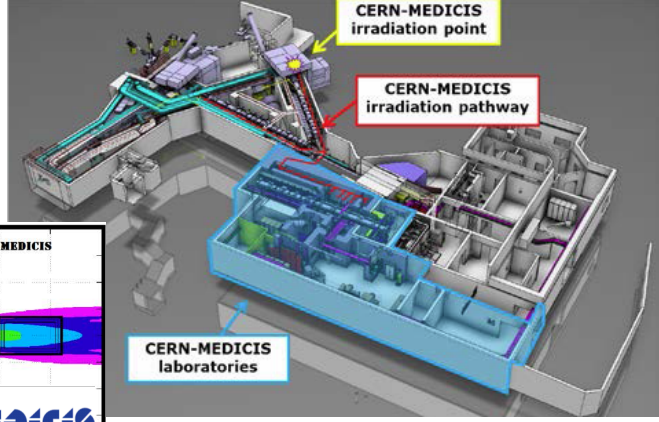
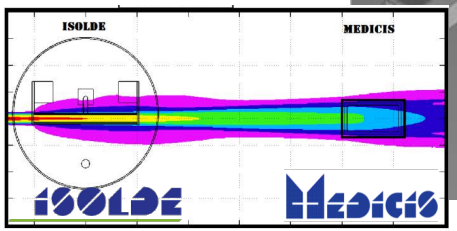
KU LEUVEN

Radioisotope separation at MEDICIS

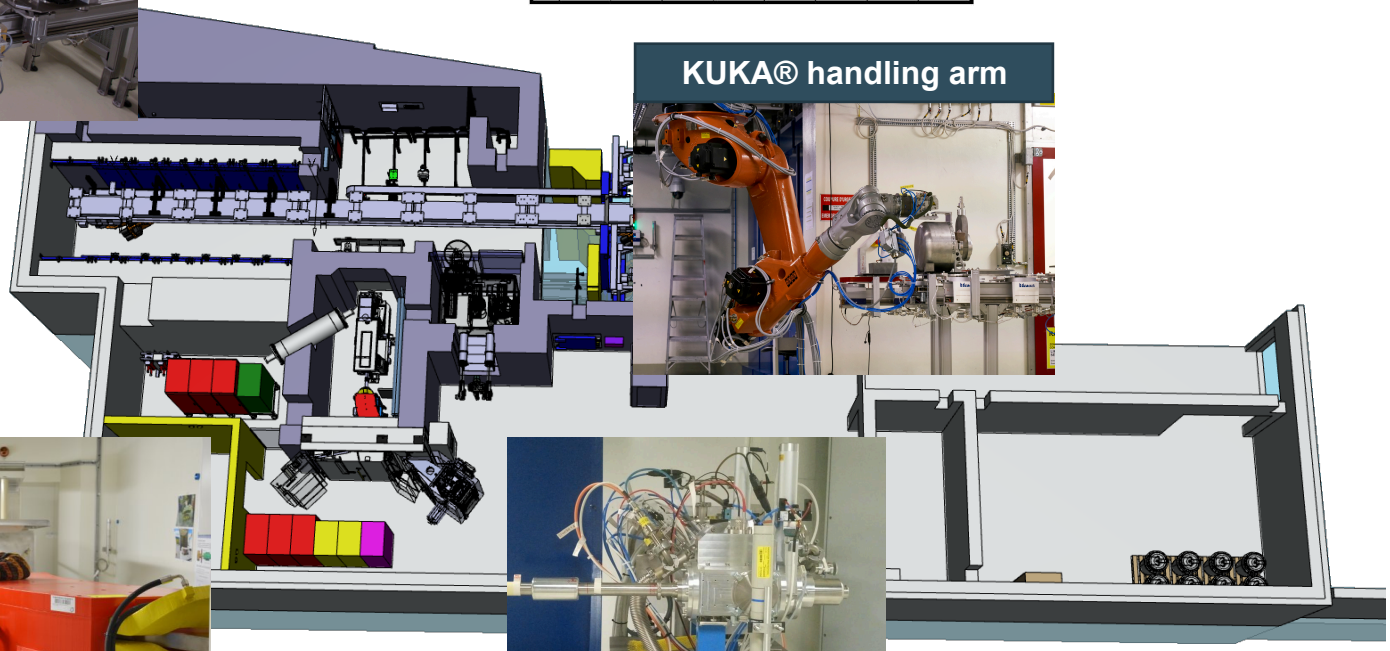
Thomas Elias Cocolios
KU Leuven IKS

CERN MEDICIS





Montrec® rail system



KUKA® handling arm

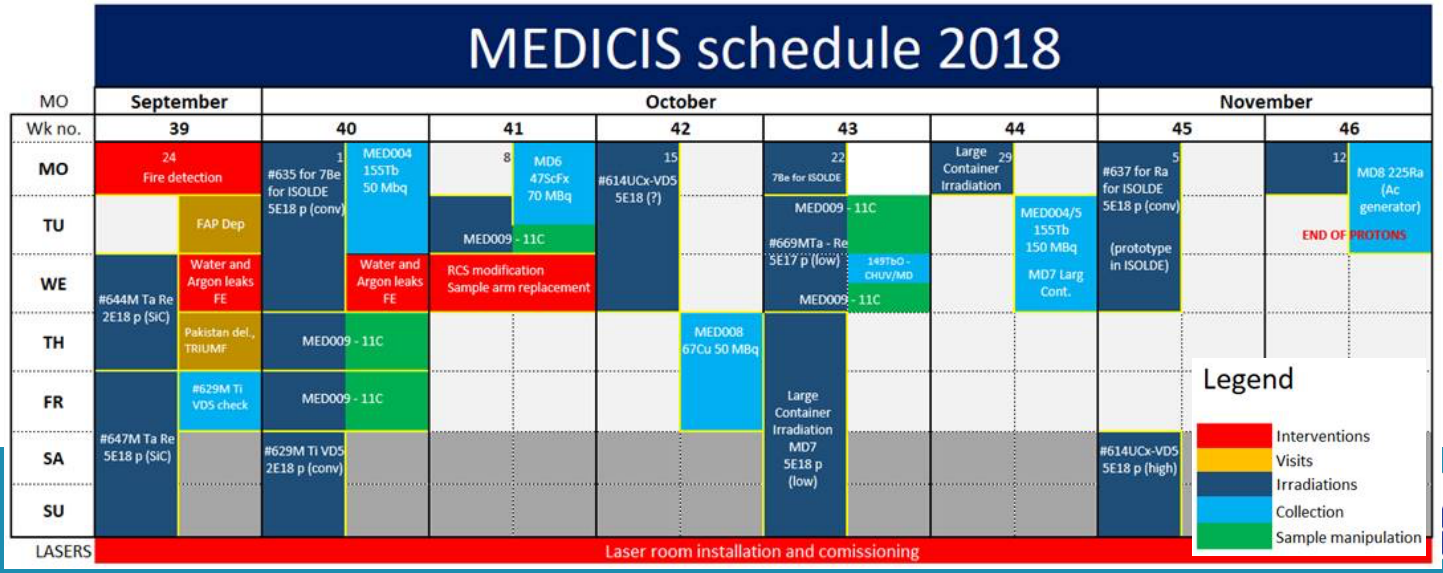
LISOL separator magnet

Collection point

- Offline separator for the collection of radioisotopes for medical research
- Planned to operate 30 weeks per year

Standard operation

- A target unit — including so far Ti, Ta, and UCx — is irradiated behind the ISOLDE HRS target; Typical irradiations last up to 12-16h;
- Targets are held until the activity goes down to 1 Sv/h at 10 cm; They are then placed at the MEDICIS separator front end;
- The target is pumped, heated up, and radioisotopes are ionised, accelerated to 30 keV, mass separated, and collected in a solid sample (e.g. Zn-coated Au foil, salt).



2018 Achievements

- 7 target units irradiated at CERN
- Separation of ^{169}Er from sample irradiated at ILL
- Contributed to 8 MEDxxx proposals (out of 16 submitted so far)
- Activities up to 75 MBq for ^{155}Tb, 100 MBq for ^{149}TbO
- Surface ionisation for ^{155}Tb of 1.2% — typical of surface ionisation

Planned upgrades & activities

- Larger container to maximise proton / target overlap
- On-site radiochemistry & γ-ray spectroscopy identification (HPGe)
- Laser ionisation to increase total efficiency (by a factor 10 to 100 depending on the element)
- Molecular beam extraction to control contaminants
- Operation during LS2 (2019-2020) with imported samples (e.g. from ILL or ARRONAX).

Room in the schedule for non-medical research applications!

Interest #1: producing isotopes

- Many trans-lead isotopes have not been studied with muonic X-ray because of the difficulty in producing targets.
- CERN MEDICIS could be used to extract long-lived isotopes, such as ^{208,209,210}Po, ^{228}Ra, ^{227}Ac.
- Those samples are isotopically pure with no mixing of neighbouring masses.
- They are all produced with rates of the order of pA at ISOLDE — to be seen at MEDICIS.

^{209}Po example

- 1 µg of ^{209}Po = 3 x 10^{15} atoms
- 1 nA of beam = 6.24 x 10^{9} ions / s
- With such a beam, this translates into 5 x 10^{5} s, namely 6 days.
- Target production with yields of the order of pA are thus not achievable, but with nA well.

One must also consider the activity of such a sample and whether it can be transported from MEDICIS and handled at PSI!!

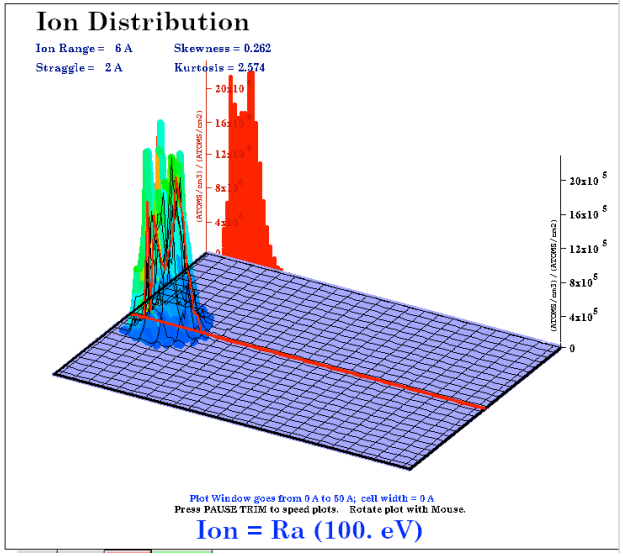
Interest #2: purify and prepare

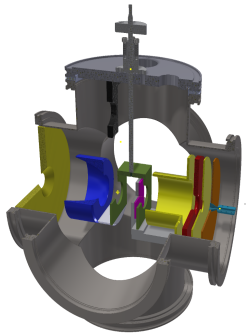
- MEDICIS could be a way to bypass chemical separation and deposition.
- Efficiency of the process is limited, though a number is pending for Ra (PhD thesis Kristof Dockx, IS637, analysis ongoing): it will be rather good (>10% for sure).
- 30 keV implantation energy is however rather deep, which is not appropriate for the μX experimental concept.

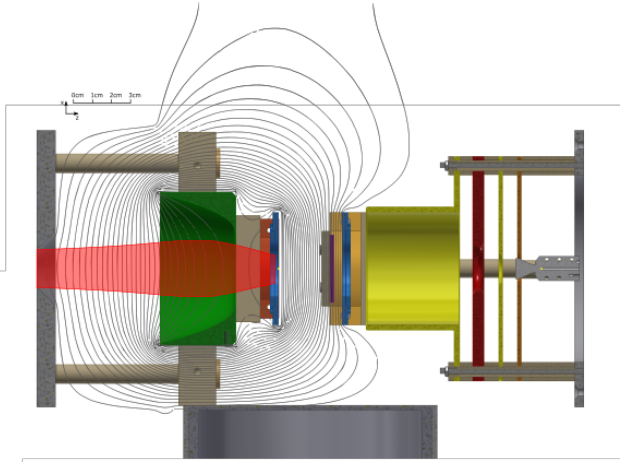
Soft landing!

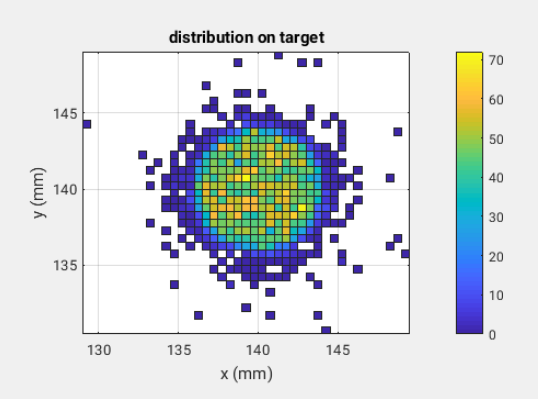
IKS Soft Landing setup

- Reducing the beam energy down to ~100 eV => 6Å depth for ^{226}Ra on Au
- Beam spot size at ISOLDE simulated to ~2 cm diameter



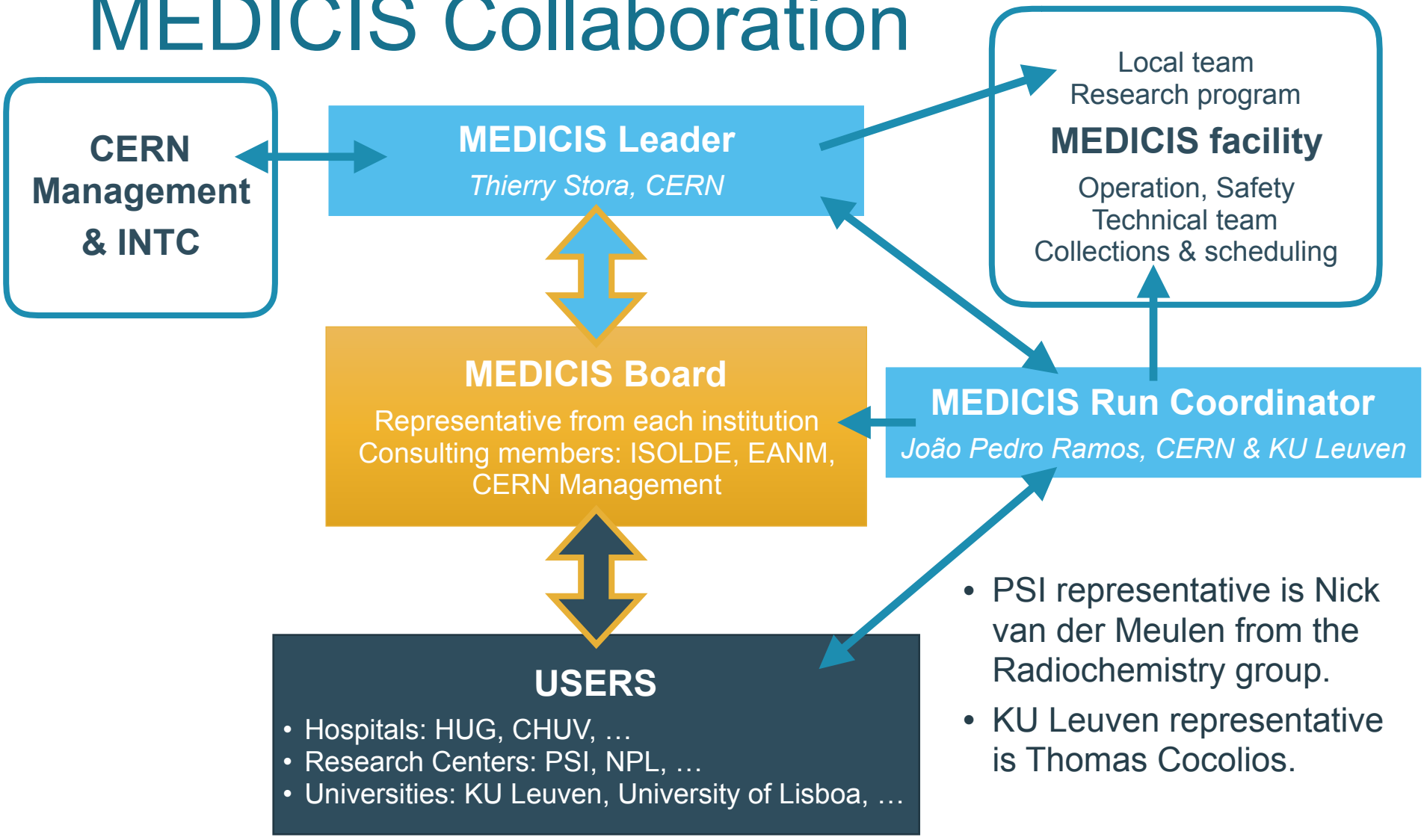






Ph.D. work of Sandro Krämer, KU Leuven. (ISOLDE LoI 198)

MEDICIS Collaboration



- PSI representative is Nick van der Meulen from the Radiochemistry group.
- KU Leuven representative is Thomas Cocolios.

Next Board meeting in Feb/March 2019