JYVÄSKYLÄN YLIOPISTO
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Production of Xe standards for the calibration of noble gas sampler stations and laboratory equipment

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Outline

- Motivation
- Upgraded Xenon production facility at Jyväskylä University, Finland
- Foil-to-gas bottle conversion at STUK
- Expected performance of the technique
- Conclusions

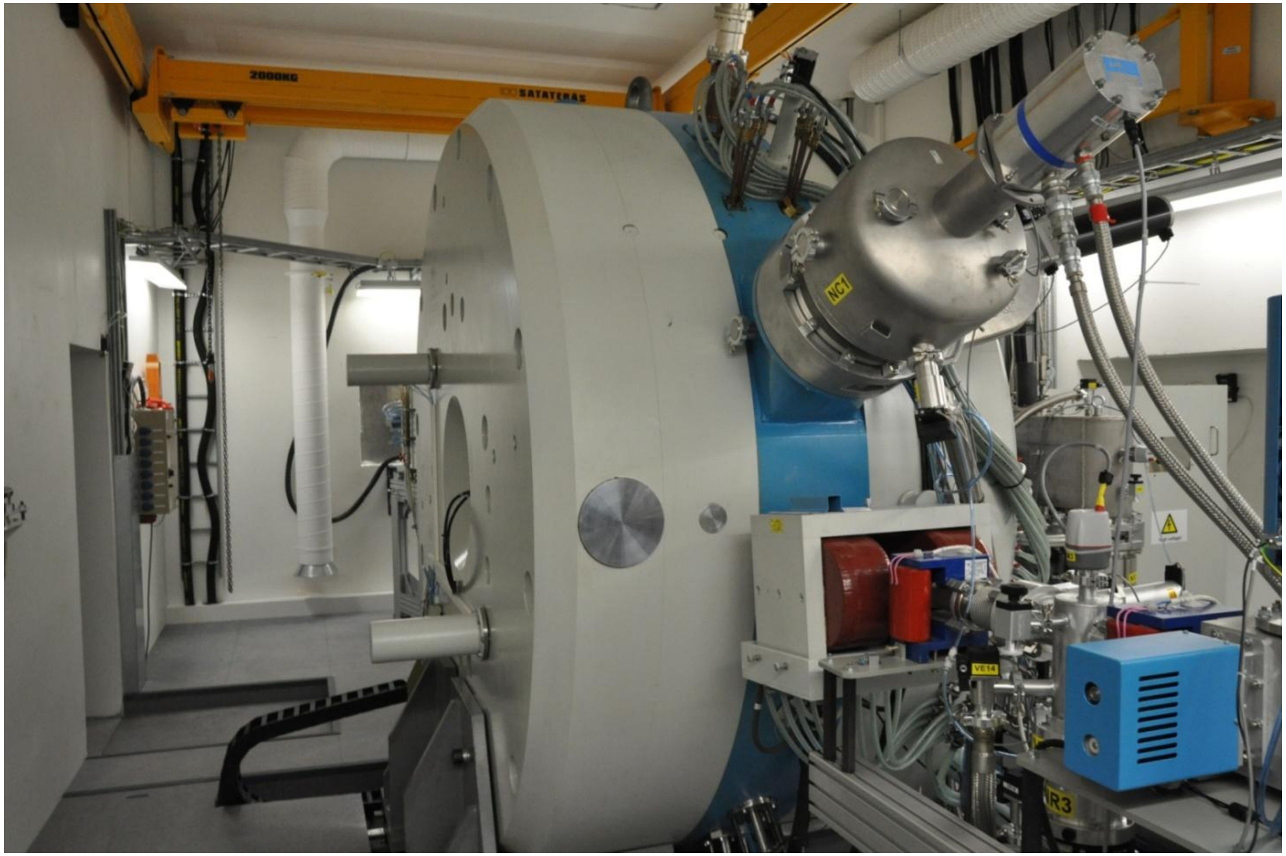
Motivation

- Pure Xe samples are required for equipment calibration and software performance evaluation.
- $^{133m}Xe/^{133}Xe$ ratio is a key signature related to discrimination between nuclear test explosion and reactor releases.

$$\mathrm{Mass}(^{133m}\mathrm{Xe}) = \mathrm{Mass}(^{133}\mathrm{Xe}) + \underbrace{233\ \mathrm{keV}}_{\sim\frac{1}{2}\ \text{electron mass}}$$

New cyclotron in Jyväskylä

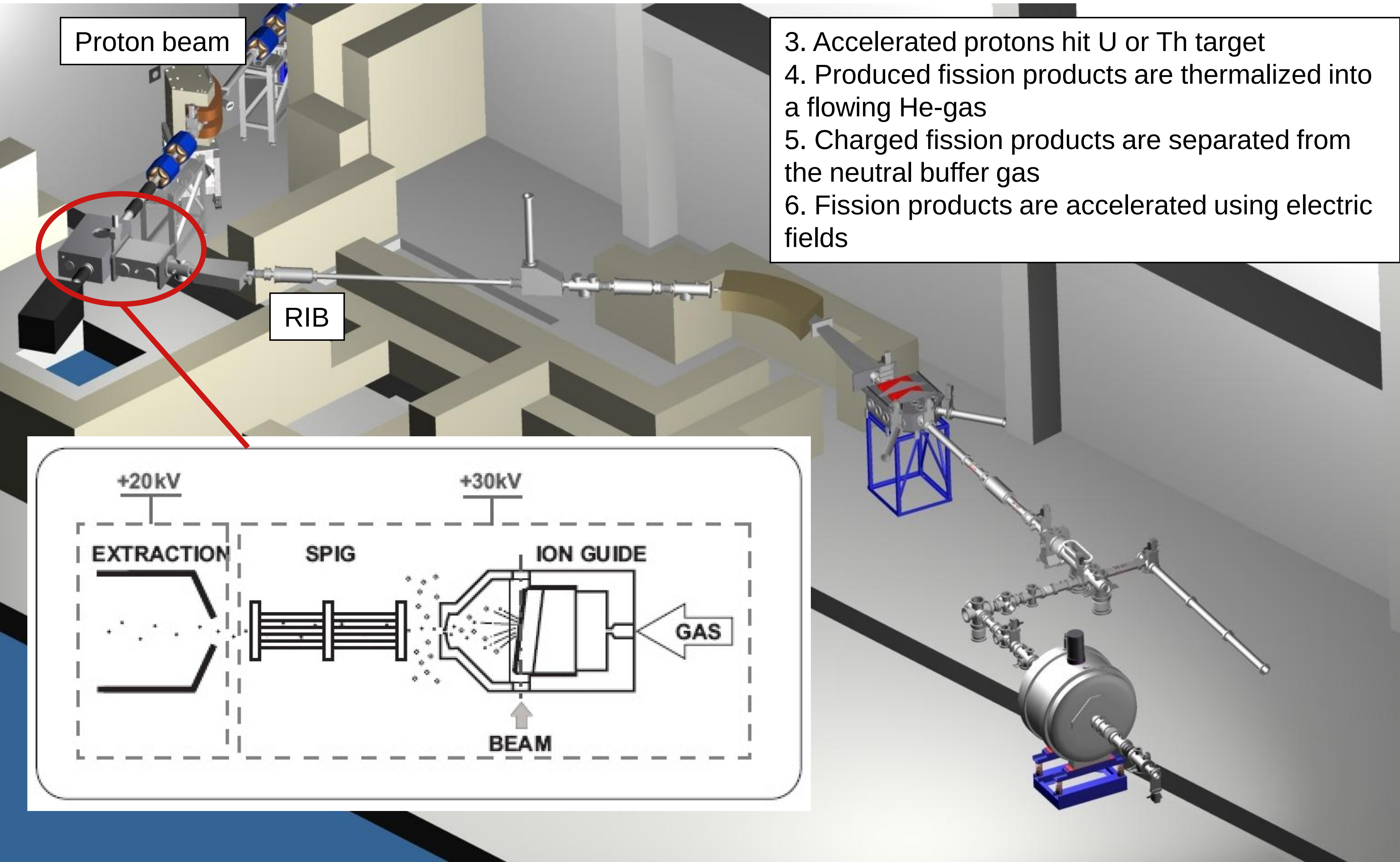
1. Proton beam is produced with the plasma ion source
2. Beam is accelerated using the cyclotron that will primarily serve the upgraded IGISOL/JYFLTRAP facility



Production of Radioactive Ion Beam (RIB)

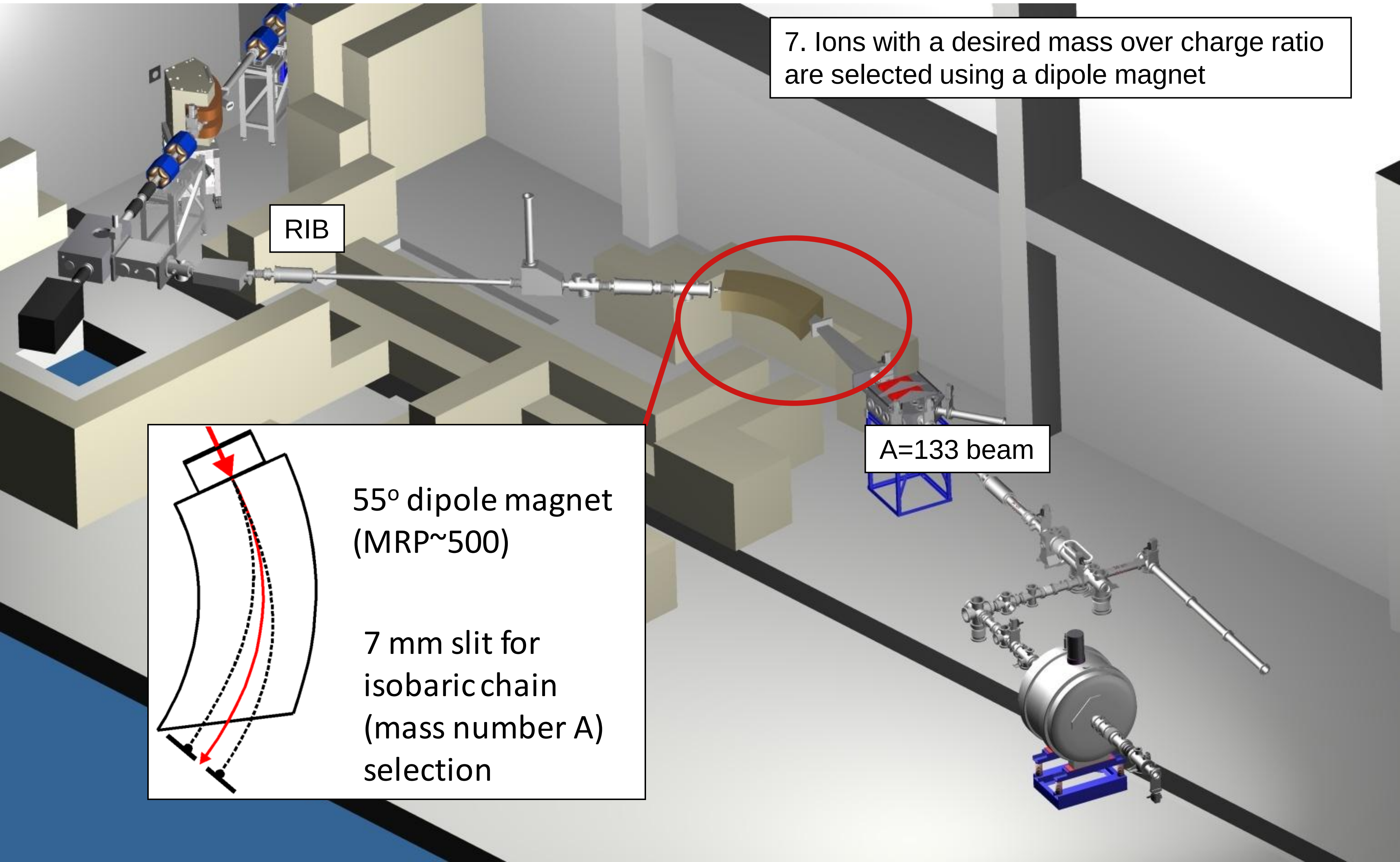
Upgraded IGISOL/JYFLTRAP facility

3. Accelerated protons hit U or Th target
4. Produced fission products are thermalized into a flowing He-gas
5. Charged fission products are separated from the neutral buffer gas
6. Fission products are accelerated using electric fields



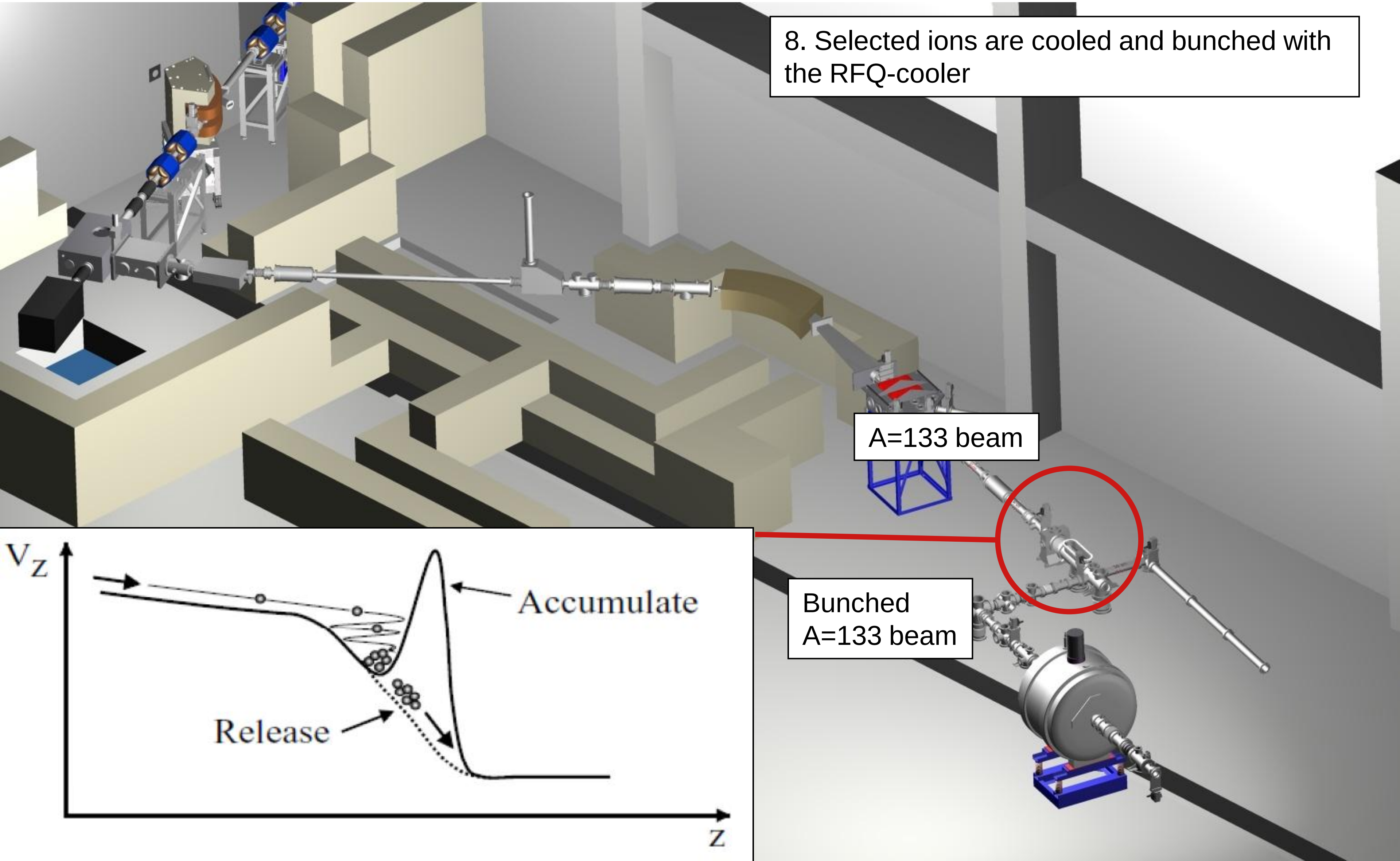
Rough mass separation

Upgraded IGISOL/JYFLTRAP facility



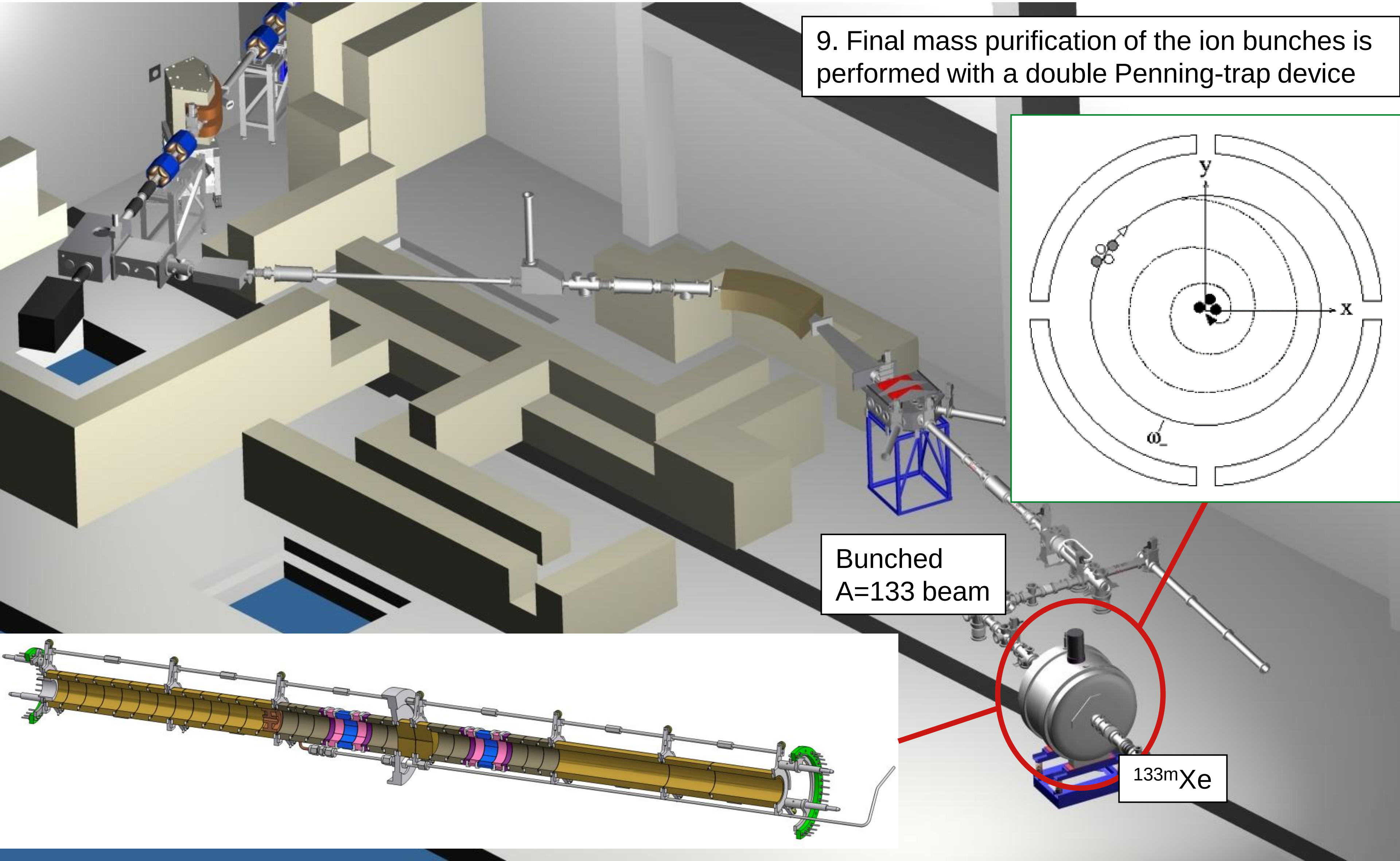
Cooling and bunching of the beam

Upgraded IGISOL/JYFLTRAP facility



Final mass purification

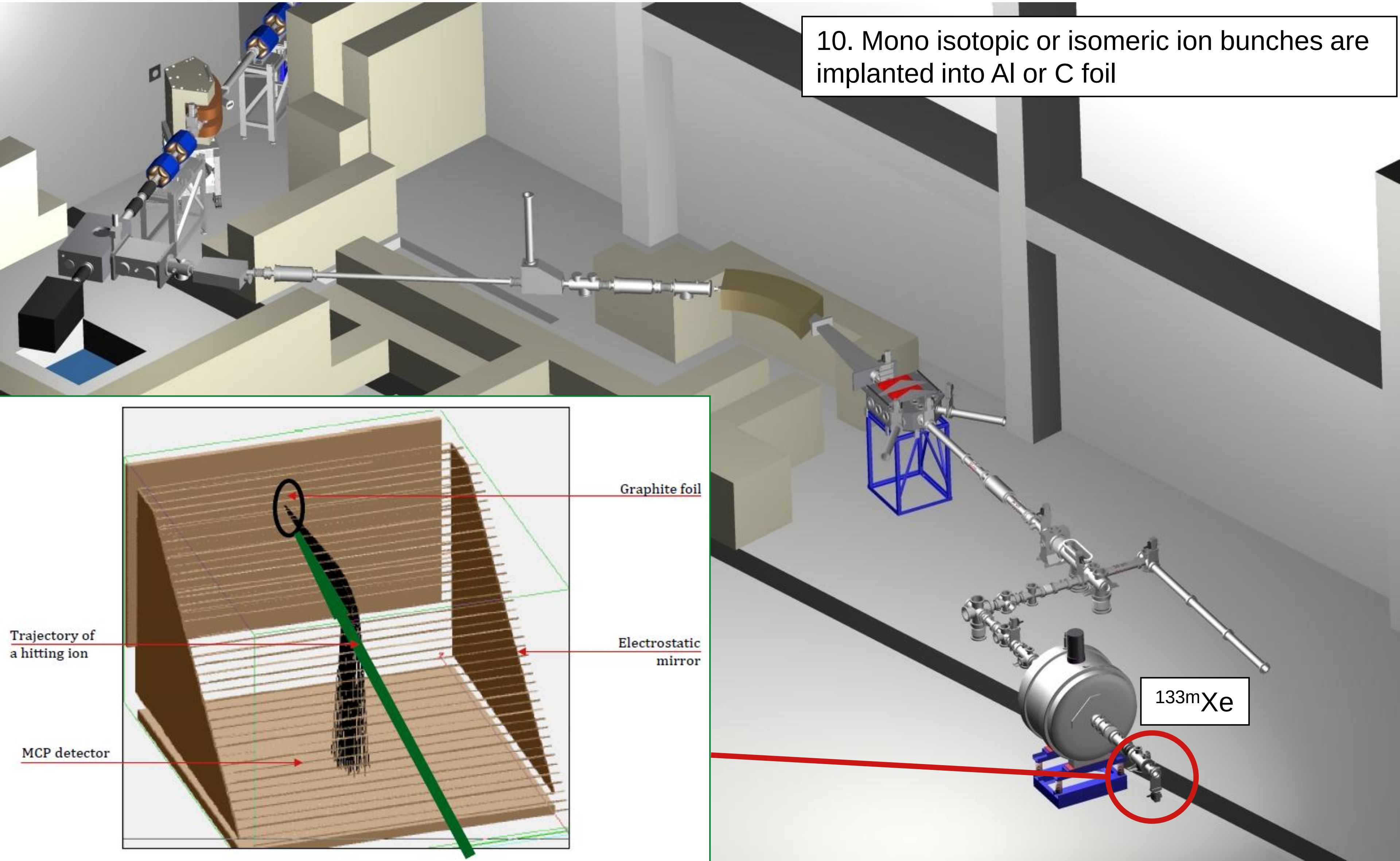
Upgraded IGISOL/JYFLTRAP facility



Implantation to solid catcher

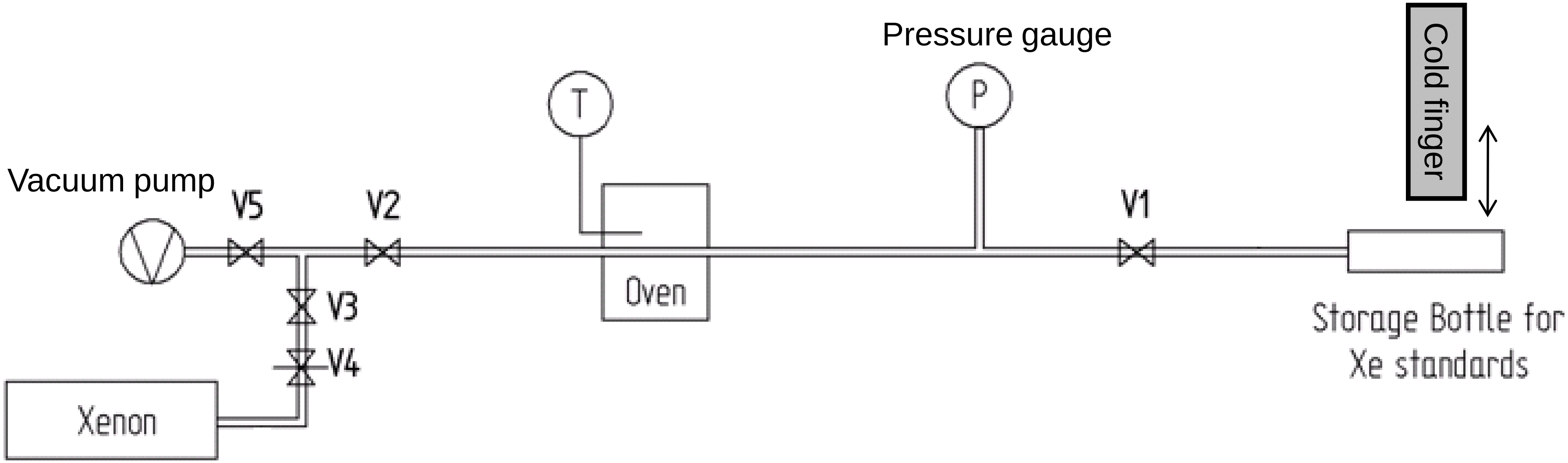
Upgraded IGISOL/JYFLTRAP facility

10. Mono isotopic or isomeric ion bunches are implanted into Al or C foil



Foil-to-gas bottle conversion at STUK

11. Gamma spectrometry for actual and reference samples
12. Implanted species are transferred from the foil to a gas bottle.

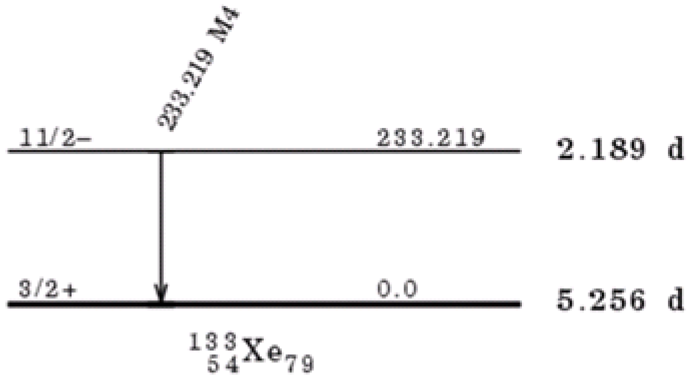


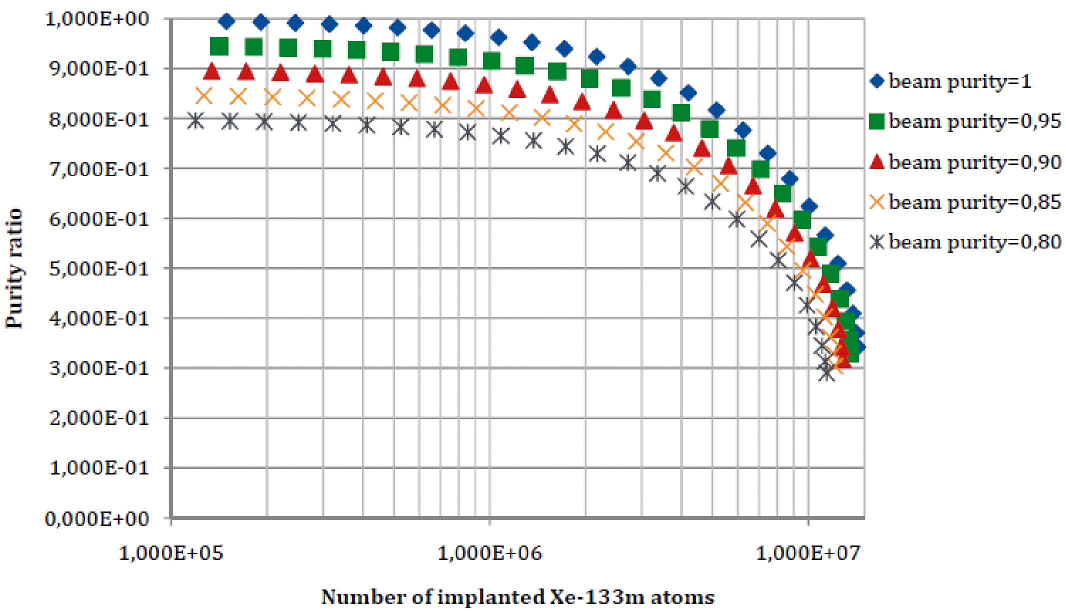
Graphite foil thickness used is 215 μg/cm^2.
2 h at 400 ^{o}C is enough to release the implanted Xe completely.
Melting point of Xe is -111.9 ^{o}C while liquid nitrogen temperature is -195.8 ^{o}C.

Expected performance of the technique

Using old IGISOL/JYFLTRAP facility it has been shown that pure samples of ^{131m}Xe, ^{133m}Xe, ^{133}Xe and ^{135}Xe can be prepared with the rate of some tens of ions per second.

<u>Example, ^{133m}Xe sample purity at the end of implantation</u>
Assume a beam purity, ^{133m}Xe/(^{133m}Xe+^{133}Xe), of 1 and a beam intensity of 50 ions/s.
These figures lead to 0.965 sample purity at the end of implantation of 10^6 ^{133m}Xe ions. The corresponding implantation time and ^{133m}Xe activity are ~5.5 h and ~3.5 Bq.





Conclusions

- Mass separator-based production of pure $^{131m, 133m, 133, 135}Xe$ samples is possible
- Graphite is a good implantation foil choice for Xe
- New cyclotron primarily serving the upgraded IGISOL/JYFLTRAP facility offers much more flexibility to scheduling of experiments
- Production of Xe samples should be possible in late 2011 or early 2012

Collaboration

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