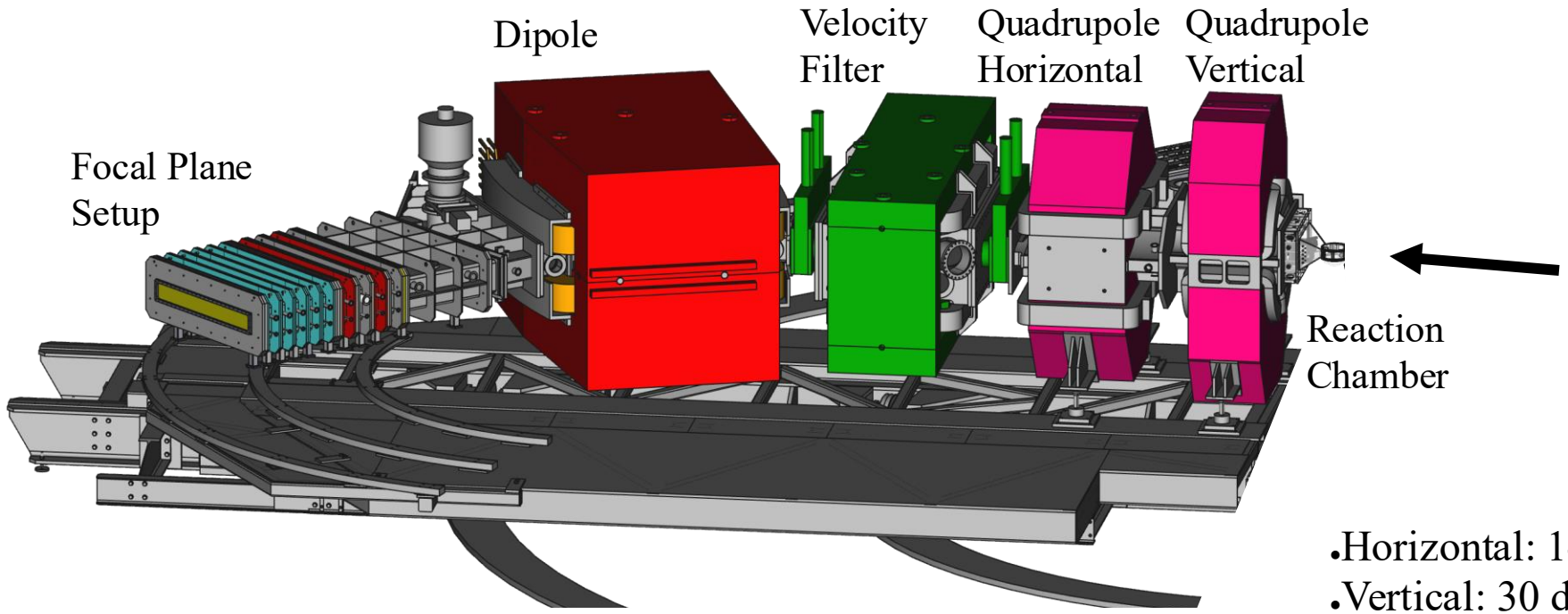
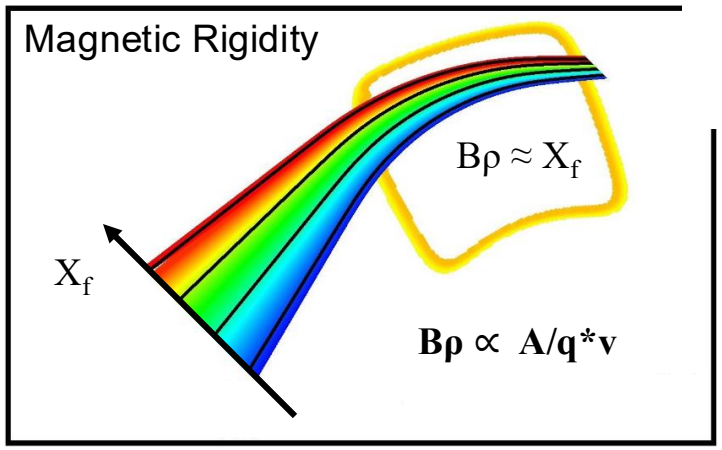
VAMOS Status

Diego Ramos

The VAMOS Spectrometer

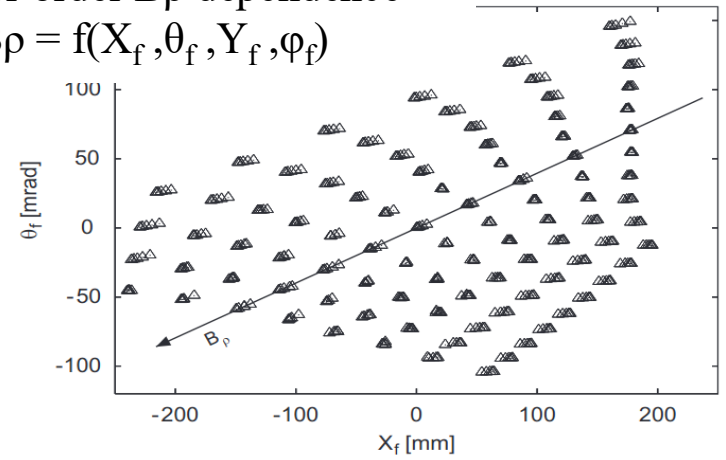


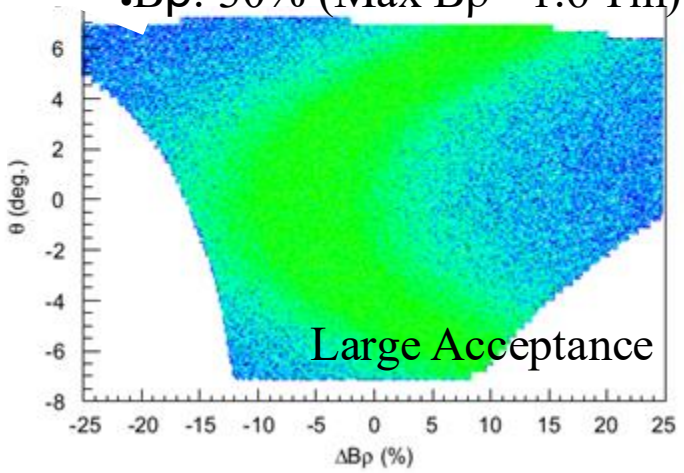
- Horizontal: 14 deg.
- Vertical: 30 deg
- Bρ: 30% (Max Bρ= 1.6 Tm)



Higher order Bρ dependence

$B\rho = f(X_f, \theta_f, Y_f, \varphi_f)$

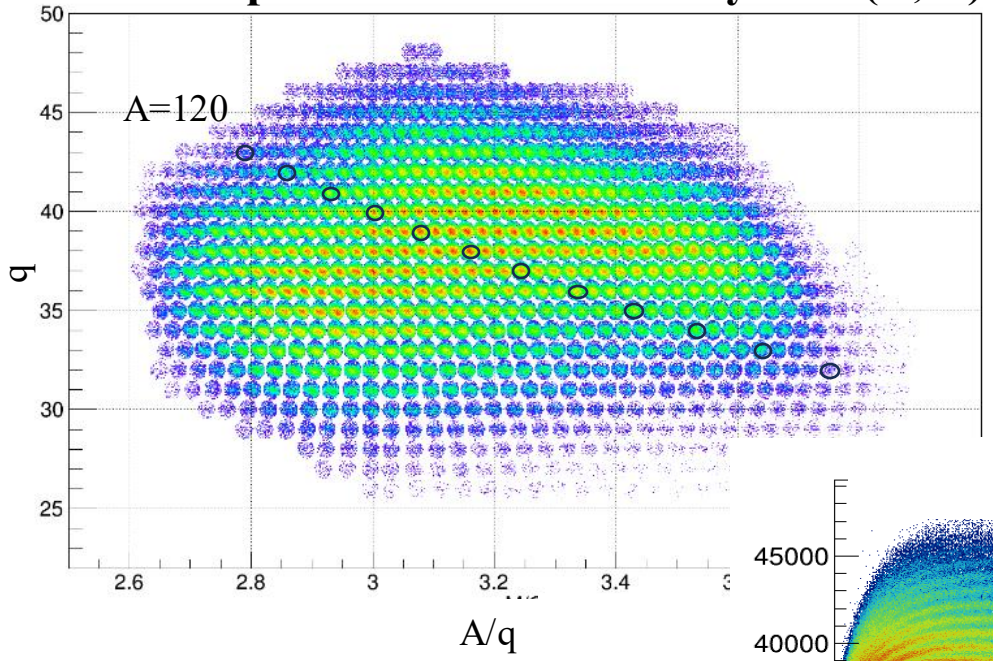




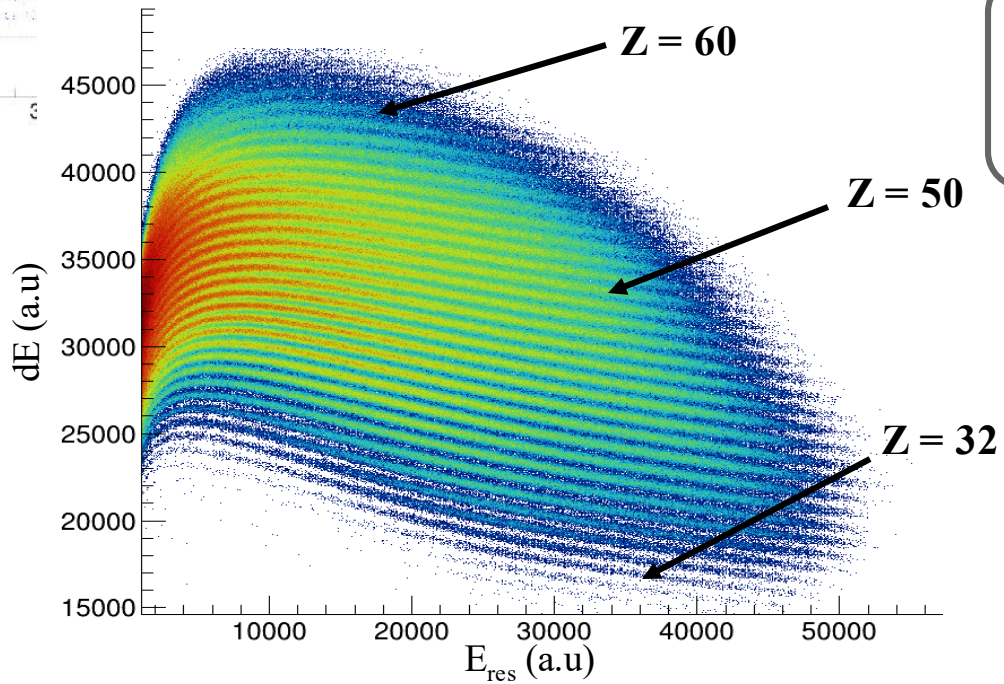
M. Rejmund et al., NIM A 646 (2011) 184

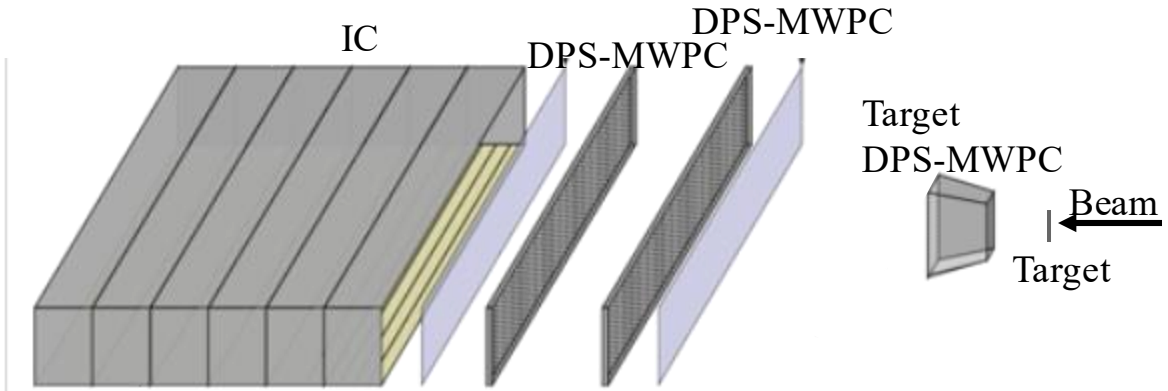
The VAMOS Detection Setup

- Goal: **Isotopic Identificion of Heavy Ions (A, Z)**



Identification capability
ΔA/A = 0.3 % (FWHM)
ΔZ/Z = 1.3 % (FWHM





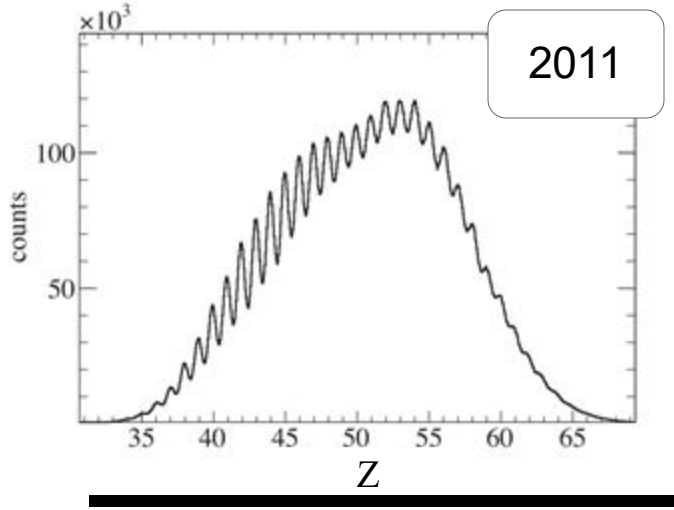
Dual Position-Sensitive MultiWire Parallel Counter

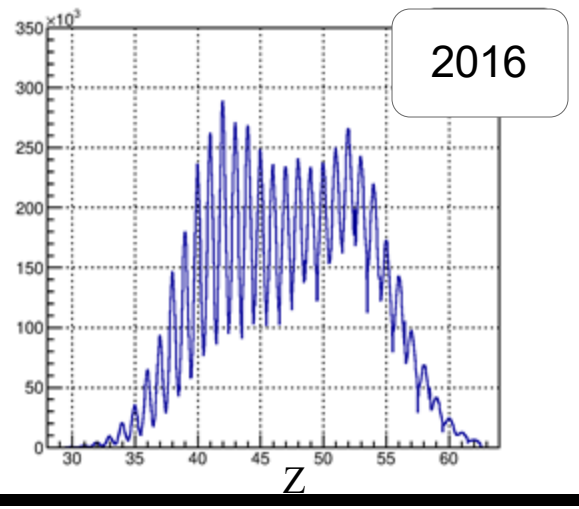
- 6 mbar iC_4H_{10} gas
- < 250 um position resolution
- < 300 ps time resolution

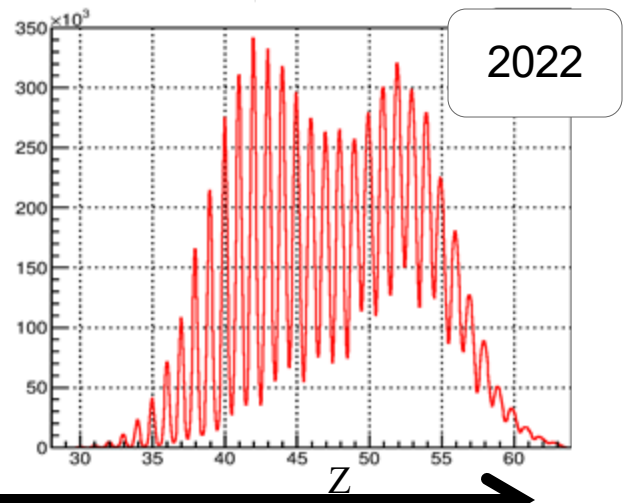
Segmented Ionization Chamber

- 50 -150 mbar CF_4 gas
- < 2% energy resolution

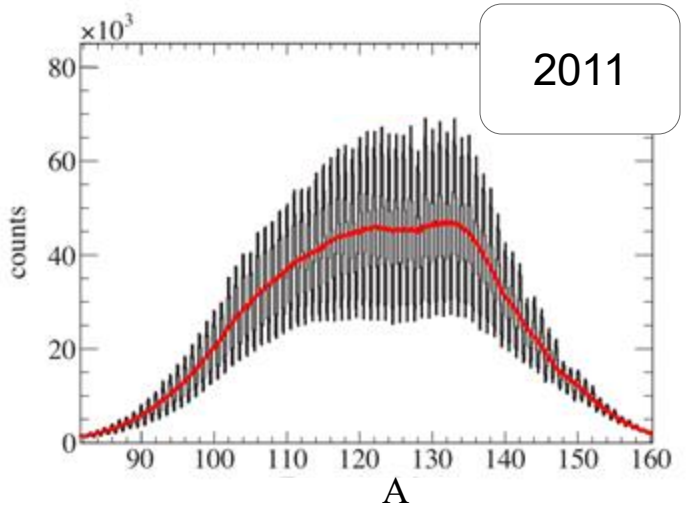
Current Status of VAMOS



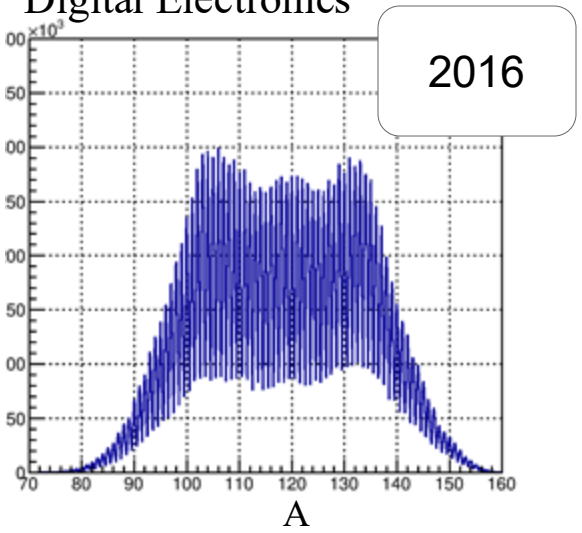




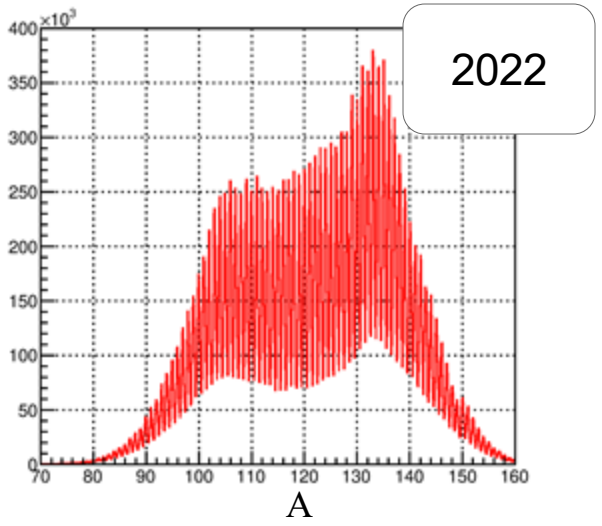
No Target PS-MWPC
DC + IC + Si (focal plane)



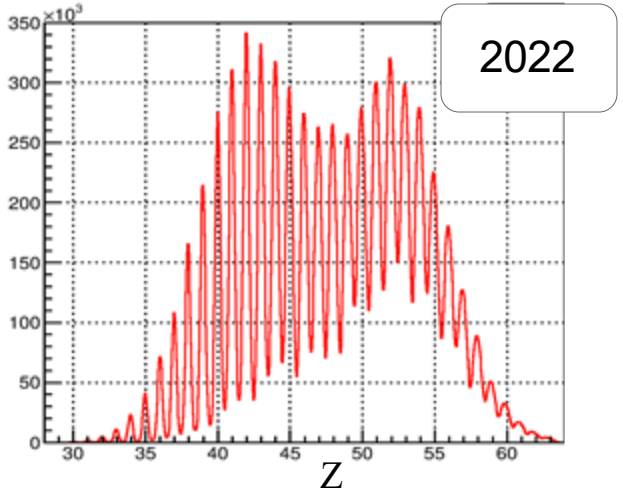
Target PS-MWPC
High Segmentation IC
Digital Electronics



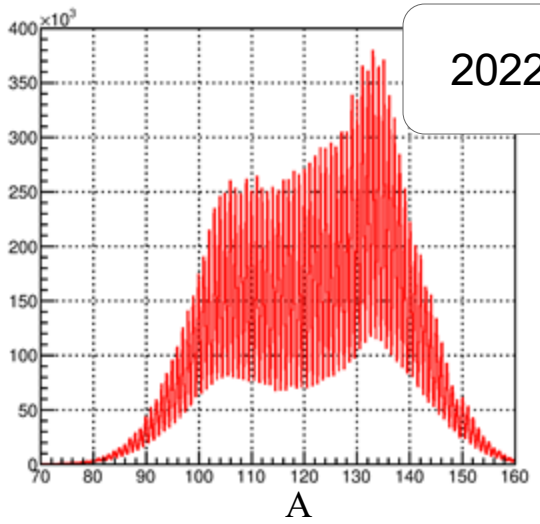
Focal Plane PS-MWPC
Higher Segmentation IC

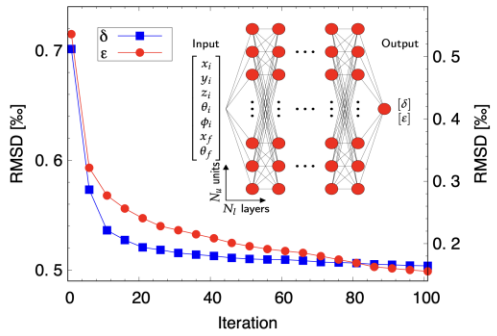


Current Status of VAMOS



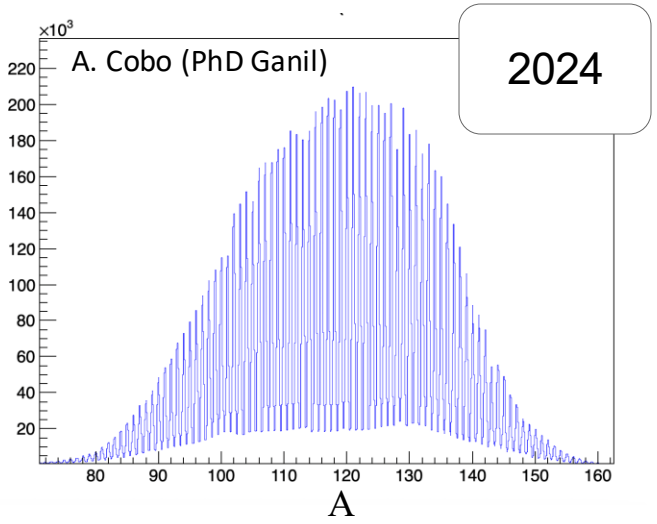
Focal Plane PS-MWPC
Higher Segmentation IC

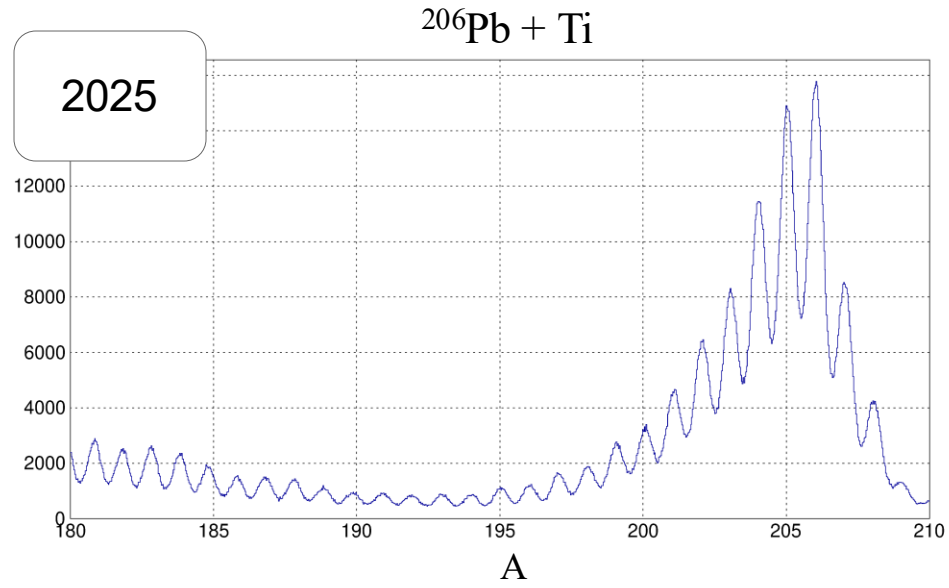




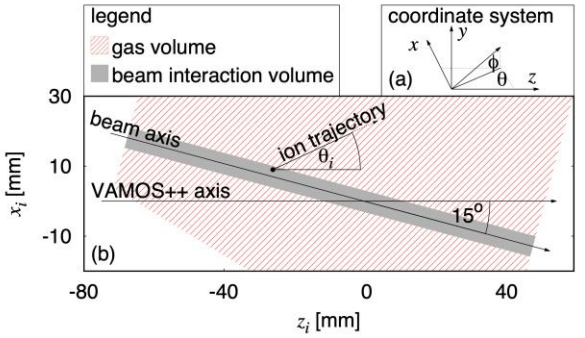
Seven-dimensional trajectory reconstruction for VAMOS++
M. Rejmund & A. Lemasson NIM A 1076, 170445 (2025)

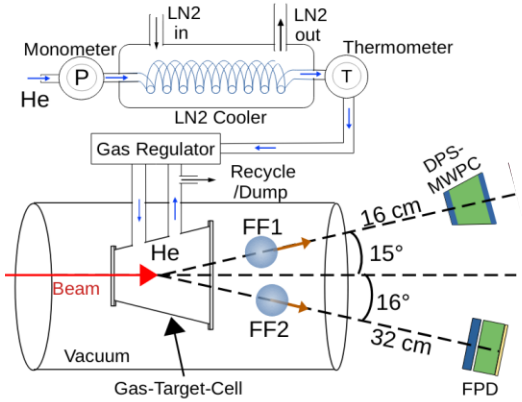
Improved ToF and θ measurements
Neural-Network Brho reconstruction



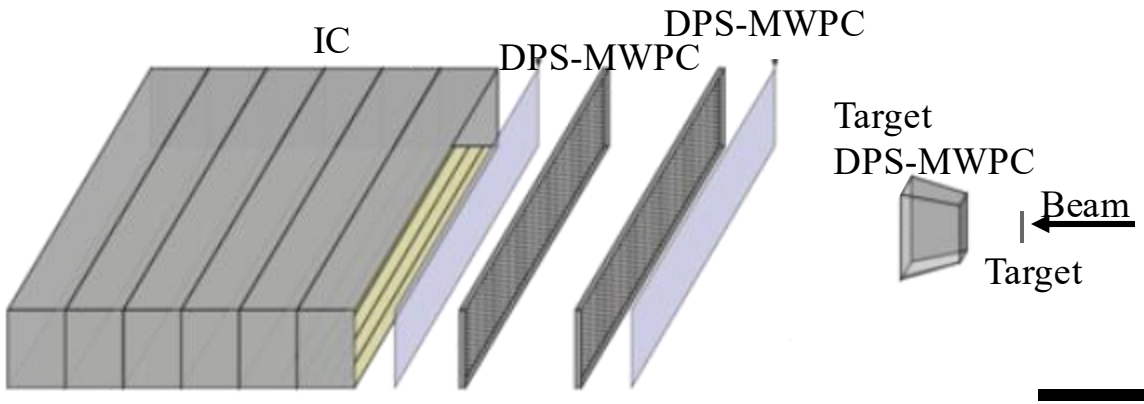


Reconstruction posible in a reaction volume





The VAMOS Setup for LIGHT IONS



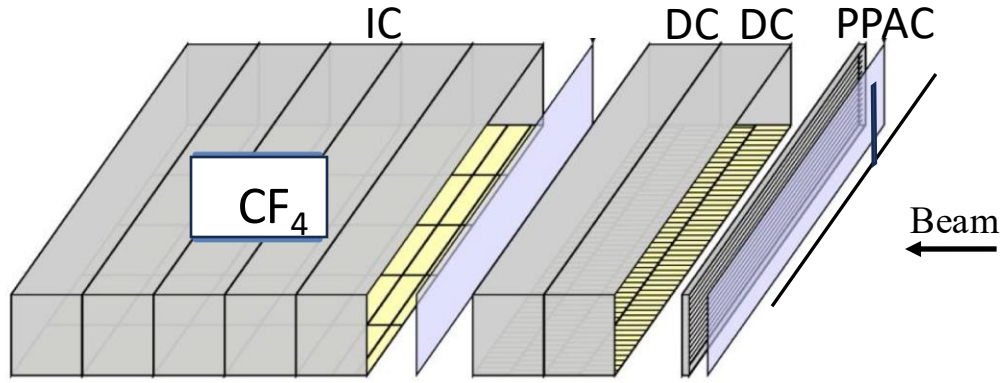
Dual Position-Sensitive MultiWire Parallel Counter

- 6 mbar iC_4H_{10} gas
- < 250 um position resolution
- < 300 ps time resolution

Segmented Ionization Chamber

- 50 -150 mbar CF_4 gas
- < 2% energy resolution

High Efficiency Z<30



Parallel Plates Avalanche Counter

- 13 mbar iC_4H_{10} gas
- < 300 ps time resolution

Drift Chambers

- 13 mbar iC_4H_{10} gas
- < 500 um position resolution

Segmented Ionization Chamber

- 150-200 mbar CF_4 gas
- < 2% energy resolution

VAMOS in AGATA/MUGAST @ GANIL

- SPIRAL 1 Beams
- Light Targets
- VAMOS @ 0 deg

- SETUP FOR Z<30 ions detection:
- ToF = Focal Plane CATS

$$^{47}K + d \rightarrow {}^{48}K + p$$

Methodology

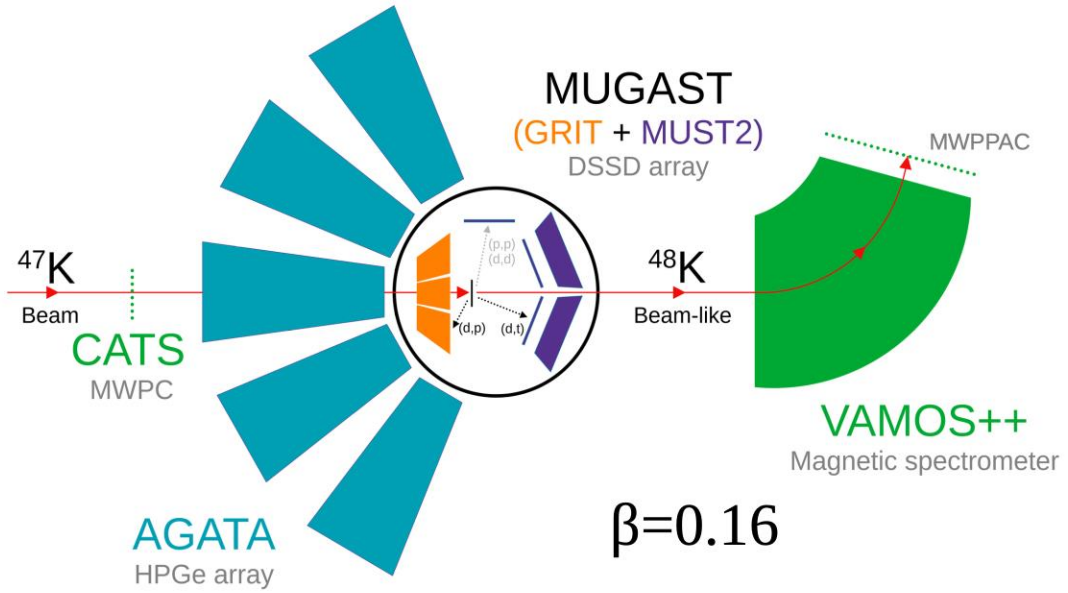
SPIRAL1+
- ^{47}K RIB @ 7.7MeV/u.
- 5×10^{5} pps, 10^{-4} mass res. → pure beam

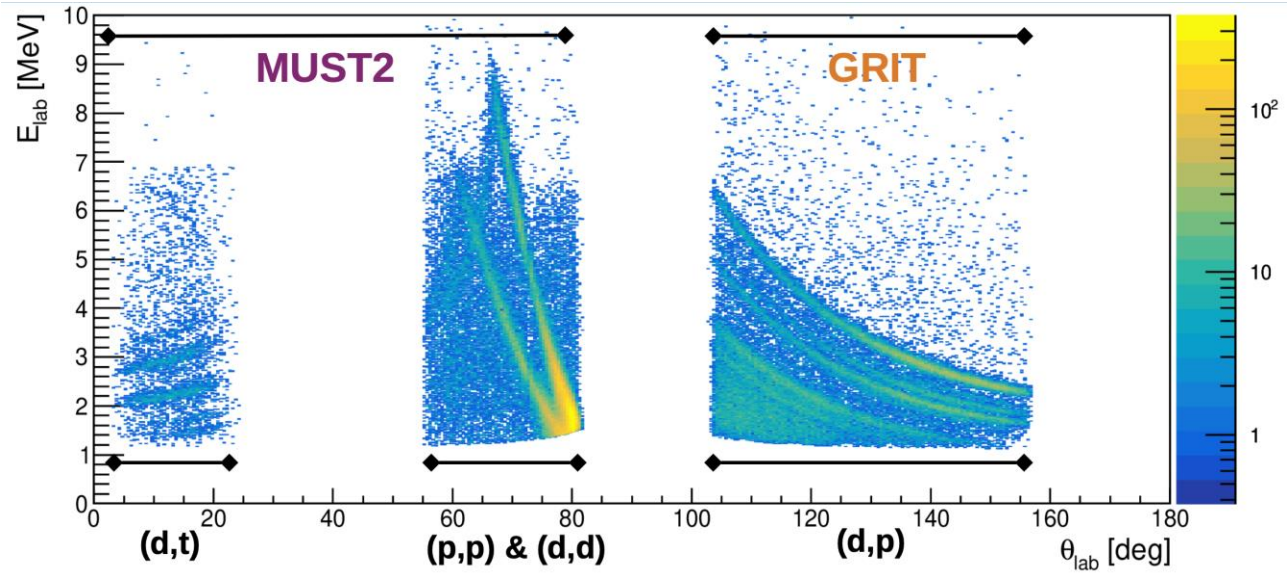
TARGET
- 0.31(2) mg/cm^2 CD_2

VAMOS++
- Zero degree; fast counting
- **Recoil timing** & reject C reactions

MUGAST
- **Light ejectile** detection
- FWHM ≈ 300 keV in ^{48}K excitation.

AGATA
- **Prompt γ-ray** emissions
- 16 ATC's @ 18 cm
- Pulse shape analysis, add-back & DC
- FWHM ≈ 7 keV @ 1.8 MeV; β = 0.16





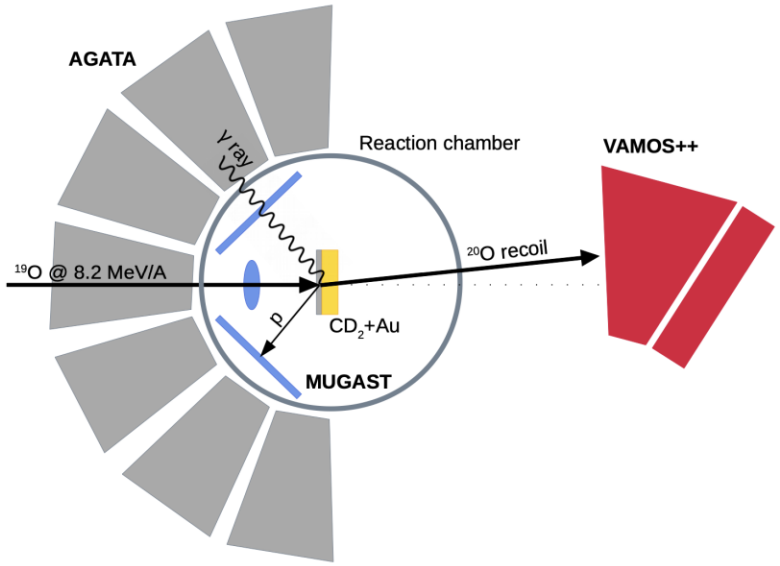
PhD C.J. Paxman

VAMOS in AGATA/MUGAST @ GANIL

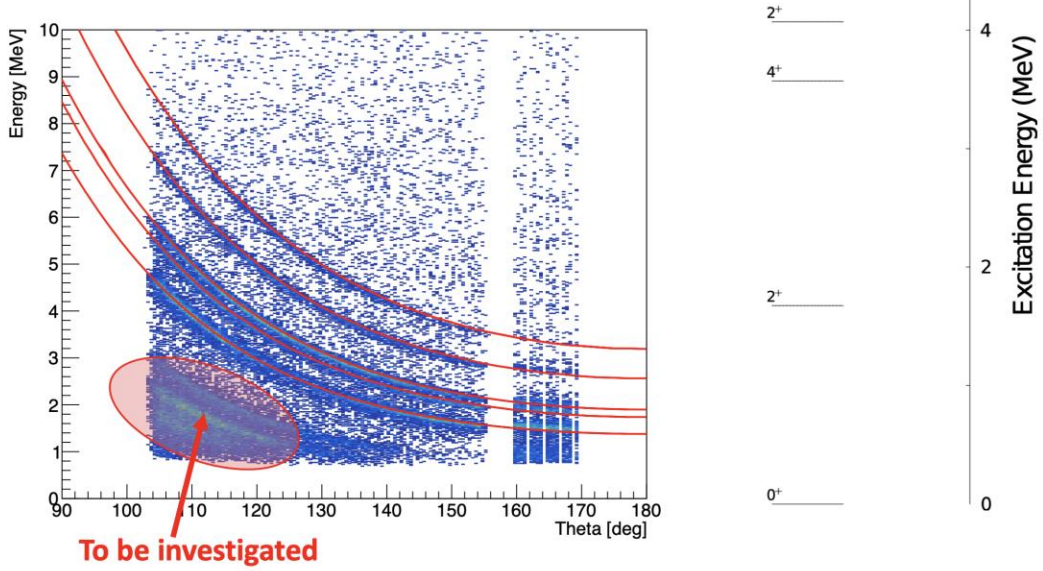
- SPIRAL 1 Beams
- Light Targets
- VAMOS @ 0 deg

- SETUP FOR Z<30 ions detection:
- ToF = Focal Plane CATS

$$^{19}O + d \rightarrow {}^{20}O + p$$



- ^{19}O(d,p)^{20}O reaction
- Beam ^{19}O 8 MeV/A
  i: 4x10^5 pps
  99% purity
- Target CD$_2$ 0.3 mg/cm^2
  + Au 24.4 mg/cm^2
- Spectroscopy + DSAM
- AGATA array +
  MUGAST + VAMOS

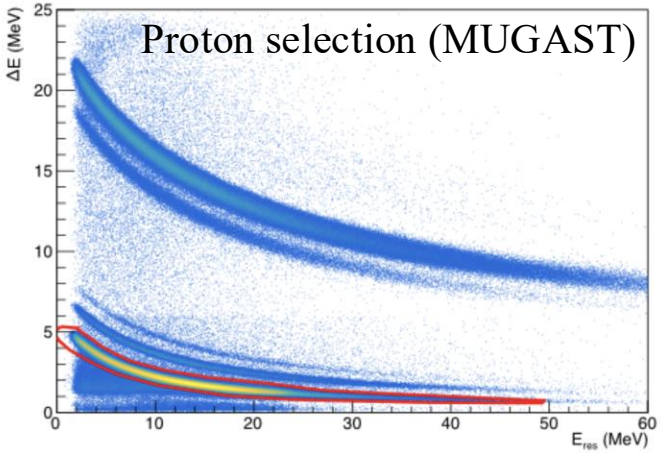


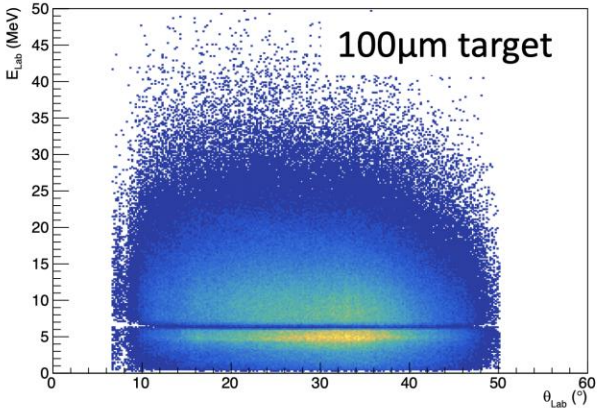
VAMOS in AGATA/MUGAST @ GANIL

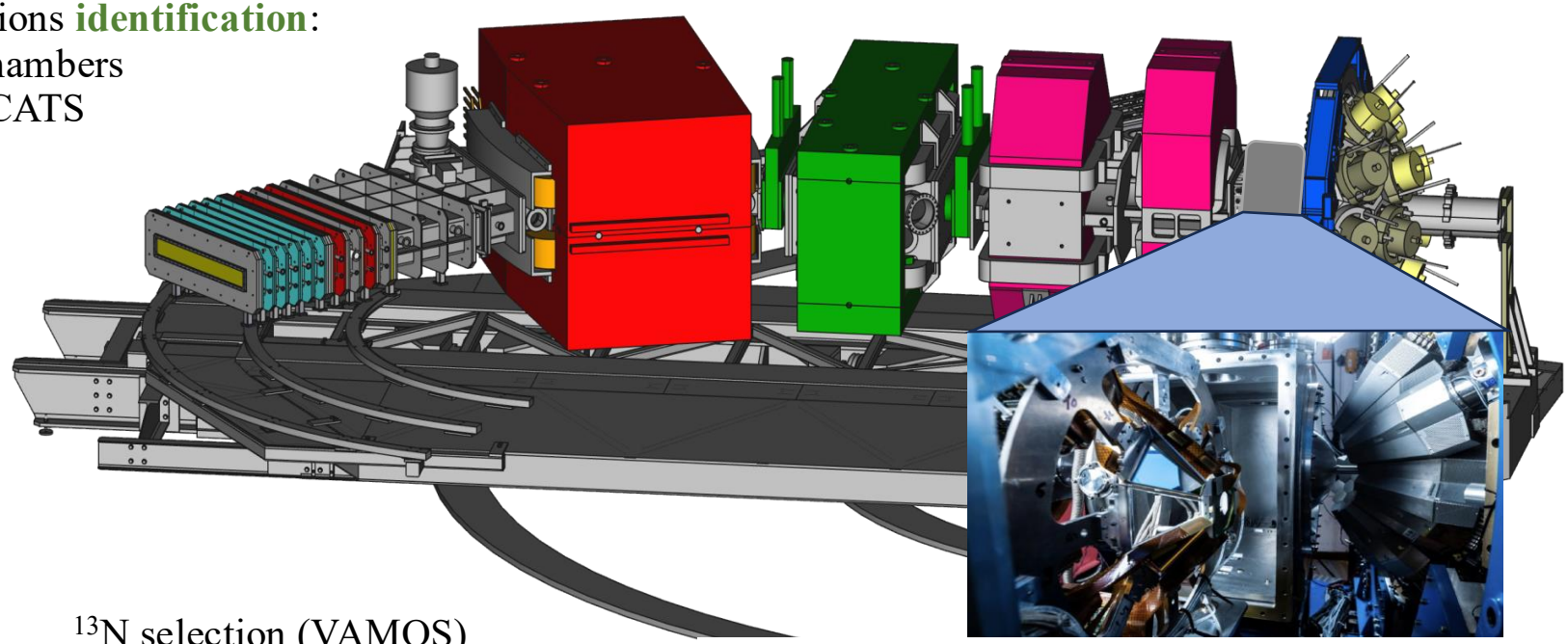
- SPIRAL 1 Beams
- Light Targets
- VAMOS @ 0 deg

- SETUP FOR Z<30 ions **identification**:
- Positions = Drift Chambers
- ToF = Focal Plane CATS

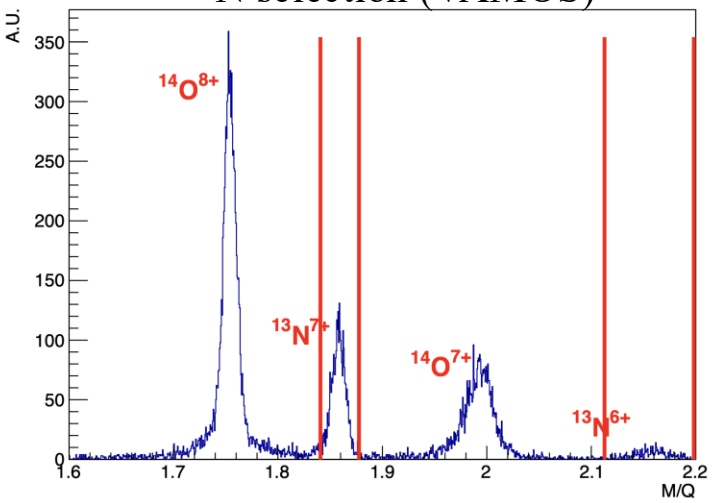
$$^{14}O + p \rightarrow {}^{15}F \rightarrow {}^{13}N + 2p$$

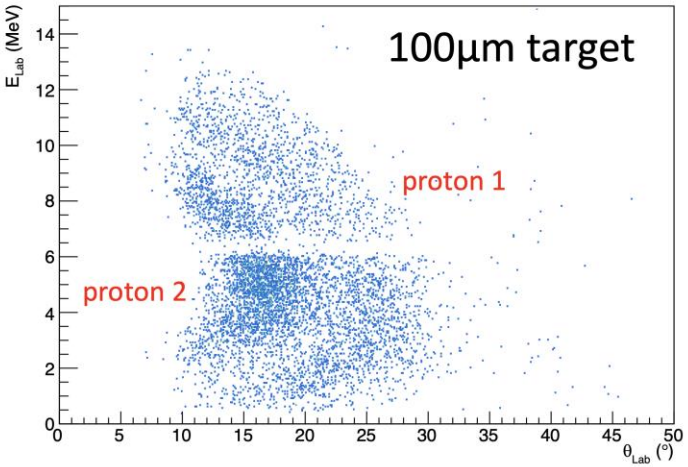






^{13}N selection (VAMOS)





Clear 2-proton kinematics

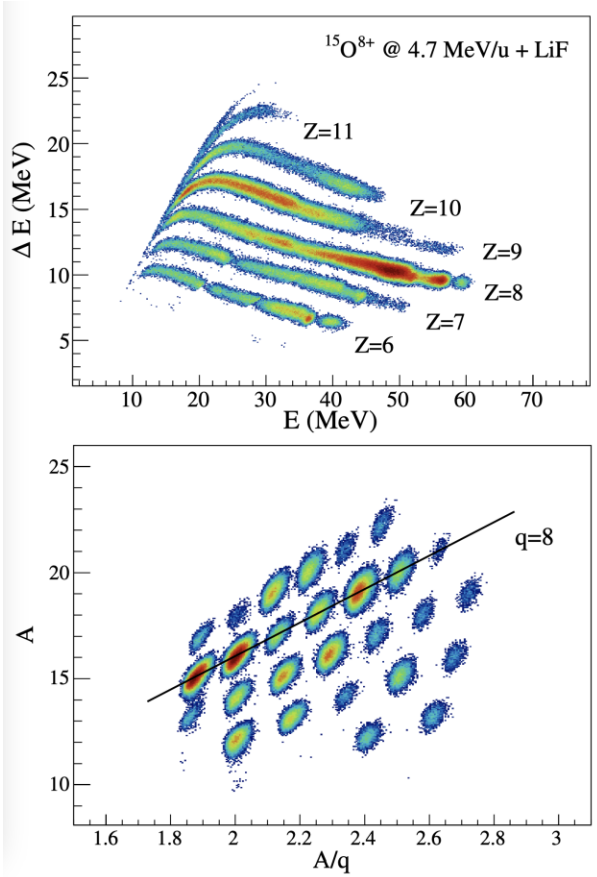
PhD V. Girard-Alcindor

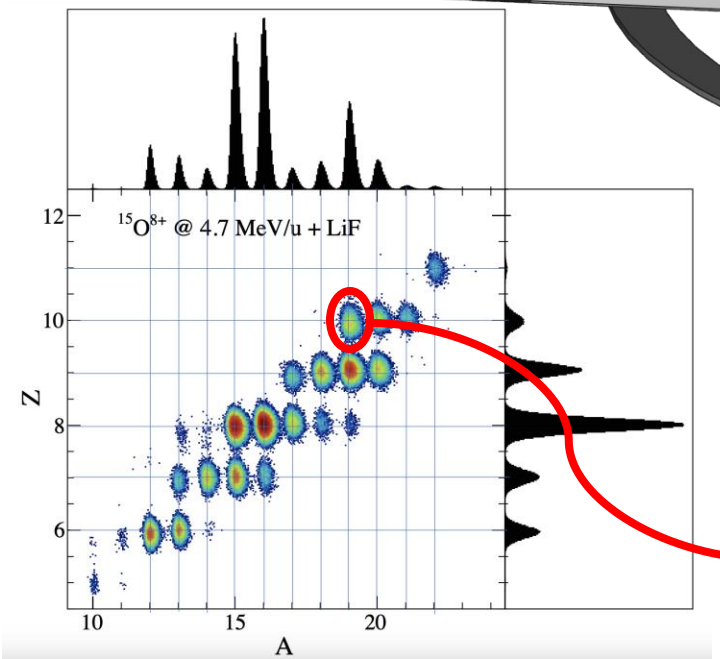
VAMOS in AGATA/MUGAST @ GANIL

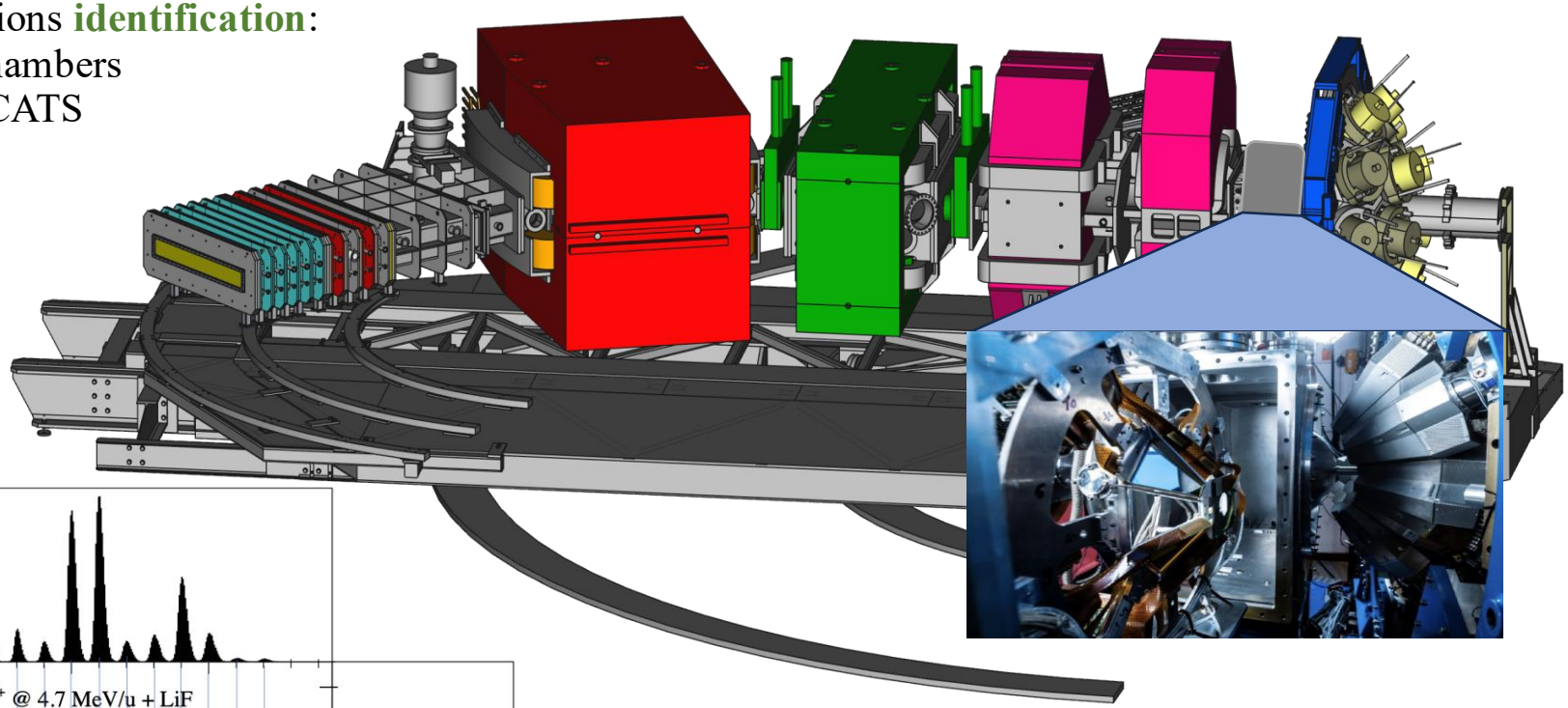
- SPIRAL 1 Beams
- Light Targets
- VAMOS @ 0 deg

- SETUP FOR Z<30 ions **identification**:
- Positions = Drift Chambers
- ToF = Focal Plane CATS

$$^{15}O + {}^{7}Li \rightarrow {}^{19}Ne + t$$







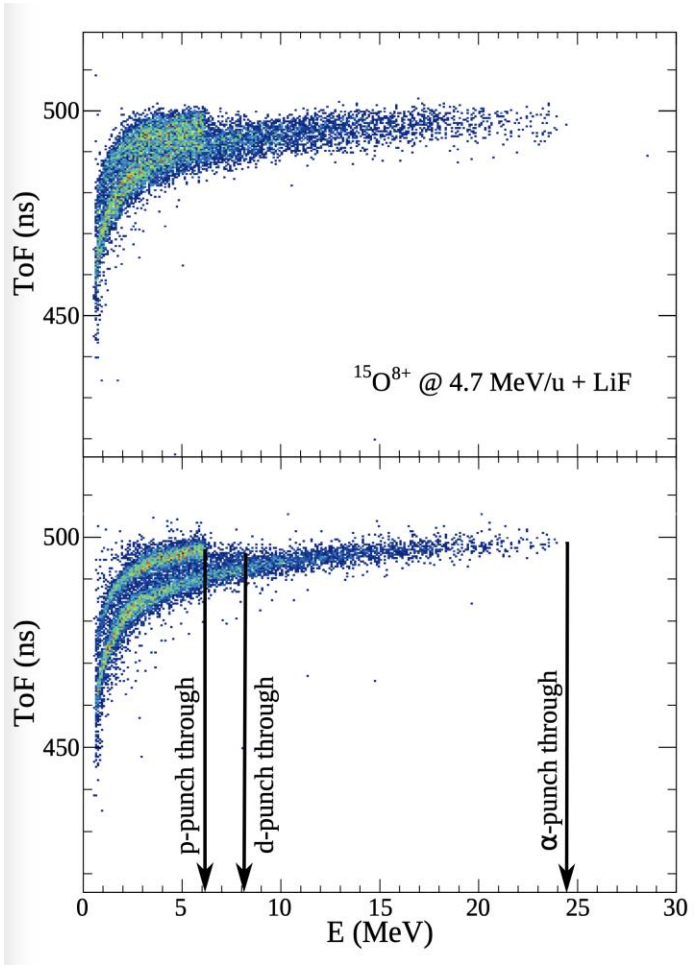
- Full isotopic identification of beam-like residues from reactions in Li + F
- Identification of ^{19}Ne

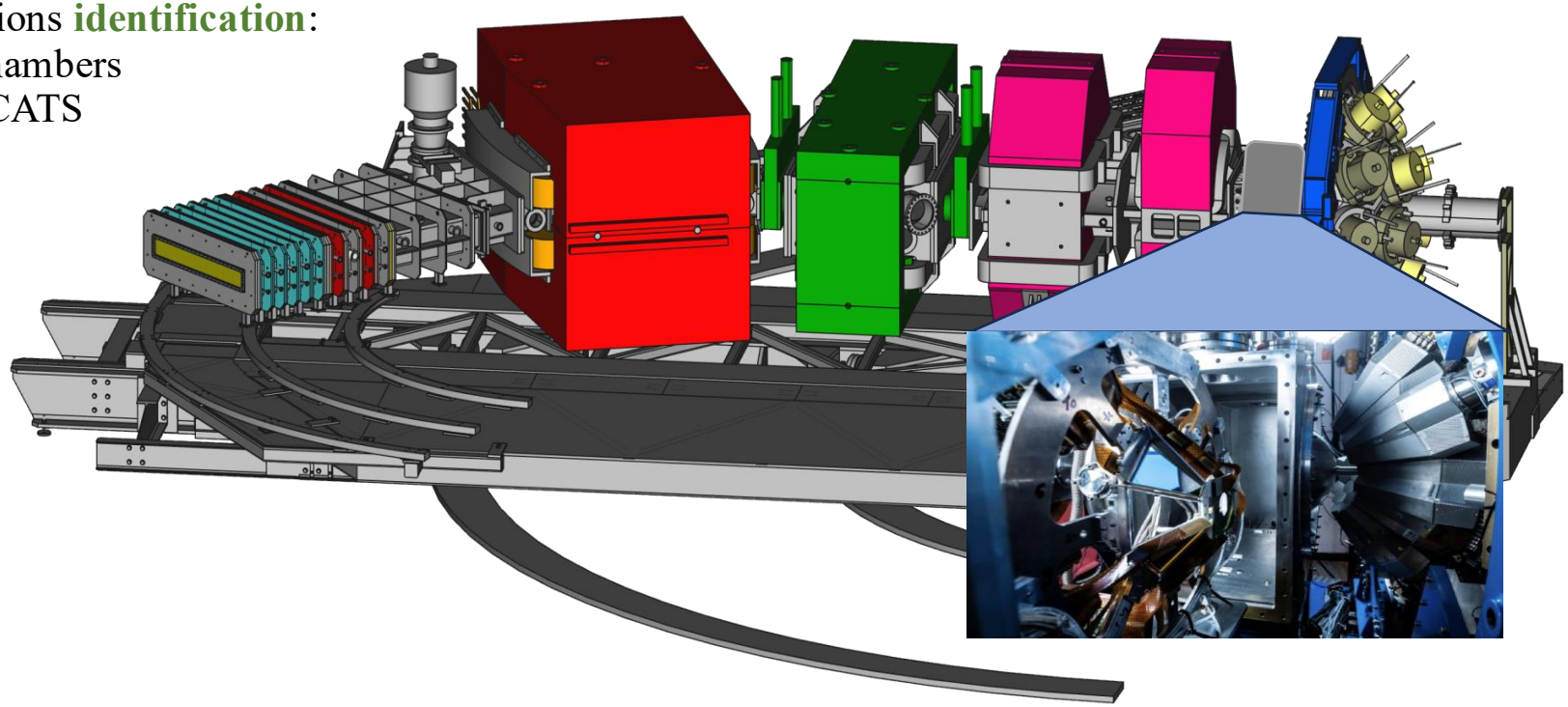
M. Assié et al. NIM A 1014, 165743 (2021)

VAMOS in AGATA/MUGAST @ GANIL

- SPIRAL 1 Beams
- Light Targets
- VAMOS @ 0 deg

- SETUP FOR Z<30 ions **identification**:
- Positions = Drift Chambers
- ToF = Focal Plane CATS





- Slow light ions -> No dE:E identification in MUGAST
- High Beam Intensity –> No Start detector -> No ToF:E identification in MUGAST

The Magnetic Rigidity of Beam-like recoils measured in VAMOS provides a good T_0

$$\beta_{VAMOS} = \left(\left(\frac{3.107}{B\rho[Tm]} \frac{[A]}{[q]} \right)^2 + 1 \right)^{-1/2}$$

$$TOF = TOF_{VAMOS-MUGAST} - \frac{D_{VAMOS}}{\beta_{VAMOS}}$$

M. Assié et al. NIM A 1014, 165743 (2021)

Light Charged Particles @ VAMOS

^{19}Ne @ 10 AMeV

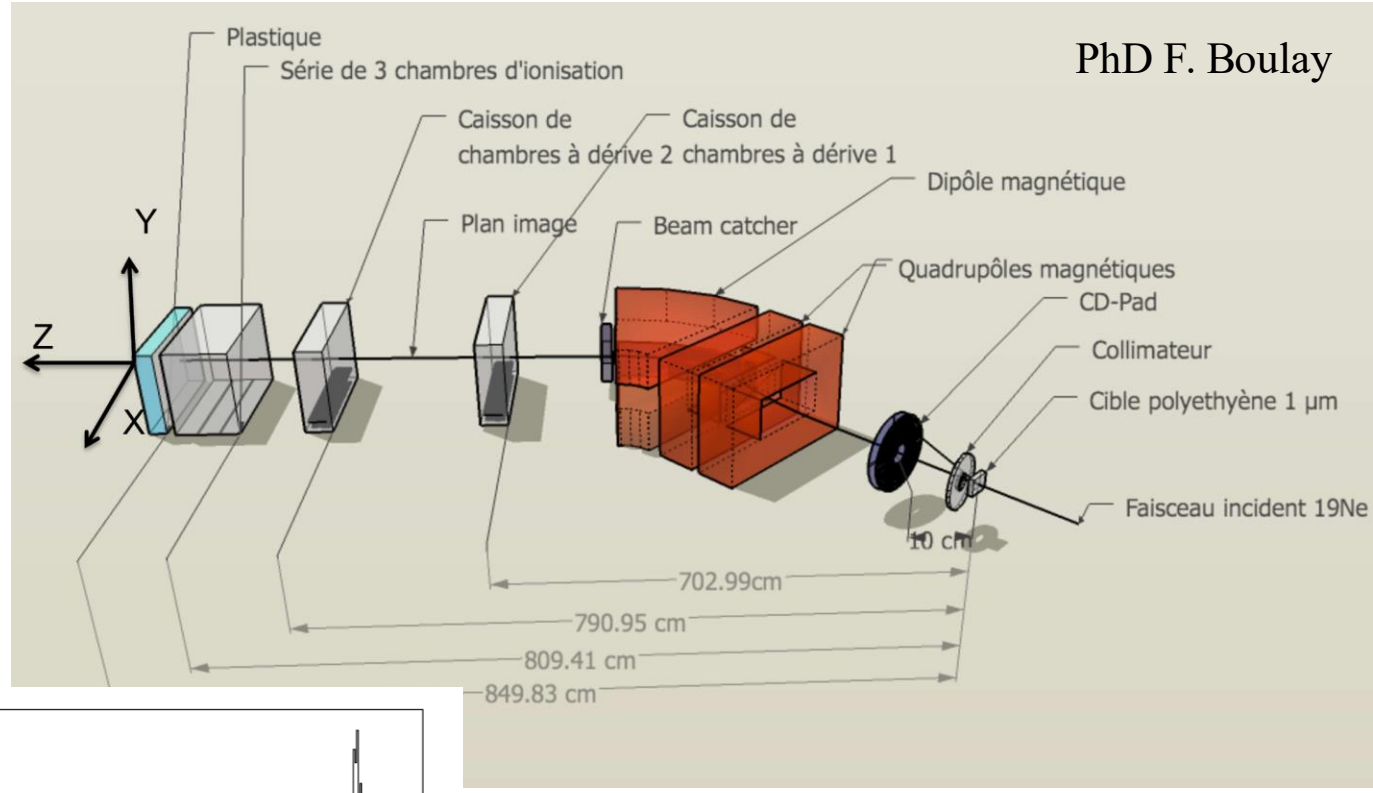
$$^{19}\mathrm{Ne} + \mathrm{p} \rightarrow \left(^{20}\mathrm{Na}\right)^{*} \rightarrow \left(^{19}\mathrm{Ne}\right)^{*} + \mathrm{p}'$$

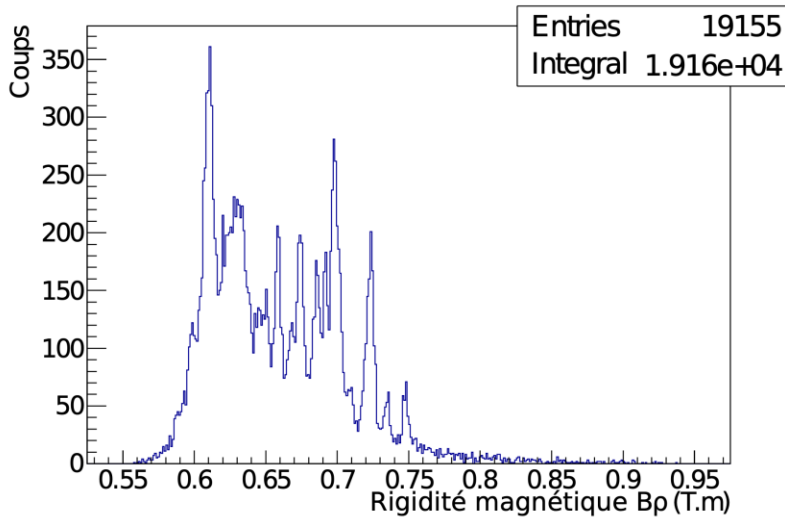
$$\left(^{19}\mathrm{Ne}\right)^{*} \rightarrow {}^{18}\mathrm{F} + \mathrm{p}''$$

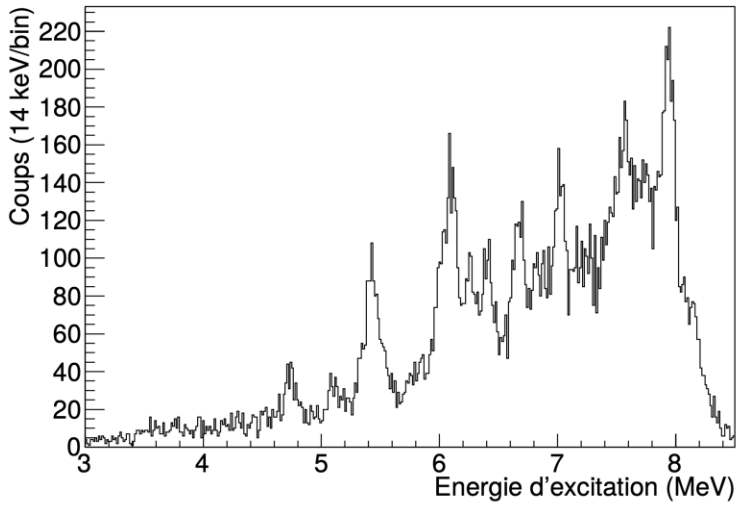
$$ou \qquad \left(^{19}\mathrm{Ne}\right)^{*} \rightarrow {}^{15}\mathrm{O} + \alpha$$

$$ou \qquad \left(^{19}\mathrm{Ne}\right)^{*} \rightarrow {}^{19}\mathrm{Ne} + \gamma$$

- p' detected at the VAMOS focal plane:
  - DC @ 40 mbar iC_4H_{10}
- p'' and α_s detected in silicion telescope (CD-Pad)







- Reconstruction of the ^{19}Ne excitation energy from the magnetic rigidity measured in VAMOS

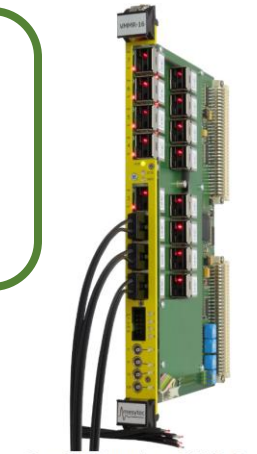
p@10 MeV -> σ =30 keV

- Limiting factor: No emission angles detection

NEEDS for VAMOS@GRIT/AGATA 2

- REDUCTION OF Focal Plane DEAD TIME:
  - 50 us readout deadtime of GASIPLEX
  - ⇩
  - 8 us deadtime with MMR adapted to DC

- Efficient focal plane detection:
  - PPAC
  - Drift Chambers
  - Adaptation to proton/He detection



Up to 2048 channels per VMMR-16

Stacked boards for 128 channels

60 x140 x20mm³

- Start & Emission Angles Measurement
  - First Prototype Detector under study

- Reduction of focal plane PileUp
  - Perpendicular Segmentation of Ionization Chamber
  - New Electronics (11x5 channels -> MDPP)

- VAMOS @ 0 deg -> Unreacted Beam blocker design

NEEDS for VAMOS@GRIT/AGATA 2

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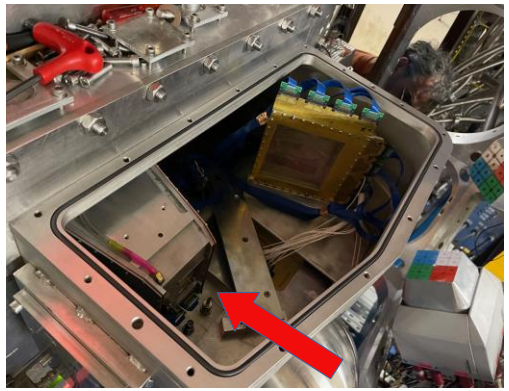
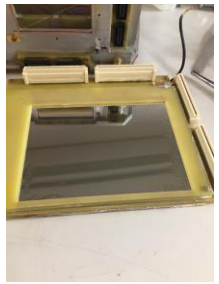
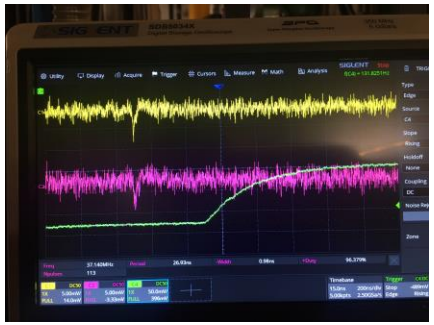




LI-DPS-MWPC



Alphas @ 16MeV

- Start & Emission Angles Measurement
  - First Prototype Detector under study

- Reduction of focal plane PileUp
  - Perpendicular Segmentation of Ionization Chamber
  - New Electronics (11x5 channels -> MDPP)

- VAMOS @ 0 deg -> Unreacted Beam blocker design

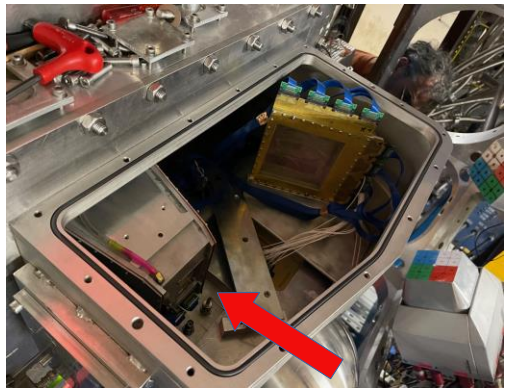
NEEDS for VAMOS@GRIT/AGATA 2

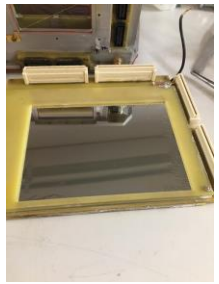
- REDUCTION OF Focal Plane DEAD TIME:
  - 50 us readout deadtime of GASIPLEX
  - ⇩
  - 8 us deadtime with MMR adapted to DC

Up to 2048 channels per VMMR-16

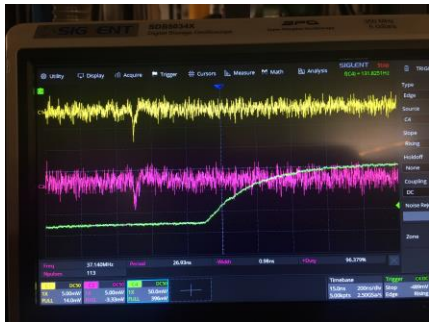
Stacked boards for 128 channels

60 x140 x20mm³





LI-DPS-MWPC



Alphas @ 16MeV

- Efficient focal plane detection:
  - PPAC
  - Drift Chambers
  - Adaptation to proton/He detection

- Start & Emission Angles Measurement
  - First Prototype Detector under study

- Reduction of focal plane PileUp
  - Perpendicular Segmentation of Ionization Chamber
  - New Electronics (11x5 channels -> MDPP)

- VAMOS @ 0 deg -> Unreacted Beam blocker design

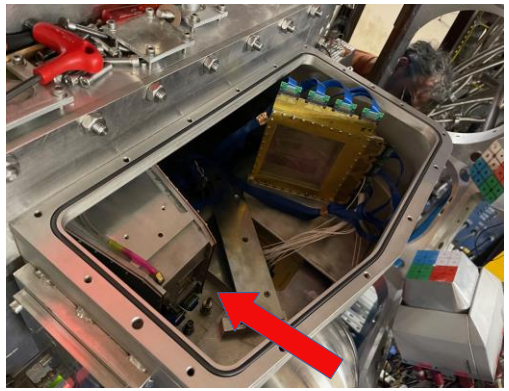
NEEDS for VAMOS@GRIT/AGATA 2

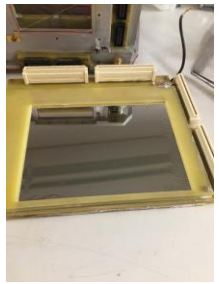
- REDUCTION OF Focal Plane DEAD TIME:
  - 50 us readout deadtime of GASIPLEX
  - ⇩
  - 8 us deadtime with MMR adapted to DC

Up to 2048 channels per VMMR-16

Stacked boards for 128 channels

60 x140 x20mm³





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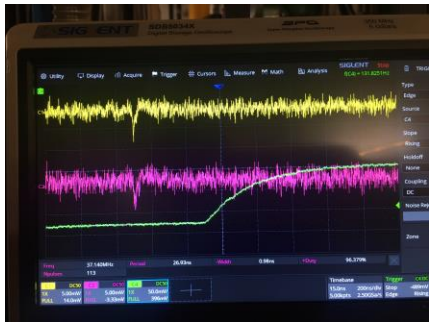

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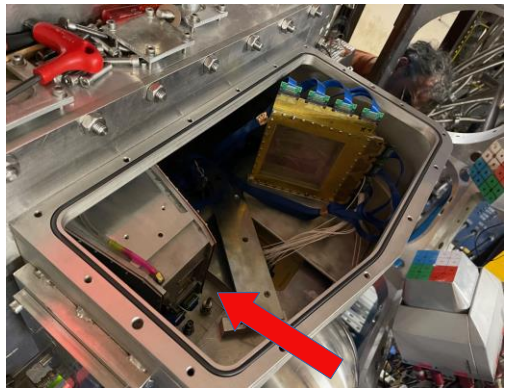

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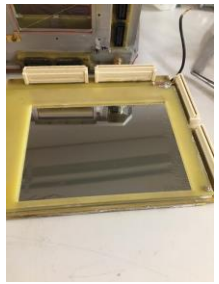

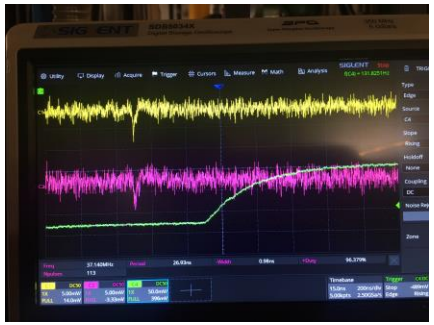

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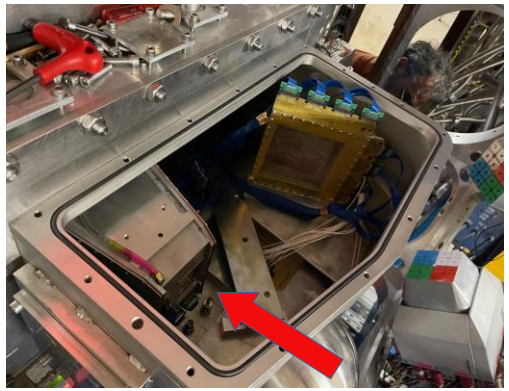

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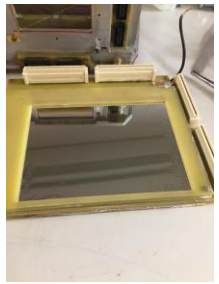

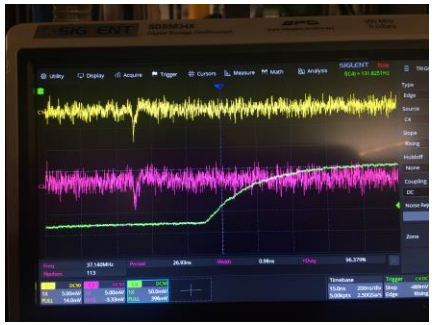

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VAMOS is one of the most performing spectrometers today

It was/will be useful/crucial for different physical cases

Developments are ongoing to explote its capabilities for this campaign