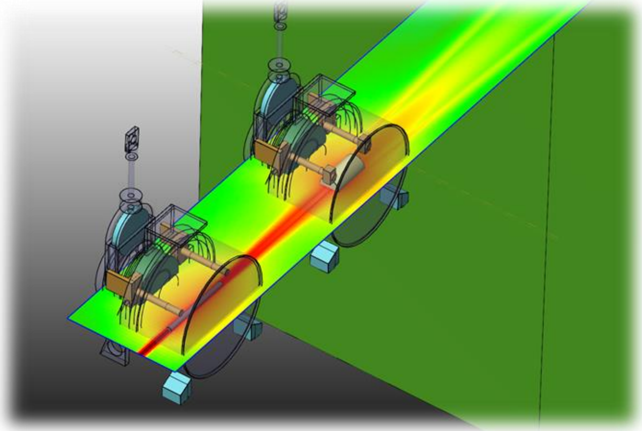
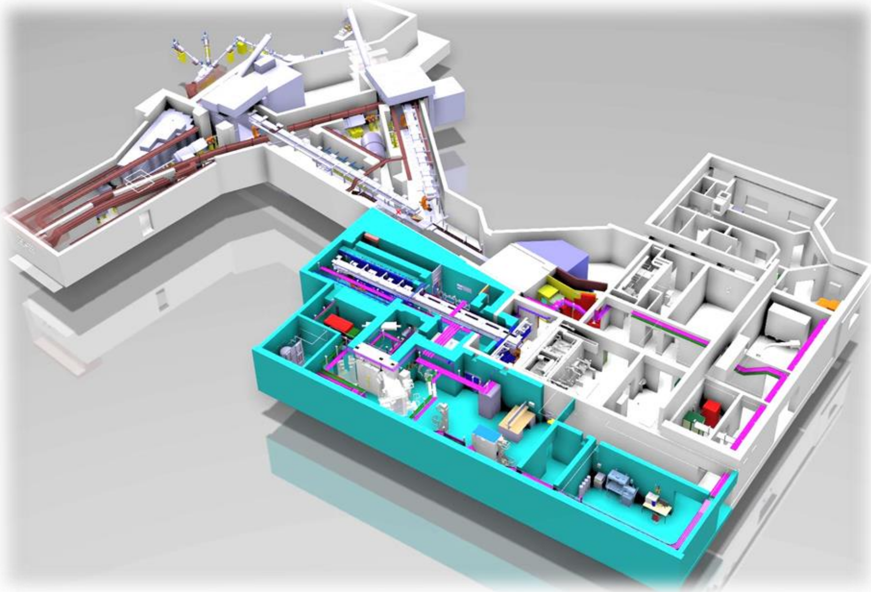


MEDICIS

Technical developments for MED22-23

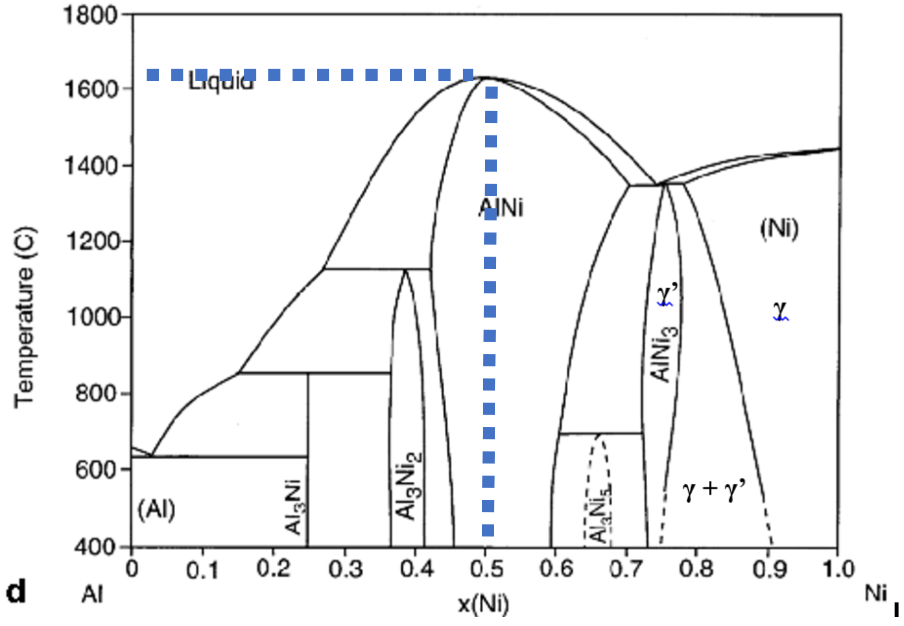
Charlotte DUCHEMIN (Joined the team on 1st August 2019)

Supervisor KU Leuven: Thomas COCOLIOS
Supervisor CERN: Thierry STORA

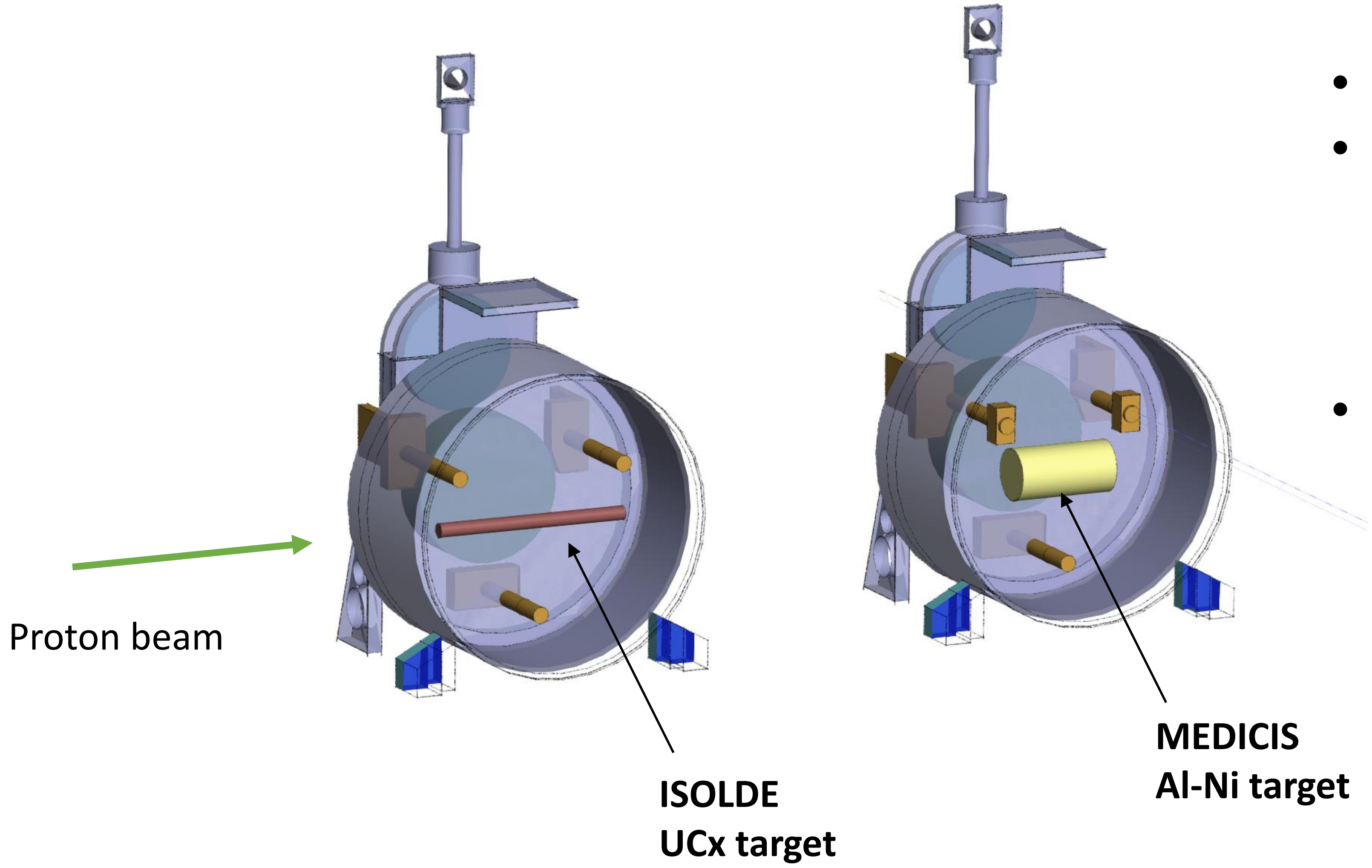


MED 23 – Imaging of iron metabolism

- Interest in both Fe-52 and Fe-59 for imaging purposes
  - Both can be produced via spallation reactions on nickel
- The idea is to produce an alloy nickel/aluminium
  - Increase the melting point from 1450 ^oC (nickel) to 1600 ^oC
- Expertise at KU Leuven & CERN
  - « Department of Physics and Astronomy » Thomas Cocolios group
    - Target material development for C-11 production – Simon Stegemann PhD thesis
  - « material engineering » department: Jef Vleugels willing to help
    - Currently developping TaC and TiC targets in collaboration with ISOL@MYRRHA
    - Meeting in August: to buy Ni and Al powder and press it to get disks (50 mm diameter, 50 mm length)
- First theoritical study regarding production efficiency required



MED 23 – Imaging of iron metabolism



- Proton beam: 1.4 and 2 GeV
- Al-Ni target: 50 wt% / 50wt%
  l = 10 cm, r = 2.5cm
  ρ = 4.3 g/cm^3

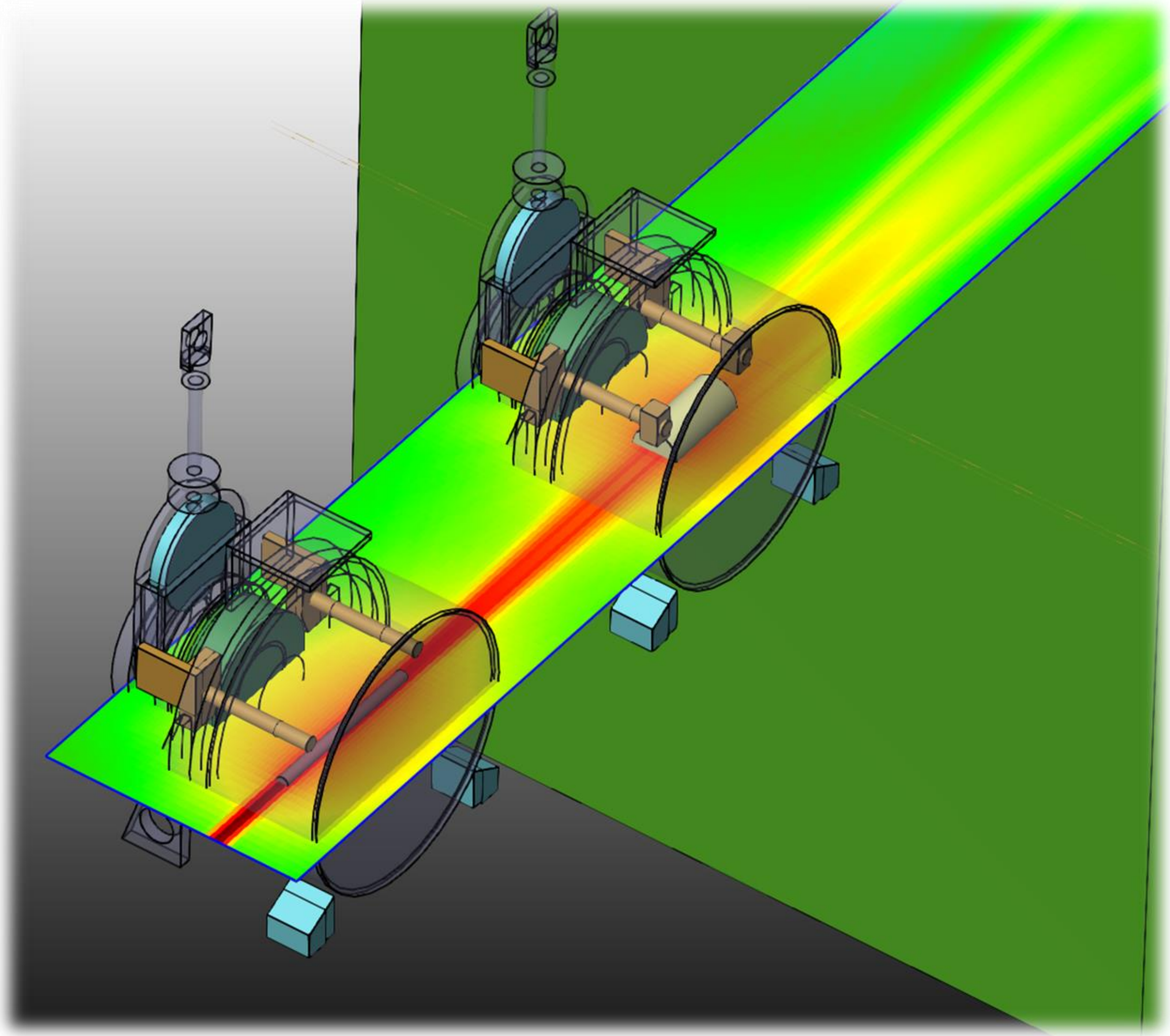
- FLUKA: 2011.2x.4 to calculate particle fluence spectra

Preliminary

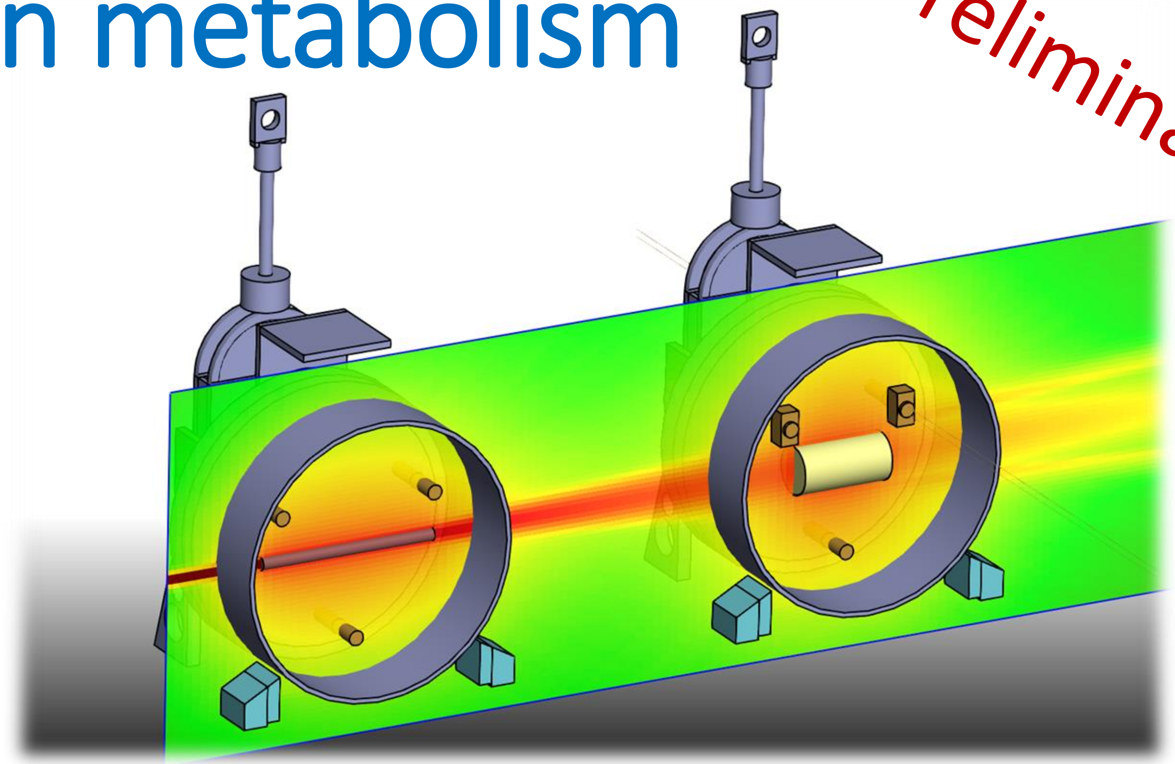
Geometry simplified, based on elements extracted from an input courtesy of J. Vollaire
Visualized with SimpleGeo®

MED 23 – Imaging of iron metabolism

Preliminary



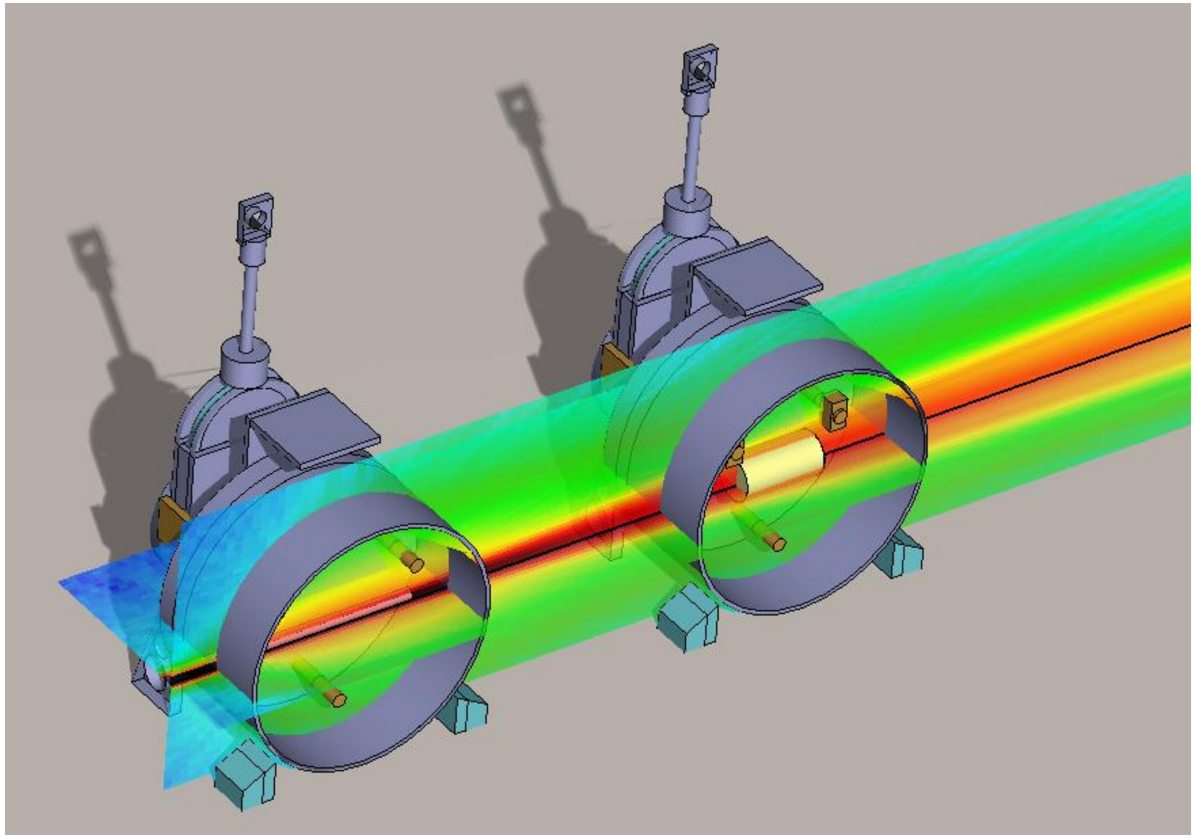
Visualized with SimpleGeo®



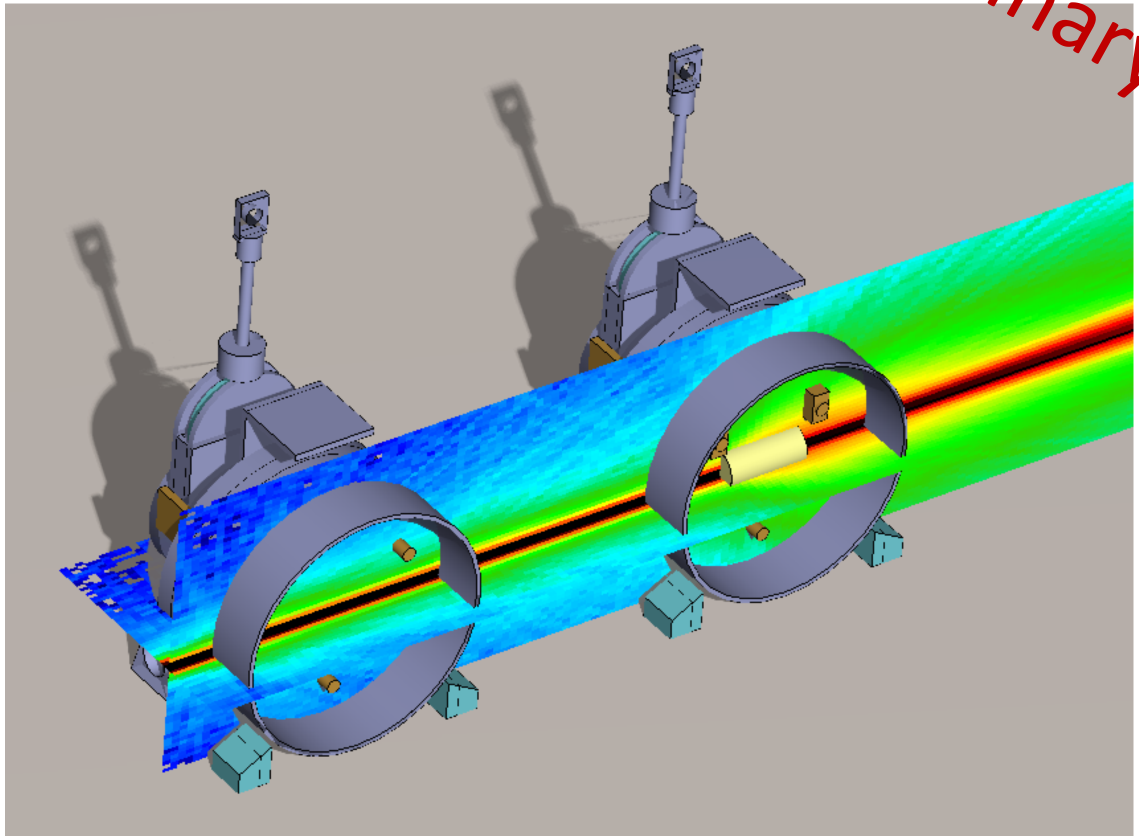
- Scoring of neutron, proton, π+, π- and photon fluence
- Off-line calculation of activity via ActiWiz giving more flexibility w.r.t. material composition & irradiation/cooling parameters

MED 23 – Imaging of iron metabolism

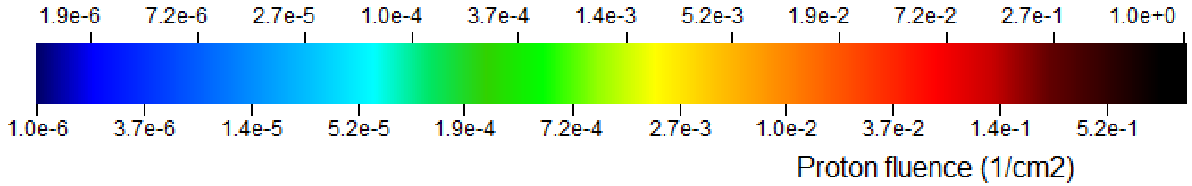
Preliminary



Primary beam impacting on the ISOLDE target before the MEDICIS Ni-Al target



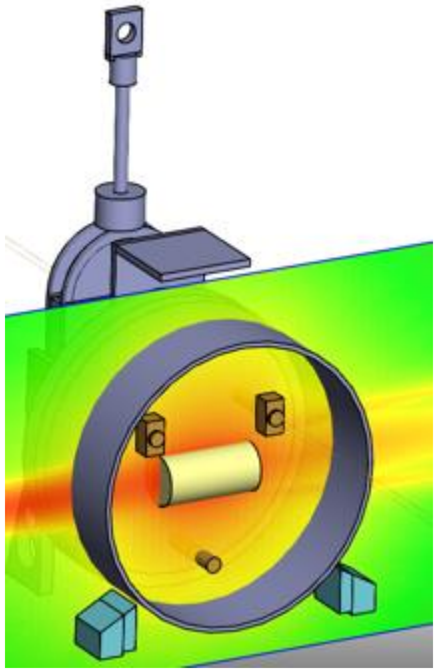
Primary beam impacting directly on the MEDICIS Ni-Al target



MED 23 – Imaging of iron metabolism

- Expected activities of Fe-52 and Fe-59 in a Ni50-Al50 MEDICIS target
  - 1 uA (6.25E12 particles/s), 1 hour irradiation, 1 hour of cooling time.

Preliminary



<table>
<tr><th>Configuration
1.4 GeV</th><th>Fe-52</th><th>Fe-59</th><th>Ratio
Fe-52/Fe-59</th></tr>
<tr><td>With ISOLDE target</td><td>57 MBq</td><td>141 kBq</td><td rowspan="2">400</td></tr>
<tr><td>Without ISOLDE target</td><td>116 MBq</td><td>287 kBq</td></tr>
</table>

x2 x2

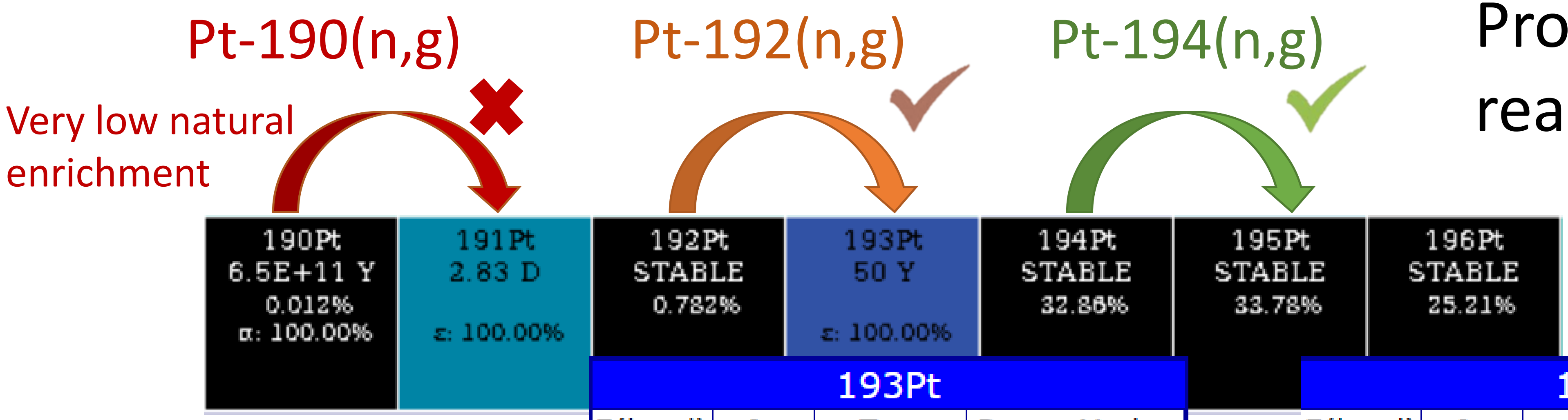
To be studied:

- Feasibility of extraction via mass separation at MEDICIS ?
  - Fe isotopes have already been extracted at ISOLDE from Y_2O_3

MED 22 - Non-invasive imaging of radioactive platinum chemotherapeutics for patient stratification

- Interest in platinum isotopes such as Pt-191, Pt-193m and Pt-195m

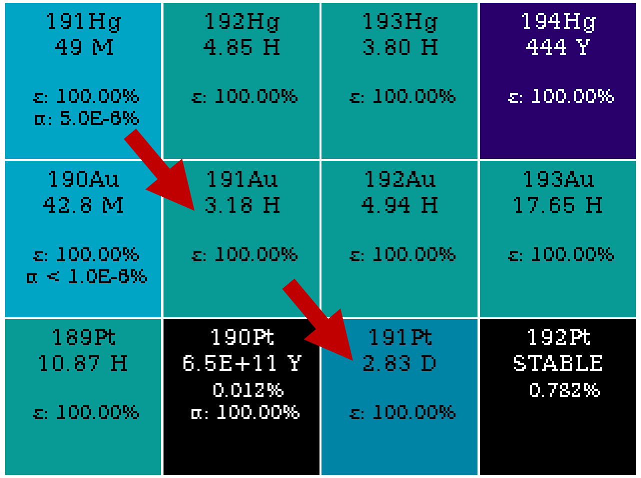
Produced in a reactor → ILL



193Pt			
E(level)	Jπ	$T_{1/2}$	Decay Modes
0.0	1/2-	50 y 6	ε : 100.00 %
0.1498	13/2+	4.33 d 3	IT : 100.00 %

195Pt			
E(level)	Jπ	$T_{1/2}$	Decay Modes
0.0	1/2-	STABLE	
0.2593	13/2+	4.010 d 5	IT : 100.00 %

MED 22 - Non-invasive imaging of radioactive platinum chemotherapeutics for patient stratification



- Production of Pt-191 at MEDICIS
  - through the decay of Hg-191
    - Hg isotopes have already been extracted at ISOLDE

- Use of a MEDICIS lead target with collection of Hg-191 ?

  - Hg-191 4.2 GBq
    (for 1 uA, 1 hour irradiation & 1h after EOI)

Preliminary

MED 22 - Non-invasive imaging of radioactive platinum chemotherapeutics for patient stratification

Production of Pt-193m and Pt-195m at MEDICIS?

- Would require direct production and collection
- No generator possible
- Pt cannot easily be extracted from the target

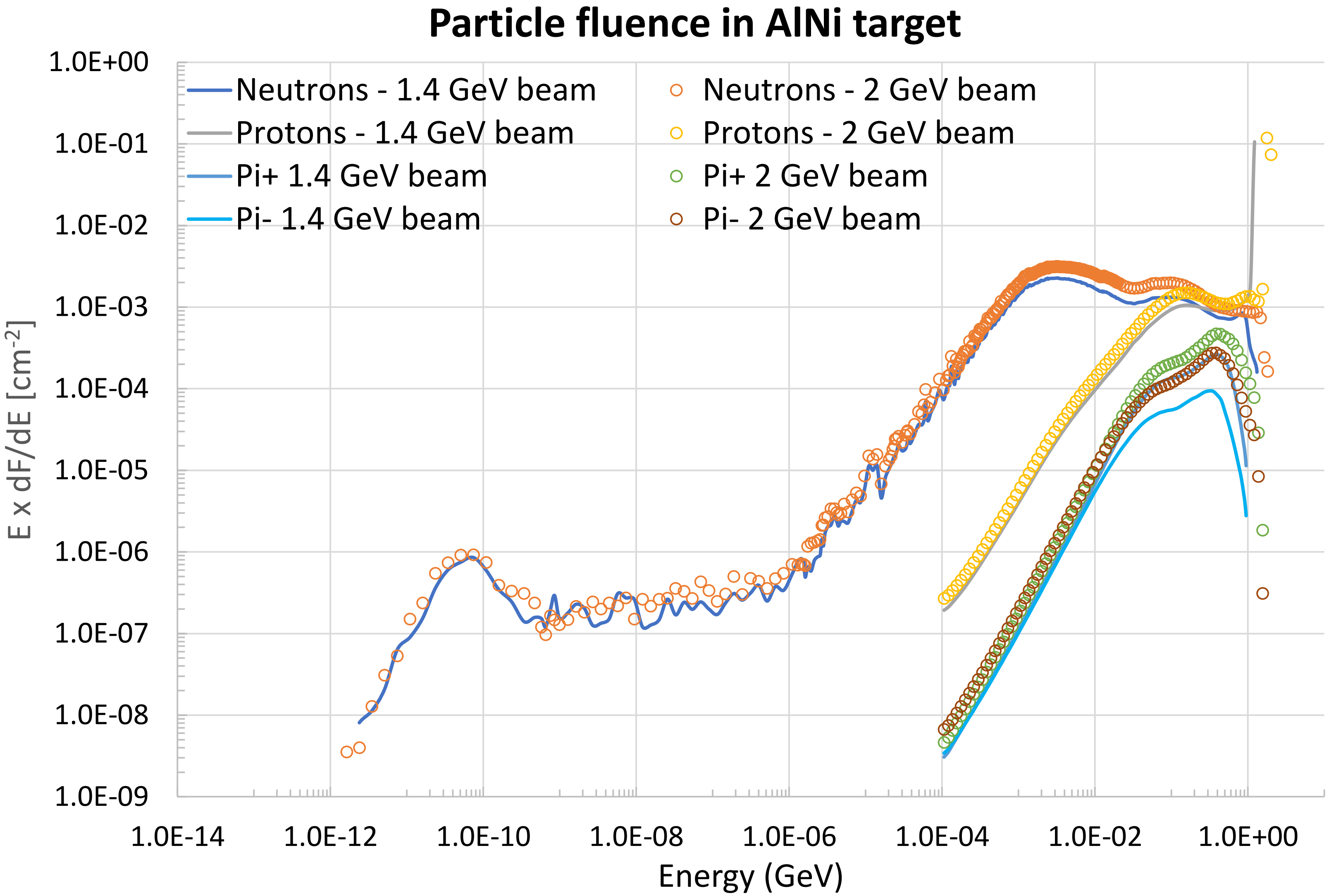
Gas chemical methods for the separation of elements in radioisotope production and activation analysis

B. L. Zhuikov*

Institute for Nuclear Research of Russian Academy of Sciences, 60th October Anniversary Prospect, 7A, Moscow, 117312, Russia

Thank you !

MED 23 – Imaging of iron metabolism

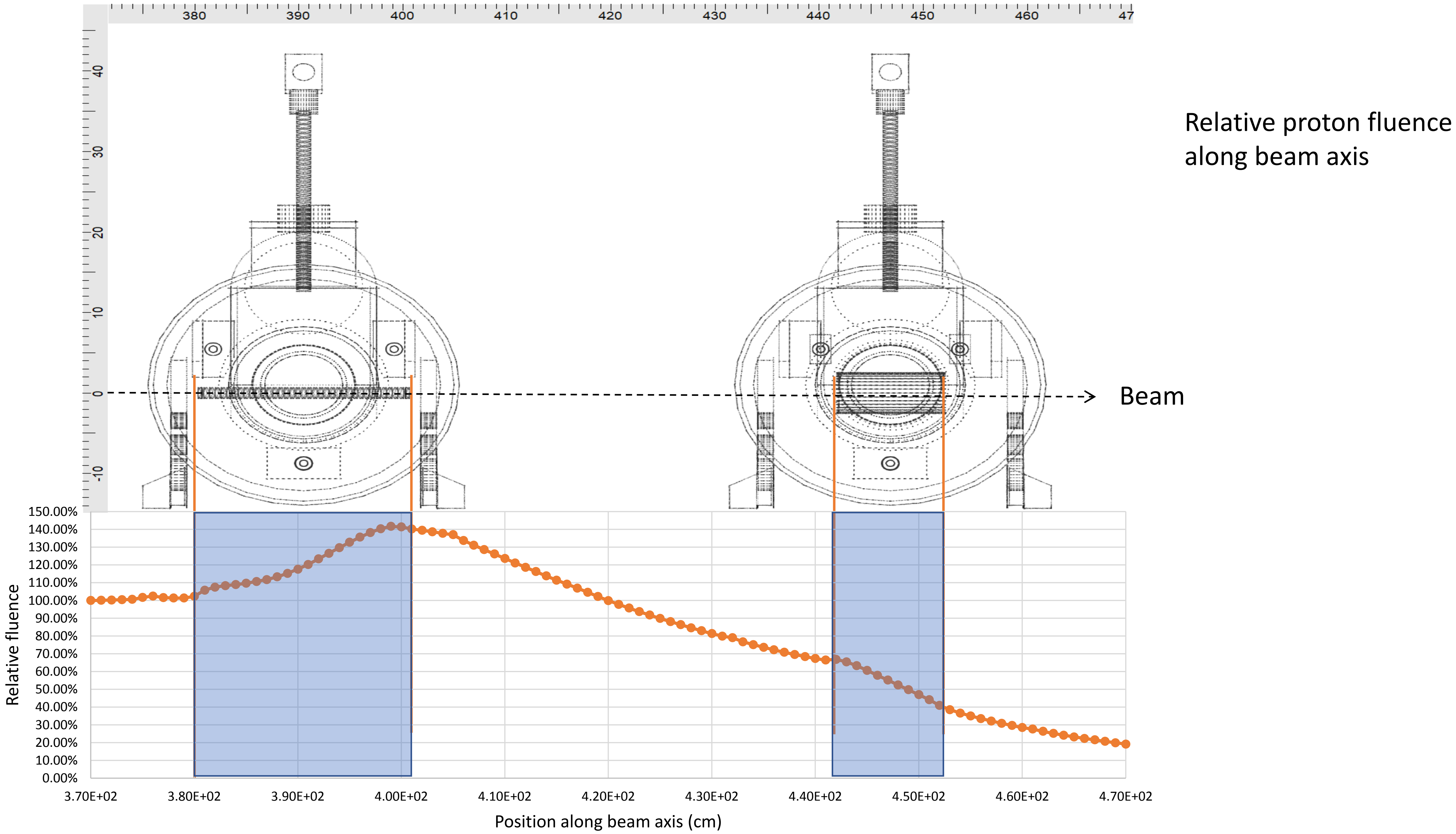


Total fluence (cm^{-2})	1.4 GeV	2 GeV	**2 GeV vs. 1.4 GeV ratio**
Neutrons	1.11E-02	1.62E-02	1.46E+00
Protons	2.43E-02	2.97E-02	1.22E+00
Pi+	5.21E-04	9.79E-04	1.88E+00
Pi-	2.06E-04	5.62E-04	2.73E+00
Total	3.61E-02	4.75E-02	**1.31E+00**

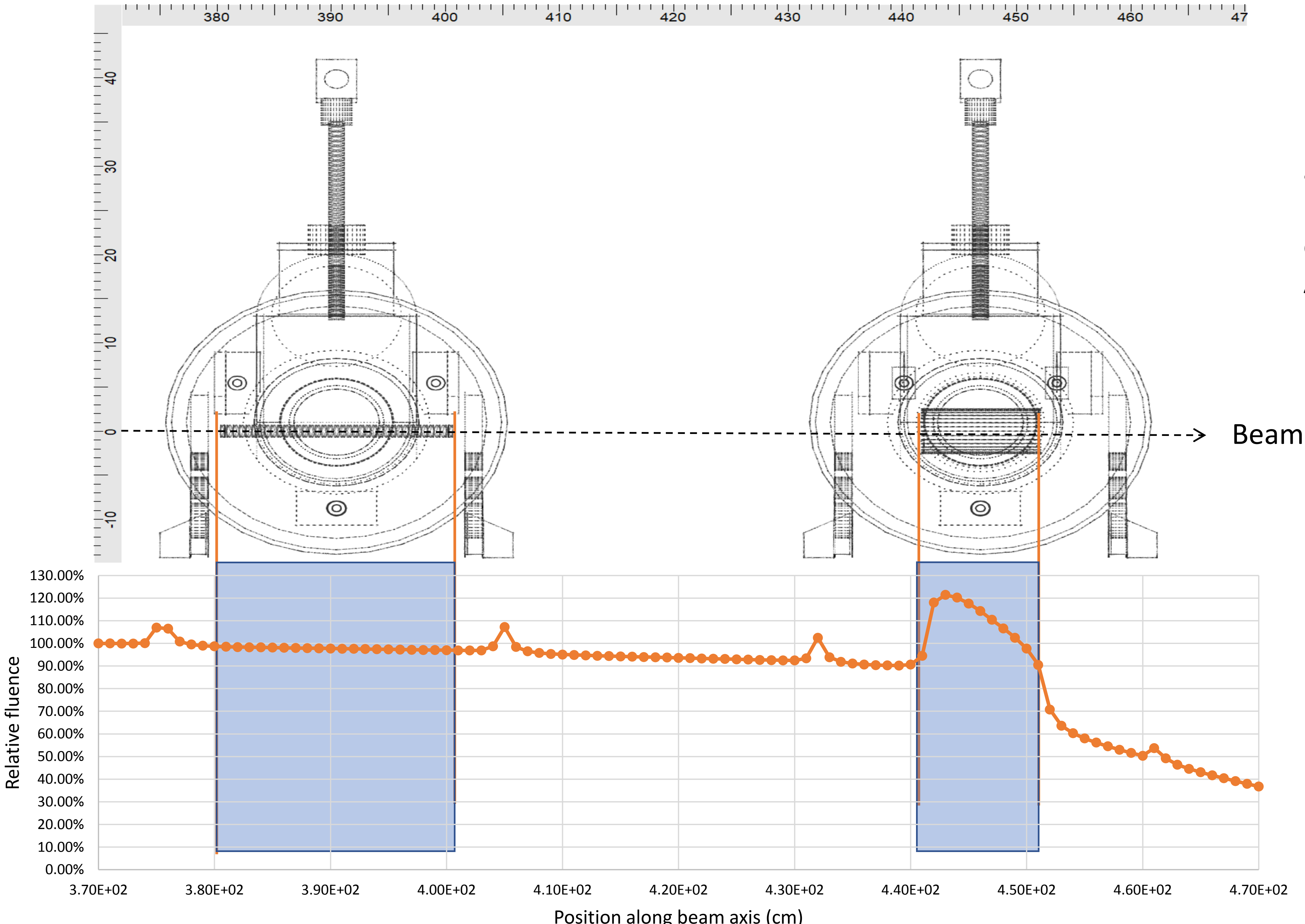
- No fundamental differences except somewhat higher pion yield
- Total yield at 2 GeV is ~30% higher
- Roughly equivalent increase in isotope production to be expected

Preliminary

* Photons not shown for clarity. Their contribution is < 1% to the isotope production of interest



Relative proton fluence
along beam axis
Beam
Relative fluence
Position along beam axis (cm)



Relative proton fluence along beam axis with primary proton beam directly impacting on the AlNi target

MED 22 - Non-invasive imaging of radioactive platinum chemotherapeutics for patient stratification

- Production of Pt-193m and Pt-195m at MEDICIS?
  - No generator possible
  - Would require direct production and collection
  - Pt cannot easily be extracted from the target

Gas chemical methods for the separation of elements in radioisotope production and activation analysis

B. L. Zhulkov*

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Though lead itself is volatile, most of these radioelements may be extracted from the lead target by gas chemical methods in a stream of air and separated with the help of high temperature chemical filters. In several experiments the pieces of irradiated Pb were mixed with quartz sand (weight ratio 1:3.5 or more) and heated slowly from 500 to 1100 °C. The heating was continued at this temperature for few hours in a stream of air. Thus lead and bismuth were transformed into nonvolatile silicate form. Re, Os, Ir, Pt, Hg and Tl radionuclides were sublimated. Re, Os, Ir and Pt were separated in a stream of oxygen with the help of chemical filters. Thus, metallic gold absorbs Pt at high temperatures (1000 °C or more) and Ir at about 300–500 °C.[8] Re and Os are more volatile in a stream of oxygen, these elements may be most effectively separated with the help of MgO or CaO filter absorbing Re at about 1100 °C.[8]