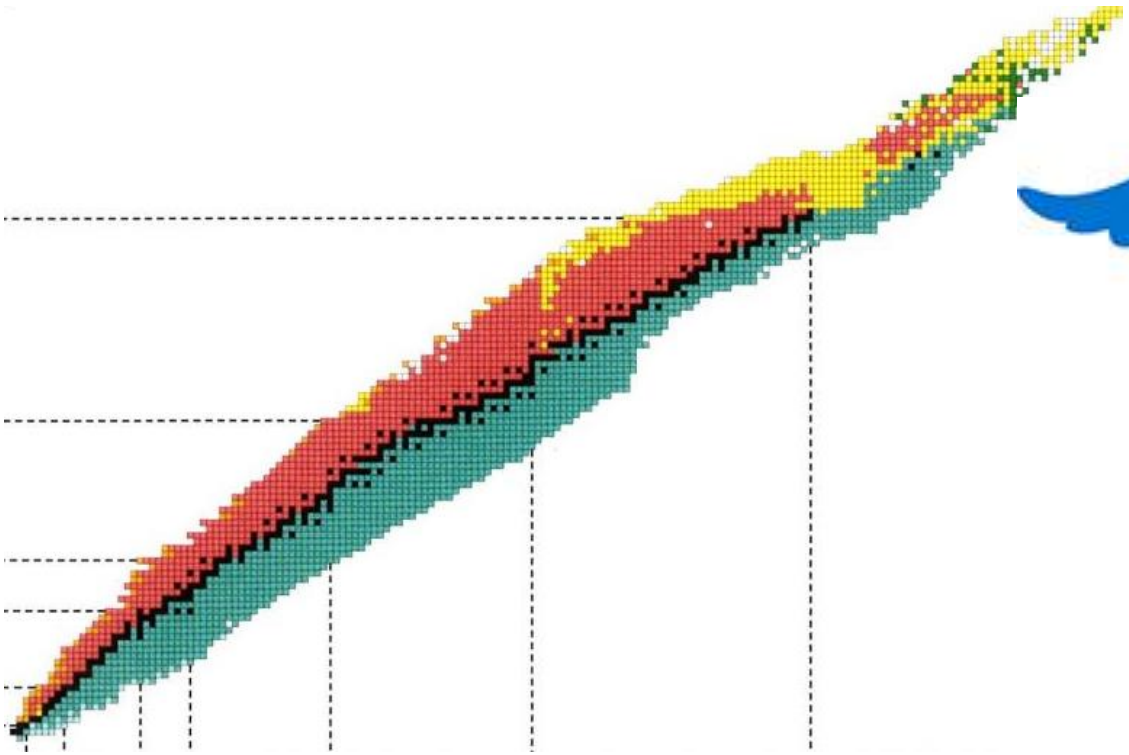
Production of medical radionuclides at ILL



Ulli Köster
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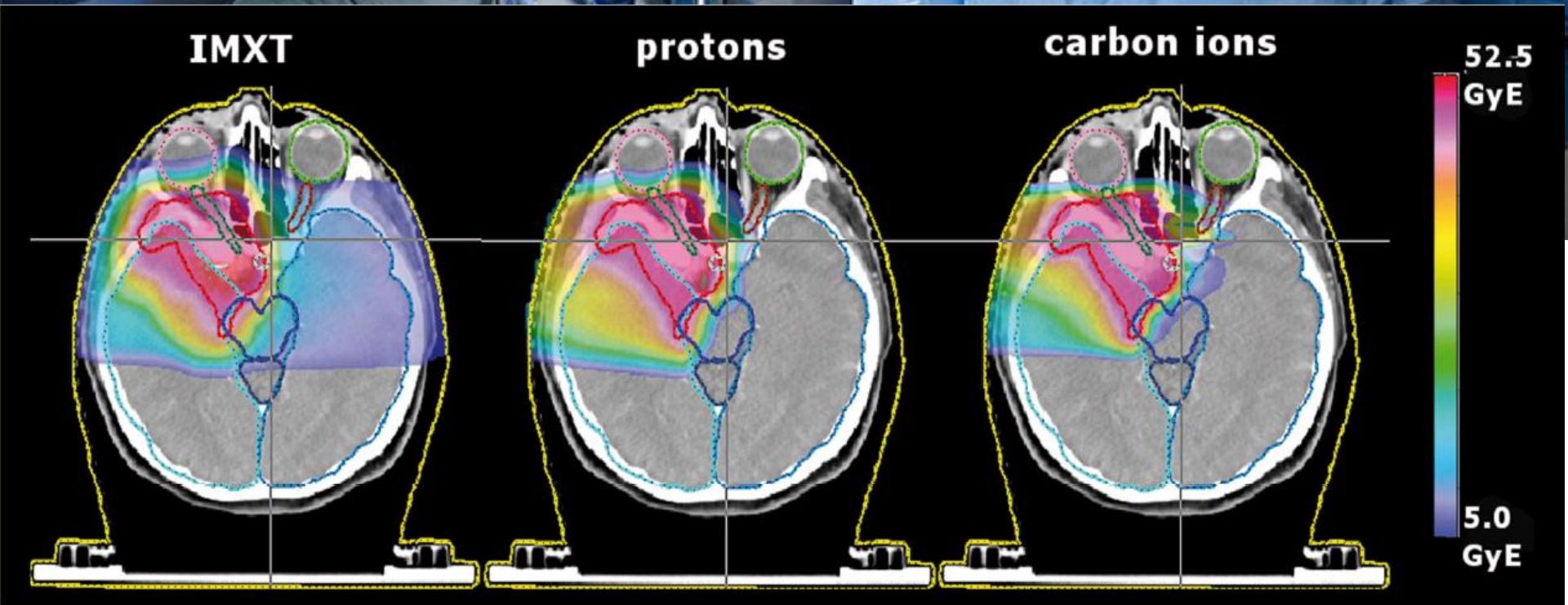
27 June 2022

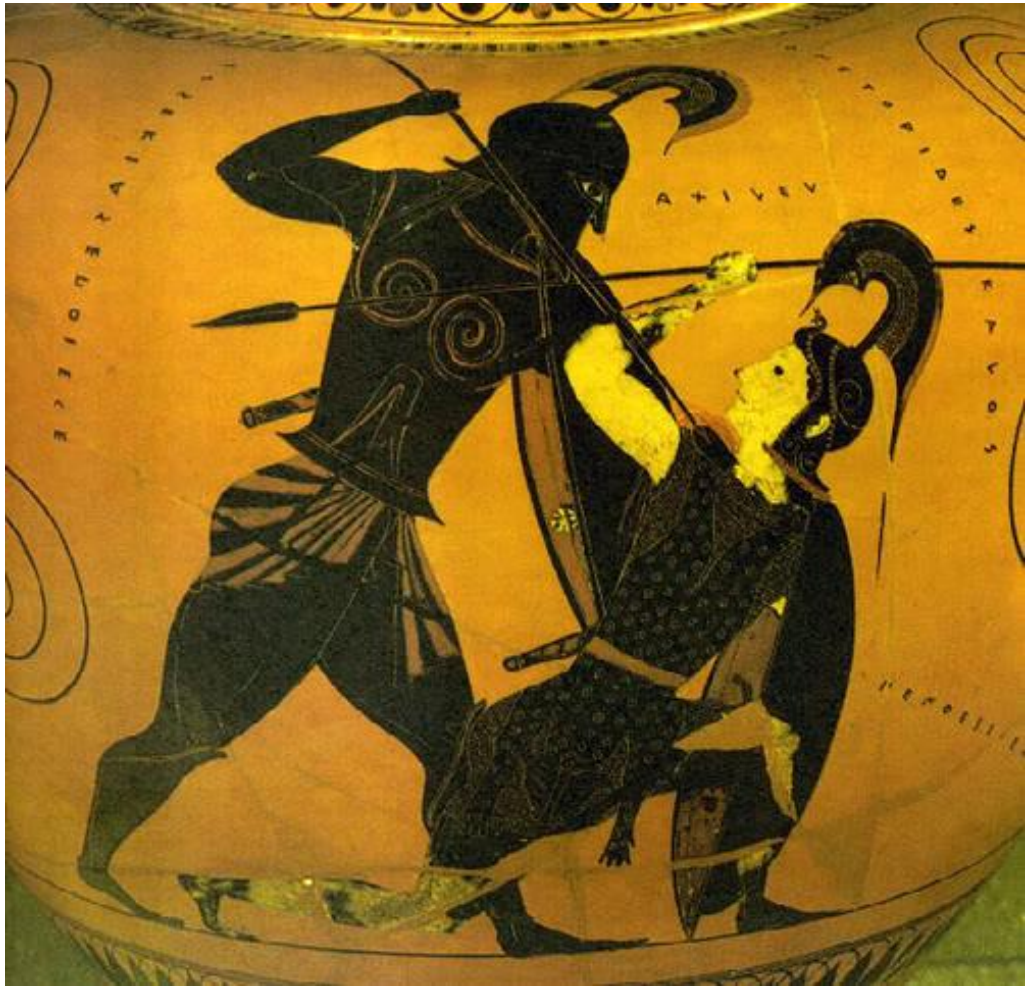
NEUTRONS FOR SOCIETY

Progress in cancer treatment

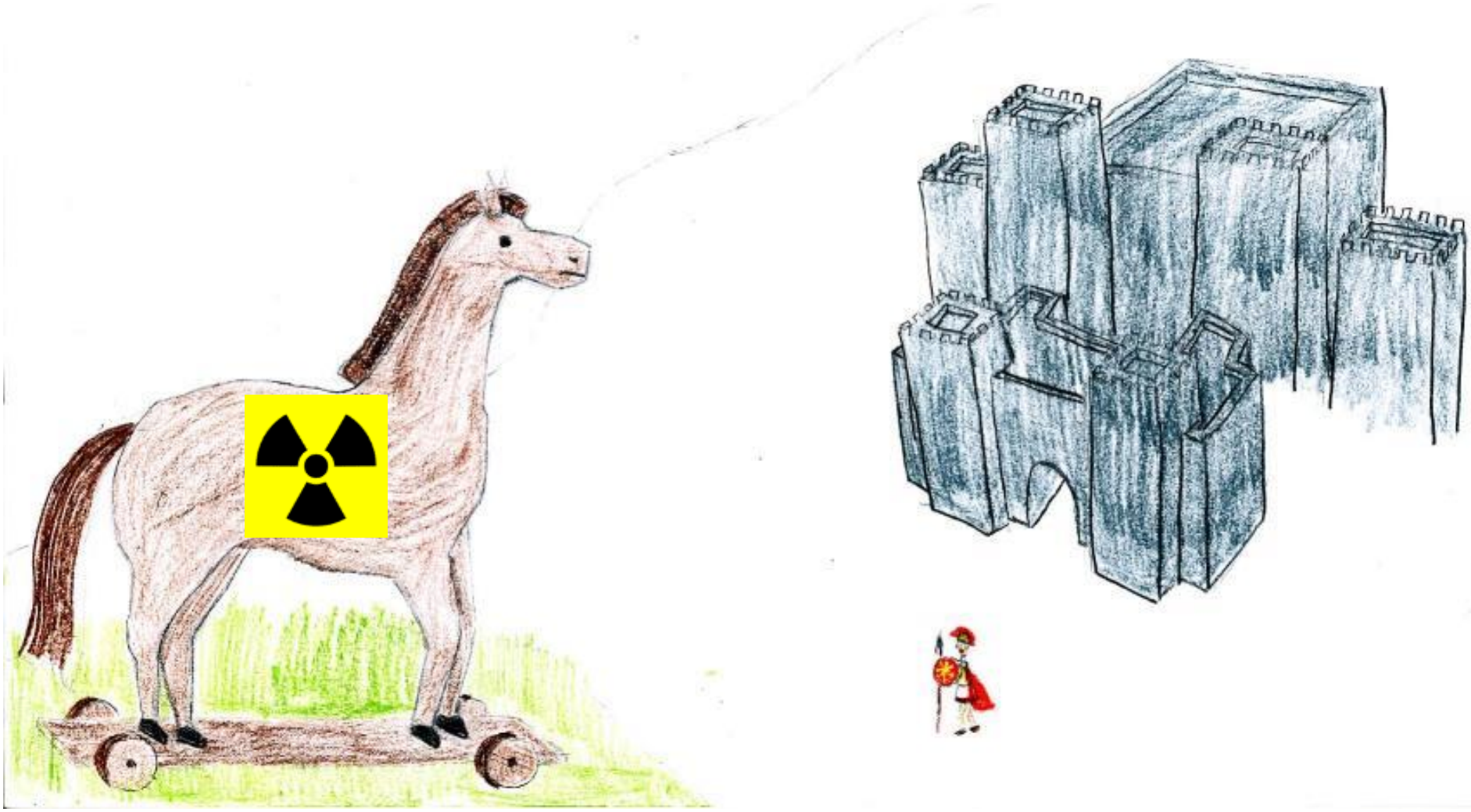


How can one treat such patients?

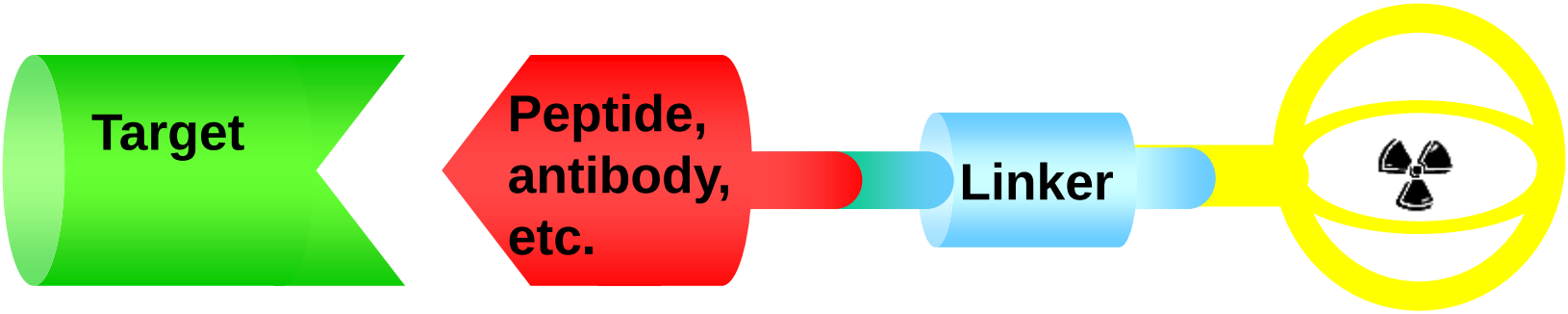
Learning from history



The principle of targeted therapies



Multidisciplinary collaboration to fight cancer



Receptor

Radionuclide

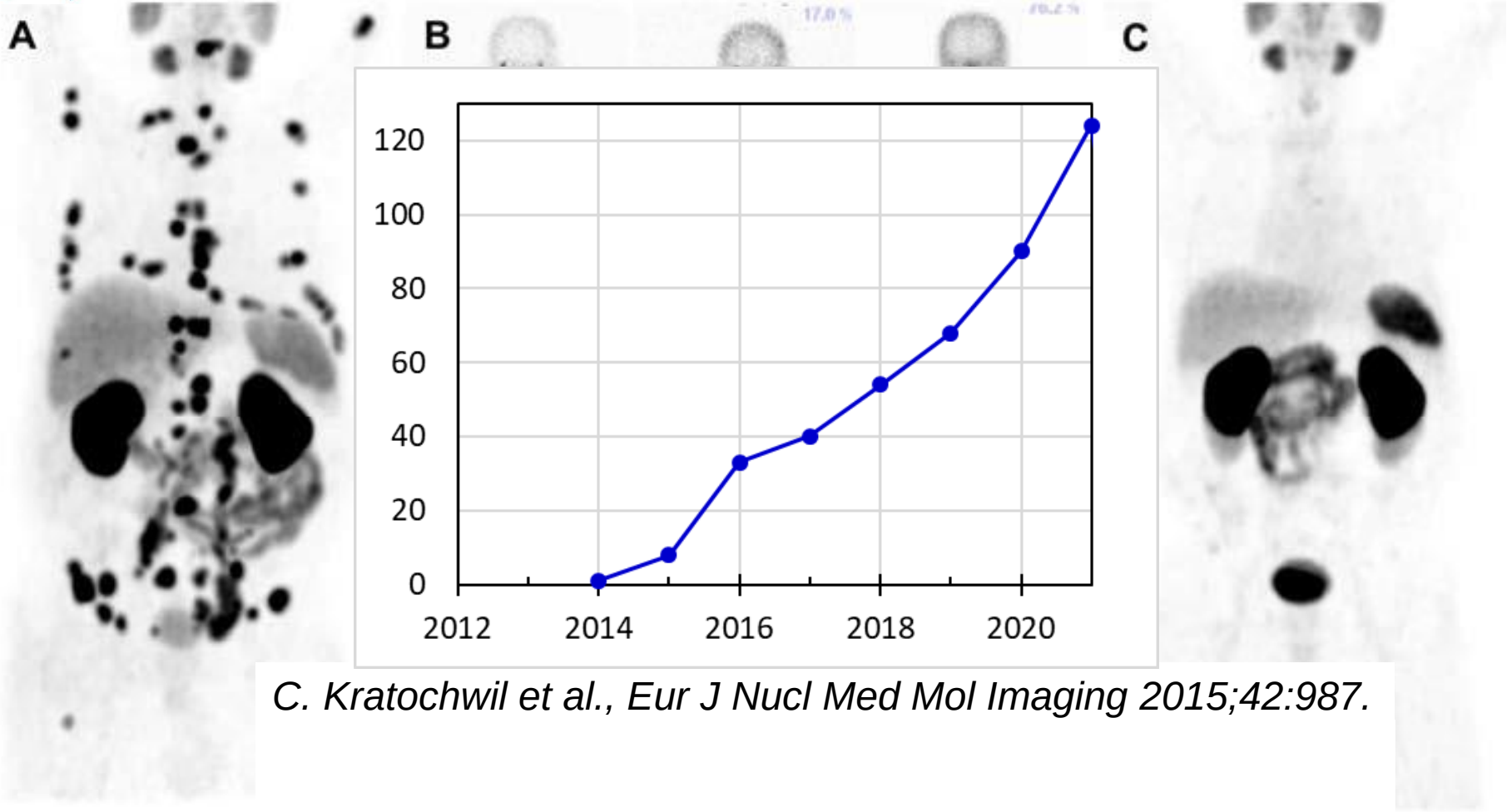
Immunology
Structural biology

Coordination chemistry

Nuclear physics and radiochemistry

Nuclear medicine and medical physics

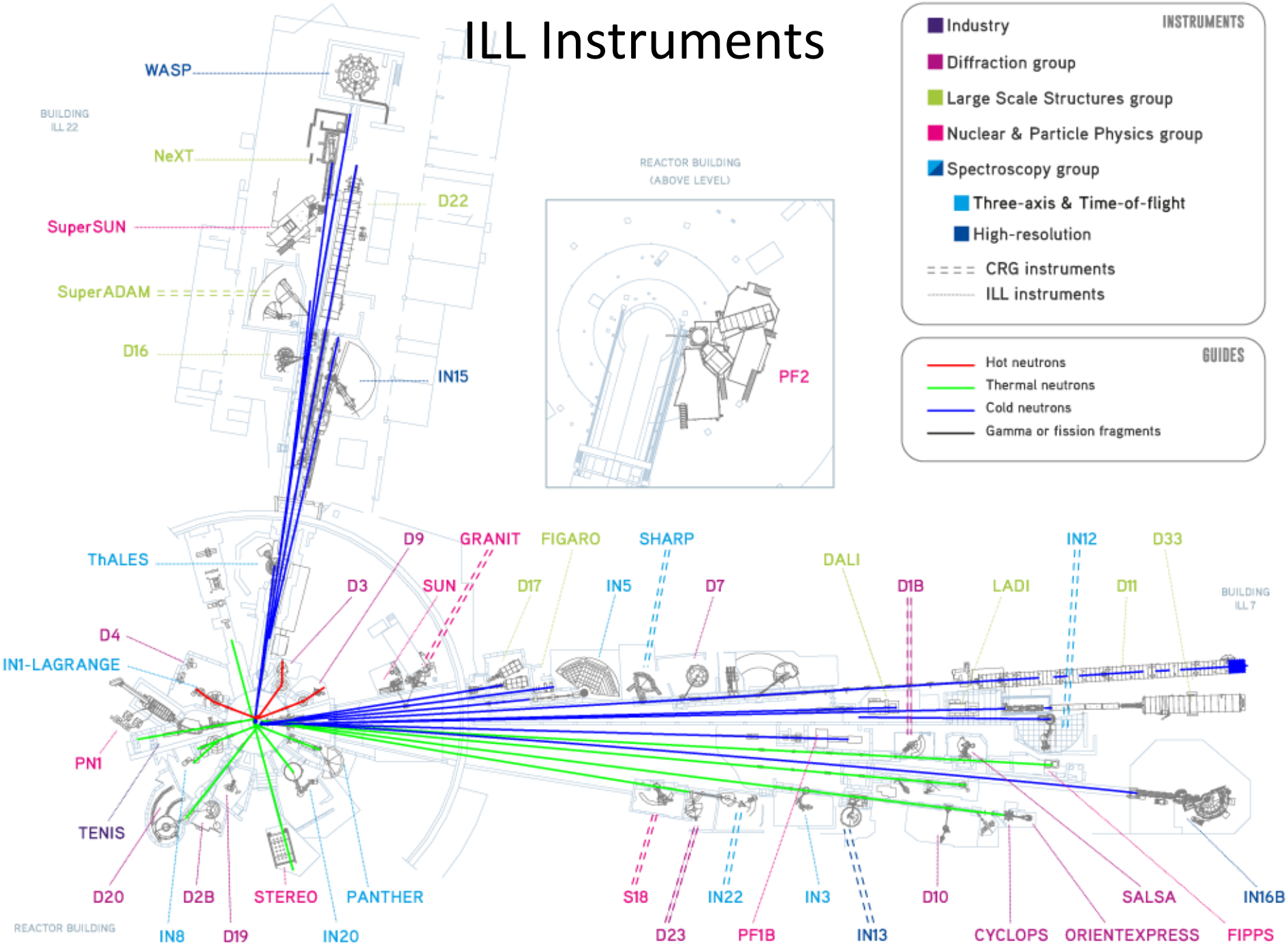
^{177}Lu-radioligand therapy of advanced prostate cancer



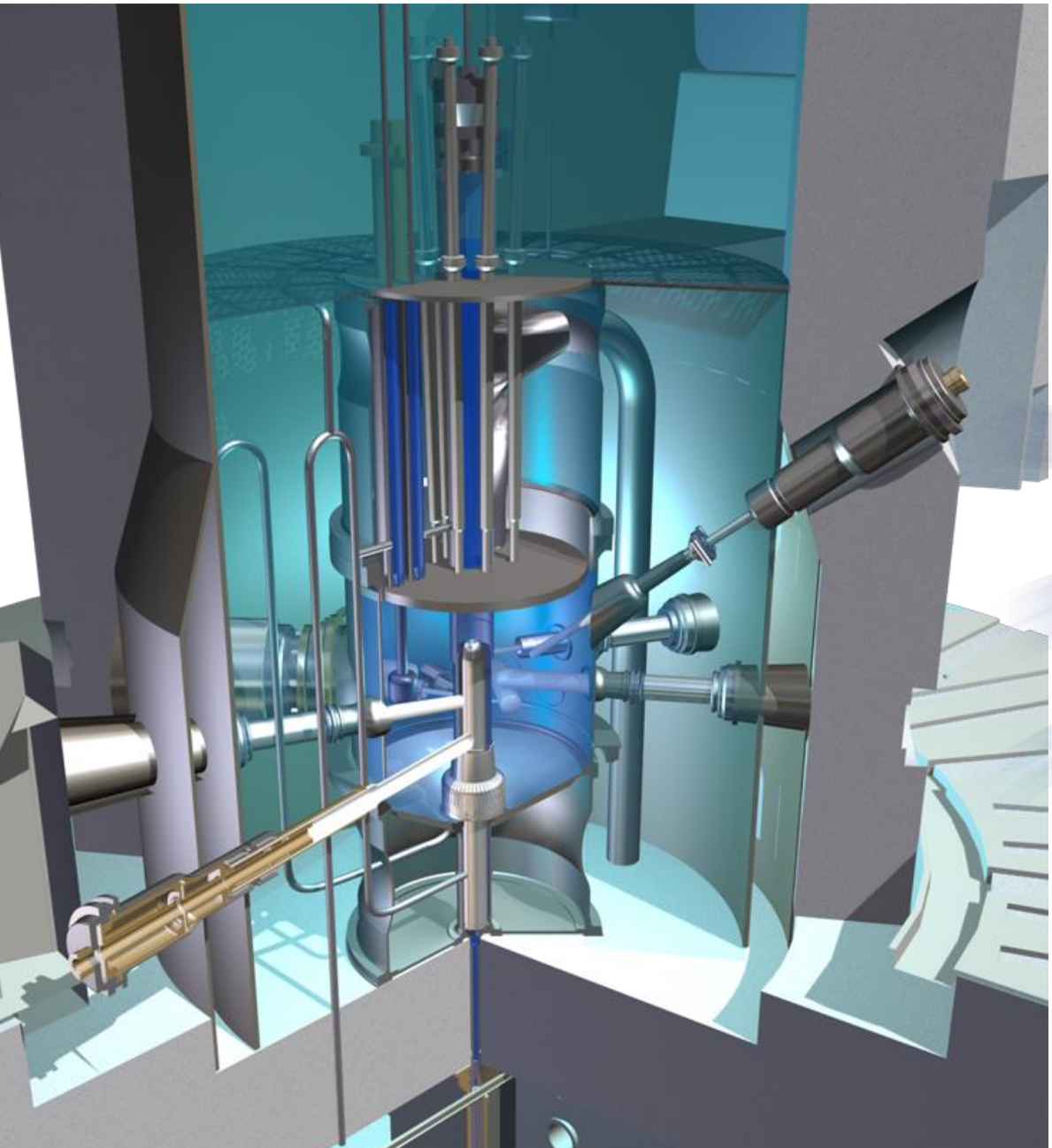
C. Kratochwil et al., Eur J Nucl Med Mol Imaging 2015;42:987.

23 Feb 2022
FDA Approval
of Pluvicto®

ILL Instruments

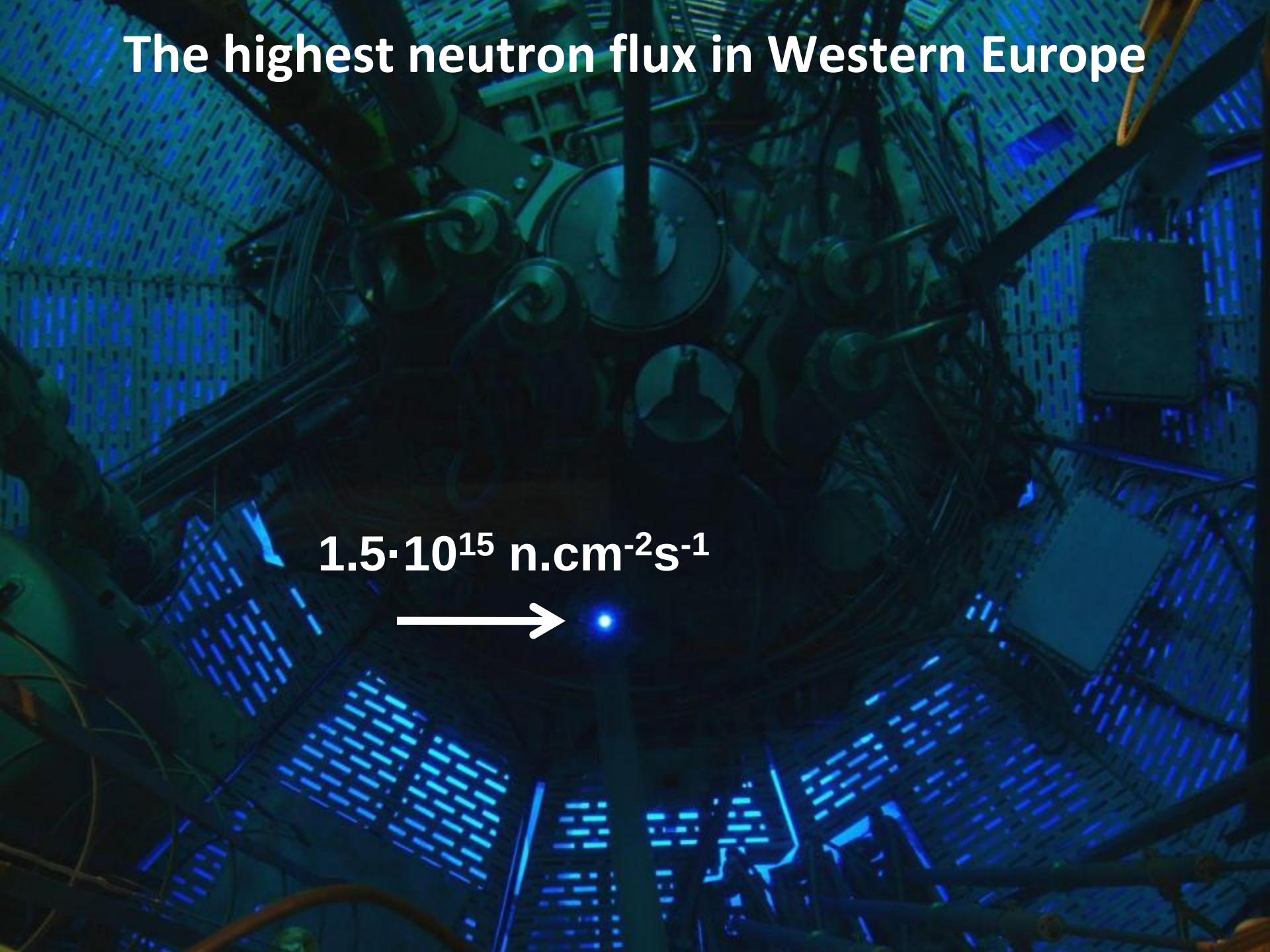


The ILL Reactor

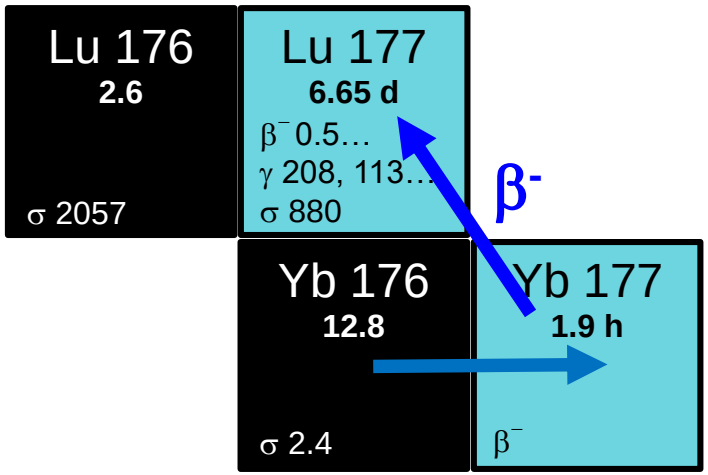


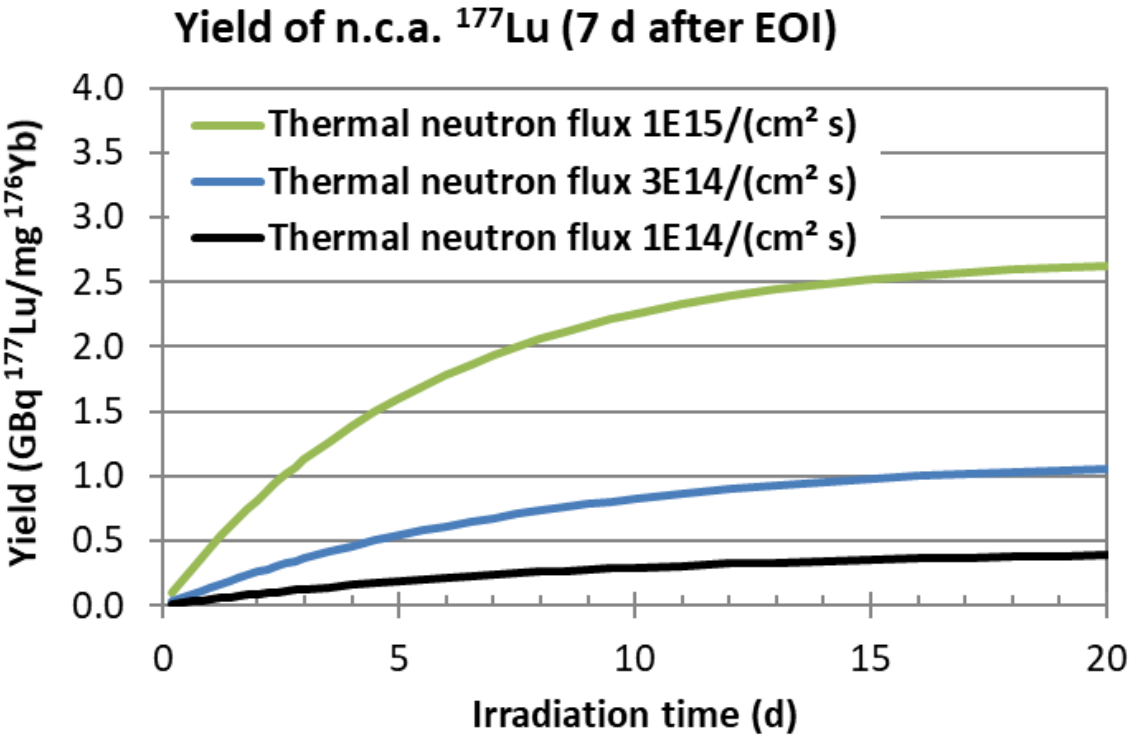
$5 \cdot 10^{18}$ neutrons/s generated at 57 MW

The highest neutron flux in Western Europe



Indirect production of no-carrier-added ^{177}Lu



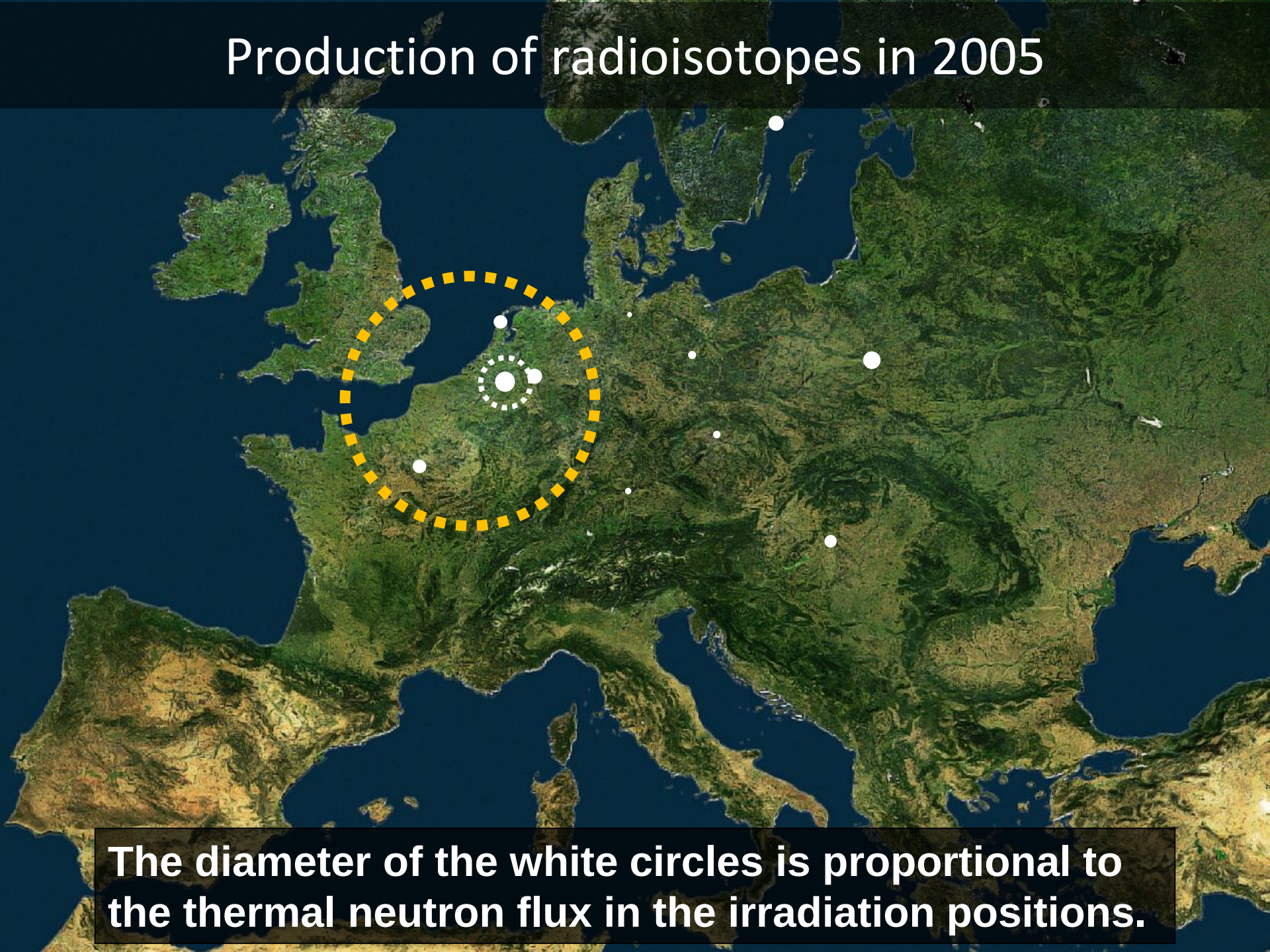


Estimate for 100% enriched ^{176}Yb;
depends in reality also on neutron spectrum, self shielding, etc.

Specific activity ≈ theoretical
Yield depends on σ and Φ

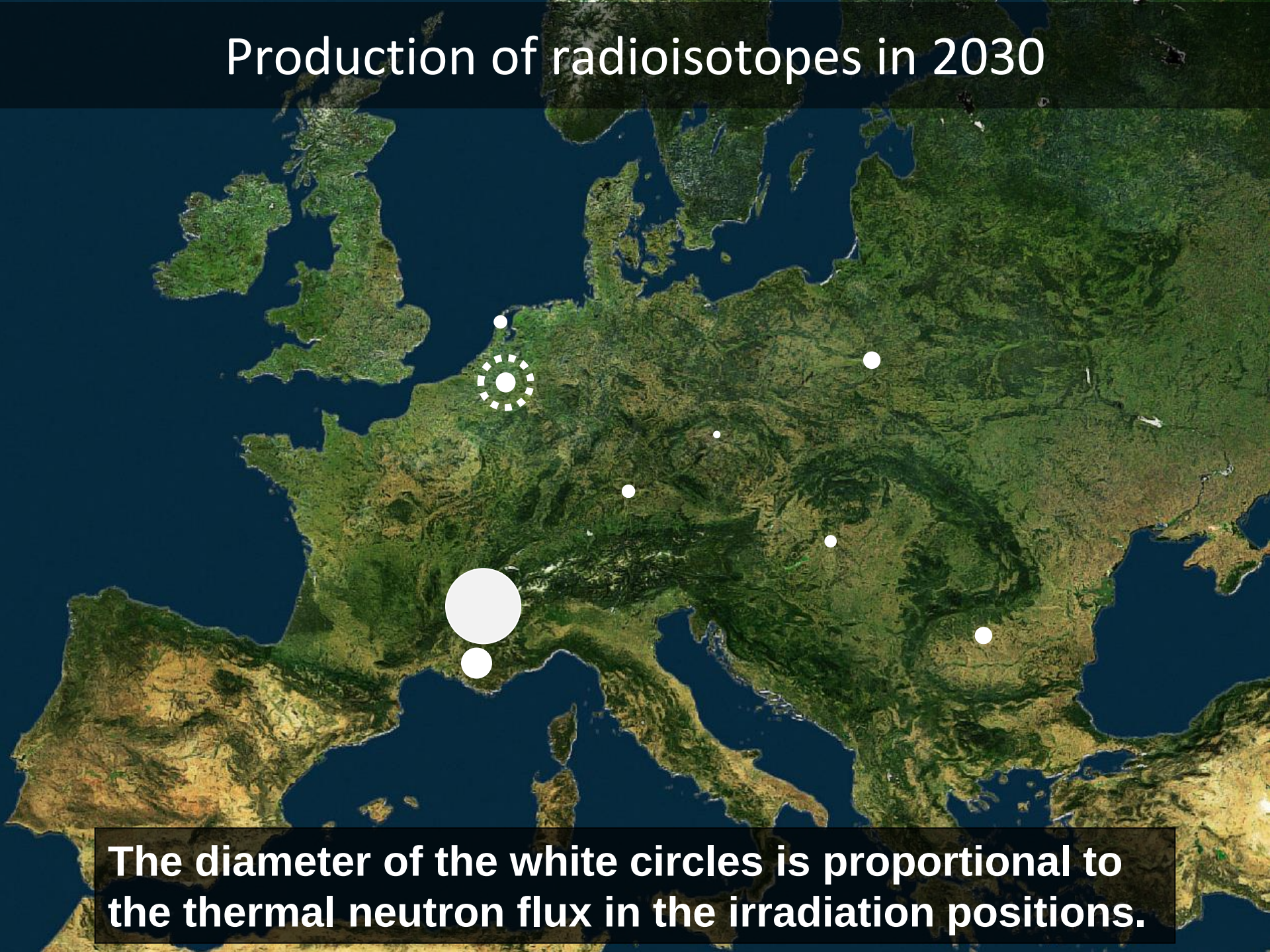
High neutron flux is a very strong competitive advantage !

Production of radioisotopes in 2005



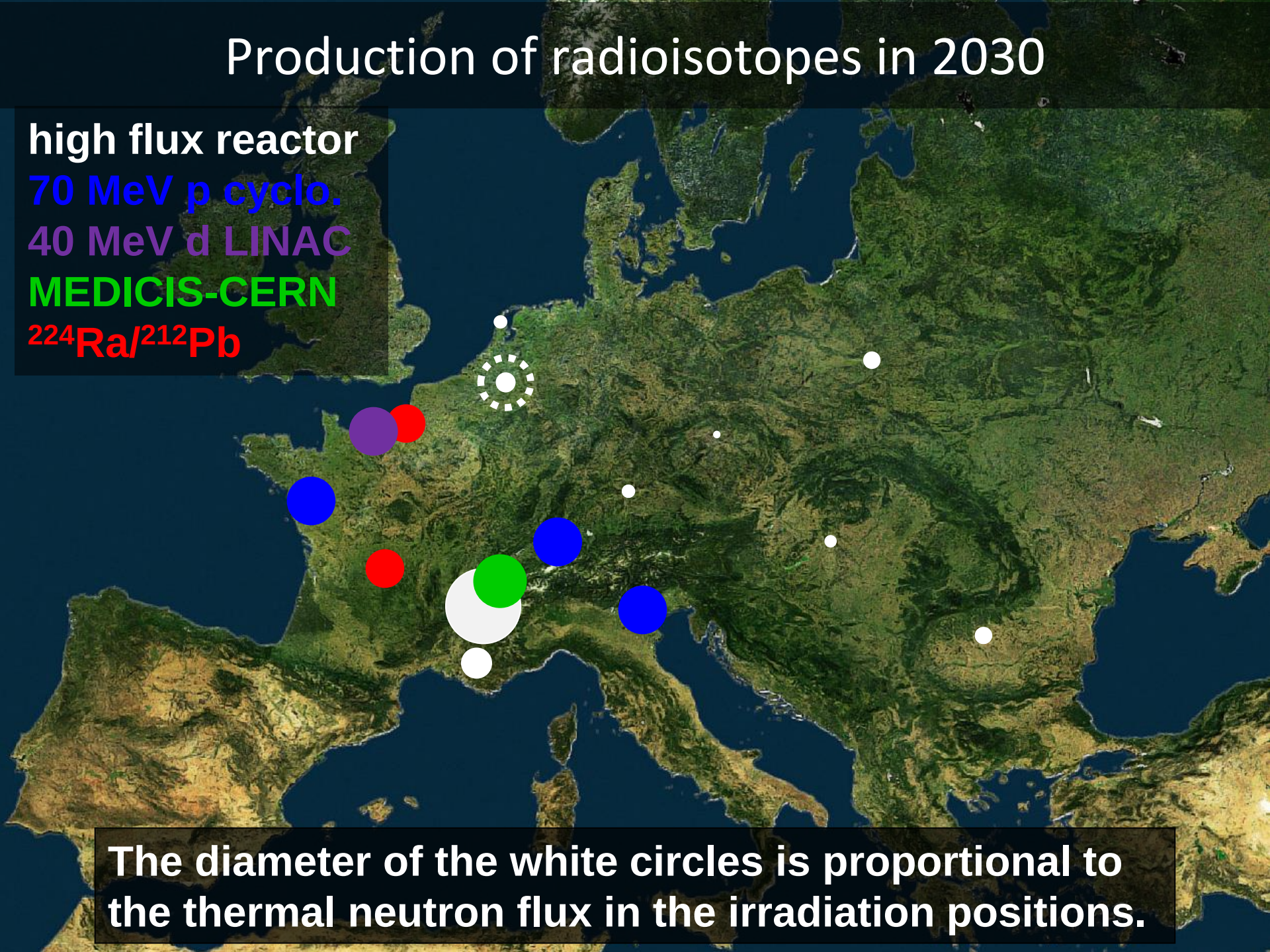
The diameter of the white circles is proportional to the thermal neutron flux in the irradiation positions.

Production of radioisotopes in 2030



The diameter of the white circles is proportional to the thermal neutron flux in the irradiation positions.

Production of radioisotopes in 2030



The diameter of the white circles is proportional to the thermal neutron flux in the irradiation positions.

The “gold standard” for radionuclide therapy

2019:

1611 scientific users coming to ILL for experiments

> 4000 patients supplied with ^{177}Lu from ILL

Collaboration with Isotope Technologies Munich

2009: first ^{176}Yb irradiations for ITM who were developing n.c.a. ^{177}Lu

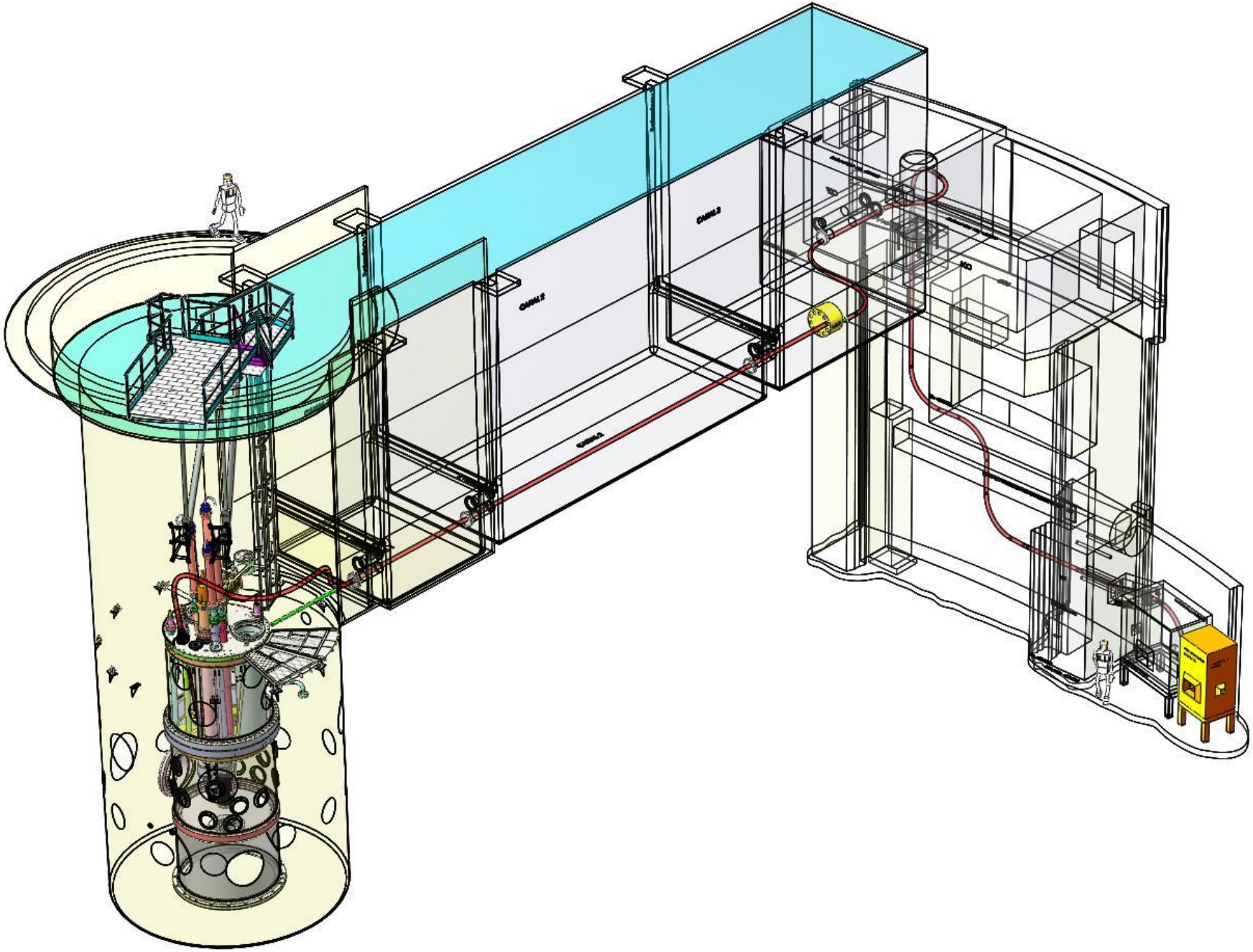
2016: ITM receives marketing authorization for EndolucinBeta (n.c.a. ^{177}Lu)

Since: production ramp-up to follow exponential rise in demand

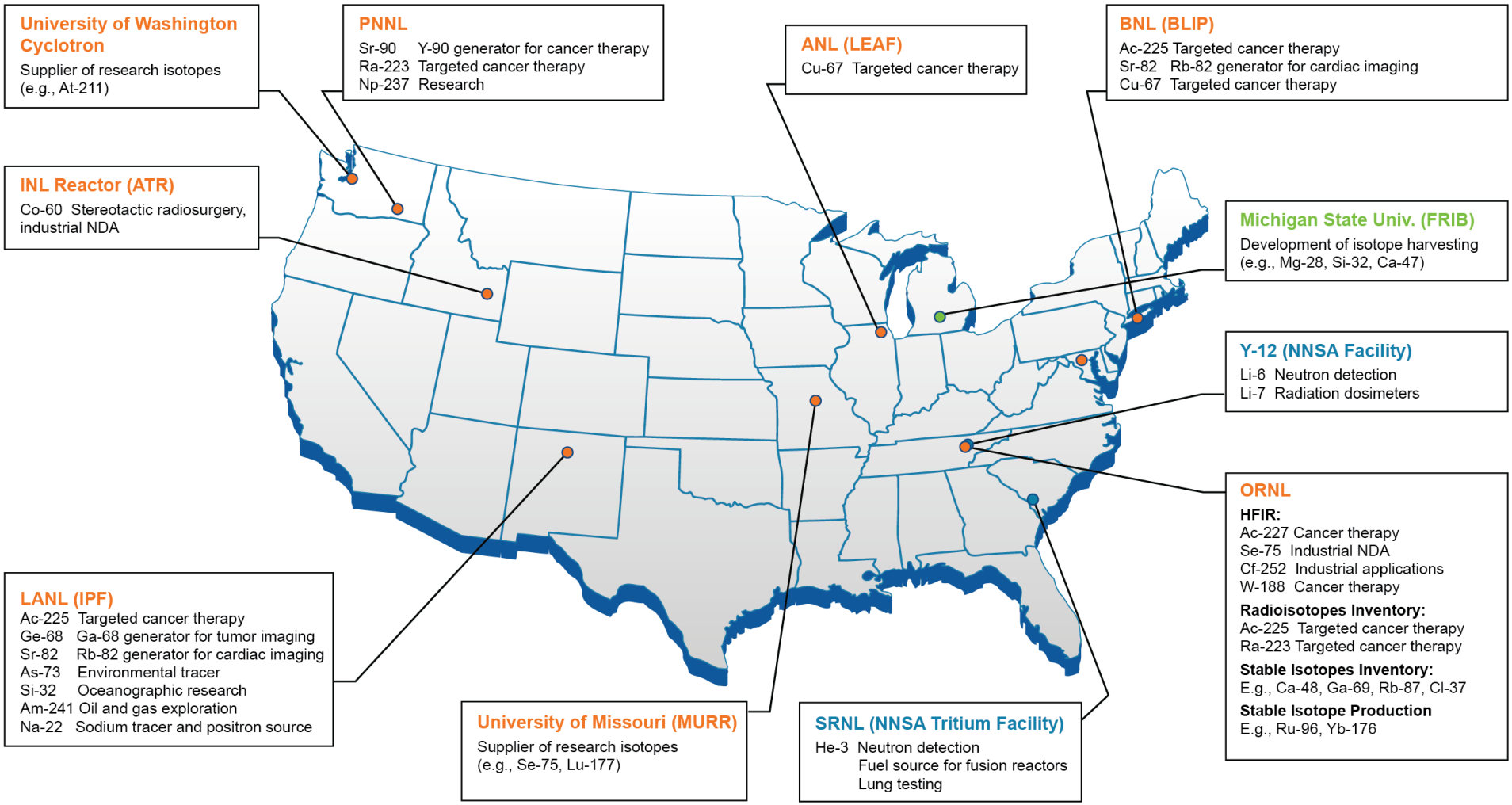
Today: itm is daily delivering ^{177}Lu world-wide

n.c.a. ^{177}Lu from itm is the main ingredient of pluvicto® (Novartis)

New automated irradiation system for V4



A great model: the US DOE Isotope Program



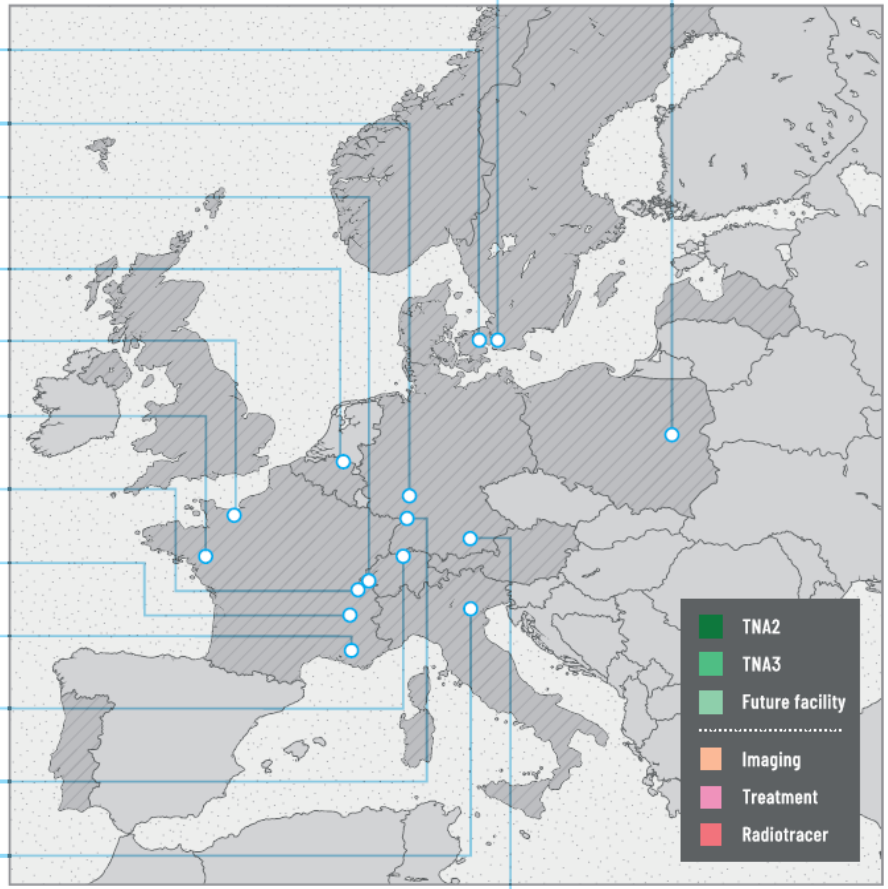
National Labs + Universities

Reactors + Accelerators + Radiochemical Labs + Mass Separators

PRISMAP: towards a European Isotope Center

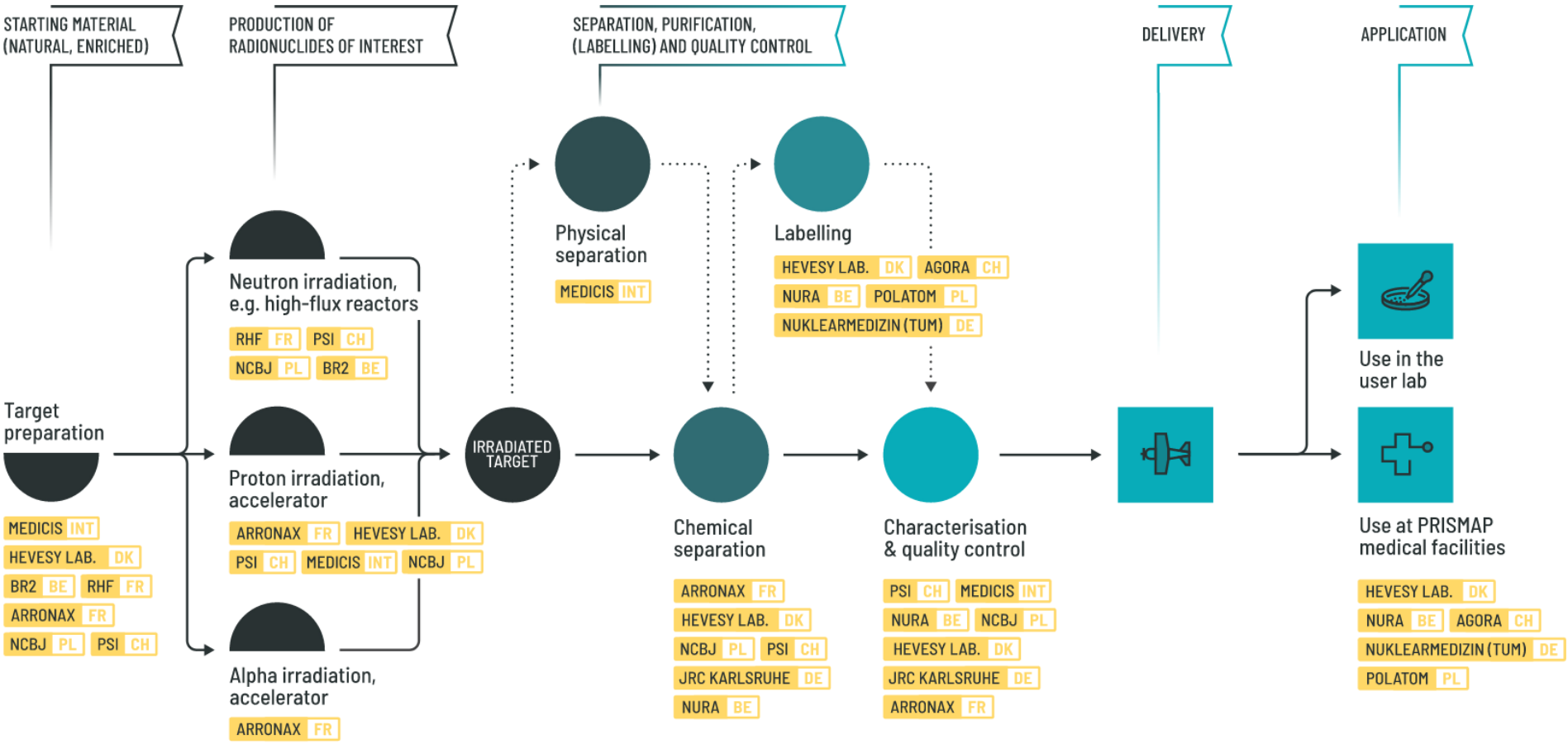
NCBJ	Narodowe Centrum Badań Ją drowych	MARIA, POLATOM
ESS	European Spallation Source ERIC	ESS
DTU	Danmarks Tekniske Universitet	HEVESY LABORATORY
GSI	GSI Helmholtzzentrum für Schwerionenforschung GmbH	FAIR
CHUV	Centre hospitalier universitaire vaudois	AGORA
SCK CEN	Studiecentrum voor Kernenergie / Centre d'étude de l'énergie nucleaire	BR2, NURA, MYRRHA
GANIL	Grand Accélérateur National d'Ions Lourds	SPIRAL 2
ARRONAX	Groupement interet public ARRONAX	ARRONAX
CERN	European organization for nuclear research	MEDICIS
ILL	Institut Max von Laue - Paul Langevin	RHF
CEA	Commissariat à l'energie atomique et aux énergies alternatives	JHR
PSI	Paul Scherrer Institut	SINQ, Injector 2
JRC	Joint Research Centre - European Commission	KARLSRUHE
INFN	Istituto Nazionale di Fisica Nucleare	ISOLPHARM, LARAMED
TUM	Klinikum rechts der Isar der Technischen Universität München	NUKLEAR-MEDIZIN

Sc 43	Sc 44g	Sc 44m	Sc 46	Sc 47	Fe 59	Cu 64	Cu 67	Ge 69
Ac 225								Ge 71
Rn/At 211								Sr 89
At 211								Pd 103
Bi 213								Ag 111
Pt 195m								Cs 131
Pt 193m								La 135
Pt 191								Tb 149
Yb 175	Tm 167	Er 169	Tm/Er 165	Er 165	Dy/Ho 166	Tb 161	Tb 155	Tb 152



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008571 (PRISMAP).

Workflow in the PRISMAP project



TO PROMOTE CROSS-BORDER ACCESS, ONLY TRANSNATIONAL ACCESS IS GRANTED.

DELIVERY OF RADIOISOTOPES EXCLUDES PACKAGING AND SHIPPING COSTS.

TRAVEL, SUBSISTENCE, AND LOCAL ACCOMMODATION COSTS ARE NOT COVERED UNDER PRISMAP.

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PRISMAP WP2 – TNA2 Facilities