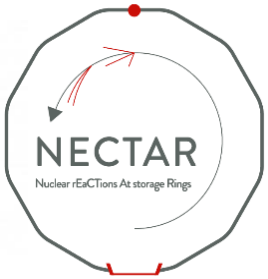
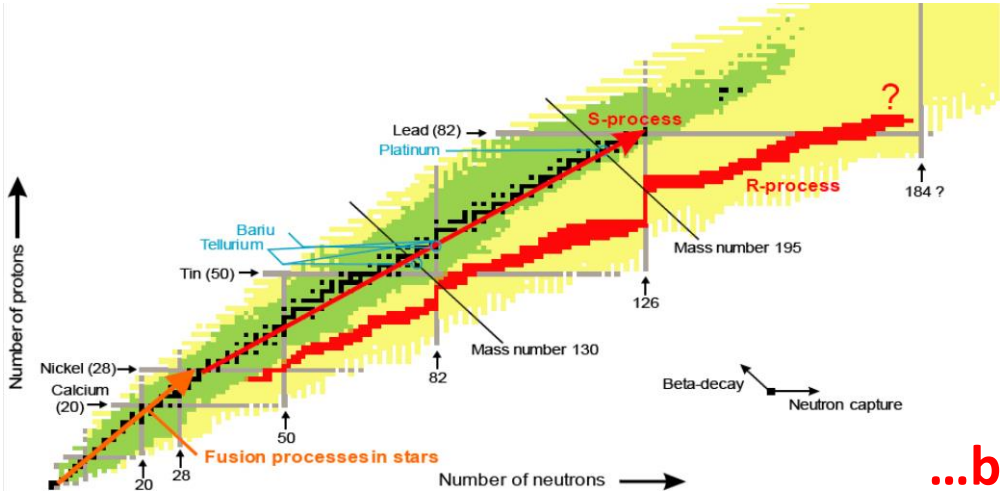


Discussion on beam time 2023-2024
ERC-Advanced grant NECTAR
(Nuclear rEaCTions At storage Rings)

Beatriz Jurado, LP2I Bordeaux, France

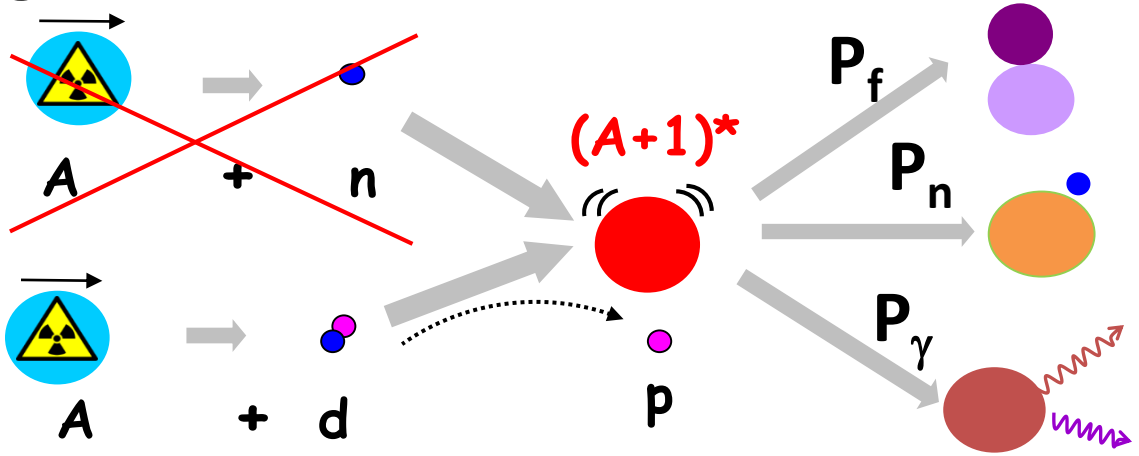
Need for neutron-induced cross sections of short-lived nuclei



- Essential for understanding the origin of heavy elements
- Energy production
- Production of radio isotopes in nuclear medicine.

…but very difficult to measure!

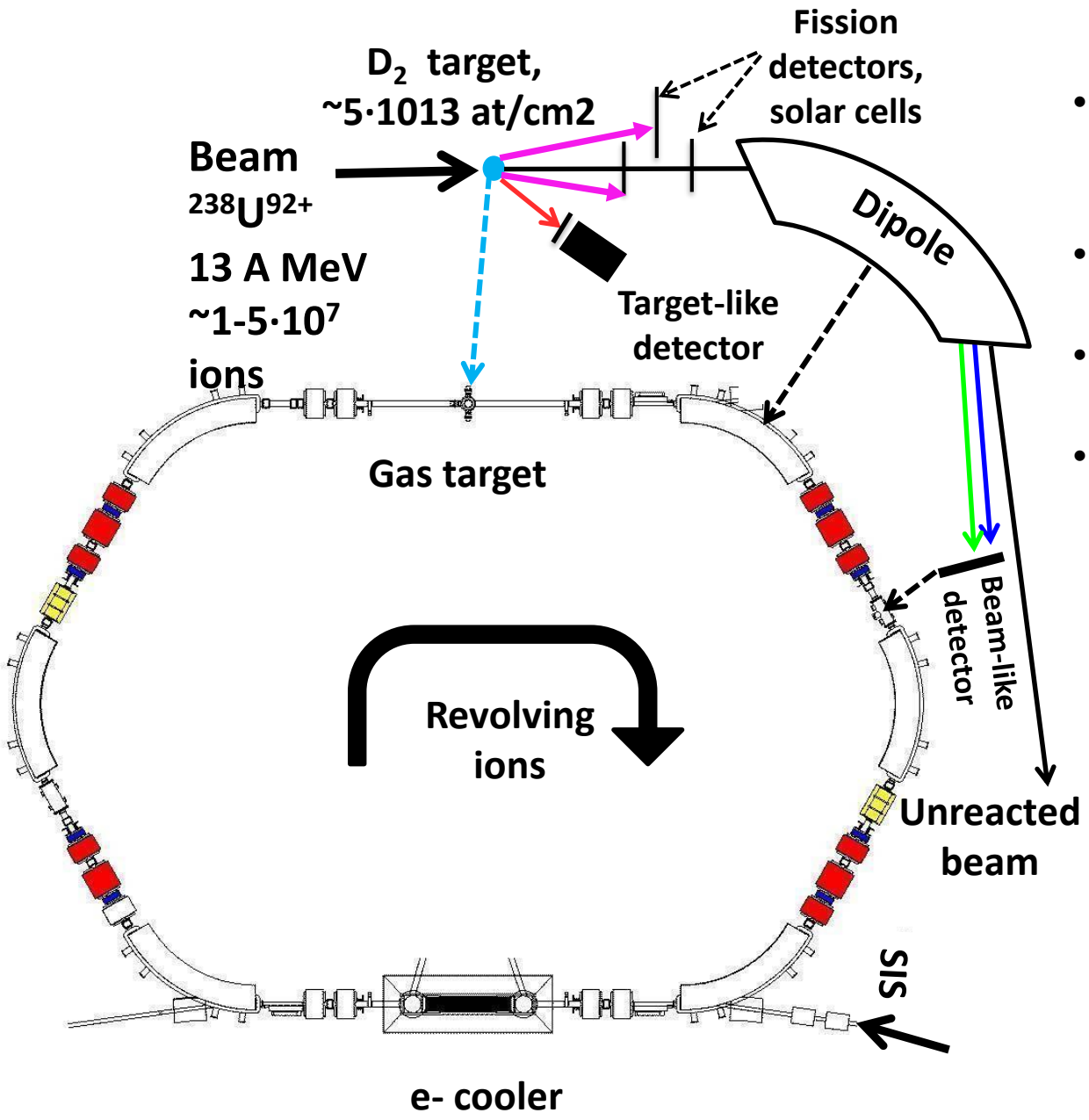
Surrogate-reaction method in inverse kinematics



$P_i(E^*)$ — Decay probabilities :

→ Used to constrain models and provide much more accurate predictions for neutron-induced cross-sections of nuclei far from stability.

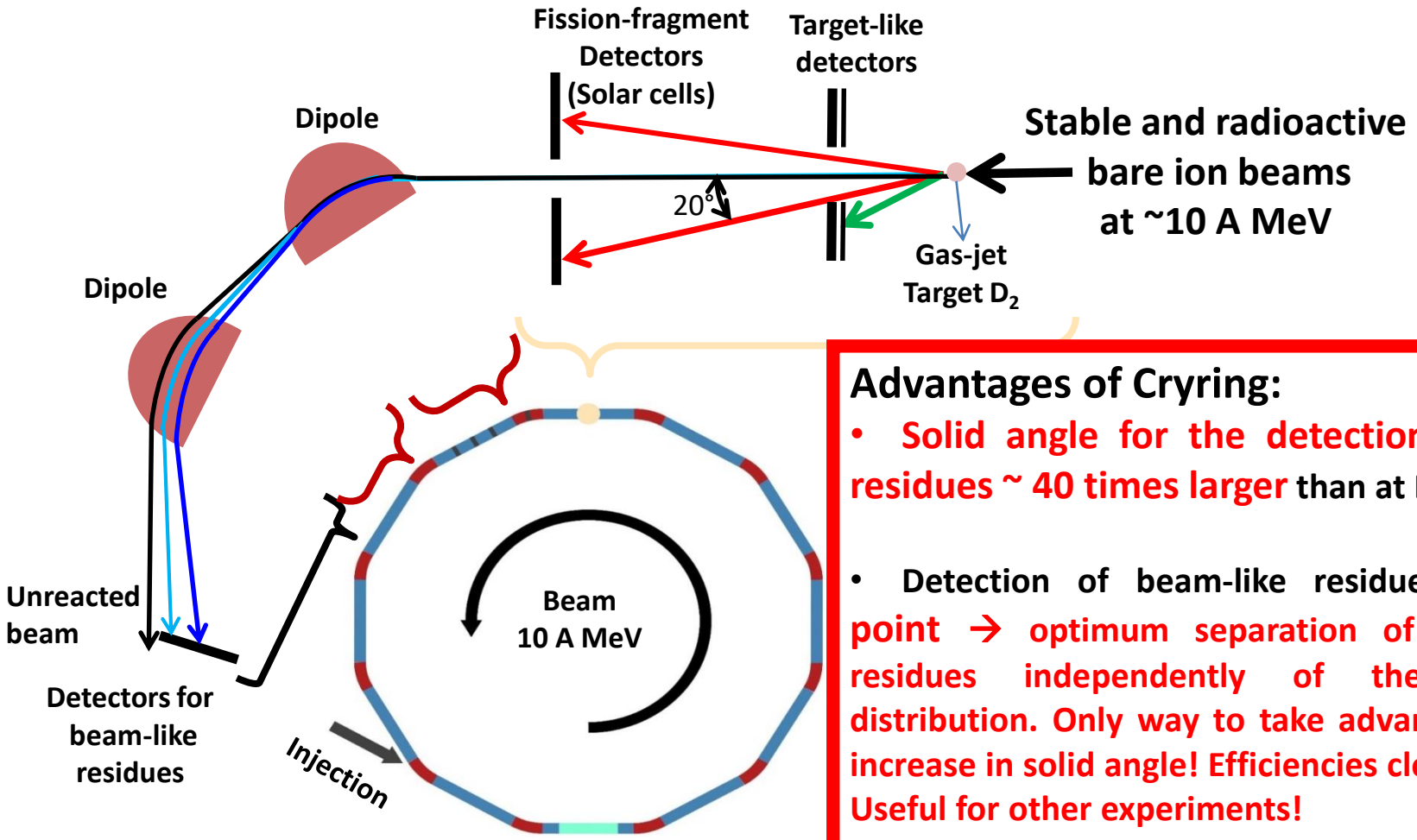
Beamtime 2024: fission proof-of-principle experiment at ESR



- **Target-like and beam-like detector are ready**, will be tested in June 2022.
- **Add fission detectors. Eff~40%.**
- **Demonstrate feasibility for measuring fission probability**
- Use measured data to infer: **^{237}U(n,γ), ^{237}U(n,n') , ^{237}U(n,f) ^{238}U(n,γ), ^{238}U(n,n') , ^{238}U(n,f)** cross sections.

Request :
21 Shifts for data taking
~3 Shifts for ESR preparation

Perspectives, 2025 and beyond



Advantages of Cryring:

- **Solid angle for the detection of target residues ~ 40 times larger** than at ESR.

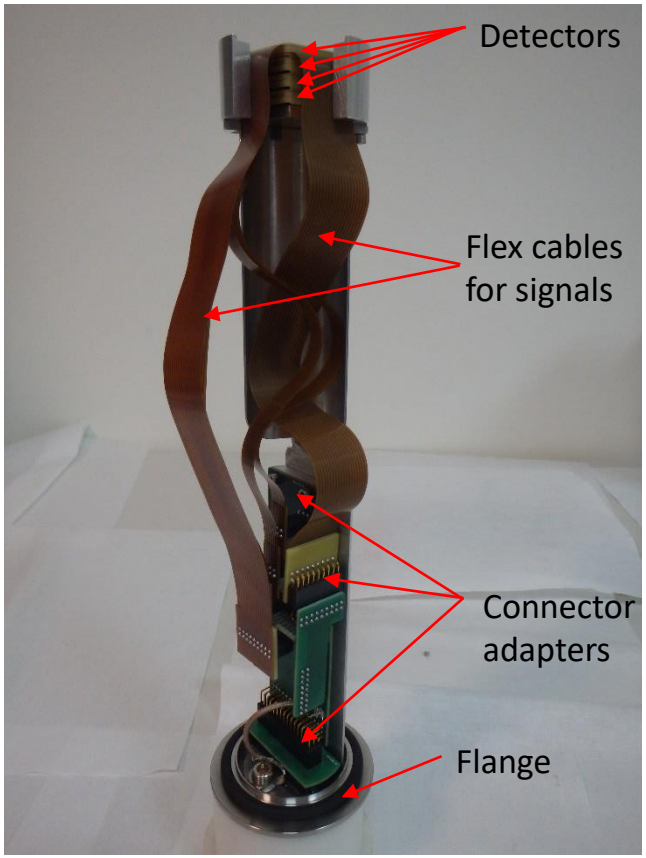
- Detection of beam-like residues at **focal point → optimum separation of the heavy residues independently of their angular distribution. Only way to take advantage of the increase in solid angle! Efficiencies close to 100%. Useful for other experiments!**

- **Fission efficiency close to 100%** (instead of 40% at ESR)

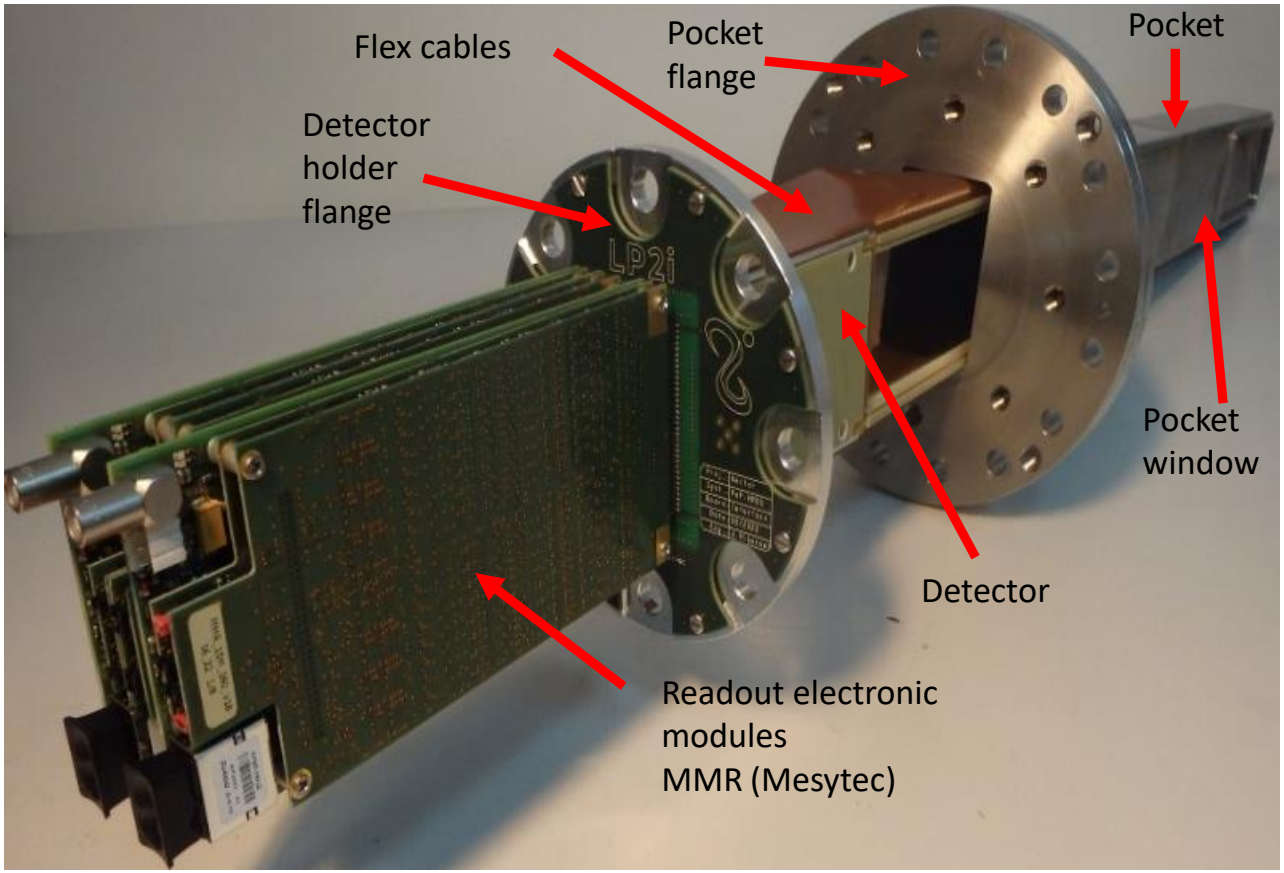
- If transmission between ESR & Cryring is optimized, luminosity can be better @ Cryring (duty cycle, half radius of ring, better vacuum).

Back-up slides

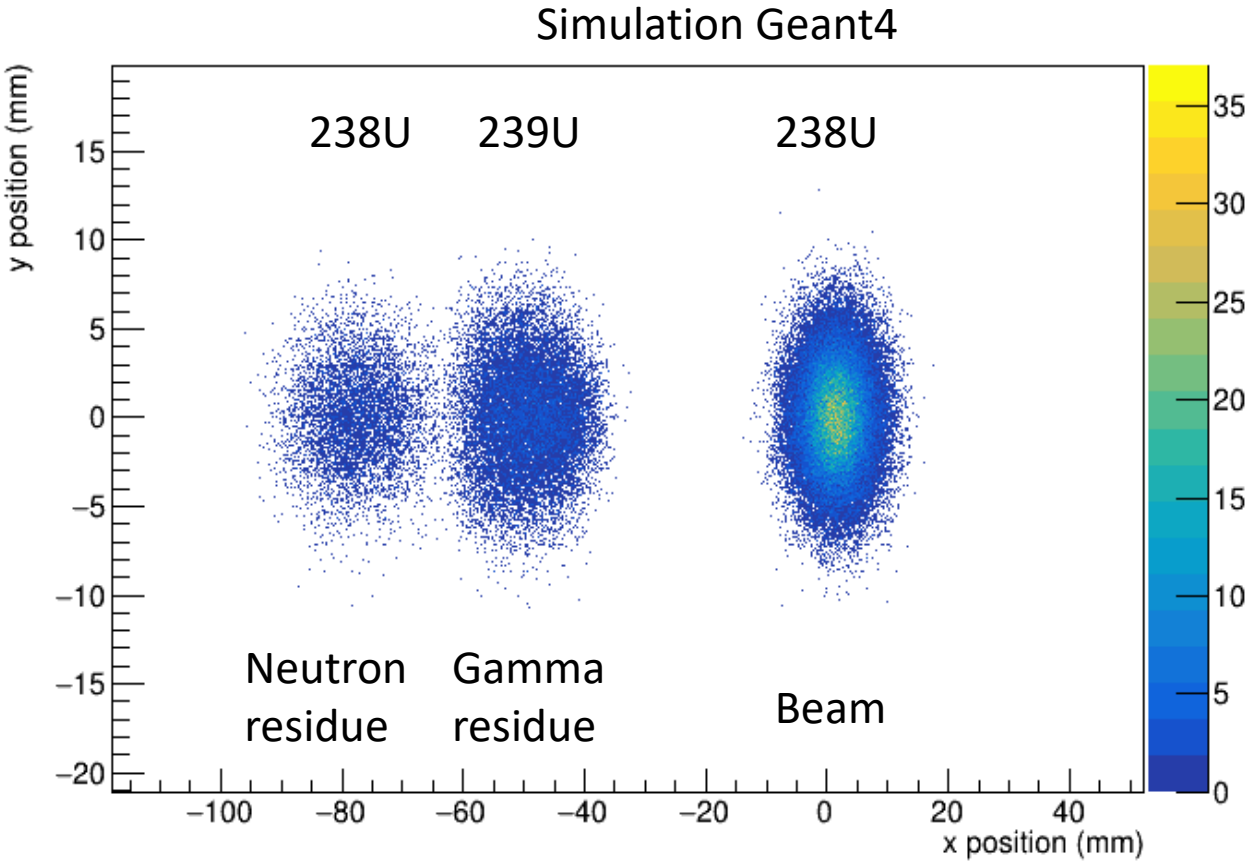
Target-residue detection system for ESR (Ready!)



Beam-like residue detection system for ESR (Ready!)



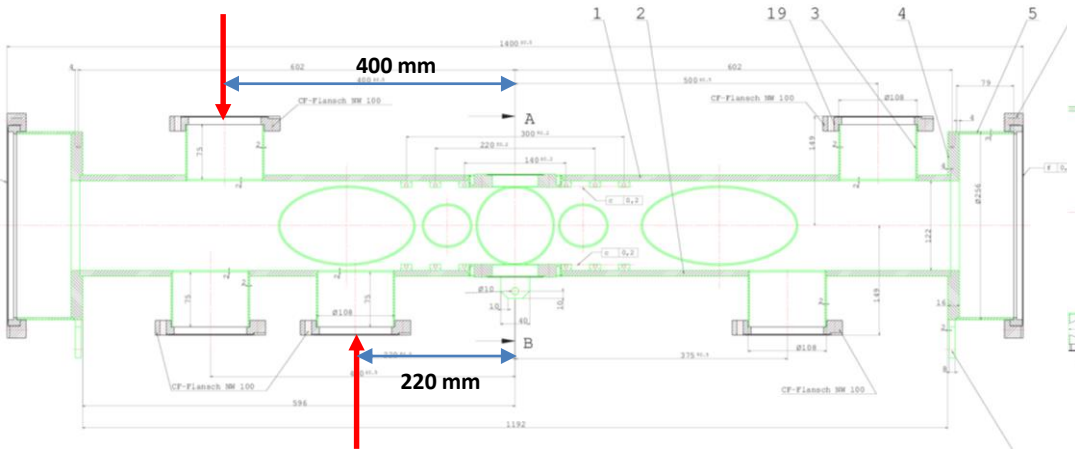
Beam and beam-like residues at heavy residue detector position
238U(d,p) at 13 A MeV E*=0-8 MeV @ ESR

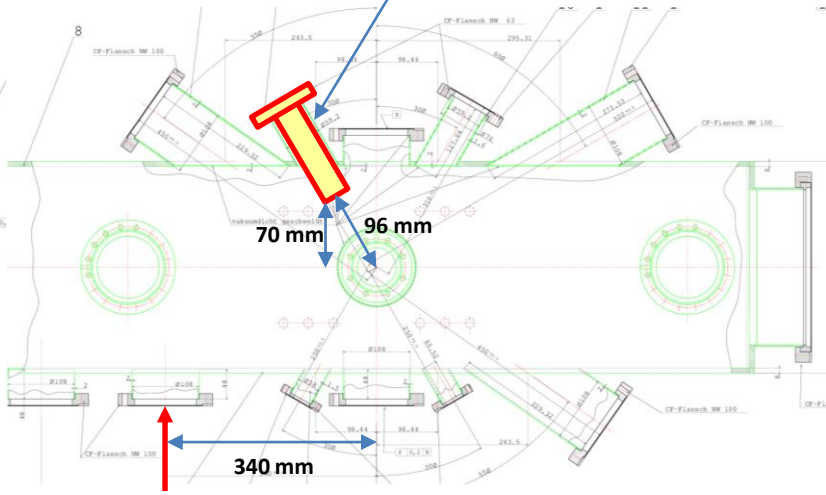


Full separation, full transmission!

ESR target chamber

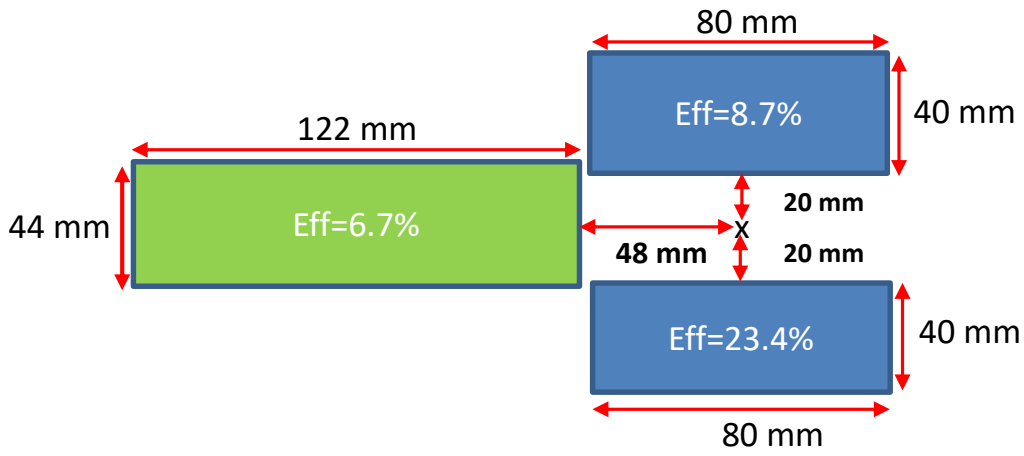
Telescope for
target residues





Red arrows: Ports where we can
insert fission detectors
in pockets behind windows.

Sketch of fission detector at ESR



Simulated total efficiency with Geant4: ~ 39%

Average luminosity and requested beamtime

Number of decelerated $^{238}U^{92+}$ ions N_0	Beam frequency f	H_2 target density N_t	Overlap parameter η	Lifetime τ	Preparation time t_0	Measurement time T	Average luminosity <L>
$5 \cdot 10^7$	0.46 MHz	$5 \cdot 10^{13}$ atoms/cm^2	0.13	8 s	40 s	55 s	$1.5 \cdot 10^{25}$ cm$^{-2} \cdot$s^{-1}

Beam time to measure decay probabilities with 5-10% for (d,p) and 15-25% for (d,d')

Reaction	Telescope angle	Telescope solid angle	Cross section	Rate	Number of detected events	Required beam time
^{238}U(d,p) at 13 AMeV, E*=8 ± 0.5 MeV	60±3°	0.0221 sr	5.75 mb/sr	0.002 Hz	1000	6.1 days
^{238}U(d,d') at 13 AMeV, E*=6.5 ± 0.5 MeV	54+5°	0.018 sr	1 mb/sr	0.0003 Hz	140	6 days

Requested beamtime 21 shifts (18 for data taking and 3 for calibration)

~3 shifts for setting the ESR

Schedule in 2024 since we have to produce 2 pockets and the fission detectors.