GRIT @ FAIR

D.Beaumel, IPN Orsay

Direct reaction studies using SD beams

- **Take advantage of chemical independence and fast production process of in-flight beams**
- **Reactions at intermediate energies (10~50 MeV/u)**

A broad physics program of direct reaction studies can be envisioned

Purpose of SD beams : implement reactions/techniques of the low energy regime

Stripping reactions

- Nucleon, pair or cluster **addition modes**
  - ✓ unique selectivity
  - ✓ no high-energy equivalent (as e.g. quasifree scattering ↔ pickup reaction)

(d,p) reaction : neutron shell structure seen to populate unoccupied orbitals
+ surrogate reaction for (n,γ)

(α,^{3}He) and (α,^{3}He) at 20~50 MeV/u to populate high-L orbitals

Cluster transfer (^{6}Li,d) or (^{7}Li,t)

Others

(p,t) pair transfer

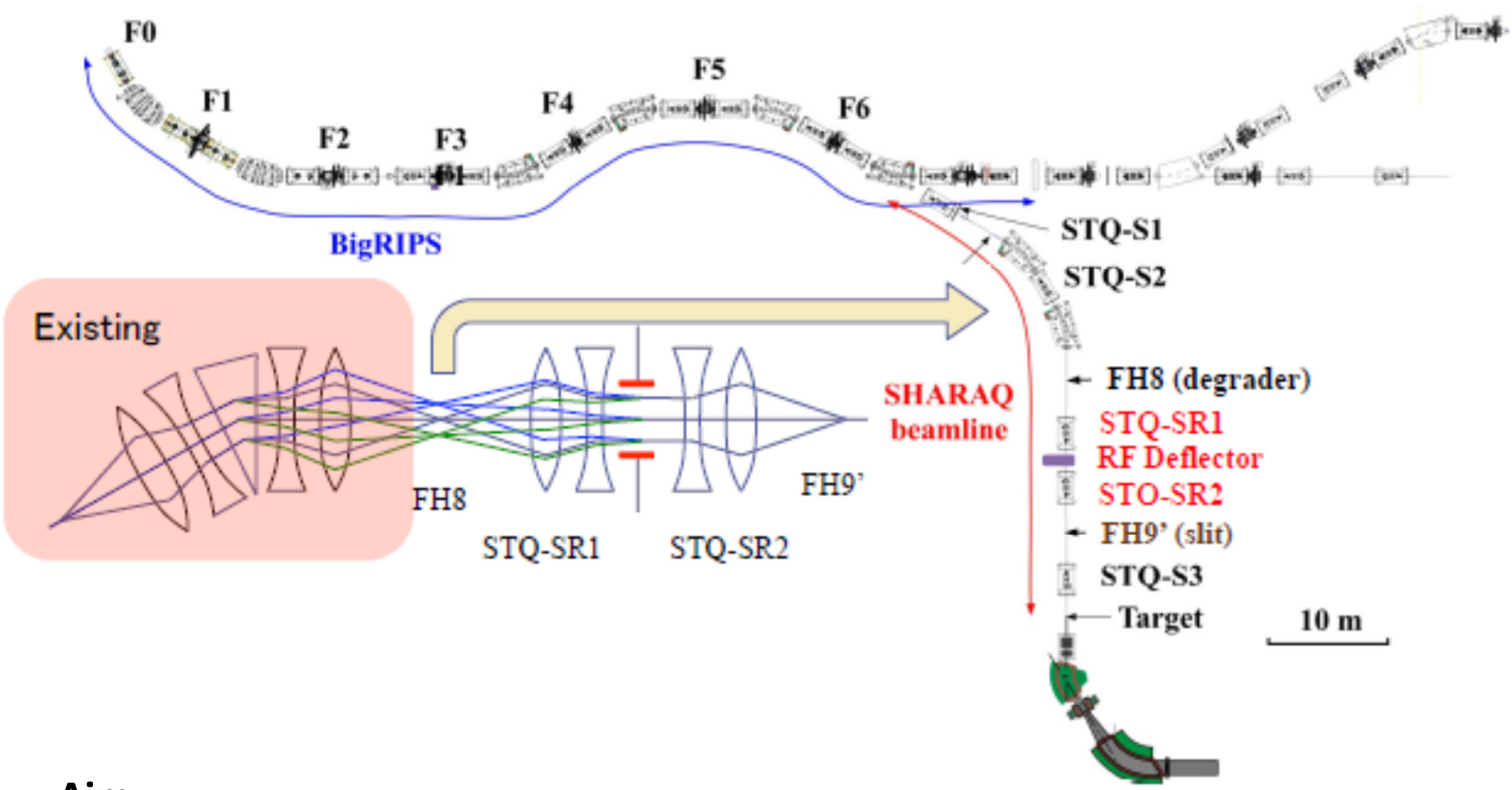
Coulex

....

Key Issues: Beam characteristics, Background

OEDO @ RIKEN

Optimized Energy Degrading Optics



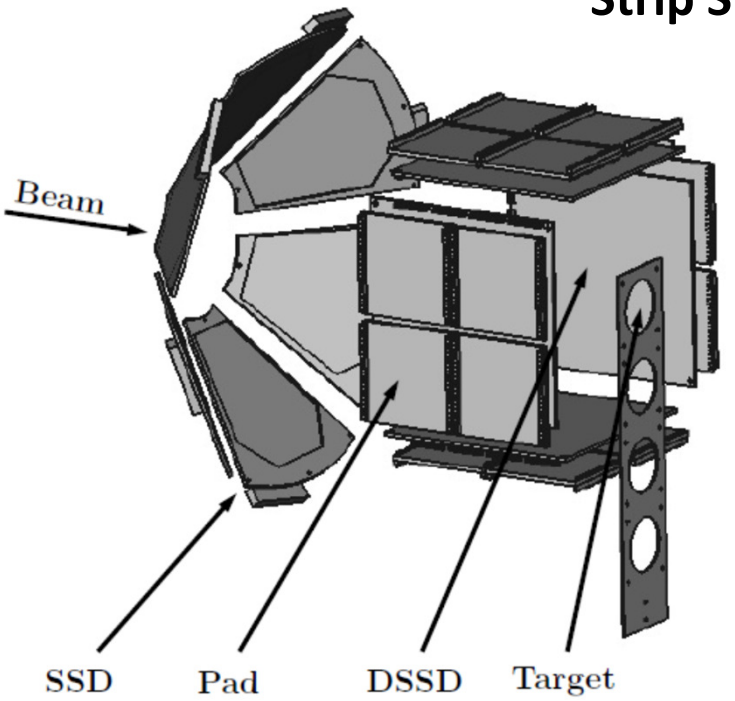
Aim:

- slow down RIBF beams to 5~50 MeV/u
- Improve beam characteristics

From: S.Shimoura
OEDO proposal

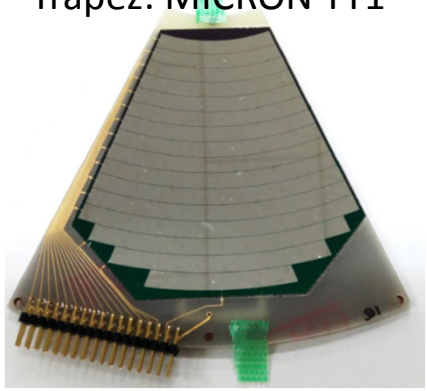
The TINA detector array

Strip Si + CsI recoil particle system

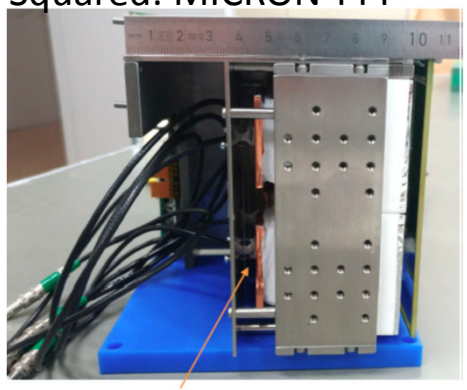


TRAPEZOID & SQUARED Shaped DSSD's

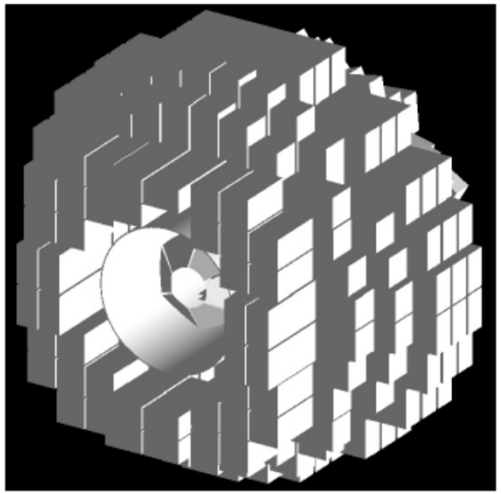
Trapez: MICRON YY1



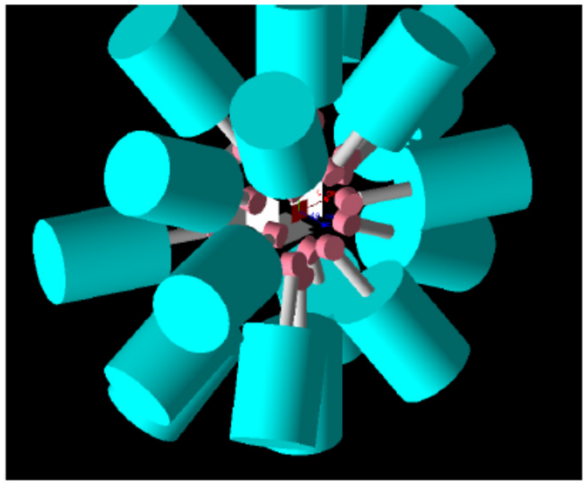
Squared: MICRON TTT



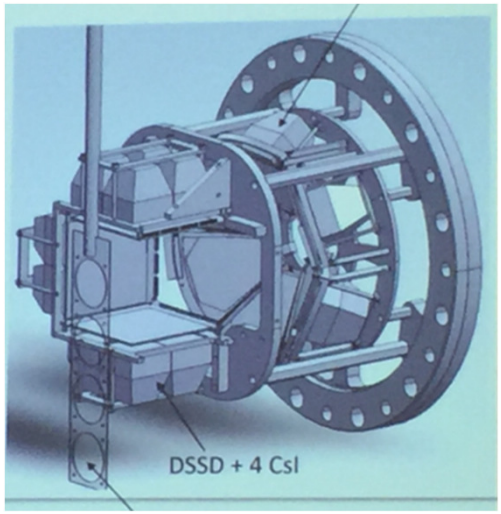
Signal processing: GET electronics



DALI2+
($\Delta E/E \approx 7\%$, $\epsilon \approx 18\%$)



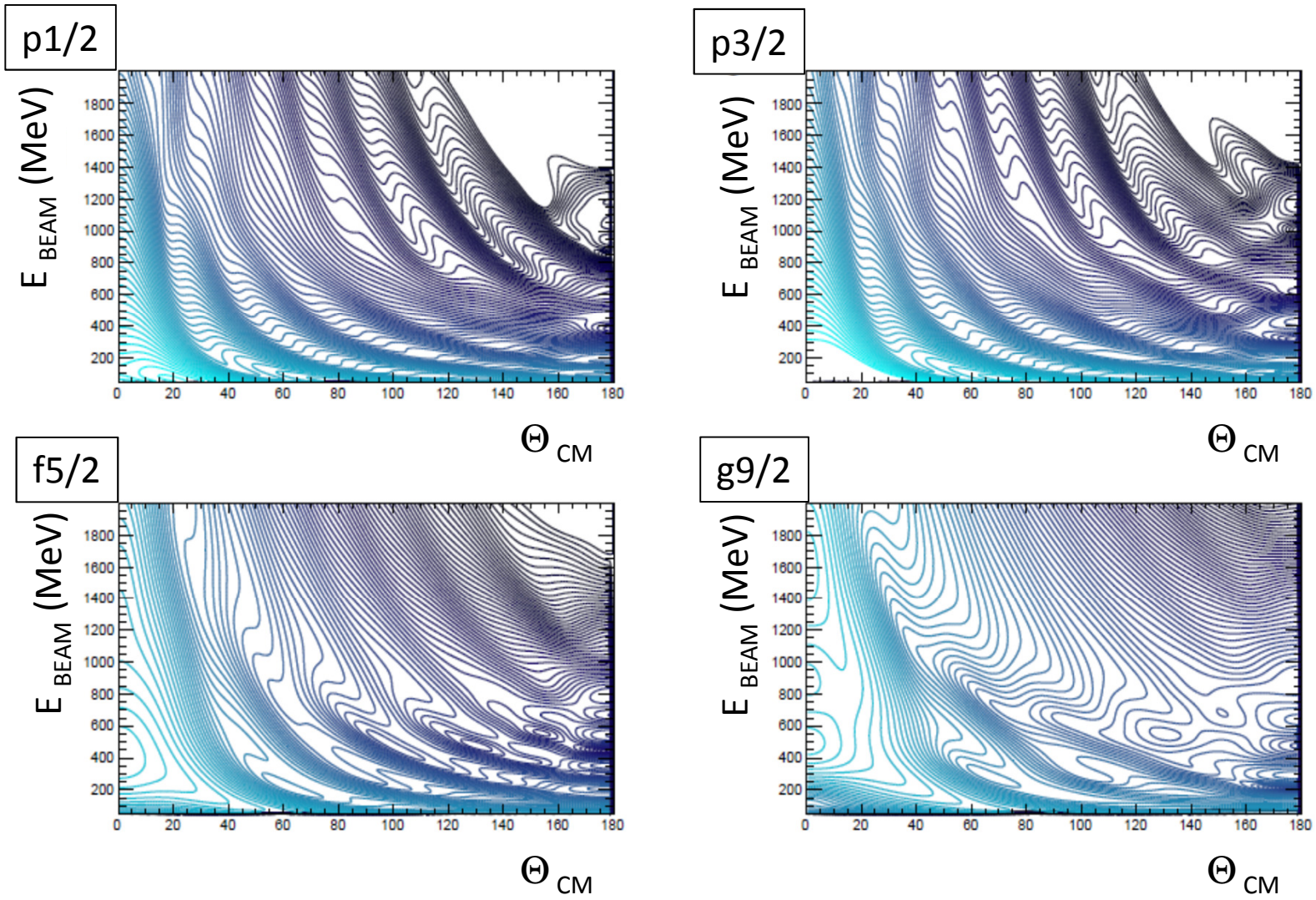
GRAPE
($\Delta E/E \approx 1\%$, $\epsilon \approx 1\%$)



Evolution of diff. cross-sections with E_{BEAM}

(AWBA Calculations)

Case of ^{54}Ti(d,p)



From: A.Matta

SIMULATIONS of direct reactions using SD beams

NPTool package for simulations of Direct reactions

A.Matta et al., JPG 43 (2016)

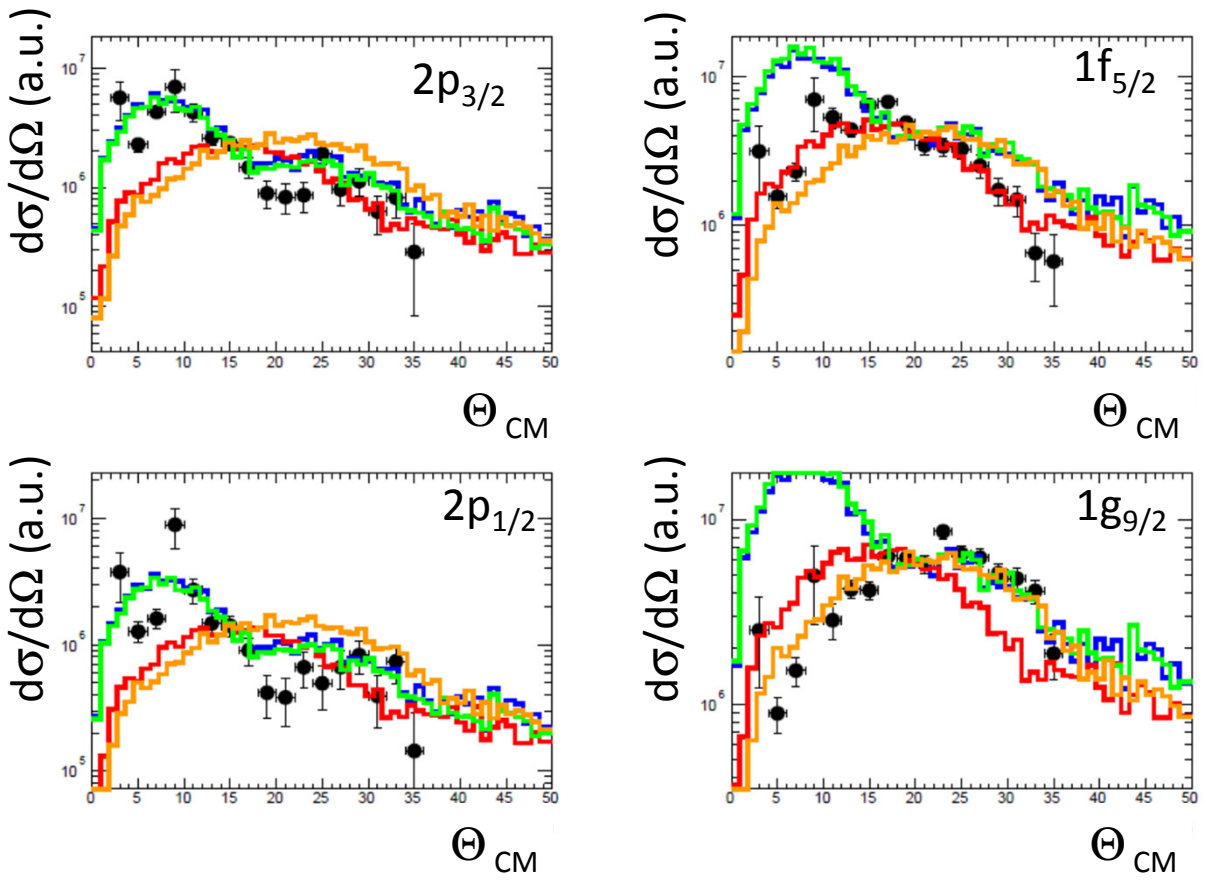
- ➢ Event generator: 2-Body kinematics and DWBA cross-sections
- ➢ Realistic detector configuration
- ➢ Detector's resolutions
- ➢ Target effects

New event generator :
Includes
- ❑ beam energy distribution
- ❑ ADWA for each energy

***Simulation results for* ^{54}Ti(d,p)** at RIKEN

- Population of p,f,g orbits
- $E_{beam} = (15 \pm 3)$ MeV/u

(E-integrated) diff X-sections sensitive to transferred L



OEDO Status&Plan

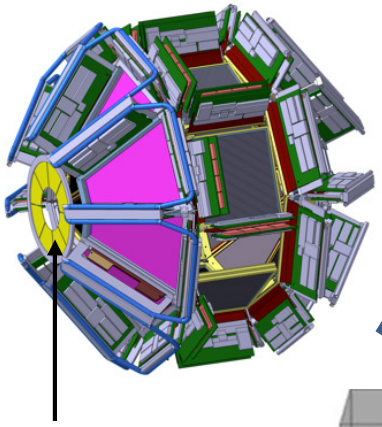
- Performed several machine study + **^{79}Se(d,p)** with TINA V1
  - 20 MeV/u (σ=0.5MeV)
  - Rates: 3x100 kHz → 10 kHz
    transmission ≅ 4%

- 1 accepted (d,p) experiment

- background reduction

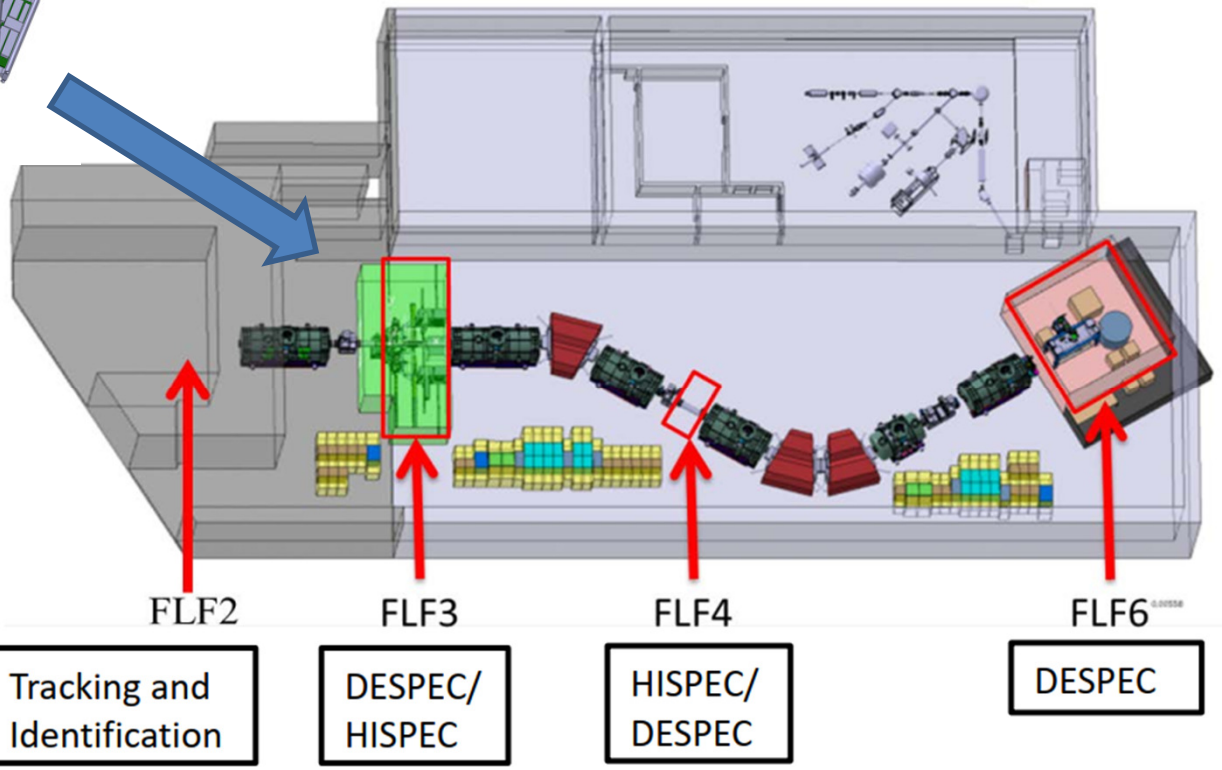
- Developments ongoing
  (Optics improvements, TINA, upgrade of SHARAQ spectrometer
  triton target…)

Low Energy Branch of the super-FRS



+ AGATA

∅10cm annular det.
(to be removed)



Present Scheme (from TDR)

- ❑ Degrader at FLF2 E ~ 100 MeV/u
- ❑ + Degrader at FLF3 E ~ 10 MeV/u

NEED

- ➢ Beam tracking
- ➢ Beam TOF
- ➢ Residue detection