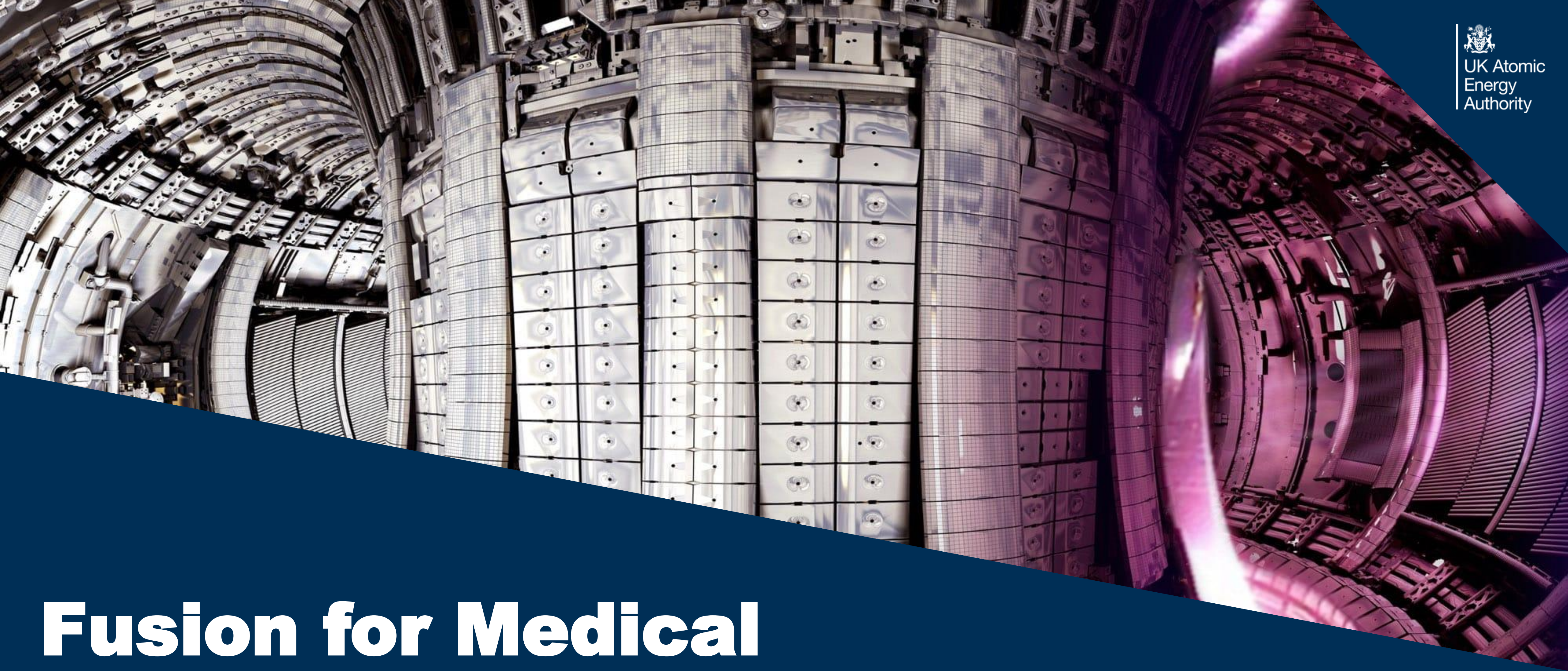


UK Atomic Energy Authority

Fusion for Medical Radionuclides

24 September 2025

UK Atomic Energy Authority

Welcome at OAS

Paul Smith, Senior Business Development Manager
MTC

training

What is Oxfordshire Advanced Skills (OAS)?

mtc training

Who are we

TBC

L2 Lean Operative

L3 Machining
L3 Mechatronics
L3 Tech Support
HNC

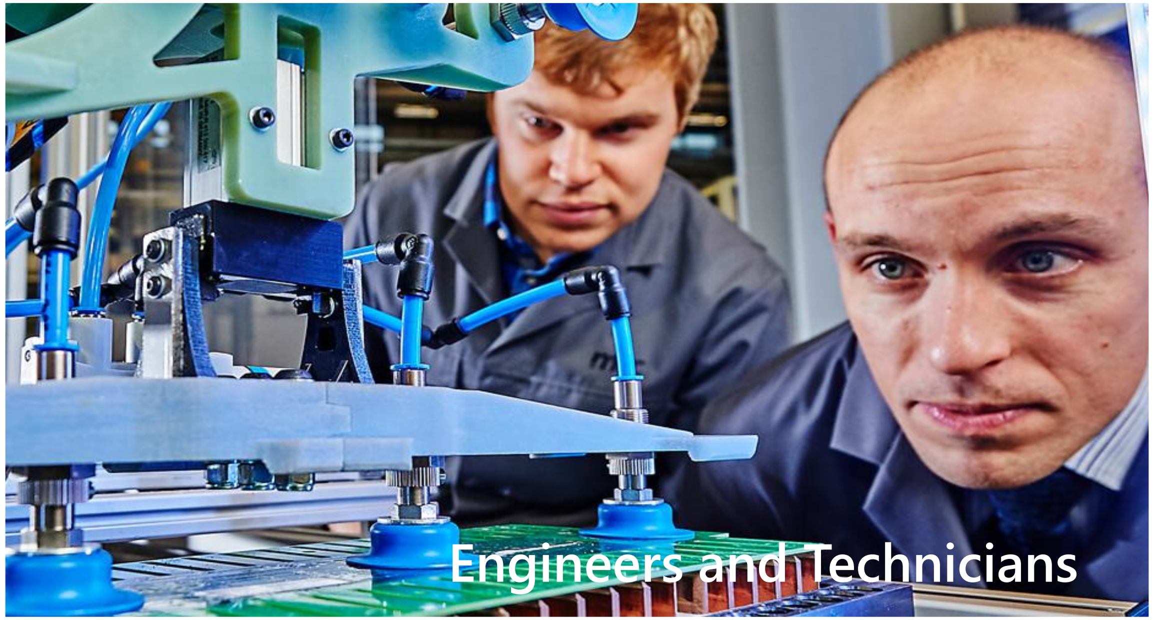
L2 Eng Operative/ Lean
L2 Nuclear Health Physics
L2 Nuclear Operative
L3 Machining
L3 Tech Support
L3 Mechatronics
HNC
L6 Nuclear Scientist and Nuclear Engineer (2026)

mtc training

Who we work with

mtc training

Who are our courses for?



Welding

- MIG / MAG
- Competency checking
- Nuclear TIG welder
- NWIT
- Tig Level 3 modules
- Mechanised & orbital TiG
- L3 welding inspection course

Welcome from UKAEA

Heather Lewtas, Chief Development Officer

UKAEA

UK Atomic
Energy
Authority

Introduction

Stefano Borini, Senior Innovation Lead

UAKEA

Agenda

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10:30 – 12:30: Presentations	
Lee Evitts & Jessica Hollis, **UKAEA**	Exploration of Fusion technology for Medical Radionuclides at UKAEA
Jennifer Young, **Barts Cancer Institute - Queen Mary University of London**	Radionuclides for Health UK
Coffee Break	
Peter Ivanov, **National Physical Laboratory**	Development of Radiochemical Purification Methods for Emerging Medical Radionuclide Standards
Ram Mullur, **Astral Systems**	Plasma to Patients
Ross Radel, **SHINE**	Fusion Technologies for Industrial and Medical Applications
12:30 – 13:30: Networking Lunch	
13:30 – 14:15: Panel Discussion	
Jamie Townes (UKIFS) Talmon Firestone (Astral Systems) Marta Barrabino (Tokamak Energy) Jennifer Young (Barts Cancer Institute - Queen Mary University of London) Kathy Chan - (Institute of Cancer Research)	
14:15 – 14:30 | Closing Remarks	
14:30 – 15:30 | Networking & Poster Session	

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UKAEA

Novel radionuclide production with high-energy D-T neutrons

Dr Lee J. Evitts (lee.evitts@ukaea.uk)

Senior Nuclear Physicist (Computational) | Team Leader, UKAEA

Applied Radiation Technology (ART)

UK Atomic Energy Authority

Experimental
Kim Lennon

Gamma spectrometry on research measurements, waste assay (e.g. for decommissioning) and detector development (e.g. neutron diagnostics)

Validation & Verification
Callum Grove

Experimental support (e.g. shielding irradiation), benchmarking codes incl. fluid activation

Computational
Lee Evitts

Nuclear analysis (neutronics) to support design of projects at UKAEA (e.g. STEP, LIBRTI, JET) and external (e.g. ITER, Gauss Fusion, General Fusion)

Fusion

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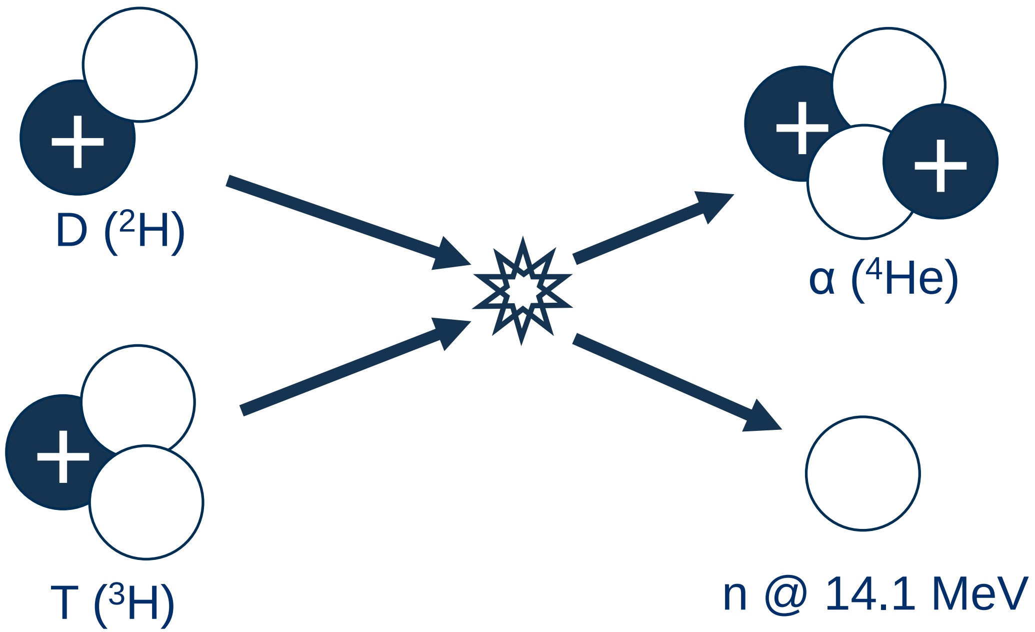
A nuclear reaction, where two (or more) nuclides can form one larger nuclide + emit energy

In the context of this talk, referring to D-T fusion, which emits a **14.1 MeV** neutron.

This high-energy neutron could be:

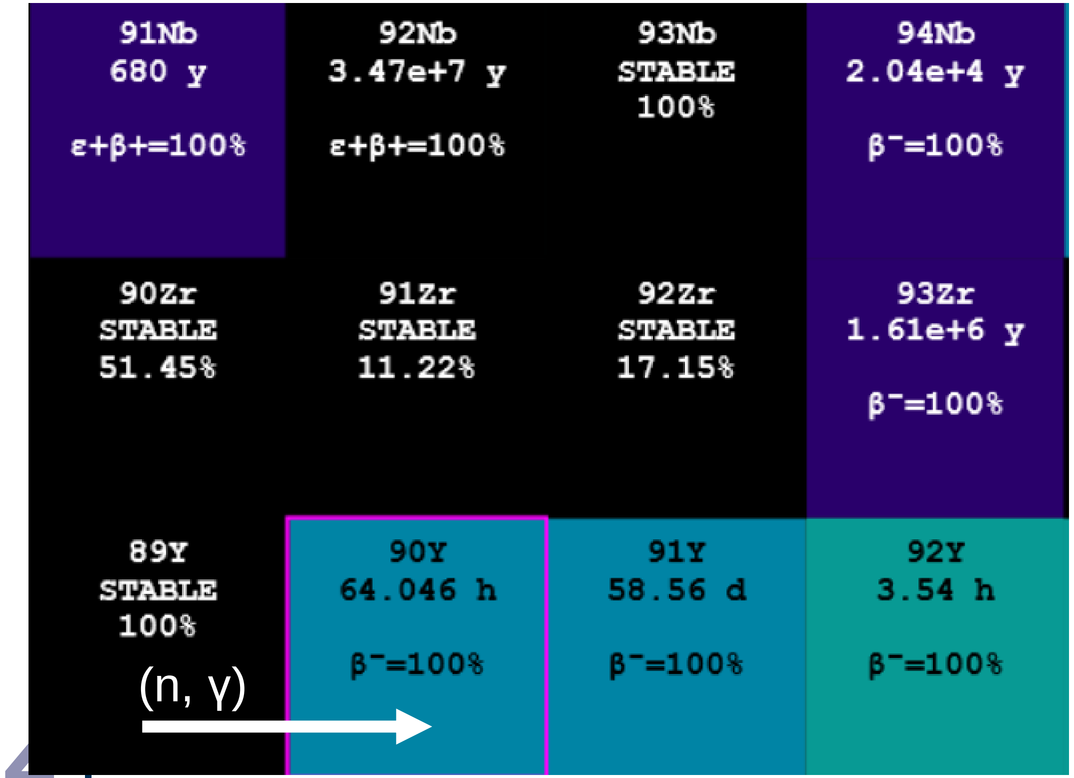
1. Multiplied/moderated to produce current nuclides (e.g. ^{177}Lu)
2. Used as-is, to produce more novel nuclides or present alternate pathways



Fusion vs fission neutrons

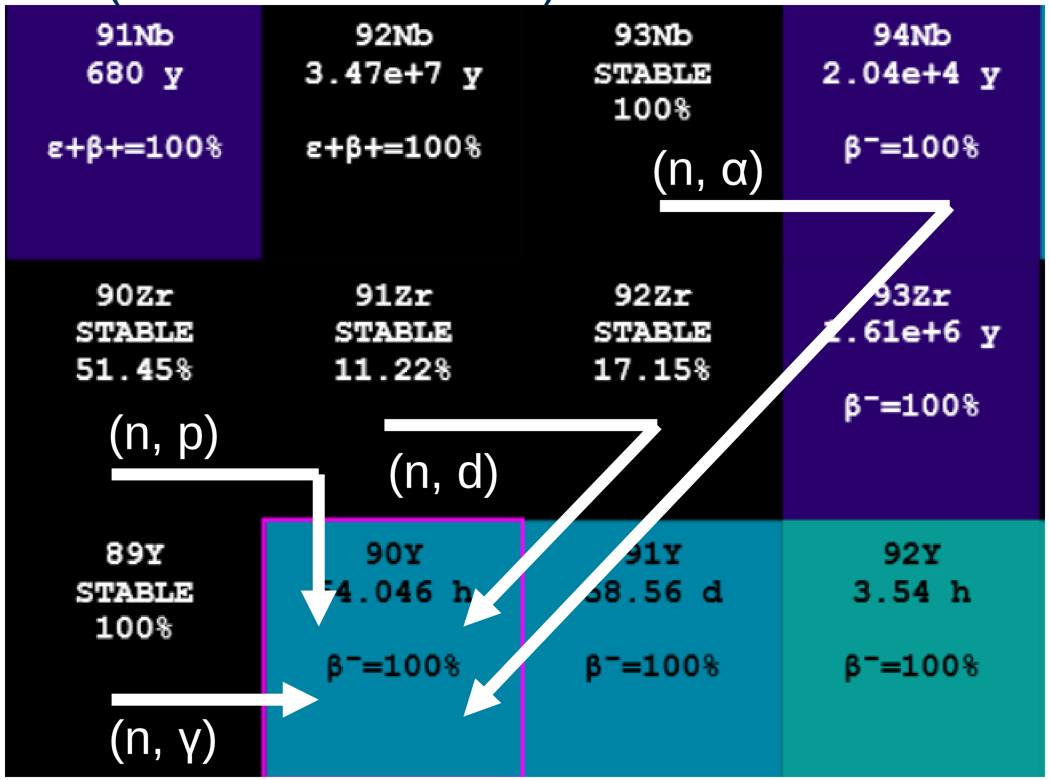
Fission:

Majority of neutrons in a research reactor are likely thermalized (~ 0.0025 eV), aiming for (n,γ) reactions, where reaction cross-section is largest!



Fusion:

Higher energy opens up more available routes (more not shown)…

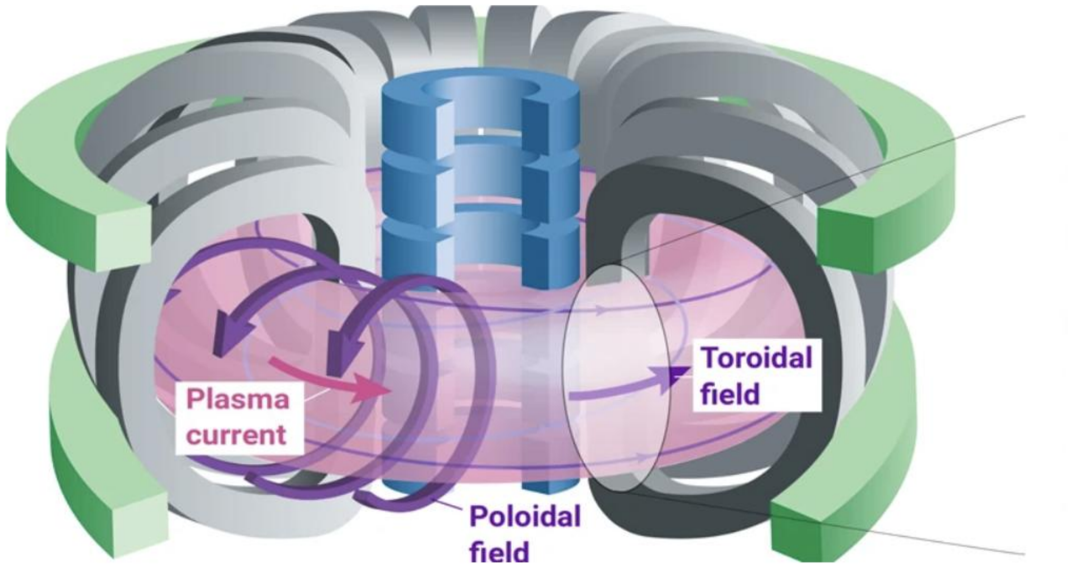


Double-edged sword, more accessible nuclides but potential for more impurities!

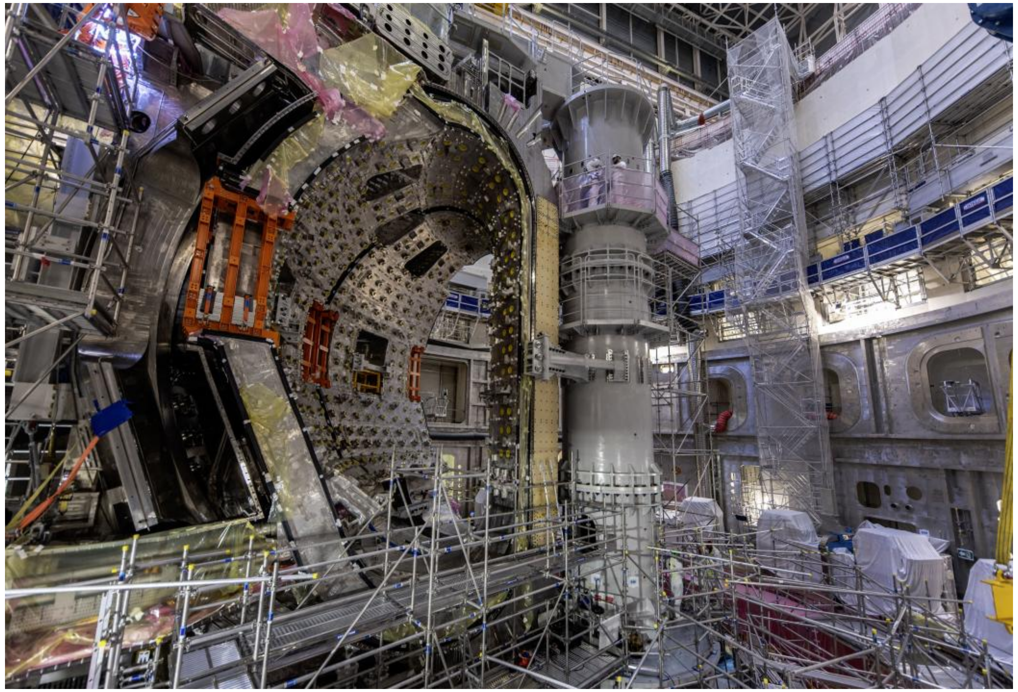
Fusion machines

A whole range of active/proposed concepts including accelerators, magnetic or inertial confinement, magnetic mirrors, etc.

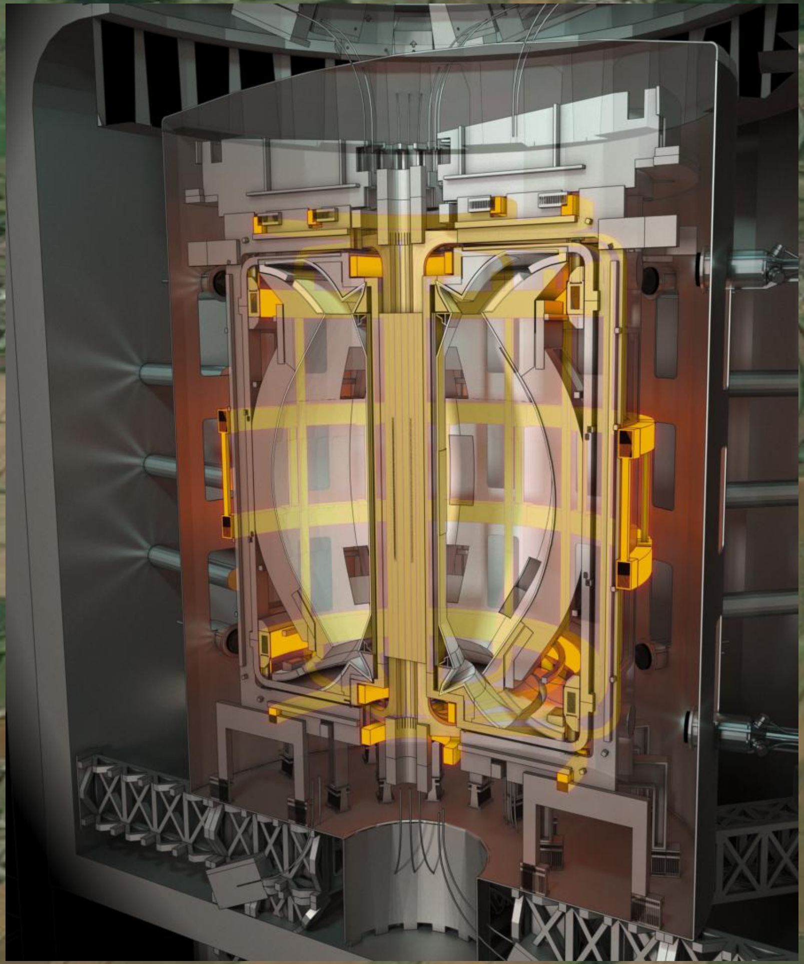
With magnetic confinement, strong magnetic fields contain a hot plasma, examples include **tokamaks** (e.g. ITER, STEP, MAST-U) and stellarators.



Tokamak Design (REF)



ITER Construction (REF)



STEP FUSION

DELIVER A UK PROTOTYPE FUSION ENERGY PLANT, TARGETING 2040, AND A PATH TO COMMERCIAL VIABILITY OF FUSION.

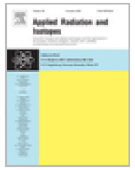
STEP MISSION

Production feasibility study

ELSEVIER

Applied Radiation and Isotopes

Volume 226, December 2025, 112163



Theoretical novel medical isotope production with deuterium-tritium fusion technology

Lee J. Evitts [a], Philip W. Miller [b], Chiara Da Pieve [c, 1], Andrew Turner [a], Stefano Borini [a]

[a] UKAEA (United Kingdom Atomic Energy Authority), Culham Campus, Abingdon, Oxfordshire, OX14 3DB, UK

[b] Molecular Sciences Research Hub, White City Campus, Imperial College London, London, W12 0BZ, UK

[c] The Institute of Cancer Research, 123 Old Brompton Rd, London, SW7 3RP, UK

Recently accepted to Applied Radiation and Isotopes:
https://www.sciencedirect.com/science/article/pii/S0969804325005081

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Methodology & Assumptions

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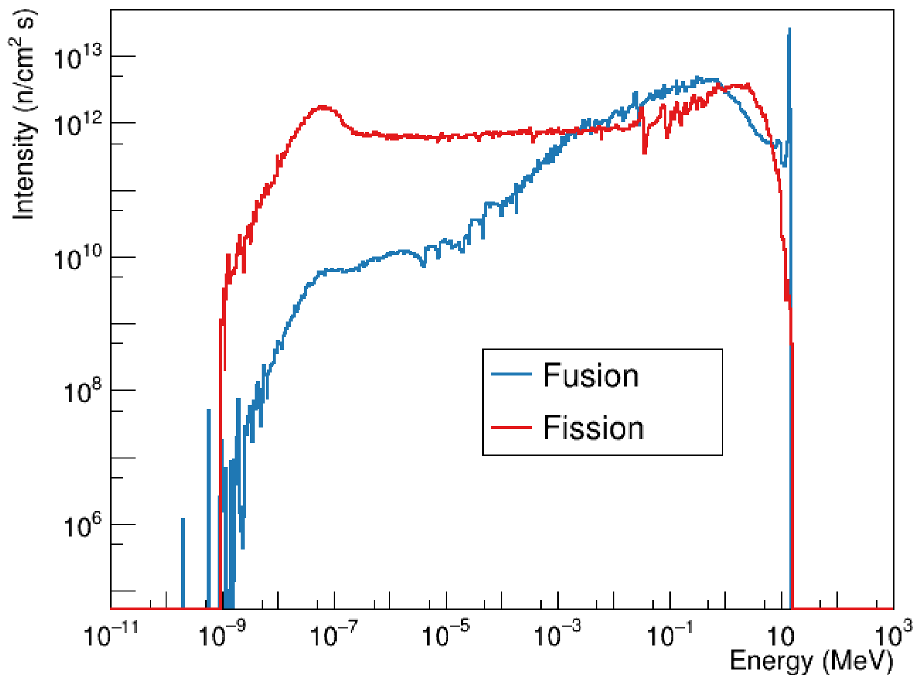
Identified all radionuclides that decay to a stable daughter with a relevant half-life (not just existing medical nuclides), and their feasible reactions.

Batch-wise inventory calculations performed with:

- FISPACT-II [1] inventory software,
- TENDL-2019 [2] nuclear data,
- example neutron spectrum in a tokamak-type device (right)[3],
- Neutron flux of 10^{14} n/(cm^2 s),
- 1 g of solid material

The results should be scalable to a device



Assumptions include:

- Target materials are 100% isotopically pure.
- Elements can be extracted with 100% efficiency, isotopes cannot.
- Irradiation period is three half-lives of the product.

[1] Sublet J. Ch. et. al. Nucl Data Sheets. (2017) 139
[2] Koning A.J. et. al. Nucl. Data Sheets. (2019) 155
[3] Fusion spectrum generated in this work with OpenMC & Paramak neutron transport calculations. Fission spectrum from HFR.

Beta (β-) Emitters

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The list of potential/novel beta emitters is extensive (right), highlights include:

Copper-67	$T_{1/2}$ ~ 62 h Energy (β-) ~100-200 keV Energy (γ) ~180 keV
Existing Route	Cyclotron ($^{68/70}Zn$ targets) but ^{64}Cu is also produced; potentially difficult to separate
Fusion Route	^{67}Zn(n, p) Molar Activity ~1800 GBq/μmol Activity ~20 GBq per target gram Isotopic purity ~100%
Notes	Usable in SPECT Can rely on existing studies Could use DOTA as suitable chelator Paired with ^{64}Cu for theragnostic

^{24}Na	^{90}Y	*^{31}Si*
^{41}Ar	^{109}Pd	*^{32}P*
^{42}K	^{112}Ag	*^{77}As*
^{47}Sc	^{136}Cs	*^{83}Br*
^{48}Sc	^{139}Ba	*^{105}Rh*
^{56}Mn	^{140}La	*^{111}Ag*
^{65}Ni	^{150}Pm	*^{131}I*
^{67}Cu	^{156}Eu	*^{149}Pm*
^{72}Ga	^{159}Gd	*^{161}Tb*
^{76}As	^{172}Tm	*^{199}Au*
^{78}As	^{173}Tm	
^{82}Br	^{175}Yb	
^{86}Rb		

Beta (β-) Emitters

Yttrium-90	$T_{1/2}$ ~ 64 h Energy (β-) ~900 keV Energy (γ) - none
Existing Route	Neutron (^{89}Y) to produce carrier-added form Or slow decay from ^{90}Sr (U fission product)
Fusion Route	^{93}Nb(n, α) Molar Activity ~1000 GBq/μmol Activity ~5 GBq per target gram Isotopic purity ~99.7%
Notes	Has already had extensive use/research behind it

^{24}Na	^{90}Y	*^{31}Si*
^{41}Ar	^{109}Pd	*^{32}P*
^{42}K	^{112}Ag	*^{77}As*
^{47}Sc	^{136}Cs	*^{83}Br*
^{48}Sc	^{139}Ba	*^{105}Rh*
^{56}Mn	^{140}La	*^{111}Ag*
^{65}Ni	^{150}Pm	*^{131}I*
^{67}Cu	^{156}Eu	*^{149}Pm*
^{72}Ga	^{159}Gd	*^{161}Tb*
^{76}As	^{172}Tm	*^{199}Au*
^{78}As	^{173}Tm	
^{82}Br	^{175}Yb	
^{86}Rb		

Beta (β-) Emitters

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Scandium-47	$T_{1/2}$ ~ 3.3 d Energy (β-) ~500 keV Energy (γ) ~160 keV
Existing Route	
Fusion Route	$^{50}V(n,\alpha)$ or $^{48}Ca(n, 2n)$ but low nat. abundance Molar Activity ~1400 GBq/µmol Activity ~600 GBq per target gram Isotopic purity ~100%
Notes	Usable in SPECT Can rely on existing studies Could use DOTA as suitable chelator Paired with ^{44}Sc for theragnostic

^{24}Na	^{90}Y	*^{31}Si*
^{41}Ar	^{109}Pd	*^{32}P*
^{42}K	^{112}Ag	*^{77}As*
^{47}Sc	^{136}Cs	*^{83}Br*
^{48}Sc	^{139}Ba	*^{105}Rh*
^{56}Mn	^{140}La	*^{111}Ag*
^{65}Ni	^{150}Pm	*^{131}I*
^{67}Cu	^{156}Eu	*^{149}Pm*
^{72}Ga	^{159}Gd	*^{161}Tb*
^{76}As	^{172}Tm	*^{199}Au*
^{78}As	^{173}Tm	
^{82}Br	^{175}Yb	
^{86}Rb		

Auger & Alpha Emitters

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Due to the available (n, 2n) reaction, some potential Auger emitters can also be created including:

^{64}Cu, ^{77}Br, ^{89}Zr, ^{119}Sb, ^{135}La and ^{201}Tl

Their production yields wouldn't compete with a cyclotron, but fusion could offer a useful alternative

There is also a good feasibility to produce alpha emitters like ^{212}Bi and ^{225}Ac, see next talk(s)

Conclusions / Future Work

It is theoretically viable to produce existing and novel medical isotopes with D-T fusion technology. However, a significant number of assumptions form the basis of this study which would need to be investigated further for any particular nuclide of interest.

For each nuclide of interest, further research would be required in, for example:

- Nuclear physics, measuring the reaction cross-sections
- Cost analysis, including acquiring and recycling target materials.
- Target design to optimize production quantities and purities.
- Development of target and product purification/extraction techniques.
- Development of appropriate GMP practices.
- Related clinical research e.g., attaching to target vectors, in-vivo stability, uptake, retention, dose, etc.

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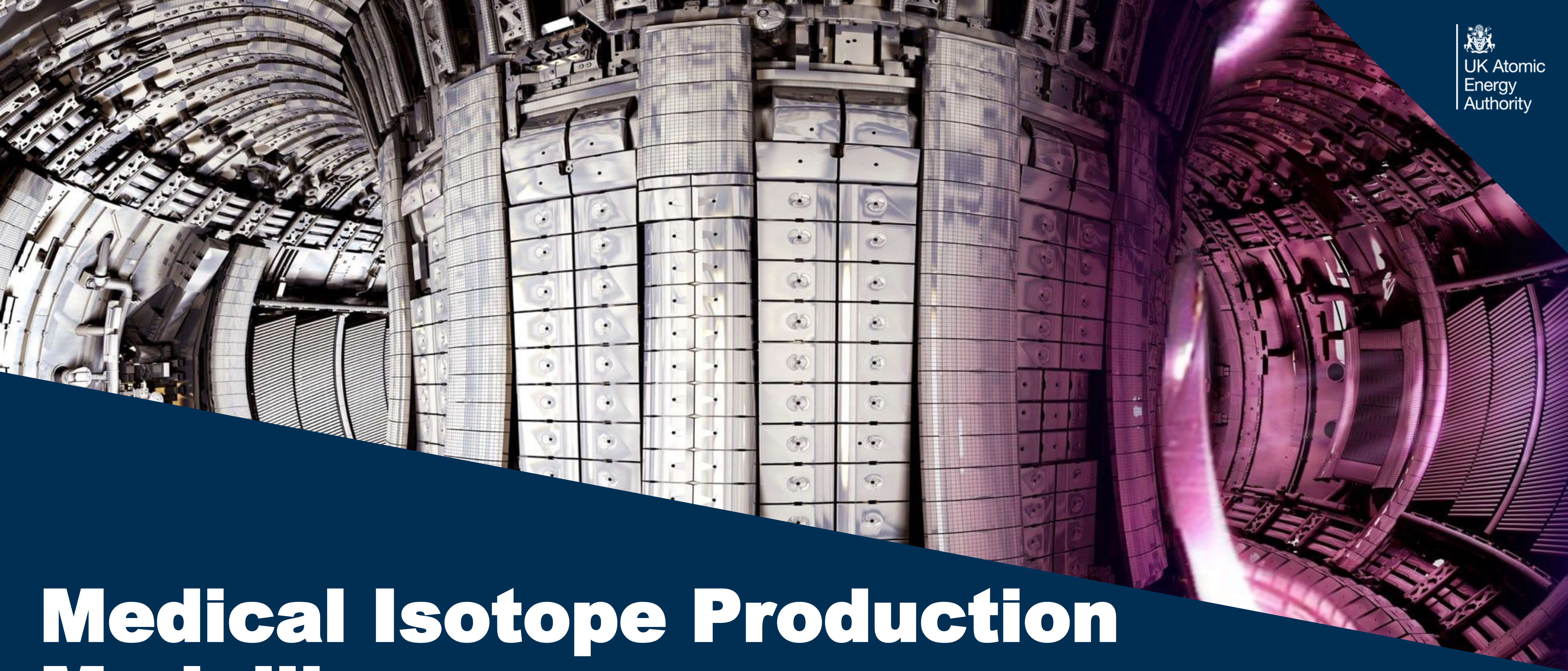
Thank you



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Medical Isotope Production Modelling

Jessica Hollis, David Foster and Mark Gilbert

UKAEA

Talk outline

UKAEA engaged with NIRO to work on four packages aimed to help understand the application of *fusion* neutrons to medical isotope production.

The work packages were:

Task 1: The comparison of Mo99 production from Uranium of varying enrichments within a fission and fusion spectrum.

Task 2: The comparison of Mo99 production from Uranium of varying enrichments within a fusion power plant spectrum – varying locations within a breeder blanket.

Task3: A scoping study for the potential production routes of various medical isotopes of interest.

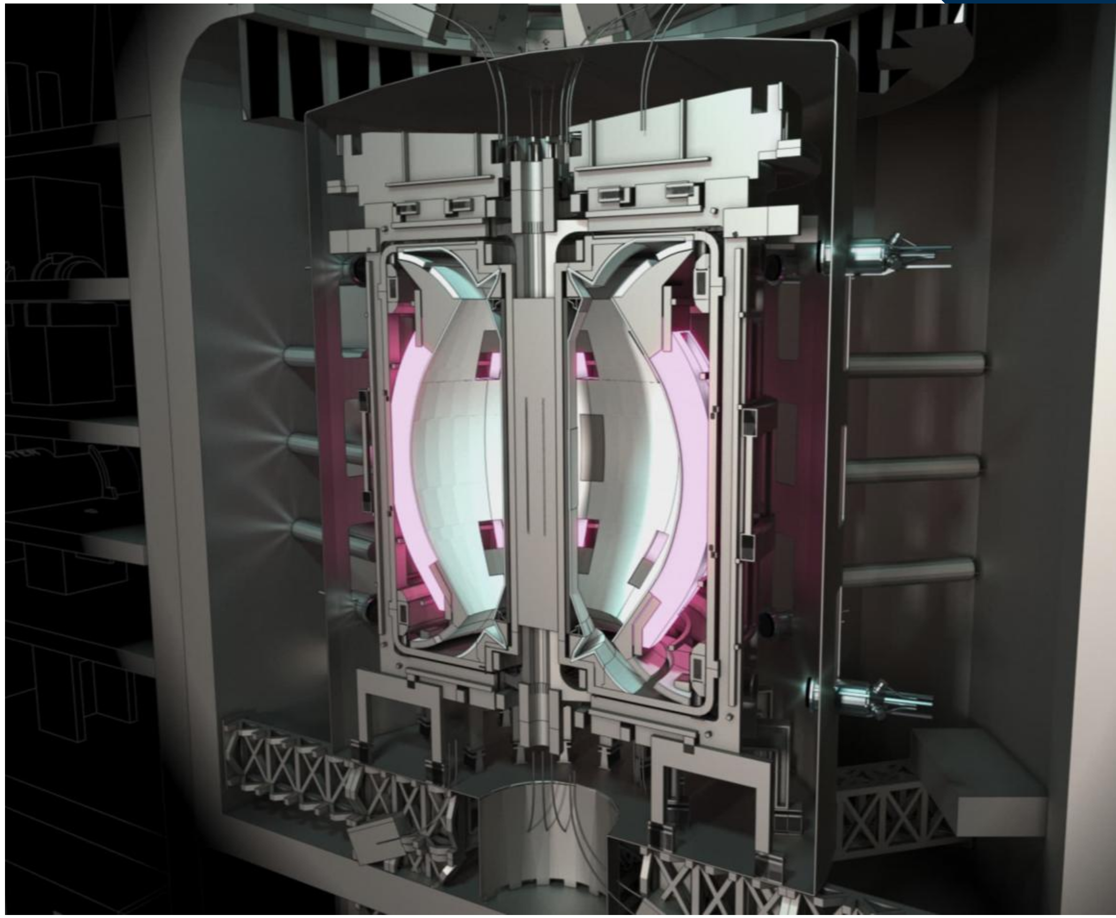
Task 4: A conceptual study (based on the results from the previous reports) to add a target station focused on radionuclide production, to the proposed LIBRTI test facility.

UKAEA activation calculations

For the delivery of fusion power UKAEA needs to understand the activation (transmutation) of reactor components

- Waste classification (£Billion sector)
- Waste mitigation – material engineering (£Billion sector)
- Worker dose – decay gammas

Solution: FISPACT-II – UKAEA's nuclear inventory code

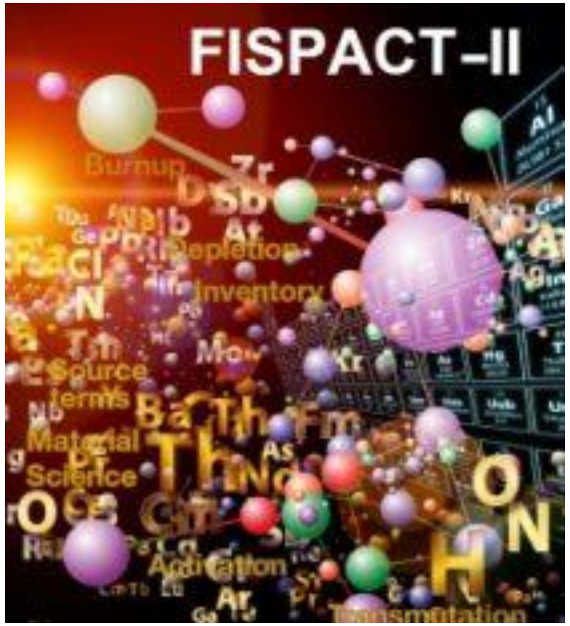


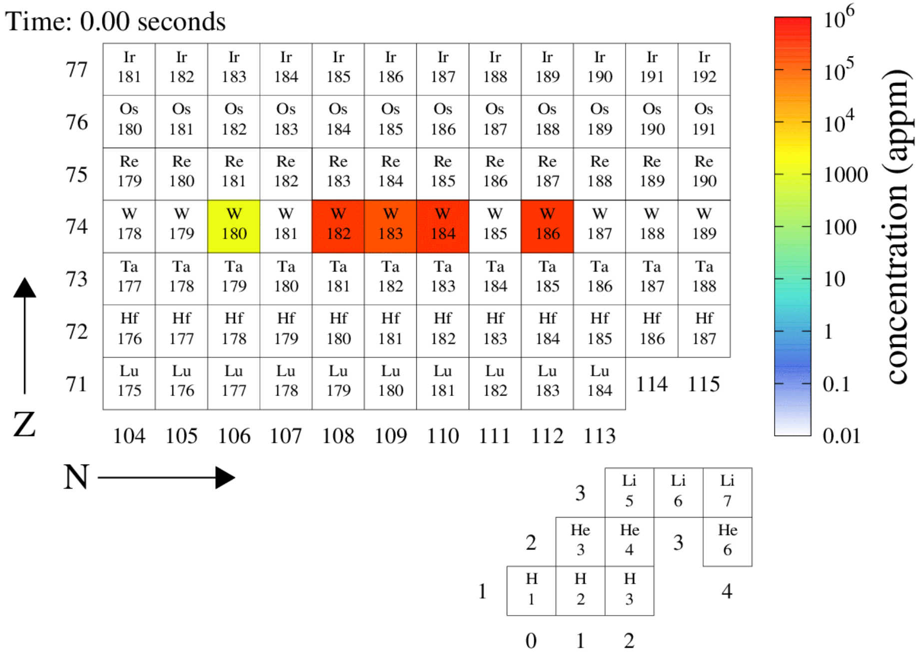
A STEP type blanket

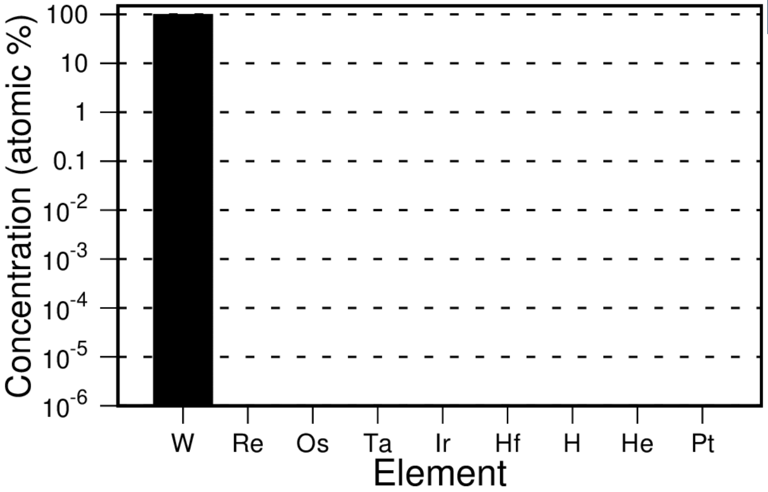
https://ccfe.ukaea.uk/uk-to-launch-search-for-industry-partners-to-develop-prototype-fusion-energy-plant/step-tokamak-breeder-blankets-ccfe/

FISPACT-II - UKAEA nuclear inventory code

Models the transmutation of a material







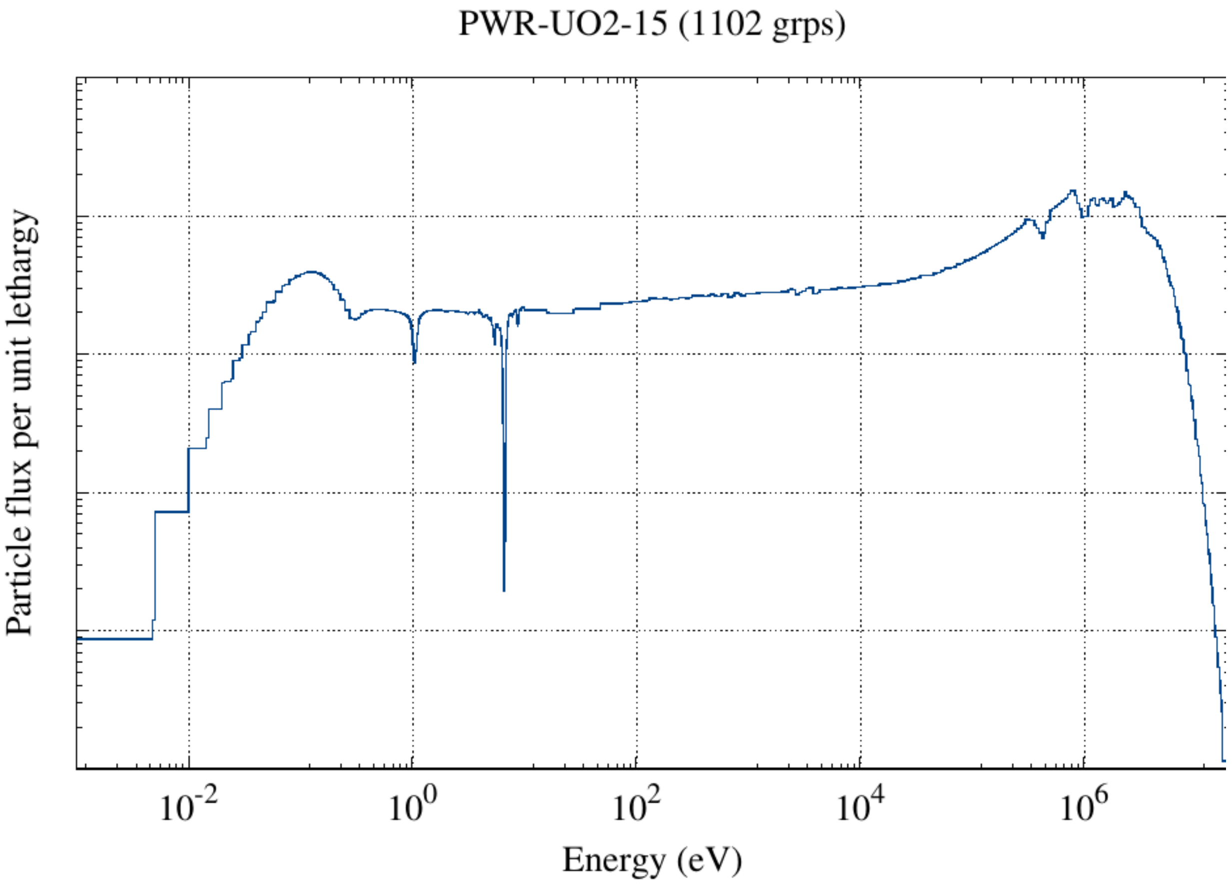
Tungsten transmutation under a fusion spectrum (M. Gilbert).

$$\frac{d}{dt}N_i = -N_i\lambda_i - N_i\sum_s \int_0^\infty \sigma_{is}(E)\phi(E)dE + \sum_{k\neq i} N_k\left(\lambda_{ki} + \int_0^\infty \sigma_{ki}(E)\phi(E)dE\right)$$

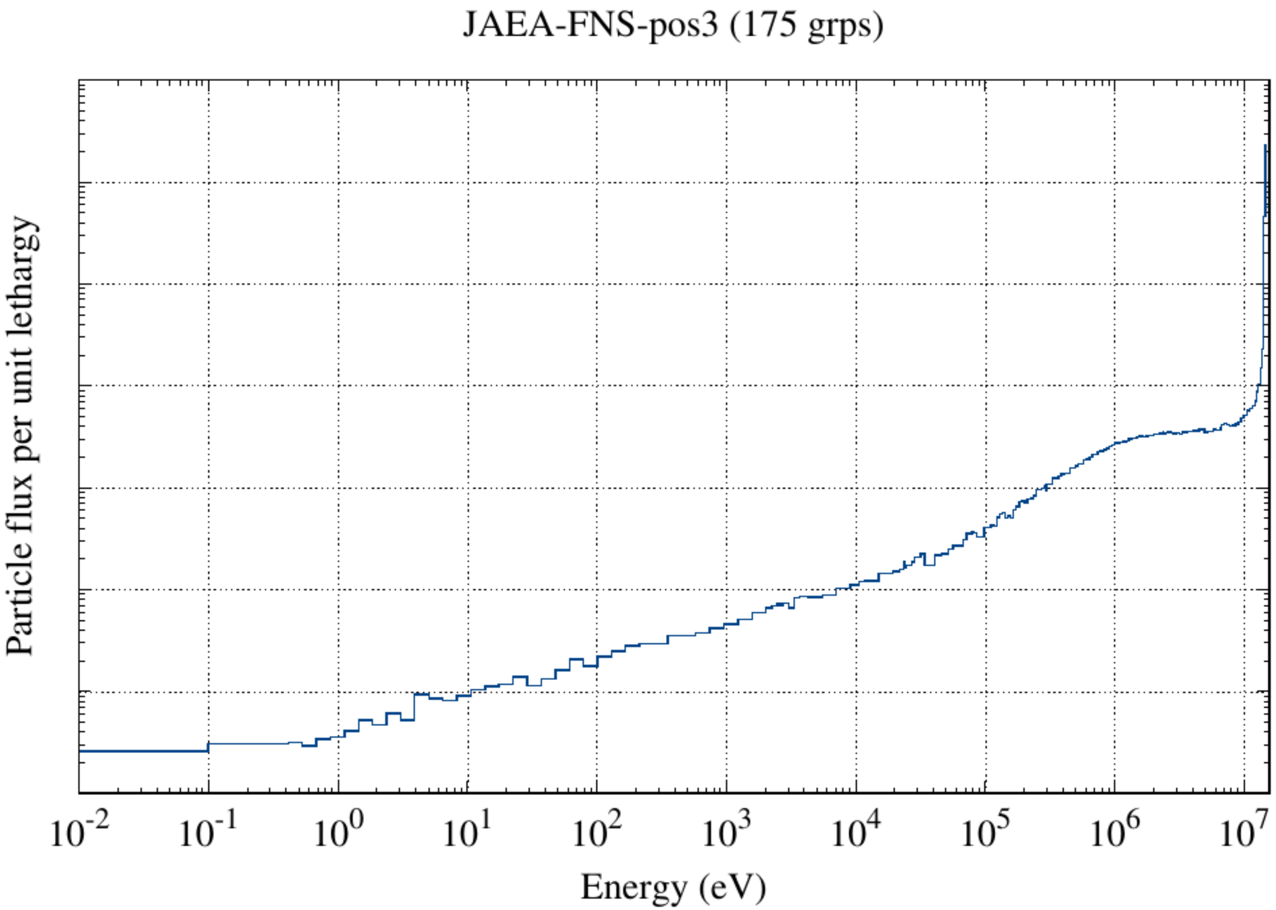
N is a list of the number of nuclides, ϕ is the projectile spectrum, σ is the cross sections and λ is the decay constant

Task 1

Comparison of Mo99 production from Uranium of varying enrichments within a fission and fusion spectrum.



Fission energy spectrum for a pressurised water reactor (PWR) at 15 GWd/THM. See FISPACT-II reference input spectra



Spectra obtained from the Fusion Neutron Source (FNS) experimental set-up at JAEA. See FISPACT-II reference input spectra

Task 1

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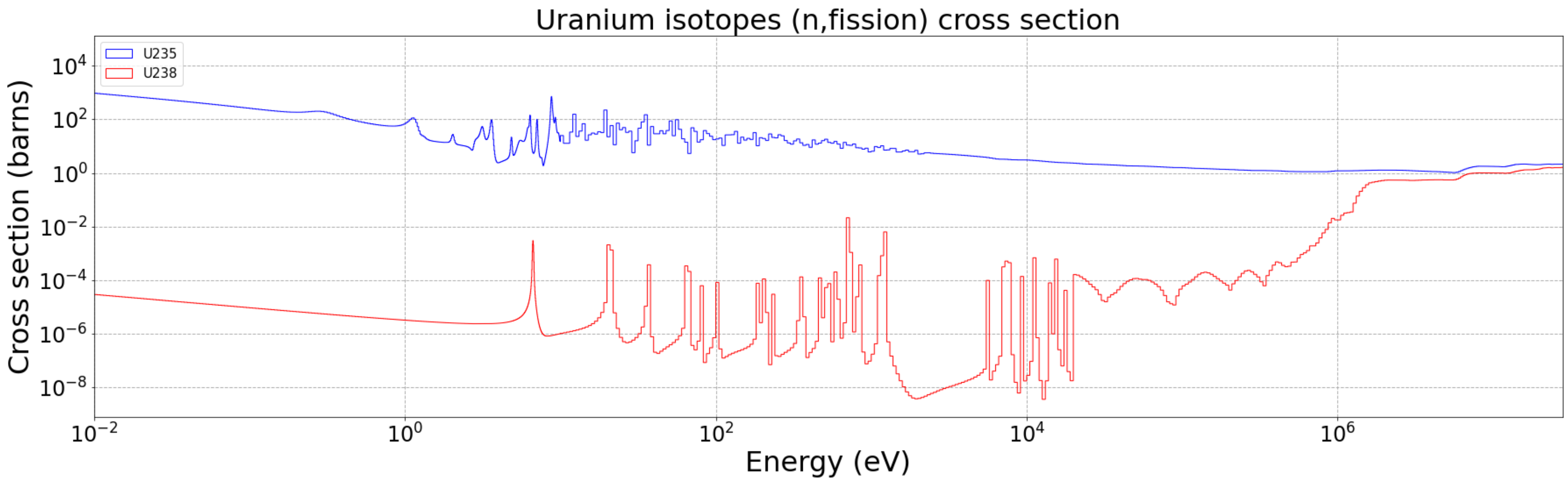
Mo99 yield (Bq) immediately post 7-day irradiation

Spectrum	1% U235 enrichment	5%U235 enrichment	10%U235 enrichment	19.7%U235 enrichment
Fission	6.919E+13	2.687E+14	5.181E+14	1.002E+15
Fusion - 14MeV monoenergetic	4.116E+12	4.215E+12	4.339E+12	4.580E+12
Fusion – FNS	3.843E+12	3.944E+12	4.069E+12	4.312E+12

- Mo99 yield is consistently at least an order of magnitude higher for the fission spectrum in comparison to the fusion spectra (higher flux and higher proportion of thermal neutrons)

- The fusion spectra shifts to energies where the cross section for U238 fission considerably increases (yet still below that of U235). The impact of enrichment is limited in these cases.



- May be optimal to use depleted uranium and not enriched uranium as it has lower cost and less regulation.

- Further research required to investigate the effect of neutron multiplicity for U238 fission.

FISPACT-II can identify the pathway of how a nuclide is produced.

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Pathway	Fission Spectrum (1% U enrichment)	Fission Spectrum (19.7% U enrichment)	Fusion Spectrum (1% U enrichment)	Fusion Spectrum (19.7% U enrichment)
U-235(n,F) → Zr-99 → Nb-99 → Mo-99	27.0	36.7	0.5	9.9
U-235(n,F) → Zr-99 → Nb-99m → Mo-99	15.4	20.9	—	5.6
U-235(n,F) → Y-99 → Zr-99 → Nb-99 → Mo-99	13.4	18.2	—	5.0
U-235(n,F) → Y-99 → Zr-99 → Nb-99m → Mo-99	7.6	10.4	—	2.9
U-235(n,F) → Nb-99 → Mo-99	4.8	6.5	—	3.8
U-235(n,F) → Sr-99 → Y-99 → Zr-99 → Nb-99 → Mo-99	1.4	1.9	—	—
U-235(n,F) → Nb-99m → Mo-99	0.9	1.3	—	0.6
U-235(n,F) → Sr-99 → Y-99 → Zr-99 → Nb-99m → Mo-99	0.8	1.1	—	—
U-235(n,F) → Mo-99 (direct)	—	0.5	—	—
U-238(n,F) → Y-99 → Zr-99 → Nb-99 → Mo-99	8.4	—	29.2	21.1
U-238(n,F) → Zr-99 → Nb-99 → Mo-99	6.3	—	24.7	17.9
U-238(n,F) → Y-99 → Zr-99 → Nb-99m → Mo-99	4.8	—	16.6	12.0

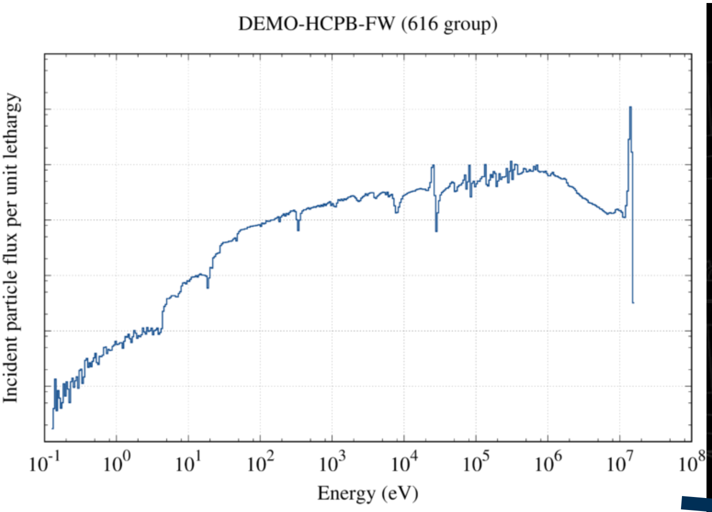
Enrichment

Mo production shifts from U235 to U238 in fusion due to the faster neutrons

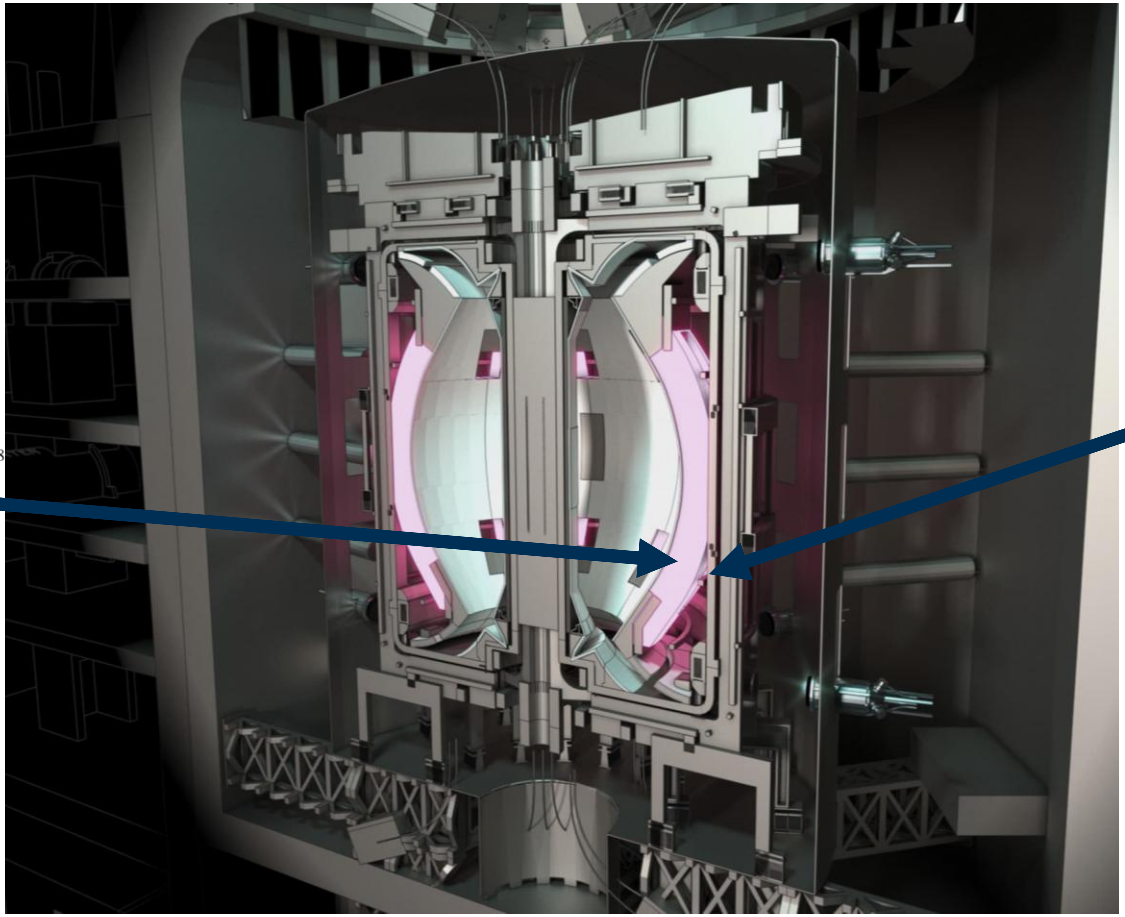
Incomplete table showing nuclide production pathways

Task 2

The comparison of Mo99 production from Uranium of varying enrichments within a fusion power plant spectrum – varying locations within a breeder blanket.

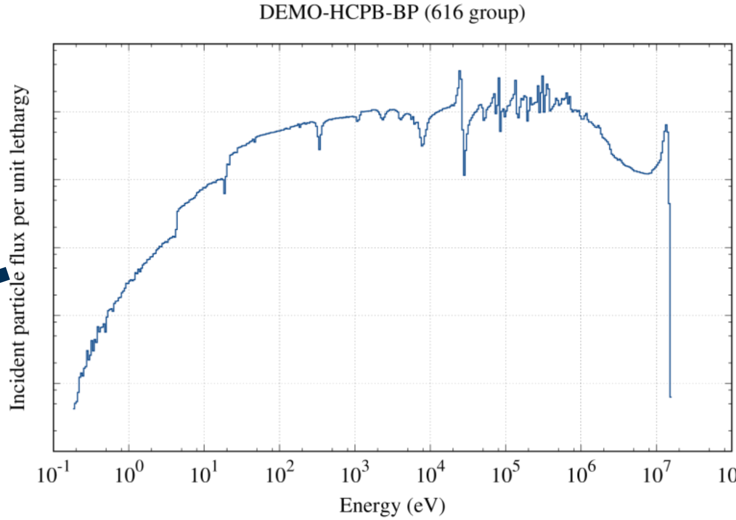


DEMO fusion concept He-cooled pebble bed, first wall. FISPACT-II reference spectra



A STEP type blanket

https://ccfe.ukaea.uk/uk-to-launch-search-for-industry-partners-to-develop-prototype-fusion-energy-plant/step-tokamak-breeder-blankets-ccfe/



DEMO fusion concept He-cooled pebble bed, backplate. FISPACT-II reference spectra

Task 2

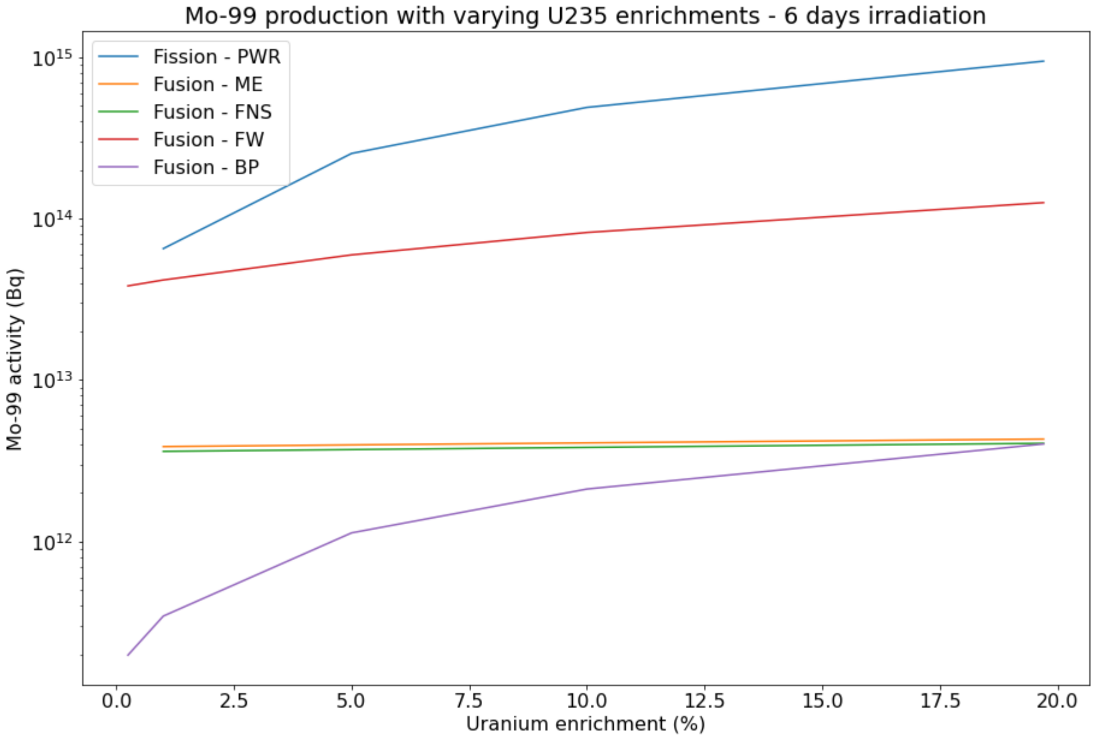
- Production of Mo99 from Uranium of varying enrichments within a fusion power plant spectrum (EU-DEMO D-T fusion reactor He-cooled pebble bed first wall and backplate).

Mo99 yield (Bq) immediately post 6-day irradiation

	0.25%	1%	5%	10%	19.7%
Firstwall	3.829E+13	4.165E+13	5.959E+13	8.202E+13	1.255E+14
Backplate	1.979E+11	3.452E+11	1.131E+12	2.113E+12	4.018E+12

- Mo99 yield is highest for the firstwall compared to the backplate due to the higher flux
- The yield increase between 0.25% and 19.7% U235 is less than an order of magnitude for the firstwall.

- As expected, the Mo99 yield for the PWR fission spectrum increases significantly with U235 enrichment
- Due to the down scatter of the ~14MeV neutrons, the backplate spectra is more favourable towards U235 fission (but has lower flux).
- Impact of enrichment is limited for the other fusion spectra (higher proportion of higher energy neutrons).



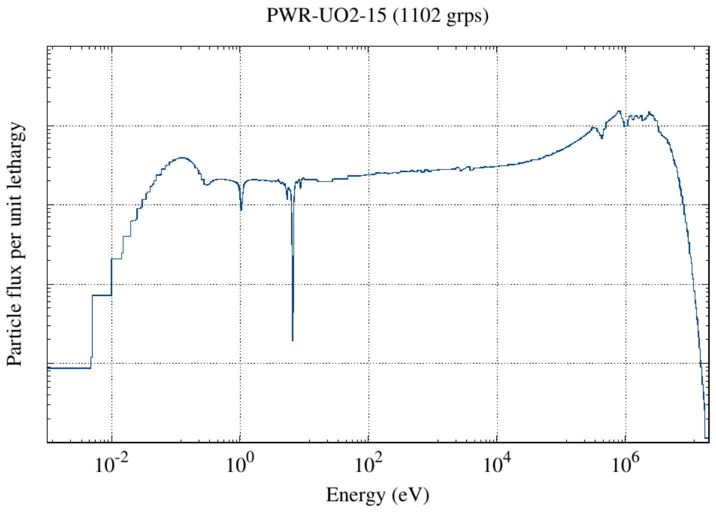
Task 3

Investigation of the production possibilities for (Cu64, Ga68, Y90, Mo99, Tb149, Lu177, Pb212, Bi213, At211, Ra226, Ac225,Th227) from all target elements or nuclides

Aim:

- identify the targets which produce the highest yields of the medical isotope
- simulate both a fission and fusion neutron environment for comparison
- Identify production methods which do not use uranium – lower risks

Method



Irradiation spectrum

→

Fe

Cu

Pb

U

Th

List of target materials

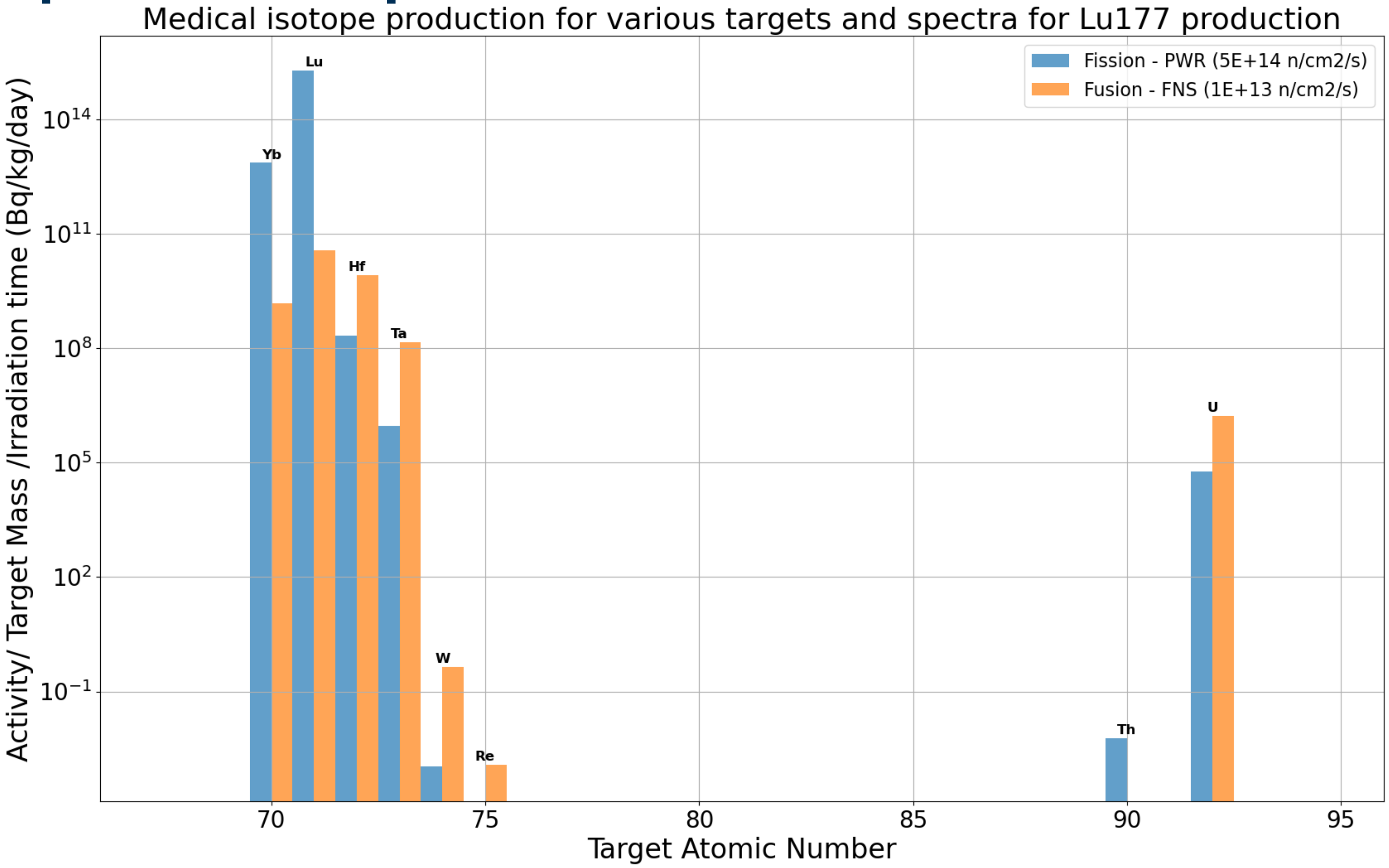
→

Ac225

Target nuclide

Task 3:

Lu177 production example

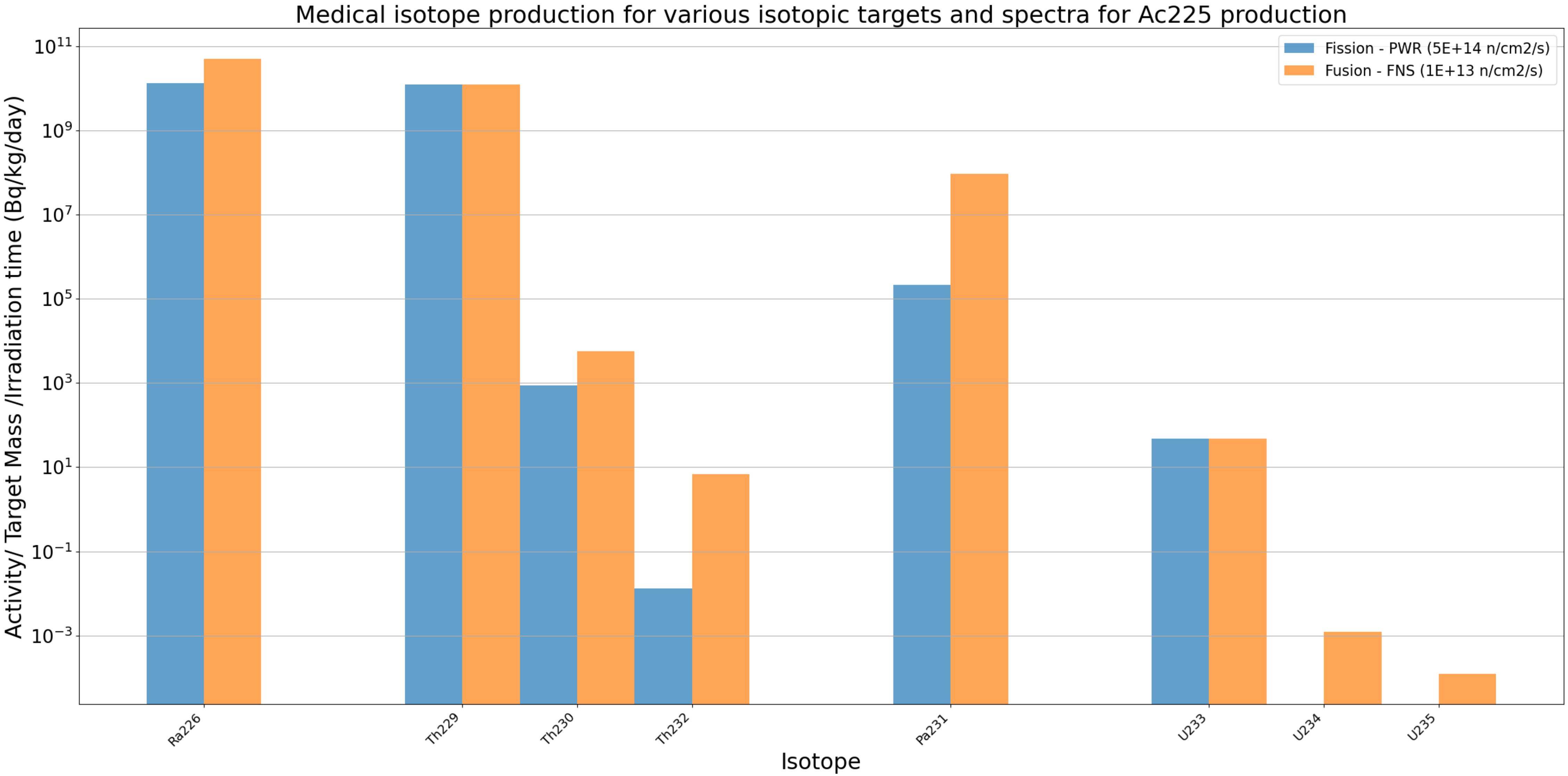


- Typical picture: islands of production around the atomic number of isotope of interest and around actinides (due to fission)
- E.g. max production of Lu177 from Lu as a target

Lu177 yield (activity/unit target mass/unit irradiation time – Bq/kg/day) obtained from the irradiation of naturally abundant targets with different neutron spectra.

Task 3:

Ac225 production example by nuclide.

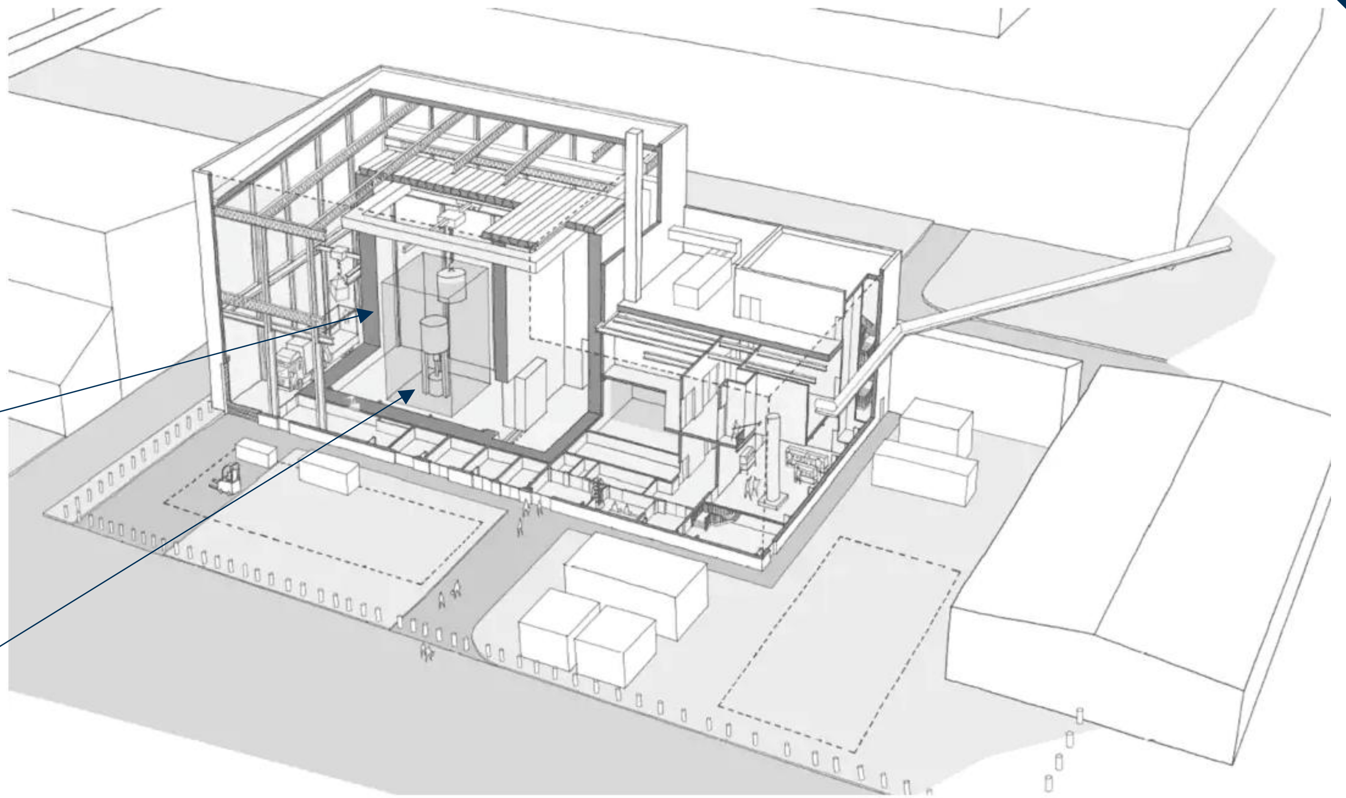


Targets simulated are stable isotopes (half life > 100 years)

Task 4: Small scale medical isotope production in the LIBRTI facility

- £200m Lithium Breeding Tritium Innovation (LIBRTI) program
- LIBRTI will develop a digital framework to model fusion blankets, develop new fusion blanket designs and drive the handling and development of tritium.
- Test tritium production of meter scale components
- Waste route

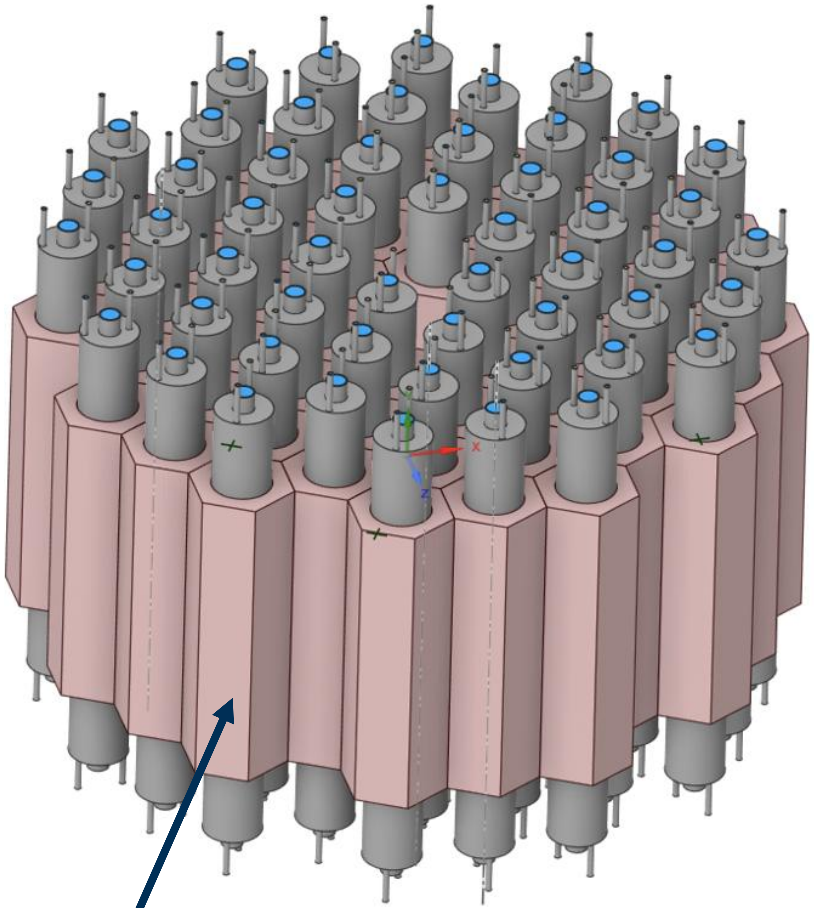
- Could be used to produce small amounts of medical isotopes in the future

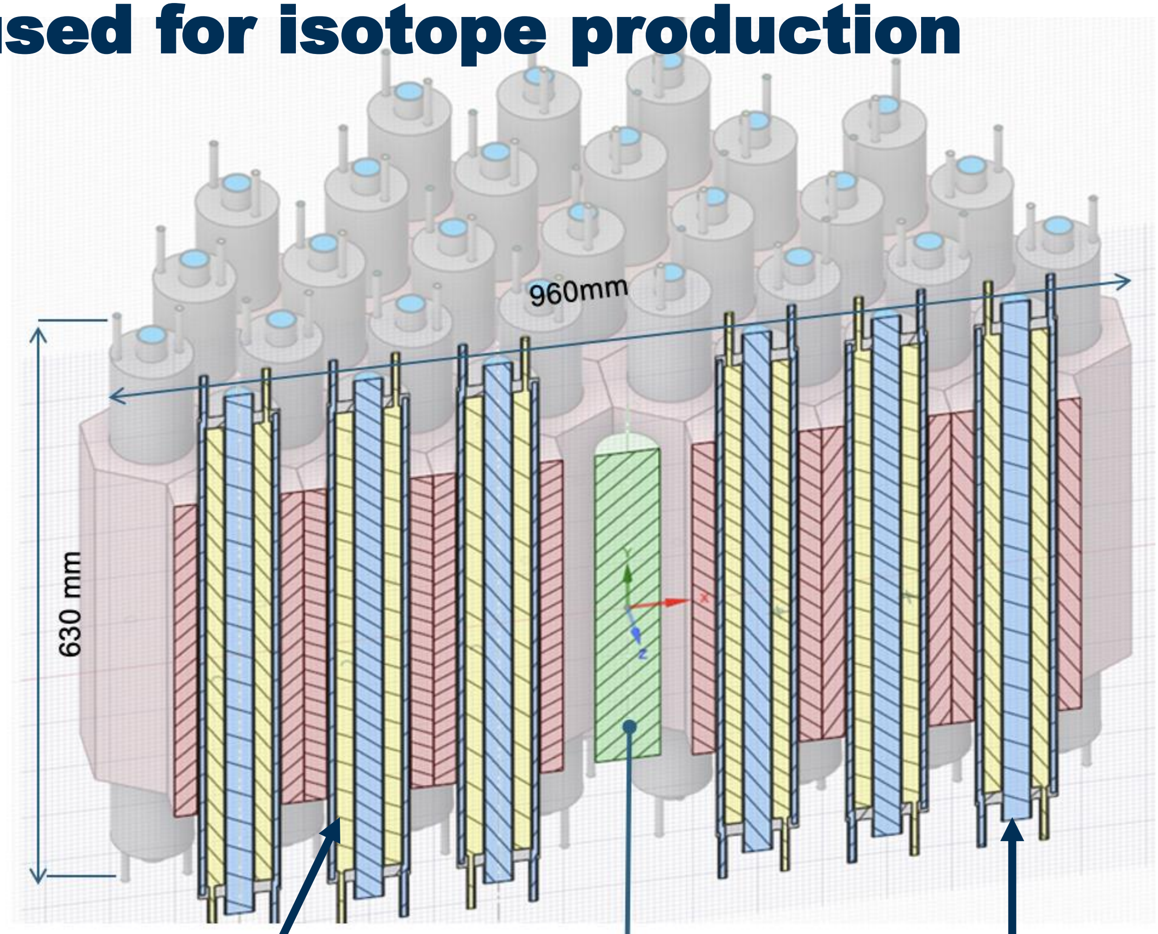


Concept sketch of the LIBRTI facility. Note the central grey box which represents the LIBRTI block house. (https://ccfe.ukaea.uk/programmes/fusion-futures/librti/)

LIBRTI modular pincell

A breeder blanket concept used for isotope production



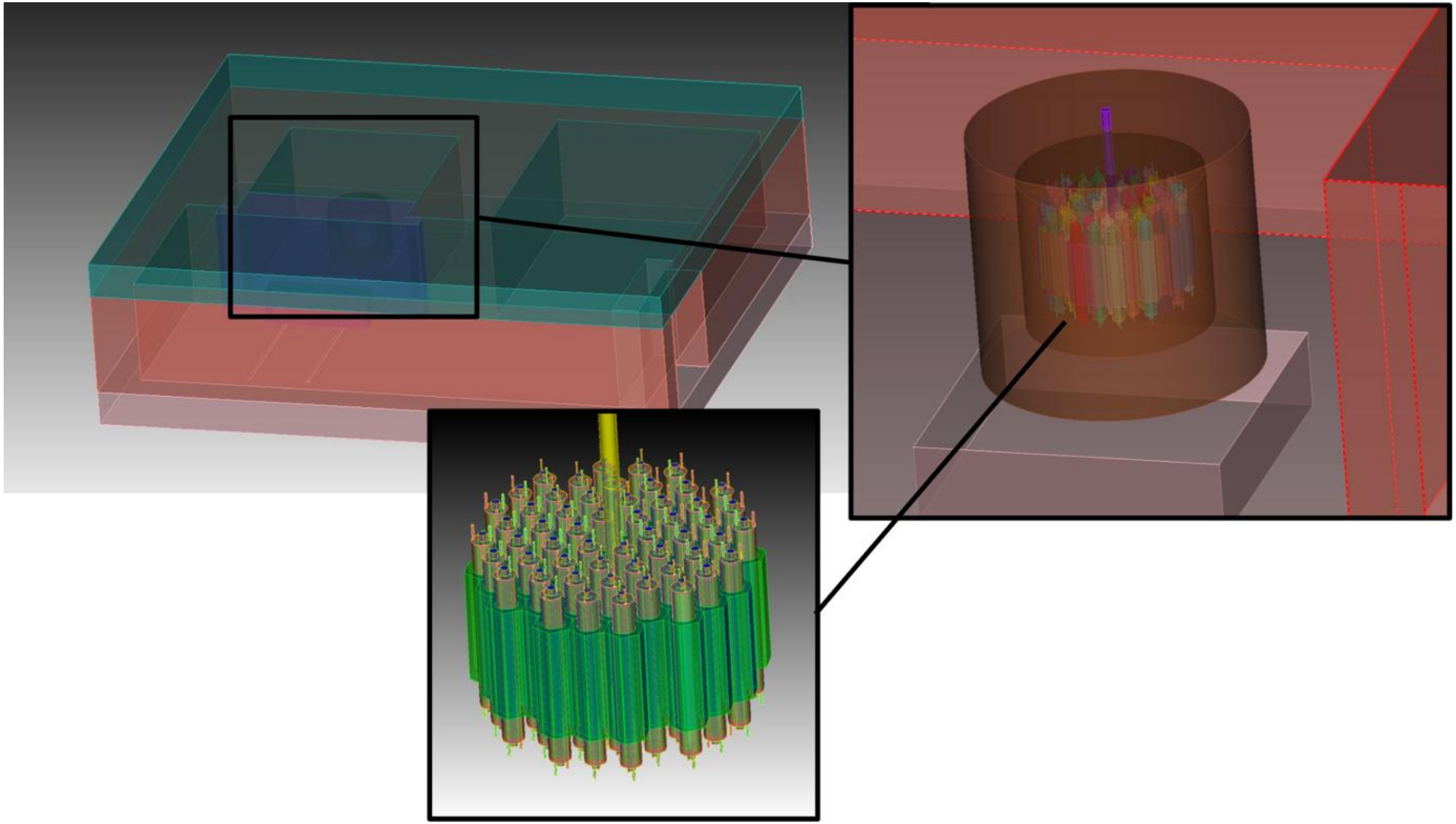


Neutron multiplier

Isotope breeder material

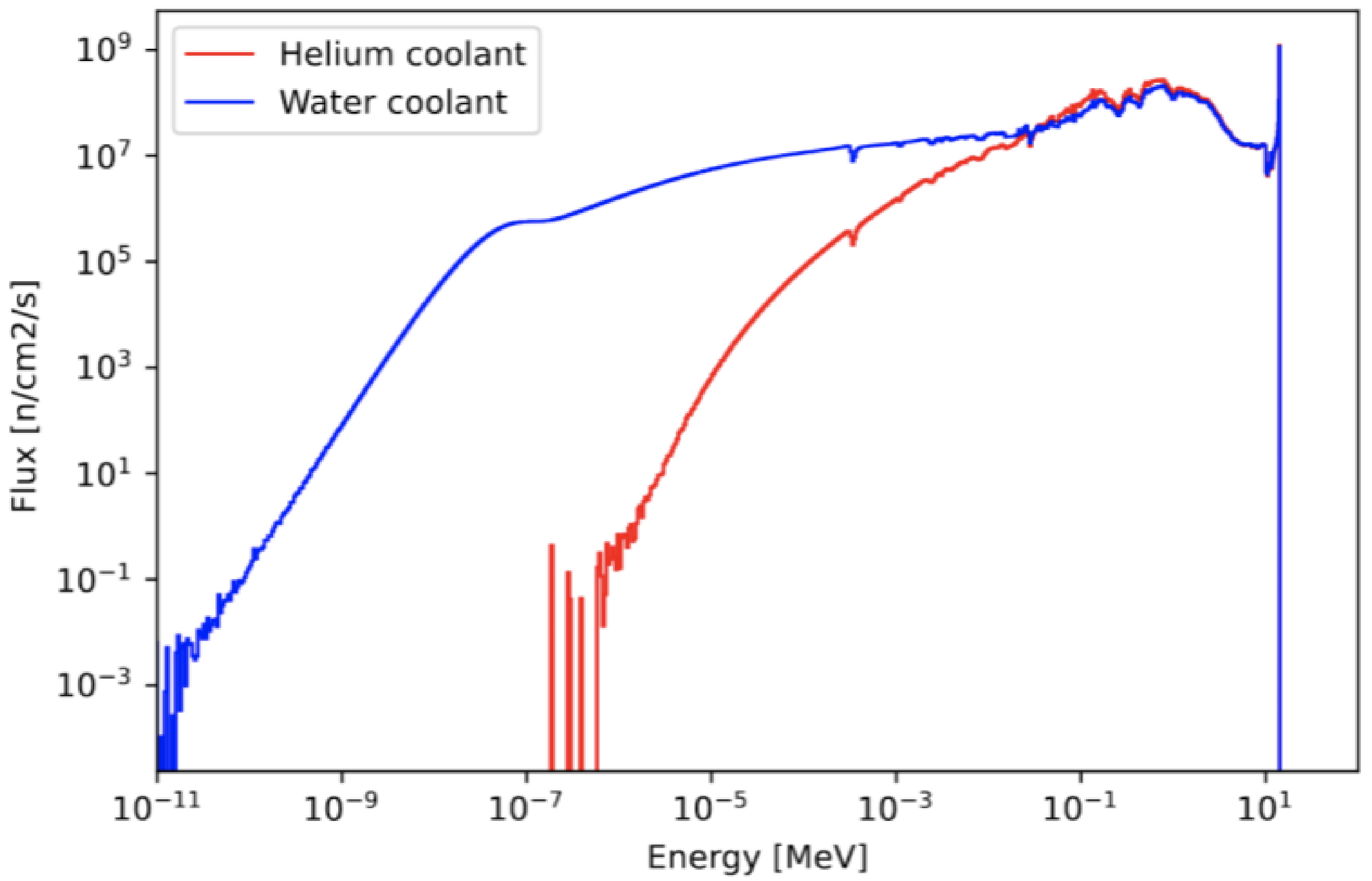
Coolant

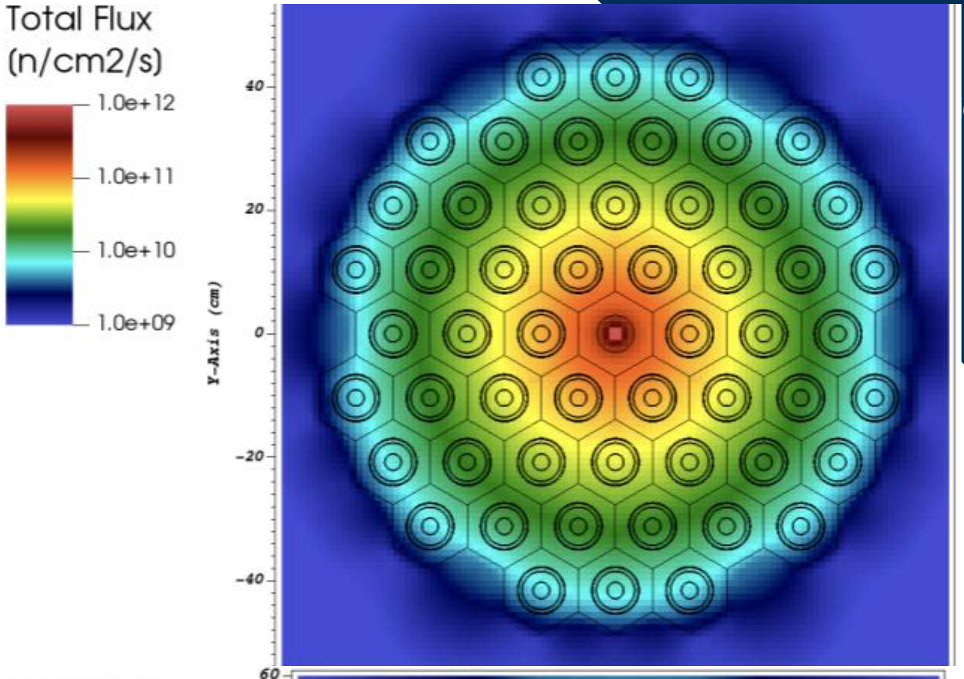
Neutron spectrum modeling

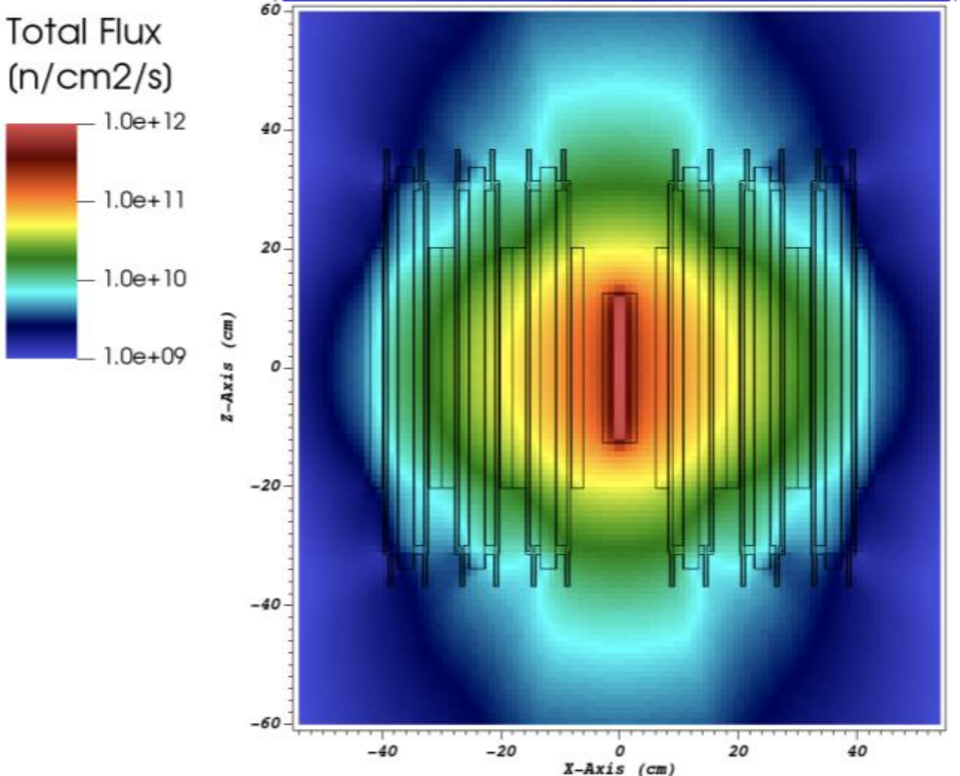


Neutron transport (OpenMC) model of the Modular pincell within the LIBRTI facility

Neutron spectrum modeling







Comparison of the average neutron spectrum within the pincell for different coolants. This shows that the neutron spectrum can be engineered, which is important to maximise key medical isotope production.

Isotope production within the LIBRTI facility

UK Atomic Energy Authority

		Yield (Bq/kg/day) in LIBRTI flux environments		
Target	Medical Isotope	Minimum	Average	Maximum
Mo100	Mo99	2.725E+8	3.065E+9	1.666E+10
Cu	Cu64	8.945E+8	4.855E+9	2.009E+10
Zn	Cu64	1.577E+8	1.342E+9	6.648E+9
Lu	Lu177	2.791E+7	8.601E+7	1.916E+8
Ra226	Pb212	1.722E+7	2.231E+8	1.250E+9
Ra226	Ac225	1.187E+6	1.206E+7	6.380E+7

Medical isotope yield (activity per target mass per irradiation time – Bq/kg/day) from an identified target irradiated with the expected spectra at different reference points within the model.

Summary

UK Atomic Energy Authority

- Fusion vs Fission Mo99 production:
  - Understood that Mo99 production from U238 becomes more significant for fusion. Depleted Uranium is a lower risk material
- Mo99 production in a breeder blanket:
  - Mo99 production per neutron is largest in the rear of the blanket, where the neutrons are *slower.* But the absolute production rate is higher at the front where the flux is higher.
- Identification of all isotope production routes
  - Scans all nuclides/elements to model isotope production.
    - Help identify optimal production routes as a function of facility
  - Can be altered to include more spectra (and projectiles)
- Used the Modular Pincell as a concept isotope production device
  - Further refinement is required
  - Concept model of Mo99, Cu64, Lu177, Pb212 and Ac225 production. Which could be used for trials etc.

Thank you very much

UK Atomic Energy Authority

Radionuclides for Health UK

Jennifer Young, Barts Cancer Institute - Queen Mary University of London

Barts Cancer Institute

Radionuclides for Health UK

Fusion for Medical Radionuclides UKAEA
September 2025

Dr Jennifer Young
jennifer.young@qmul.ac.uk

CANCER RESEARCH UK | City of London Centre | UCL, King's, Barts & the Crick

Radionuclides For Health UK

Dr Jane Sosabowski
Reader in Molecular Imaging
Barts Cancer Institute

Dr Jennifer Young
Postdoctoral Research Associate
Barts Cancer Institute

Prof Phil Blower
Professor of Imaging Chemistry, Head of Department of Imaging Chemistry and Biology

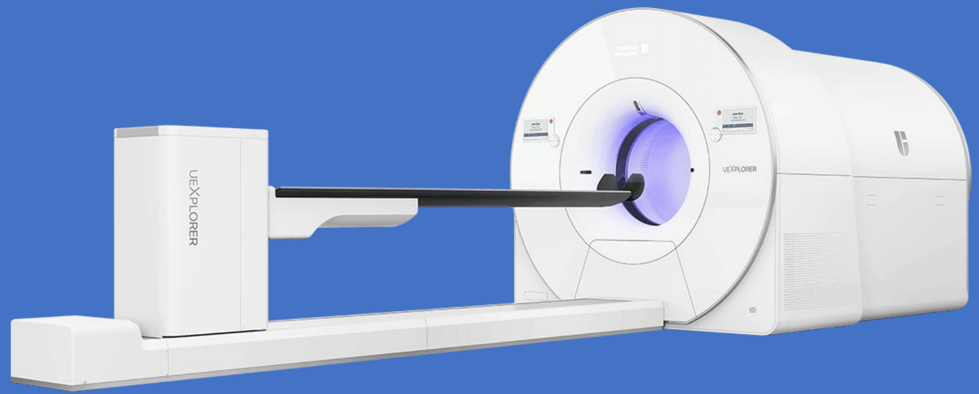
UKRI Engineering and Physical Sciences Research Council
UKRI Research England
Queen Mary University of London
Catapult Medicines Discovery
MITHRAS Next Generation Molecular Imaging and Therapy with Radionuclides
BNMS British Nuclear Medicine Society
National Nuclear Laboratory
Department for Energy Security & Net Zero
University of Cambridge
University of Oxford
King's College London
Newcastle University
UCL
NIHR National Institute for Health Research
CTRad NCRI Radiotherapy Research Group
Barts Cancer Institute
inflect Partners
Cancer Research UK Centre for Drug Development
KWF
27 EU Prismap
ICR The Institute of Cancer Research
Manchester 1824 The University of Manchester
University of Birmingham
Imperial College London
University of Southampton
Cancer Research UK Beatson Institute
Cancer Research UK RadNet City of London
IPEM Institute of Physics and Engineering in Medicine
NPL National Physical Laboratory
NOAR
Invicro
BIR The British Institute of Radiology
Prifysgol Bangor University
Neuroendocrine Cancer UK
Barts Charity
The Royal Marsden NHS Foundation Trust
ATLEY Solutions
RSC Interest Group Radiochemistry
ImaginAb
IDUG
University of Hull
University of Copenhagen
Astral Systems
Prostate Cancer UK
Llywodraeth Cymru Welsh Government
cyclife aquila nuclear EDF Group

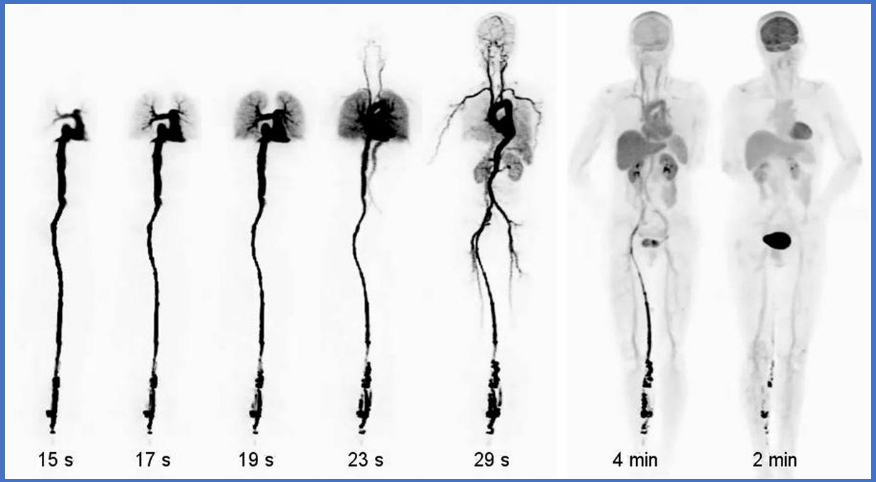
Radionuclides For Health UK

Nuclear Medicine Resurgence

Driven by two complementary areas

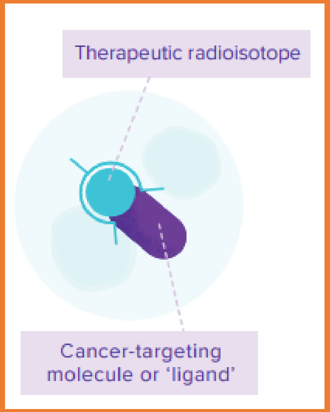
Total Body Positron Emission Tomography (PET)

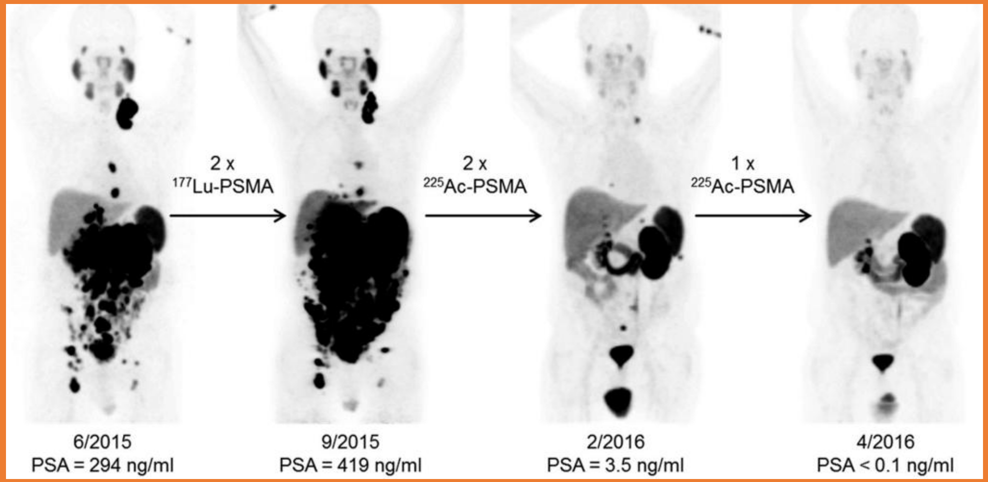




Journal of Nuclear Medicine March 2019, 60 (3) 299-303

Molecular Radiotherapy





Kratochwil et al, J Nucl Med 2016; 57:1941–1944

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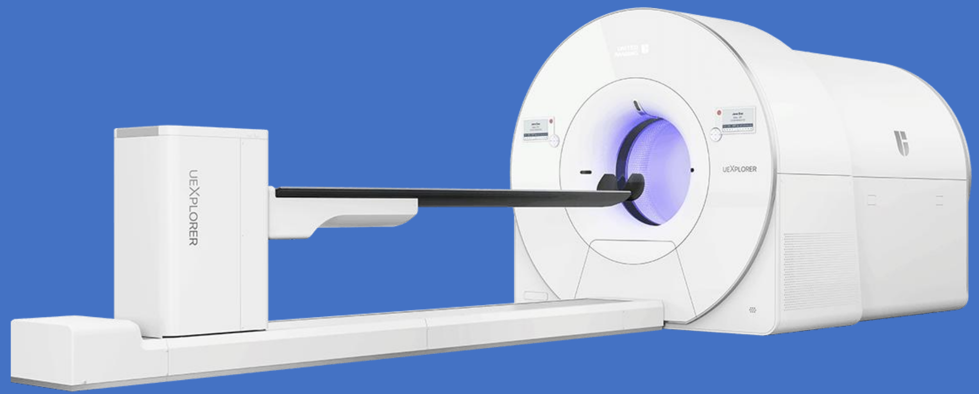
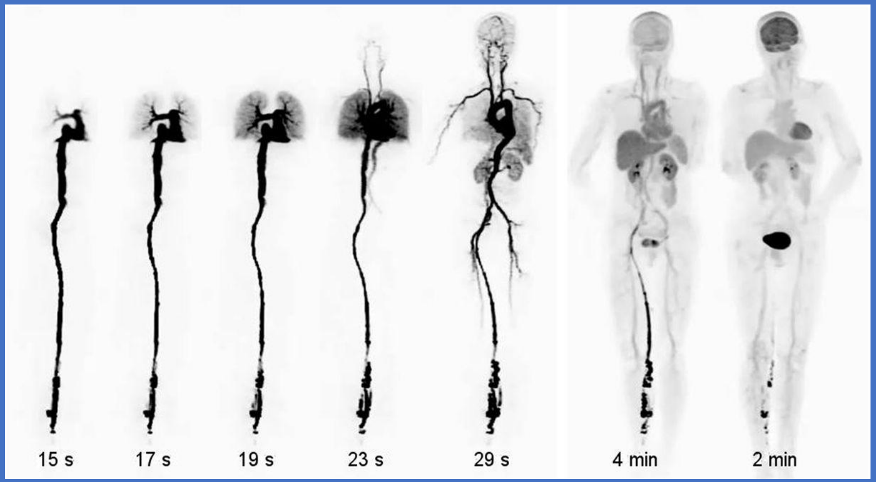




Journal of Nuclear Medicine March 2019, 60 (3) 299-303

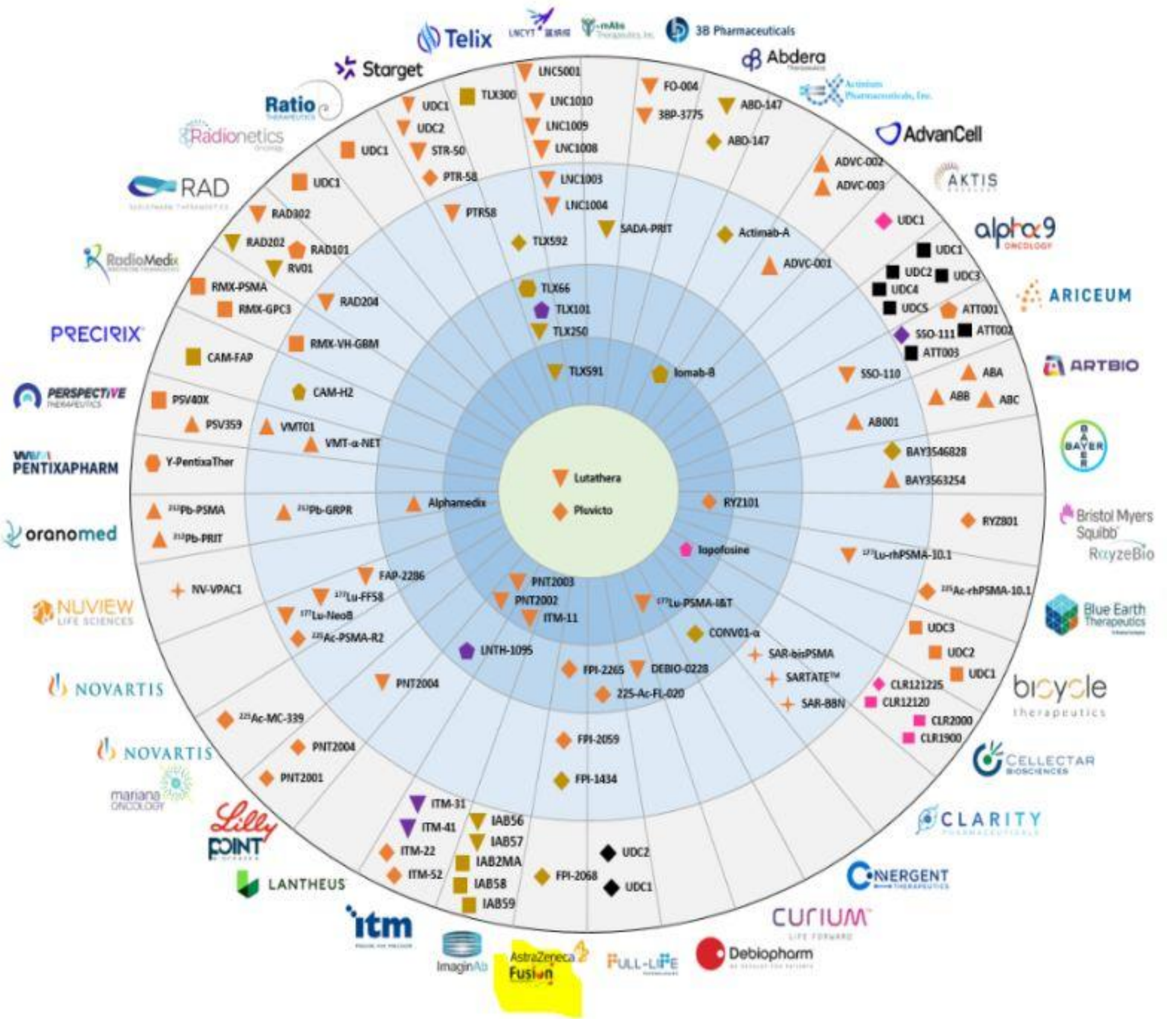
NPIP

With an investment of £32 million from the UK Government through UK Research and Innovation (UKRI), NPIP's ground breaking total-body PET technology platform will help drive the nation's reputation as a global life science superpower.

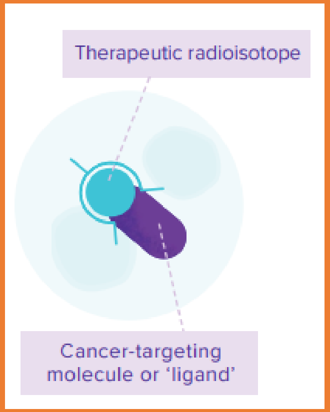
Radionuclides
For Health
UK

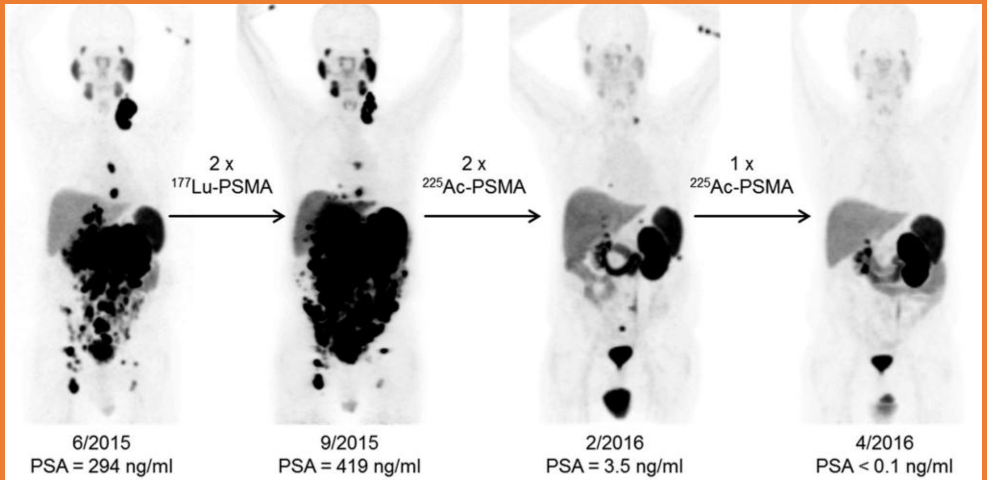
Nuclear Medicine Resurgence

Driven by two complementary areas



Molecular Radiotherapy





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Driven by two complementary areas

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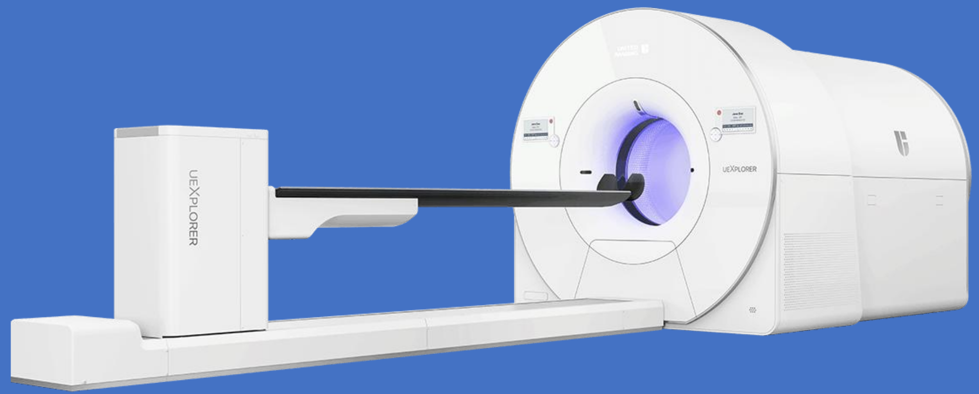

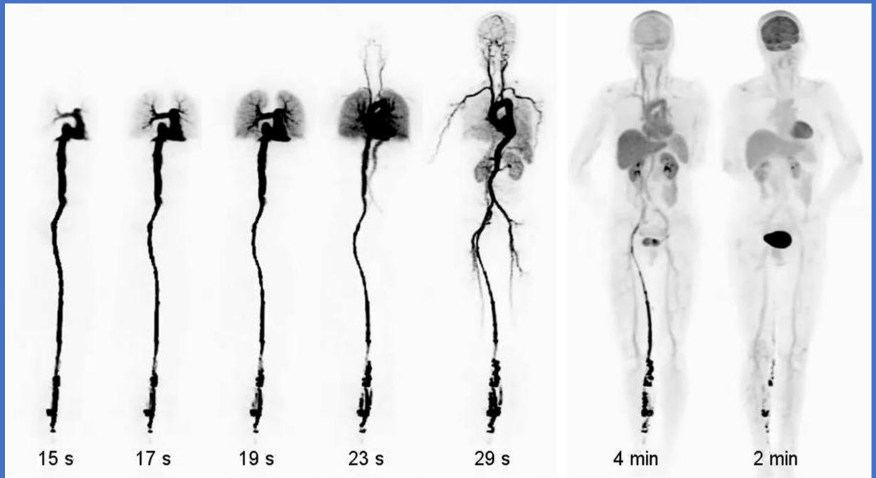

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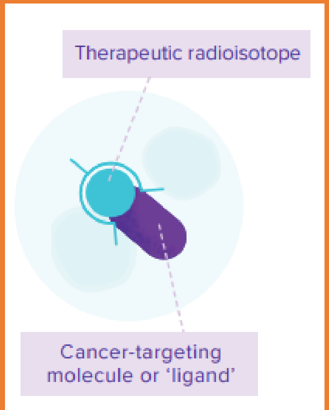

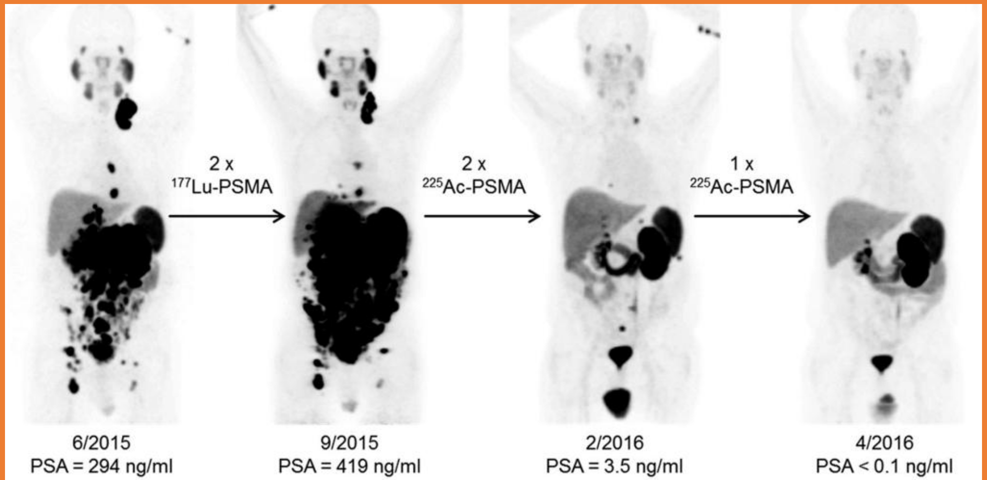

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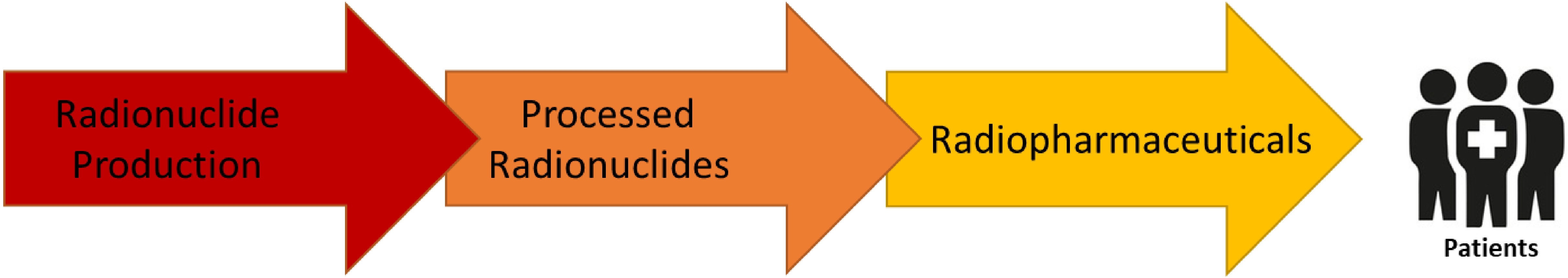
Radionuclides For Health UK

Vision for UK

From Radionuclide Production to Molecular Radiotherapy for Patients



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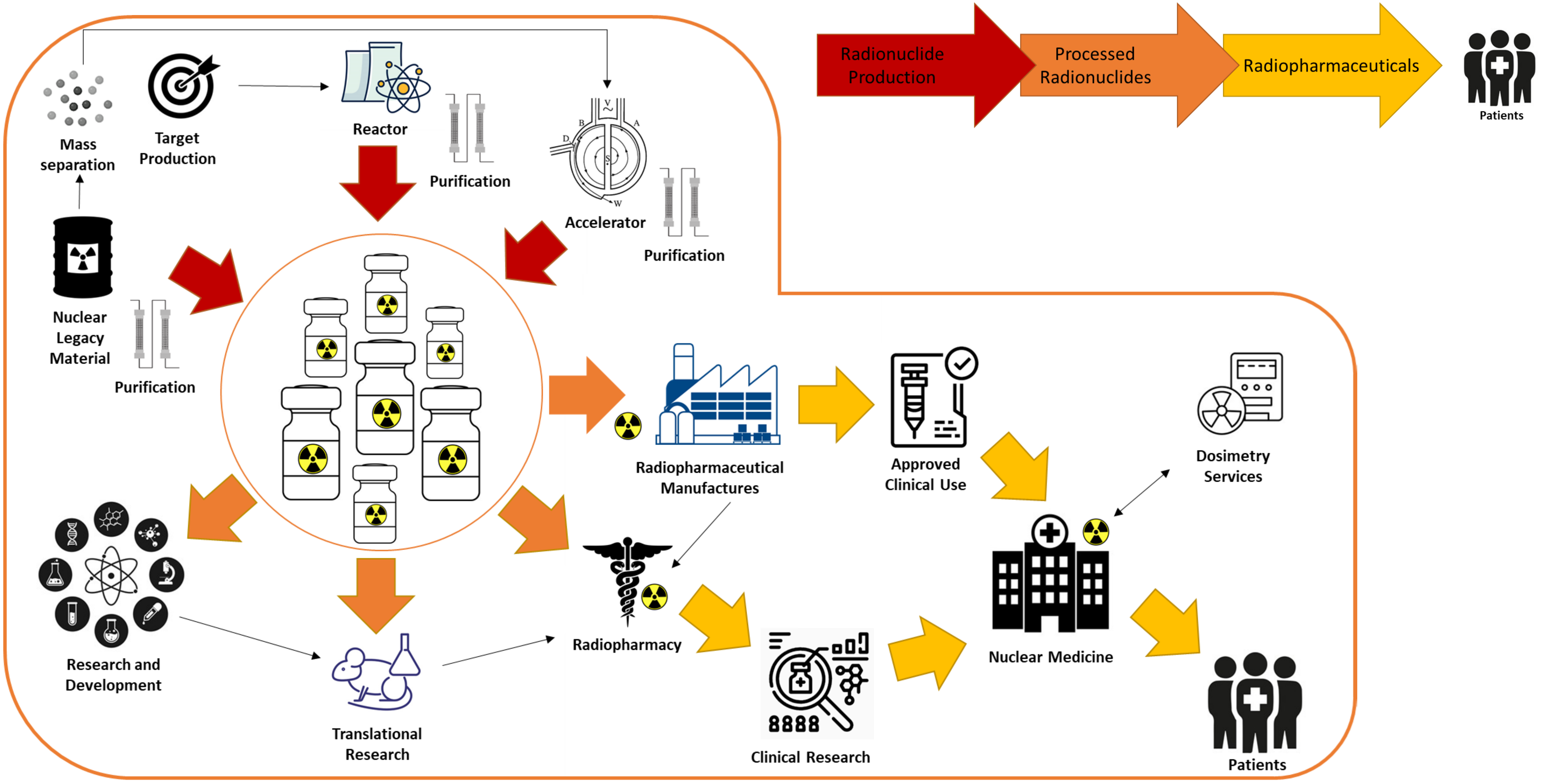

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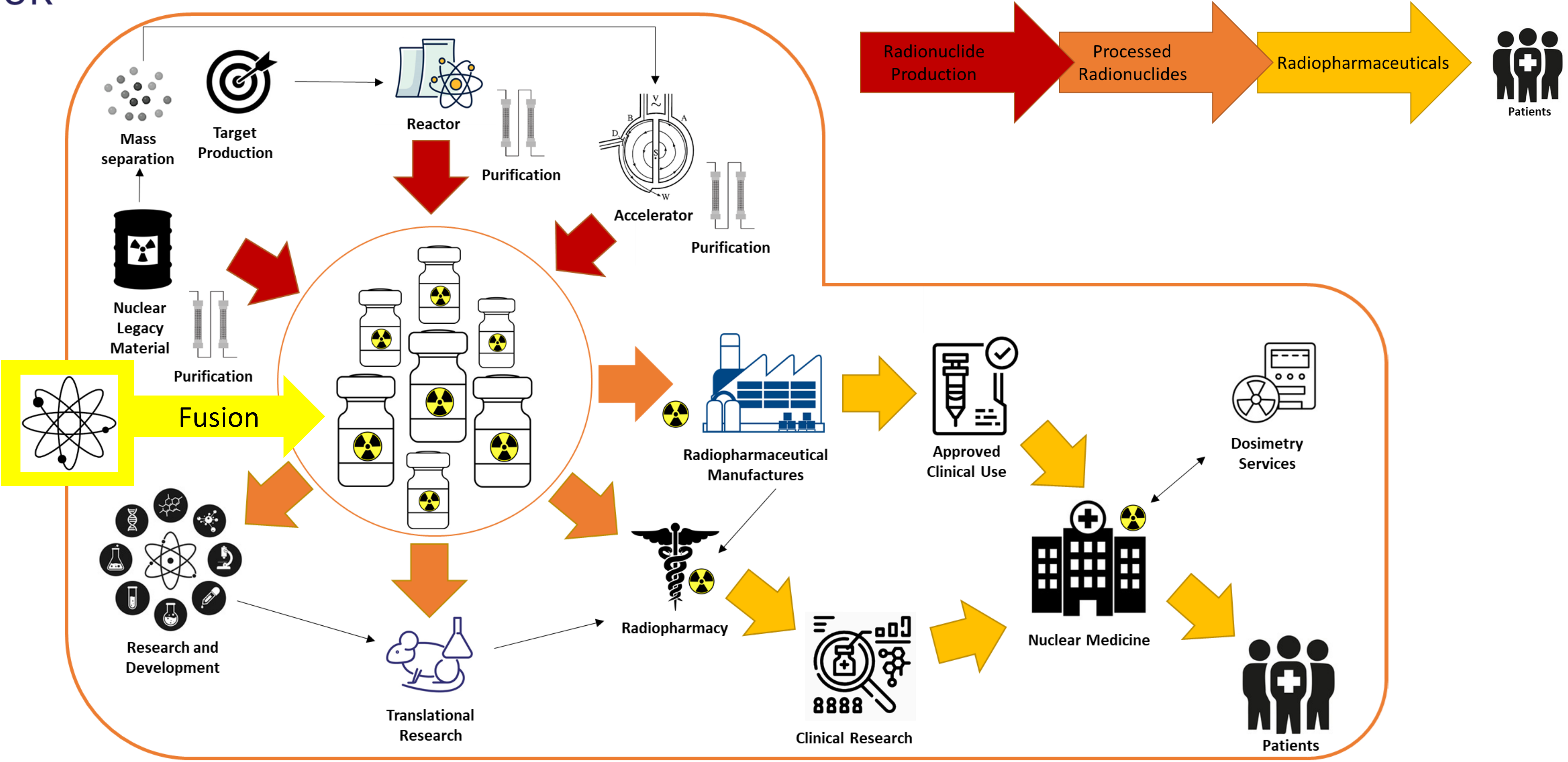

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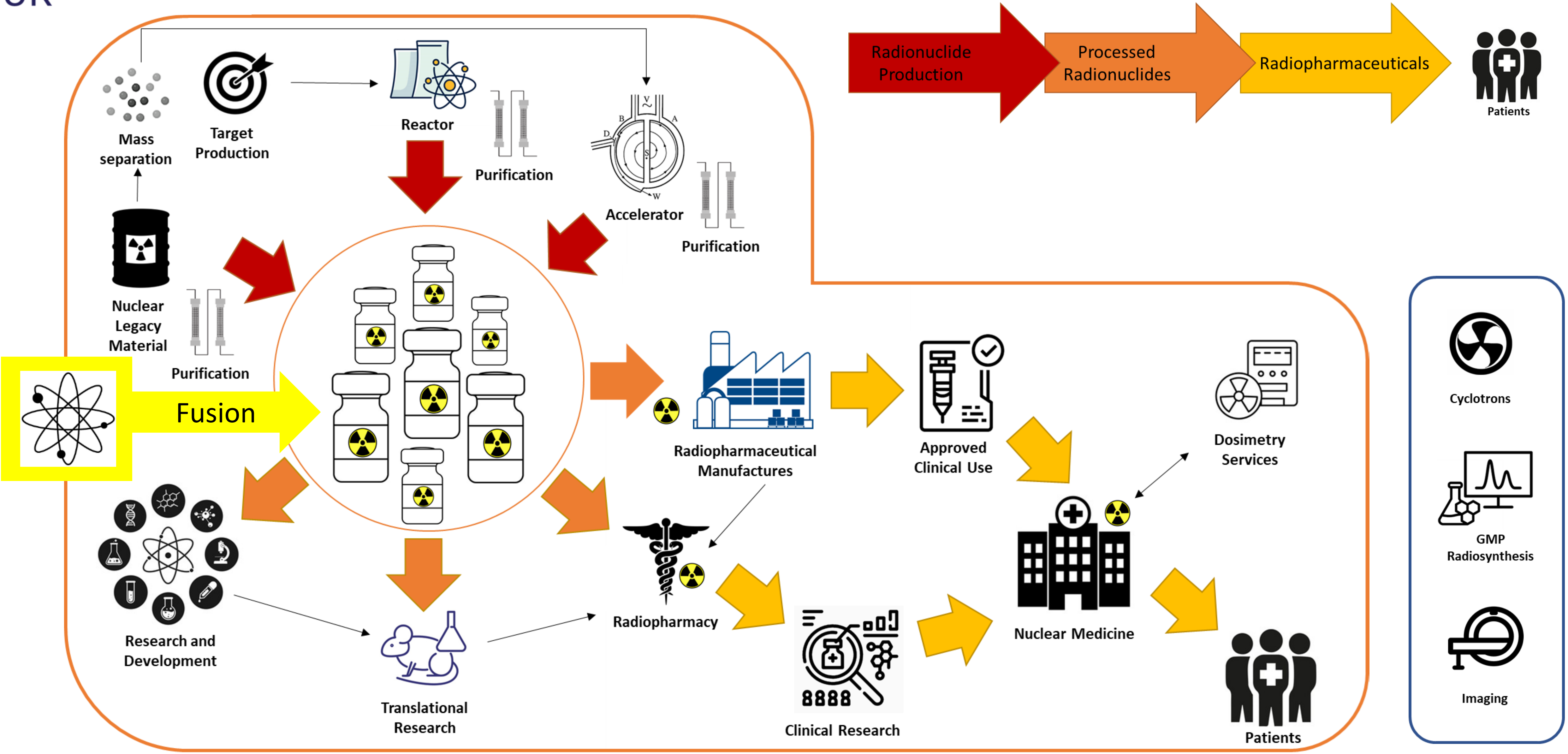

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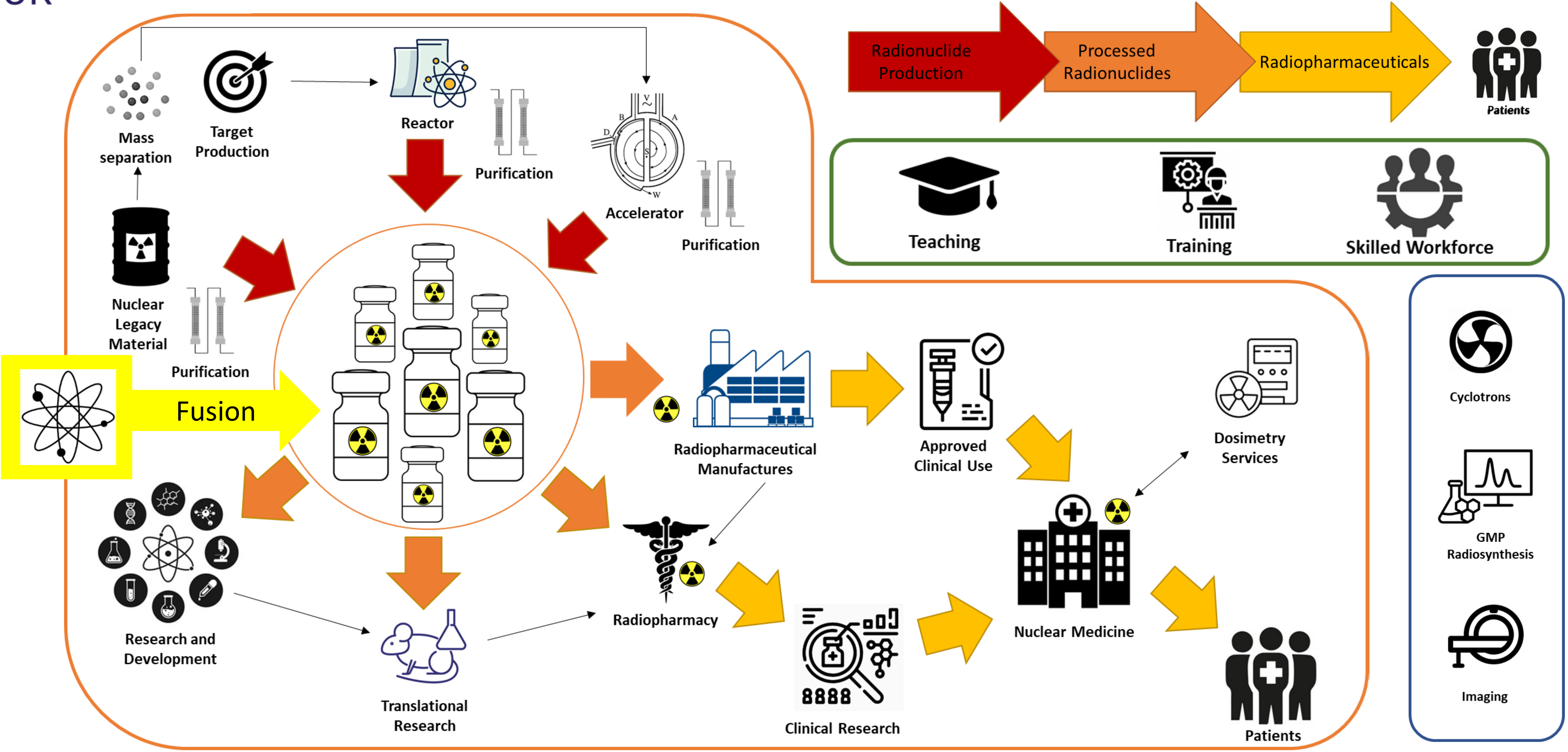
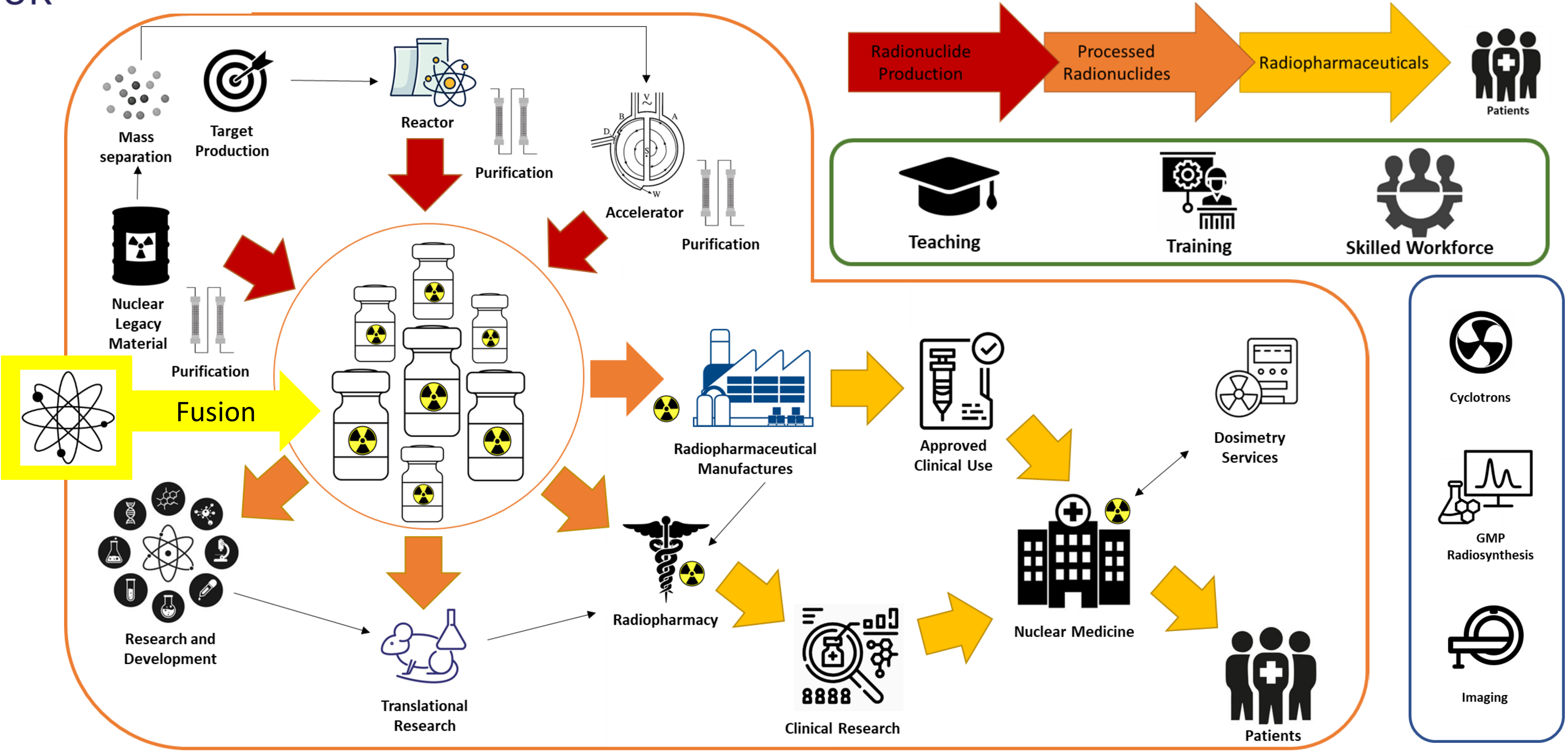


Radionuclides For Health UK

What do we have now?



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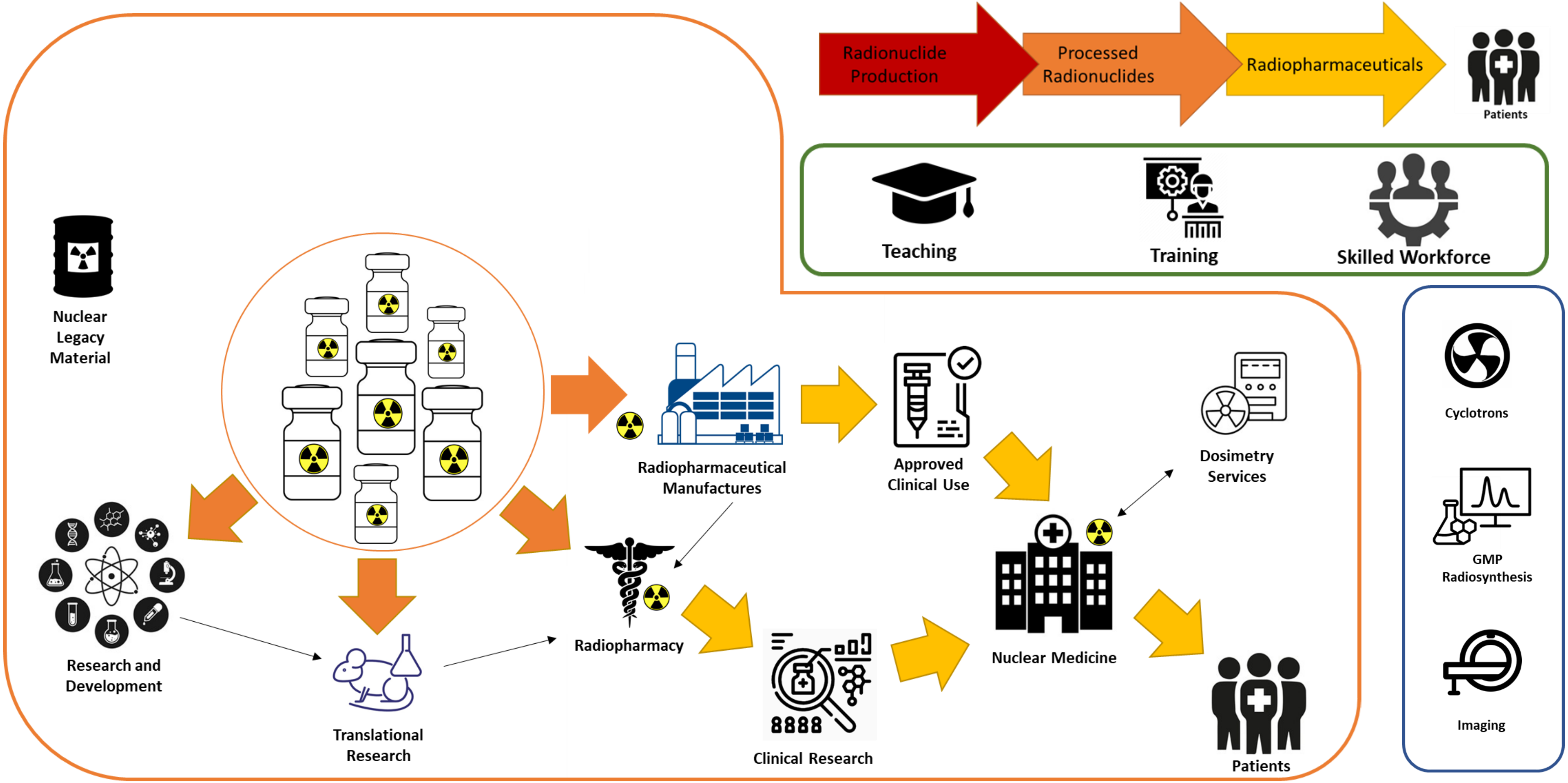

Radionuclides For Health UK

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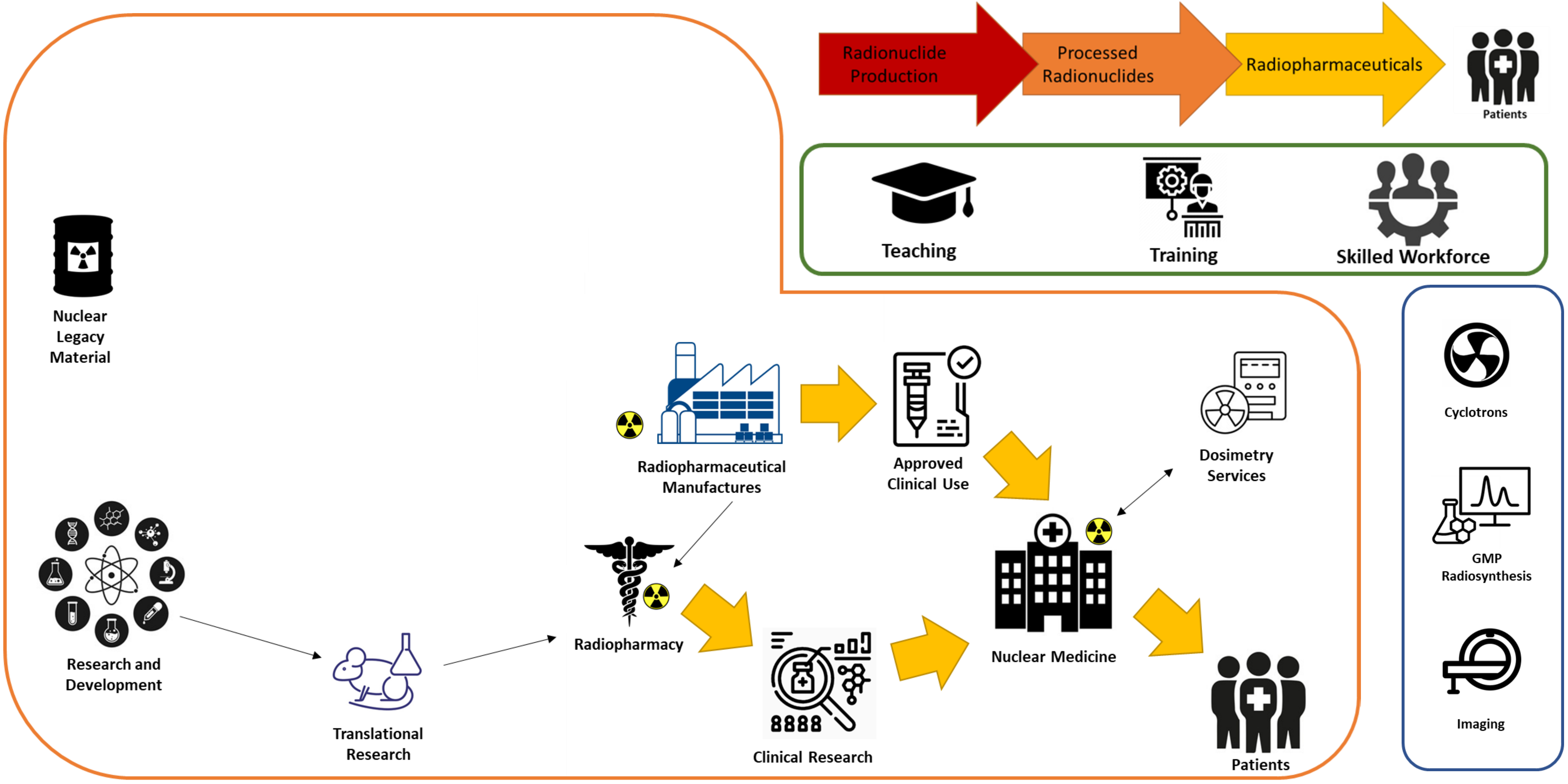

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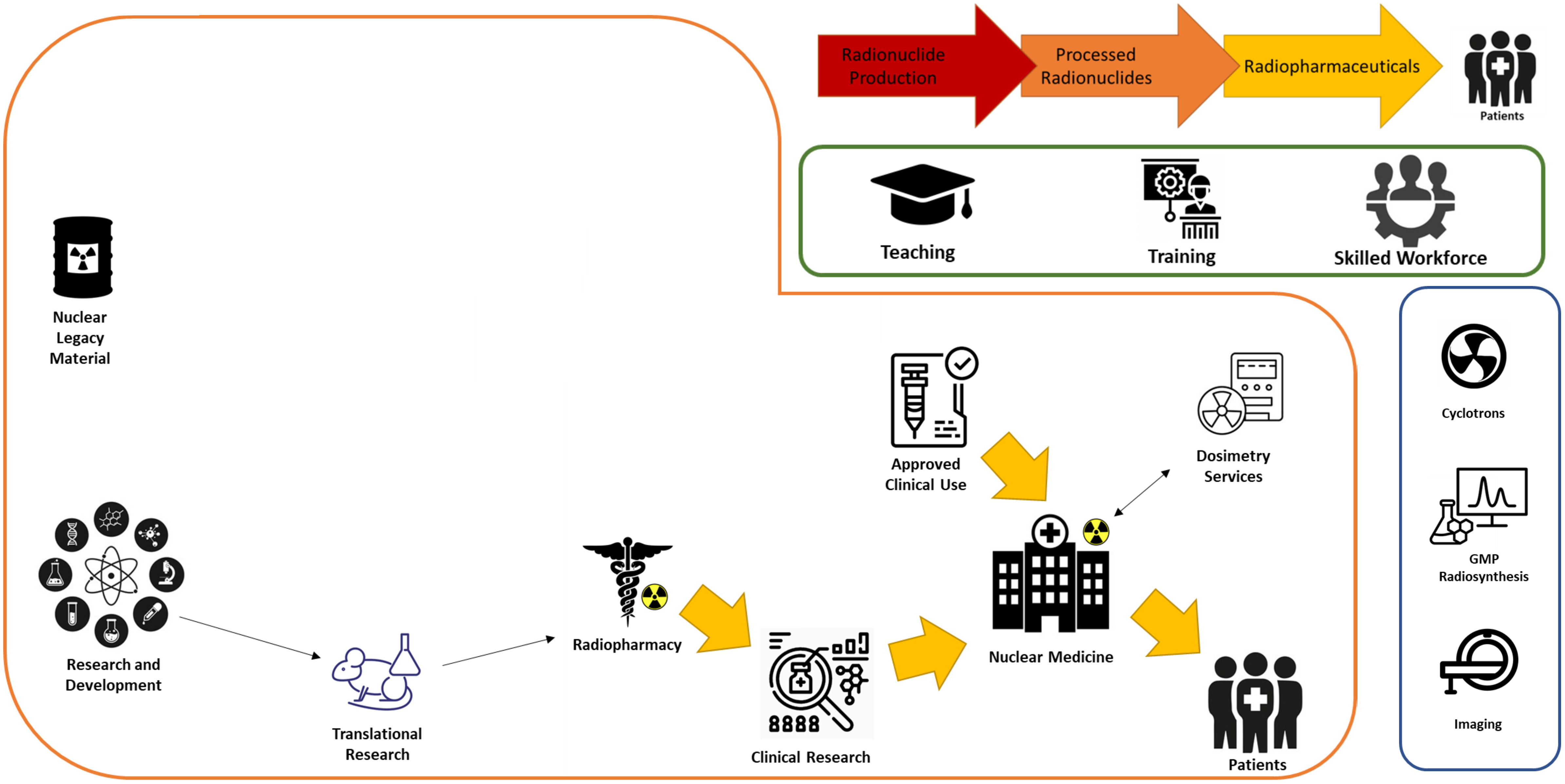

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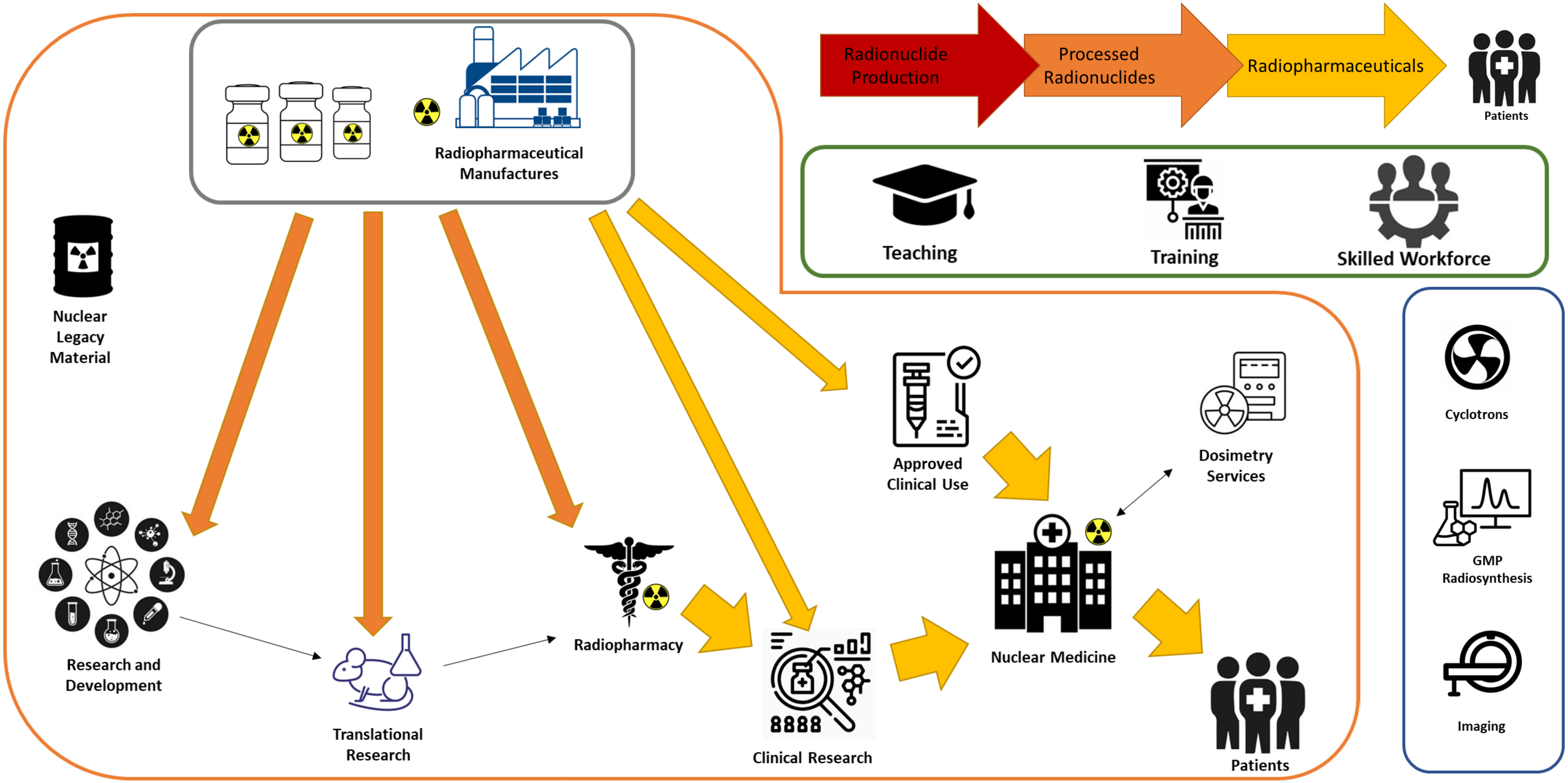

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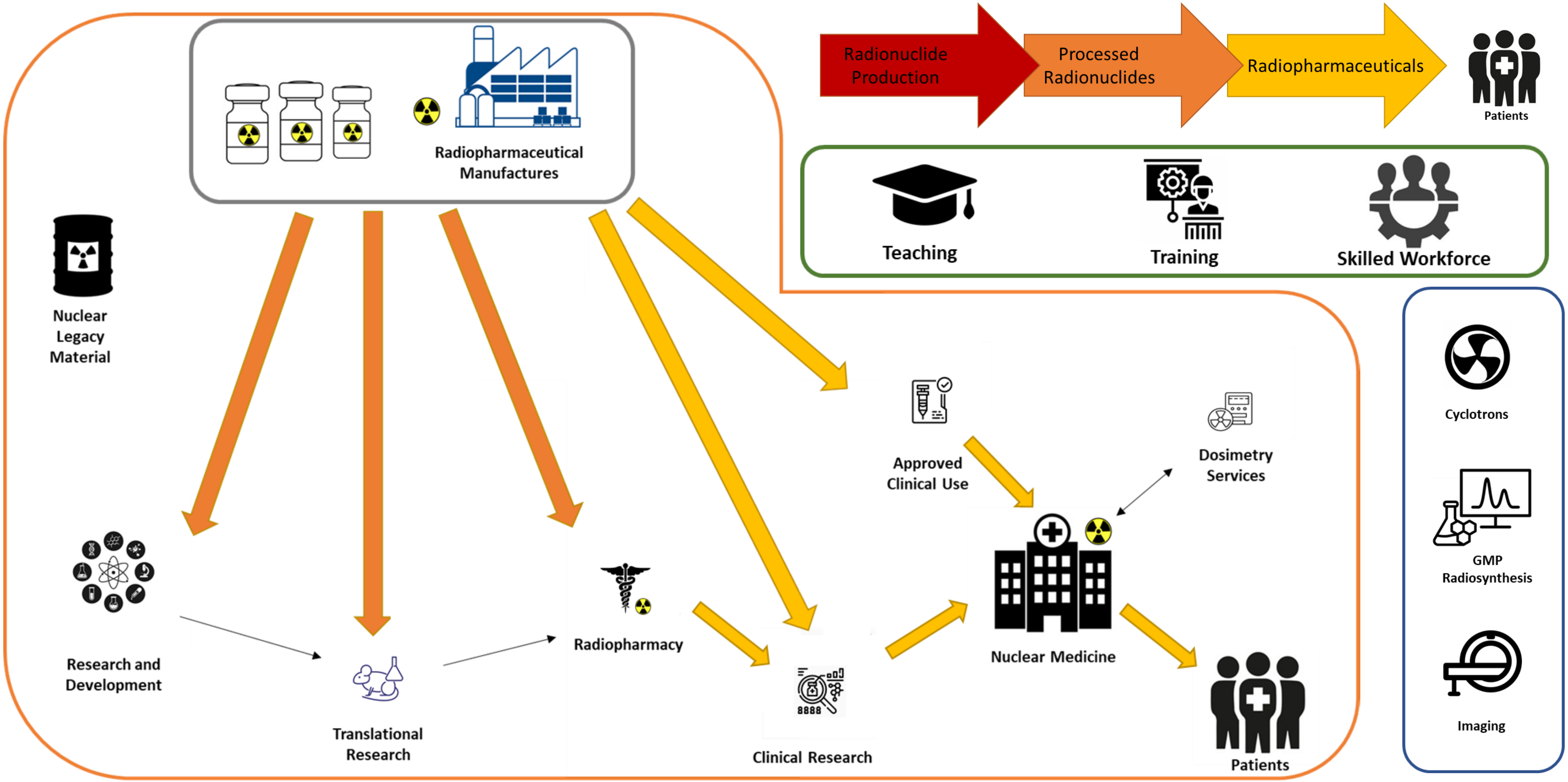

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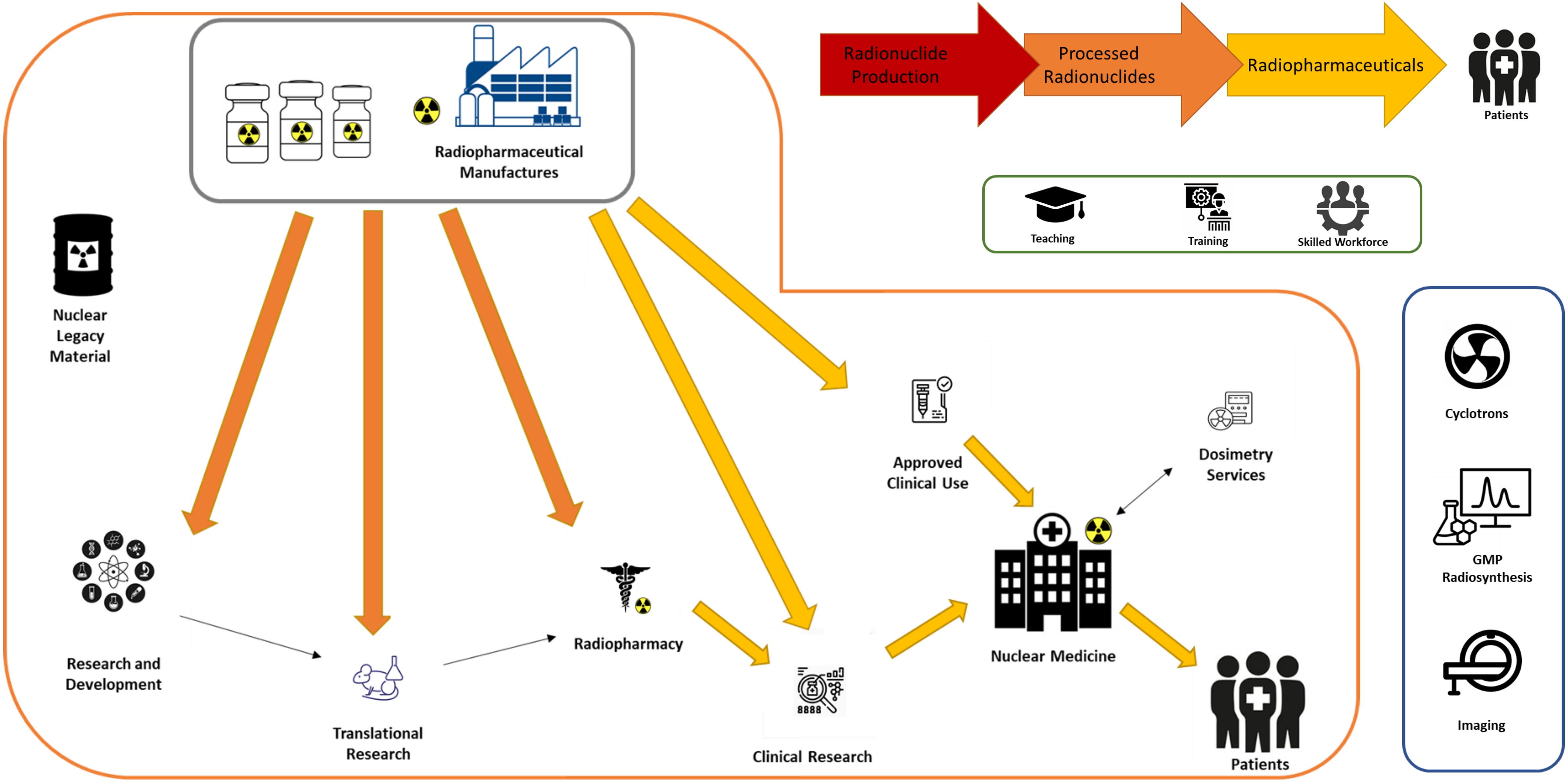
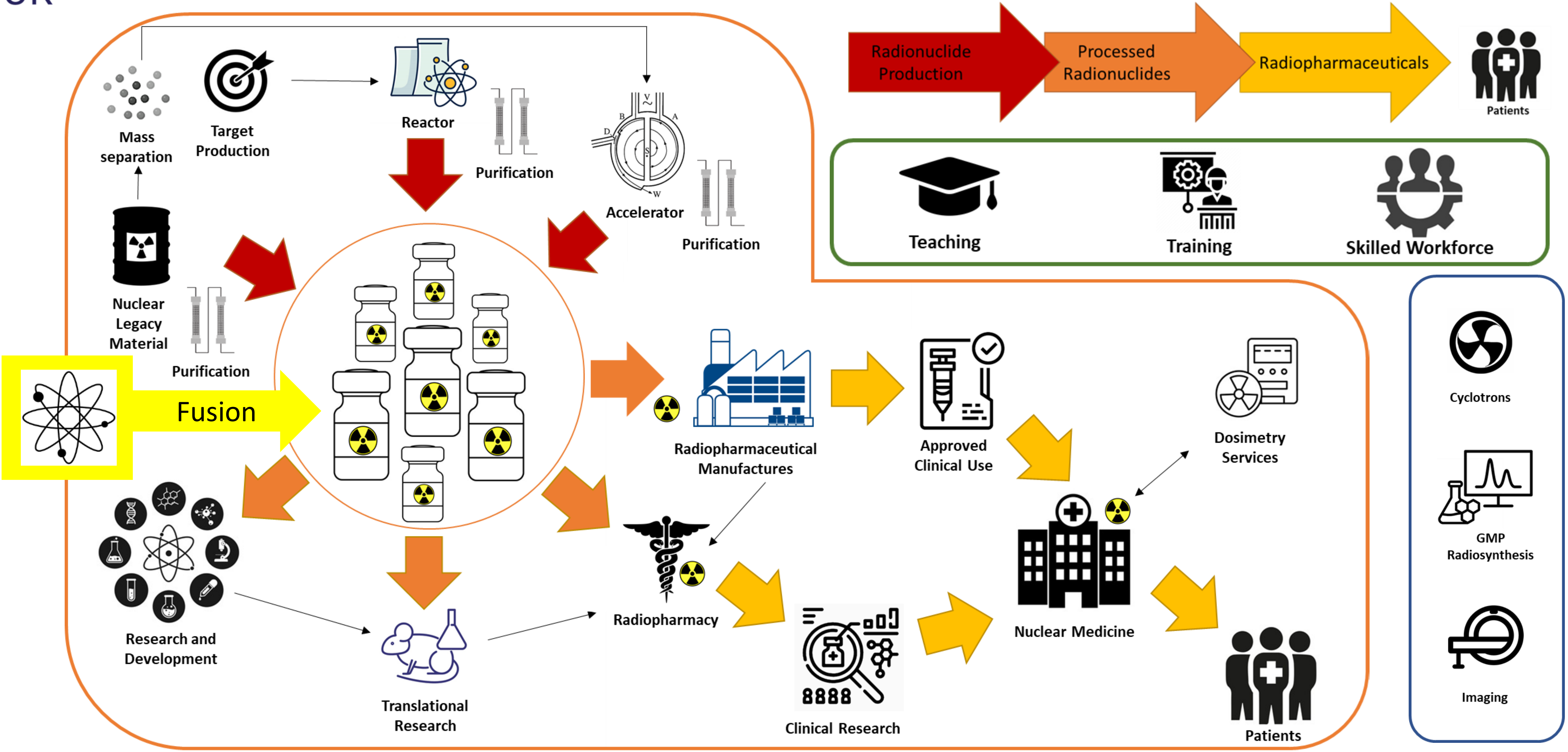


Vision for UK

From Radionuclide Production to Molecular Radiotherapy for Patients



UK Initiatives to Improve Radionuclide Supply

Queen Mary University of London

King's College London University of London

Radionuclides For Health UK

Department for Energy Security & Net Zero

Medical Radionuclide Innovation Programme

National Nuclear Laboratory

Llywodraeth Cymru Welsh Government

Advanced Radioisotope Technology for Health Utility Reactor (ARTHUR)

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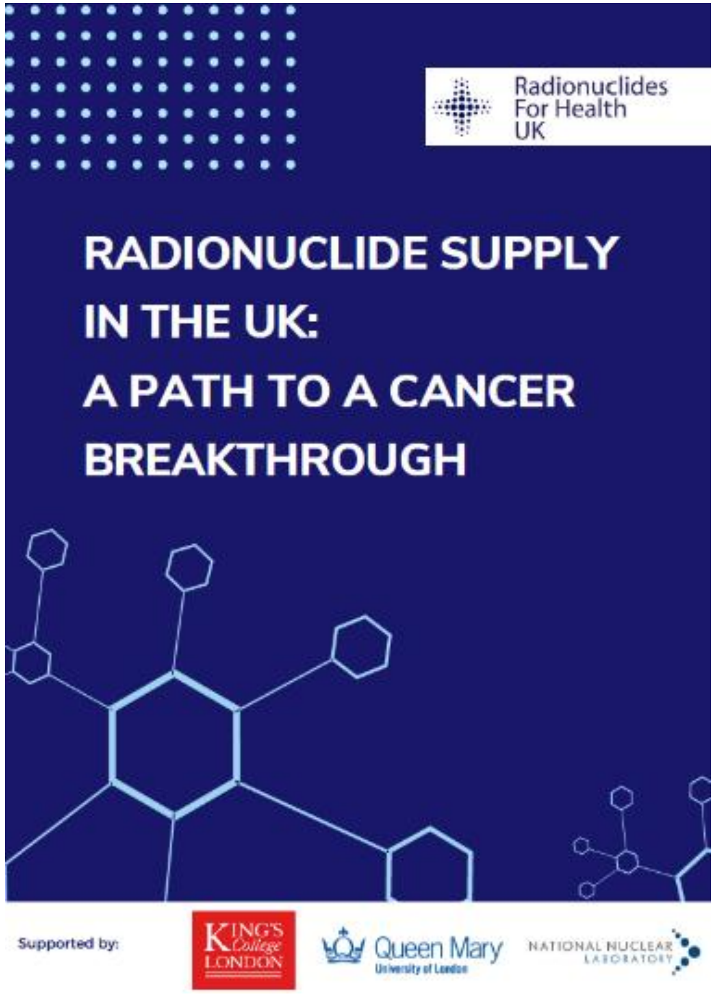
Advocacy for Improved Radionuclide Supply to Support Research and Benefit Patients



1. Nuclear infrastructure
2. Processing capabilities
3. Regulatory framework
4. Centralised radiopharmacy
5. Skills gap

https://www.bartscancer.london/radionuclides-for-health-uk/

Research Projects

Research Projects
At-211
I-124
Lead-212

Radionuclides For Health UK

Department for Energy Security and Net Zero

Medical Radionuclide Innovation Programme

Department for Energy Security & Net Zero

Medical Radionuclide Innovation Programme

Dept for BEIS
@beisgovuk
Official

Yesterday, Chief Scientific Advisor @psmonks visited @HuMIC_ to launch a £6m Medical Radionuclide Innovation Programme – a new scheme developing technologies which will produce nuclear materials for diagnostics and cancer therapies #InnovationNation

Awarded Innovation Projects	
Queen Mary University of London: Development of UK **Astatine-211** Production Capability	Cyclife Aquila Nuclear: Hot Cells to House a **Lead-212** Generator for Integration Into a Hospital Environment
King's College London: Development of UK **Iodine-124** Production Capability	National Physical Laboratory: Research of the End-to-End Accelerator Production of **Actinium-225** from Radium-226
Urenco: Development of UK Supply Chain for **Copper** Medical Isotopes	Dalton Cumbrian Facility: Optimised Production of Theragnostic Isotopes of **Copper and Scandium**
National Nuclear Laboratory: Investigating the Recovery of Strontium-90 From Legacy Nuclear Material for the Sustained Production of **Yttrium-90** for Targeted Therapies	National Nuclear Laboratory: Sustainable Production of Radionuclides for **Targeted Alpha Therapy** from UK Stocks of Recycled Uranium
National Nuclear Laboratory: Accelerated Supply of Radionuclides for Cancer Treatment by Developing Protactinium and **Actinium** Separation Techniques	National Physical Laboratory: Medical Radionuclide Production by Laser Wakefield Accelerator

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UK

Welsh Government

Project ARTHUR

Llywodraeth Cymru
Welsh Government

PRESS RELEASE

Welsh Government unveils major plans for national nuclear medicine laboratory in north Wales

Major new plans to make Wales a global centre of excellence and the leading location for medical radioisotope production in the UK, which would help address a fast-approaching supply crisis for nuclear medicine around the world have been unveiled today by the Welsh Government.

First published: 10 January 2023
Last updated: 10 January 2023

- Welsh Government's Project ARTHUR would see the creation of a public sector national laboratory for the supply of medical radioisotopes, needed for the diagnosis and treatment of diseases such as cancer.
- Facility would be a global centre of excellence in nuclear medicine, making Wales the leading location for medical radioisotope production in the UK.
- Development will lead to the creation of highly skilled jobs over several decades.
- Economy Minister calls on the UK Government to help fund the project to avoid a "future health and economic crisis."

Share this page:

In the UK, across Europe, and further afield, the equipment in facilities

Optioneering Technical Report	Completed in 2020
Office for Nuclear Regulations Study	Completed in 2021
Strategic Outline Business Case	Completed in 2021
Supply and Demand Study	Completed in 2022
Feasibility Study	Completed in 2024
Outline Business Case	Ongoing

Adjournment debate in UK Parliament on the 22nd Feb 2023

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UK National Nuclear Laboratory

Health and Nuclear Medicine Directorate

United Kingdom
National Nuclear
Laboratory

2.2.3

Health and Nuclear Medicine

Each year, thousands of NHS patients benefit from the advances of nuclear medicine in their treatment.

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SCIENCE

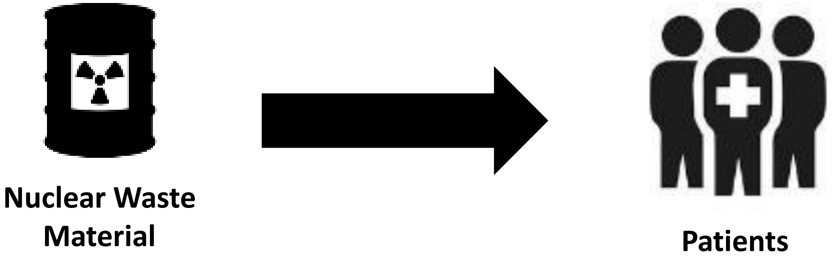
Nuclear waste could be used to target cancer cells

Kat Lay, Health Editor

Monday May 30 2022, 1.20pm, The Times

A production process has been developed that could mean waste from nuclear power stations such as Sizewell in Suffolk can be put to good use

ALAMY



Phase 1 clinical trial of Alpha particle PRRT with ^{212}Pb-DOTAMTATE

https://jnm.snmjournals.org/content/early/2022/01/06/jnumed.121.263230

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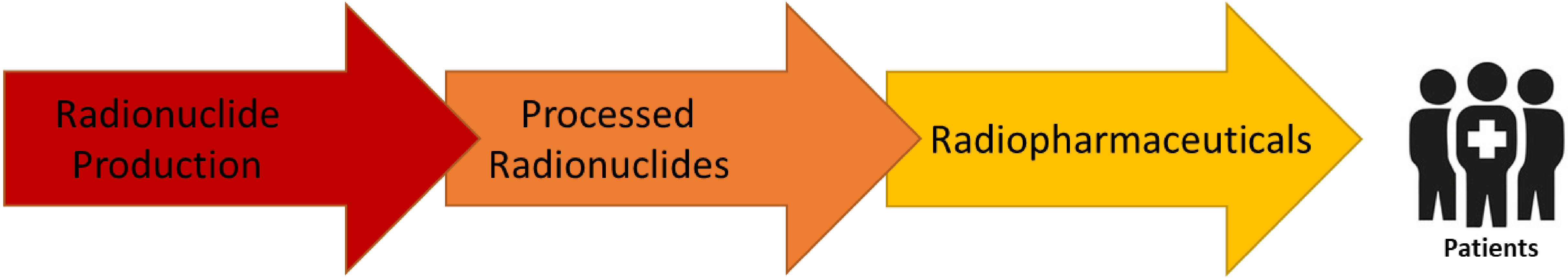
Vision for UK

From Radionuclide Production to Molecular Radiotherapy for Patients



Radionuclides For Health UK

Thank You

Queen Mary University of London
National Nuclear Laboratory
King's College London
Newcastle University
UCL
NIHR National Institute for Health Research
UKRI Engineering and Physical Sciences Research Council
Catapult Medicines Discovery
Department for Energy Security & Net Zero
CTRad NCRI Radiotherapy Research Group
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Manchester 1824 The University of Manchester
University of Birmingham
BNMS British Nuclear Medicine Society
University of Cambridge
University of Oxford
Imperial College London
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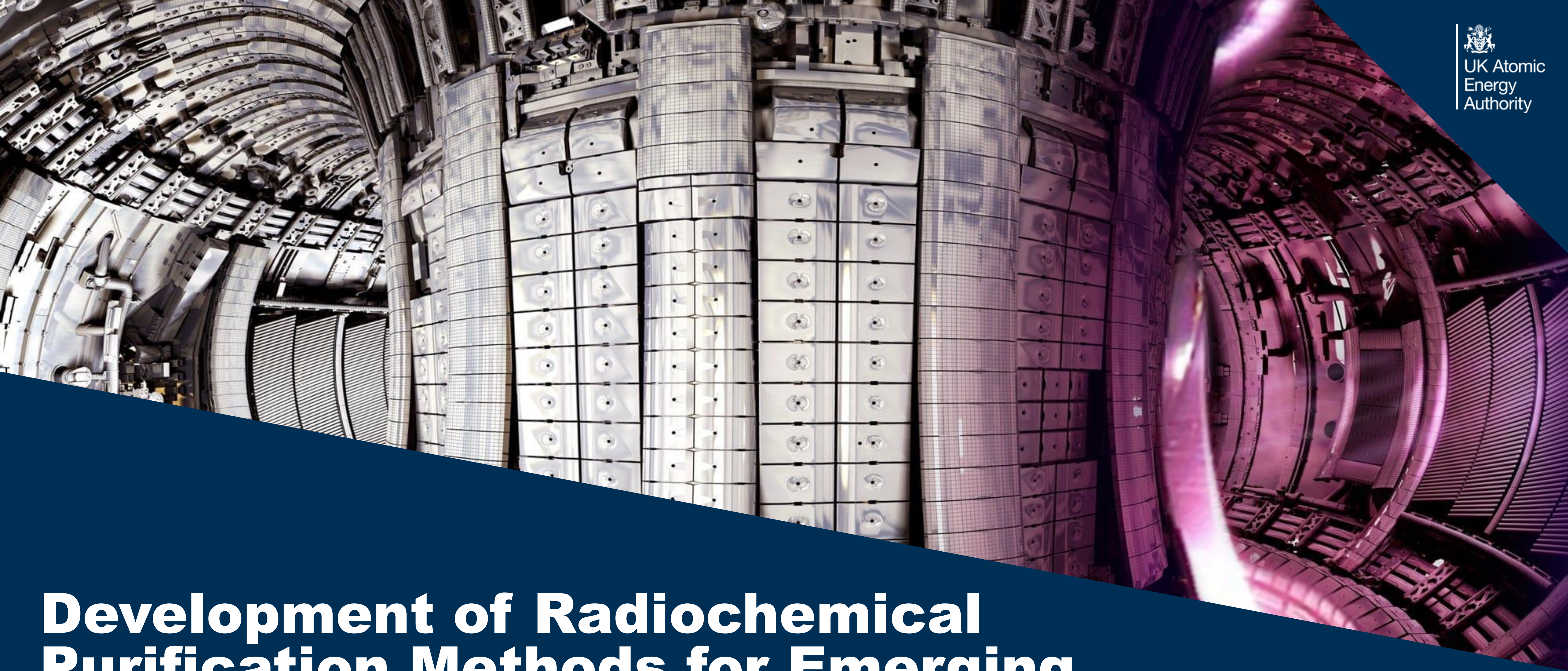
University of Hull
University of Copenhagen
Astral Systems
Prostate Cancer UK
Llywodraeth Cymru Welsh Government
cyclife aquila nuclear EDF Group

jennifer.young@qmul.ac.uk

UK Atomic Energy Authority

Coffee Break

See you at 11:45



UK Atomic Energy Authority

Development of Radiochemical Purification Methods for Emerging Medical Radionuclide Standards

Peter Ivanov, National Physical Laboratory

National Physical Laboratory

Development of radiochemical purification methods for emerging medical radionuclide standards

Peter Ivanov

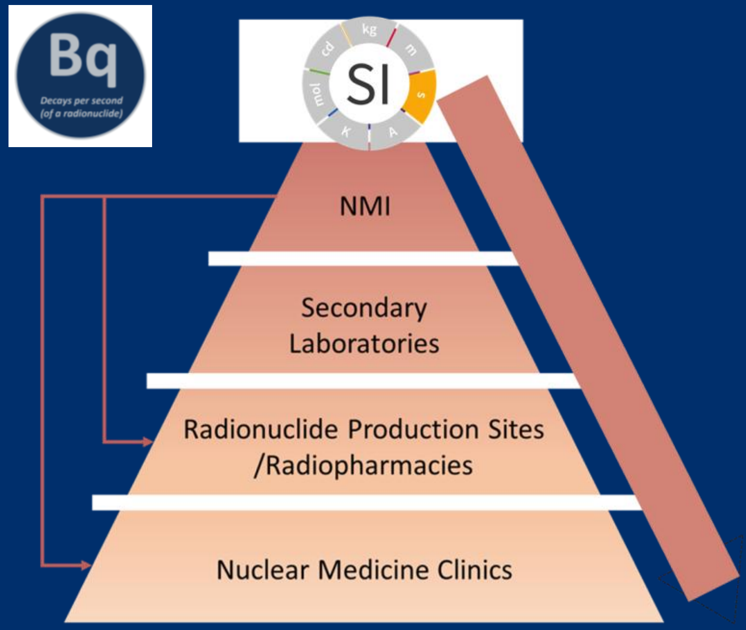
National Physical Laboratory

Fusion for Medical Radionuclides Event, 24 Sept 2025, UKAEA

NPL

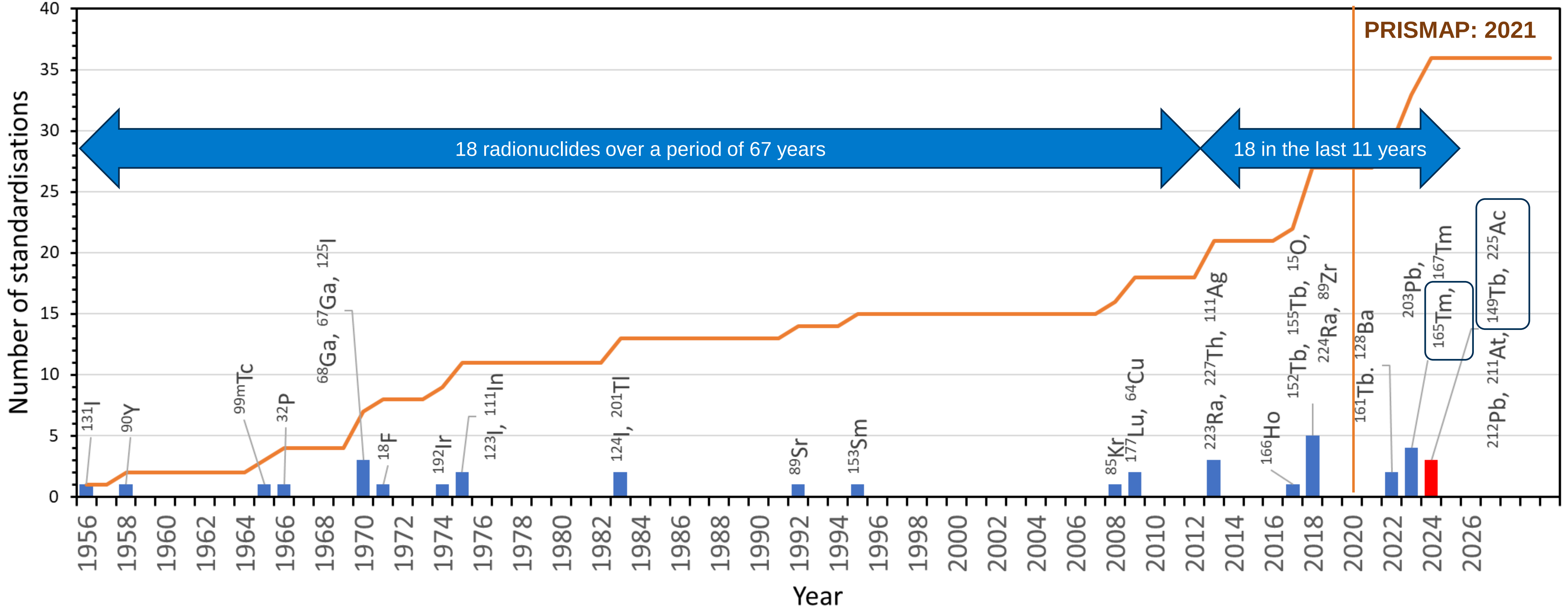
National Physical Laboratory

- A National Laboratory and the UK's National Measurement Institute (DSIT owned Public Corporation)
- A key part of the UK 's nuclear medicine infrastructure providing metrology support across value chain for more than 100 years.
- Expertise includes traceable radioactivity and radiochemistry measurements, imaging and therapeutic dosimetry.
- Strategic partnerships with industry, government, academia, charities and regulators



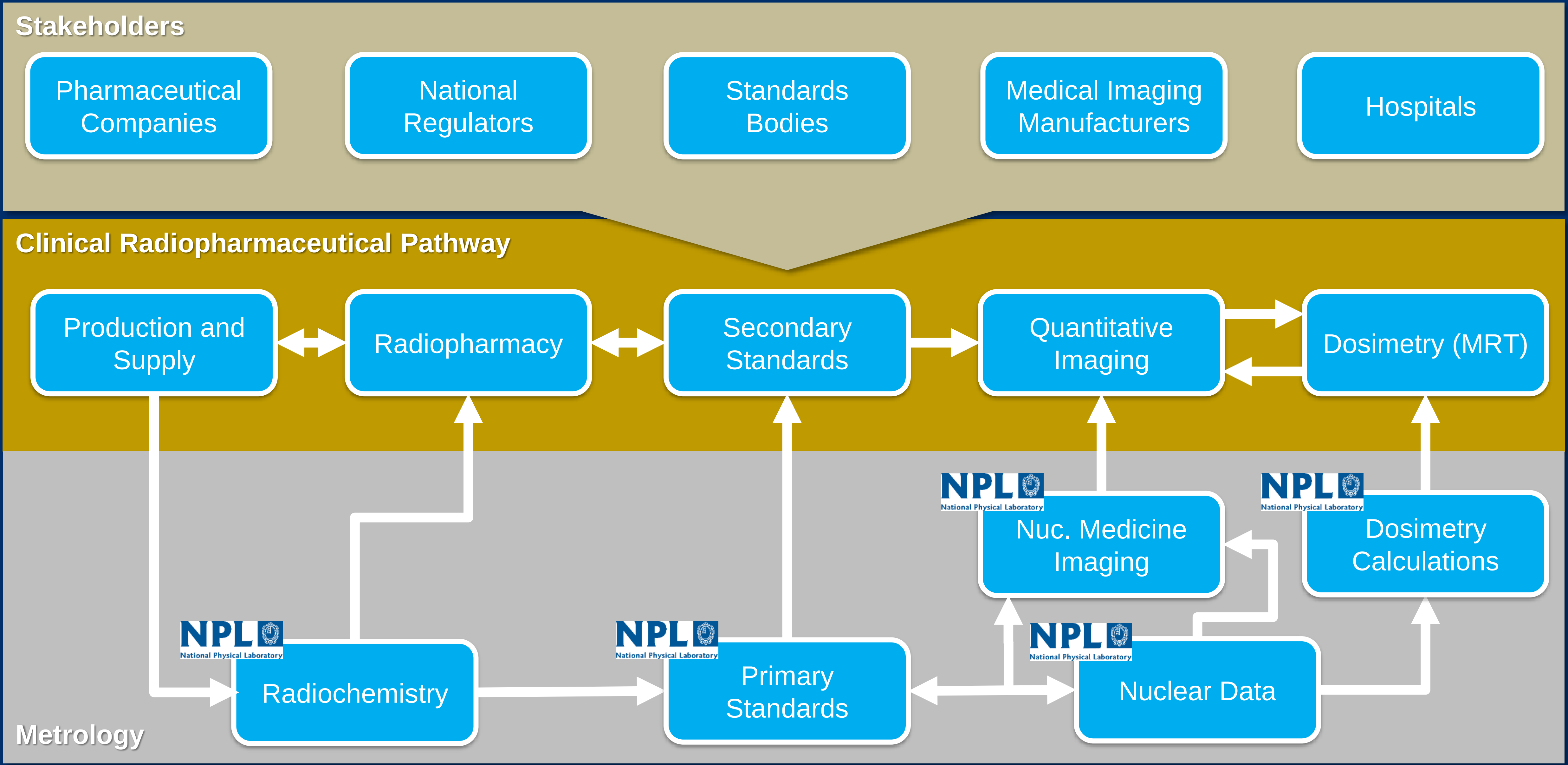
Medical Radionuclide Standardisation at NPL

NPL

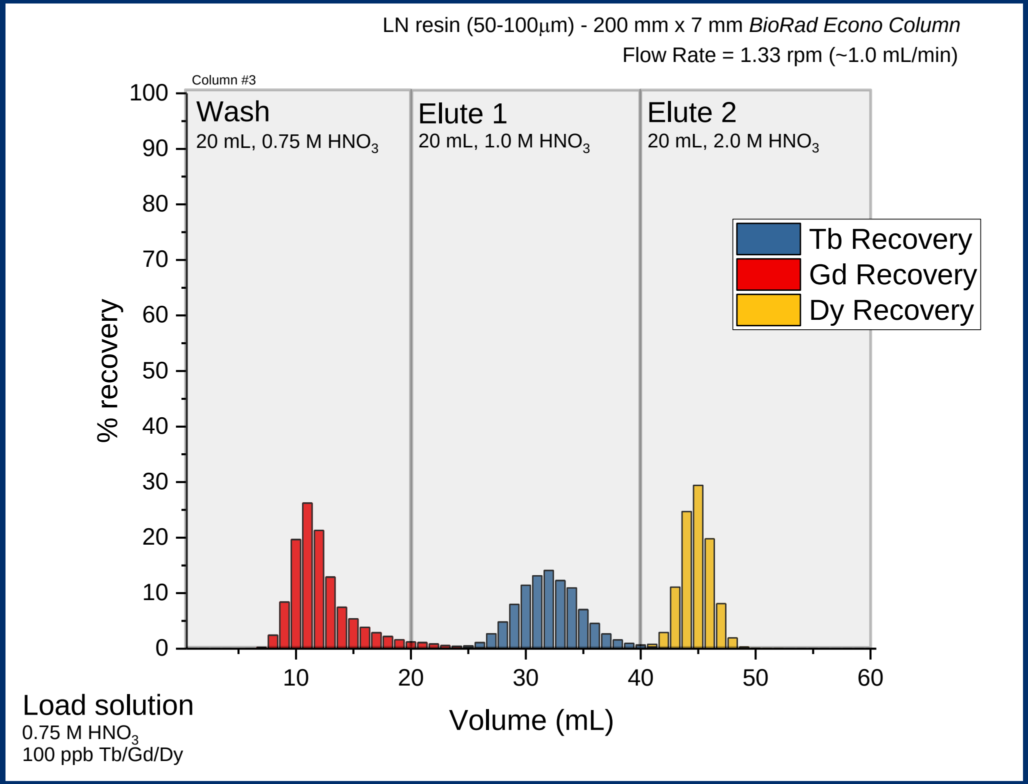


PRISMAP (CERN-MEDICIS) collaboration has greatly increased the number of medical radionuclide primary standards prepared by NPL

Comprehensive metrology for nuclear medicine



Radiochemical separations

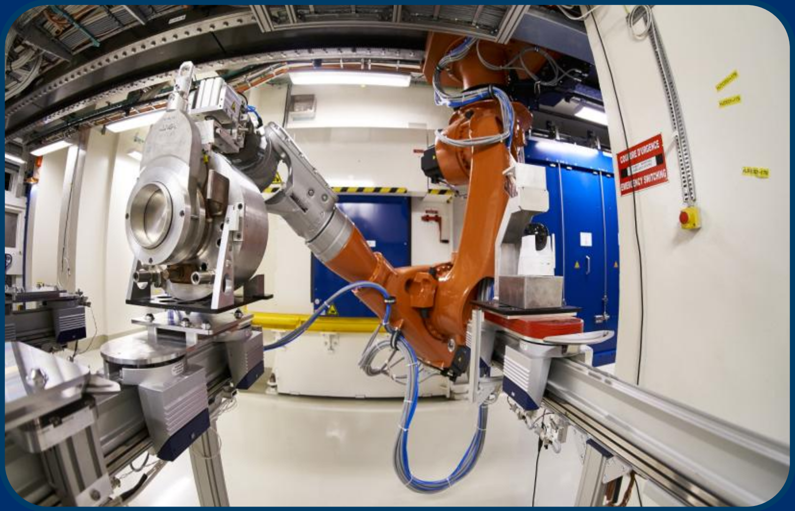


- **Provide high-purity sources** for standardisation and nuclear data measurements
- **Better binding efficiency** of targeting molecule by removing long-lived or stable impurities
- **Reduced side-effects** from radioactive or stable impurities
- **Increased specific activity**
- **Less imaging interferences** (SPECT/PET)

Case study: Theranostic Terbium Isotopes

^{149}Tb	^{152}Tb	^{155}Tb	^{161}Tb
Alpha therapy	PET diagnostics	SPECT diagnostics	Beta/Auger therapy SPECT diagnostics
4.12 h	17.5 h	5.32 d	6.89 d

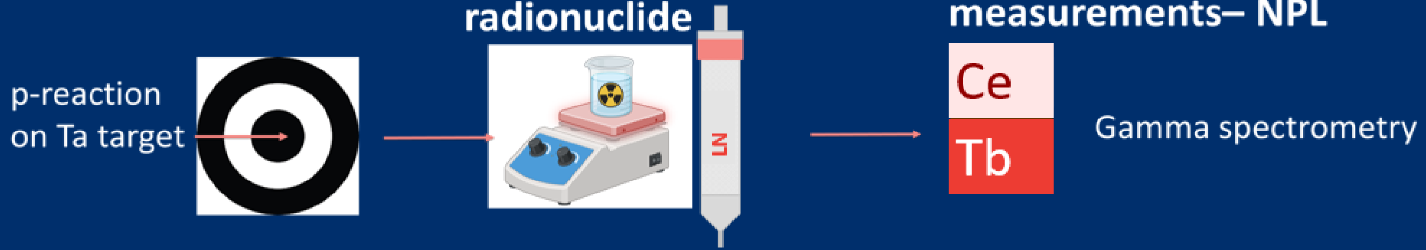
- Proton-induced spallation reaction on a Tantalum target
- On-line mass separation at 155 m/q



Production Facility – CERN MEDICIS

Radiochemistry – NPL Preparation of target radionuclide

Contaminant assessment + nuclear decay data measurements– NPL



^{155}Tb Purification

- Selective oxidation of cerium
- Chromatographic separation on TEVA resin

Selective oxidation of cerium:

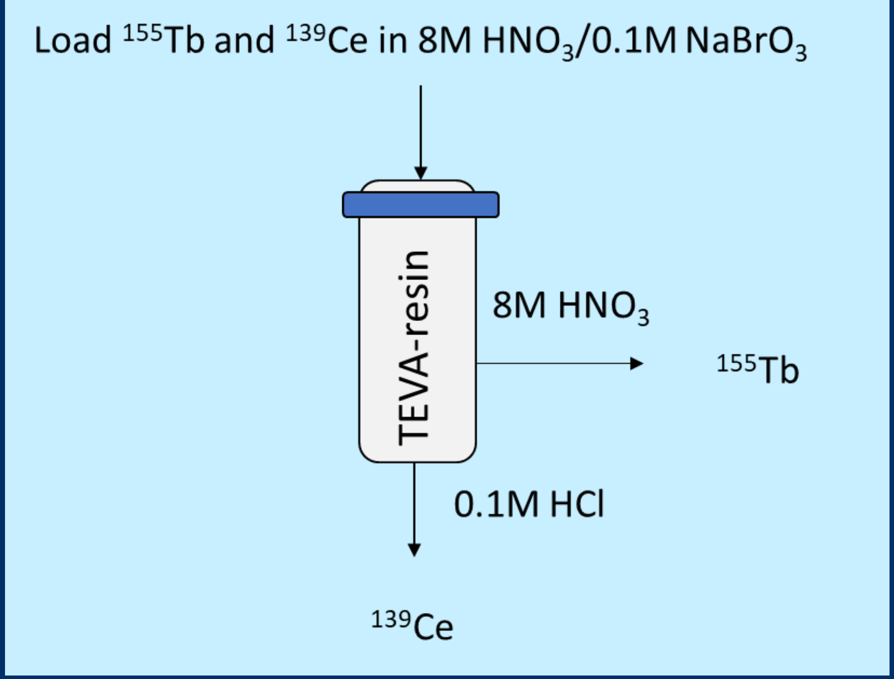
Ce(III) → Ce(IV)

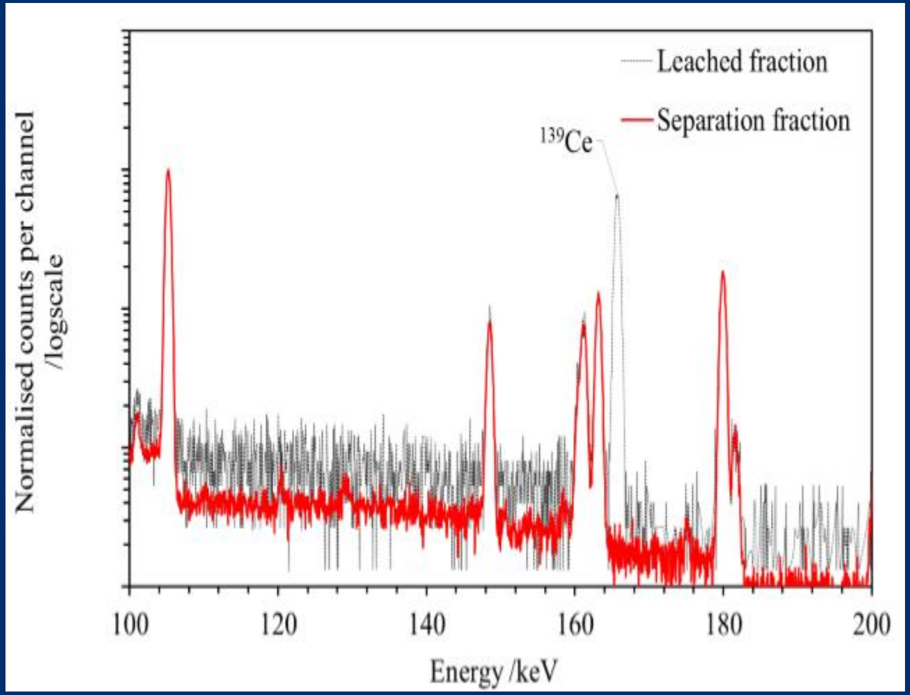
Tb(III) ~~→~~ Tb(IV)

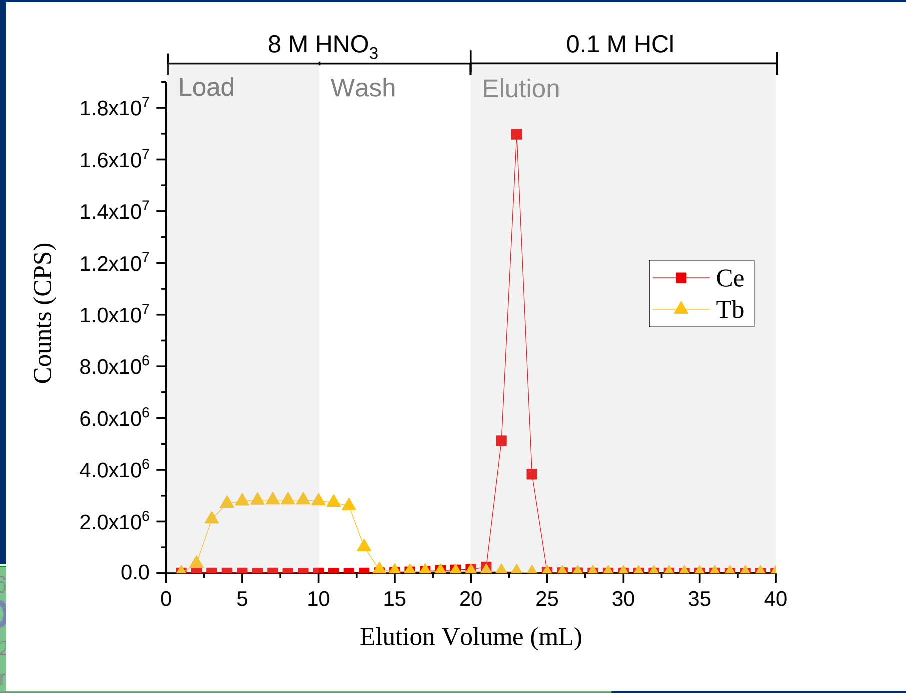
Supplied ^{155}Tb = ~ 8.1 MBq

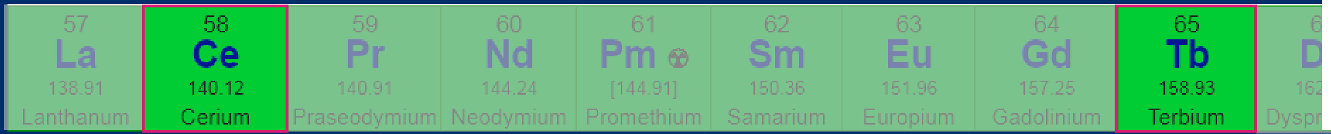
^{139}Ce before ~ 31%

^{139}Ce after < 0.021%

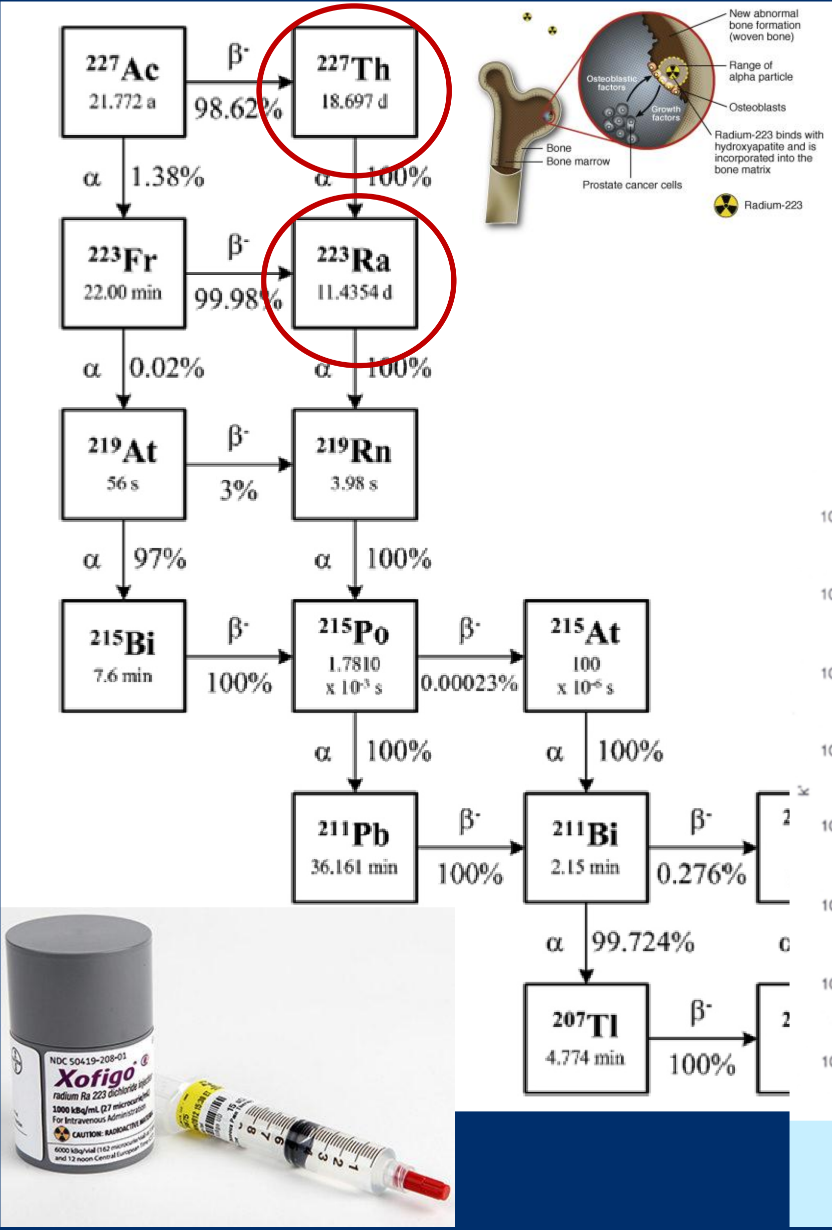


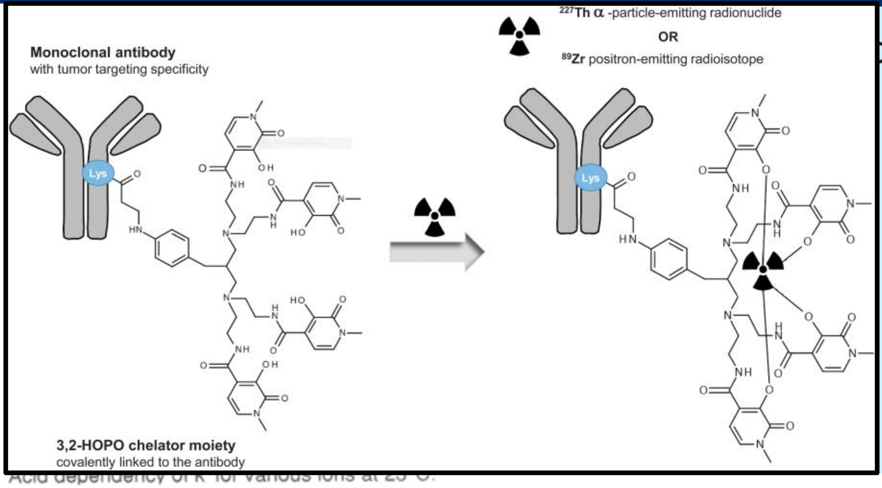


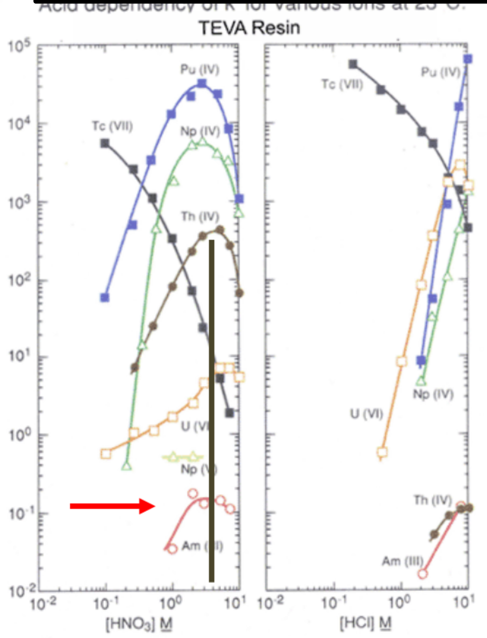




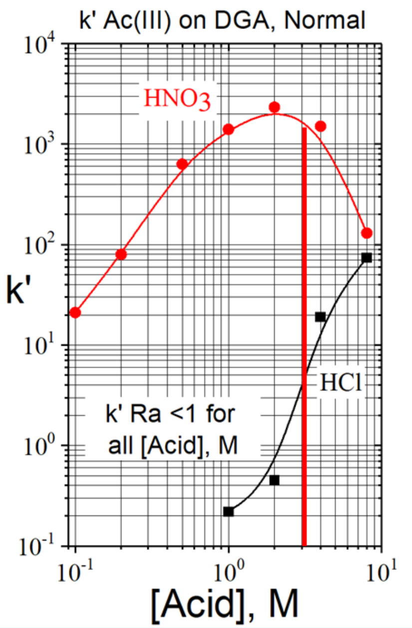
Purification of $^{223}Ra/^{227}Th$



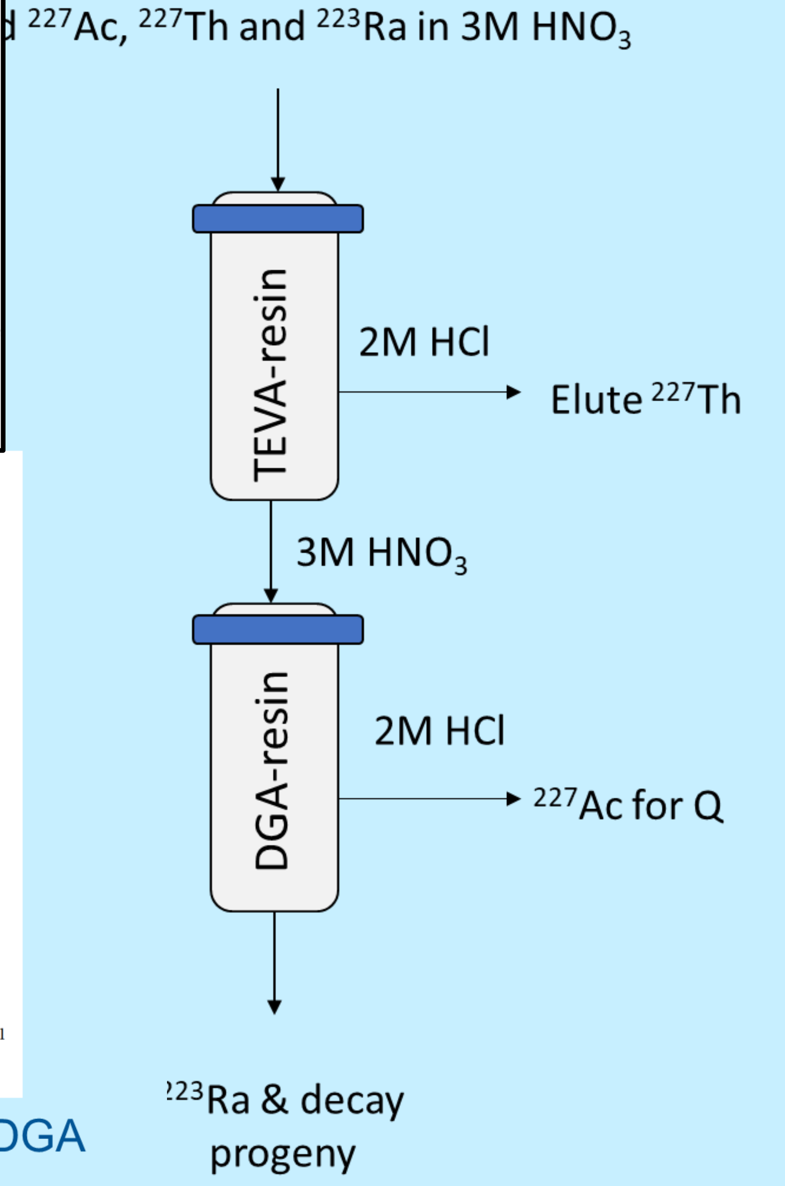




TEVA



DGA



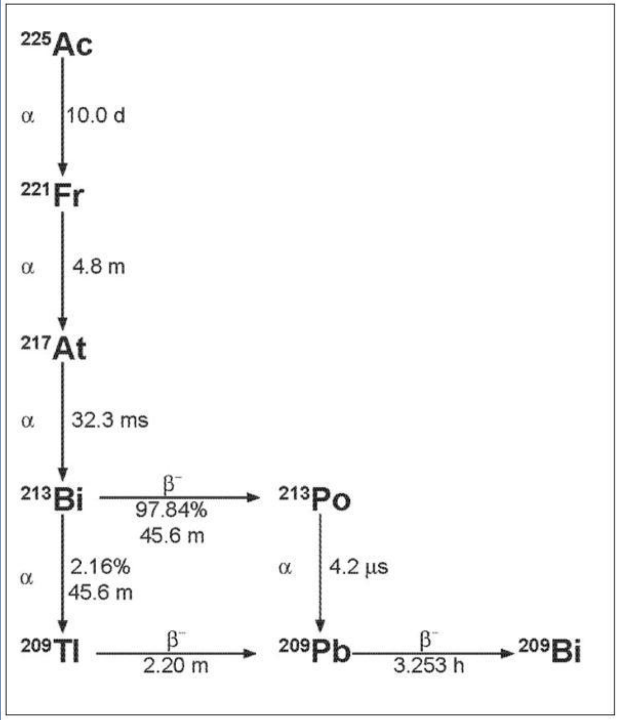
Ac-225 Production at CERN-MEDICIS

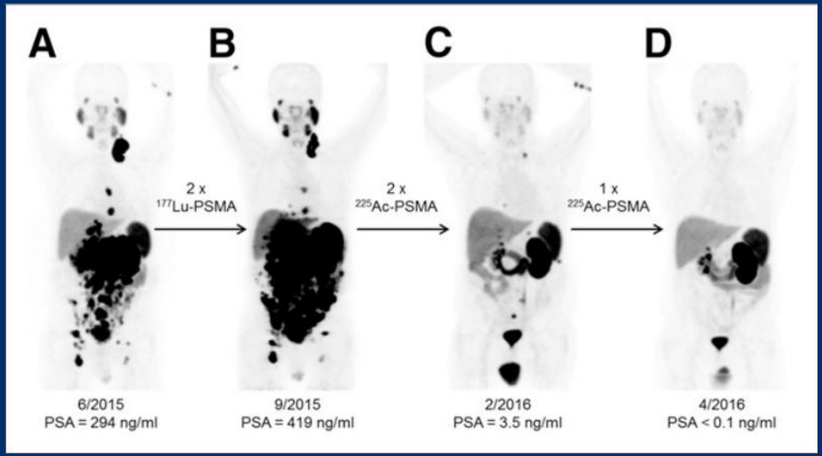
$^{232}Th(p,x)^{225}Ra \rightarrow ^{225}Ac$

TARGET PREPARATION → RADIONUCLIDE PRODUCTION → RADIONUCLIDE PURIFICATION

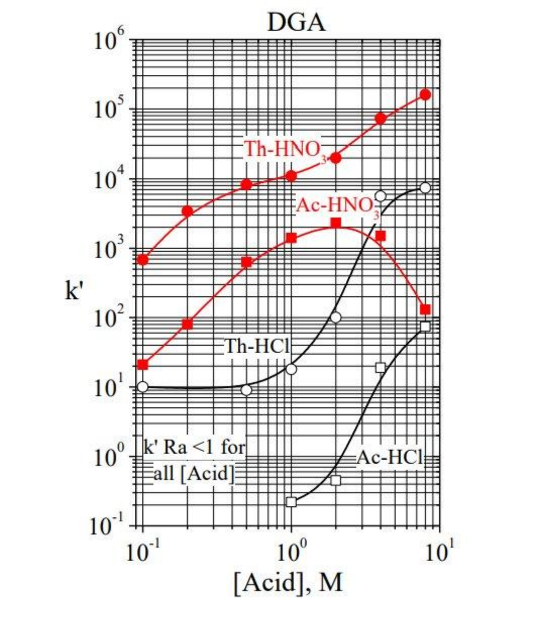
Production Facility - CERN - MEDICIS

Purification Scheme – NPL





- ^{225}Ac recovery of 97%
- <0.1% Ra-225 in the ^{225}Ac solution



- Load in 2 M HNO_3
- Rinse in 2 M HNO_3
- Elute in ~ 0.1 M HCl

Ac-225 Production at Birmingham (MRIP)

Exploring novel production routes for emerging medical radionuclides in the UK.

- REAPAR: Research of the End-to-end Accelerator Production of Ac-225 from Ra-226

TARGET PREPARATION → RADIONUCLIDE PRODUCTION → RADIONUCLIDE PURIFICATION → QUALITY CONTROL

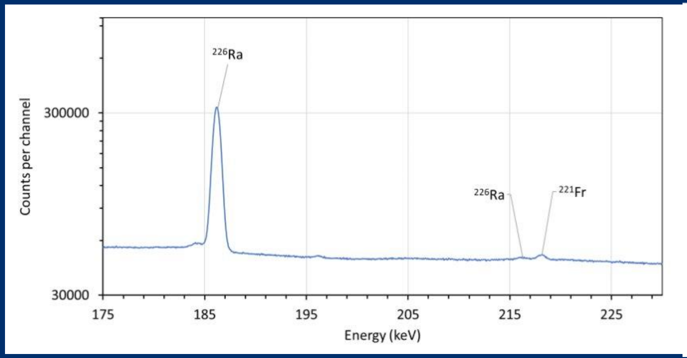
- Irradiation: 18 MeV protons, 10 uA, 4 hours

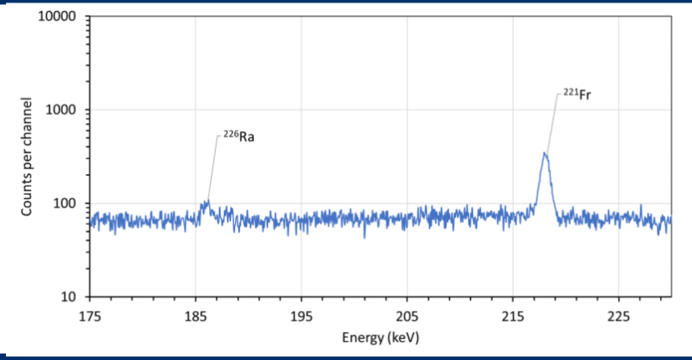
Production Facility - UoBirmingham

$^{226}Ra(p,2n)^{225}Ac$

Purification Scheme – NPL

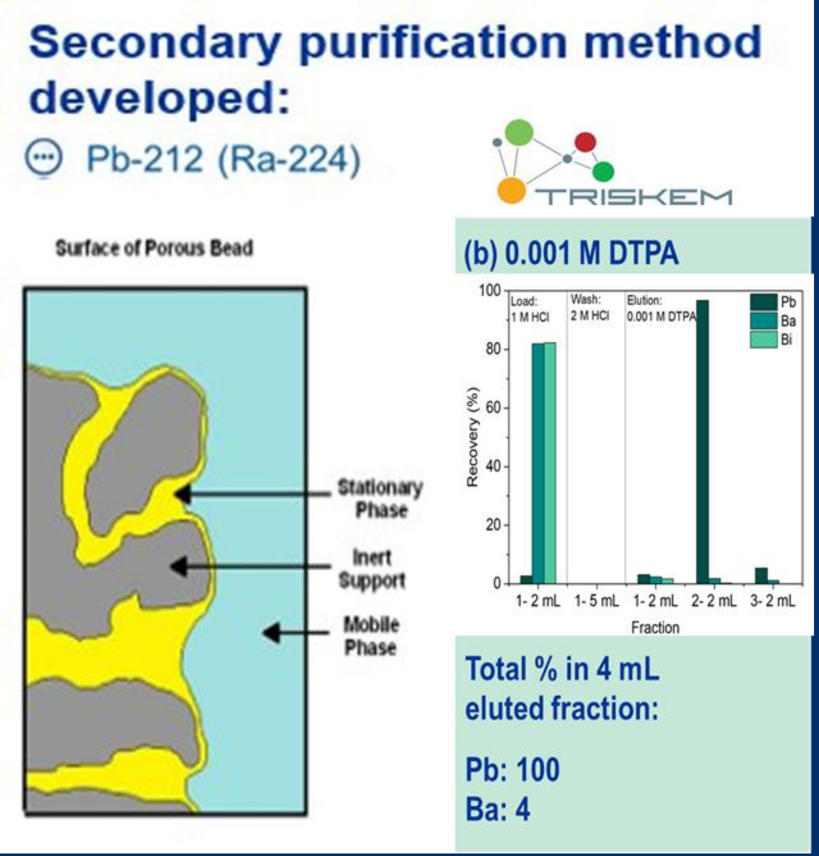
Contaminant Assessment – NPL

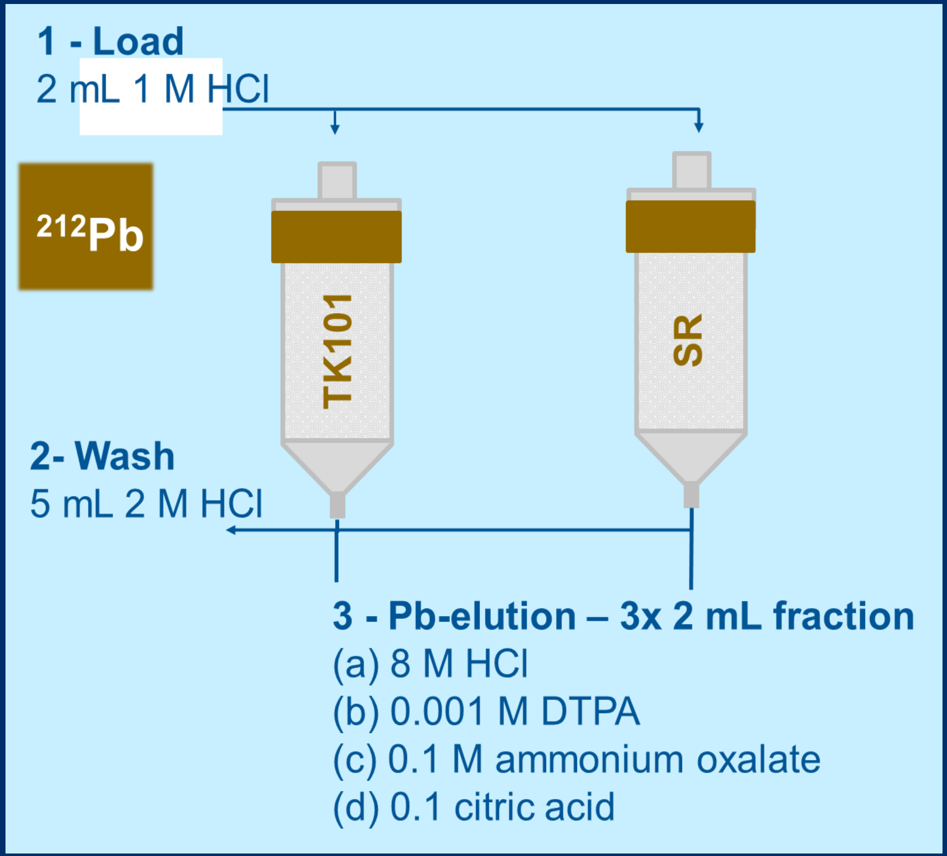




^{226}Ra effectively removed from ^{225}Ac

Purification of ^{212}Pb from ^{224}Ra generator





- Method validation completed using a $^{224}Ra/^{212}Pb$ generator from Oak Ridge National Laboratory, which was set-up by Barts Cancer Institute QMUL for first-in-UK ^{212}Pb-labelled peptide studies.
- Post-purification, initial radionuclide calibrator measurements were completed at NPL to generate a calculator for ^{212}Pb activity determination.

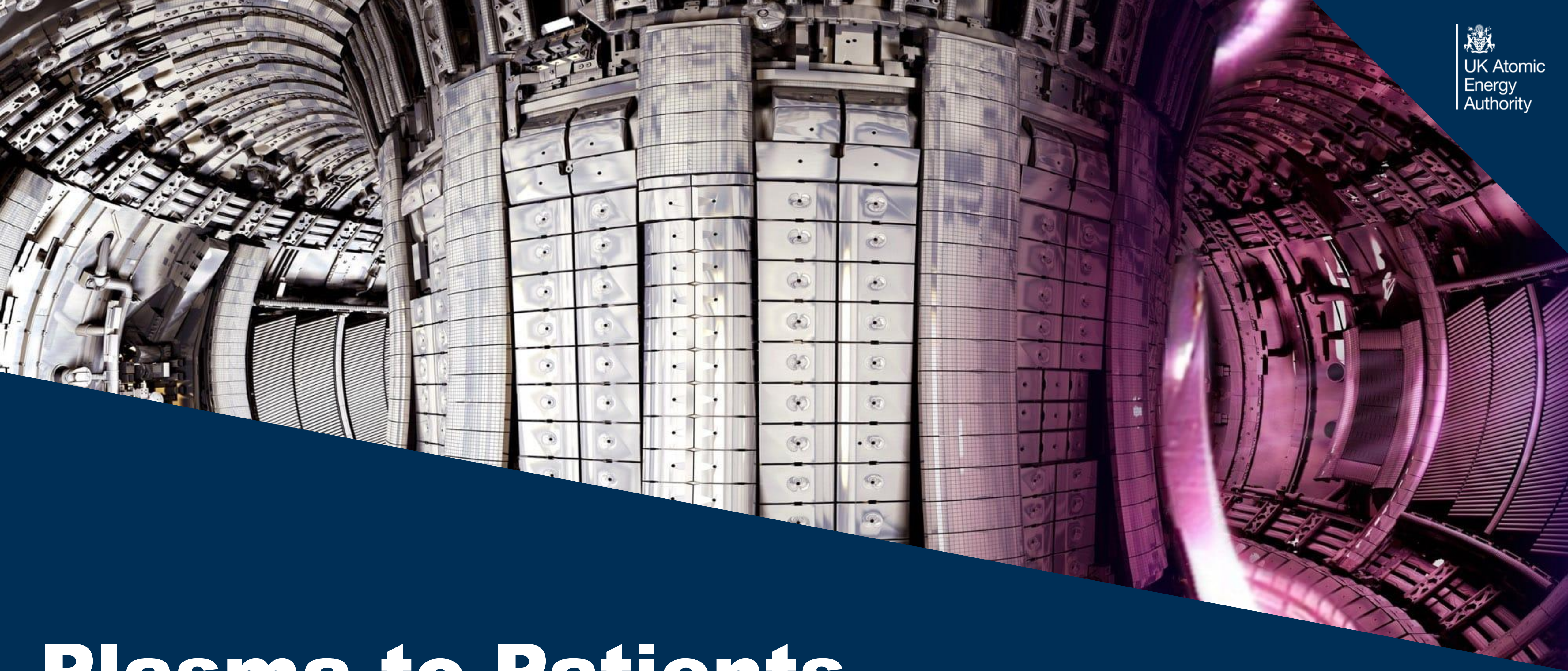
NPL
National Physical Laboratory

Nuclear Metrology Group:

Hibaaq Mohamud, Anu Bhaisare, Frankie Falksohn, Alex Tribolet, Ben Russell, Seán Collins, Paddy Regan and Peter Ivanov

Department for Science, Innovation & Technology

This work was supported by the UK Government’s Department for Science, Innovation and Technology



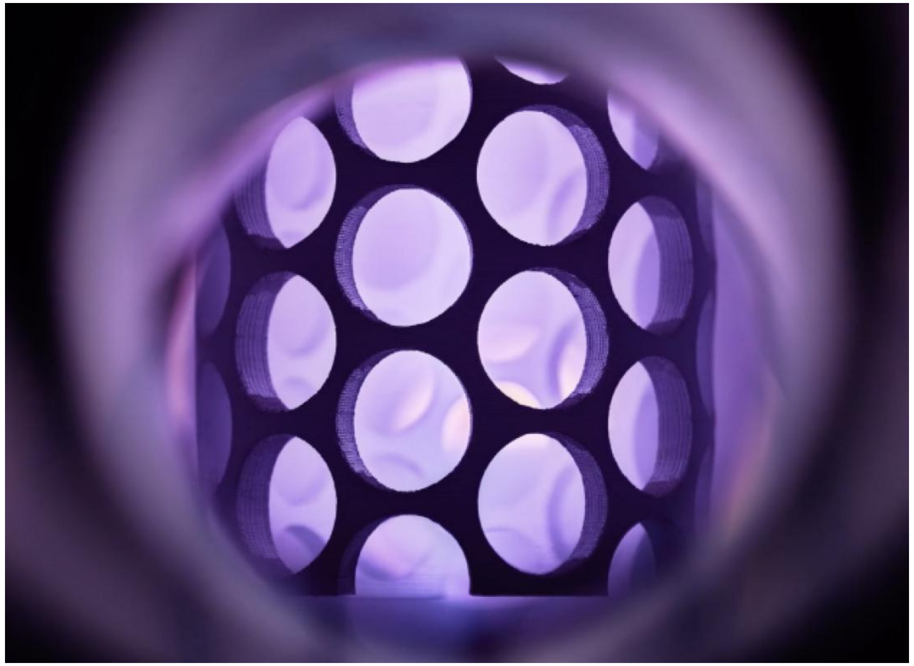
UK Atomic Energy Authority

Plasma to Patients

Ram Mullur, Astral Systems

Pioneering Multi State Fusion For Isotopes Production – *Plasma to Patients*

UKAEA: Fusion for Medical Radionuclides;
September 24th, 2025,
Culham Campus, Oxfordshire, UK



A Nuclear Medicine Renaissance is on…

ASTRAL SYSTEMS

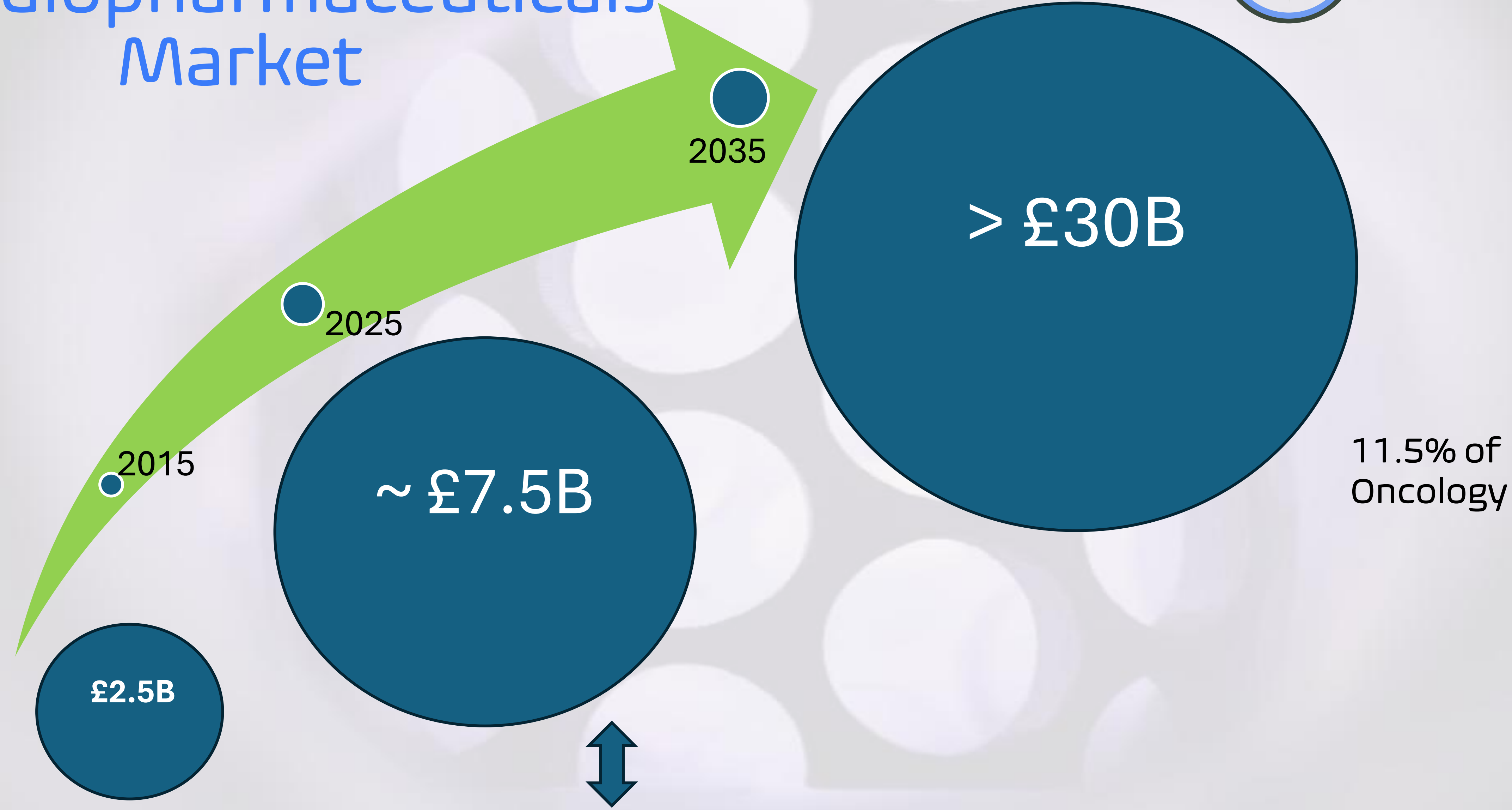
- 15 Radiopharmaceuticals approved in last 10 years
  - vs. 6 in the same period prior
- Pipeline of 500 + drugs → and growing
- Increasing # of startup Radiopharma, CDMOs and Isotope companies
- Over £ 22B invested over the past decade (vs. £ 7B in Fusion)

BAYER NOVARTIS Lilly Bristol Myers Squibb AstraZeneca + +

- Radiopharmaceuticals → moving up in the Cancer-treatment hierarchy
- Novel Therapy and Theranostic radioisotopes → drug R&D pipeline: Cu-64/67; Ac-225; Pb-212….
- <u>Quest is on for novel routes to produce isotopes</u>
  - New Generator-based options; Power/Utility reactors, Accelerator-based platforms….
  - Astral advancing Fusion Neutrons for isotopes – Furthering UK's Leadership in Fusion

Global Radiopharmaceuticals Market

ASTRAL SYSTEMS



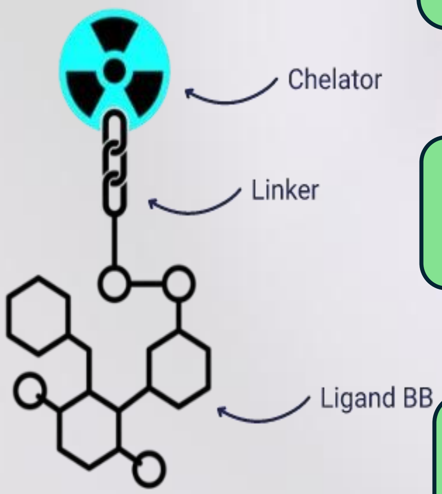
Nuclear Medicine represents ~4.5% of Oncology

Trends Driving Isotopes and Radiopharmaceuticals

ASTRAL SYSTEMS

Advances in Imaging and Computing

Advent of “new” Beta, Alpha and Positron **Emitting Isotopes**



Advances in Linkers and Chelating Chemistry

Advances in Disease-Biomarkers →Precision Medicine

Cancer Treatment and Patient Care

Demography and Epidemiology

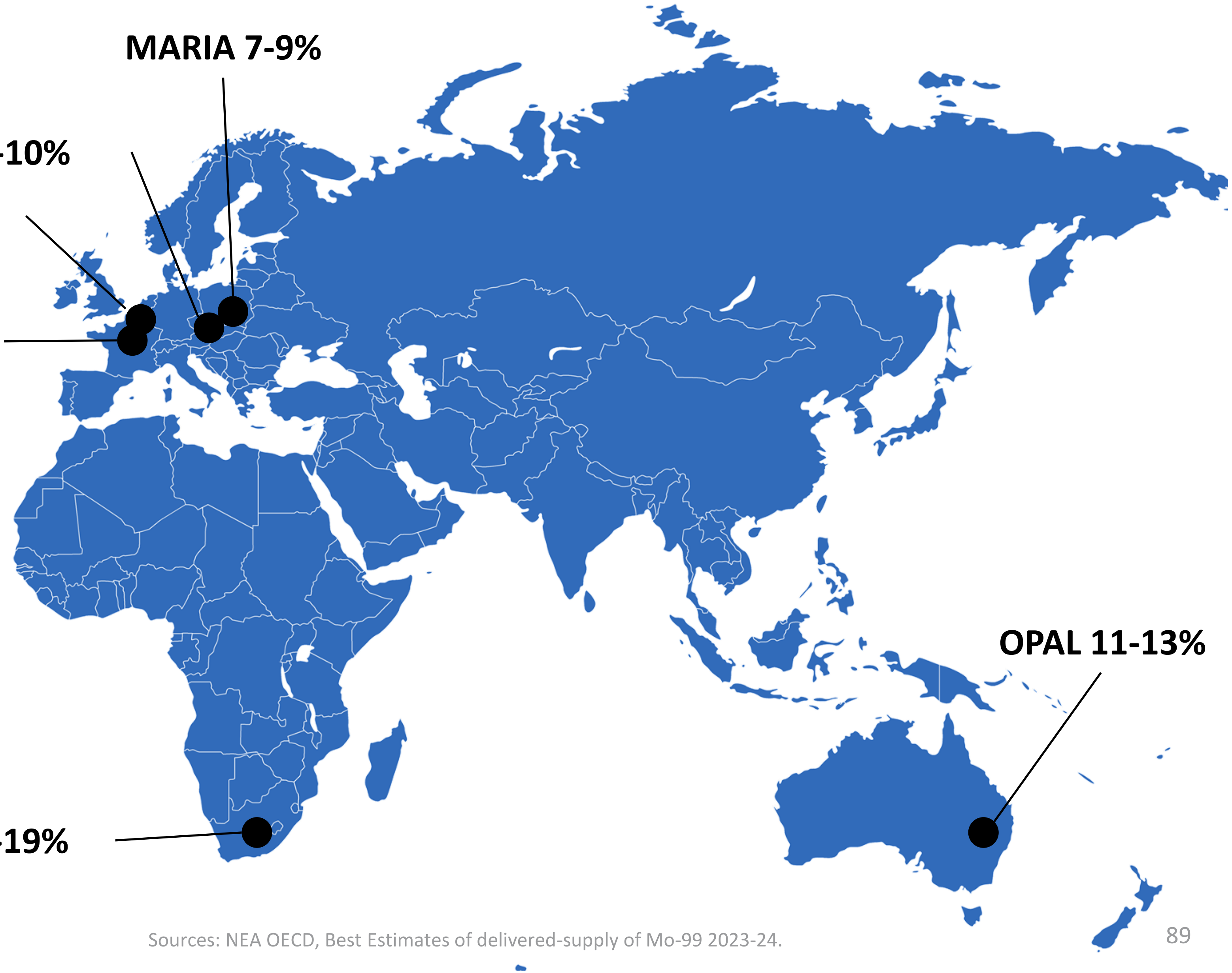
Existing treatments reaching their limits

=

Quest for new tools to beat (treat) cancer

Isotope needs are rising, key infrastructure projections are dire

- Neutron Reactors - few across the world
- 6 reactors produce **85%** of reactor made medical radionuclides
- Many scheduled to slow / shut down 2030→ 2035
- 72% of global capacity will be lost within the next decade



Sources: https://post.parliament.uk/research-briefings/post-pn-0558/

Sources: NEA OECD, Best Estimates of delivered-supply of Mo-99 2023-24.

UK in shortage of critical Isotopes and Radiopharmaceuticals

- **Over 750,000** radionuclide-drug procedures are carried out in UK each year
    - 100% of therapeutic isotopes and 80% of diagnostic isotopes **imported**
- Numerous medical radionuclide **shortages** in recent years
    - I-131 shortage has been especially prominent
    - Only projected to get **worse**

UK in shortage of critical Isotopes and Radiopharmaceuticals

Sovereignty and Security of critical medical Isotopes are undeniable imperatives

Costs of not achieving them are high and the overall impact on healthcare could be deleterious

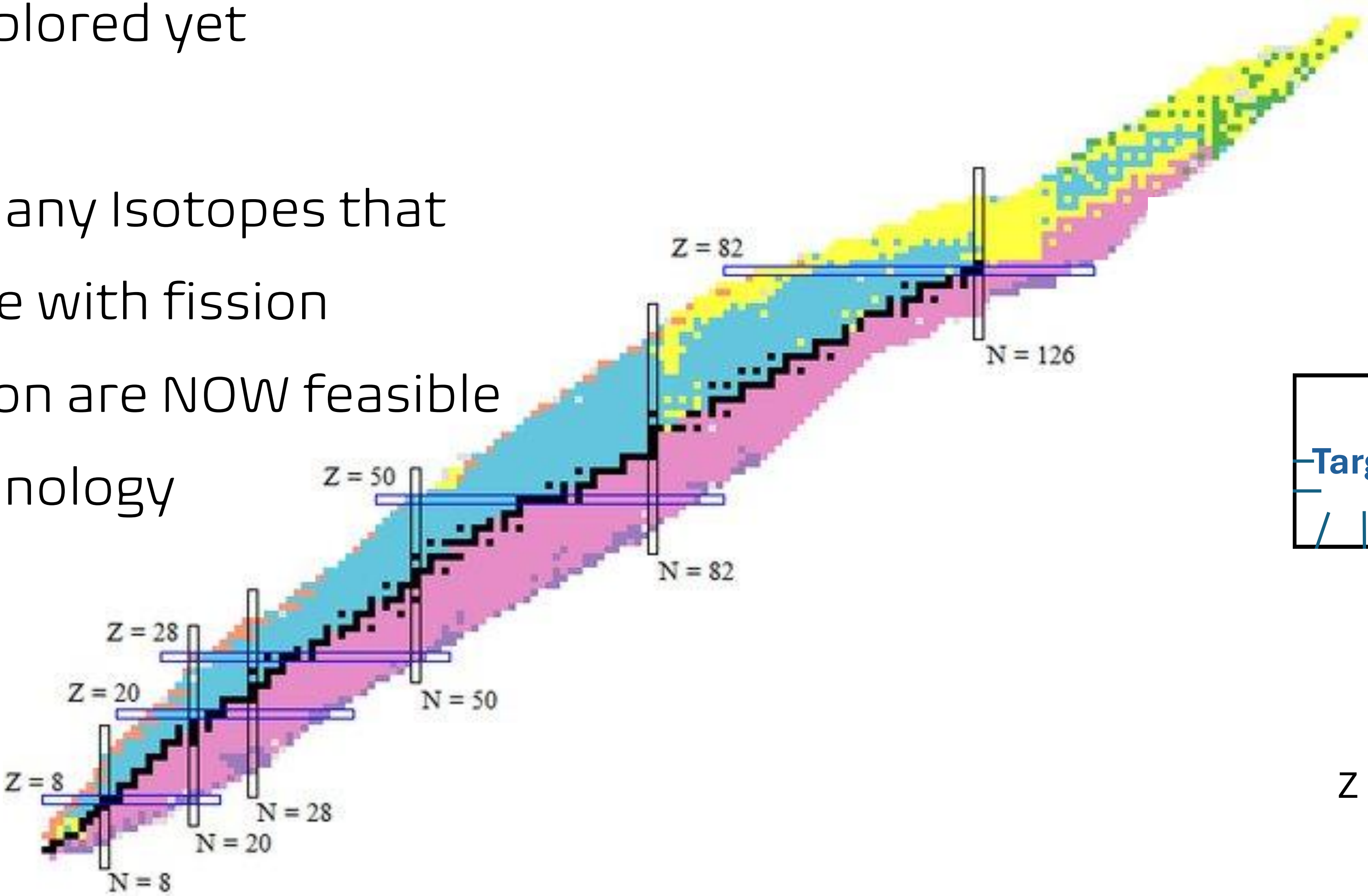
Astral is Changing Paradigms

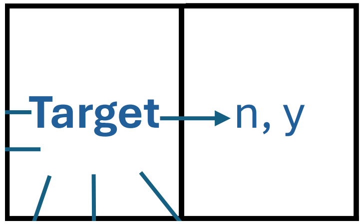
- Enabling an efficient and effective neutron platform for fusion research and isotope production:
  - ➢ Greater neutron output
  - ➢ Greater flux (n/cm2/s)
  - ➢ Greater continuous fluence
- Superior economics:
  - 1000+ hours of DD neutron time logged
  - 6 commercial DT reactors in Q1, 2026
  - **Low cost per neutron – highly scalable**
- Will decentralise neutron-produced isotopes as cyclotrons did for proton-produced isotopes
- Will usher better prospects for isotopes production by addressing many of the existing supply vulnerabilities

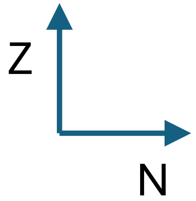
Unlocking Novel Pathways to Isotopes

- Threshold 14MeV reactions which have not been explored yet

- Production of many Isotopes that could not be made with fission neutron-irradiation are NOW feasible with Astral's Technology



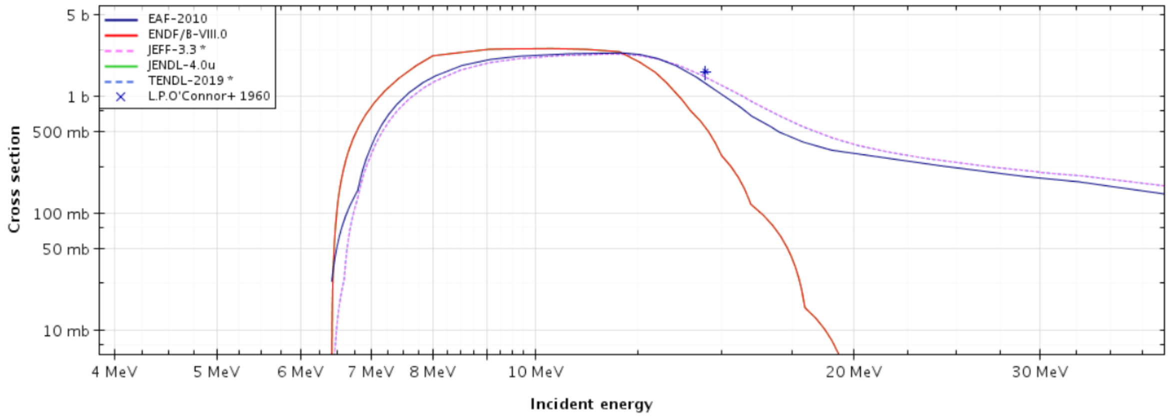




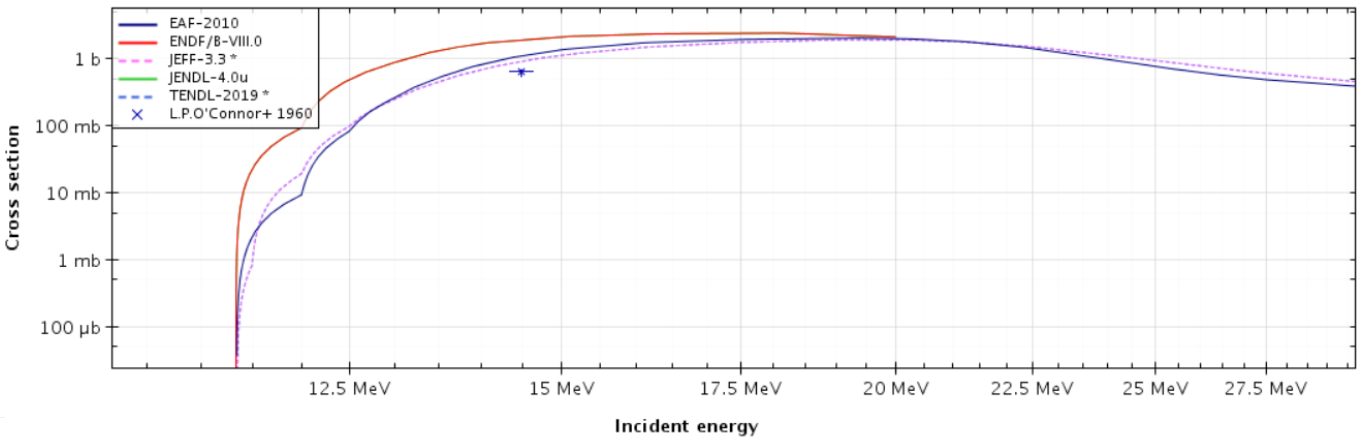
McMaster University Collaboration

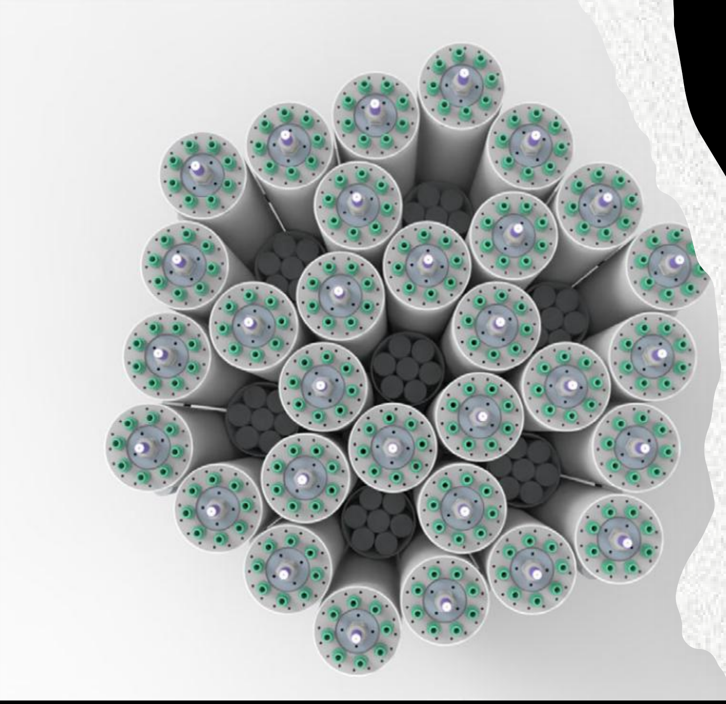
- Production of Ac-225 and Pb-212 using 14 MeV neutrons
- Ra-226 (n,2n) Ra-225-> Ac-225
- Ra-226 (n,3n) Ra-224 -> Rn-220 -> Po-216 -> Pb-212

Ra226 (n,2n) or Ra225 production



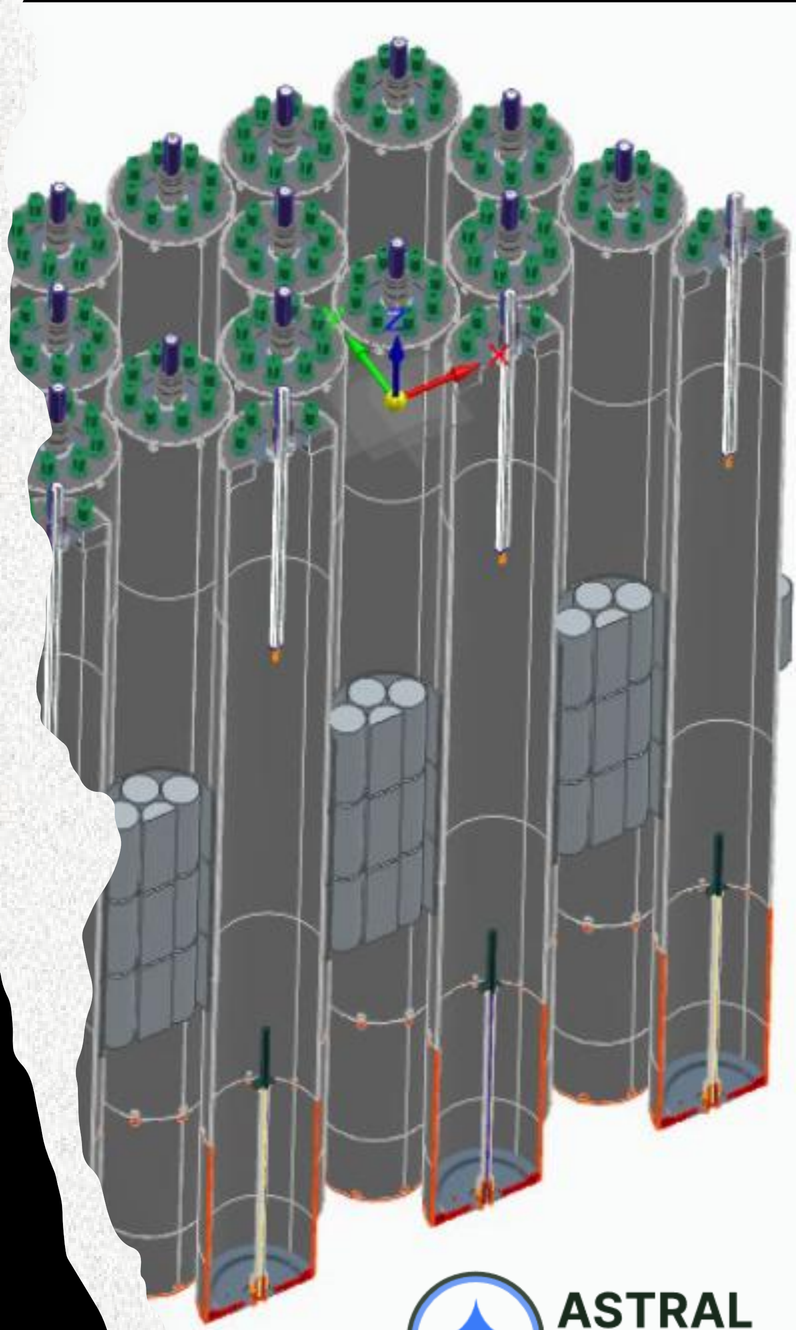
Ra226 (n,3n) or Ra224 production





Join us to positively impact healthcare

- Compact, Modular and Cost-effective target (neutron) irradiation platform
- High Energy neutrons, higher output, fluence & flux - enabling unprecedented (n, Xn) reaction pathways (for medical isotopes)
- We invite all interested parties to propose your medical isotope production experiments and research projects
- Fusion neutrons available now!



ASTRAL SYSTEMS

UK Atomic Energy Authority

Fusion Technologies for Industrial and Medical Applications

Ross Radel, SHINE

Fusion Technologies for Industrial and Medical Applications

SHINE™

Ross Radel, PhD, PE

September 2025

SHINE’s Sustainable Approach To Fusion

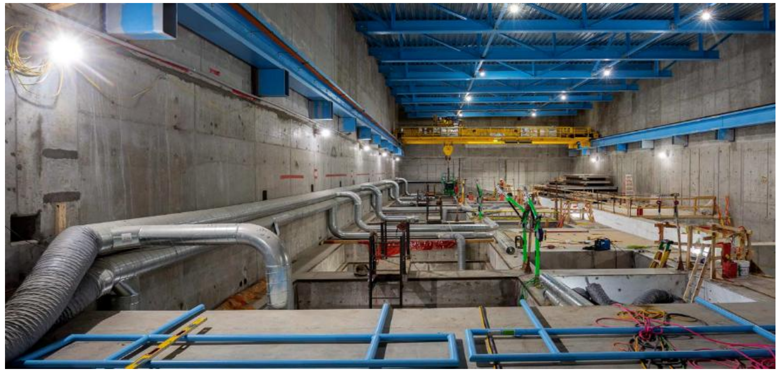
VISION: TRANSFORMING HUMANKIND THROUGH FUSION TECHNOLOGY

- Phase 1: Delivering low-yield fusion systems (DD & DT) for 10+ years
  - Years of licensing facilities with activation, tritium, rad waste disposal, etc.
  - Providing commercial neutron radiography and DT irradiation services

- Phase 2: Producing medical isotopes
  - Delivering Lu-177 for cancer treatment; scaling up volume quickly
  - Commissioning Mo-99 facility with 8 fusion systems, fission subcritical assemblies, and aqueous U/FP processing
  - Significant experience gained in nuclear construction, licensing, rad waste mitigation/handling, and decommissioning planning

- Phase 3: Applying lessons learned towards aqueous UNF recycling pilot facility and investigating fusion-enabled transmutation

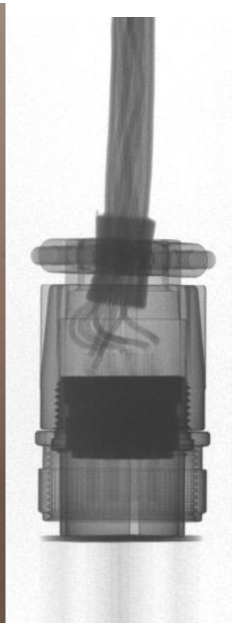
- Phase 4: Looking for opportunities to apply our hard-gained experience and expertise to support the broader fusion community

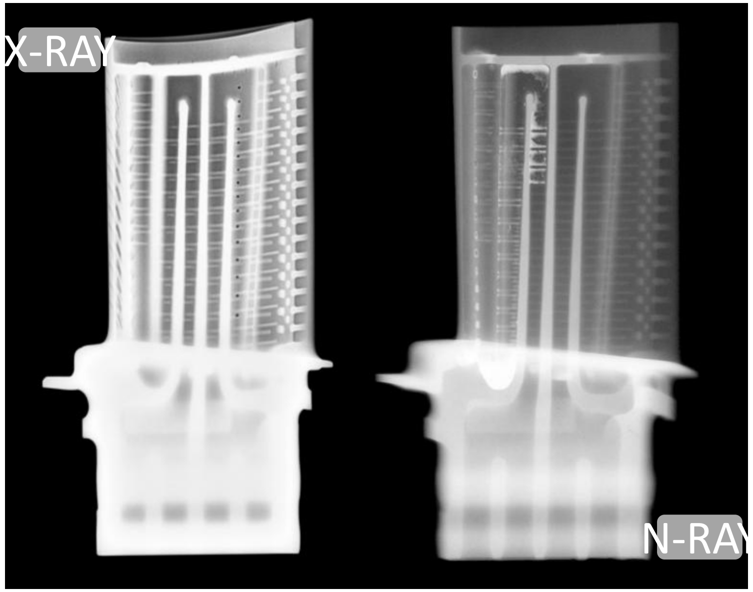


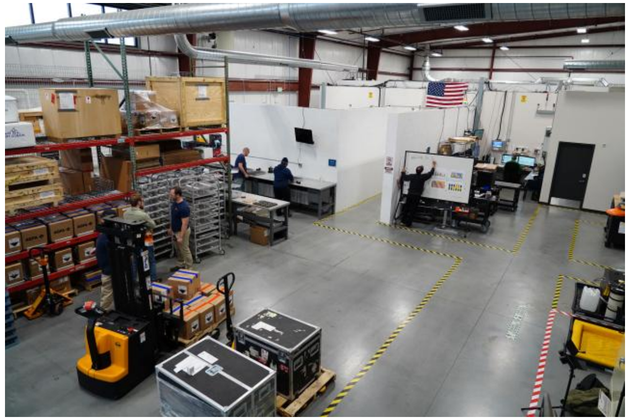
SHINE

SHINE's Phoenix Neutron Imaging Center

- Accelerator-based neutron source removing the reliance on aging reactor sources for neutron imaging and neutron radiation testing
  - 10,000 square foot (929 m^2) facility in Fitchburg, Wisconsin, USA
- The neutron source has been in commercial operation since 2020 and has been reliably operated with >99% uptime during this period
- Built from the ground up as a neutron radiography facility
  - Thermal and fast neutron beamlines for 2D imaging, 3D CT imaging, & radiation effects testing
  - ASTM Category I Image Quality
- The facility maintains active compliance/permits with:
  - ATF, ITAR, and DoD explosives safety and security regulations
  - Aerospace & defense quality programs (ISO9001, AS9100, NAS410, etc.)





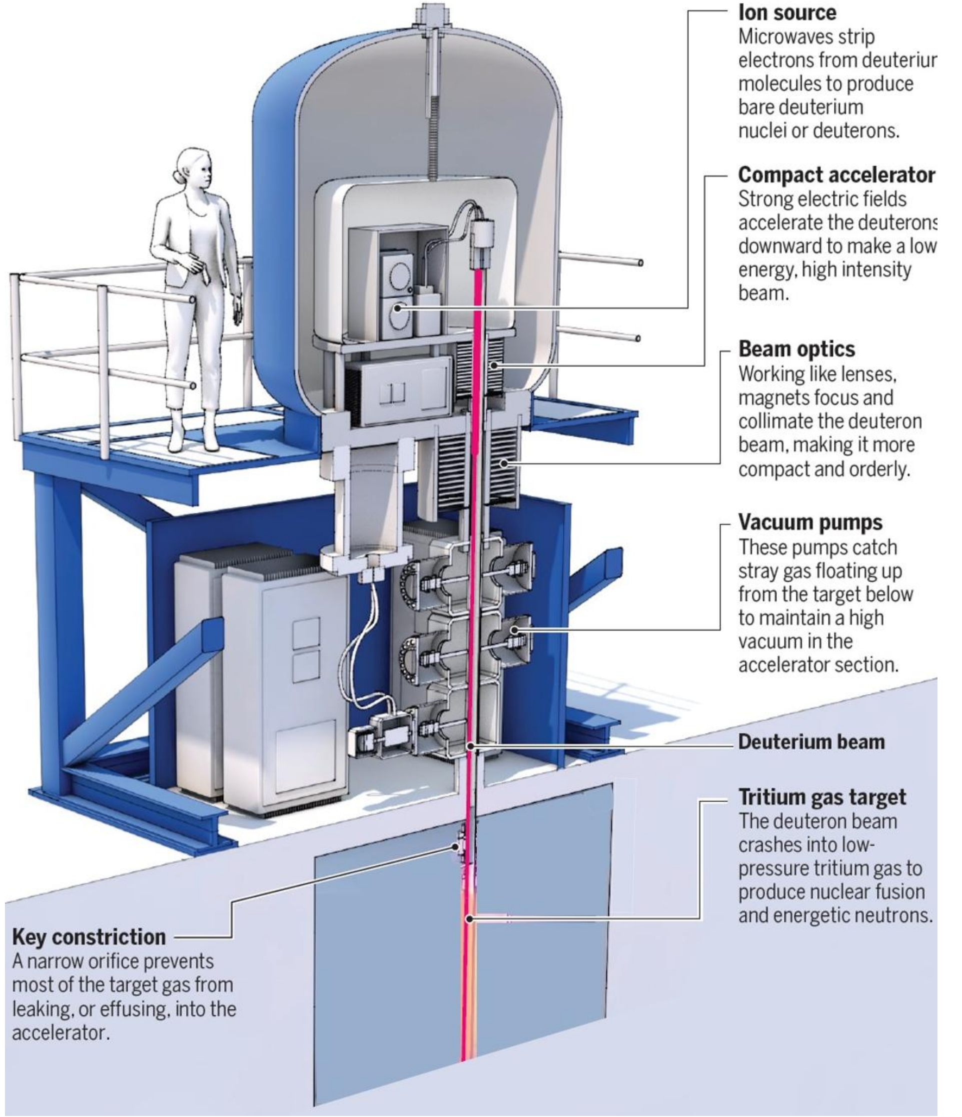


SHINE

High-Yield DT Neutron Source Overview

Sequence of Operation

1. Microwave ion source creates dense deuteron plasma
2. Up to 80 mA of deuteron current extracted (~90% D^+)
3. DC accelerator extracts ion beam (up to 315k V)
4. Magnetic solenoid focus and x-y steering of ion beam
5. Differential pumping system maintains target pressure at ~40 Torr while keeping accelerator pressure under 40 mTorr
6. Beam strikes tritium (or deuterium) gas target and generates neutrons in a line source as the beam slows in the gas
7. Up to 4.6×10^{13} n/s measured output

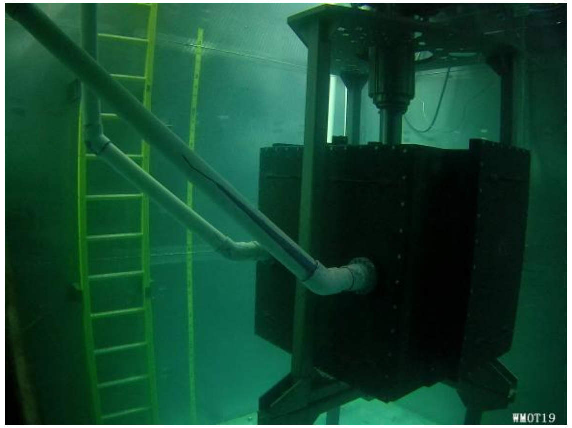


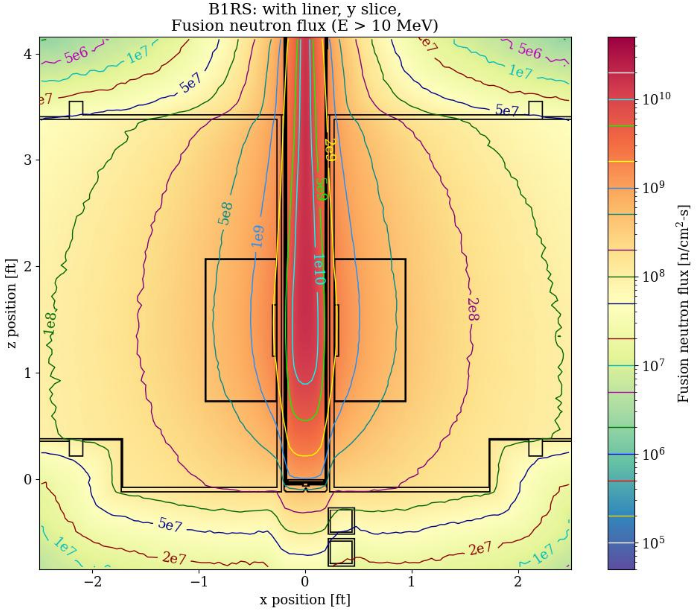
SHINE

FLARE™ by SHINE – Rad Hard Testing

FUSION LINEAR ACCELERATOR FOR RADIATION EFFECTS

- SHINE launched a high flux 14 MeV neutron irradiation service in 2023
  - >1.3×10^{13} n/s DT steady-state source
  - 4.1×10^{9} n/cm^2/s for small irradiation volumes
- Supports multiple test protocols including single event effects, displacement damage, and total ionizing dose
- Very large irradiation cavity supports testing of multiple parts and conditions simultaneously
- Fully licensed facility for tritium handling and DT neutron operations





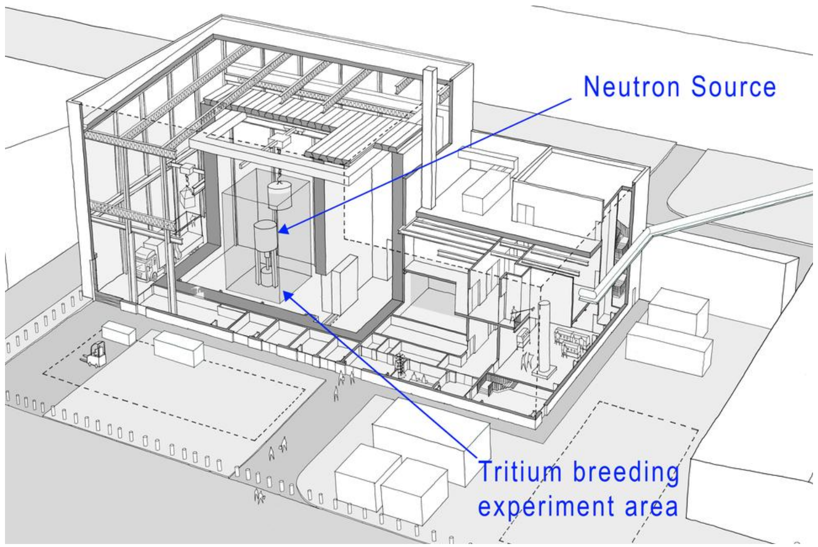
Available fast flux with 1.3e13 n/s source

Service commercially available to fusion system developers, defense microelectronics survivability community, and others

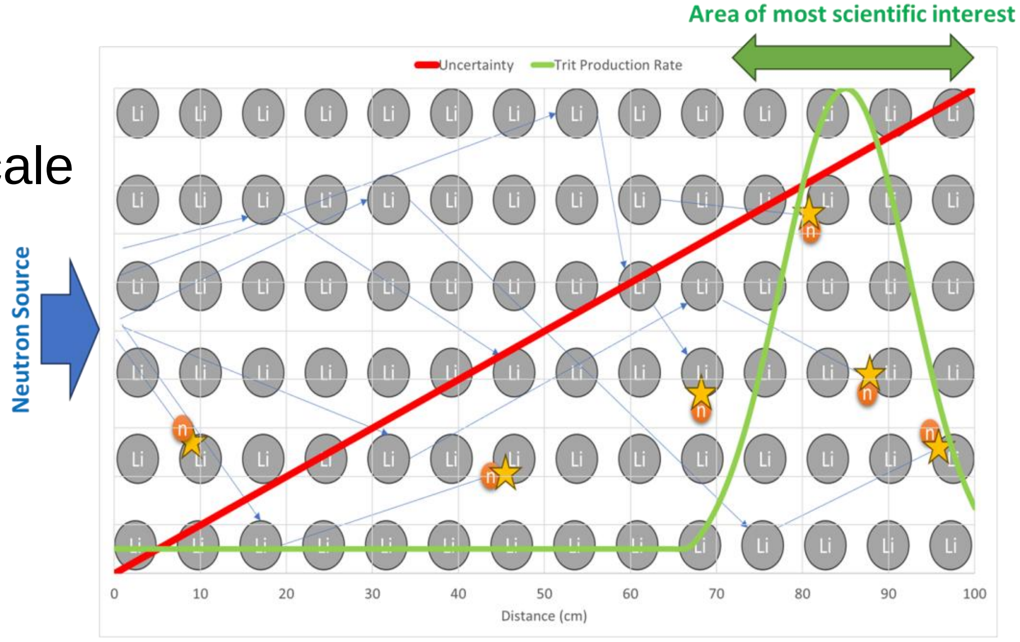
SHINE

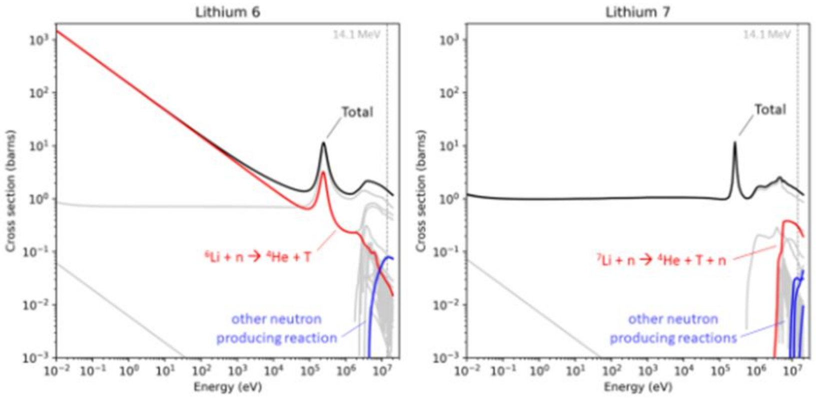
Lithium Breeding Tritium Innovation (LIBRTI)

UKAEA PROGRAM FOR ENGINEERING-SCALE BREEDING BLANKET TESTING



- Tritium breeding is needed for a sustainable fusion fuel cycle
- SHINE was selected to provide a FLARE-like DT neutron source to support the UKAEA LIBRTI project
- Breeder blanket efficacy is critically dependent upon both neutron and tritium transport
  - Most tritium is created ~1m from the source as neutrons need to be moderated to where the X-section is more potent
  - Uncertainty increases as you move through the blanket
  - High starting flux needed for neutrons to reach that deep
- LIBRTI is the first facility to construct a breeder test on this scale and with **sufficient neutron flux / T_2 production**

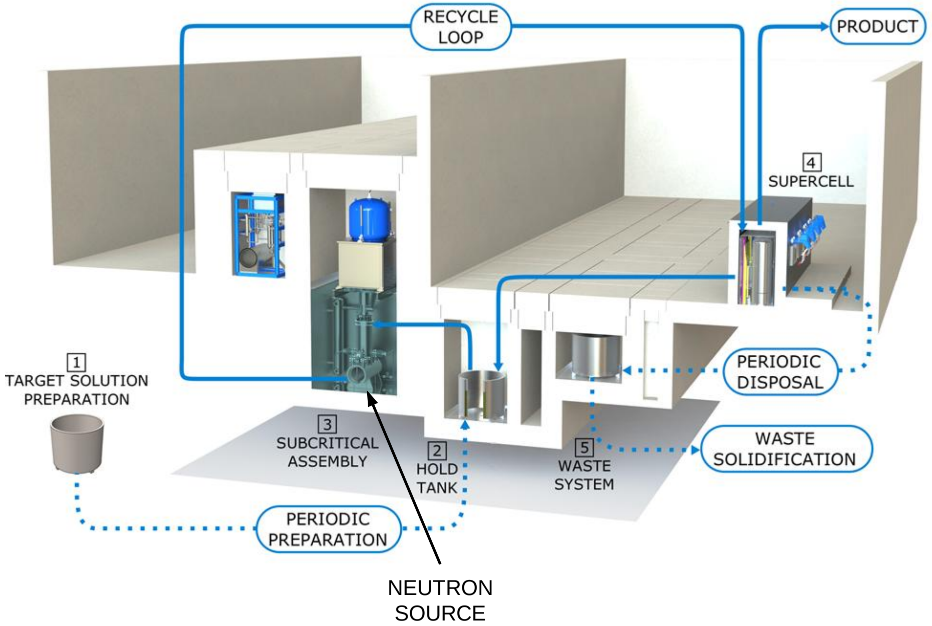




SHINE

Fission Product Production/Separation

- Licensed and constructed. Installing process equipment.
- Facility will produce >50% of US **Mo-99** demand
  - 10 CFR Part 50 SER issued in early 2023
  - 2[nd] site in Netherlands; site eval and licensing underway
- Production Process
  1. Irradiate aqueous LEU subcritical assembly with DT neutrons
  2. Up to 1 MW of fissions produced
     a. Mo-99 has a ~6% cumulative yield
  3. Transfer UO_2SO_4 to hold tanks and then the “super cell”
     a. Mo-99 extraction, purification, QC & packaging
  4. Final products ship to customers



SHINE

Therapeutic Isotopes

- SHINE has established the largest source of GMP Lu-177 currently produced in North America
  - Emergent cancer treatment isotope – rapidly growing usage
- Vertical integration & technology are our key differentiators
  - Yb Enrichment: We produce our own Yb-176 via in-house electromagnetic separation
  - Irradiation: Research reactors today; moving to in-house irradiation
  - Lu-177 Processing: Our technology provides significant scaling advantage
- Producing GMP Lu-177 from our Wisconsin, USA facility
  - 200,000 doses per year capability

Lu-177 Product Spec Sheet

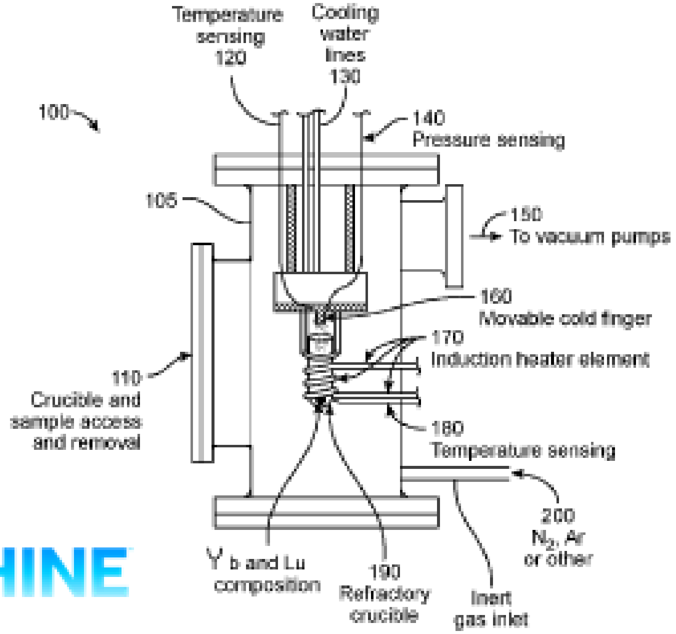
PACKAGING OPTIONS	10 mL flat bottom vial 2mL conical glass vial
CHEMICAL FORM	n.c.a. $^{177}LuCl_3$ in 0.04M HCl solution
SPECIFIC ACTIVITY	≥3,000 GBq/mg at SHINE calibration time
RADIOCHEMICAL PURITY	≥99% as $^{177}LuCl_3$
RADIONUCLIDIC PURITY	≥99.9% ^{177}Lu
RADIOACTIVITY CONCENTRATION AT SHINE CALIBRATION TIME	1.0Ci/mL (37GBq/mL) +/-10%
EXPIRY	10 days from the end of synthesis
STANDARD CALIBRATION TIME	Tuesdays 1200 central time (U.S) at 1.00 Ci/mL
CGMP	Meets ICH-Q7 and FDA-21CFR
RADIOLABELING YIELD	≥ 99%

Lu-177 Production Process

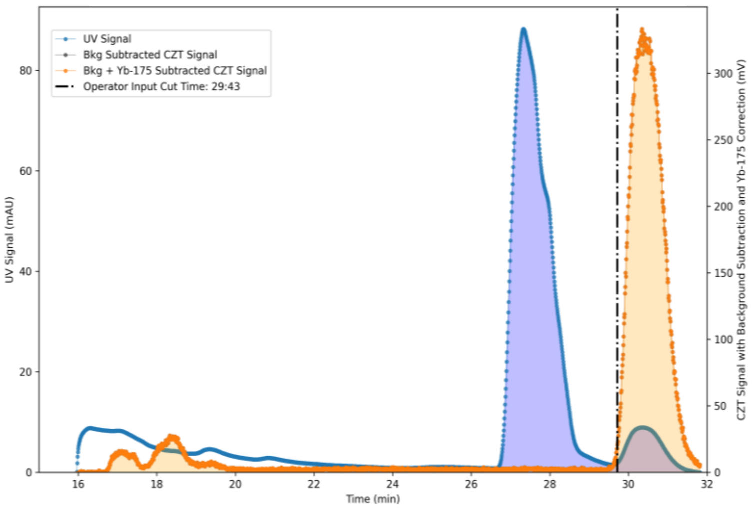
SHINE

Enrichment, Separation, and Purification

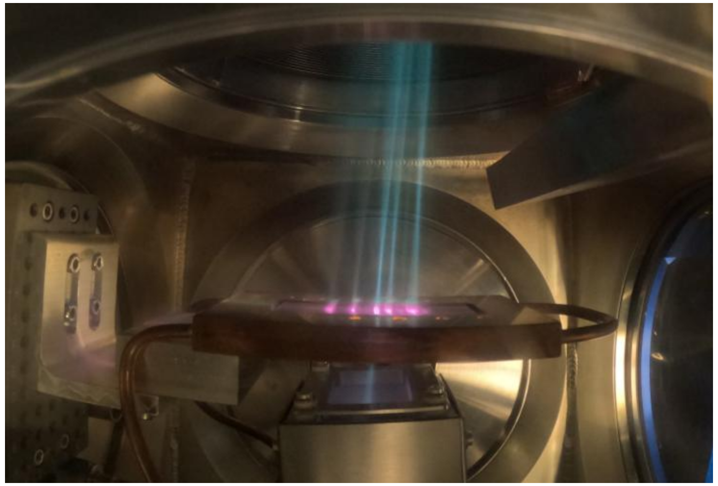
- Built/operating enrichment system with improved yield/purity
  - 50 g/year Yb-176 production per machine; >99.7% isotopic purity
  - Producing more Yb-176 than is being consumed today
- Thermal distillation separation relies on the wide variation of boiling points (Lu: 3,402 °C, Yb: 1196 °C)
  - Irradiated metal target is heated under vacuum
  - Yb sublimates and is captured on a cold trap; Lu concentrates
- Material dissolved in HCl and purified via HPLC process
- Testing these processes for Tb-161 production today



Typical HPLC Output



SHINE

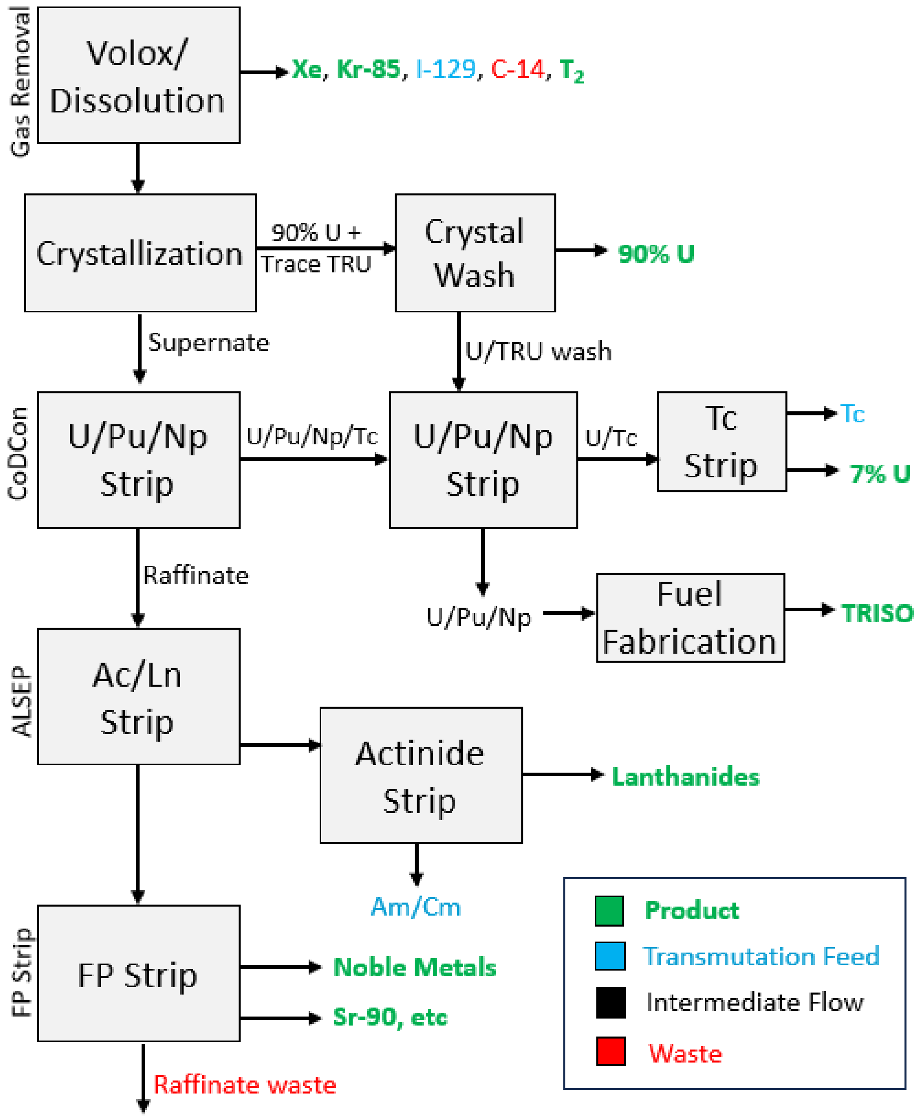


UNF Recycling and Isotope Recovery

NEWLY DEVELOPED TECHNOLOGIES PRESENT UNIQUE OPPORTUNITIES

- Evaluating technology improvements for regulatory compliance and improved economics
  1. Voloxidation for pre-processing fuel assemblies allows isolation of iodine/tritium to avoid liquid contamination
  2. CoDCon extraction to create a **blended U/Pu** stream
  3. Removal of minor actinides (via ALSEP) from the waste stream; future transmutation
  4. Harvest platinum group metals and rare earth elements for sale
     a. Am-241, Kr-85, and Sr-90 are commercial targets as well
  5. >95% of waste volume expected to be suitable for near-surface disposal
     a. Assessing deep bore disposal with Deep Isolation

- Approach combines proven and novel technologies and implements SHINE's improved safety and regulatory approach to greatly reduce the lifecycle cost of a recycling facility



SHINE

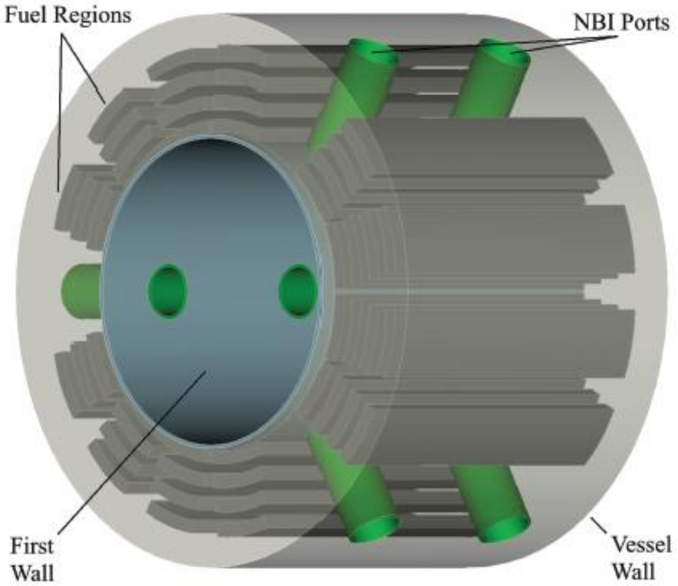
Longer Term: Transmutation

MAXIMIZING BENEFITS OF A CLOSED FUEL CYCLE

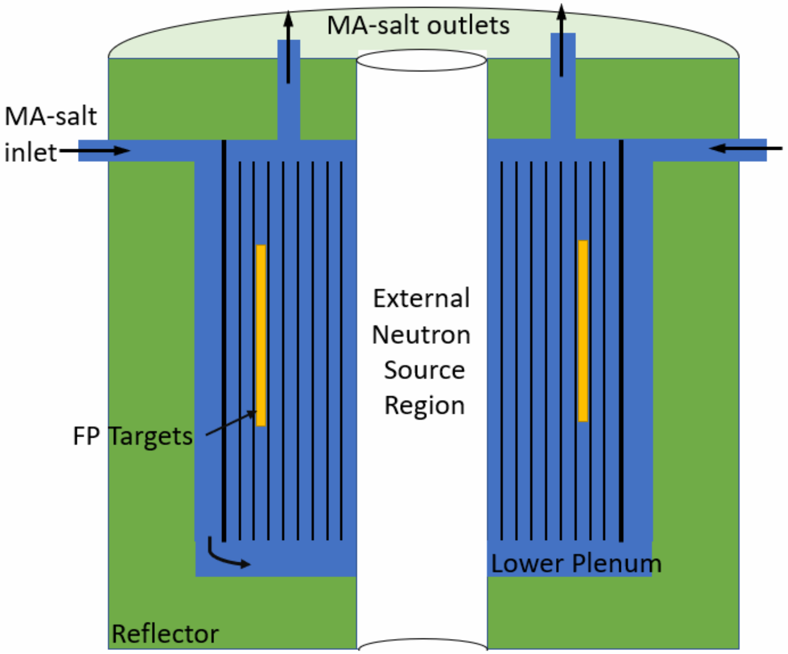
- Goal: Eliminate minor actinides (Np, Am, Cm) via fast fission
  - Assessing liquid (molten salt) core options
  - Evaluating fusion-driven subcritical systems and critical systems
  - Additionally, fission products (e.g. I-129 and Tc-99) can be converted to shorter lived or stable isotopes via neutron capture

- Benefits:
  - Molten cores: Minor actinides don't enter fuel rod supply chain
  - Systems can operate nearer to (or at) critical levels due to increased negative reactivity
  - Molten salt core allows for rapid capture of short-lived fission products for secondary sale
    - Significant separation development to be performed

- SHINE has been awarded an ARPA-E NEWTON grant to investigate/test blanket technologies over the next 3 years



Courtesy of UW-Madison*



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*) J.Ruegsegger, et al. "Scoping Studies for a Lead-Lithium-Cooled, Minor-Actinide- Burning, Fission-Fusion Hybrid Reactor Design", Nuclear Science and Engineering,2023

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Thank you for listening!

If you have any questions, please email
innovation@ukaea.uk

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Agenda

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10:30 – 12:30: Presentations	
Lee Evitts & Jessica Hollis, **UKAEA**	Exploration of Fusion technology for Medical Radionuclides at UKAEA
Jennifer Young, **Barts Cancer Institute - Queen Mary University of London**	Radionuclides for Health UK
Coffee Break	
Peter Ivanov, **National Physical Laboratory**	Development of Radiochemical Purification Methods for Emerging Medical Radionuclide Standards
Ram Mullur, **Astral Systems**	Plasma to Patients
Ross Radel, **SHINE**	Fusion Technologies for Industrial and Medical Applications
12:30 – 13:30: Networking Lunch	
13:30 – 14:15: Panel Discussion	
Jamie Townes (UKIFS) Talmon Firestone (Astral Systems) Marta Barrabino (Tokamak Energy) Jennifer Young (Barts Cancer Institute - Queen Mary University of London) Kathy Chan - (Institute of Cancer Research)	
14:15 – 14:30 | Closing Remarks	
14:30 – 15:30 | Networking & Poster Session	