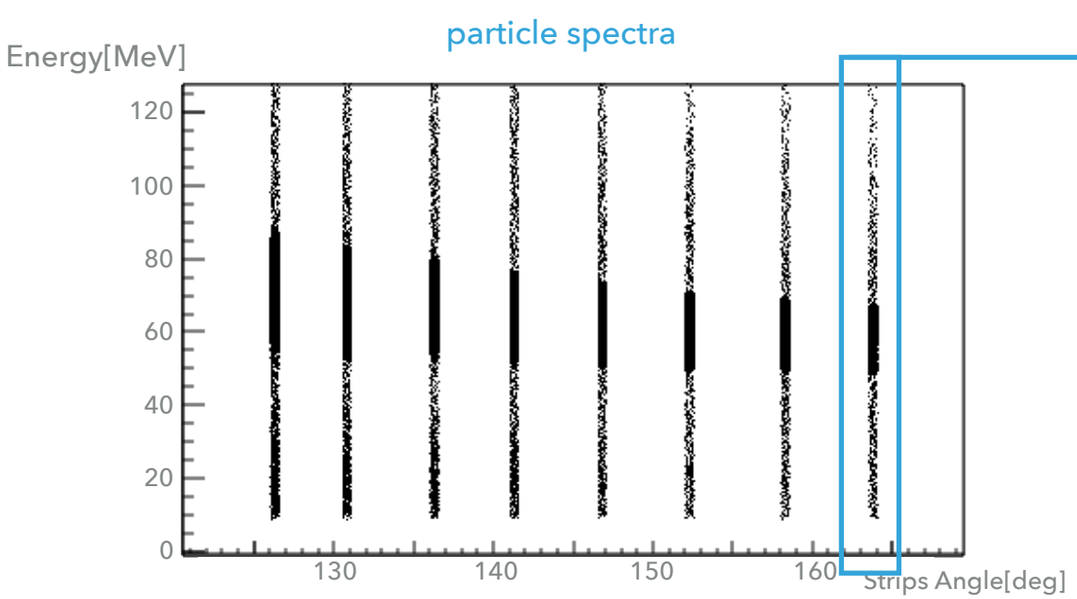
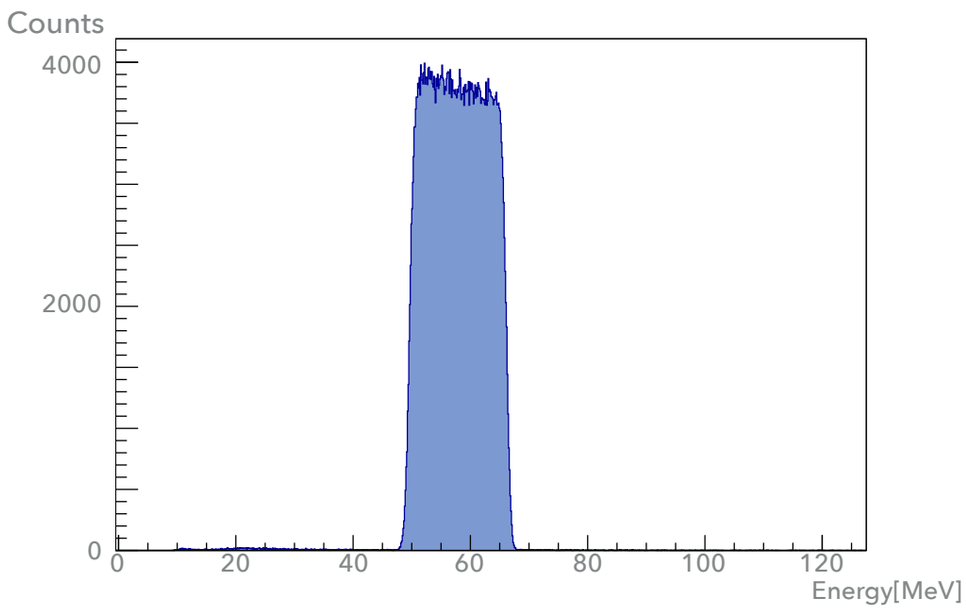


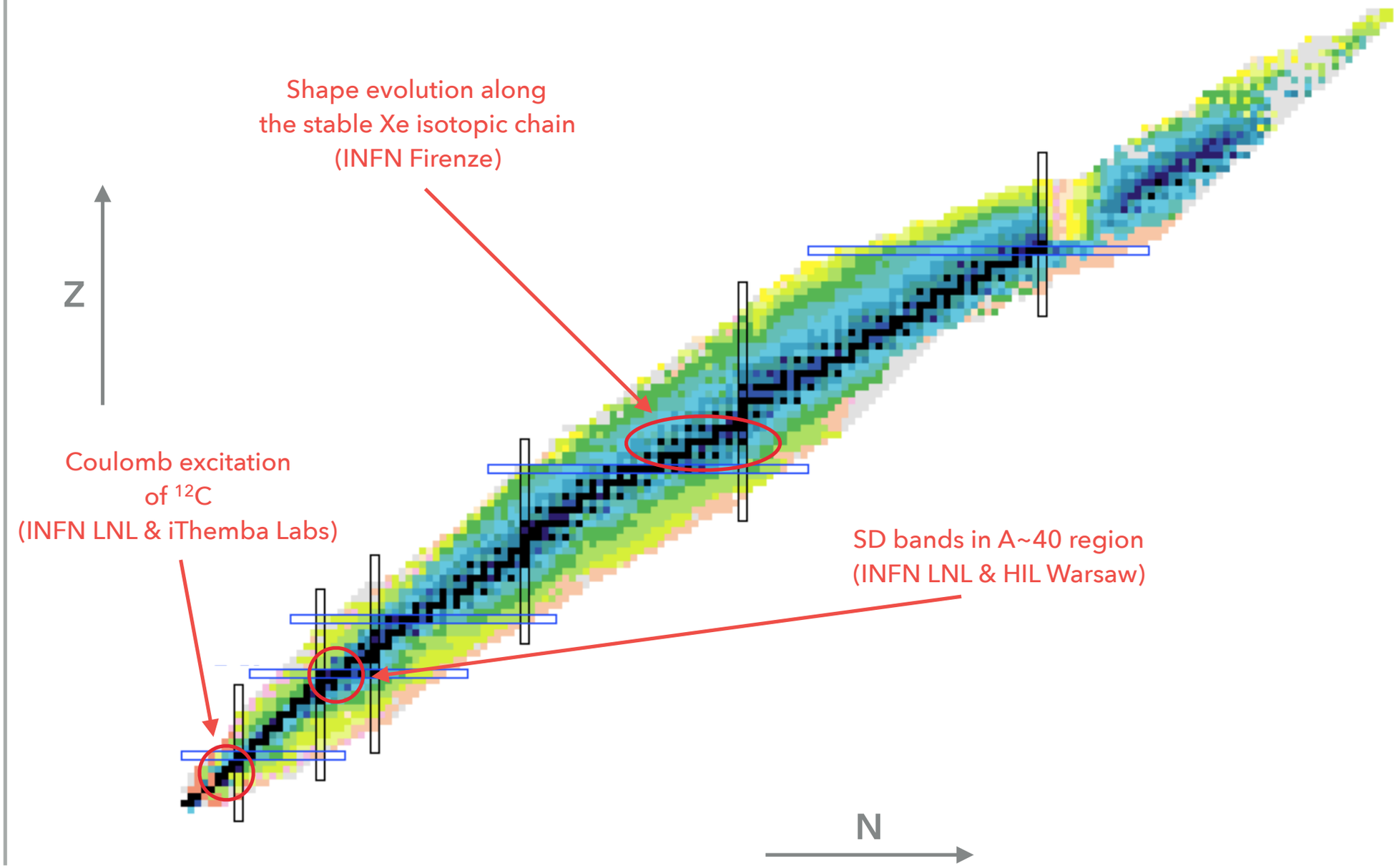






SPIDER & GALILEO @LNL

- Physical cases: stable beams



SPIDER & GALILEO @LNL

- Physical cases: stable beams

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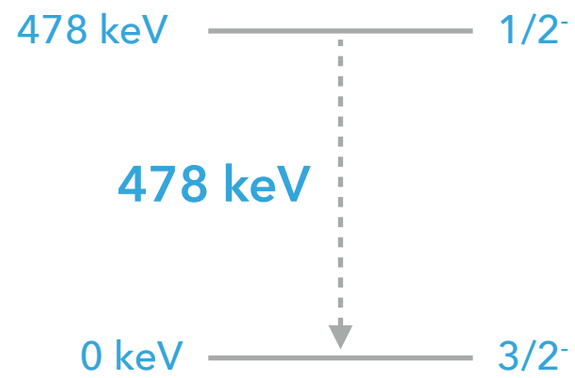
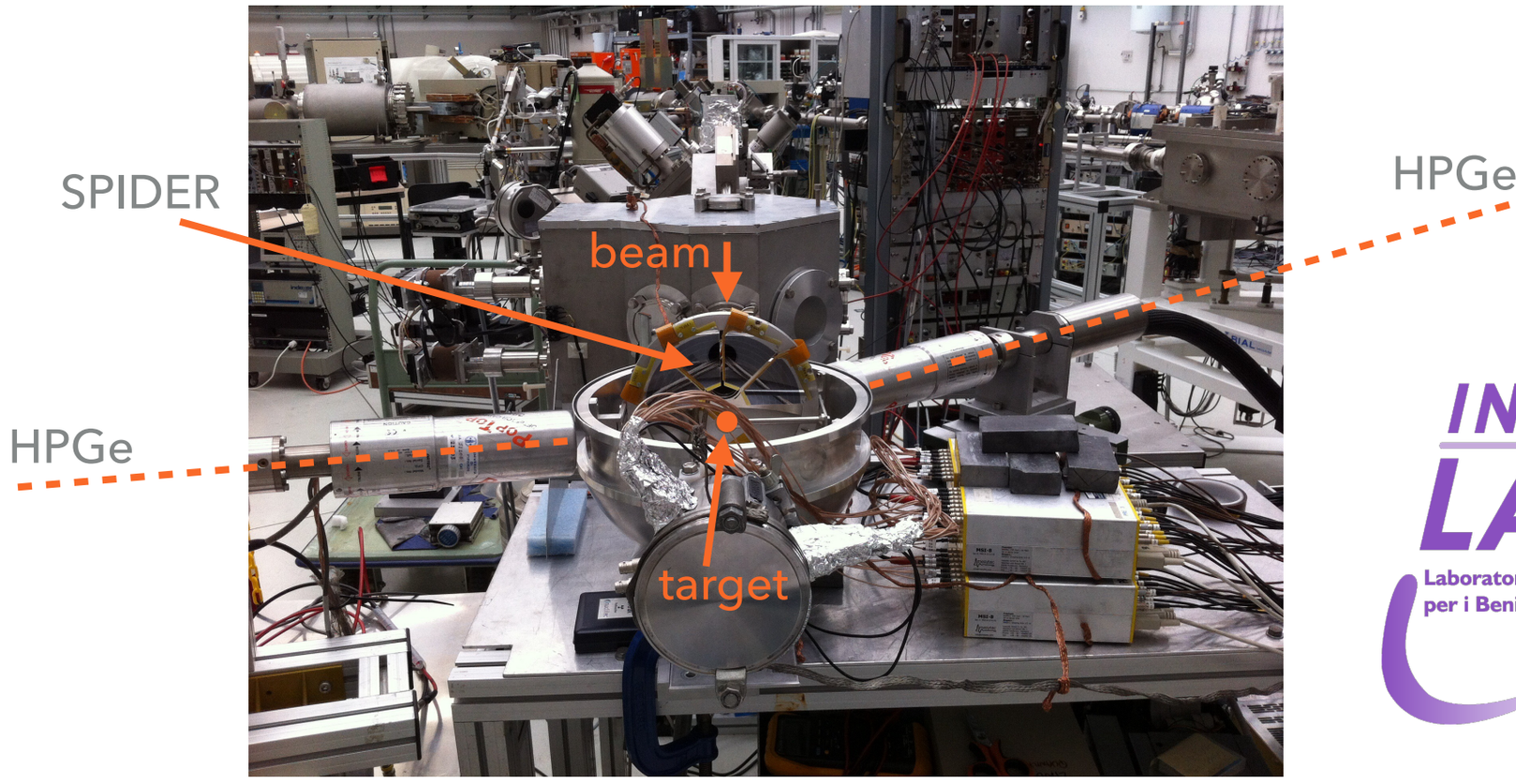
SPIDER @LABEC: ^{7}LI

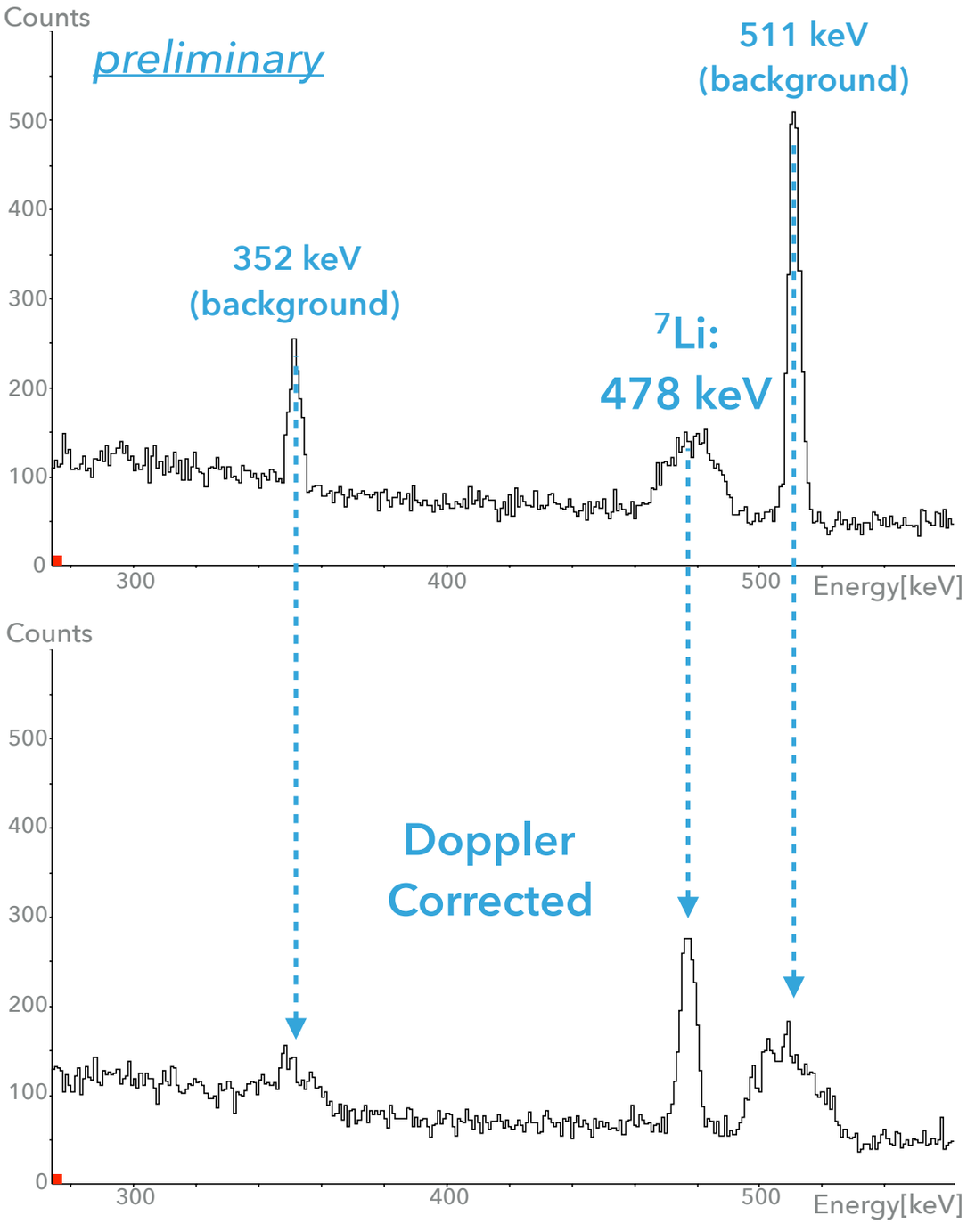
- ^{7}Li @ 6 MeV on 0.5 mg/cm^{2} ^{27}Al target
- Safe energy (180°) = 6.35 MeV
- 4 SPIDER sectors (backward angles), 2 HPGe detectors
- 31 h of beam time (~1 pnA)



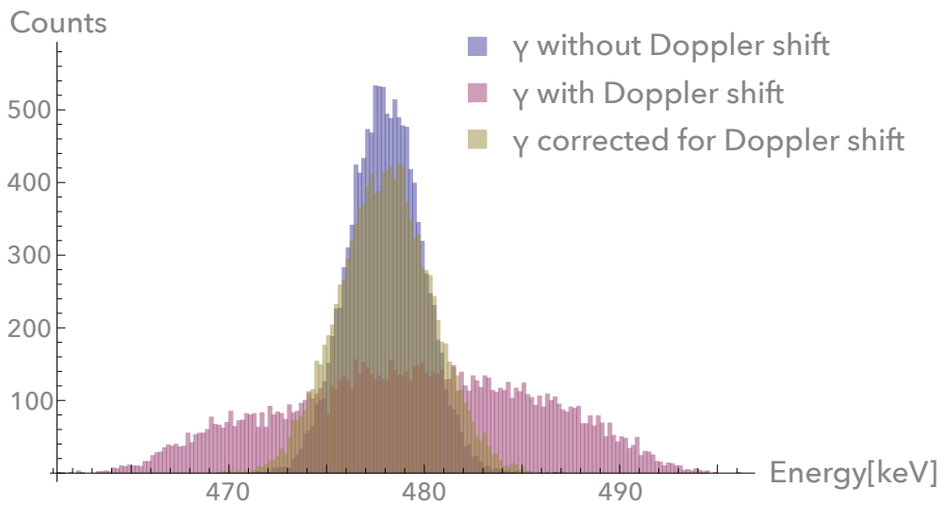


- Introduction
- SPIDER& GALILEO @LNL
- **SPIDER @LABEC: ^{7}Li**
- Coulomb excitation @SPES

SPIDER @LABEC: ^{7}LI

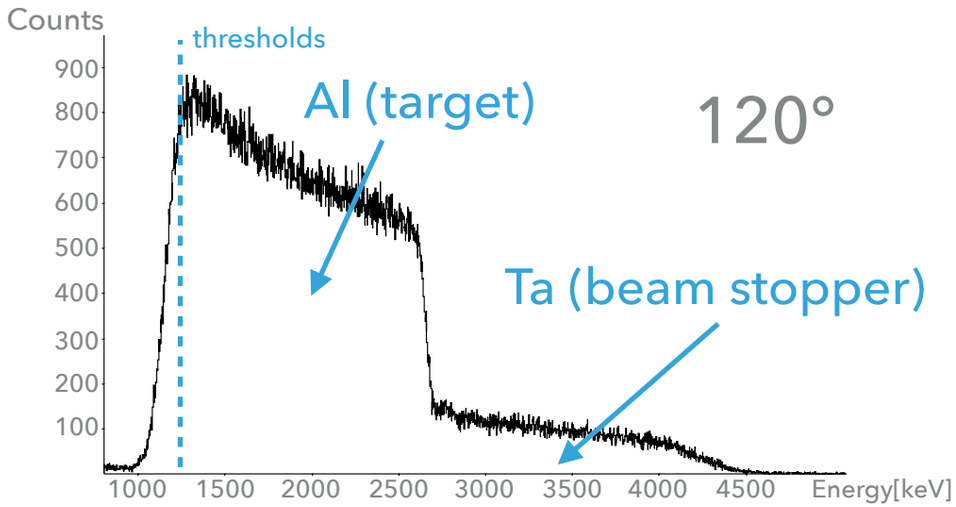


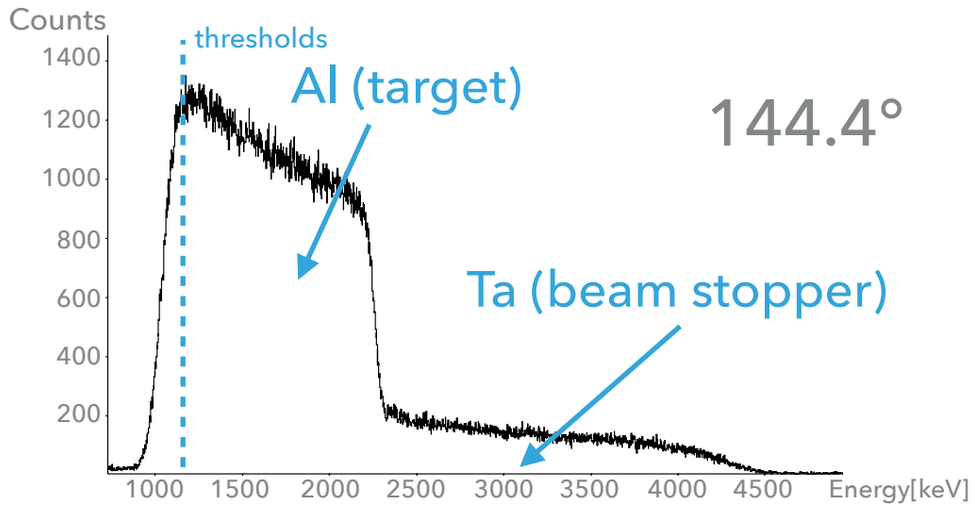
- Gamma spectra: 478 keV (from the first excited level 1/2- -> 3/2-)
- Random coincidences: natural background
- Doppler correction: from FWHM = 18.4 keV to FWHM = 5.7 keV (intrinsic FWHM (@ 478 keV) = 4.3 keV)
- Simulations: FWHM after Doppler correction = 5.3 keV



SPIDER @LABEC: ^{7}LI

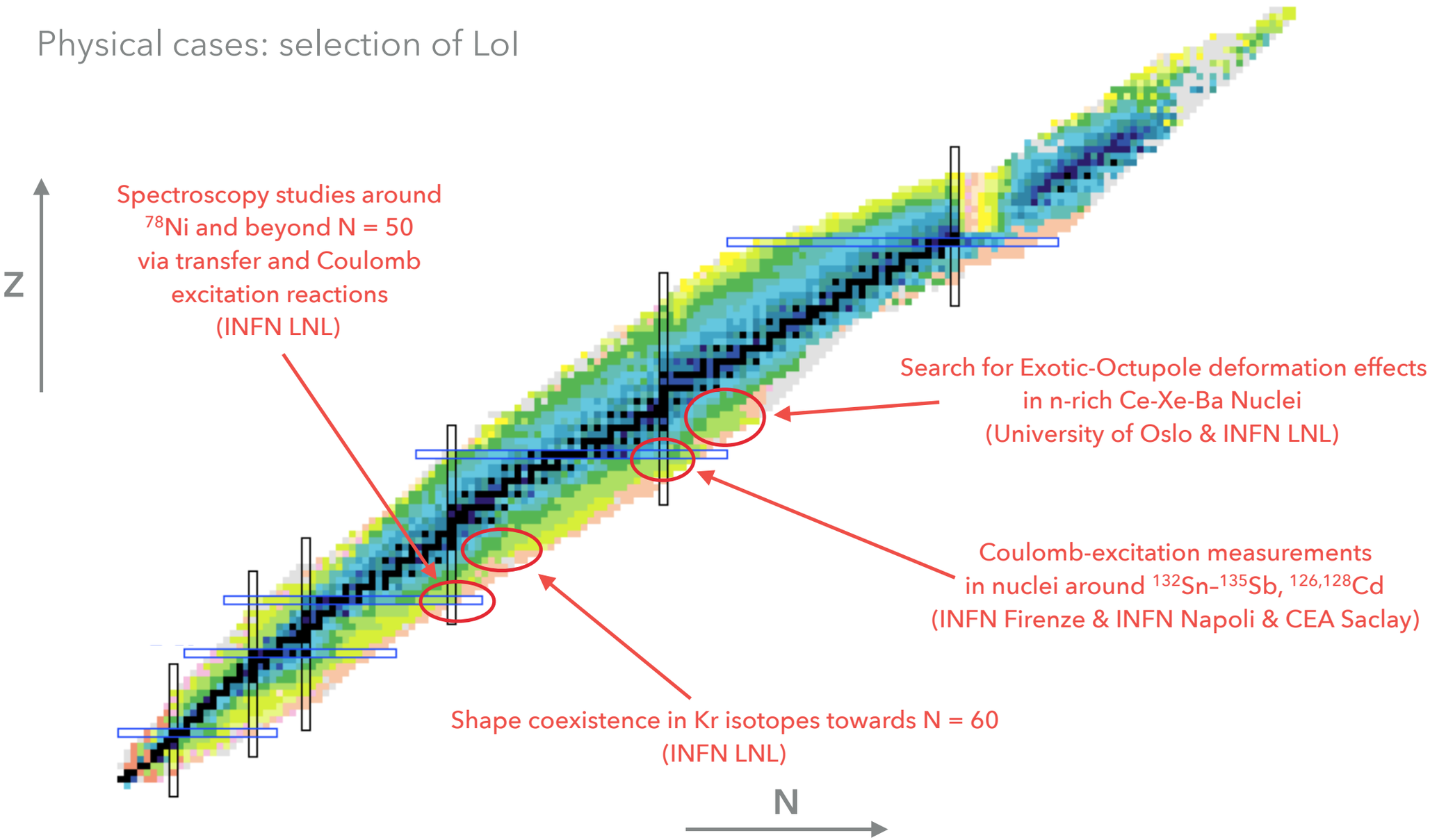
- Total number of counts: ~1500 (GOSIA estimations confirmed) -> ~190 for each angular range
- Possibility to study the angular dependence of the cross section (quadrupole moment)
- Particle spectra (singles acquisition mode):





COULOMB EXCITATION @SPES

- Low beam intensity (high cross sections), perfect beam energy (2-5 MeV/A)
- Physical cases: selection of LoI



GAMMA FIRENZE (FULL TIME)

- ADRIANA NANNINI
- MARCO ROCCHINI

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@1st HIE-ISOLDE experiment @CERN

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@1st HIE-ISOLDE experiment @CERN

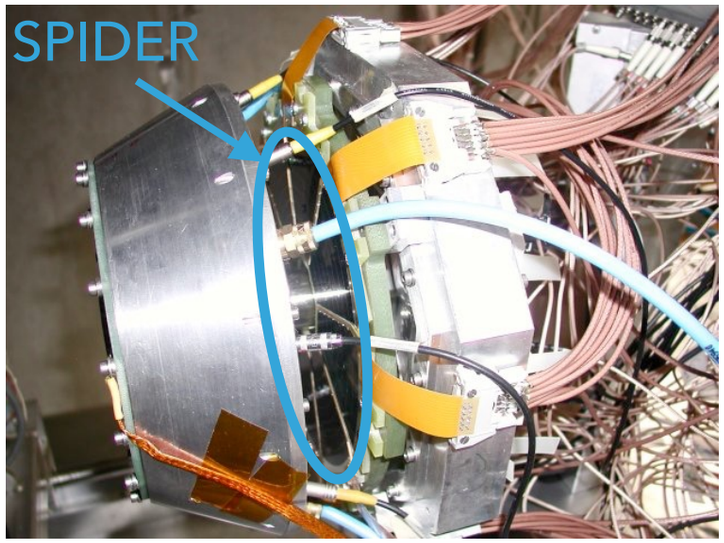
- MARCO OTTANELLI
- (BARBARA MELON)
- ANDREA PEREGO
- NICLA GELLI (NEW ENTRY!)

- PIETRO SONA
- ANGELA GIANNATIEMPO
- PIERGIORGIO BIZZETI

STRONG NATIONAL COLLABORATION WITH GAMMA LEGNARO, PADOVA, MILANO, PERUGIA. MANY INTERNATIONAL COLLABORATION

SiliconPIeDEtectoR

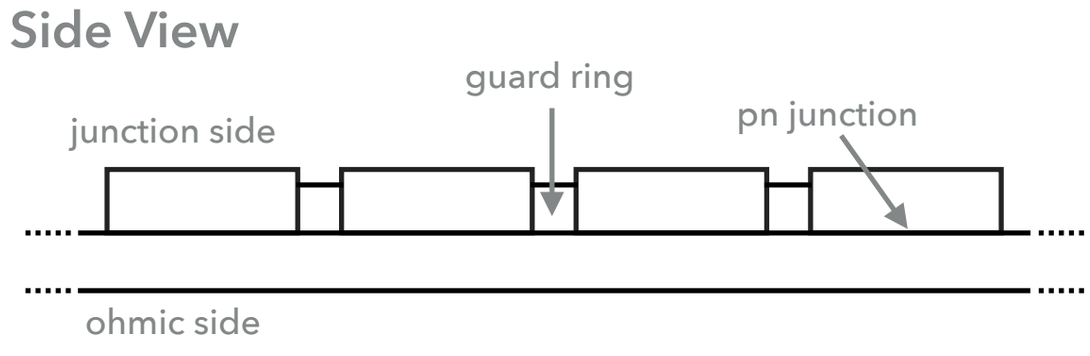
- SPIDER has been developed as ancillary detector for ~4π HPGe arrays for Coulomb excitation measurements

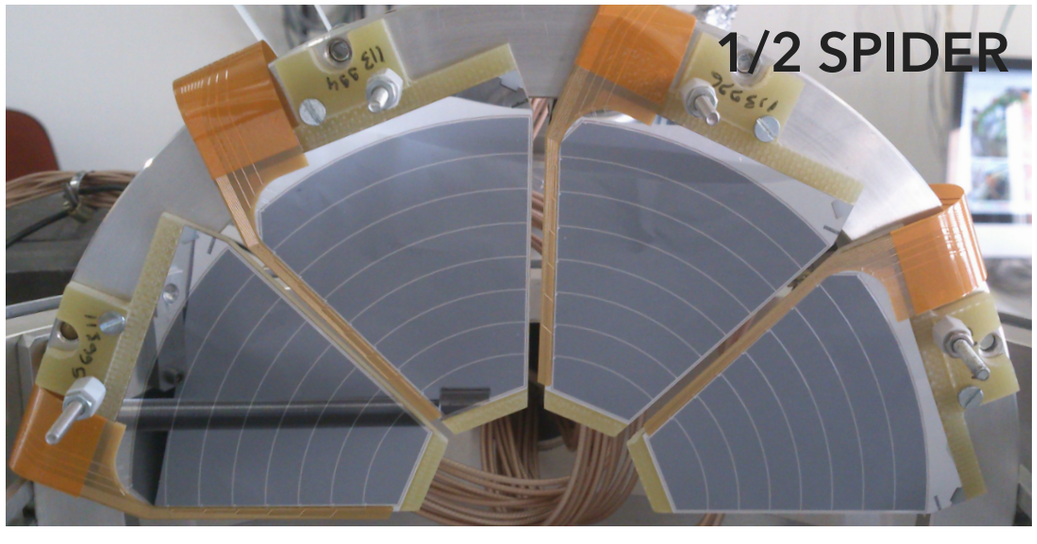


- We started from the silicon detectors of the second stage of the Ring Counter detector (GARFIELD apparatus @ LNL)

- Sectors: 8 independent strips, guard ring (to minimize cross-talk between contiguous strips)

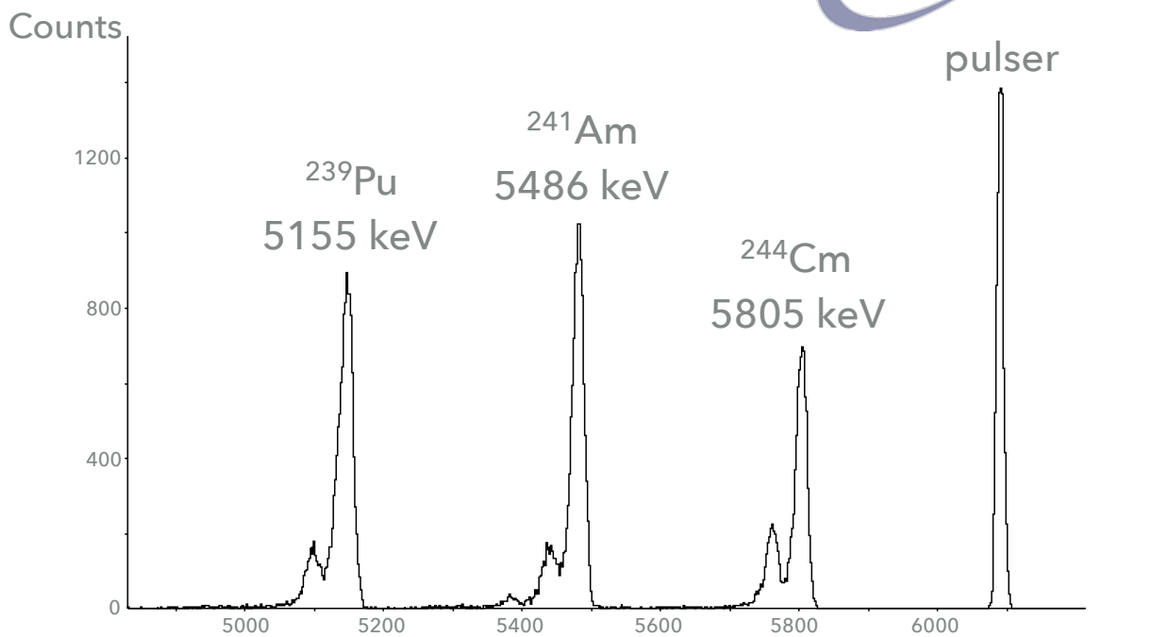
- Detector thickness: ~300 μm, dead layers: 50 nm in the junction side and 350 nm in the ohmic side



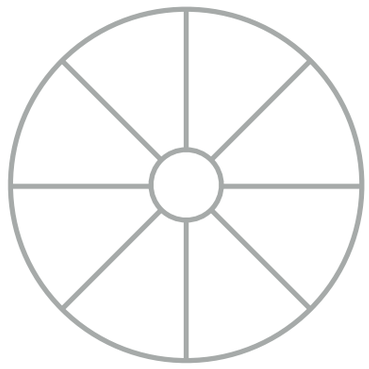


SiliconPIeDEtectoR

- Energy resolution: FWHM ~21 keV for α-particles @ ~5.5 MeV
- Intrinsic efficiency: ~1
- Angular ranges at 80 mm from the target (8 sectors, disk configuration):



strip	int. radius [mm]	ext. radius [mm]	theta min. [deg]	theta max. [deg]	theta dif. [deg]	solid angle [sr]
1	76.7	85.0	43.8	46.7	3.0	0.02892
2	68.1	76.5	40.4	43.7	3.3	0.03035
3	59.5	67.9	36.6	40.3	3.7	0.03134
4	50.9	59.3	32.5	36.5	4.1	0.03161
5	42.3	50.7	27.9	32.4	4.5	0.03085
6	33.8	42.1	22.9	27.8	4.9	0.02872
7	25.2	33.6	17.5	22.8	5.3	0.02491
8	16.6	25.0	11.7	17.3	5.6	0.02090



Solid angle coverage: 14.5 %

Polar angle coverage: 19.4 %

Diameter: 17 cm