Recent developments of the 1 MV AMS facility at the *Centro Nacional de Aceleradores*

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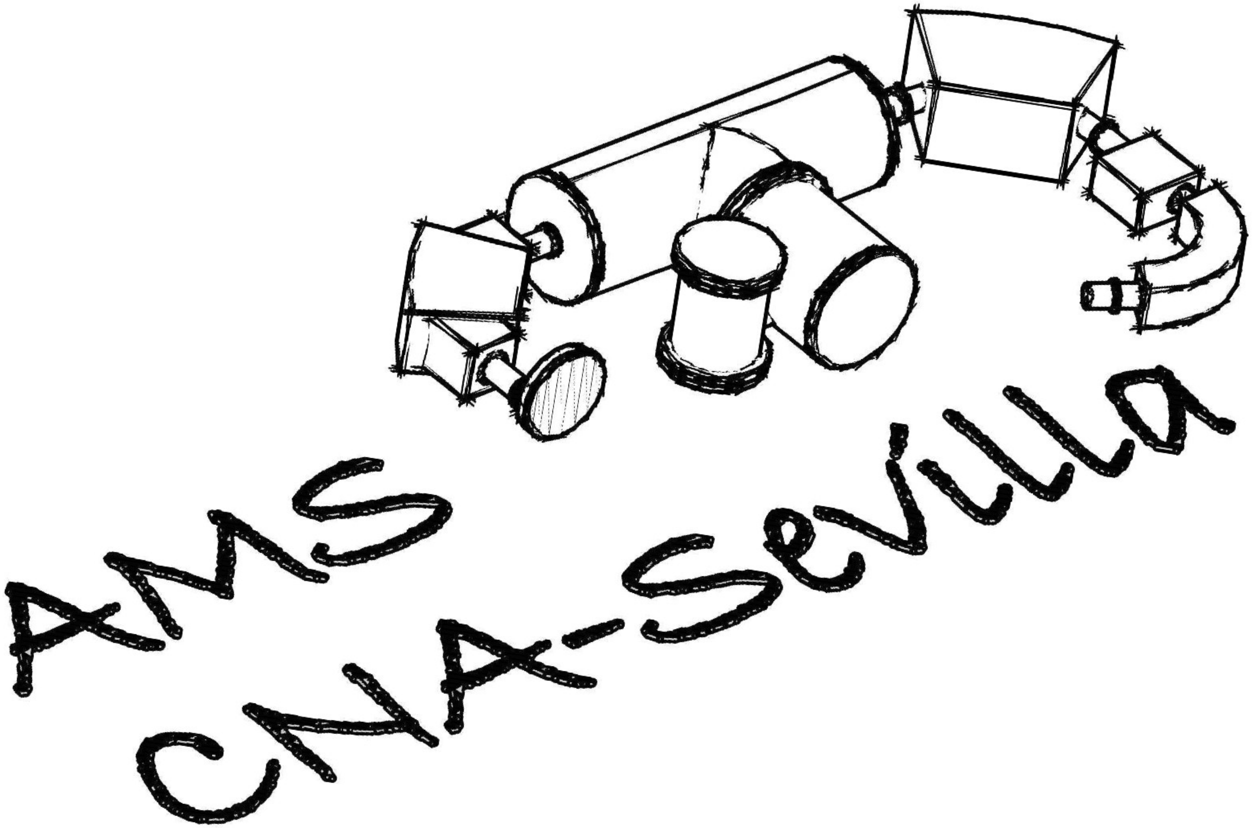
Outline

- The facility
- Recent developments
- Results
    - Stripper
    - Detector
- Conclusions



AMS at CNA

2005
multielemental SARA
(High Voltage Engineering Europe)

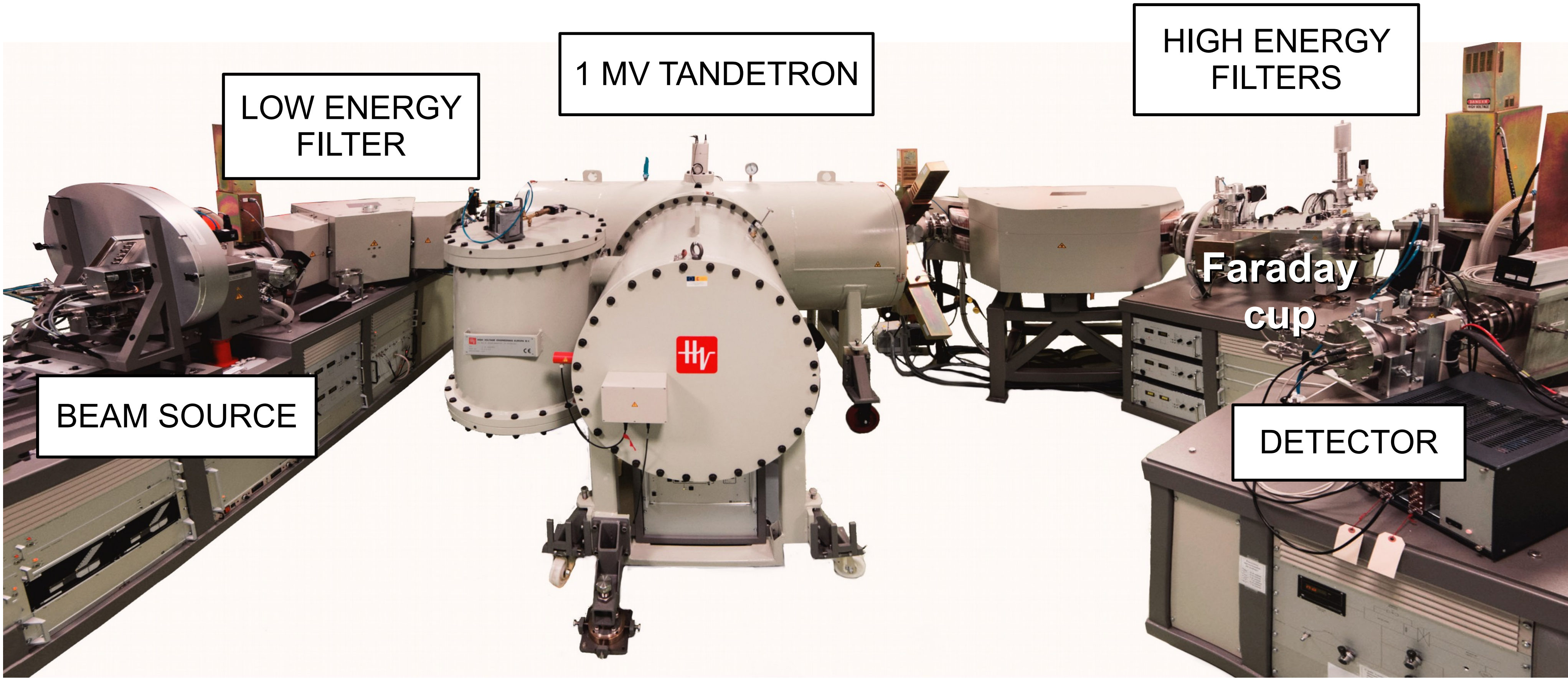
2012
^{14}C-dedicated Spanish MICADAS
(ETH-Zürich)

Measured isotopes: **^{14}C, ^{10}Be, ^{26}Al, ^{41}Ca, ^{129}I, ^{236}U and ^{239,240}Pu**.

- *archaeology*
- *geology*
- *environmental sciences*
- *medicine*

The facility

SARA: Spanish Accelerator for Radionuclides Analysis



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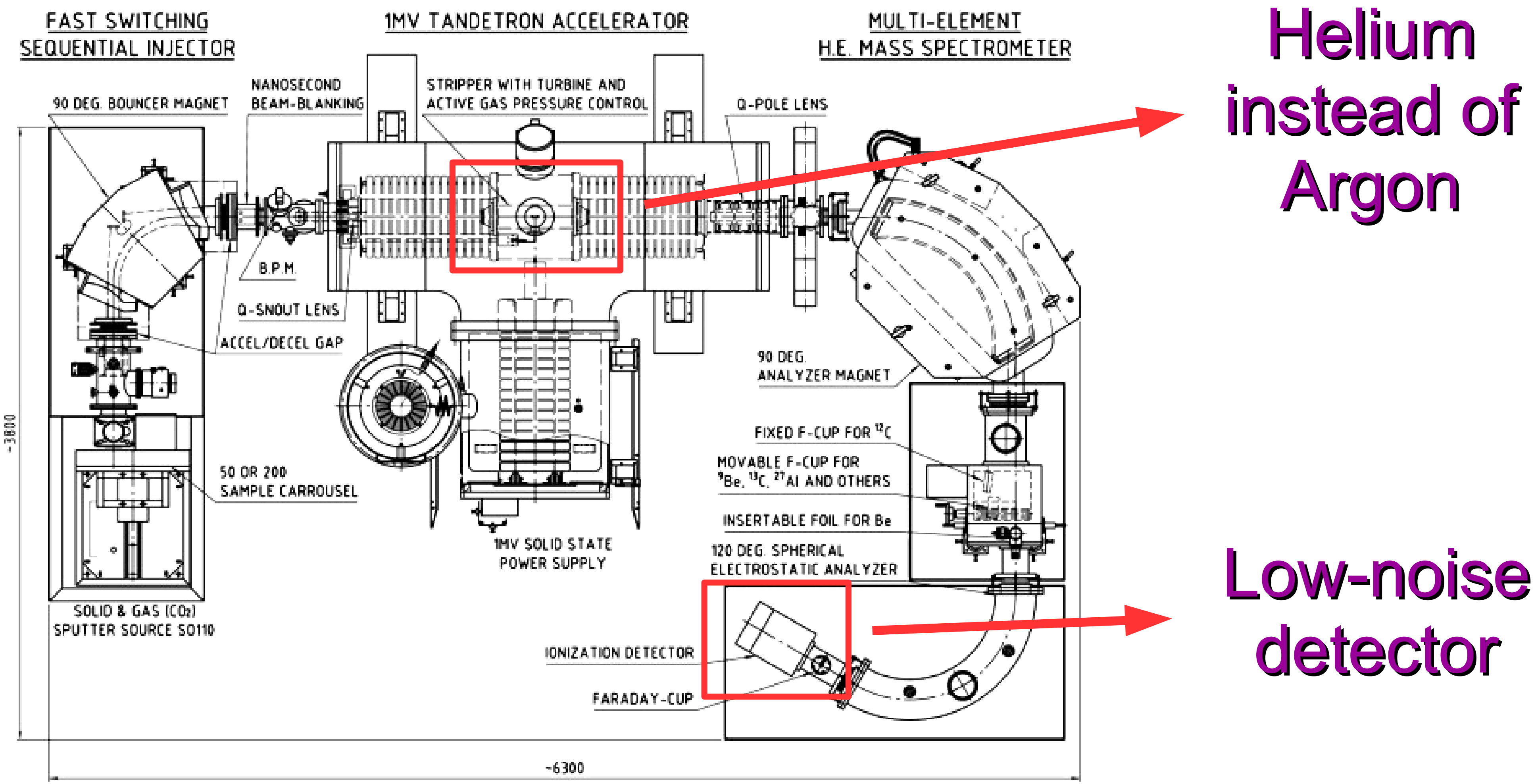
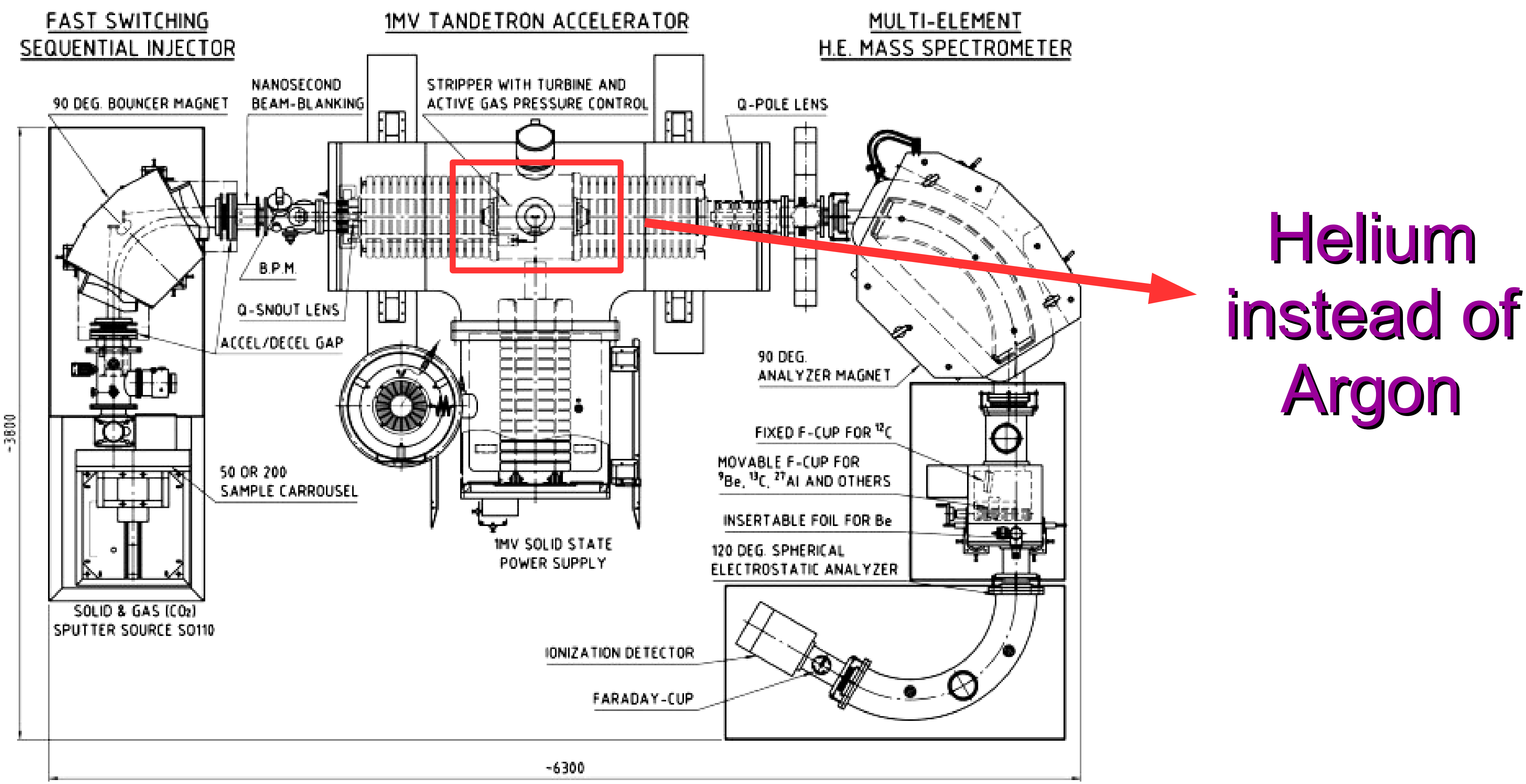
Recent developments

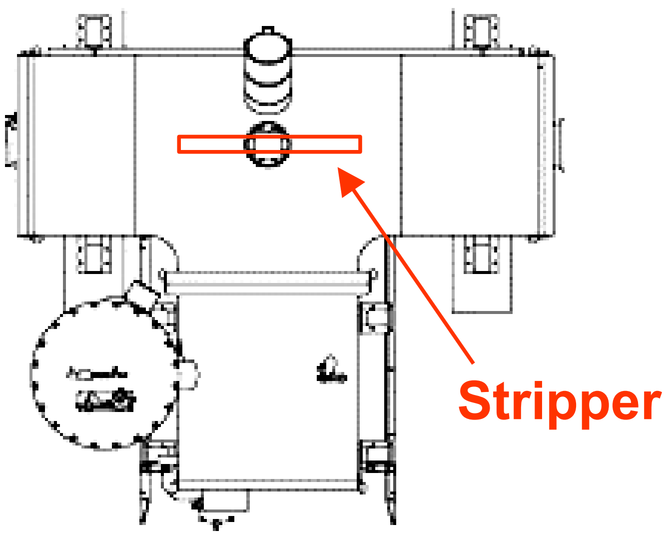


Improving the transmission



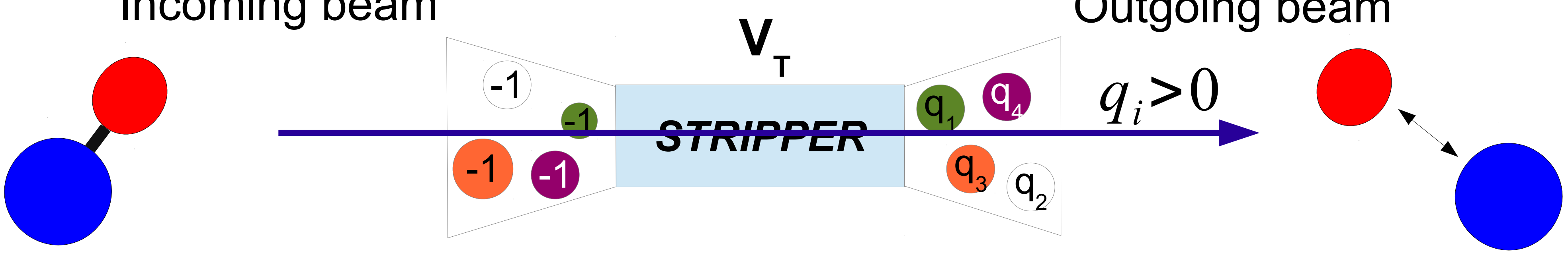
The stripping process

1 MV Tandetron



The **stripping** process:

- Makes the molecules break up



$$E_{in} = E_{source}$$

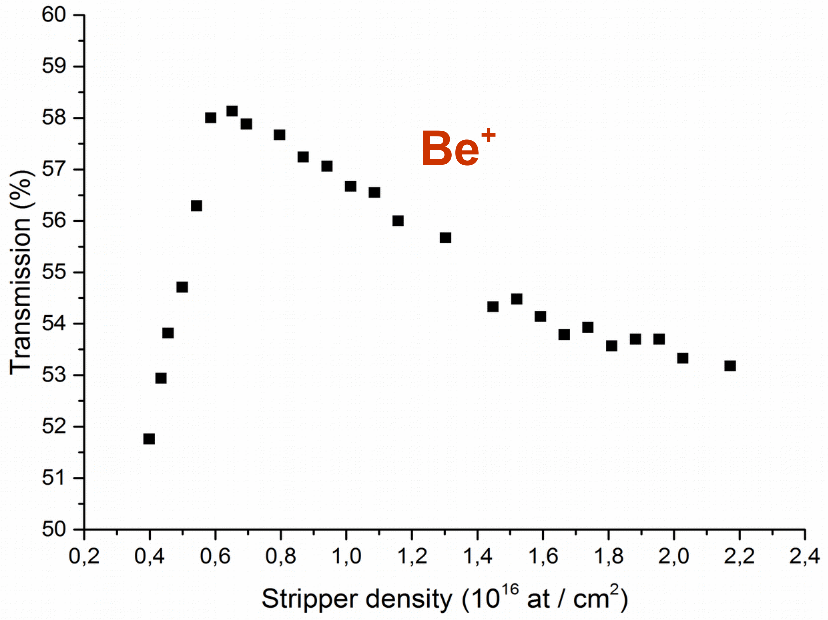
$$E_{out} = \left(\frac{m_{out}}{M_{in}} + q \right) e V_T + \frac{m_{out}}{M_{in}} E_{in}$$

The transmission

$$Transmission = \frac{I_{HE}}{q \cdot I_{LE}}$$

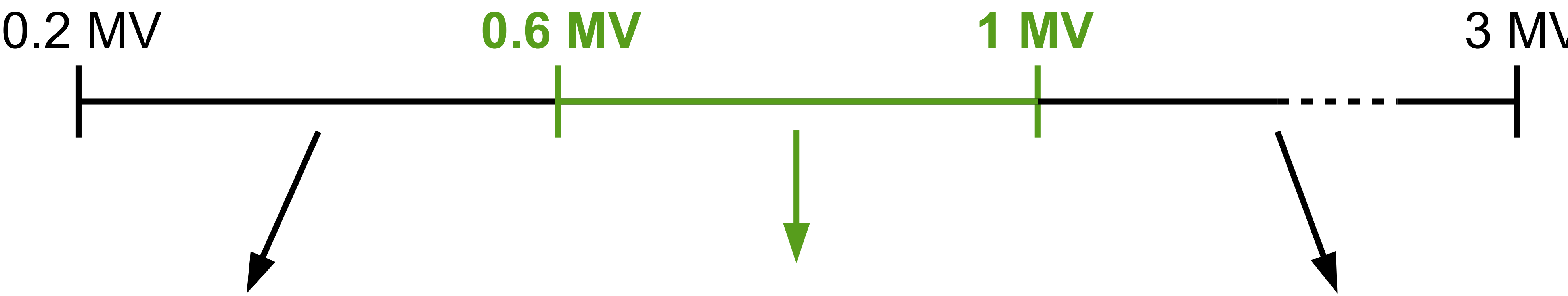
The **transmission** for a selected state charge depends on:

- Nature of the incoming beam,
- Stripping gas,
- Stripper pressure,
- Beam energy.



High charge state fractions and **minimal scattering losses** are essential for low energy AMS

He as a stripper



- High charge state yield
- Low scattering losses

Schulze-König et al., 2011
Vockenhuber et al., 2013

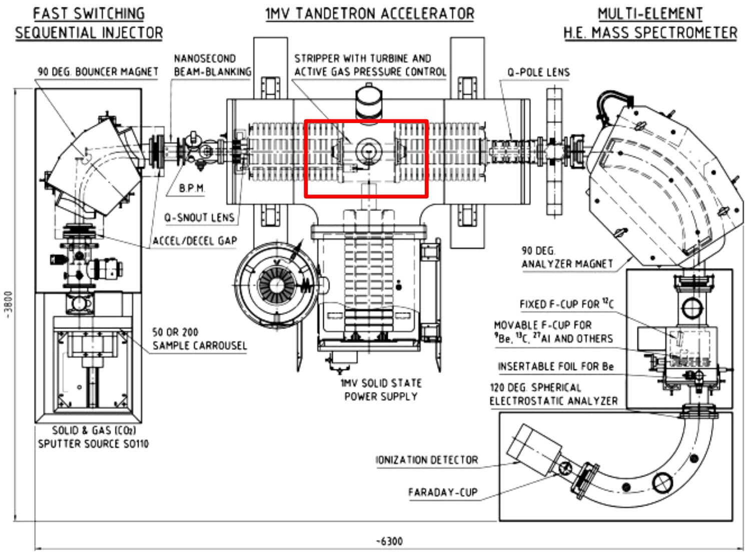
- High charge state yield

Winkler et al., 2015

SARA!

Results

- Part 1: He stripping
- Part 2: detector

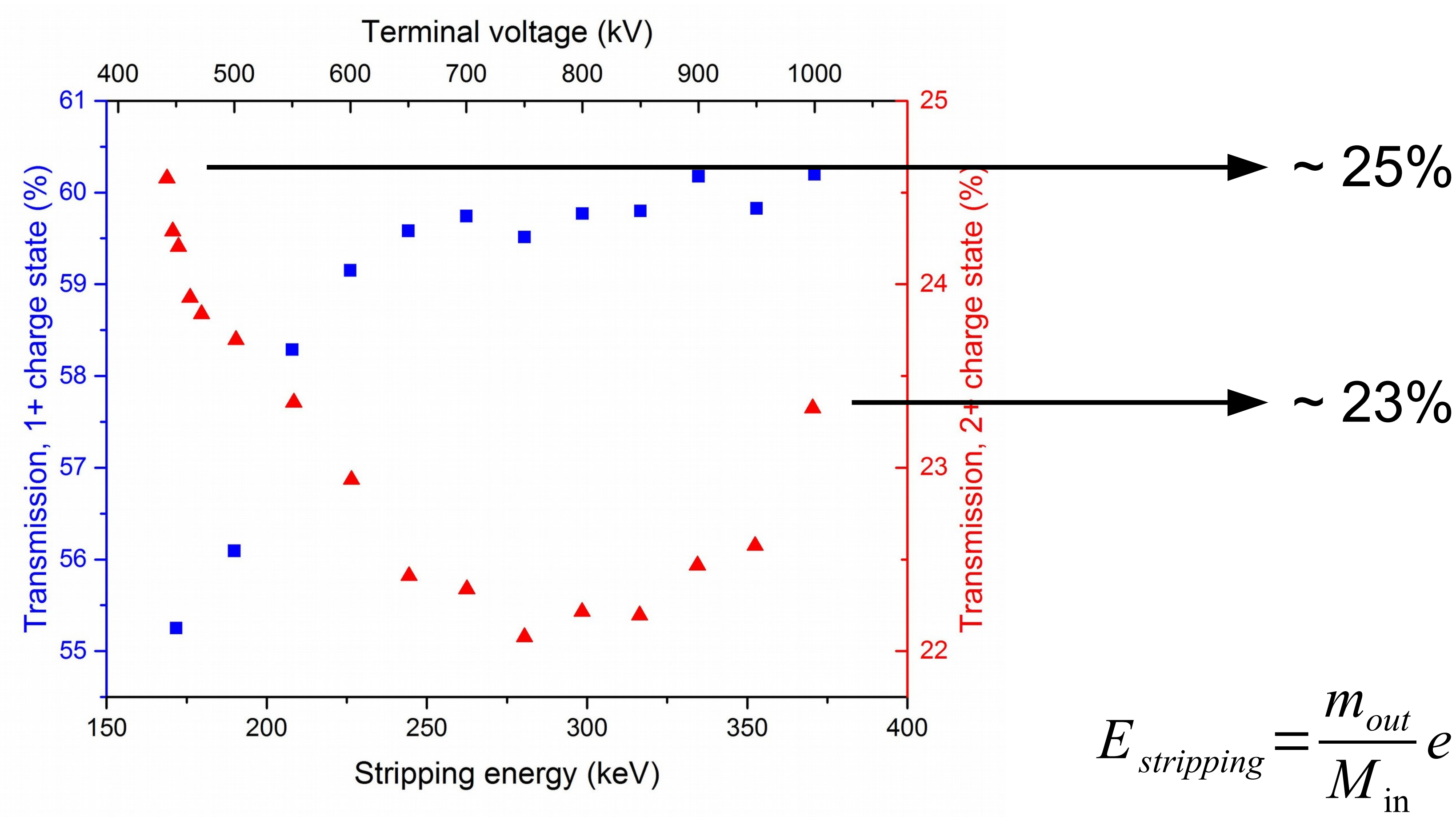


Results (1/2)

Isotope	Charge state	Terminal voltage (kV)	Energy (keV)	Maximum transmission Ar (%)	Maximum transmission He (%)
Beryllium	1+	1000	1370	58	60
Beryllium	2+	1000	2370	25	23
Aluminum	2+	1000	2650	54	60
Aluminum	3+	1000	3650	13	18
Iodine	3+	1000	4030	10	27
Uranium	3+	650	2590	13	50

Results (2/2)

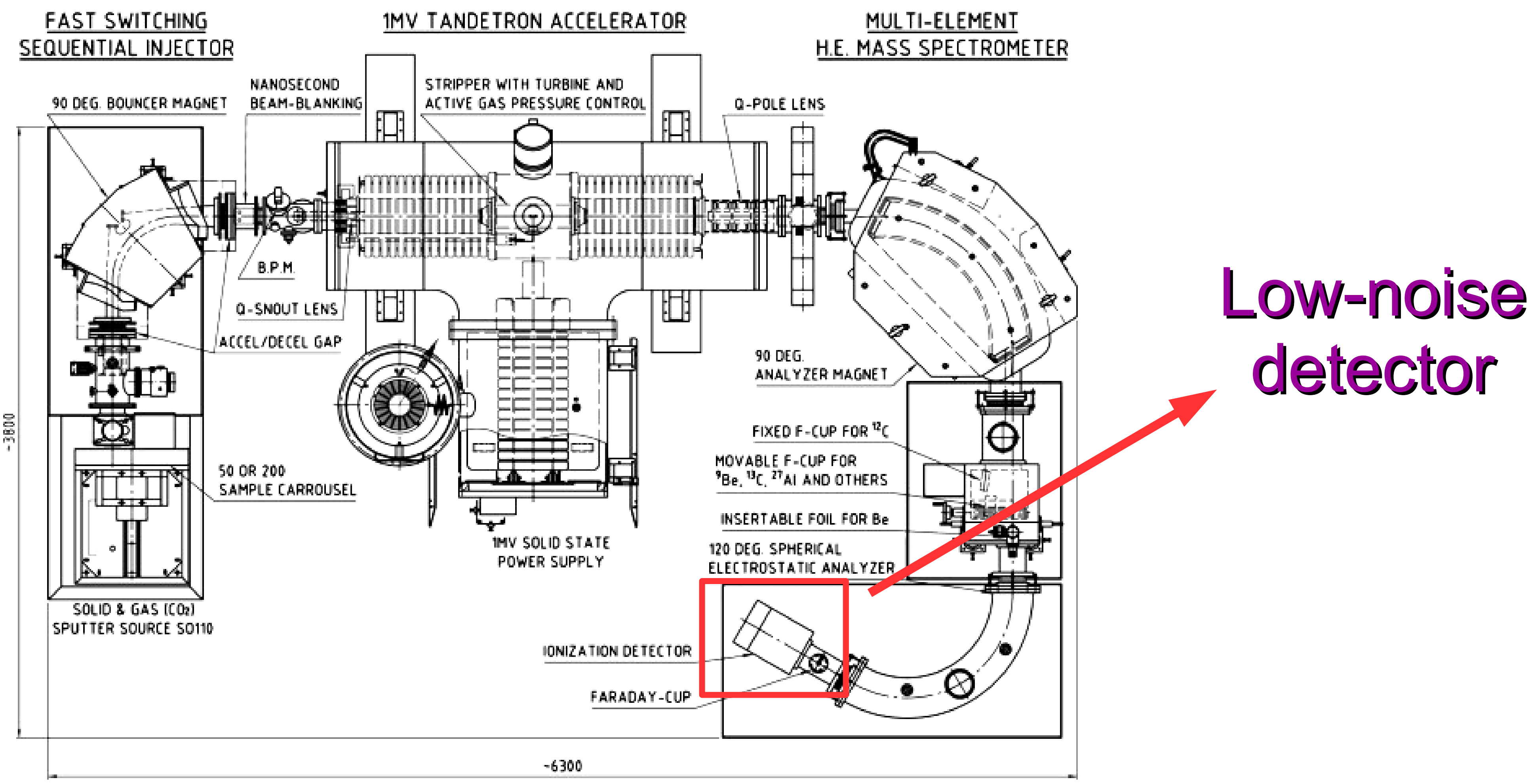
Isotope	Charge state	Terminal voltage (kV)	Maximum transmission Ar (%)	Maximum transmission He (%)
Beryllium	1+	1000	58	60
Beryllium	2+	1000	25	23



Low ^{10}B BG

$$E_{stripping} = \frac{m_{out}}{M_{in}} e\left(V_T + V_{source}\right)$$

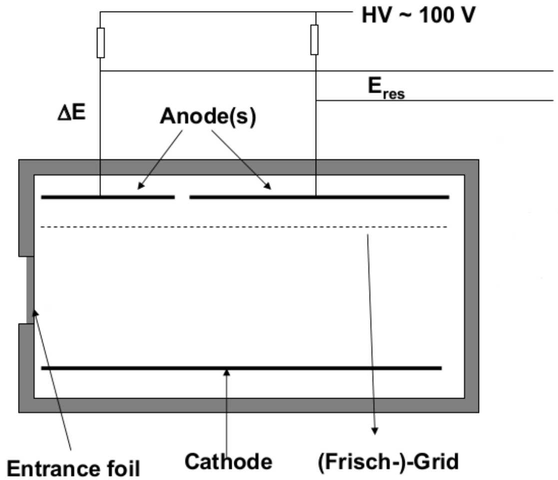
Improving the detection

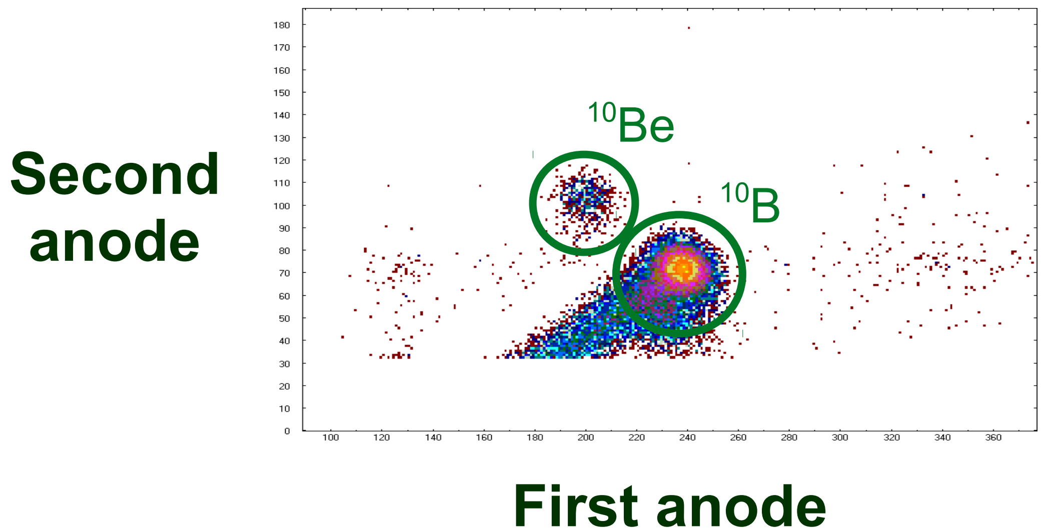


The rare isotope detector

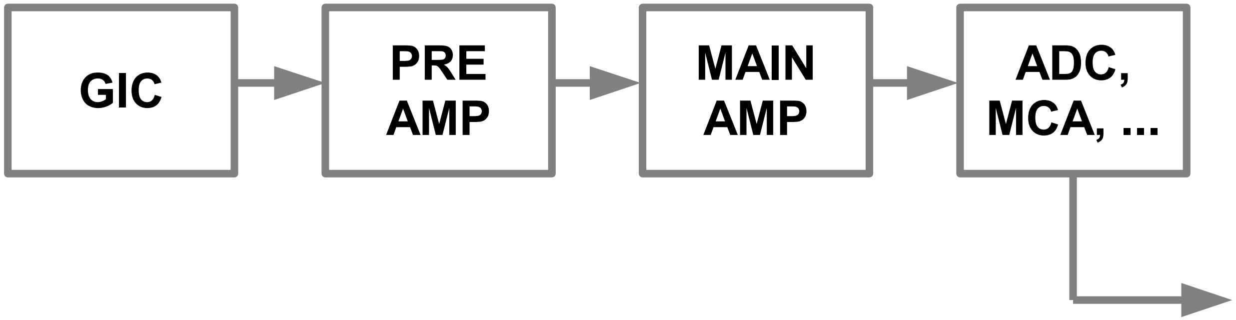
Gas Ionization Chamber

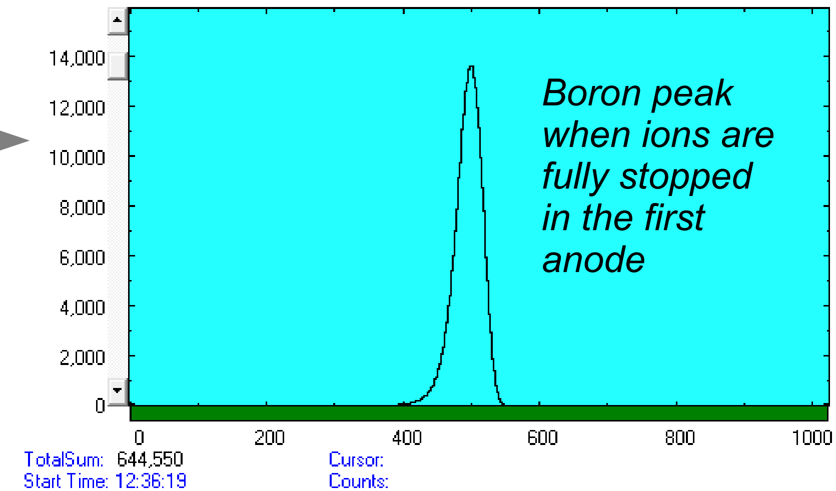
- Rare isotope
- Isobutane
- Two anodes
- Frisch grid
- $Si_3N_{3.2}$ entrance foil
- Dedicated electronics





Improving the detection





Maximizing signal to noise ratio

$$\frac{\textit{signal height}}{\textit{resolution}}$$

Reduce:

- Geometrical effects
- Energy straggling in the entrance window
- Electronic noise

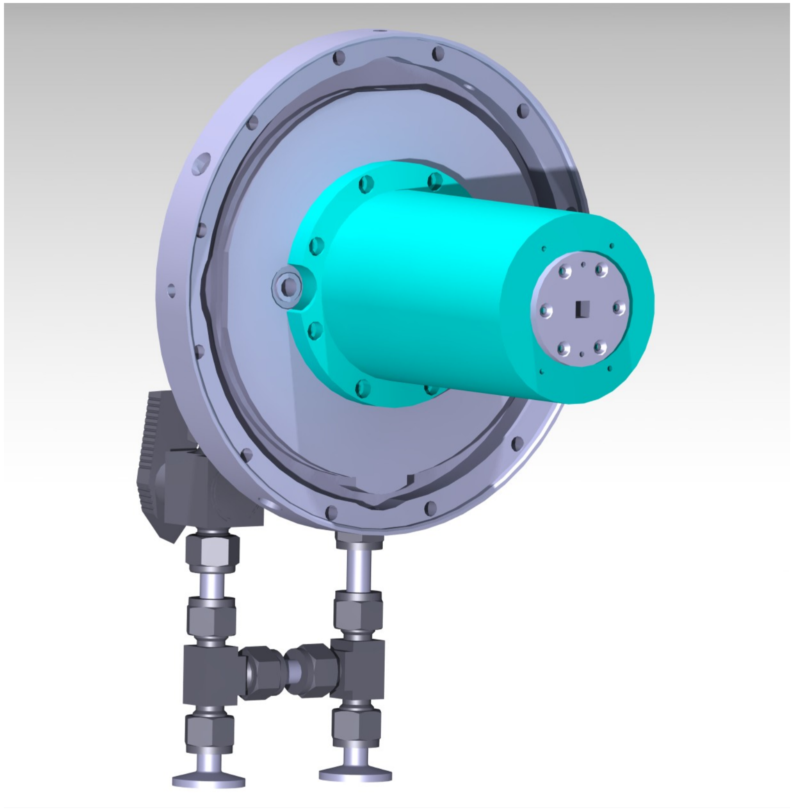
Increase:

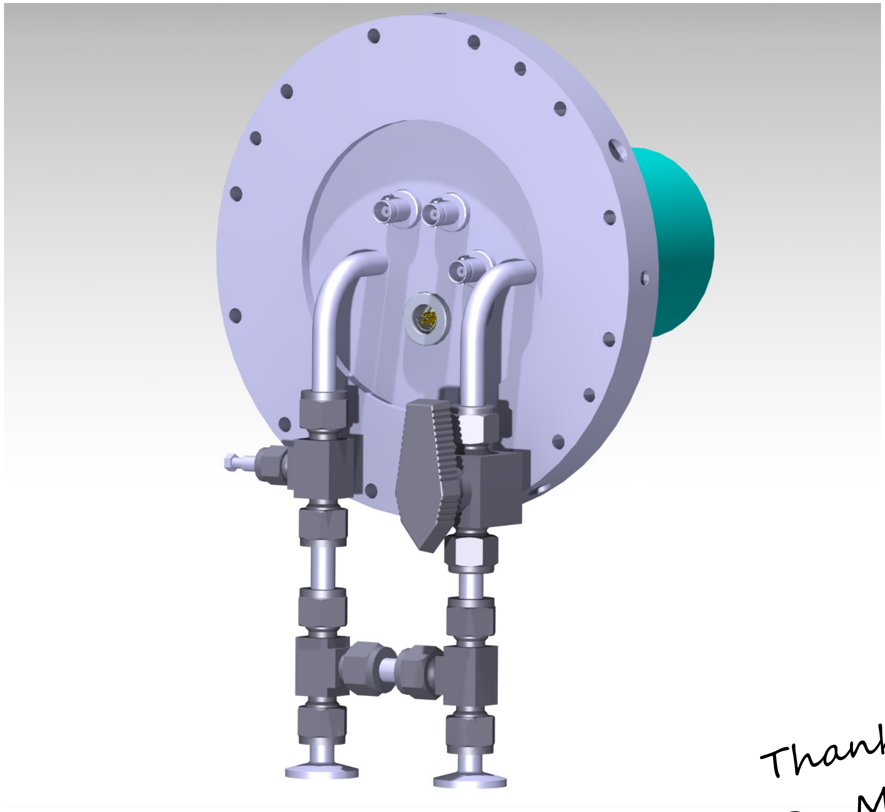
- Ionization yield per energy loss
- Efficiency in charge collection
- Active area

The ETH-Zürich detector

Very low-noise design

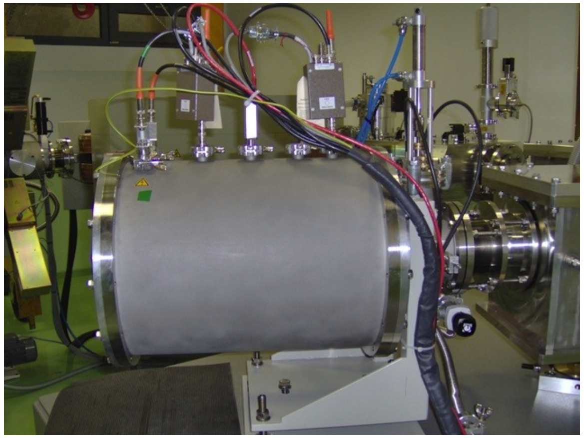
- Dead areas minimized
- CREMAT preamplifiers
- Signal cable length minimized

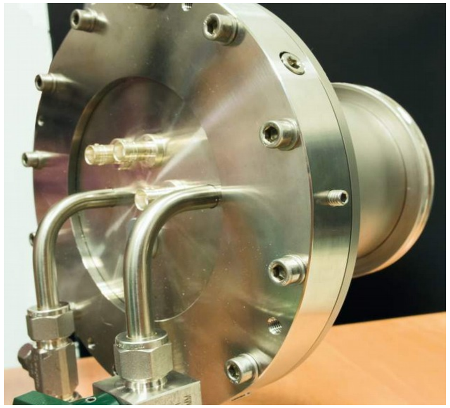




Thank you Dr. Müller!

The ETH-Zürich detector

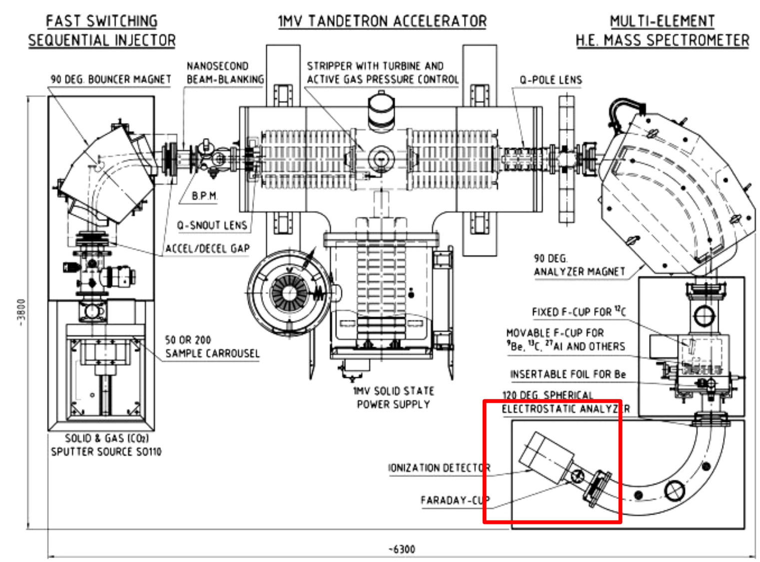




	Originally installed	Current set-up
Anodes length	32 cm	10 cm
Preamplifiers	ORTEC	CREMAT
Amplifiers	ORTEC	CANBERRA
Amplifiers shaping time	1.5 μs	1.5 μs

Results

- Part 1: He stripping
- Part 2: detector



Results

- R_{gas} : Charge production yield and collection
- R_{noise} : Electronic noise (detector, preamplifier)
- R_{foil} : Straggling due to the SiN entrance window (Sun et al., 2007)

$$R^2_{tot} = R^2_{gas} + R^2_{noise} + R^2_{foil}$$

	Gas (keV)	Electronic noise (keV)	$Si_3N_{3.2}$ thickness (nm)	$Si_3N_{3.2}$ straggling (keV)	Full resolution (keV)
Old GIC	26	29	40	8	**40**
ETH GIC	25	22	50	9	**34**

For a ^{9}Be beam at 1300 keV, with ions fully stopped in the first anode

What's next?

Current setup

- Efficiency
- Background
- High counting rates (~ 10 kHz)

Useful upgrades

- Passive absorber cell
- TOF detector

Conclusions

- SARA is a LE-AMS facility that recently underwent some changes to improve its performance.
- He gas has been introduced to increase the transmission of heavy ions through the accelerator.
- A low-noise GIC has been mounted to obtain better resolutions.
- Useful upgrades could be helpful to further improve measurement conditions.

¡Gracias!

Any questions?