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Adelaide Convention Centre, Australia

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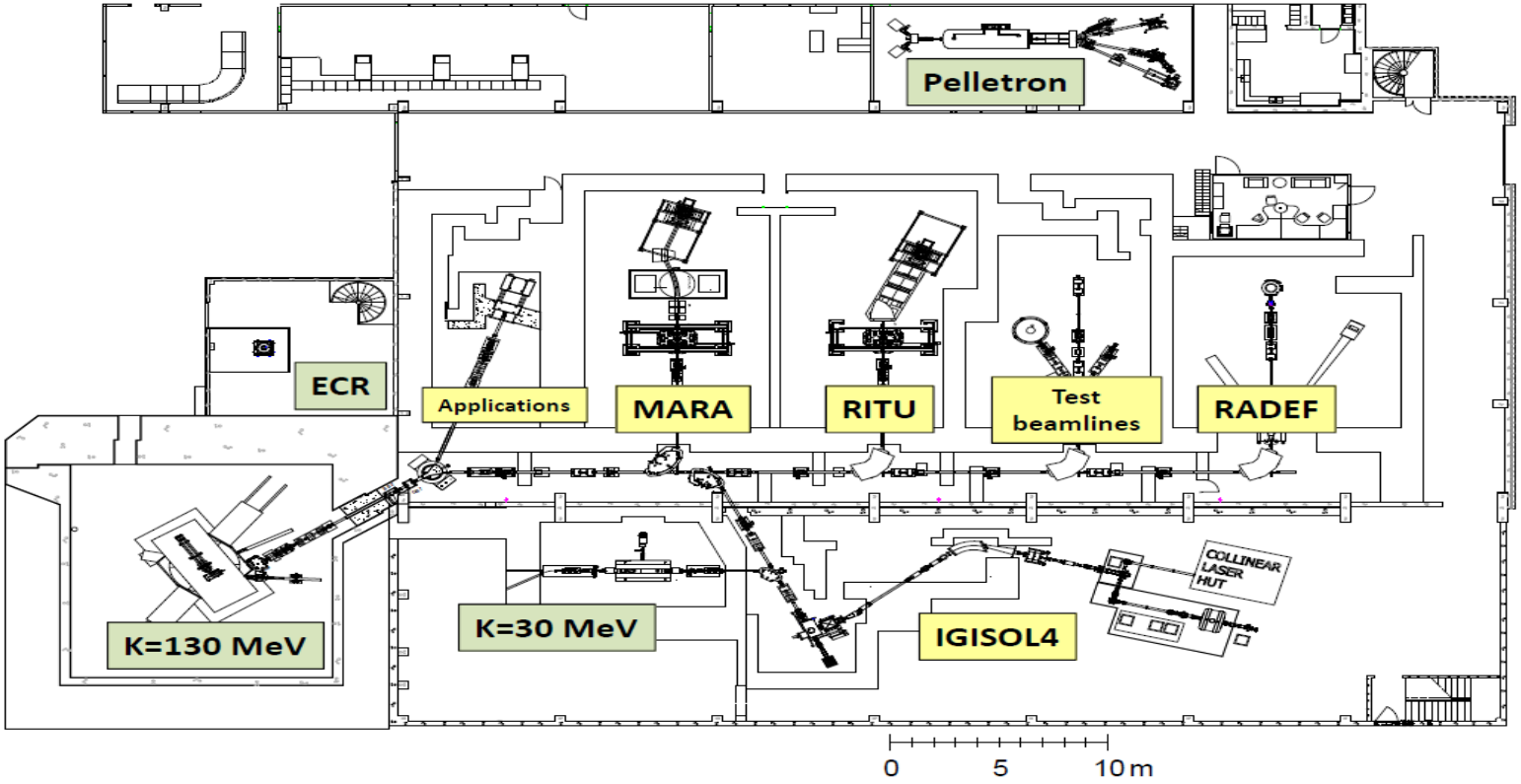
MARA, Mass Analyzing Recoil Apparatus, A new tool at JYFLACCLAB

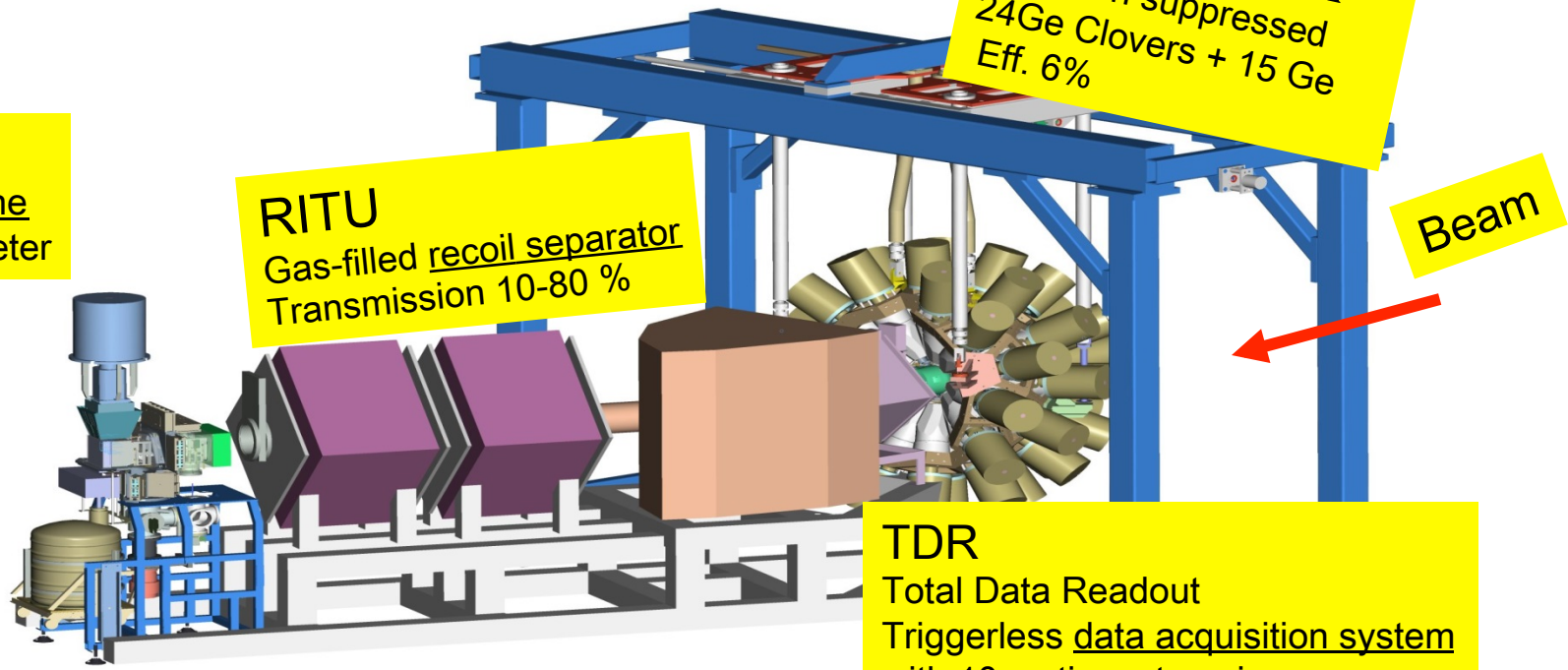
Juha Uusitalo
Department of Physics
University of Jyväskylä (JYFL)
Finland

Content

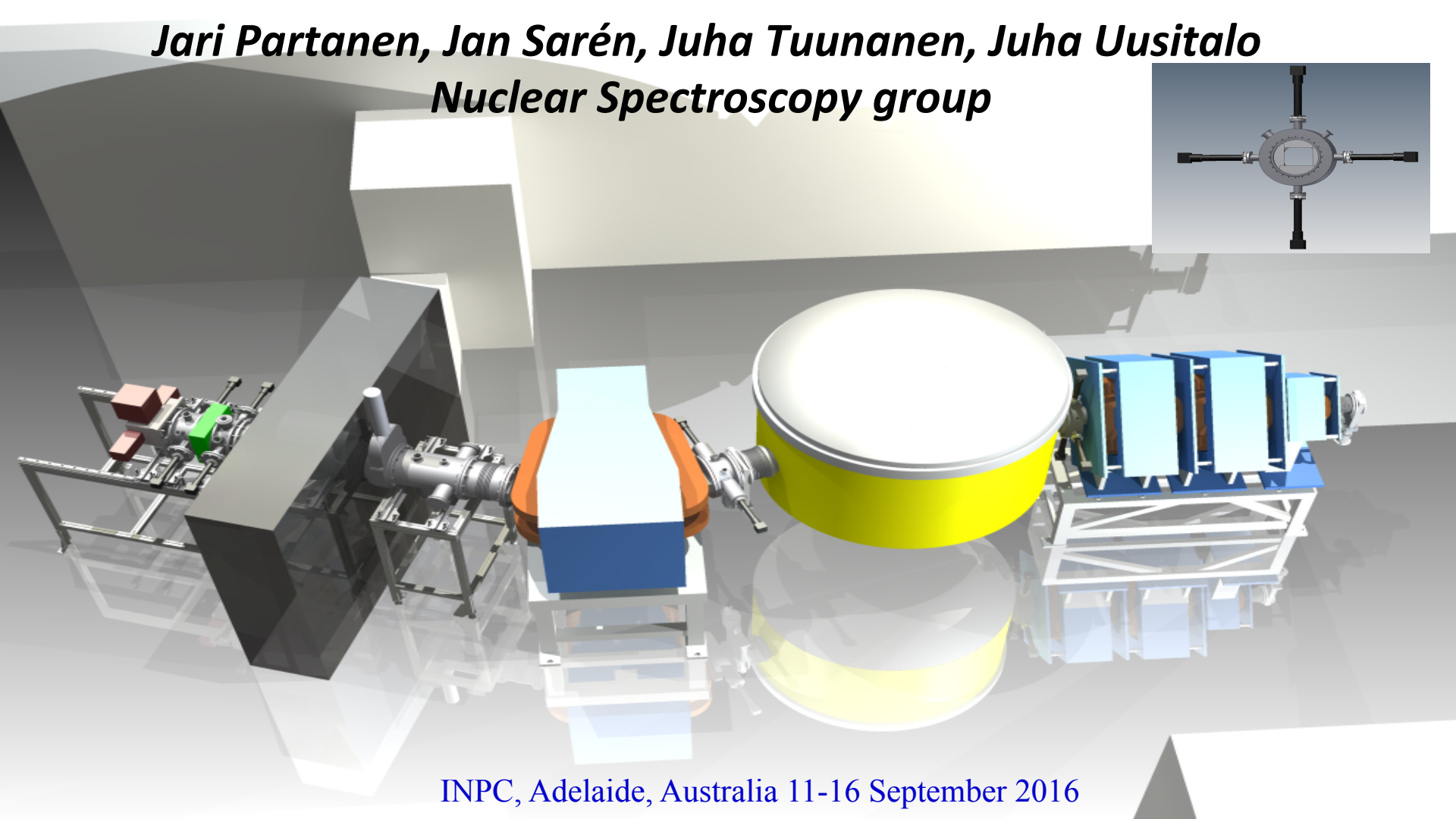
- JYLF Accelerator Laboratory
- Gas-filled recoil separator RITU, the working horse for two decades
- MARA, vacuum-mode mass analyzer


Pelletron
ECR
Applications
MARA
RITU
Test beamlines
RADEF
K=130 MeV
K=30 MeV
IGISOL4
COLLINEAR LASER HUT
0
5
10 m

RDT Instrumentation at JYFL in Jyväskylä, Finland



Jari Partanen, Jan Sarén, Juha Tuunanen, Juha Uusitalo
Nuclear Spectroscopy group



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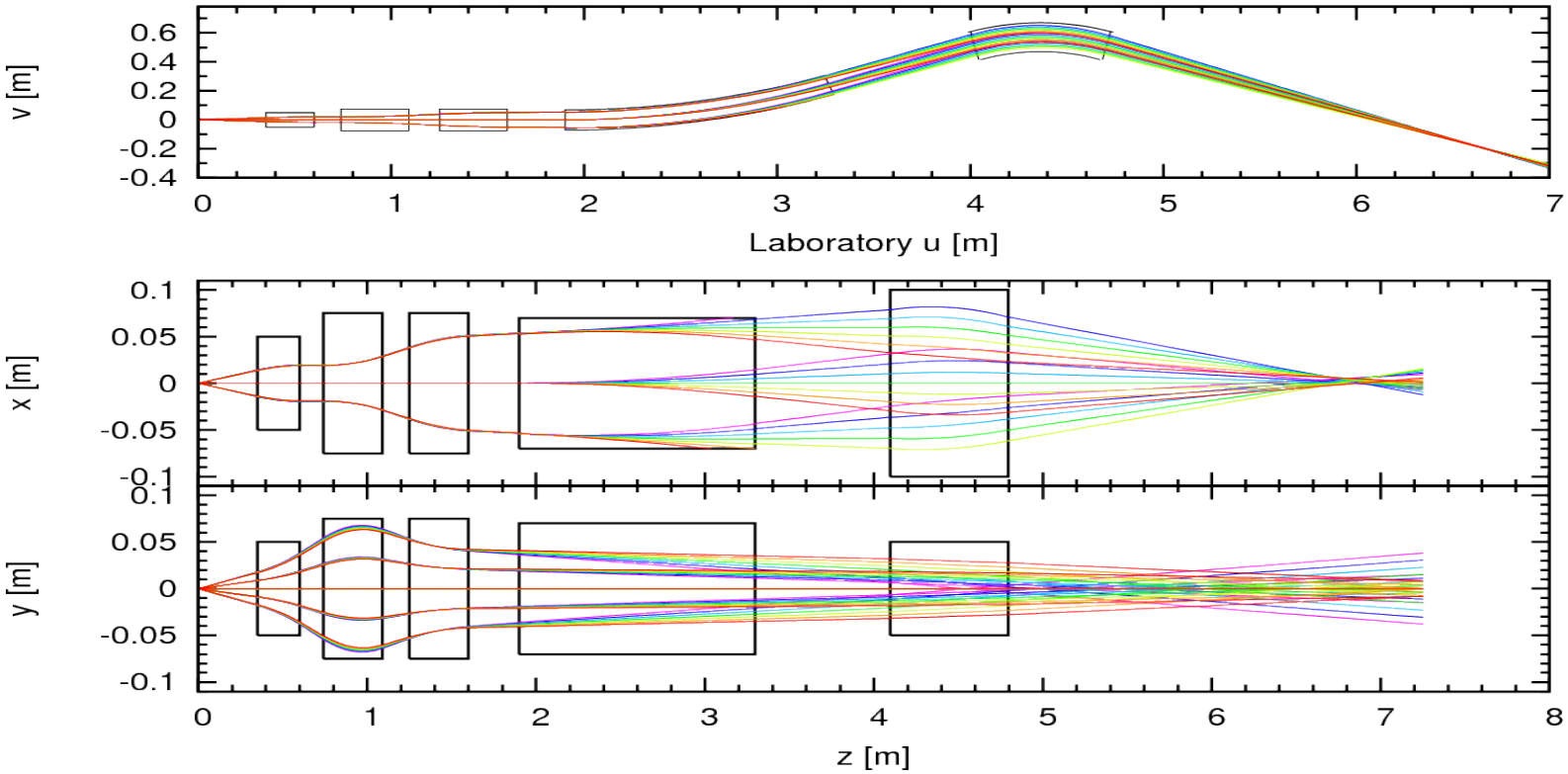
MARA


v [m]
0.6
0.4
0.2
0
-0.2
-0.4
0
1
2
3
4
5
6
7
Laboratory u [m]
x [m]
0.1
0.05
0
-0.05
-0.1
y [m]
0.1
0.05
0
-0.05
-0.1
0
1
2
3
4
5
6
7
8
z [m]

Main properties of the new JYFL MARA separator compared to FMA @ ANL

	FMA	MARA
- Configuration	QQEDMDEDQQ	QQQEDMD
- Horizontal magnification	-1.93	-1.55
- Vertical magnification	0.98	-4.48
- M/Q dispersion	10.0 mm/% (variable)	8.1 mm/%
- First order resolving power, 2 mm beam spot	259	259
- Solid angle acceptance central m/q and energy	8 msr	10 msr
- Energy acceptance for central mass and angle	+20 % - 15 %	+20 % - 15 %
- M/Q acceptance	± 4 %	± 7 %

MARA vs. RITU

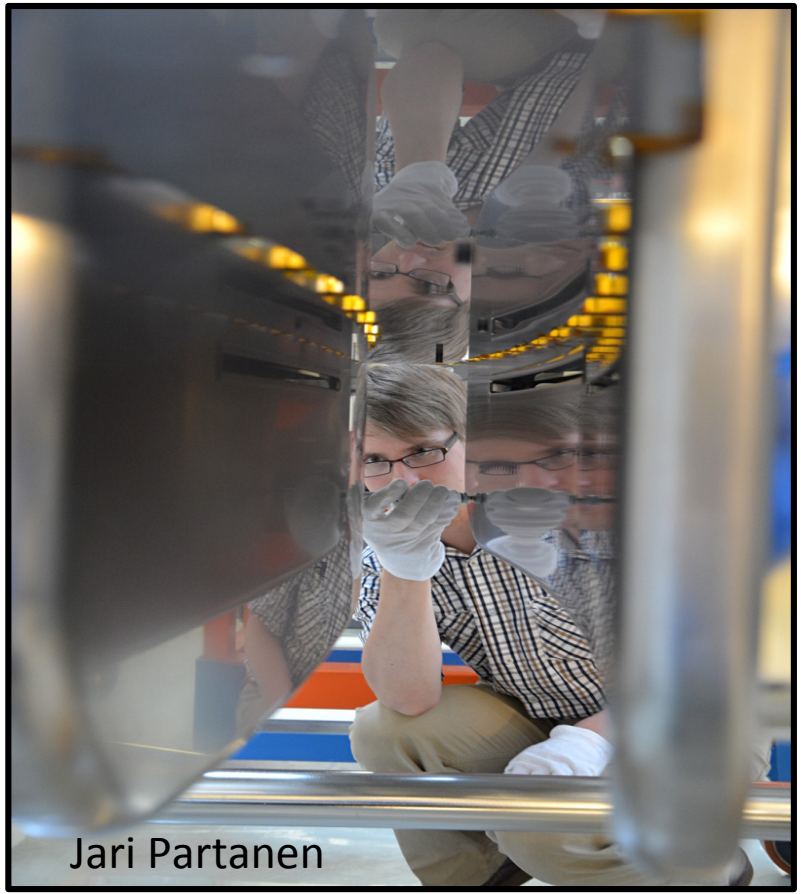
MARA

- For studies of fusion-evaporation residues
- Mainly along the N~Z line
- Symmetric and inverse kinematics can be used
- Energy focus
- m/q resolving power of 250
  - separate m/q peaks
  - identification of evaporation channel
- 2–3 charge states accepted

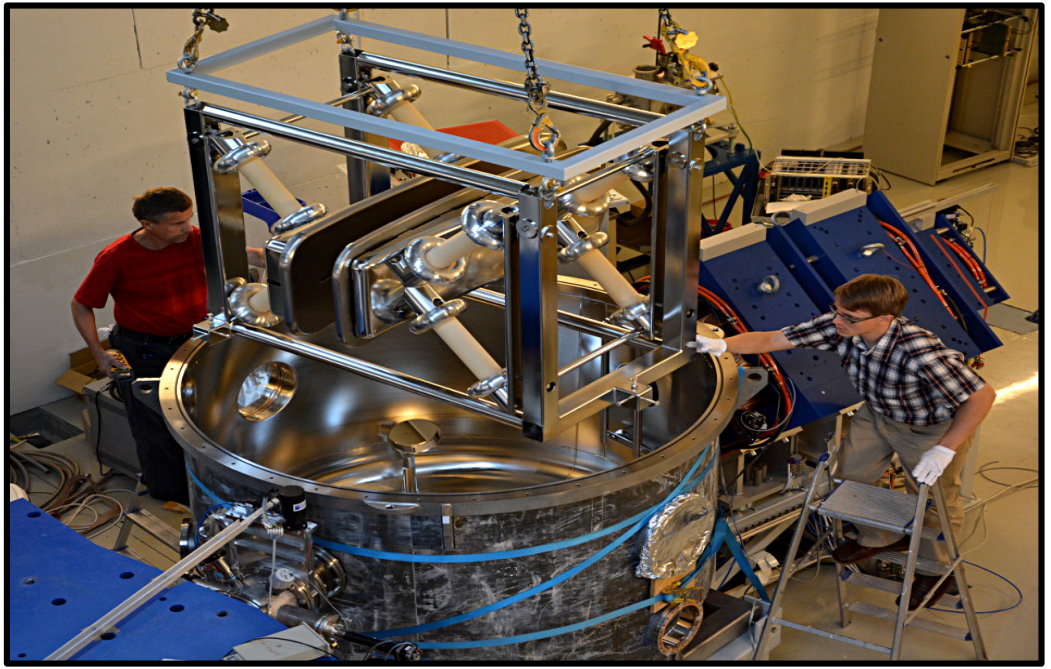
RITU

- For studies of fusion evaporation residues
- A > 150
- Only asymmetric “normal” kinematics
- Velocity focus
- Evaporation channel cannot be identified event by event
- Transmission independent of the initial charge state
  - high transmission

MARA, Construction



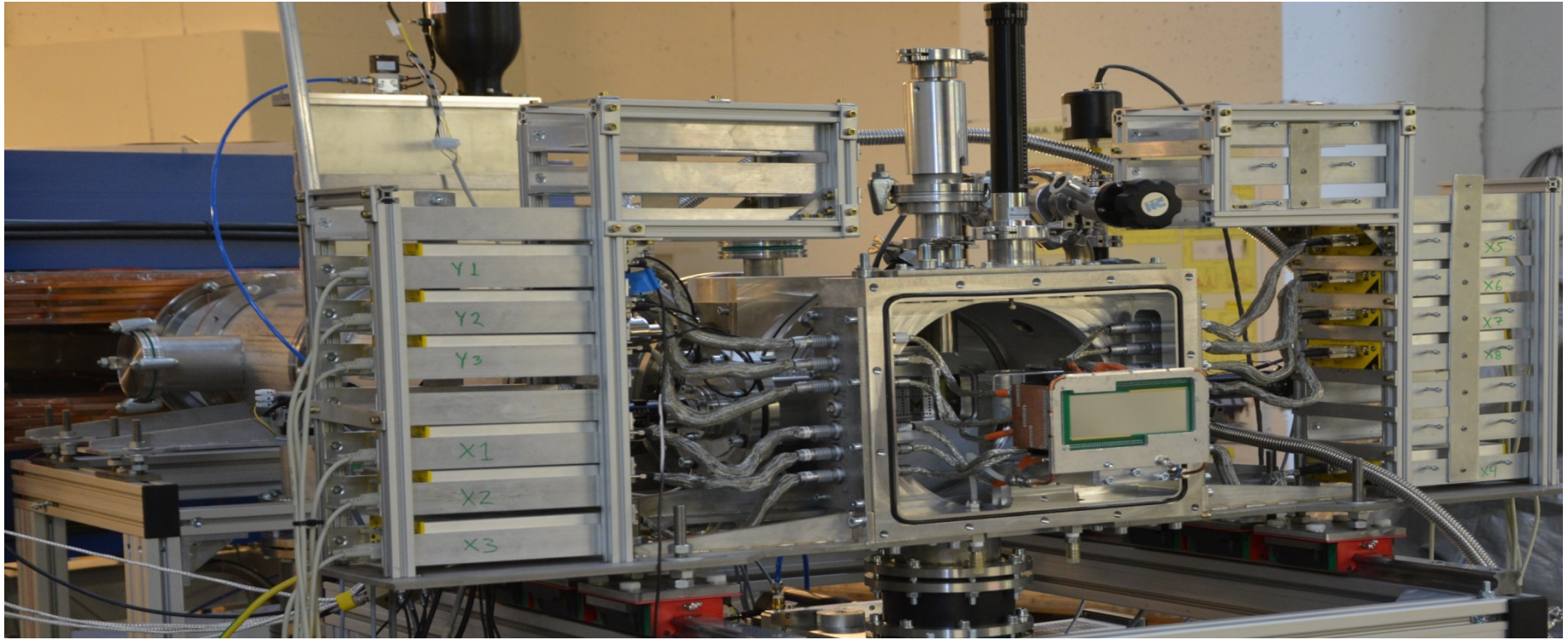
Jari Partanen



Juha Uusitalo

photo: Jan Saren

Jari Partanen



DSSD 48 mm x 128 mm, 1 mm^2 pixels, BB17

0,45 mm^2, BB20

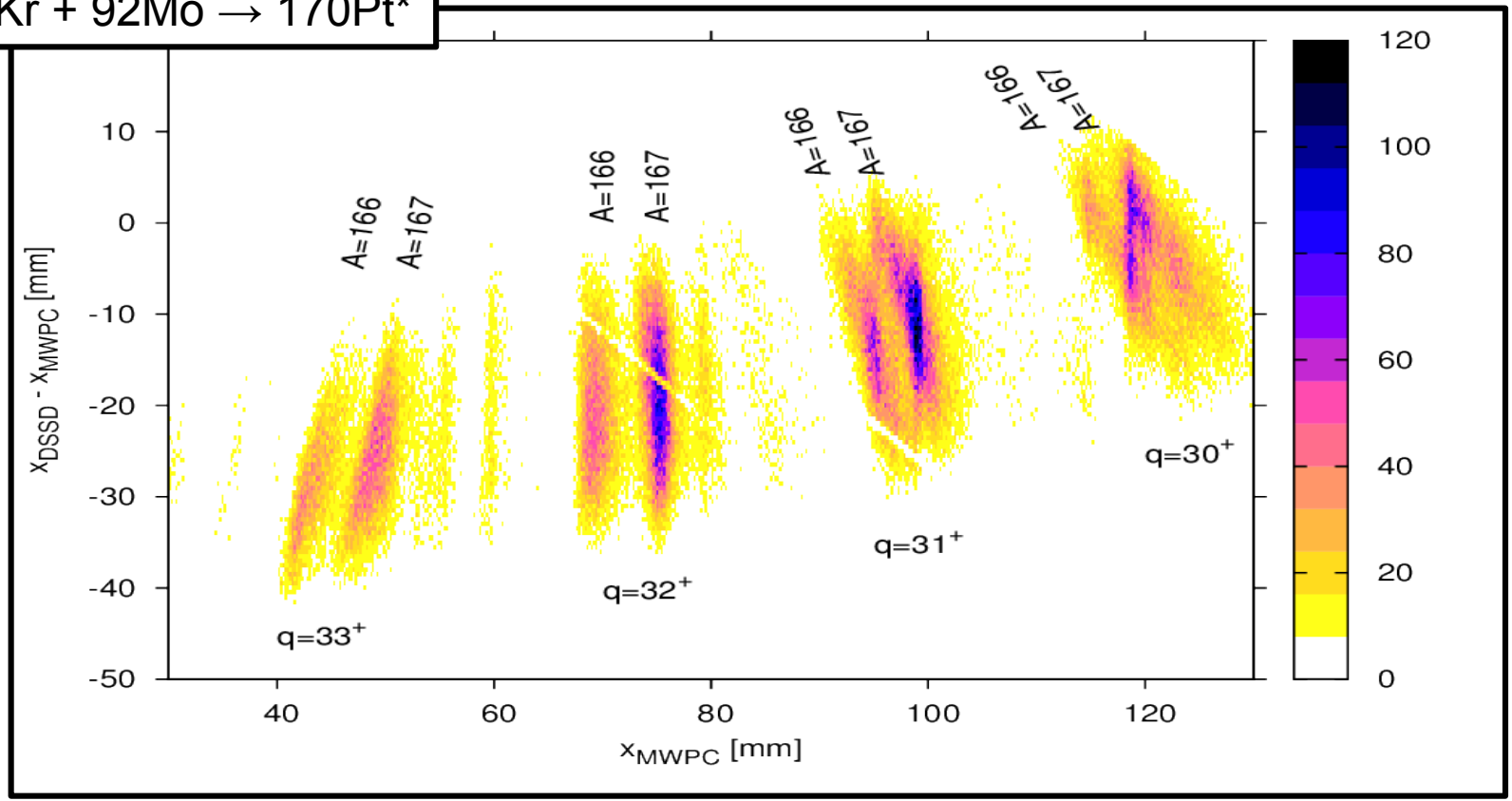
Punch-through silicons, silicon box array

MARA, Commissioning runs (M01)

- **Part 1: Slightly asymmetric**
  - 78Kr + 92,98Mo → 176Pt*
- **Part 2: Symmetric**
  - 40Ar + 45Sc → 85Nb*
  - 40Ar + natCa → ~80Sr*
- **Part 3: Inverse kinematics**
  - 78Kr + 58Ni → 136Gd*
  - 2 BGO's around the target for normalization, 2 Clover Ge's at the focal plane, punch through detector behind the DSSD
- **Part 4: Asymmetric**
  - 40Ar + 124Sn → 164Er*
  - 2 single crystal Ge's around the target, punch through detector behind the DSSD
- **Part 5: Scheduled to end of 2016**
  - full detector setups, UoY-tube, focal plane

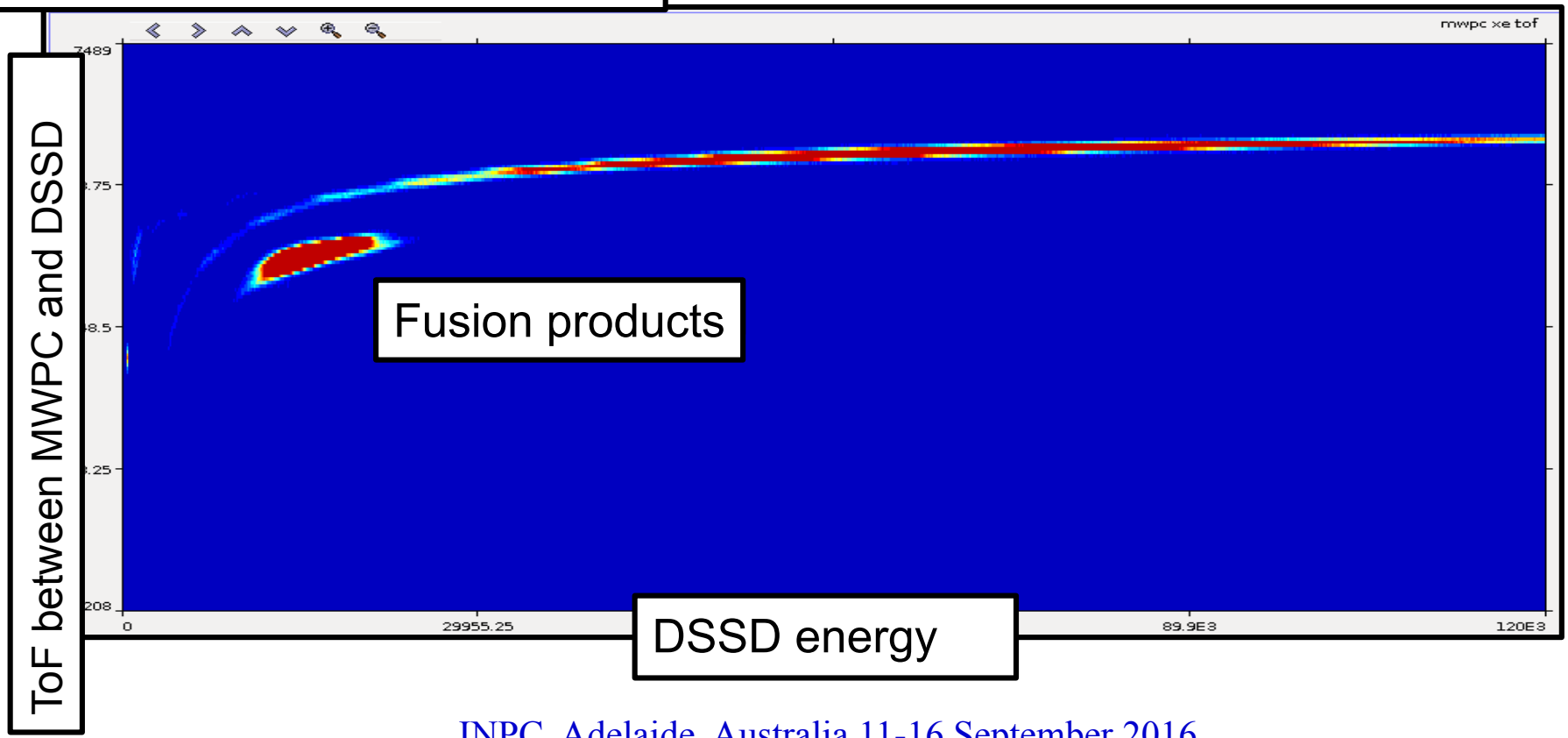
MARA, Commissioning runs

Part 1: 78Kr + 92Mo → 170Pt*

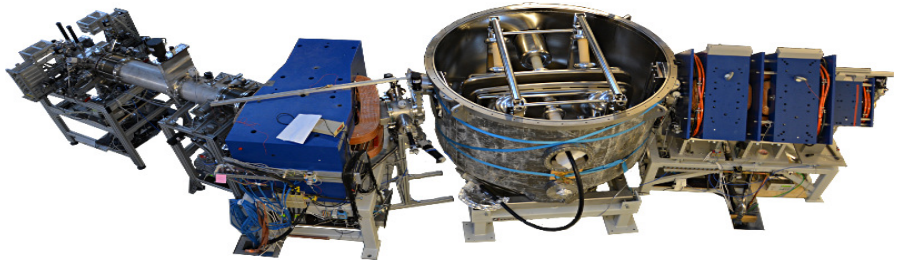


MARA, Commissioning runs

Part 4: 40Ar + 124Sn → 164Er*



MARA
***M**ass **A**nalysing **R**ecoil **A**pparatus*



MARA is a vacuum-mode recoil separator mainly for proton drip-line studies around N~Z nuclei.

The mass resolving power of MARA is about 250. In most cases, two charge states can be collected yielding around 20-30 % total observation efficiency for a typical fusion product.

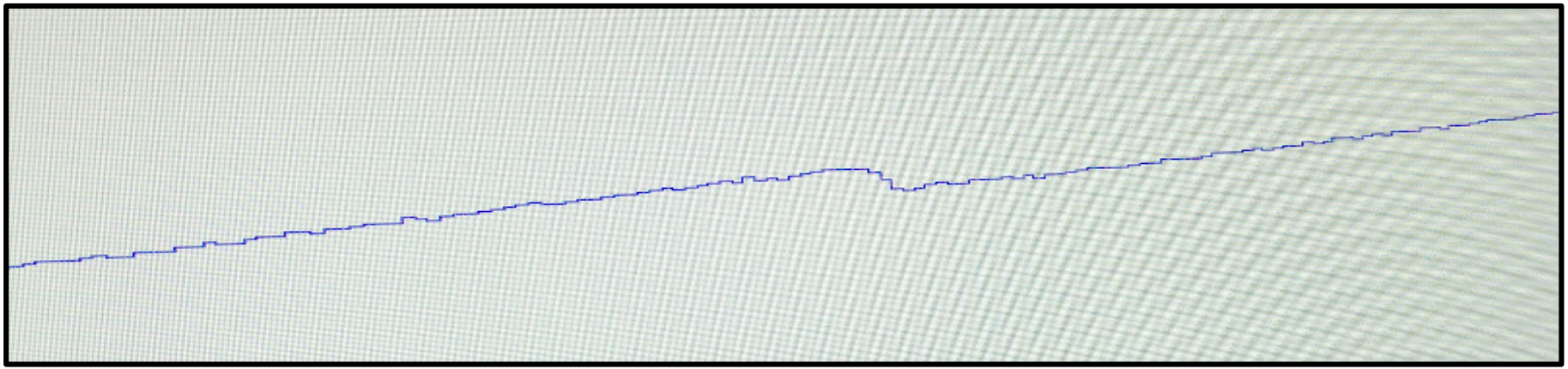
MARA is a complementary separator to RITU gas-filled recoil separator. MARA is ideal for studies of nuclei produced with symmetric and inverse reactions. RITU is better for heavier products produced with asymmetric reactions.

Almost fully commissioned. Reactions tested this far: 78Kr + 98Mo → 176Pt*, 40Ar + 45Sc → 85Nb*, 40Ar + natCa → ~80Zr*, 78Kr + 58Ni → 136Gd* and 40Ar + 124Sn → 164Er*. The last commissioning run is scheduled to be at the end of 2016. According to early results of commissionings, MARA seems to work as expected!

The first scientific experiment, utilizing reaction 78Kr+96Ru, was run in August 2016. In this first experiment, **two new isotopes were identified**. (The experiment was run in collaboration with University of Liverpool.)

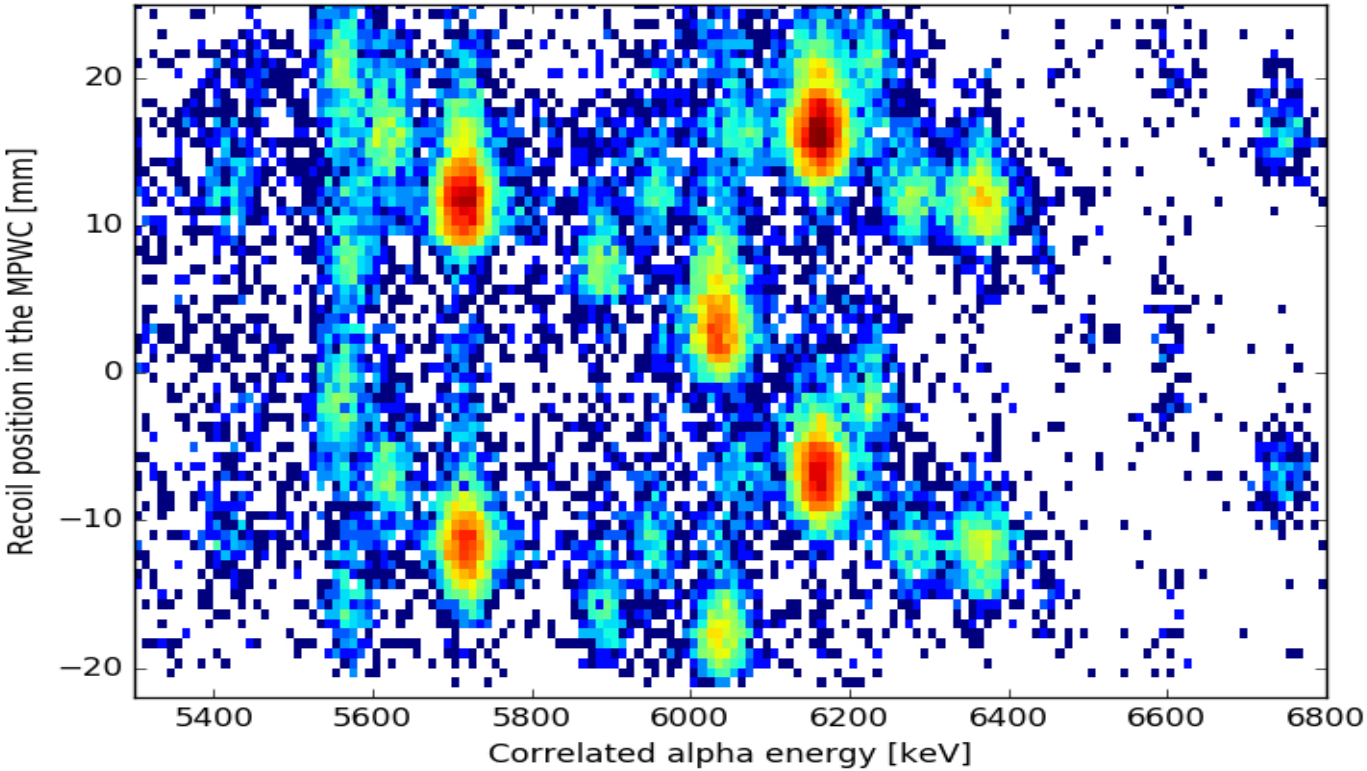
MARA, First scientific experiment

In the first MARA experiment (fusion reaction 78Kr+96Ru) a proton decay of a new isotope, 169Au, was observed in the digital traces after the fusion recoil implantation. (Photo: P. Greenlees)



Also one other new isotope 165Pt was observed in the calibration run 78Kr + 92Mo.

78Kr+96Ru


Recoil position in the MPWC [mm]
20
10
0
−10
−20
5400
5600
5800
6000
6200
6400
6600
6800
Correlated alpha energy [keV]

A target chamber under design:

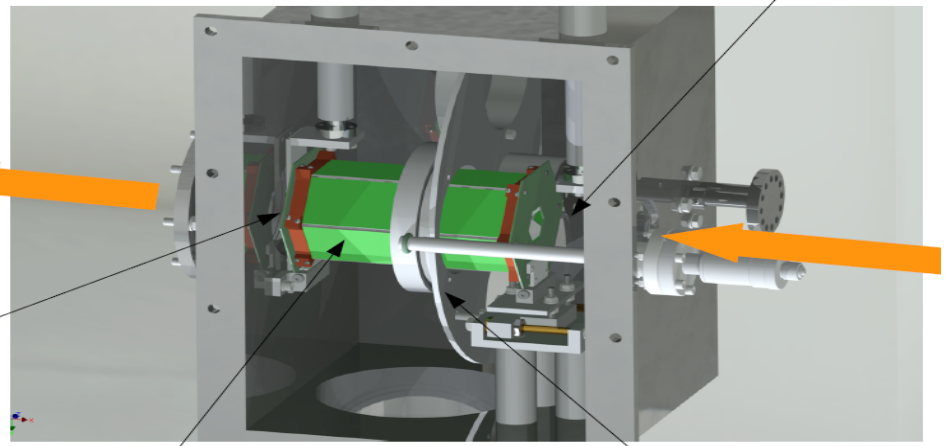
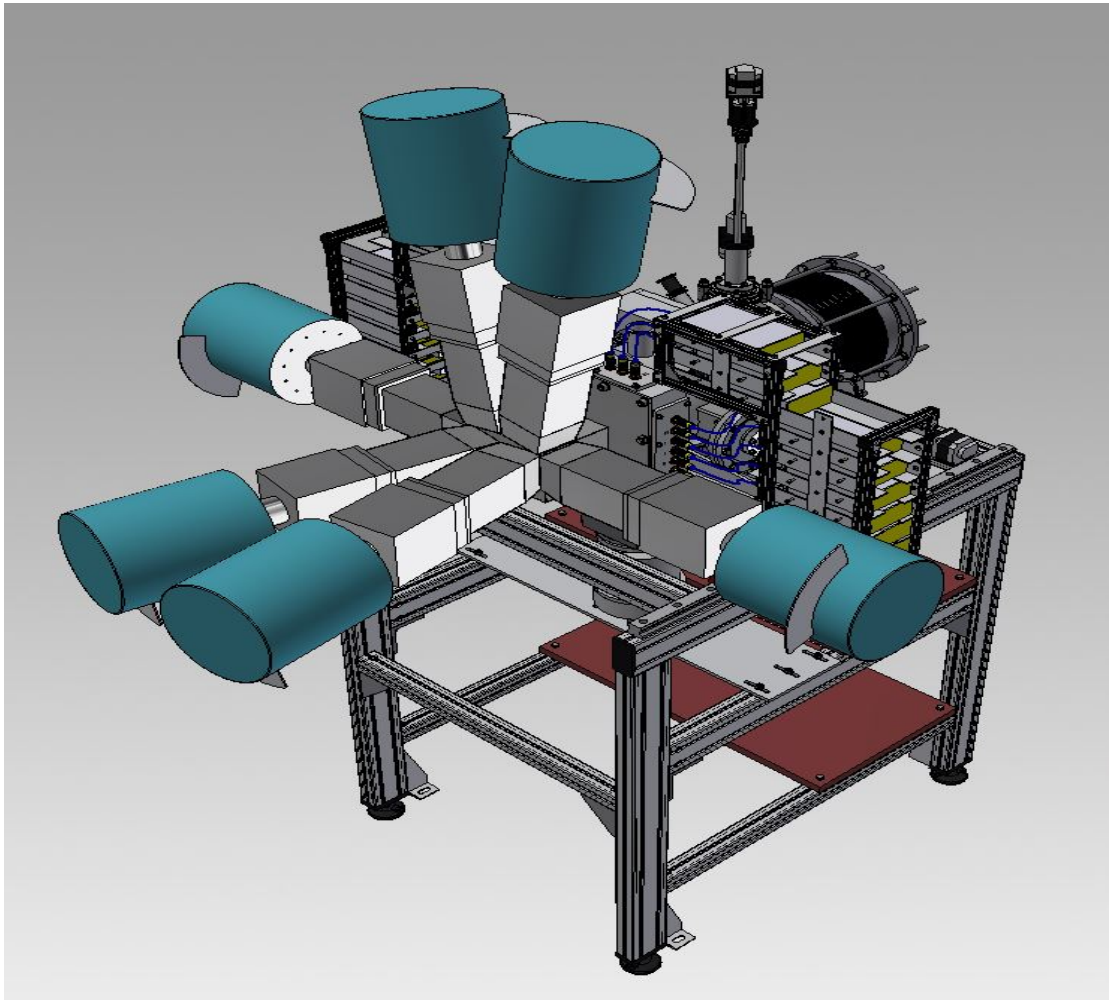


Figure 4.1: Photograph of the UoYtube charged particle veto box from beam direction. 96 CsI(Tl) crystals are arranged around the 6 sides of a hexagonal barrel. Each crystal is sealed within thin mylar foil and Ni foils with thickness of 2.5 μm were applied to all surfaces at forward angles covering the first four pairs of crystals.

> 70 % eff. to detect 1 proton

> 90 eff. To detect at least 1 proton, 2pxn and 3pxn evap. channels



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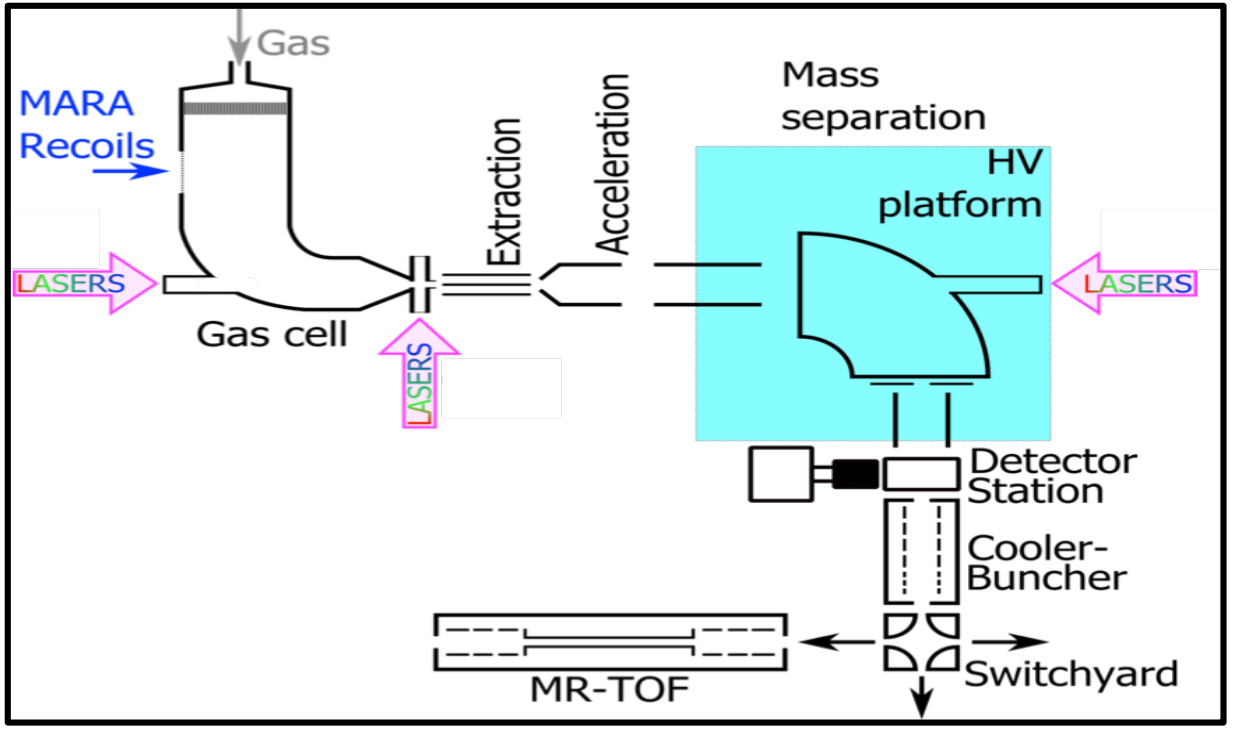
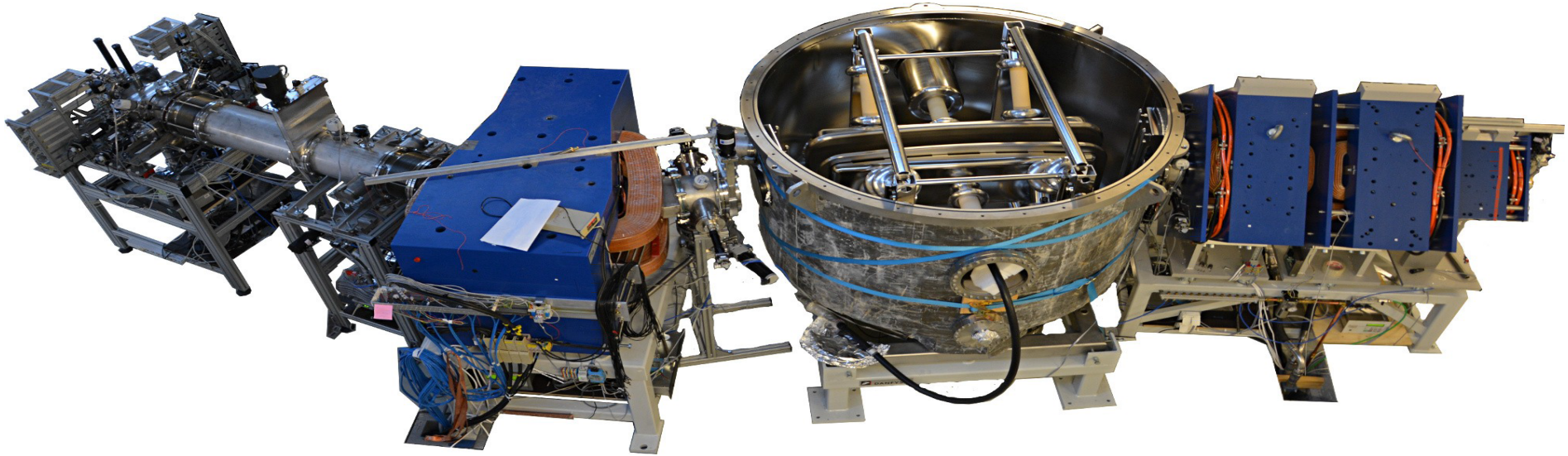
MARA, Future developments: Low-Energy Branch

Contact:
Philippos Papadakis,
Jyväskylä



MARA is ready for action



THANK YOU!