VAMOS Configurations

Opportunities for AGATA/GRIT@GANIL 2

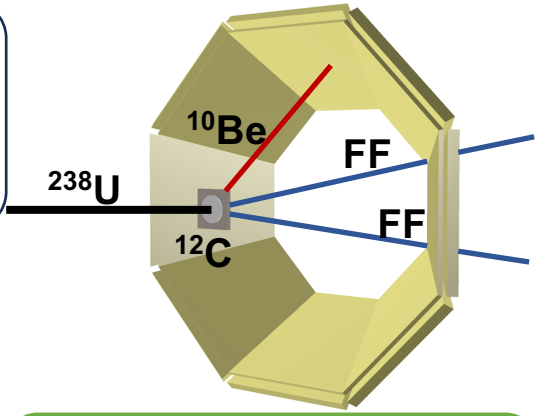
Diego Ramos

Current Status of VAMOS

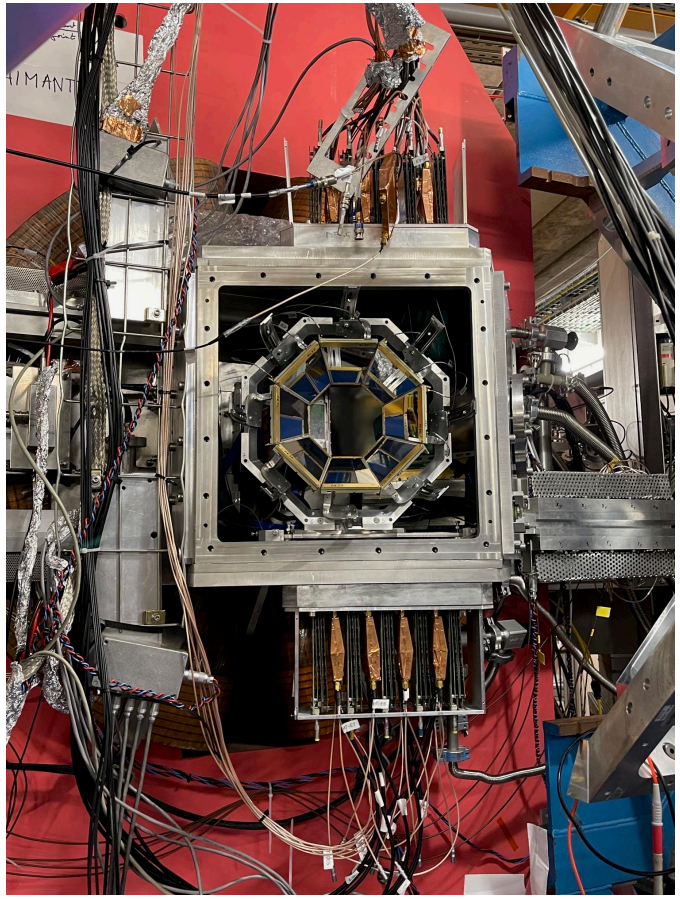
- **INVERSE KINEMATICS MNT-INDUCED FISSION**
  - **PISTA (Silicon Telescope)**
    - Selection of the incoming channel (A, Z, Ex)
    - Fission probability

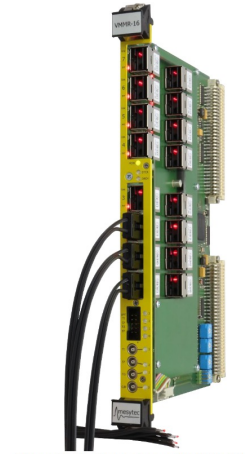
- **dE**
- 100 um thickness
- 0.5 mm strips (θ)
- 10 cm from target

- **E**
- 1 mm thickness
- 1.2 mm strips (ϕ)

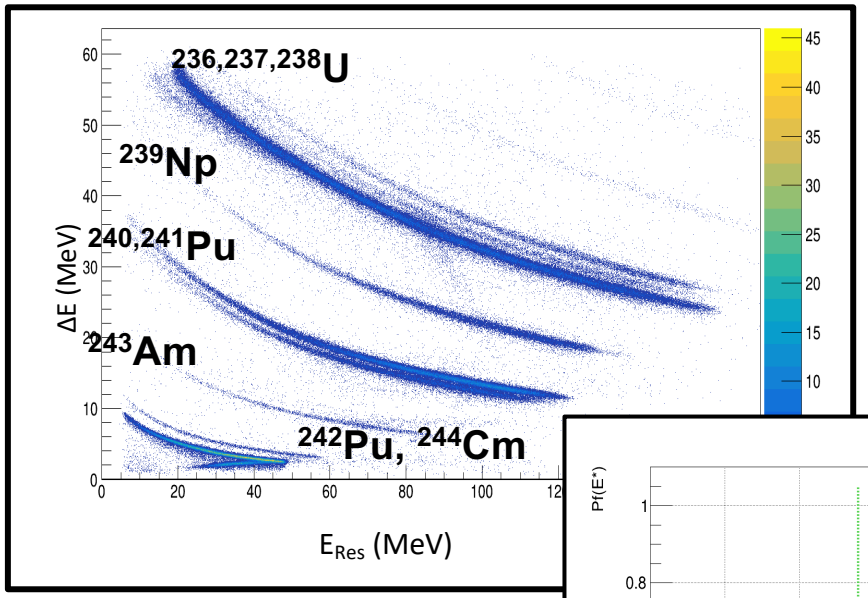


April 2020: First design
March 2023: First InBeam Experiment

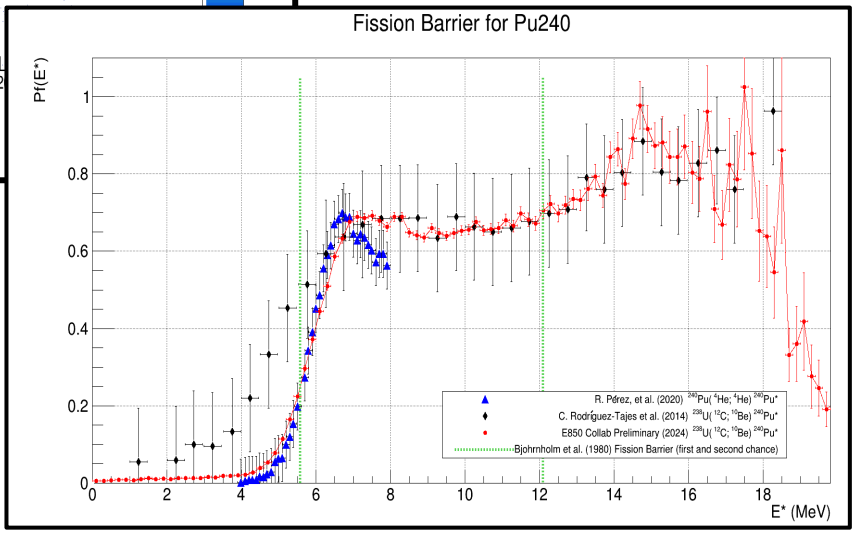




Mesytec MMR electronics



- **~ 1 kHz counting rate**
- **σ_{Ex}~ 700 keV (FWHM)**



Current Status of VAMOS

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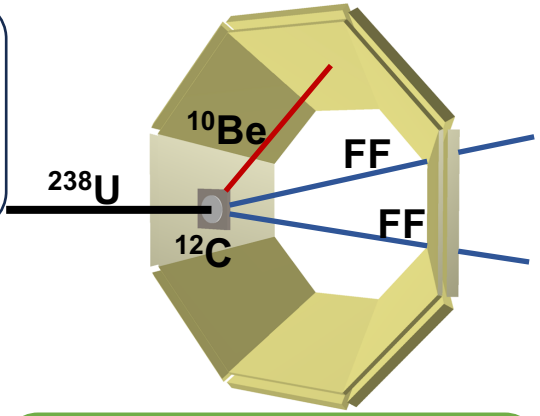

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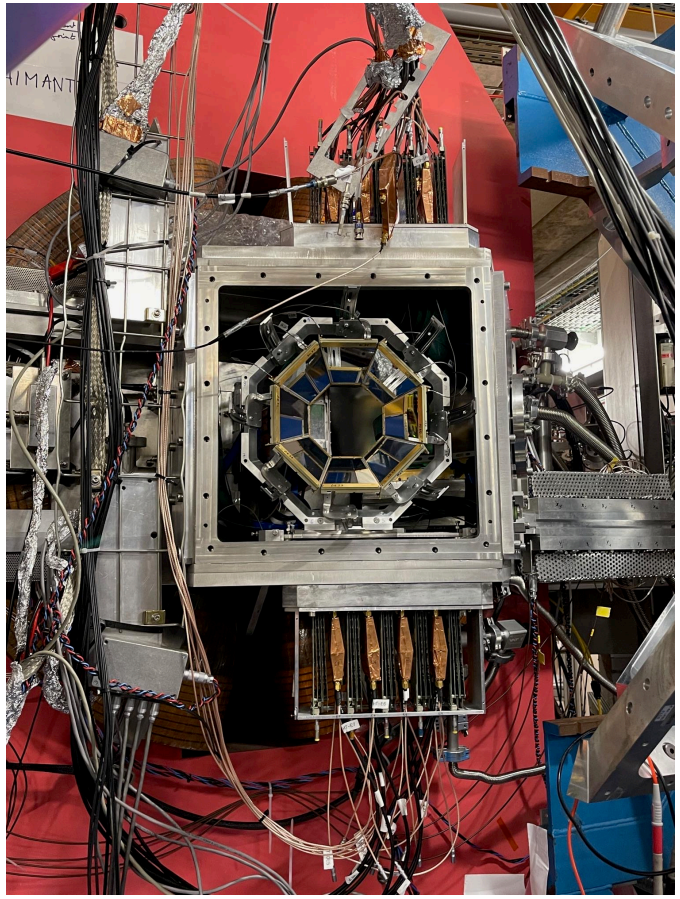

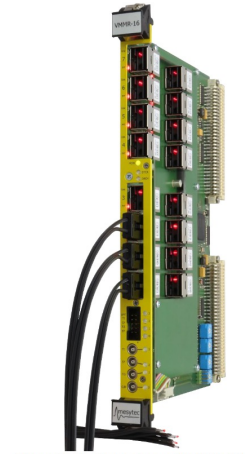

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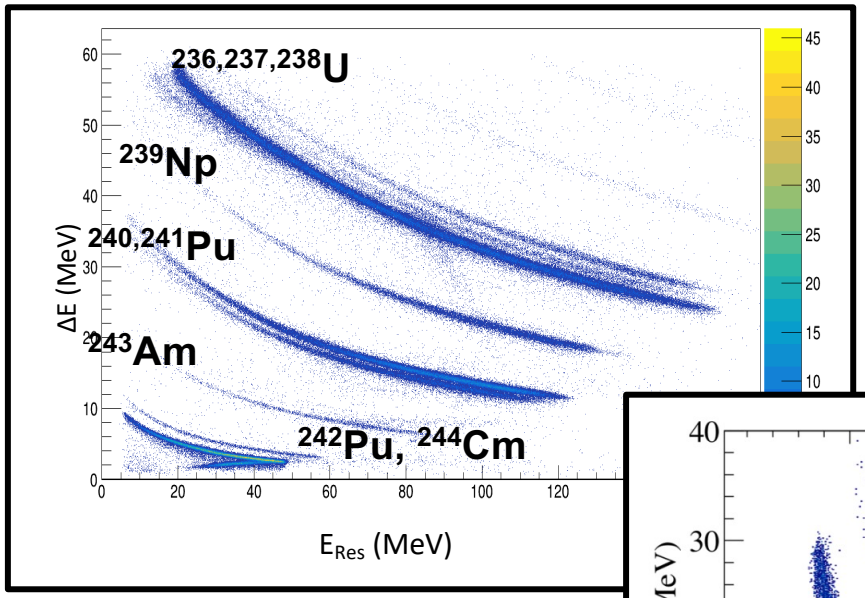

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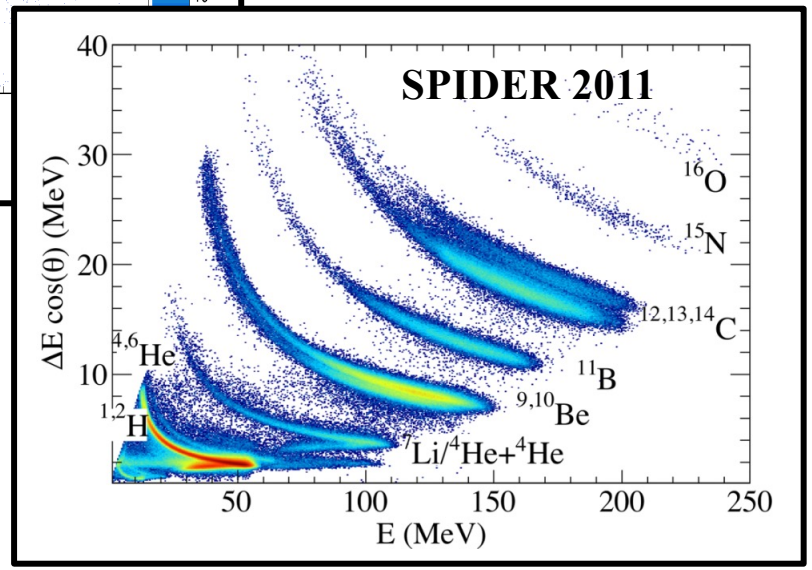
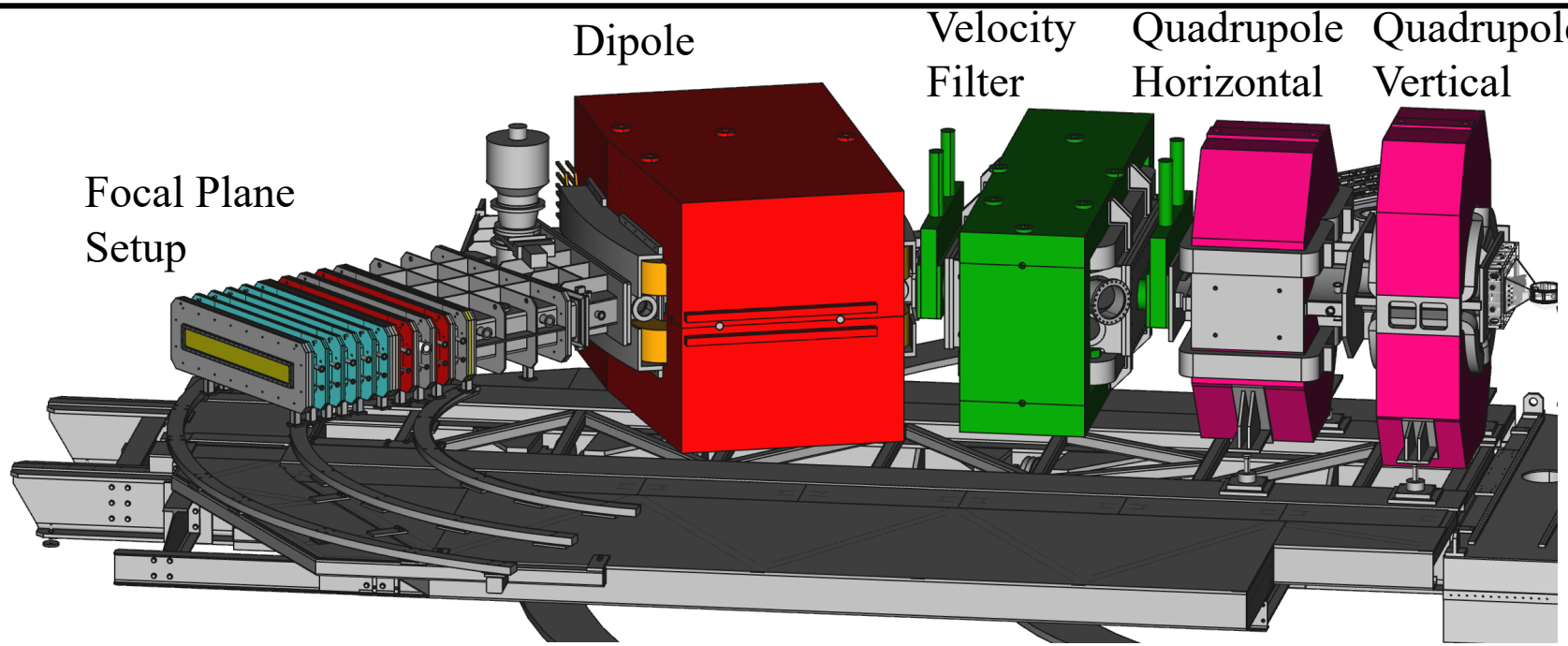
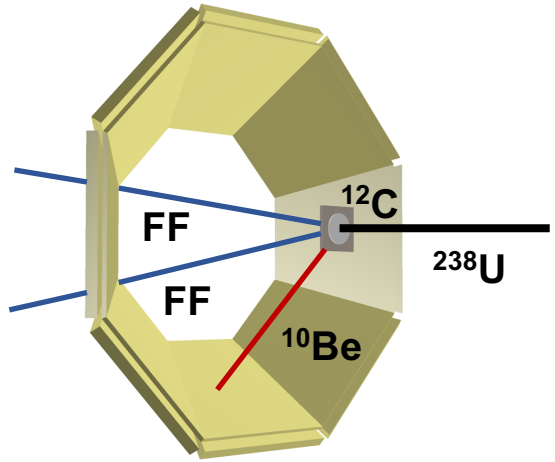
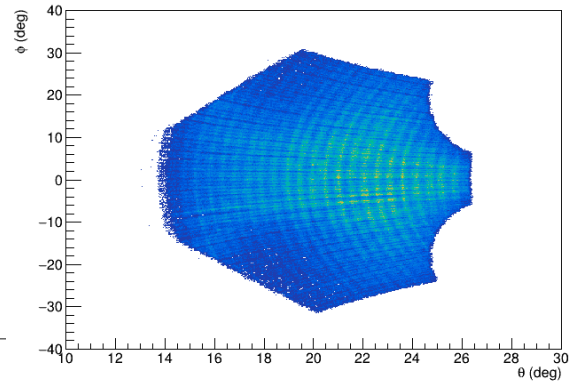
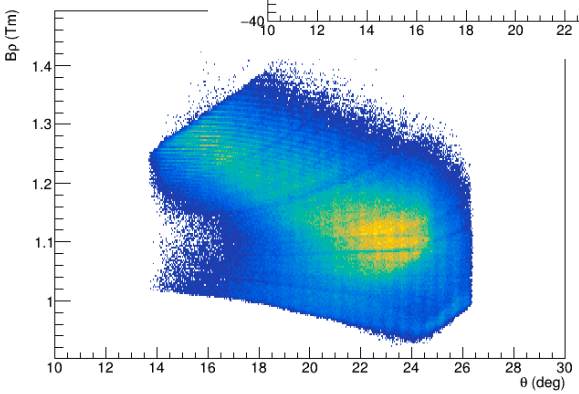


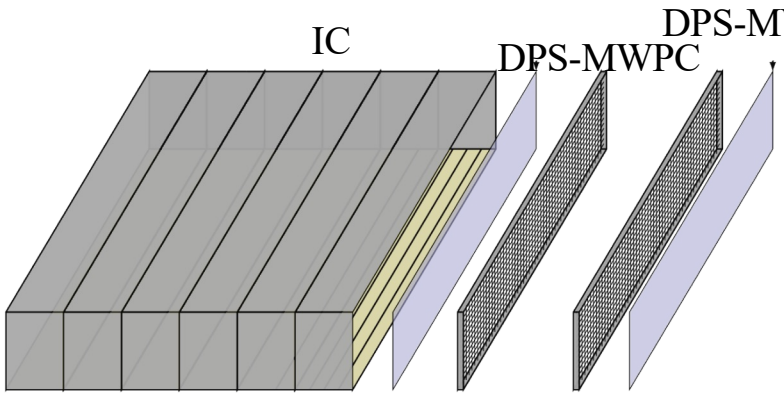
Current Status of VAMOS

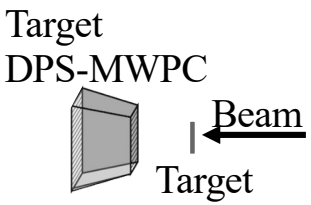






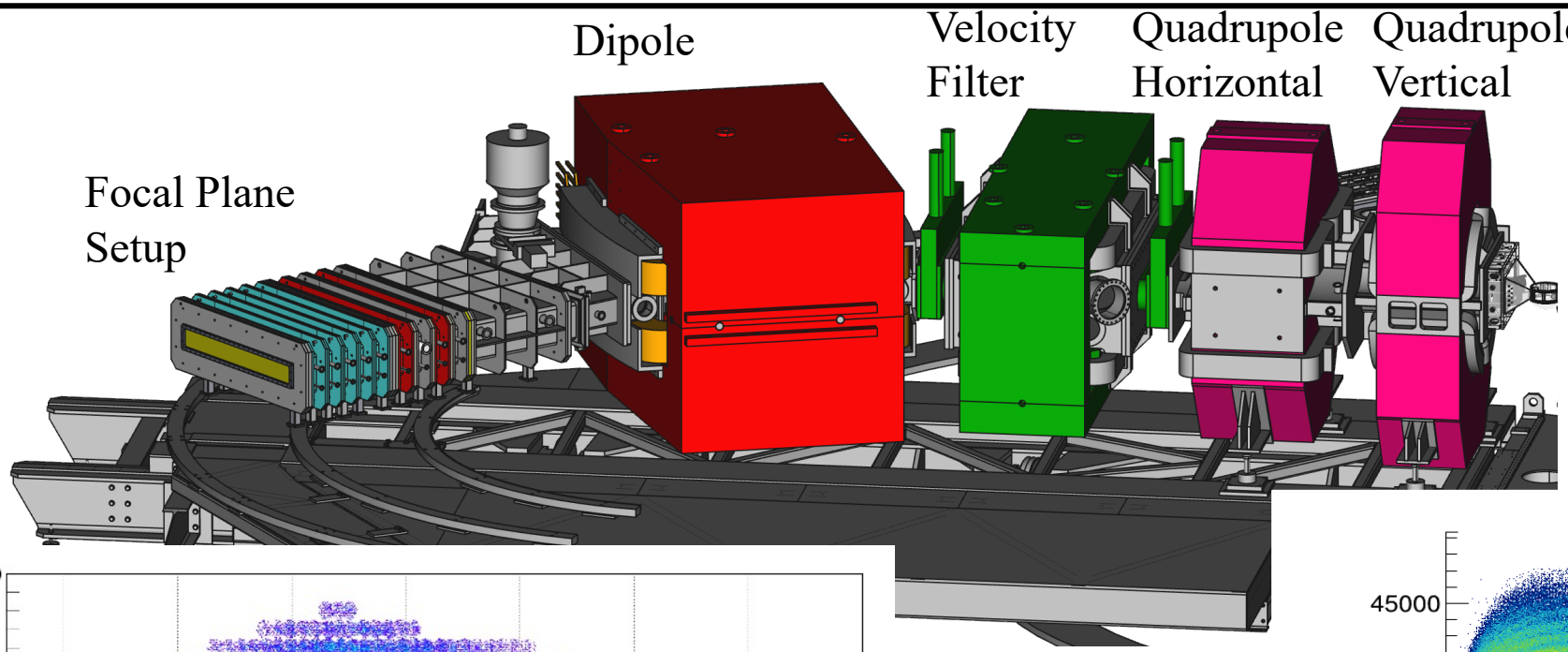


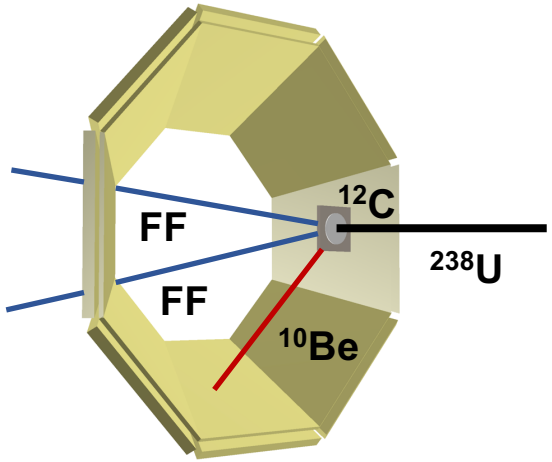


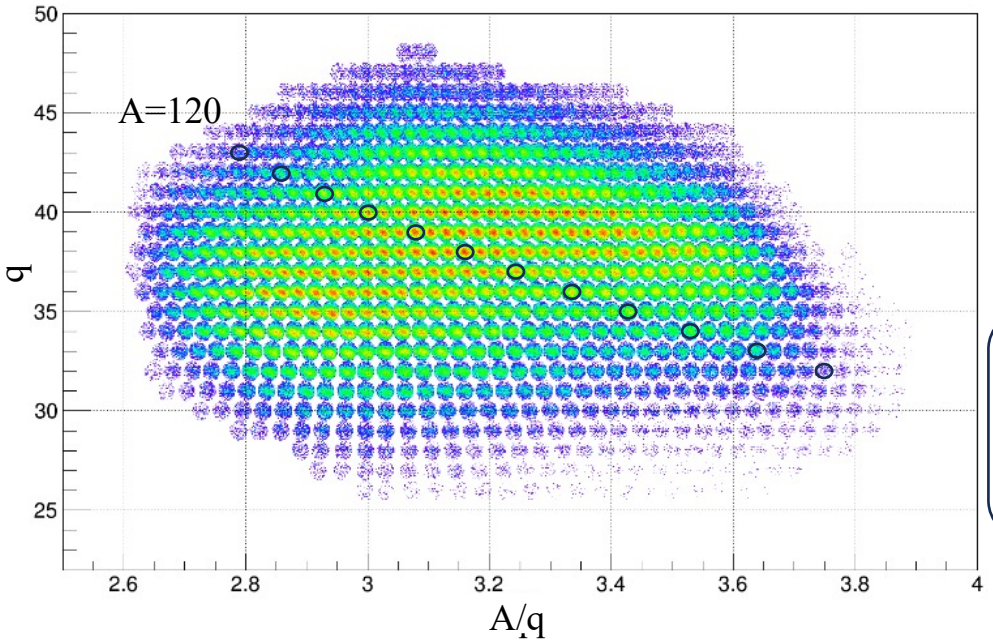


- **Intrinsic Efficiency**
  ~85% (Z>30)
- **Large Acceptance**
  30% momentum
  14 deg in horizontal axis
  60 deg in vertical axis

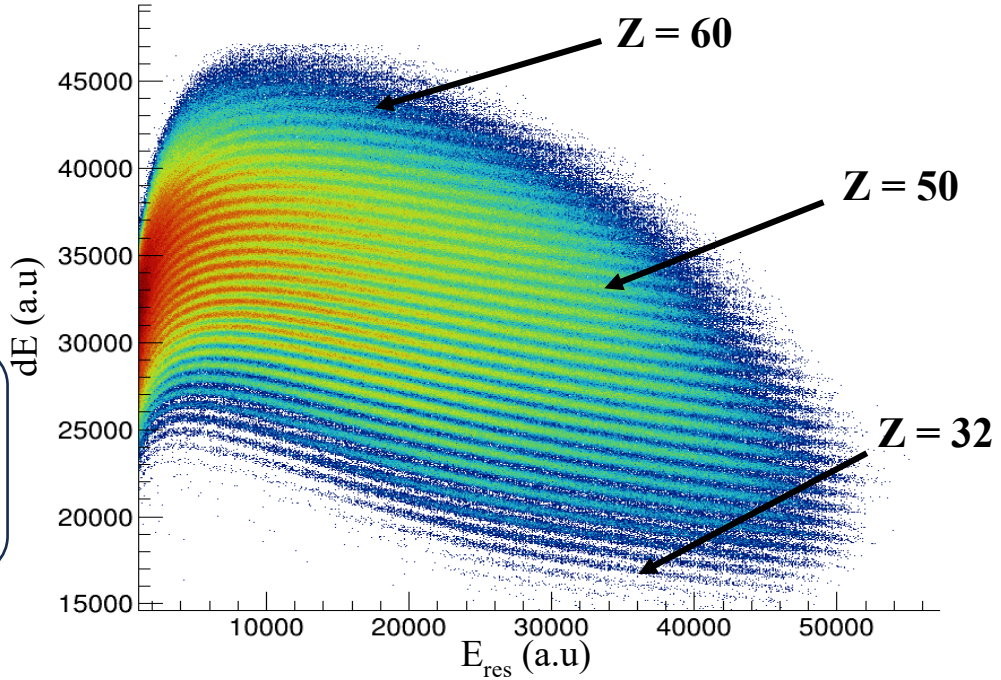
Current Status of VAMOS



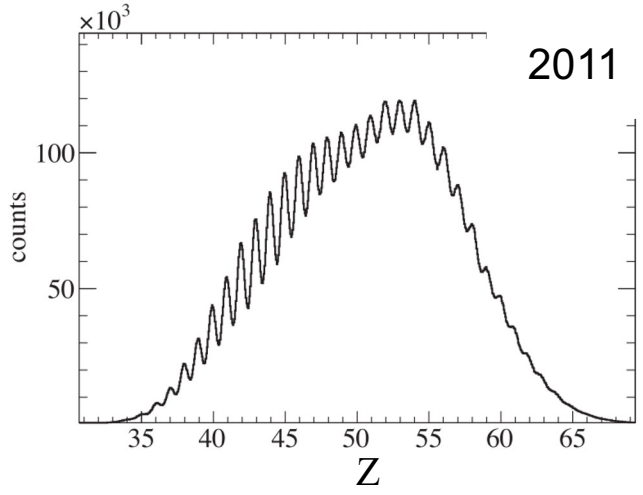


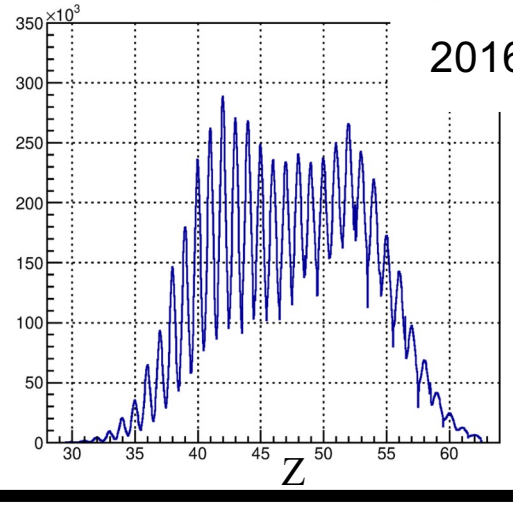


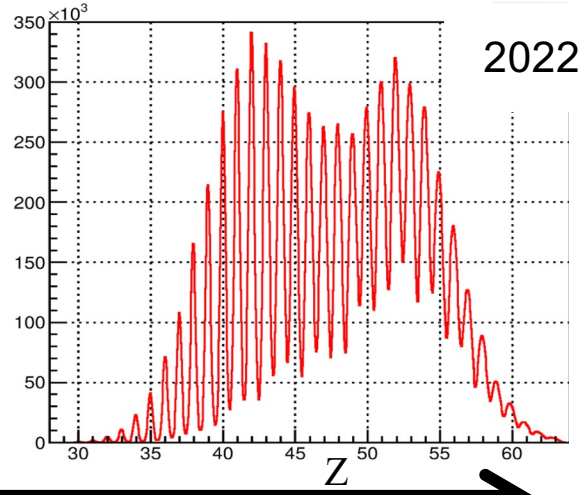
Identification capability
ΔA/A = 0.3 % (FWHM)
ΔZ/Z = 1.3 % (FWHM



Current Status of VAMOS



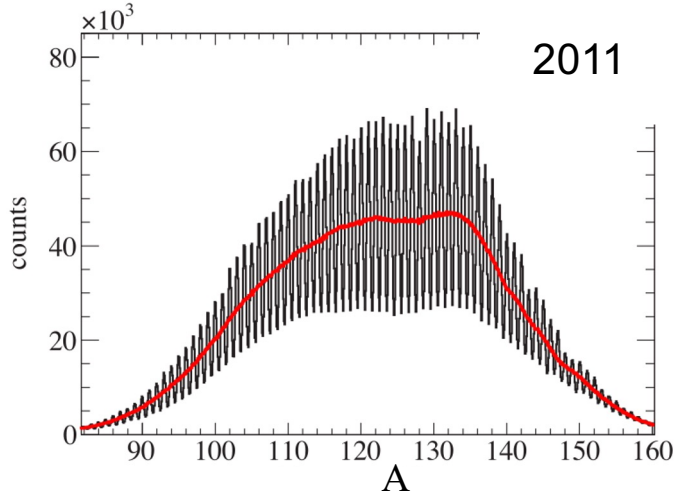


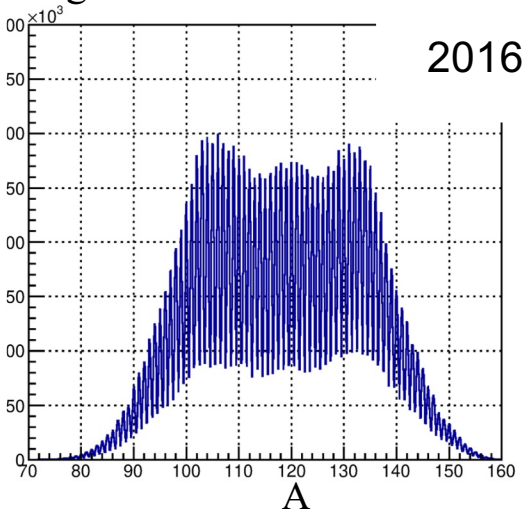


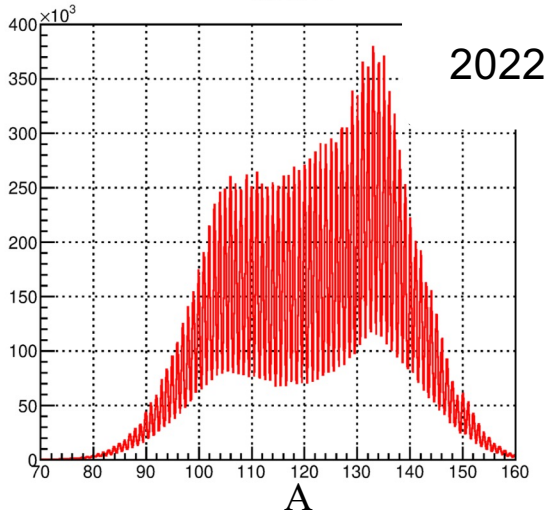
No Target PS-MWPC
DC + IC + Si (focal plane)

Target PS-MWPC
High Segmentation IC
Digital Electronics

Focal Plane PS-MWPC
Higher Segmentation IC







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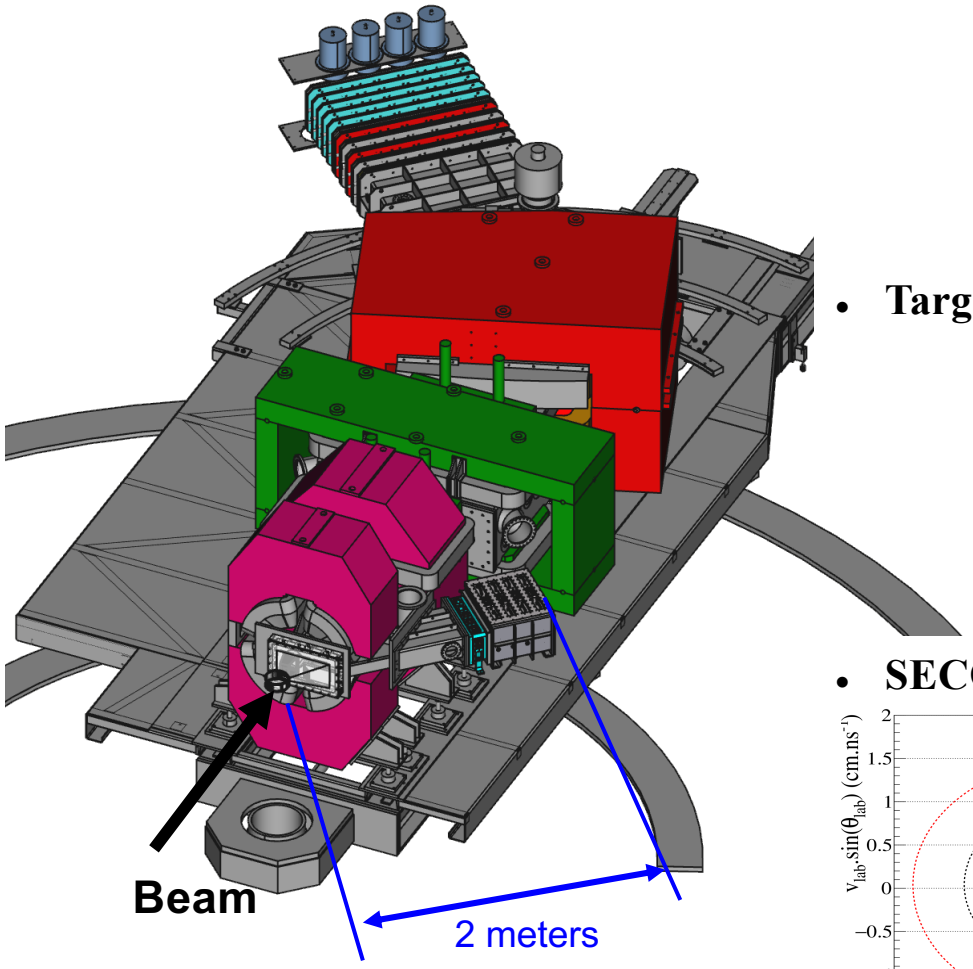
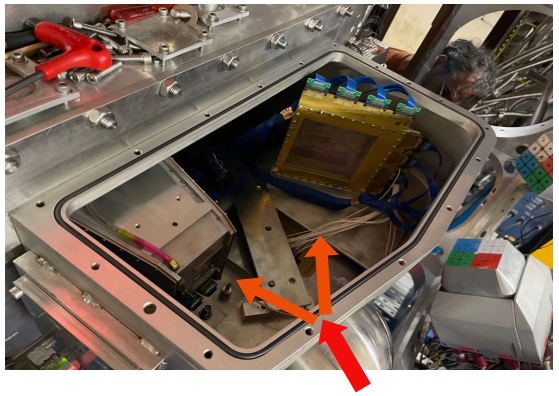


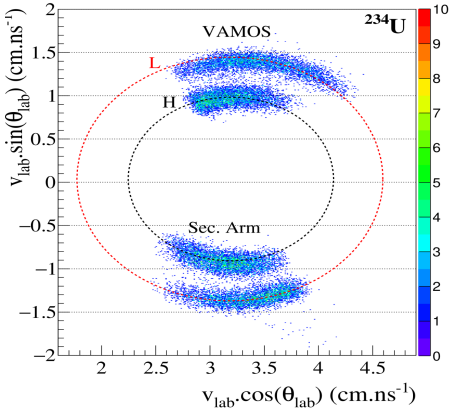
- **VAMOS FP** Mesytec Electronics for TOF VAMOS
  - MCFD & MTDC

  -Solving Obsolescence problems
  - Allow Multiplicities >1

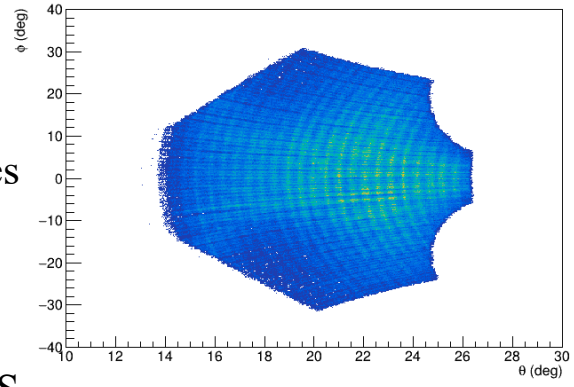
- **Target MW**



- **SECOND ARM**



- Measurement of emission angles
- Vertex@Target reconstruction



- 40±7 deg with respect to VAMOS
- Reconstruction of the center of mass velocities of both fission fragments in coincidence

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

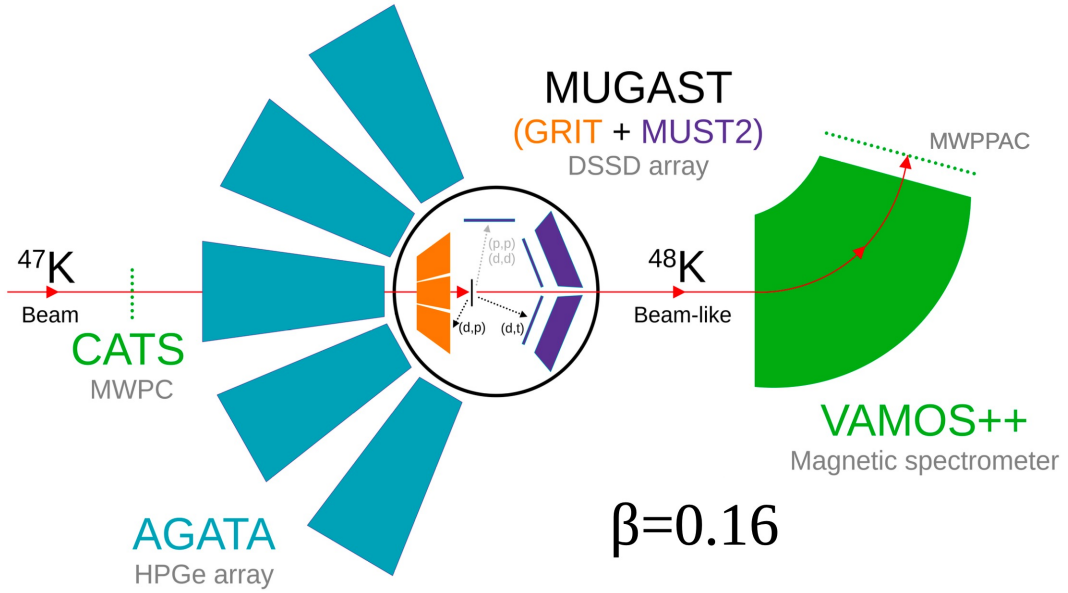
SPIRAL1+
- ^{47}K RIB @ 7.7MeV/u.
- 5×10^{5} pps, 10^{-4} mass res. → pure beam

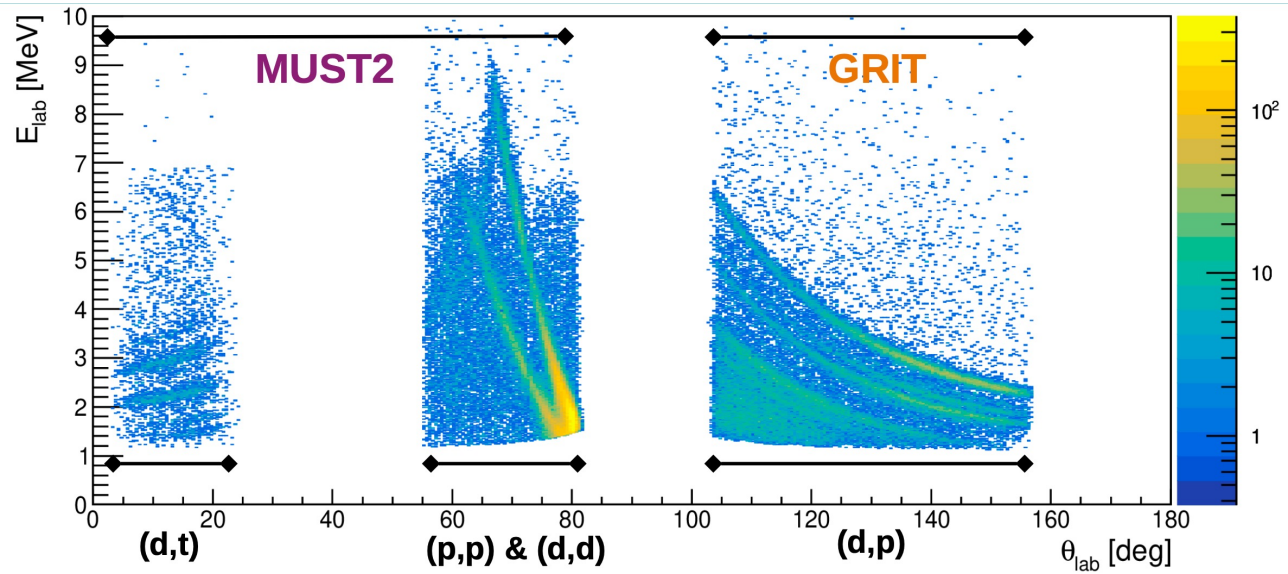
TARGET
- 0.31(2) mg/cm^2 CD_2

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





VAMOS in AGATA/MUGAST @ GANIL

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

- SETUP FOR Z<30 ions detection:
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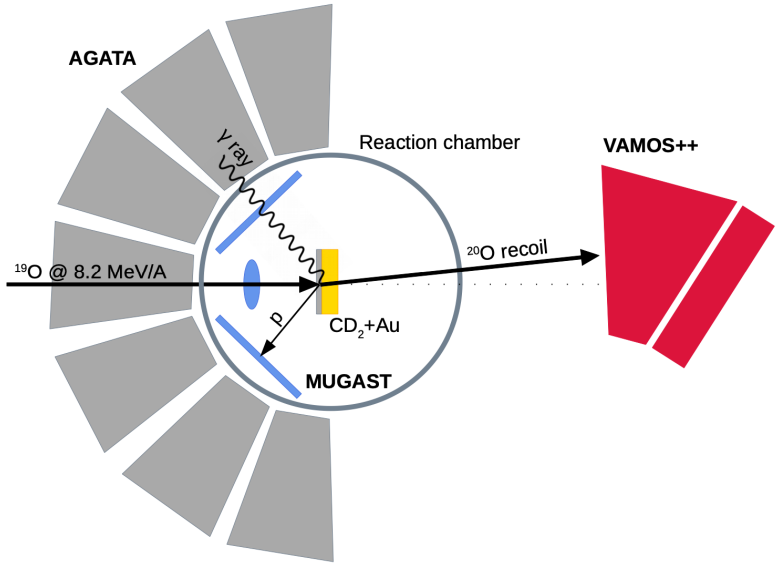
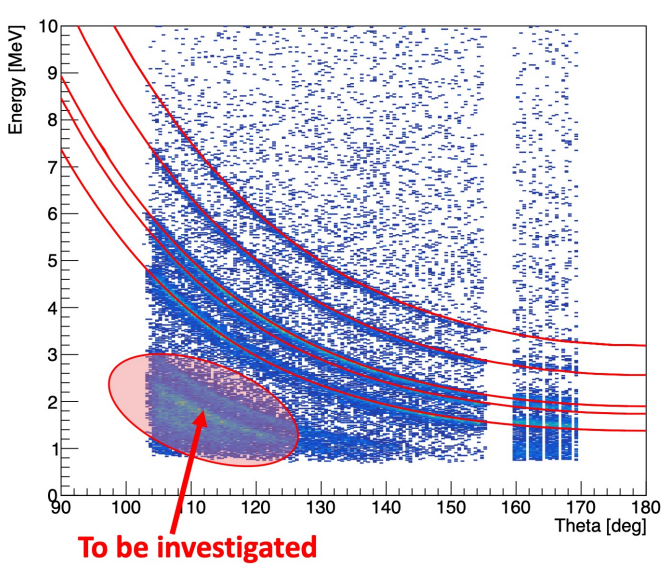
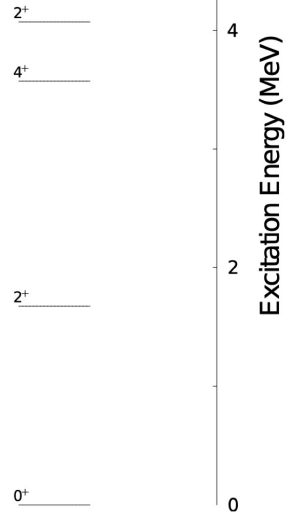
$$^{19}O + d \rightarrow {}^{20}O + p$$



- ^{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



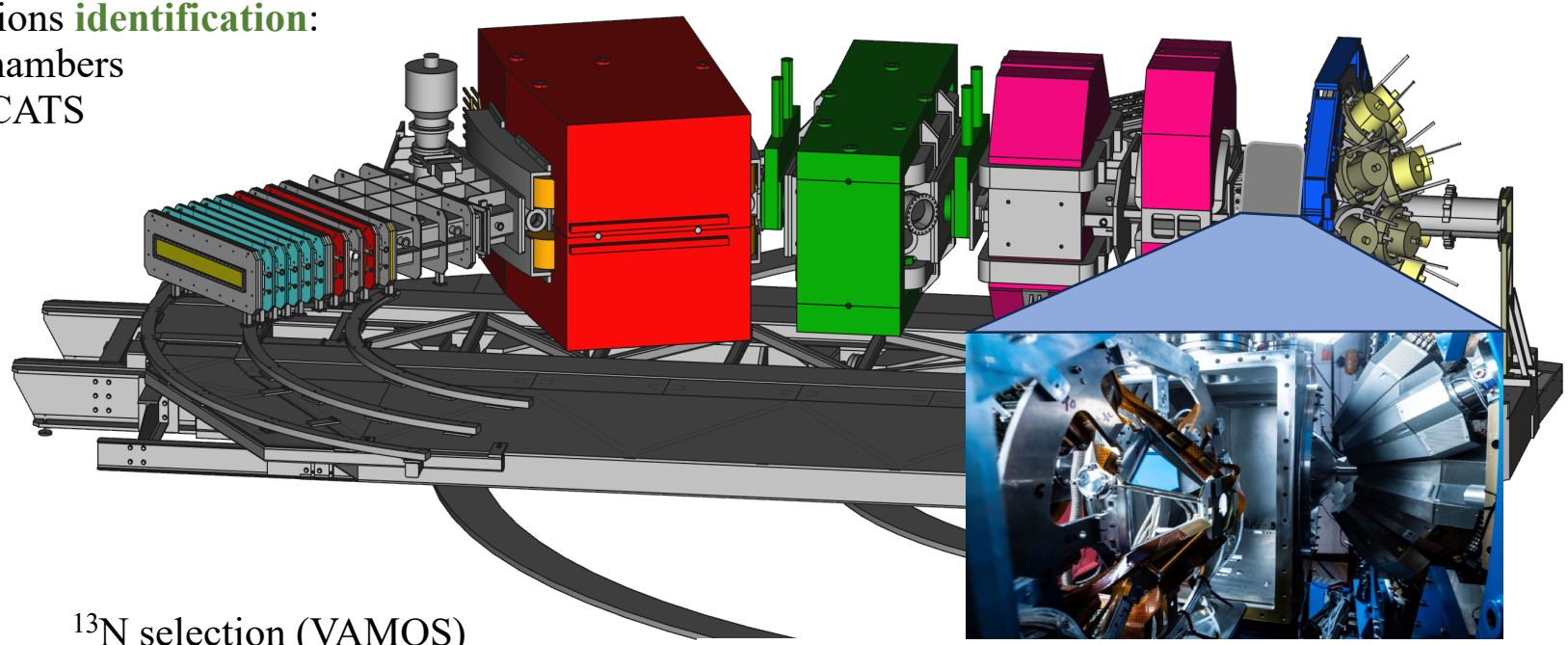


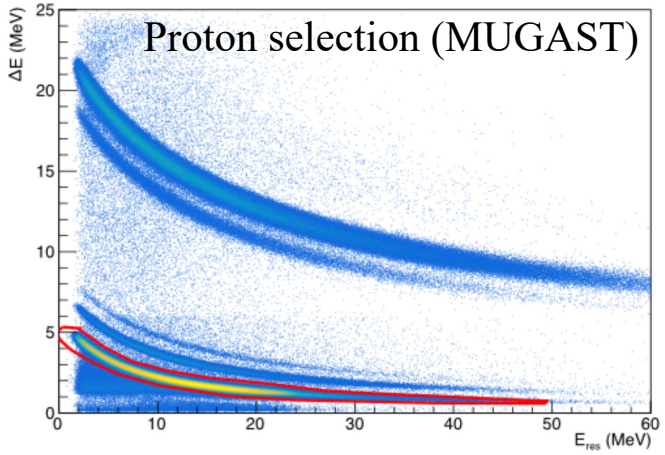
VAMOS in AGATA/MUGAST @ GANIL

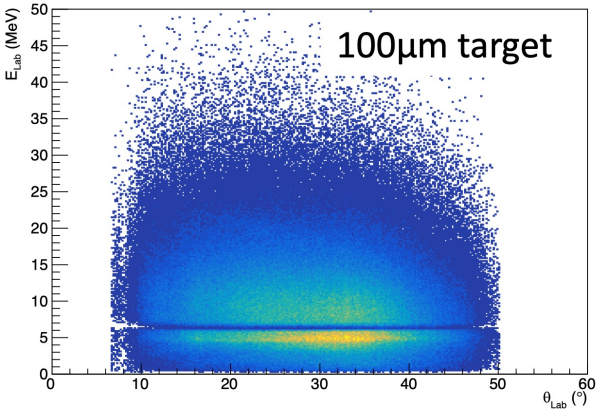
- SPIRAL 1 Beams
- Light Targets
- VAMOS @ 0 deg

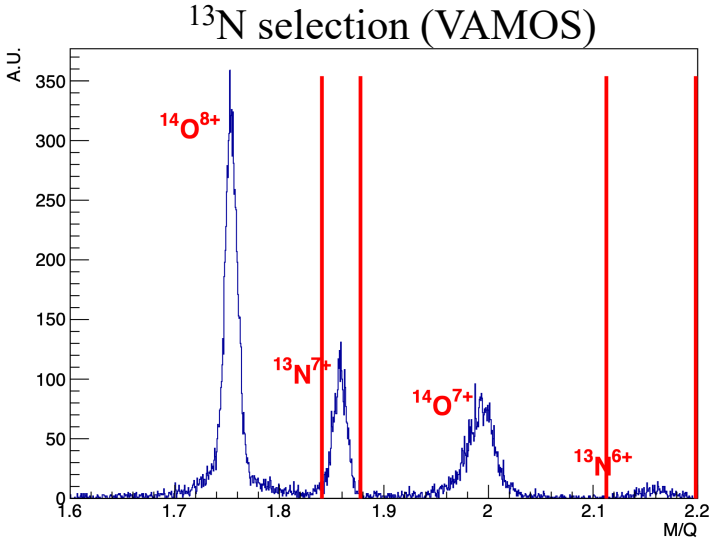
- SETUP FOR Z<30 ions **identification**:
- Positions = Drift Chambers
- ToF = Focal Plane CATS

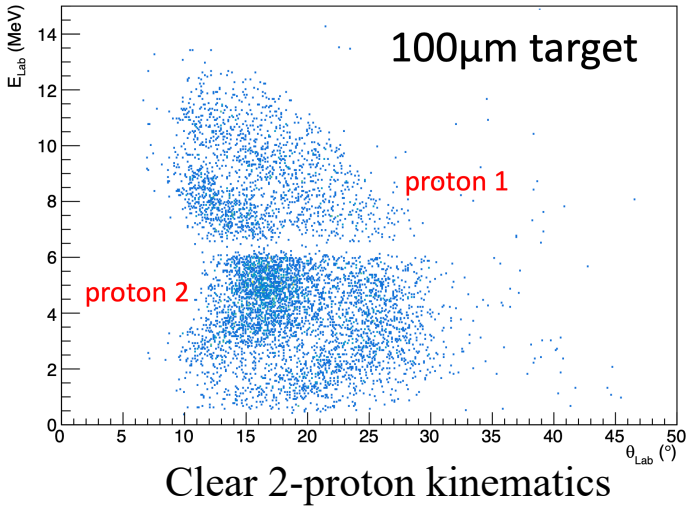
$$^{14}O + p \rightarrow {}^{15}F \rightarrow {}^{13}N + 2p$$











Clear 2-proton kinematics

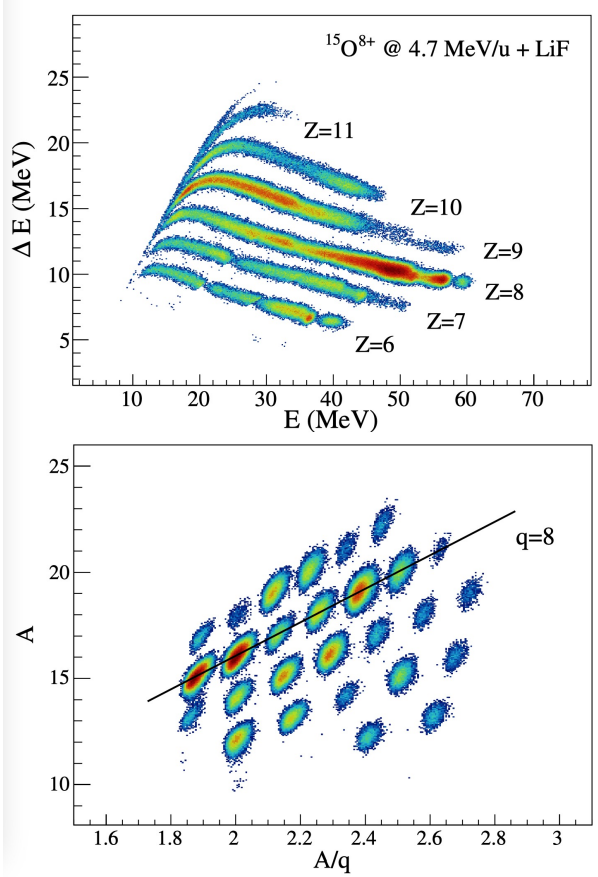
PhD V. Girard-Alcindor

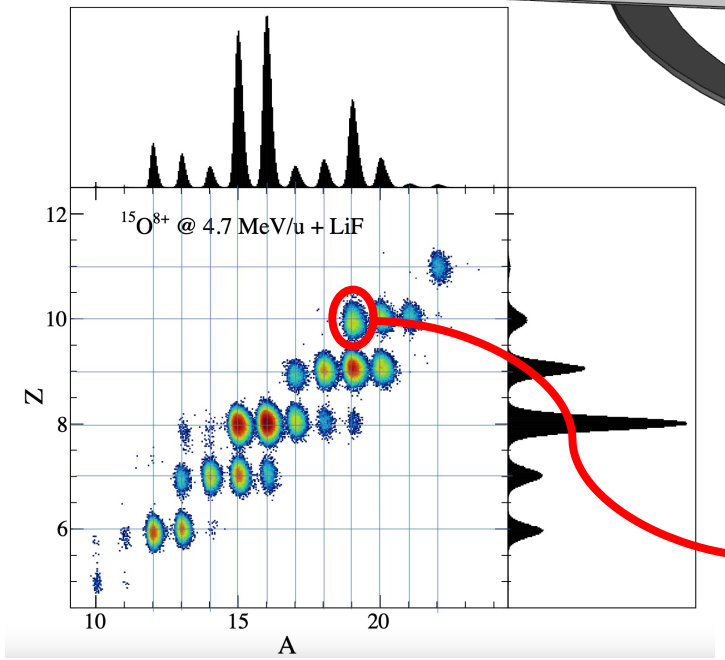
VAMOS in AGATA/MUGAST @ GANIL

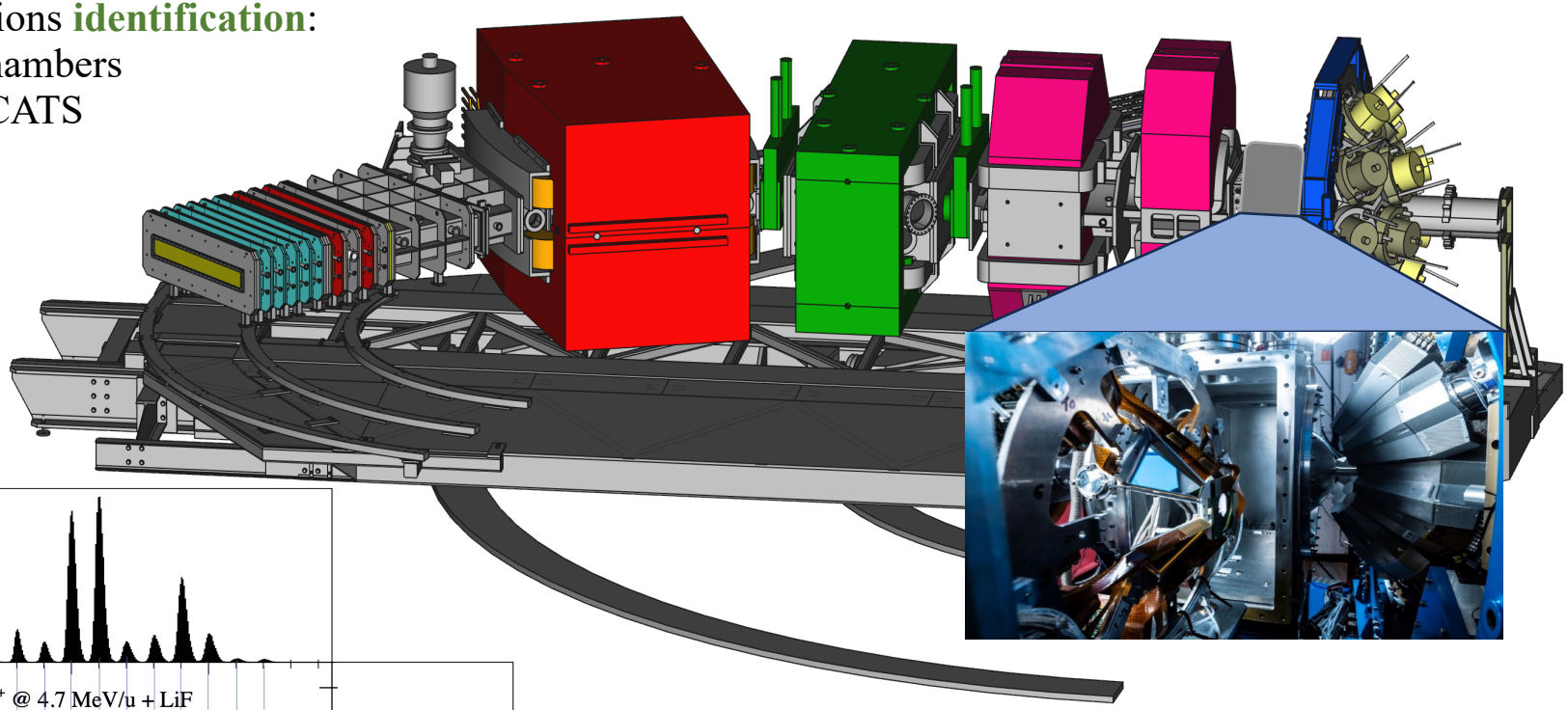
- SPIRAL 1 Beams
- Light Targets
- VAMOS @ 0 deg

- 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

VAMOS in AGATA/MUGAST @ GANIL

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

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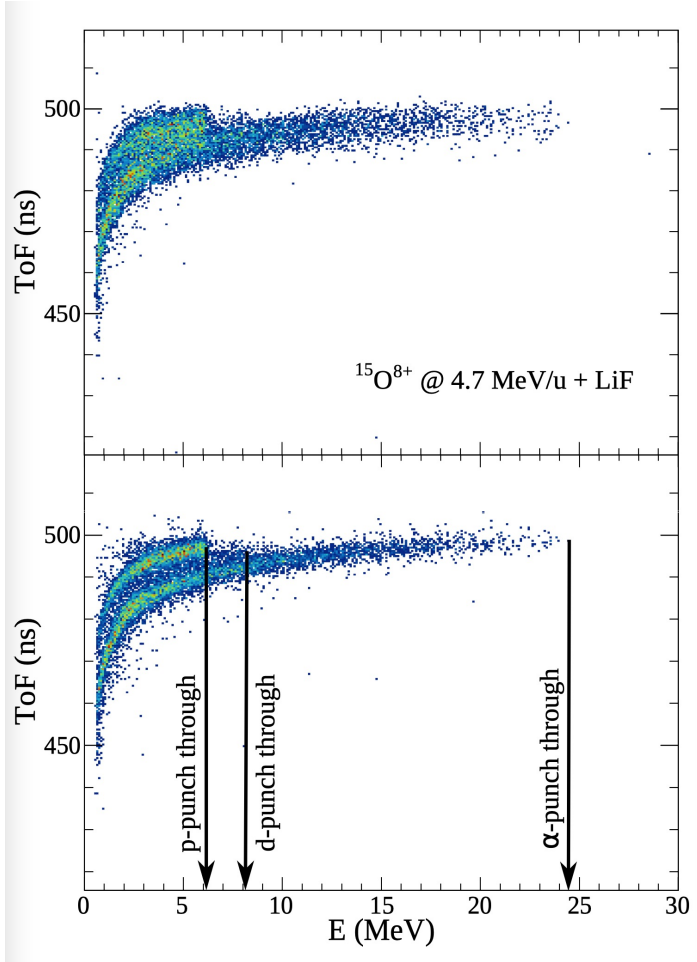
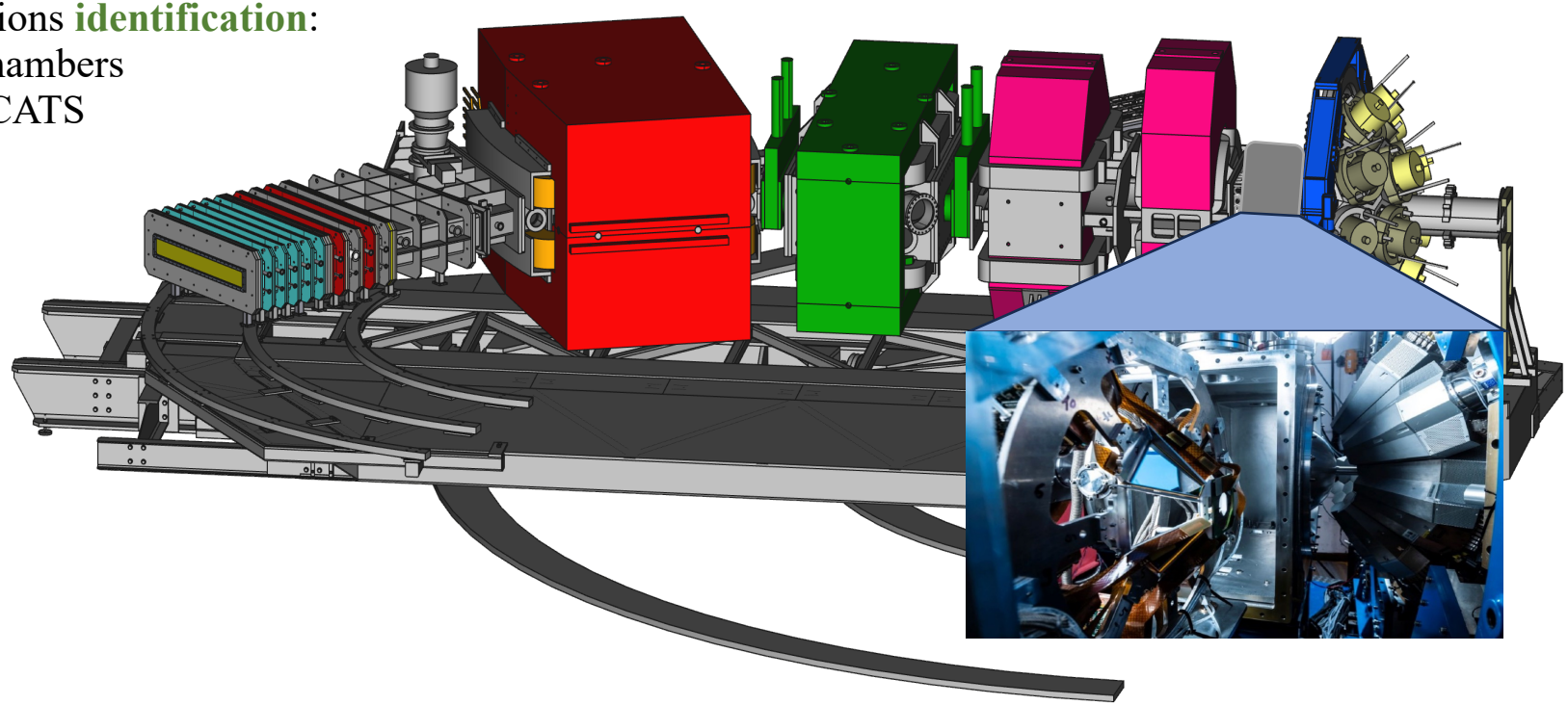
- ToF = Focal Plane CATS





- 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

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

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

Light Charged Particles @ VAMOS

^{19}Ne @ 10 AMeV

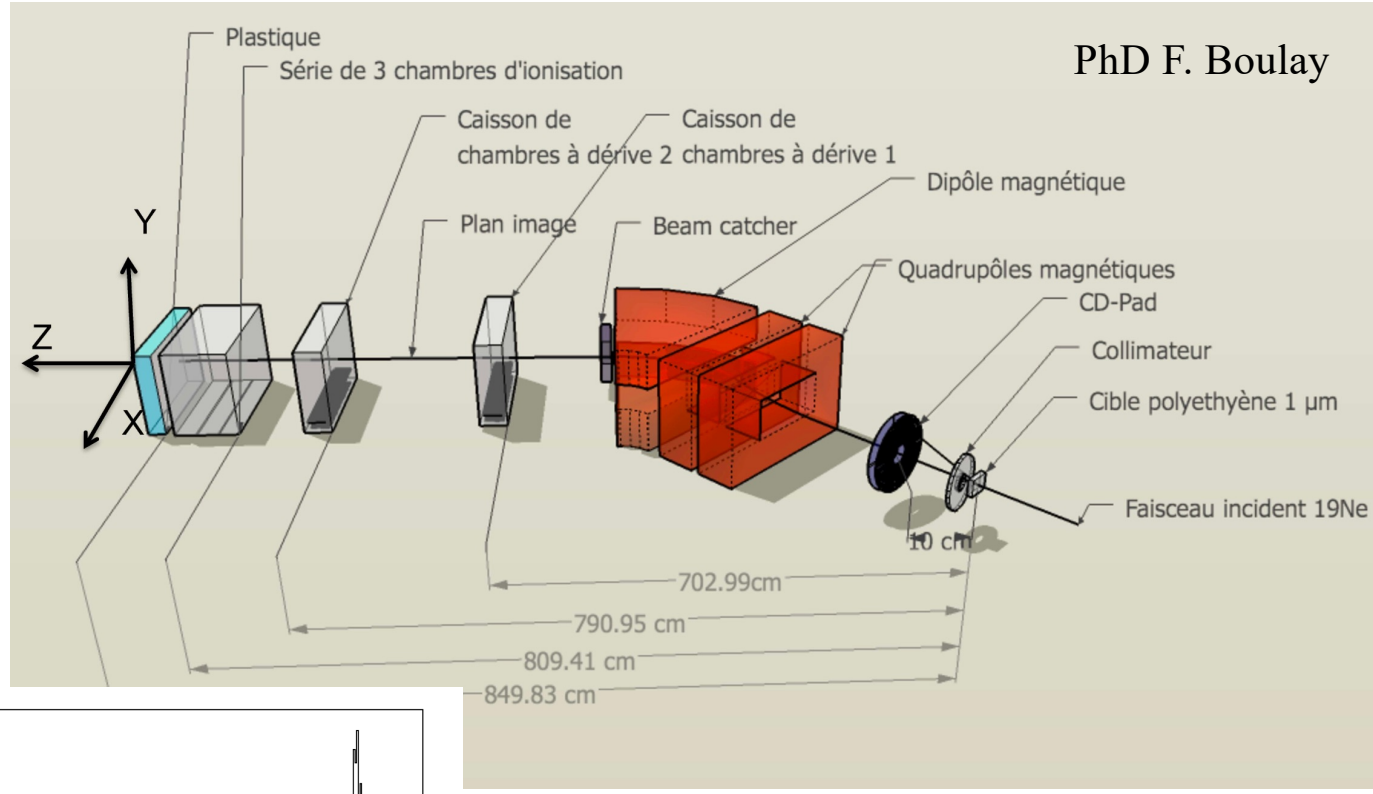
$$^{19}\mathrm{Ne} + \mathrm{p} \rightarrow \left(^{20}\mathrm{Na}\right)^{*} \rightarrow \left(^{19}\mathrm{Ne}\right)^{*} + \mathrm{p}'$$

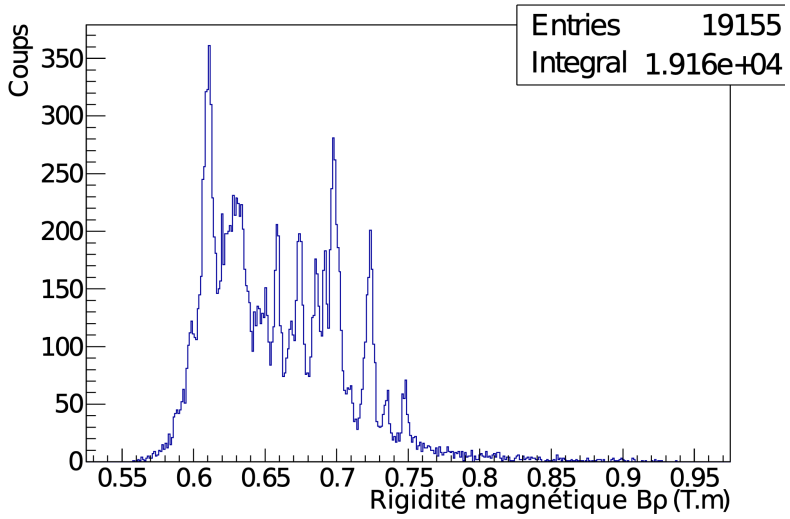
$$\left(^{19}\mathrm{Ne}\right)^{*} \rightarrow {}^{18}\mathrm{F} + \mathrm{p}''$$

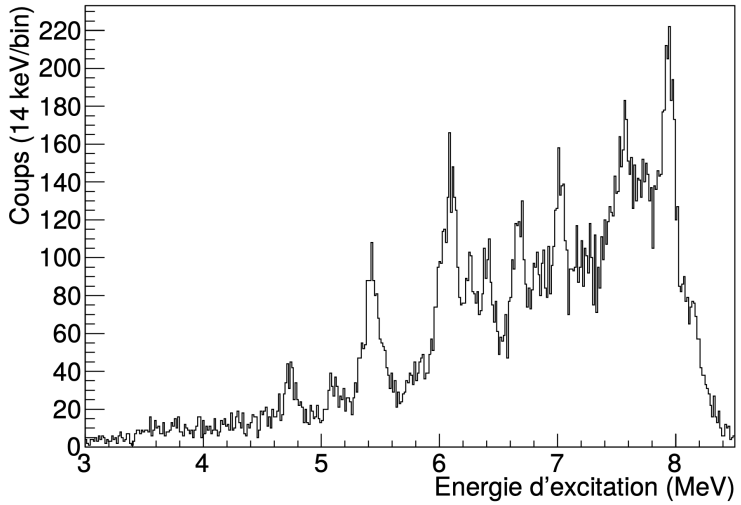
$$ou \qquad \left(^{19}\mathrm{Ne}\right)^{*} \rightarrow {}^{15}\mathrm{O} + \alpha$$

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

- 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
  - ⇩
  - 1 us deadtime with MMR adapted to MW

Up to 2048 channels per VMMR-16

Stacked boards for 128 channels

60 x140 x20mm³

- Efficient focal plane detection:
  - CATS like Multiwires
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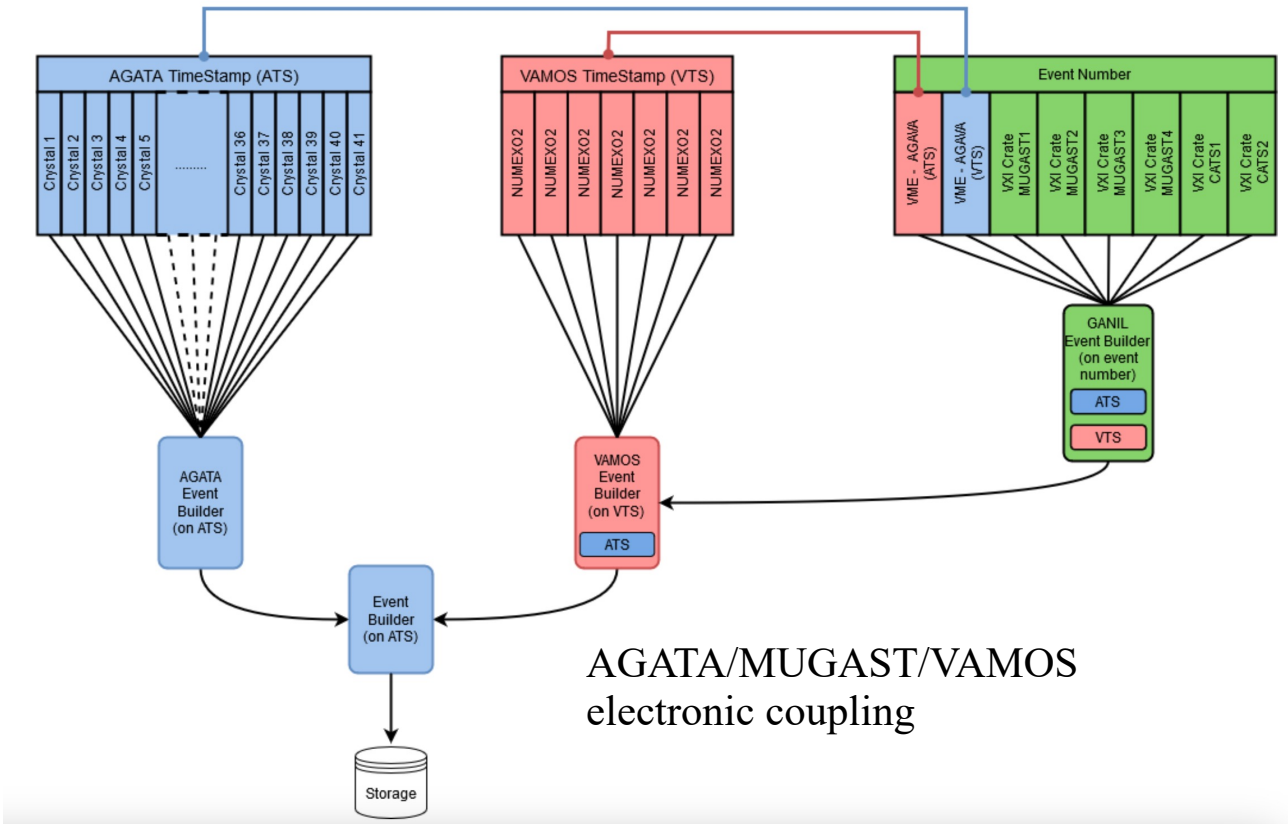
  - Adaptation to proton/He detection

- Measurement of emission angles at Target
  - Detector to be Designed

- Reduction of focal plane PileUp
  - Perpendicular Segmentation of Ionization Chamber

- VAMOS @ 0 deg -> Unreacted Beam blocker design



AGATA/MUGAST/VAMOS electronic coupling

- Coupling of the 3 electronics
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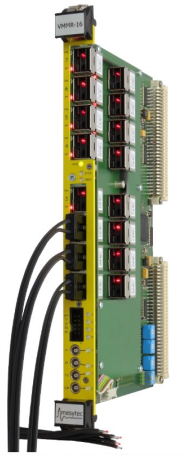

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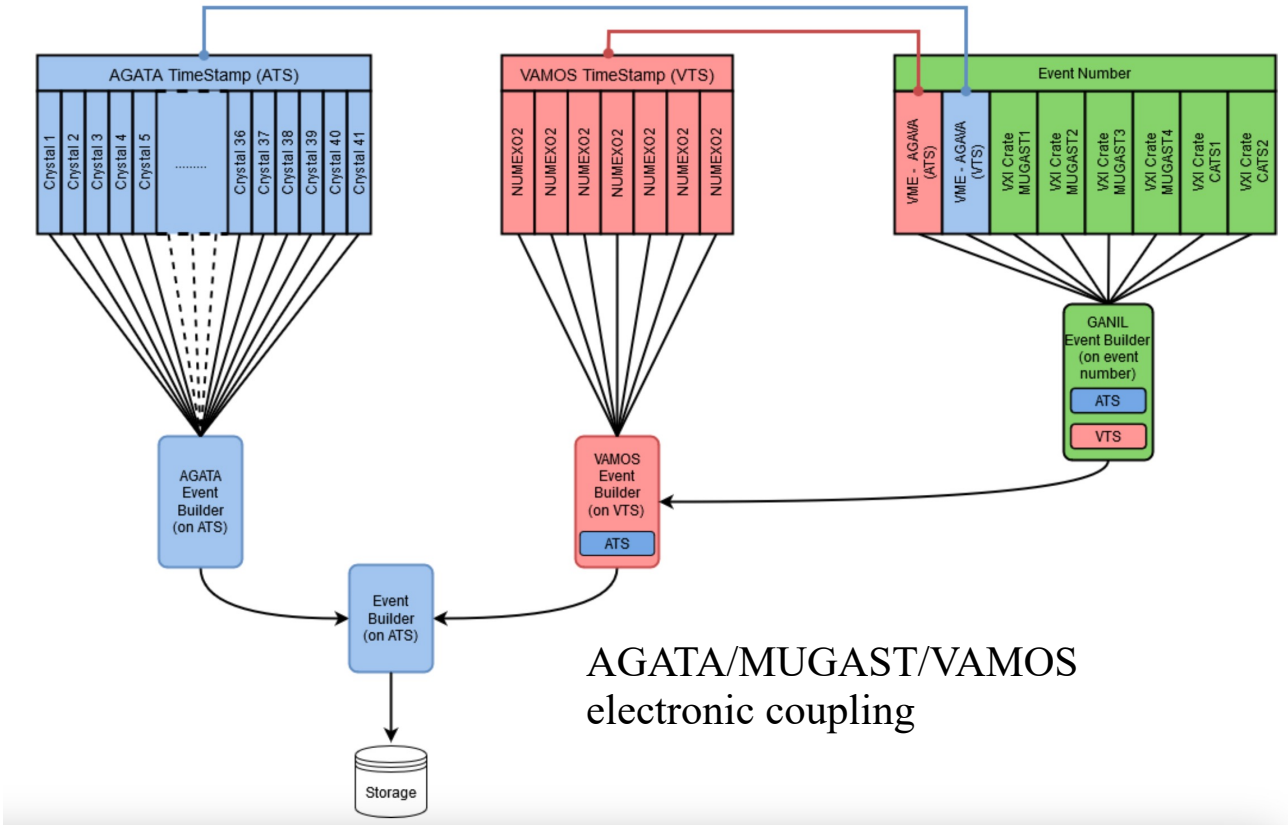

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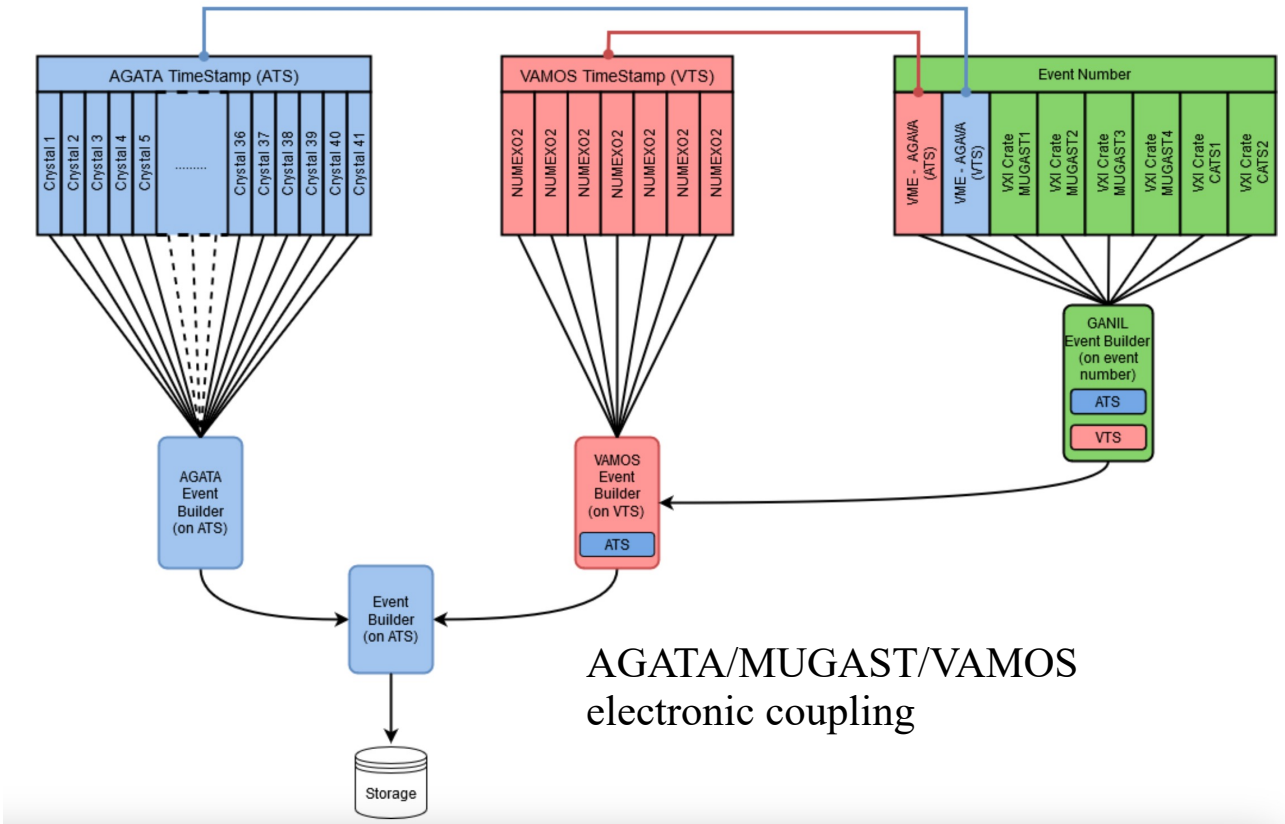

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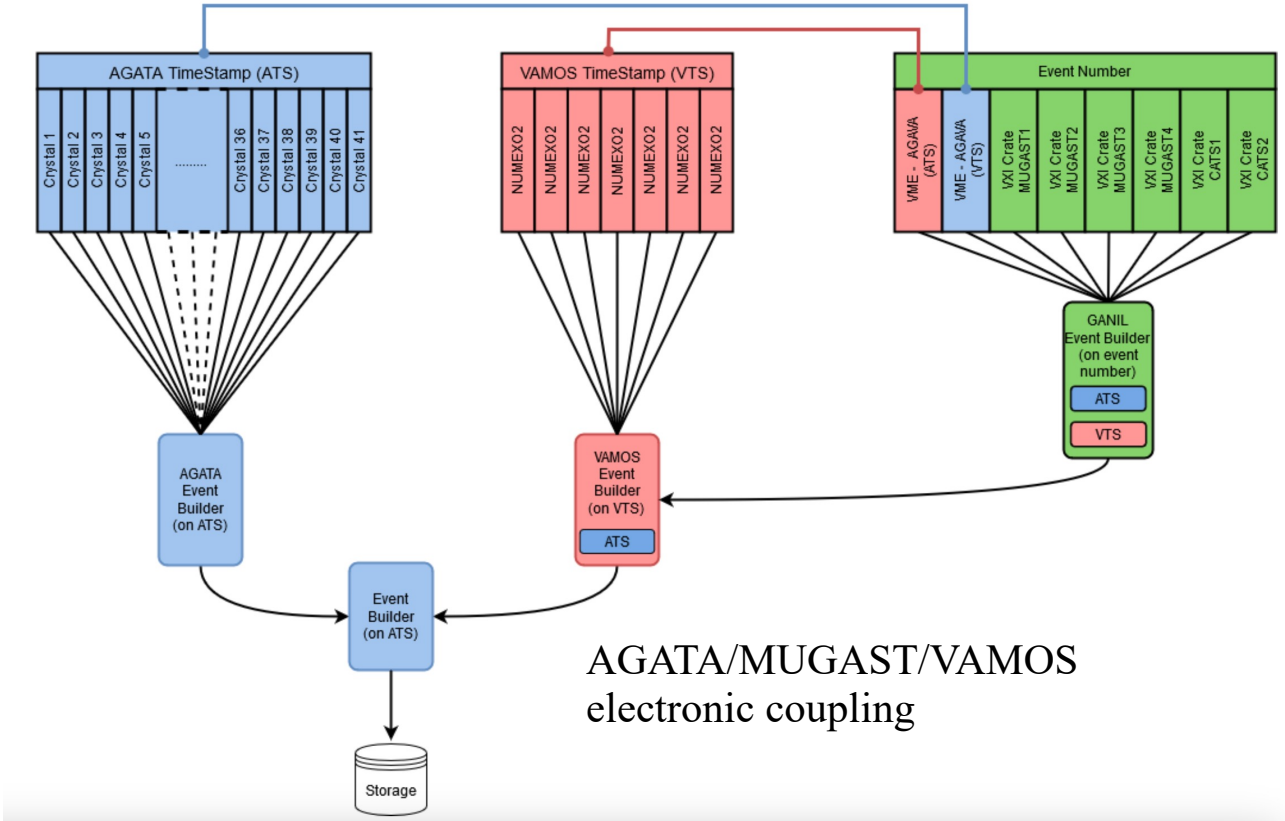

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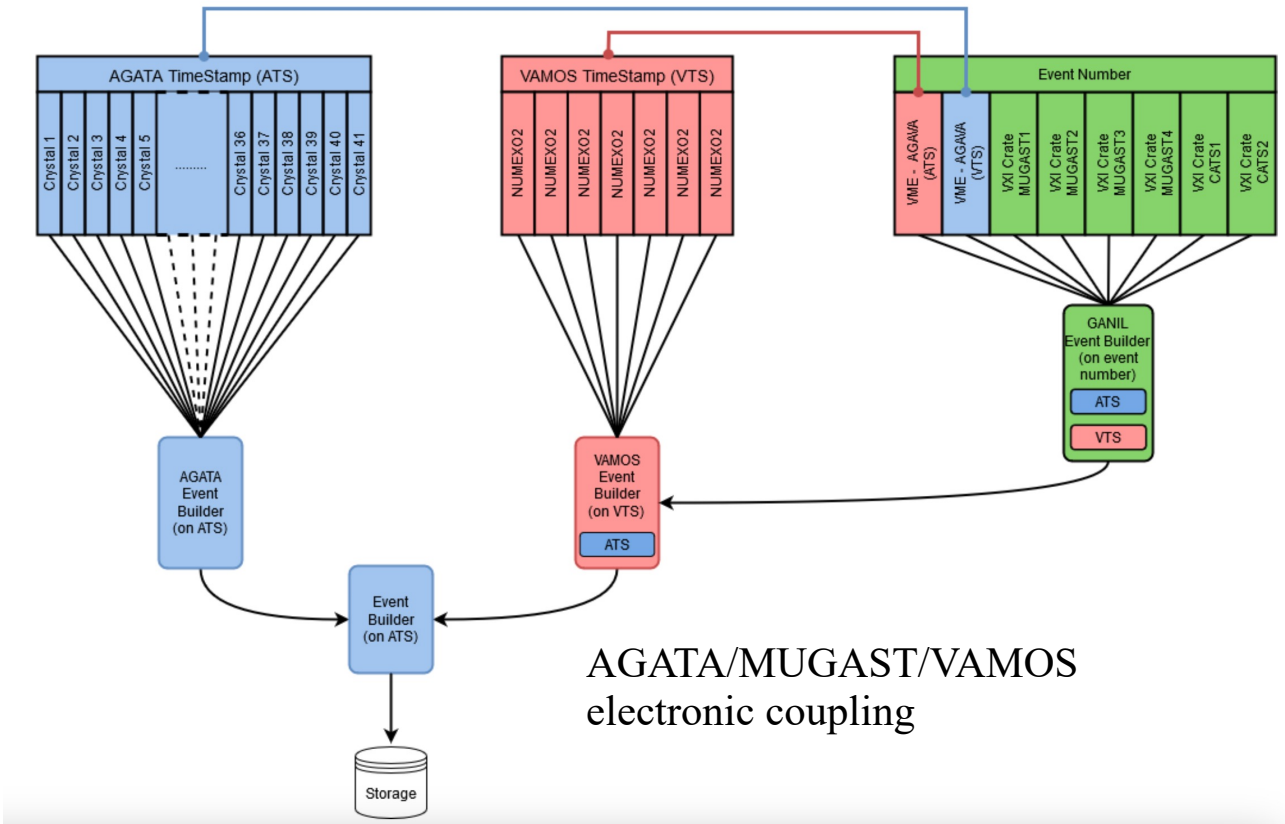

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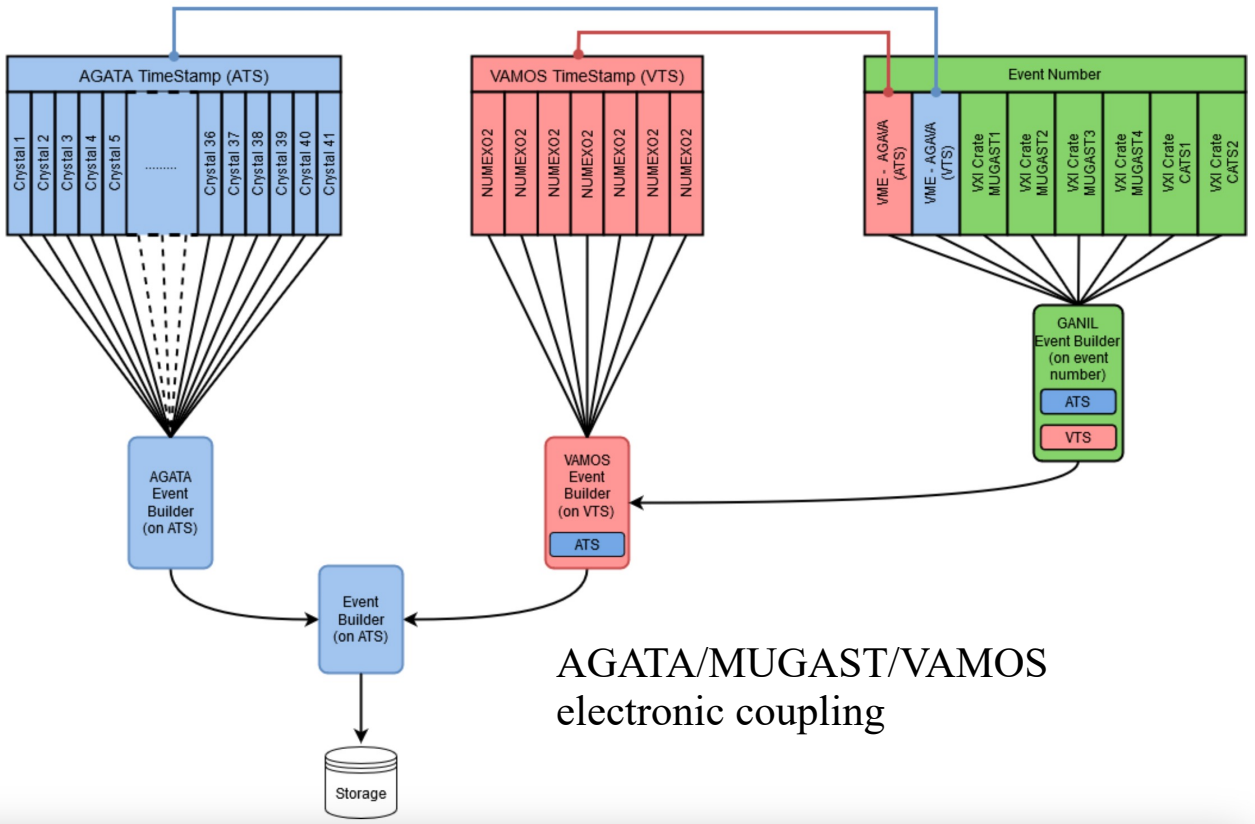

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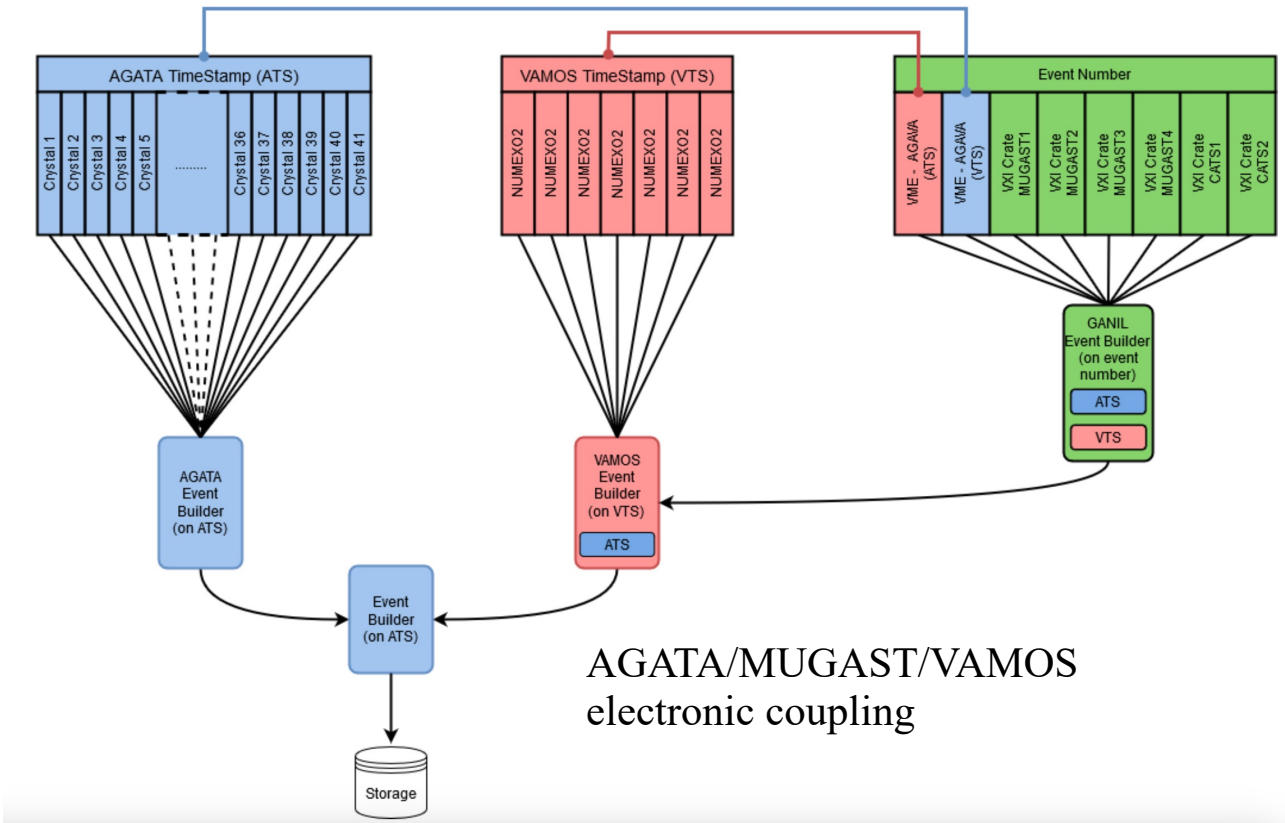

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VAMOS is one of the most performing spectrometers today
- It was/will be useful/crucial for different physical cases

VAMOS should not be a limiting factor