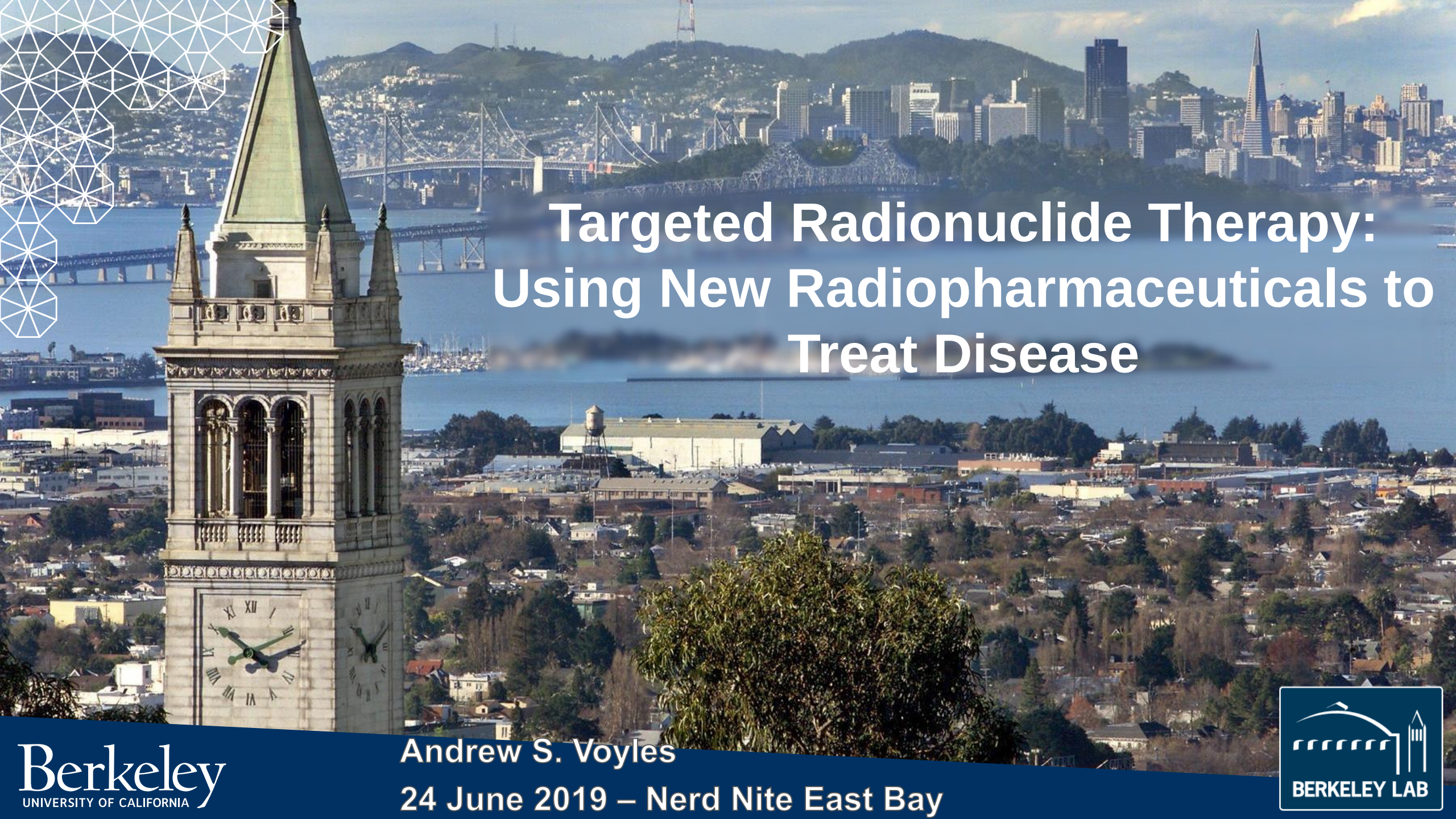


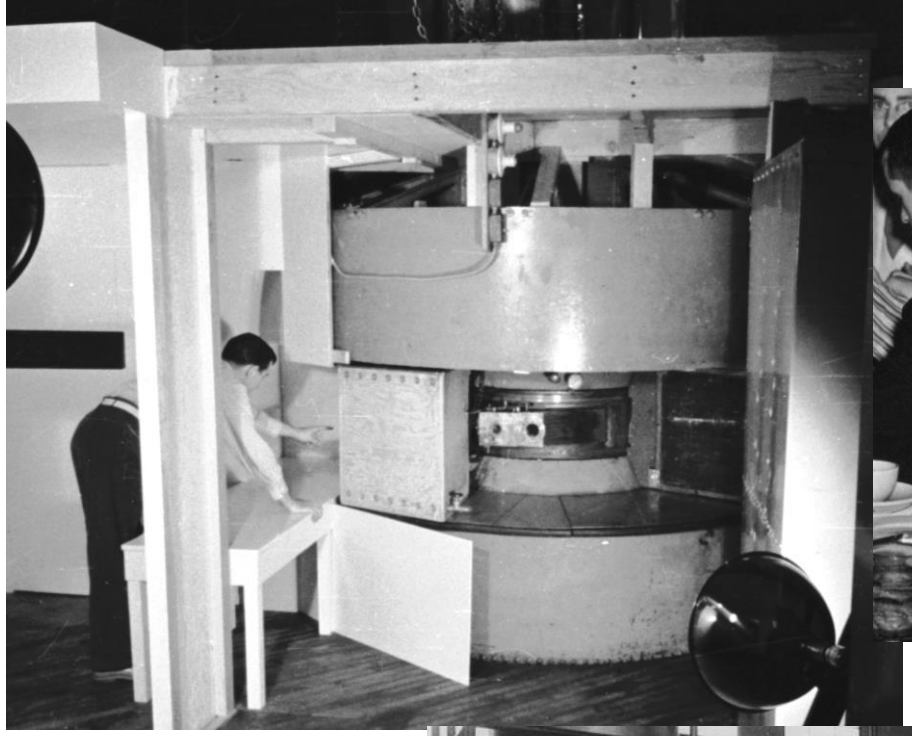
Targeted Radionuclide Therapy: Using New Radiopharmaceuticals to Treat Disease

Andrew S. Voyles

24 June 2019 – Nerd Nite East Bay

Berkeley
UNIVERSITY OF CALIFORNIA

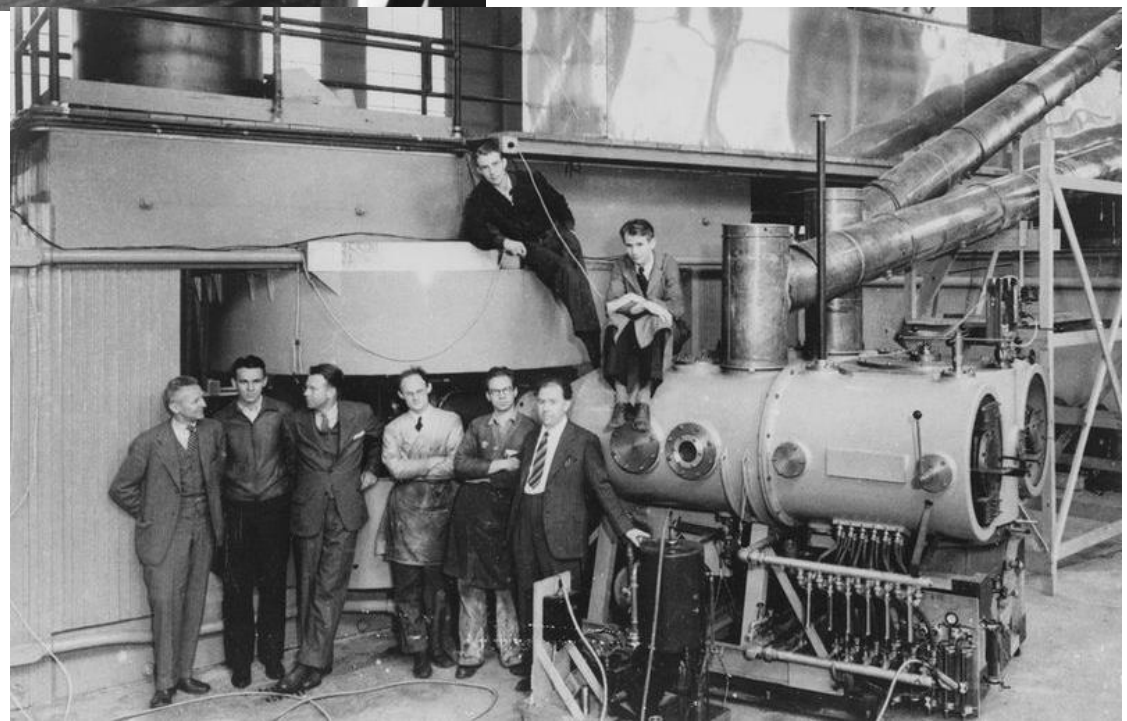
BERKELEY LAB

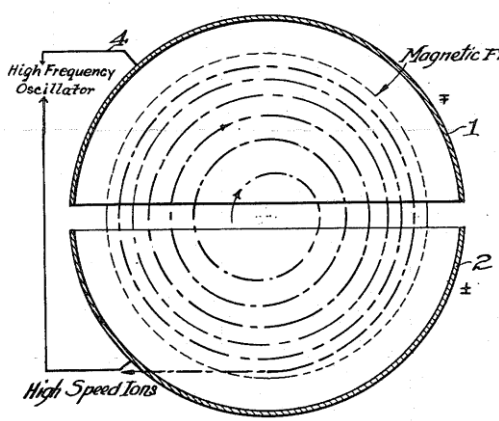


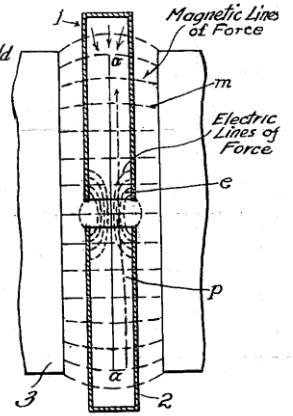
43 TECHNETIUM

Technetium is used in x-ray procedures to locate bone cancer.

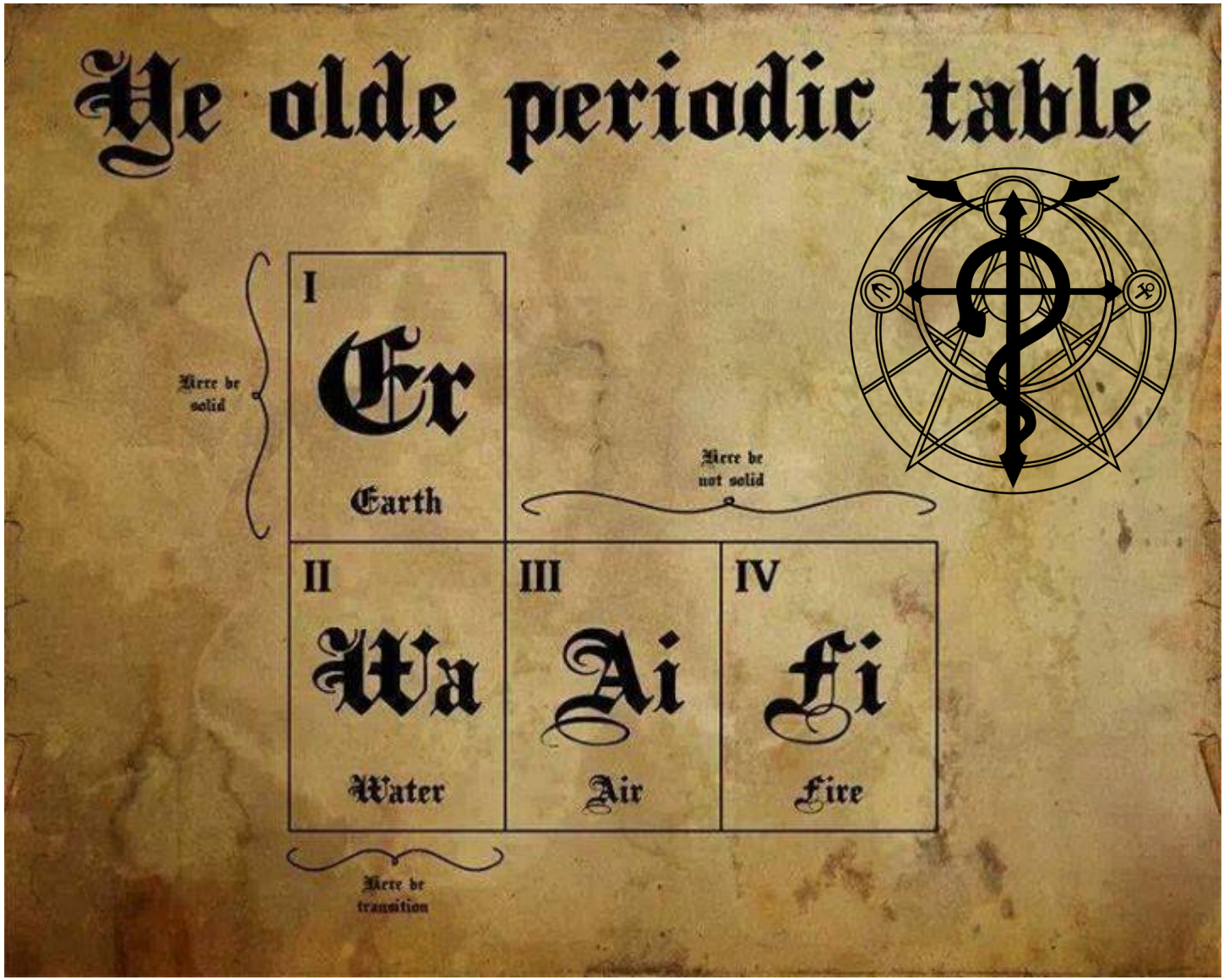
Tc

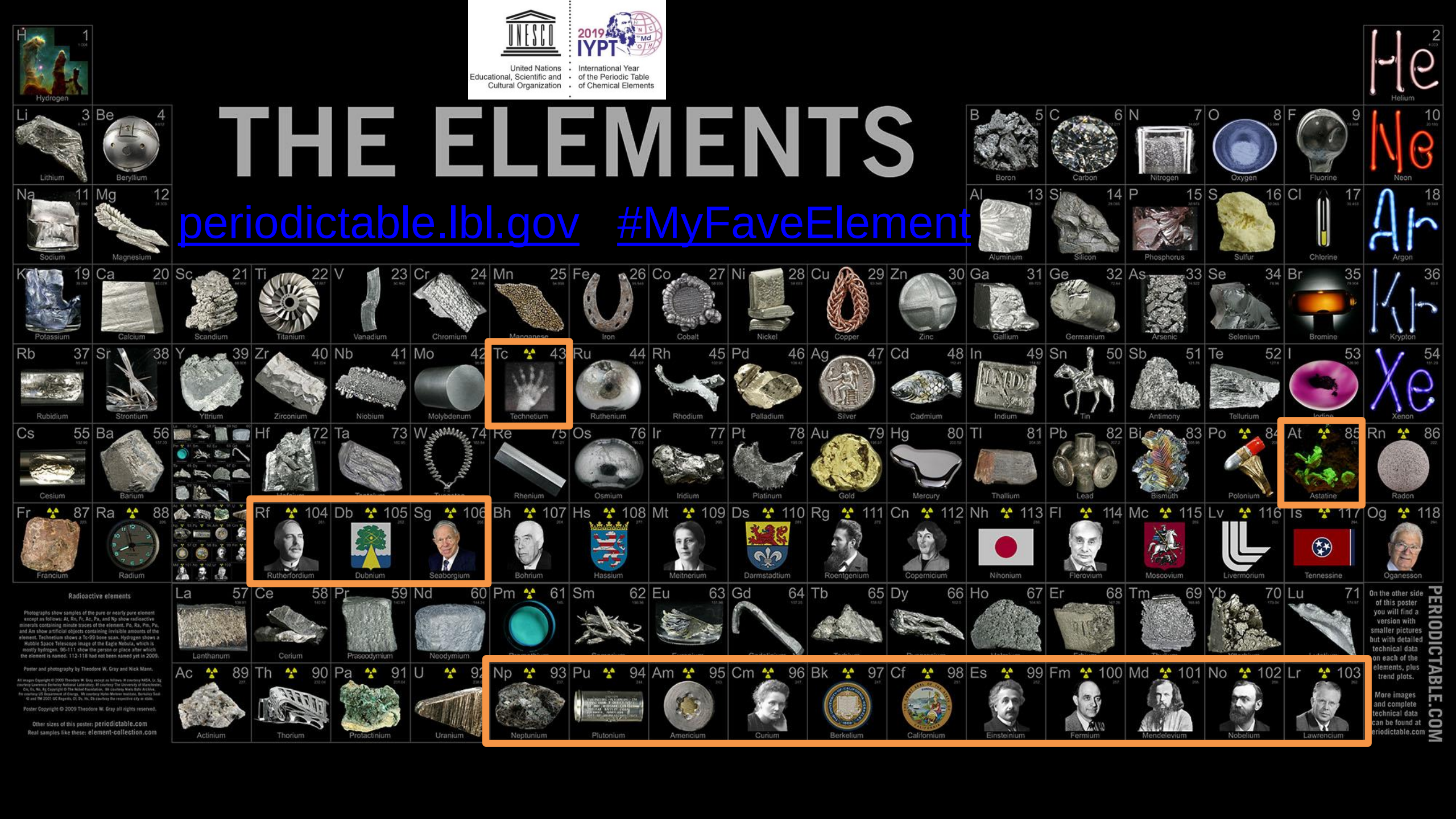


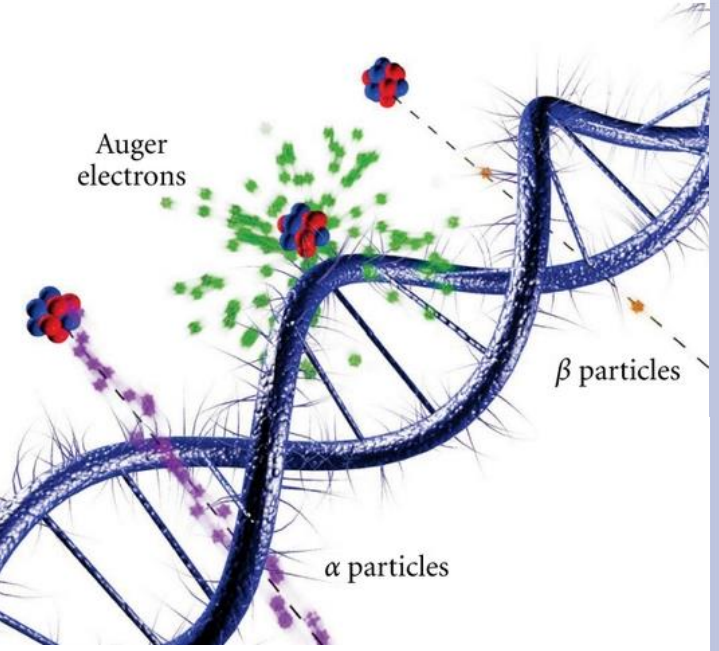


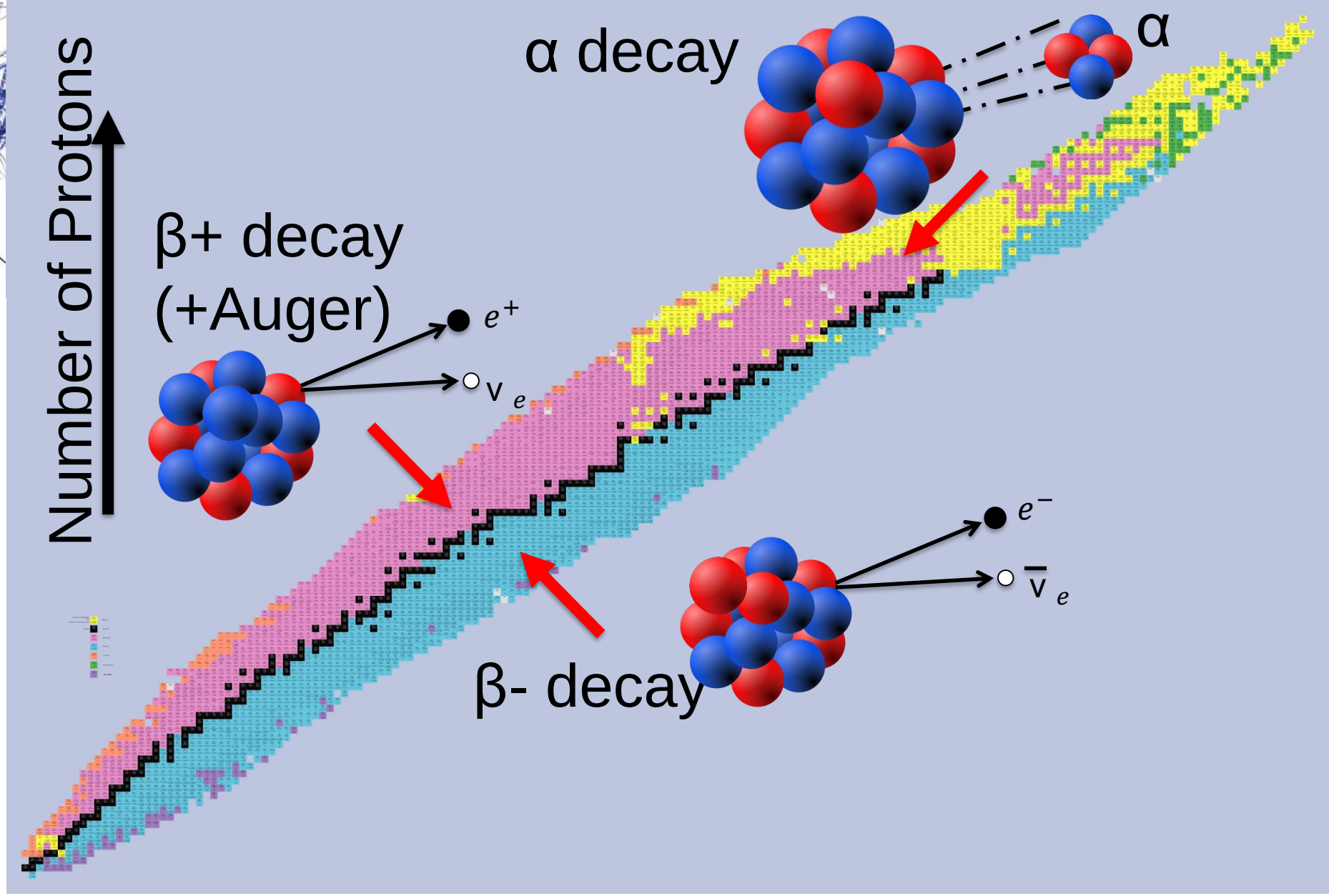


Ye olde periodic table

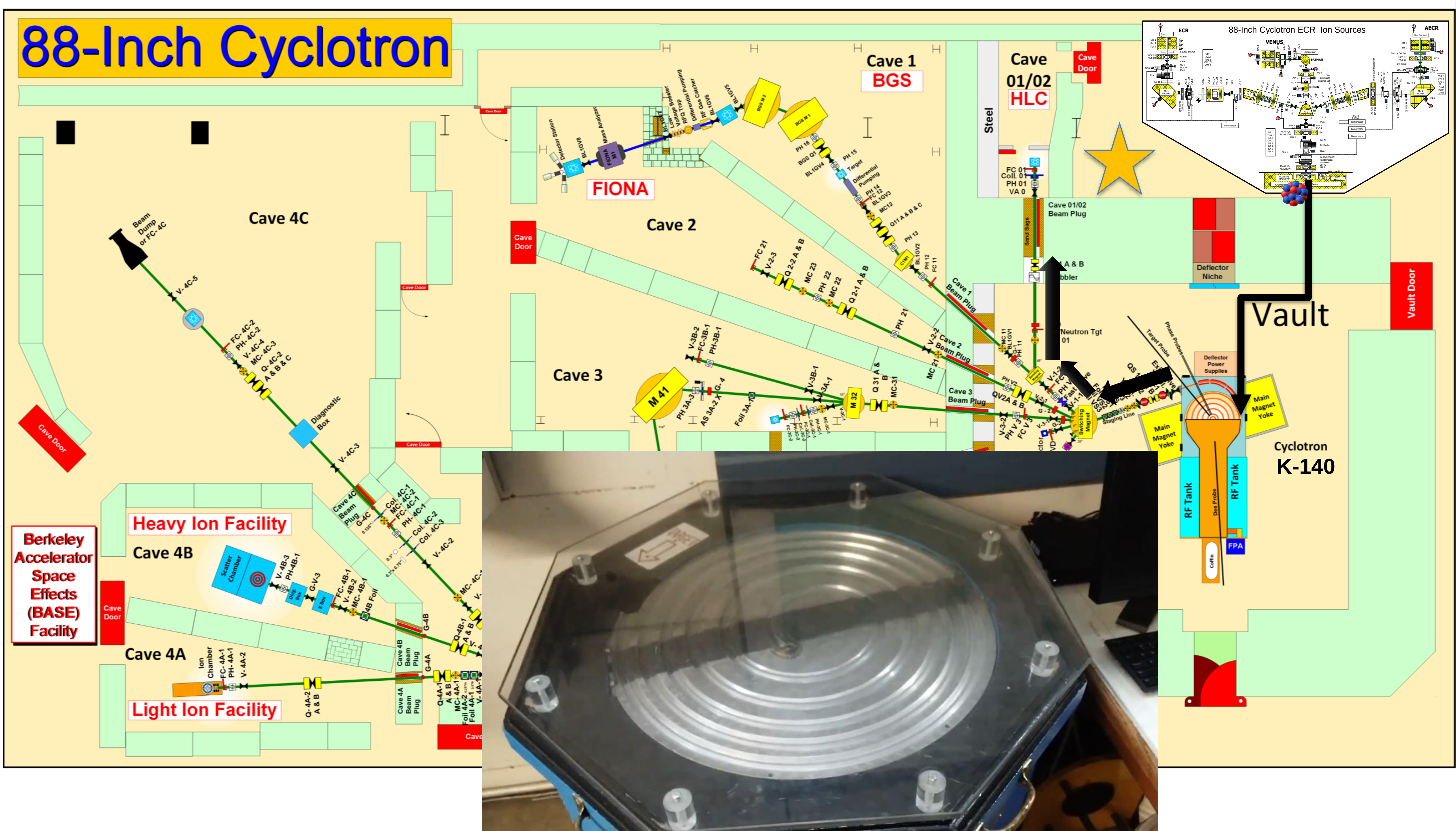



United Nations Educational, Scientific and Cultural Organization
2019 IYPT
International Year of the Periodic Table of Chemical Elements
THE ELEMENTS
periodictable.lbl.gov
#MyFaveElement
Hydrogen
Helium
Lithium
Beryllium
Boron
Carbon
Nitrogen
Oxygen
Fluorine
Neon
Sodium
Magnesium
Aluminum
Silicon
Phosphorus
Sulfur
Chlorine
Argon
Potassium
Calcium
Scandium
Titanium
Vanadium
Chromium
Manganese
Iron
Cobalt
Nickel
Copper
Zinc
Gallium
Germanium
Arsenic
Selenium
Bromine
Krypton
Rubidium
Strontium
Yttrium
Zirconium
Niobium
Molybdenum
Technetium
Ruthenium
Rhodium
Palladium
Silver
Cadmium
Indium
Tin
Antimony
Tellurium
Iodine
Xenon
Cesium
Barium
Rhenium
Osmium
Iridium
Platinum
Gold
Mercury
Thallium
Lead
Bismuth
Polonium
Astatine
Radon
Francium
Radium
Rutherfordium
Dubnium
Seaborgium
Bohrium
Hassium
Meitnerium
Darmstadtium
Roentgenium
Copernicium
Nihonium
Flerovium
Moscovium
Livermorium
Tennessine
Oganesson
Lanthanum
Cerium
Praseodymium
Neodymium
Actinium
Thorium
Protactinium
Uranium
Neptunium
Plutonium
Americium
Curium
Berkelium
Californium
Einsteinium
Fermium
Mendelevium
Nobelium
Lawrencium
Radioactive elements
Photographs show samples of the pure or nearly pure element except as follows: At, Rn, Fr, Ac, Pa, and Np show radioactive minerals containing minute traces of the element. Po, Ra, Pm, Pu, and Am show artificial objects containing invisible amounts of the element. Technetium shows a Tc-99 bone scan. Hydrogen shows a Hubble Space Telescope image of the Eagle Nebula, which is mostly hydrogen. 96-111 show the person or place after which the element is named. 112-118 had not been named yet in 2009.
Poster and photography by Theodore W. Gray and Nick Mann.
Poster Copyright © 2009 Theodore W. Gray all rights reserved.
Other sizes of this poster: periodictable.com
Real samples like these: element-collection.com
On the other side of this poster you will find a version with smaller pictures but with detailed technical data on each of the elements, plus trend plots.
More images and complete technical data can be found at periodictable.com
PERIODICTABLE.COM



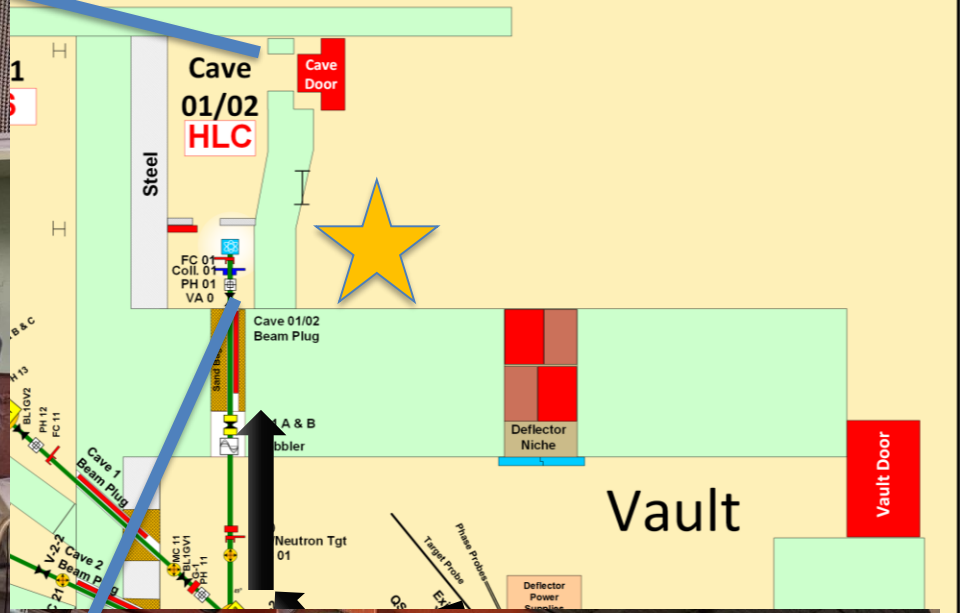


Comp Math Meth Med 2012 651475


88-Inch Cyclotron
88-Inch Cyclotron ECR Ion Sources
ECR
VENUS
AECR
Cave 1
BGS
Cave 01/02
HLC
Cave Door
Steel
FIONA
Cave 4C
Cave 2
Cave 3
Cave 01/02 Beam Plug
Deflector Niche
Vault
Vault Door
Deflector Power Supplies
Main Magnet Yoke
Cyclotron
K-140
RF Tank
Dee Probe
FPA
Coffin
Heavy Ion Facility
Cave 4B
Cave 4A
Light Ion Facility
Berkeley Accelerator Space Effects (BASE) Facility
Beam Dump or FC-4C
Diagnostic Box
Scatter Chamber
Ion Chamber
M 41
M 32
Switching Magnet
Neutron Tgt 01
Cave 1 Beam Plug
Cave 2 Beam Plug
Cave 3 Beam Plug
Cave 4A Beam Plug
Cave 4B Beam Plug
Cave 4C Beam Plug
Sand Bags
Staging Line

88-Inc

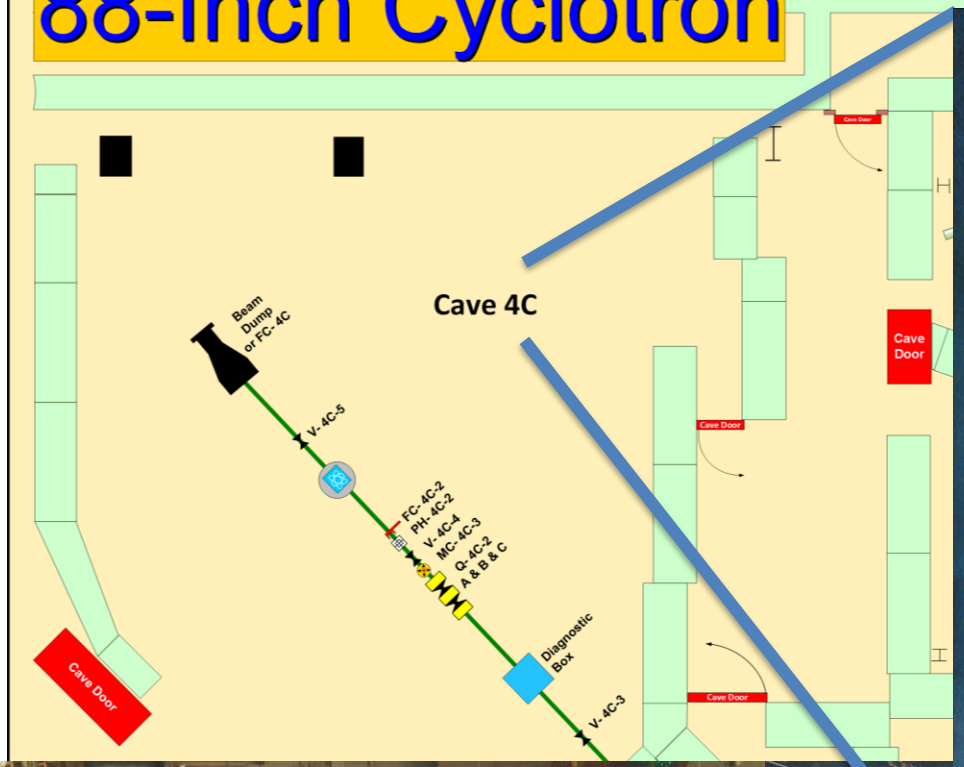

L. Bernstein

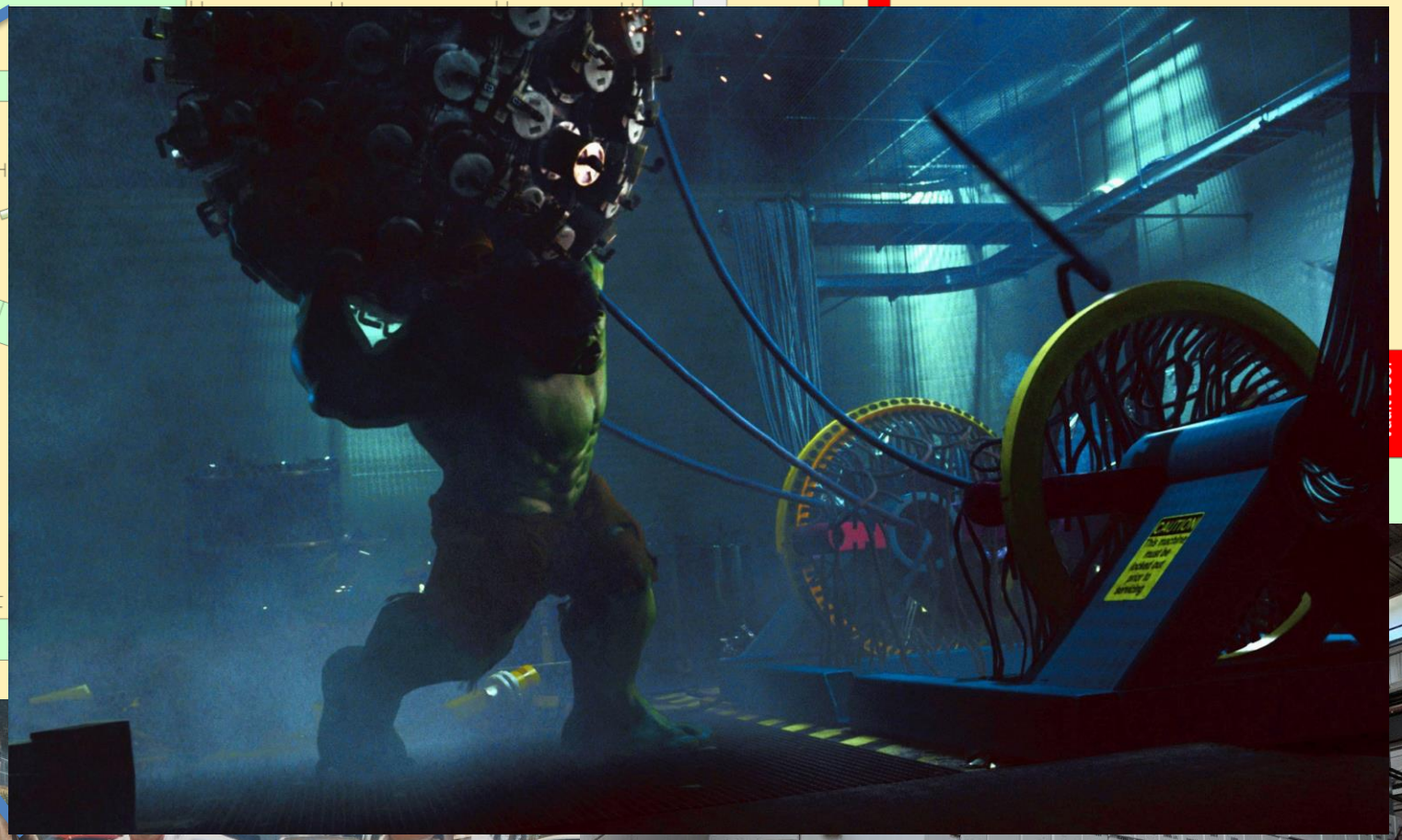

Cave
01/02
HLC
Cave Door
Steel
FC 01
Coil 01
PH 01
VA 0
Cave 01/02
Beam Plug
Deflector
Niche
Vault
Vault Door
Neutron Tgt
01
Cave 1
Beam Plug
Cave 2
Beam Plug
Deflector
Power


A. Springer

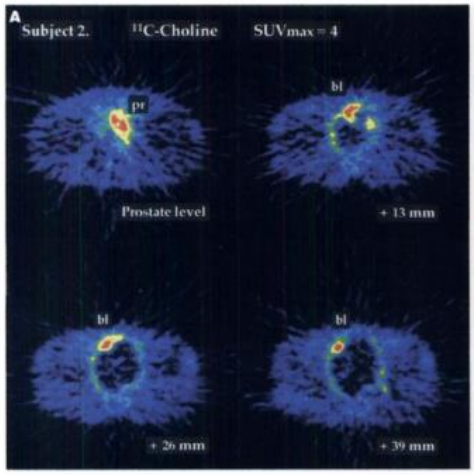
Beam
Dump
or FC- 4C
Cave Door

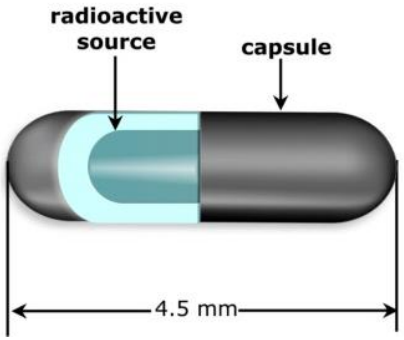
88-Inch Cyclotron





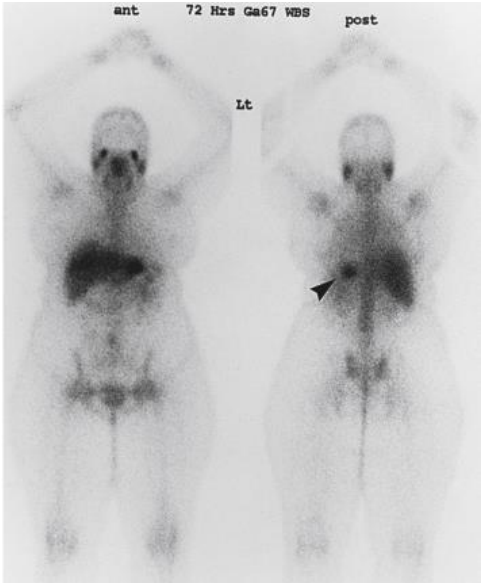
^{11}C

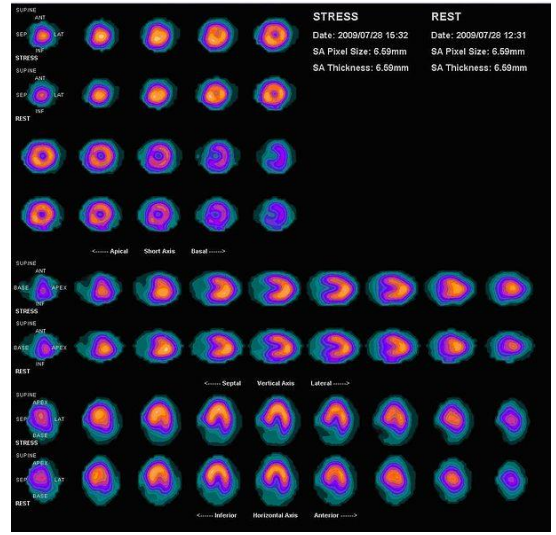




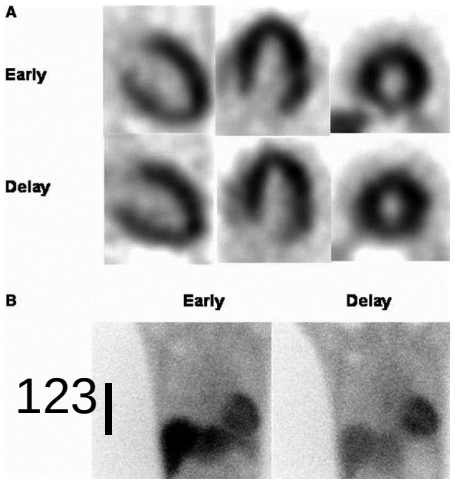
$^{90}Sr,^{131}I$

^{67}Ga

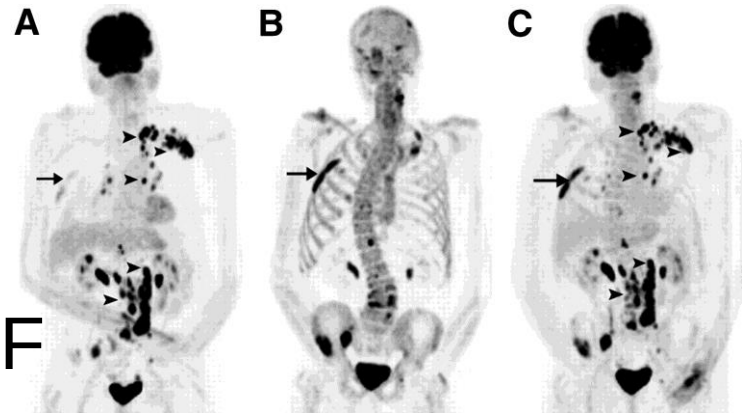




$^{99m}Tc,^{82}Rb$



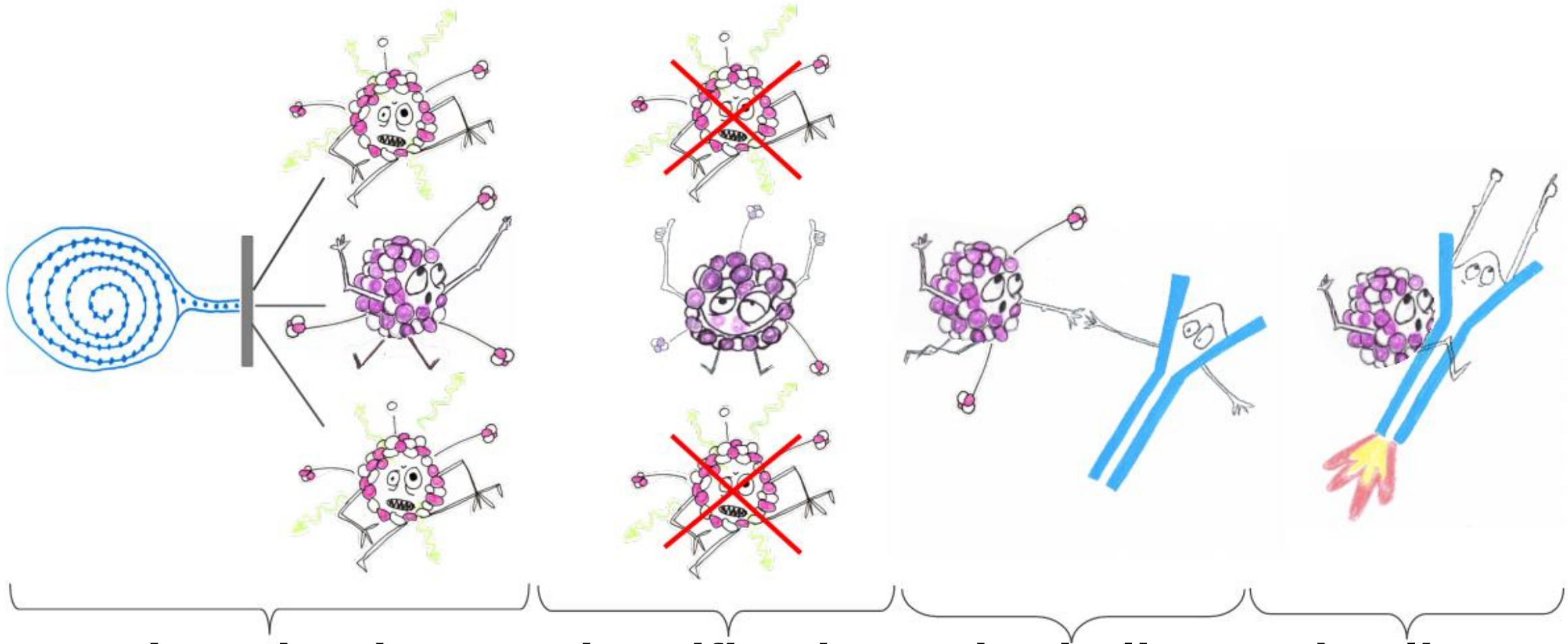
^{123}I



^{18}F

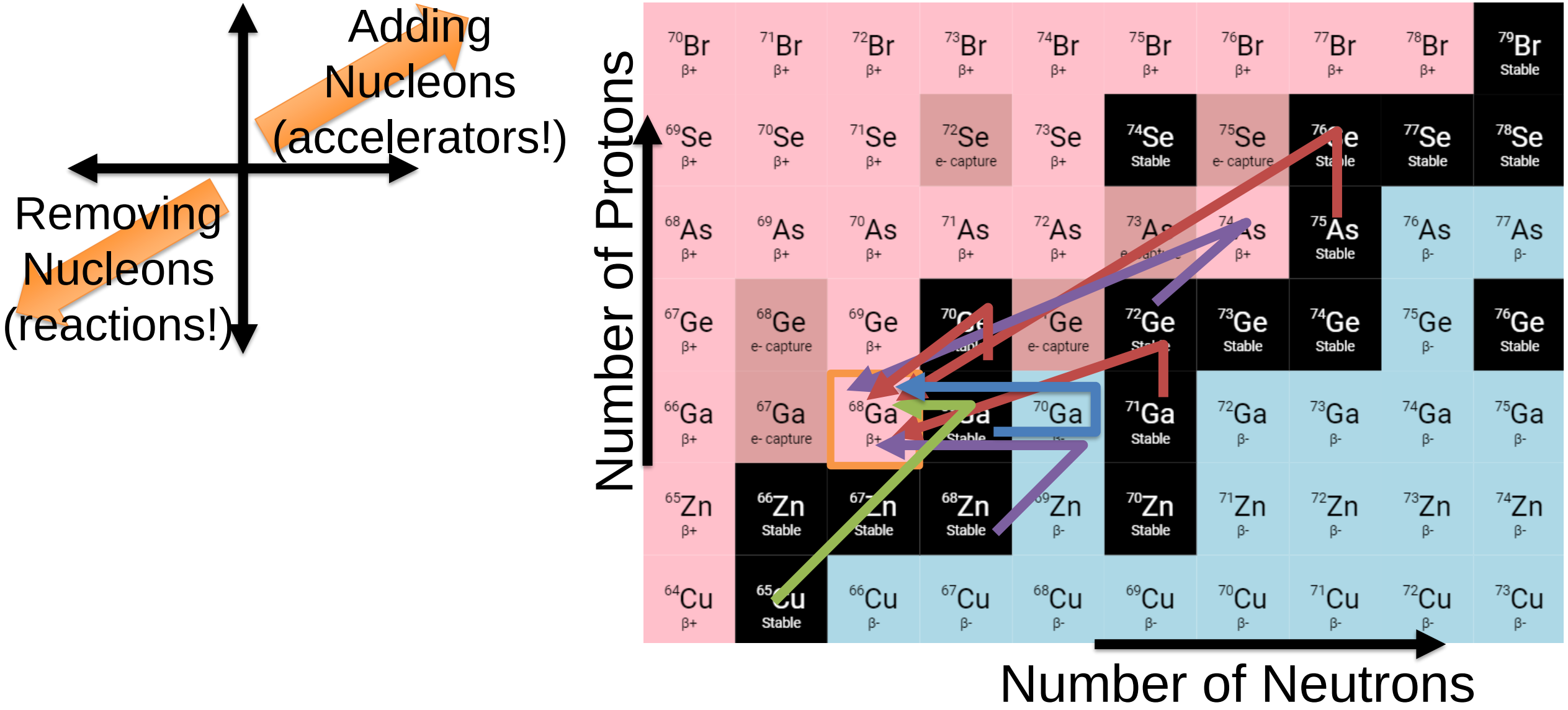
J Nucl Med 39.6 (1998): 990-995
J Nucl Med April 2009 vol. 50 no. 4 501-505

Med Mgmt Thorac Surg 2010, 30-59
Circ J 73.10 (2009): 1956-1960



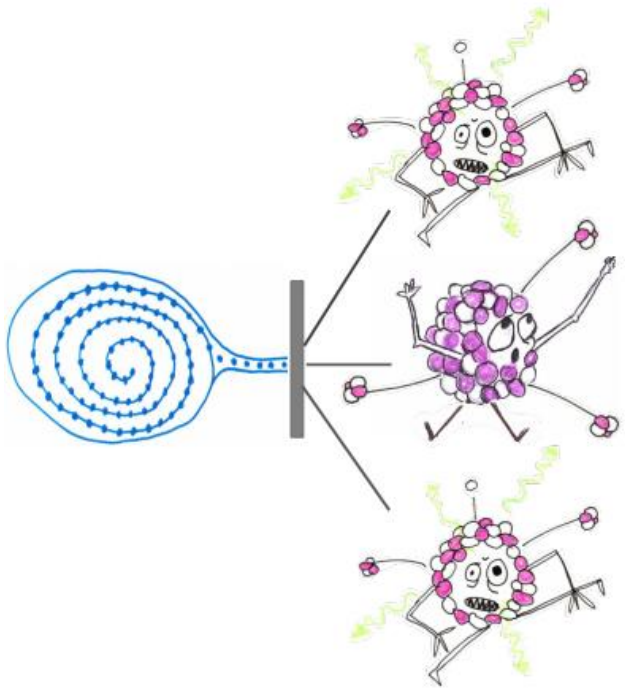
1)Production 2)Purification 3)Labeling 4)Delivery

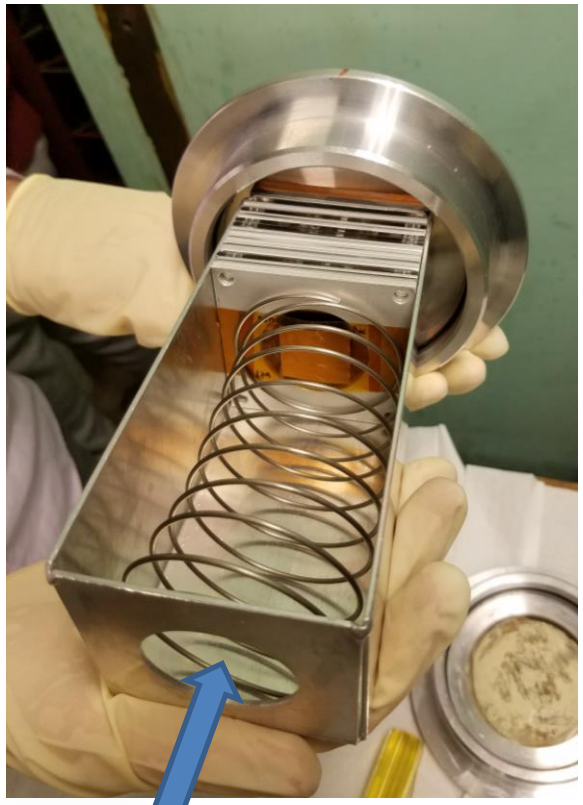
A massively interdisciplinary undertaking!

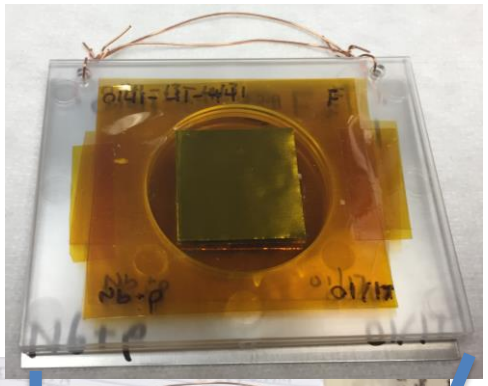


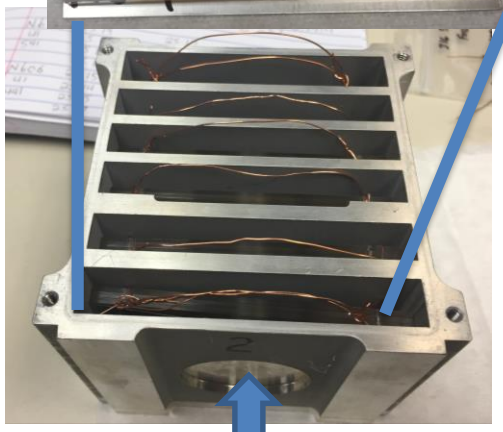
1a) Plan how to make the isotope

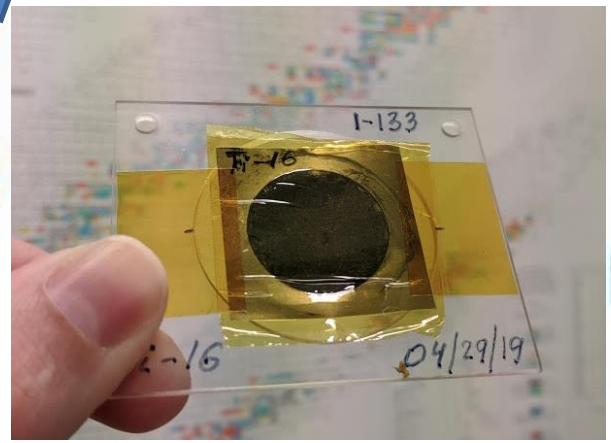
1b) Irradiate a thin target

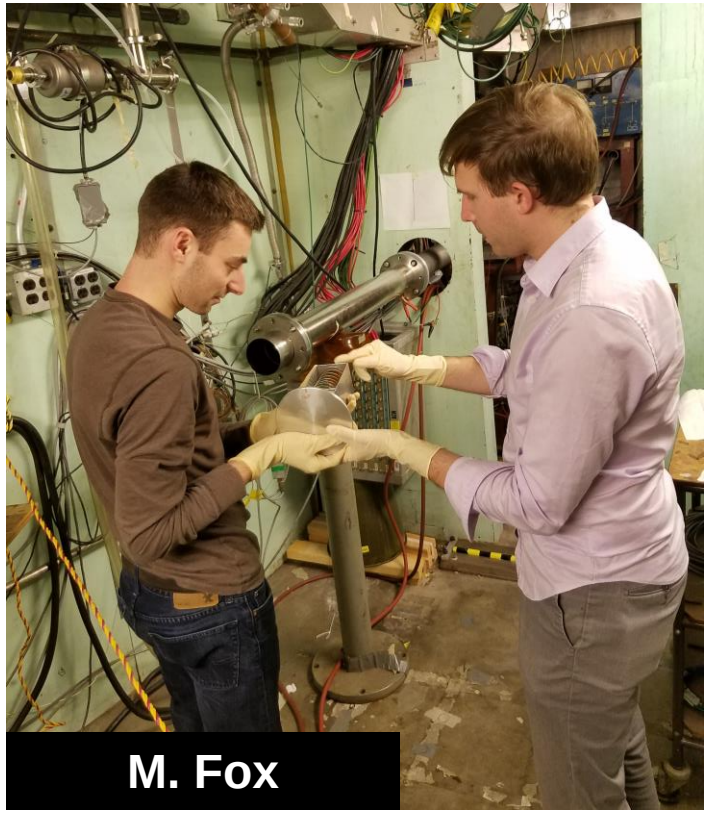




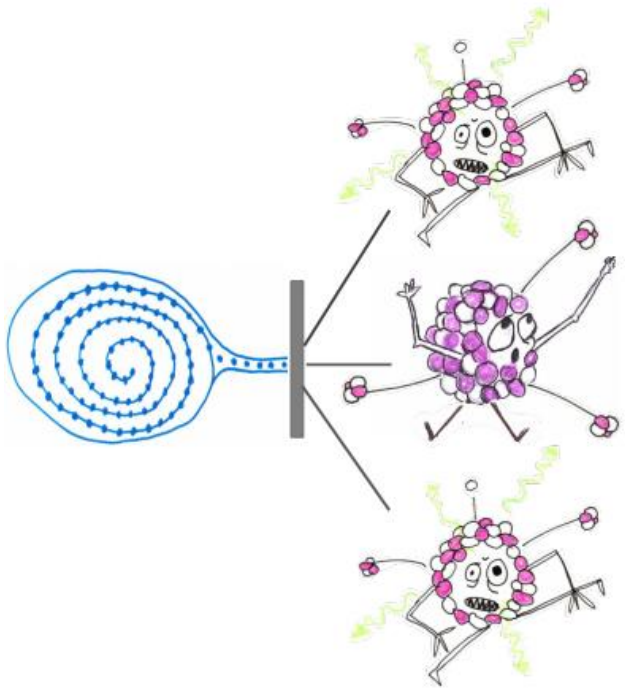




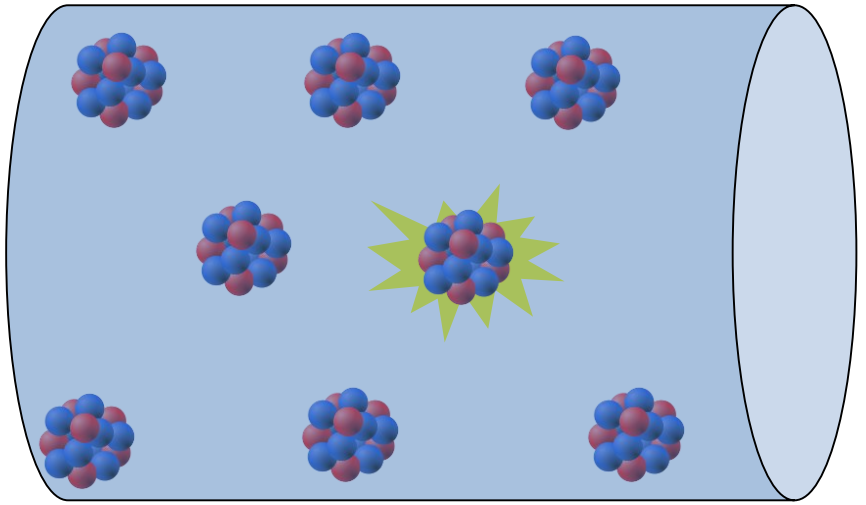


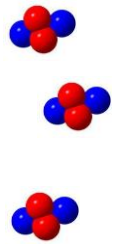


M. Fox

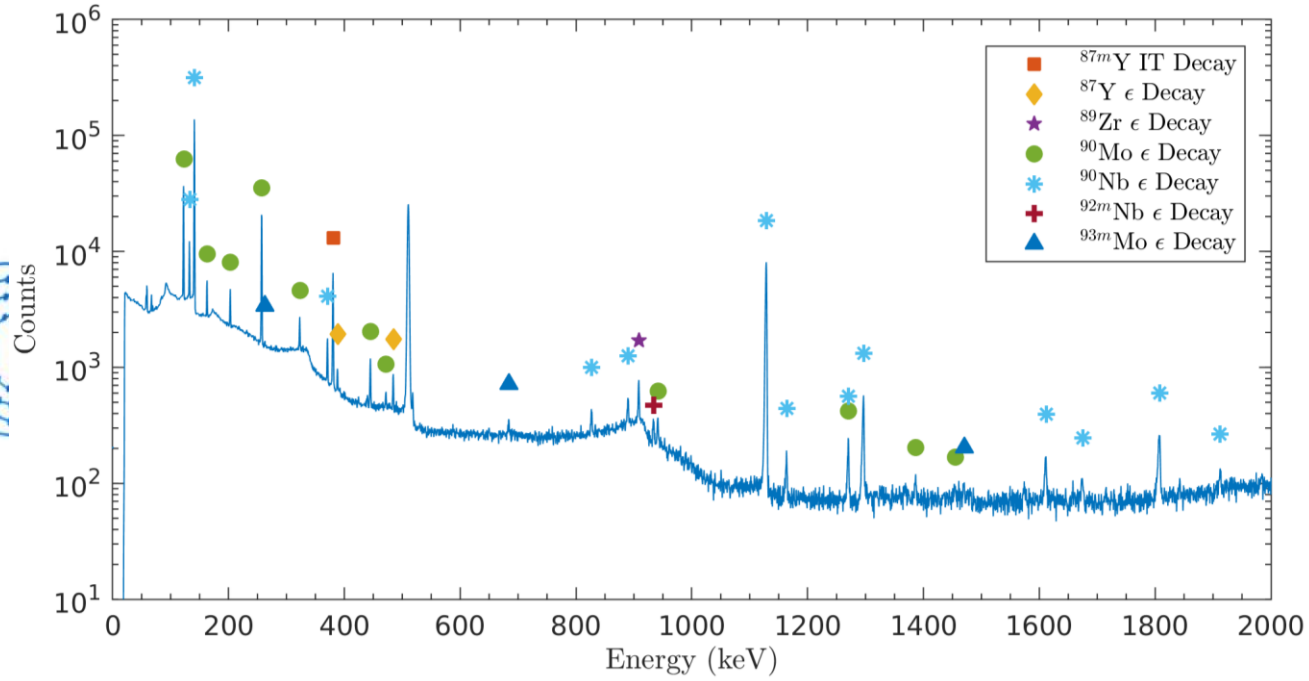


$$\sigma_{reaction} \approx \frac{\#_{reactions}}{M_{targets}\, I_{beam}}$$

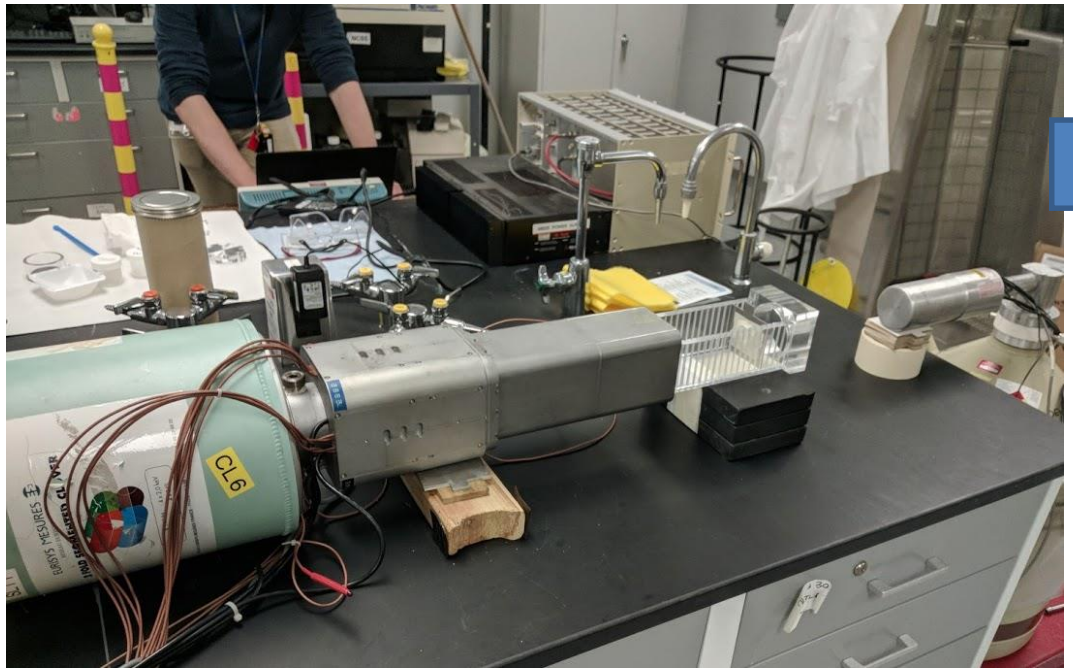


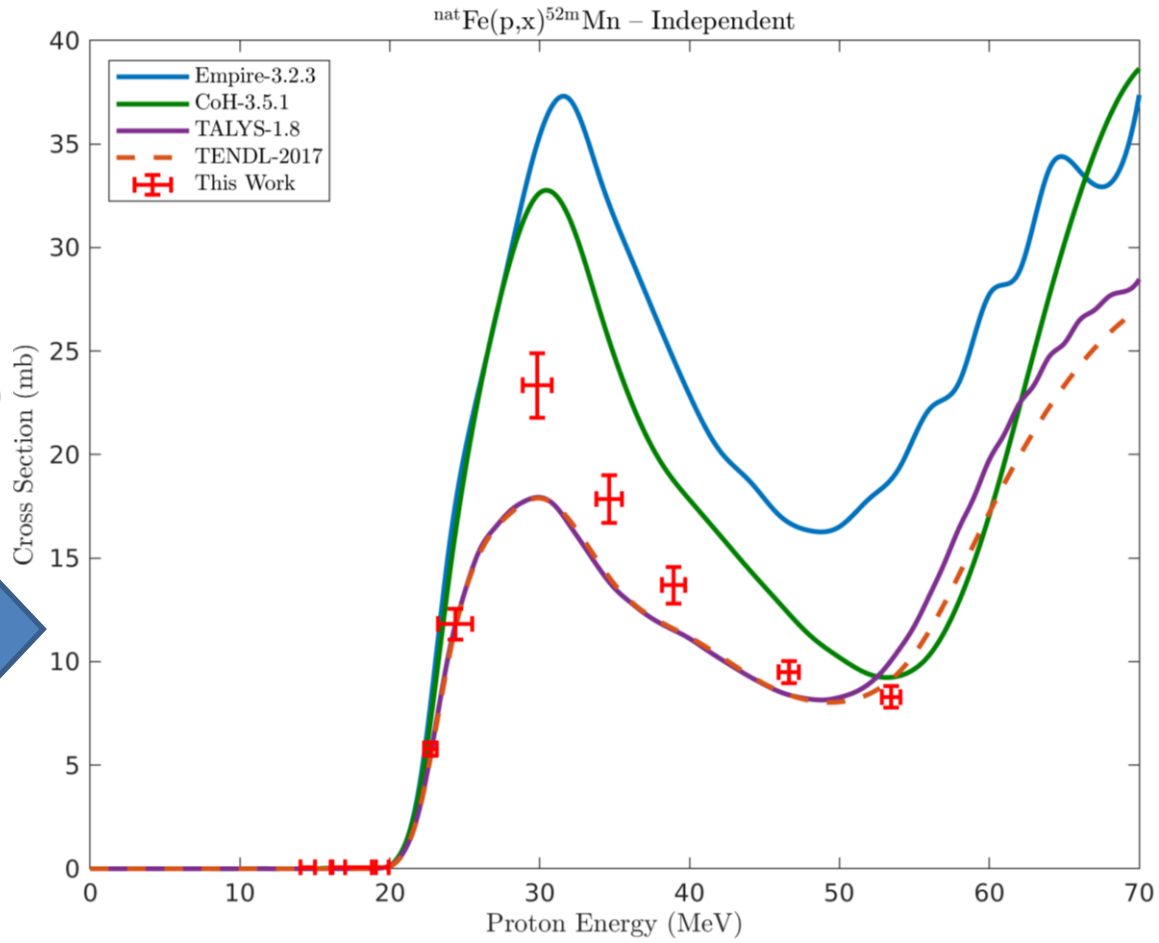


1c) Count how much was made



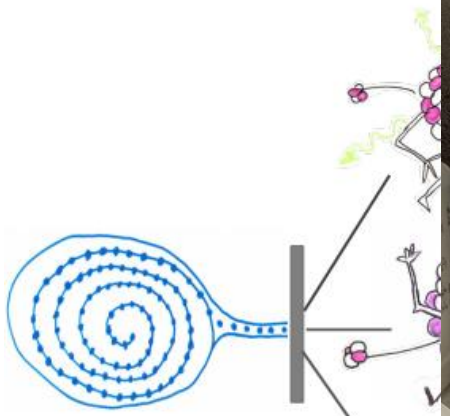
$$\sigma_{reaction} \approx \frac{\#_{reactions}}{M_{targets}\, I_{beam}}$$

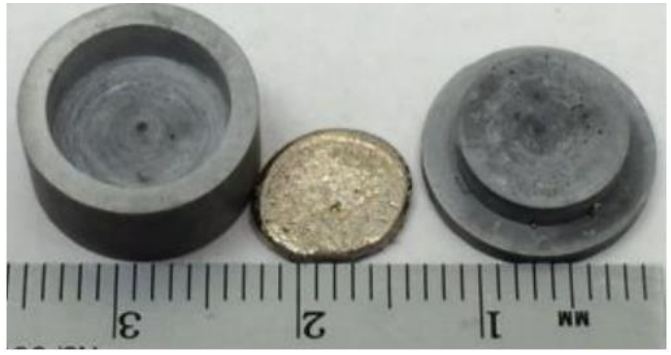


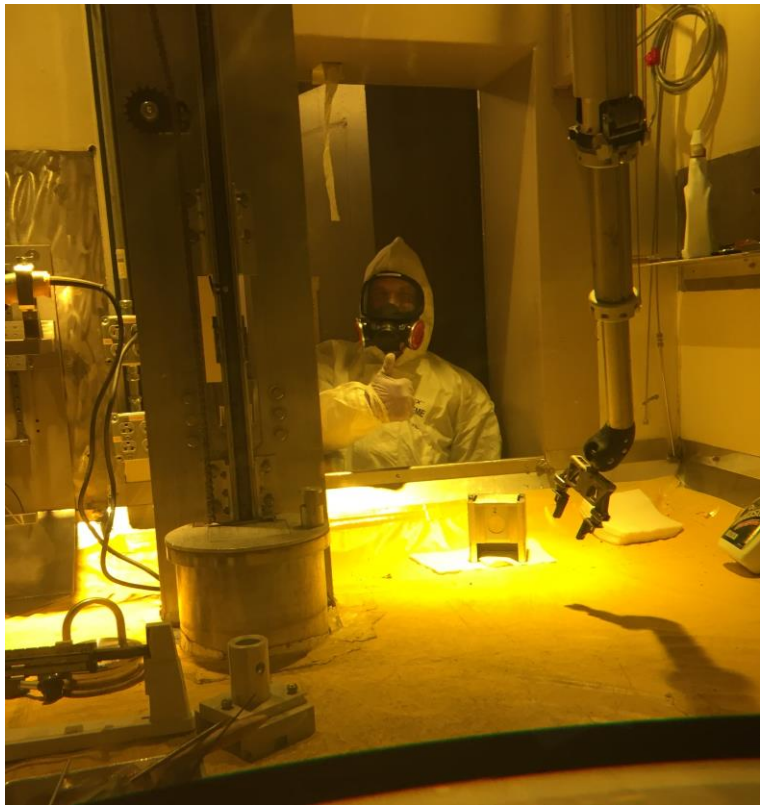


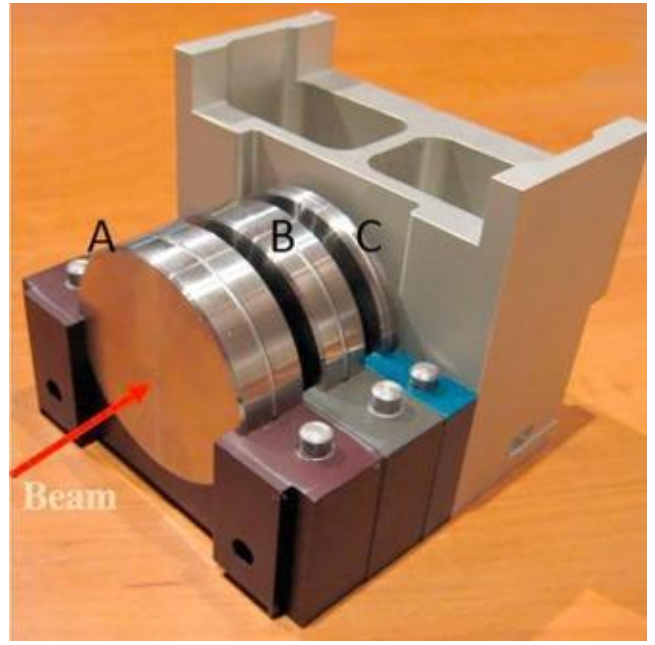
1c) Count how much was made

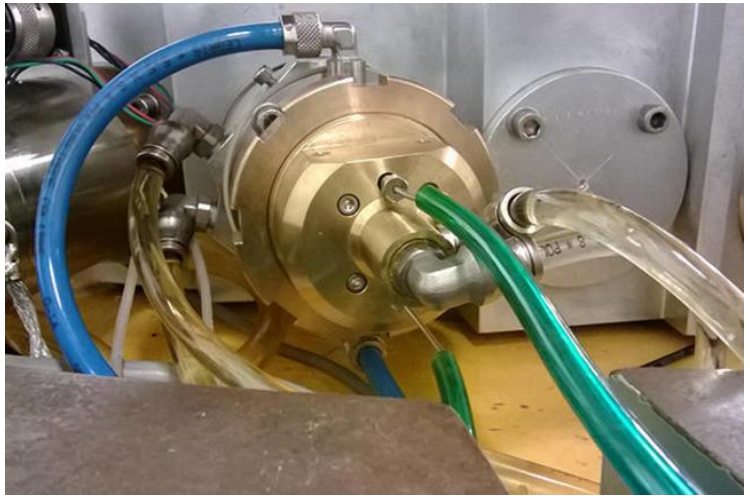
1d) Make LOTS of isotope

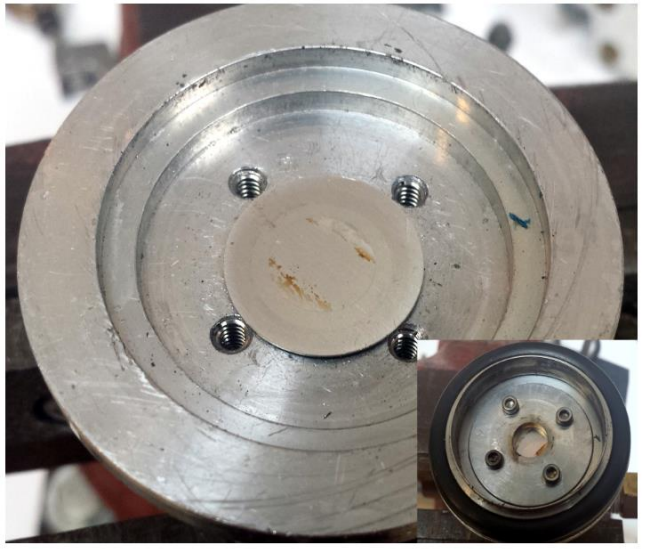


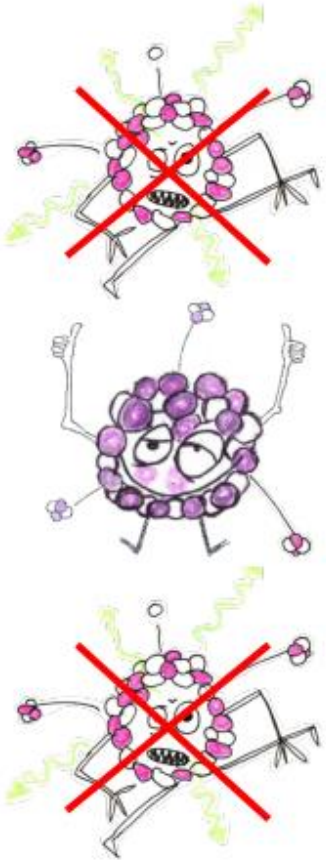




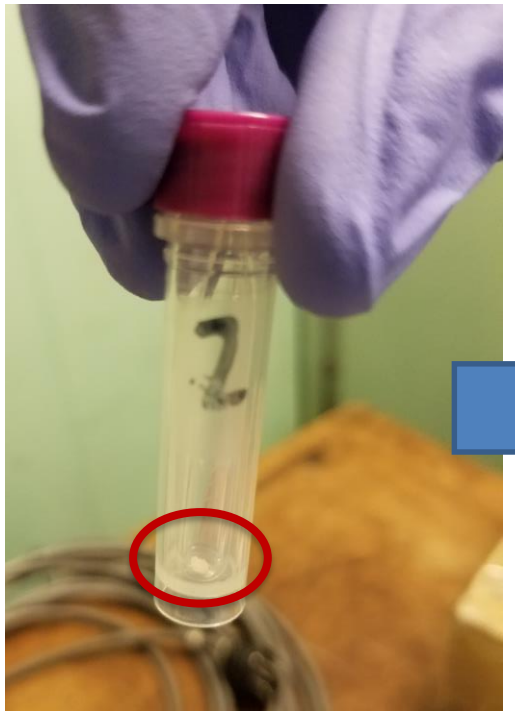


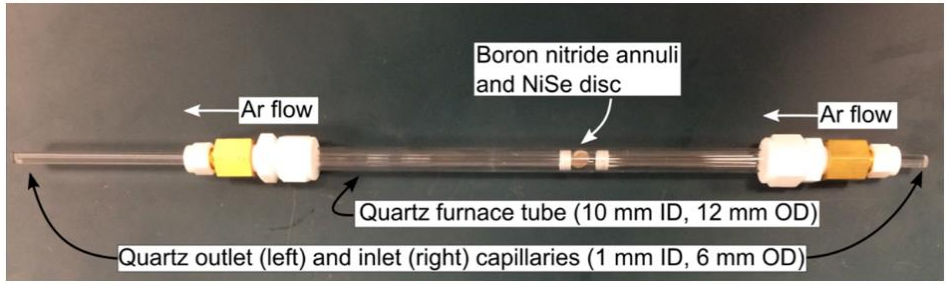




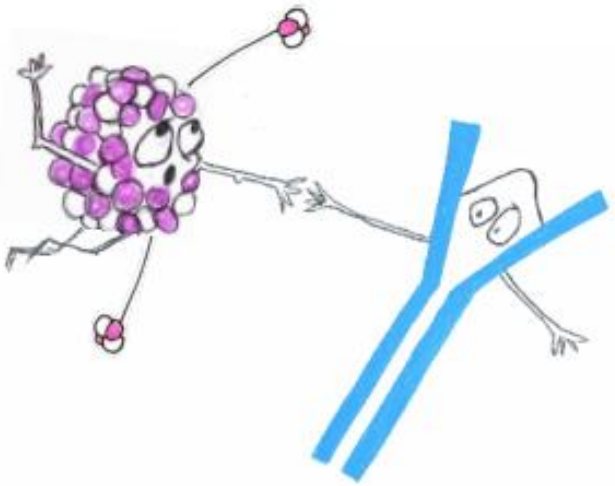


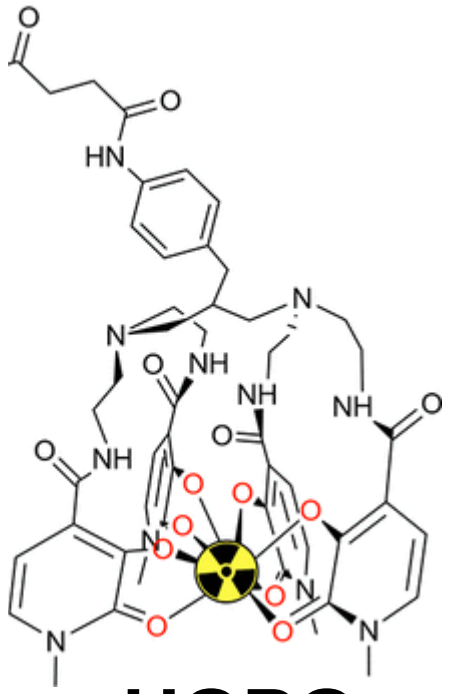
^{225}Ac





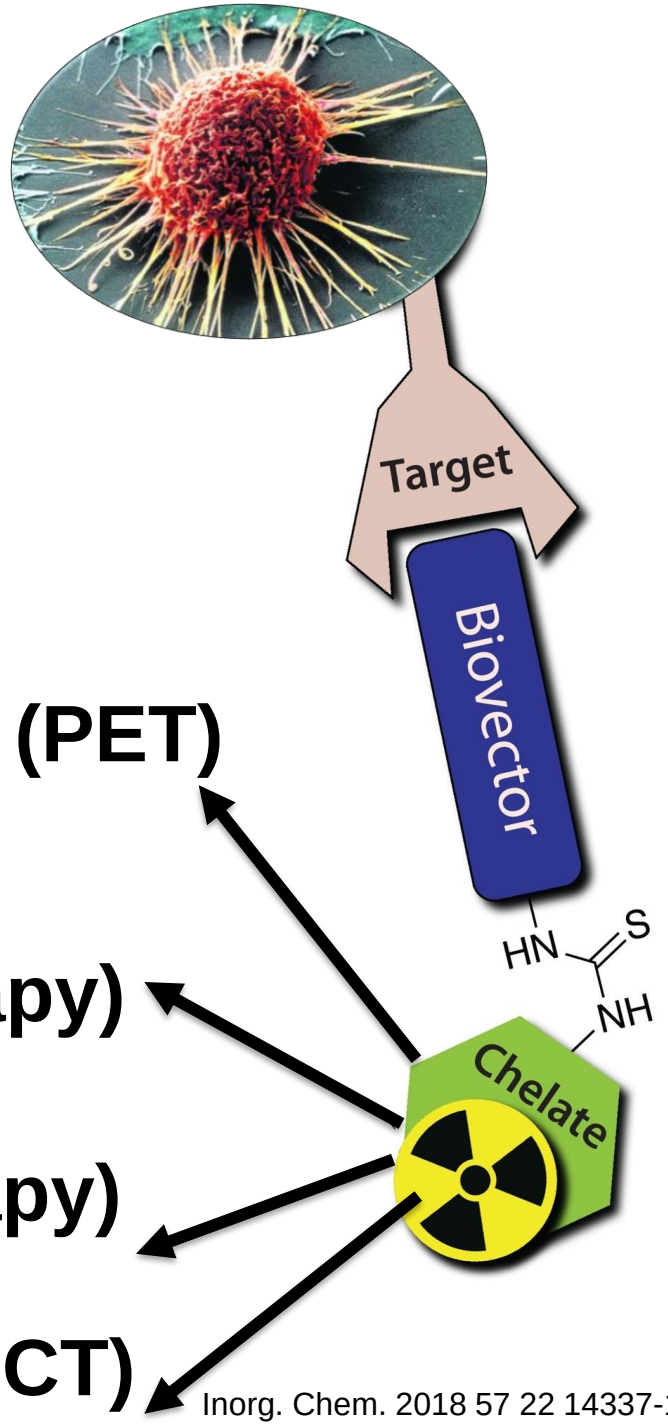
2) Purification



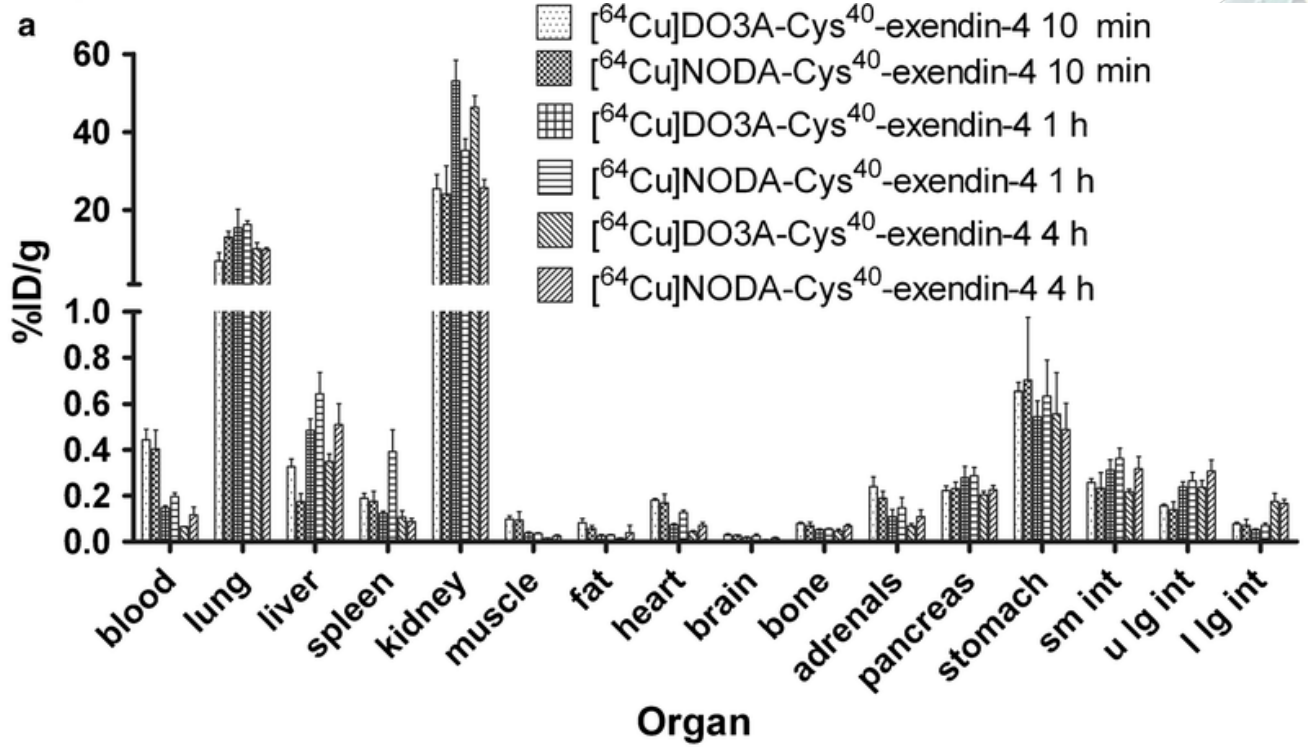


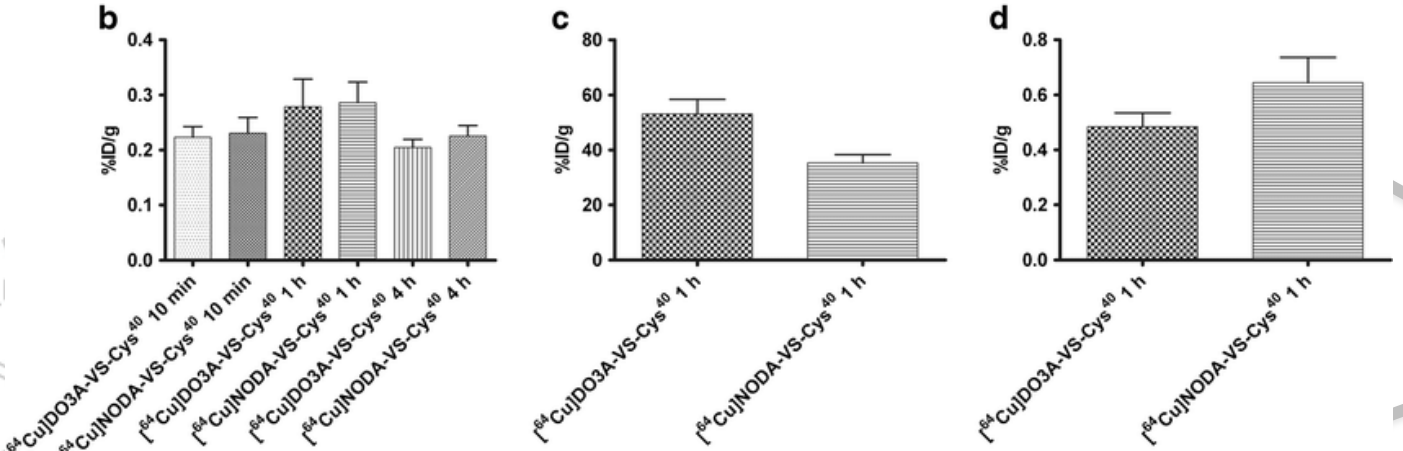
HOPO

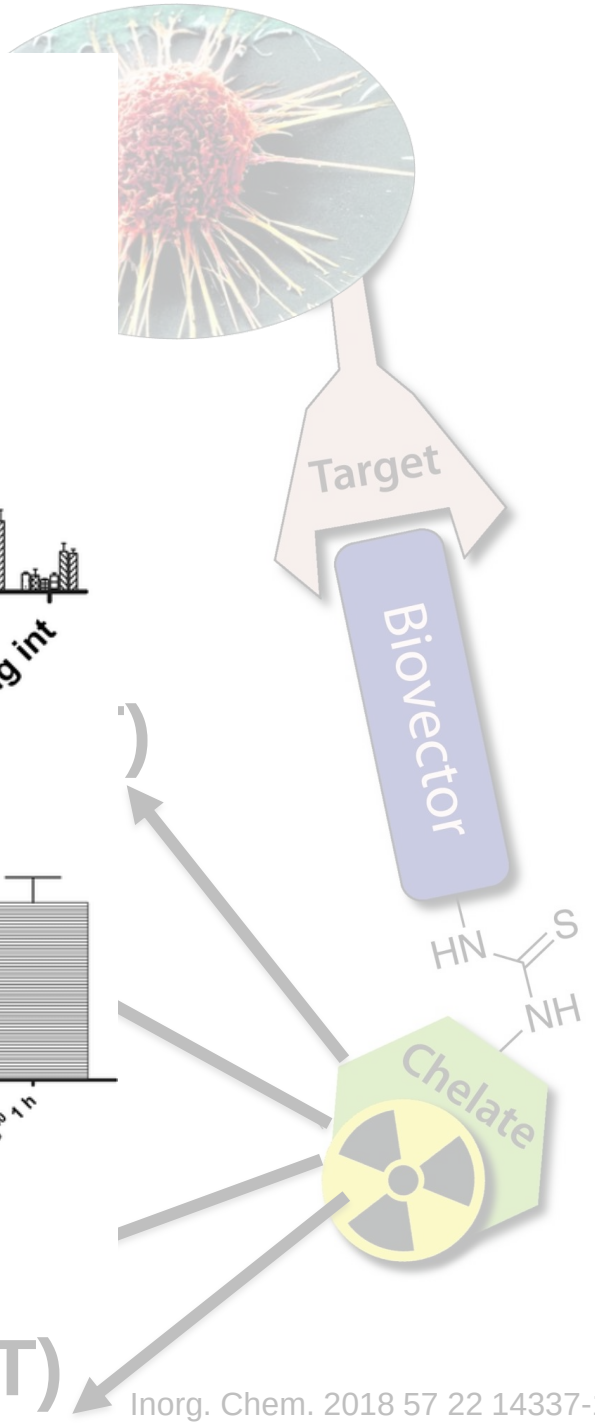
3) Labeling



Inorg. Chem. 2018 57 22 14337-14346





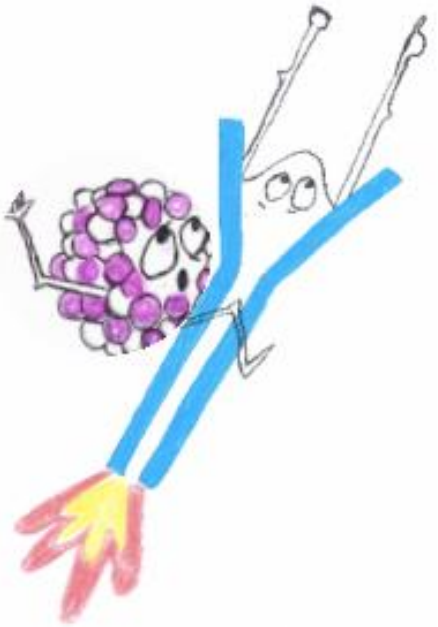


HOPO

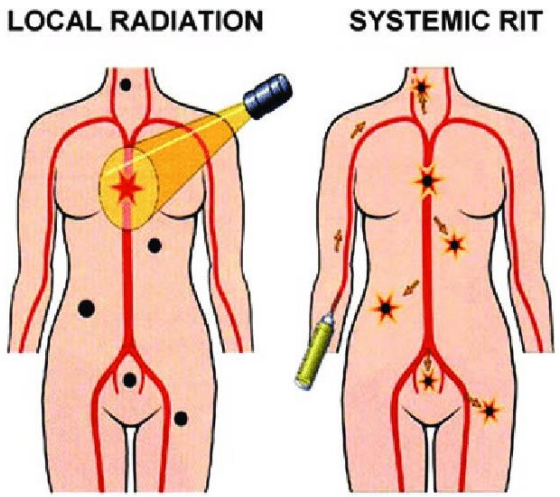
3) Labeling

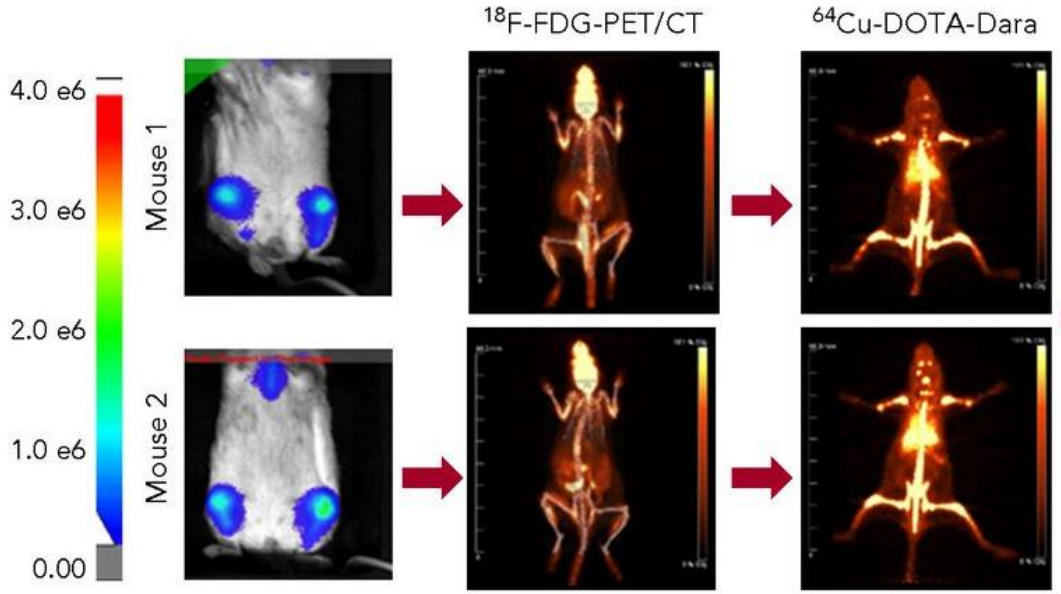
γ (SPECT)

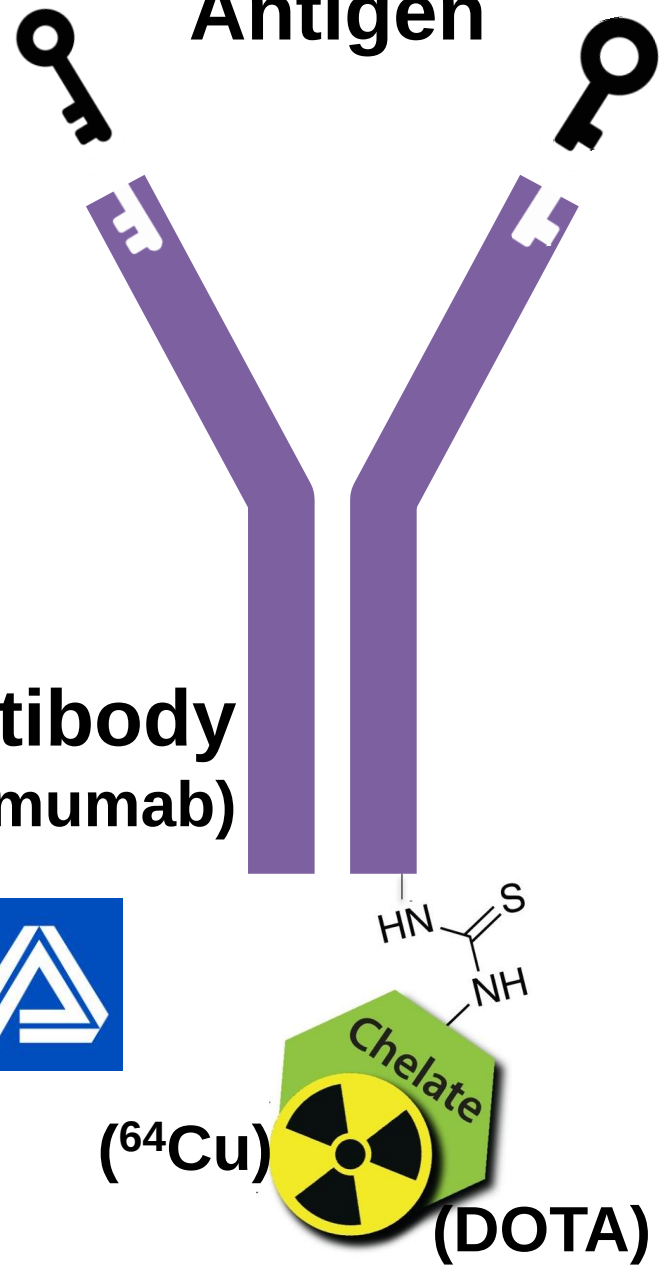
Inorg. Chem. 2018 57 22 14337-14346



4) Delivery





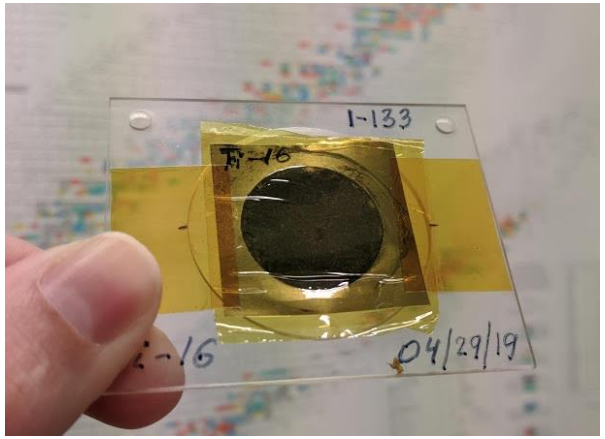


Blood, 131 (7), 741-745

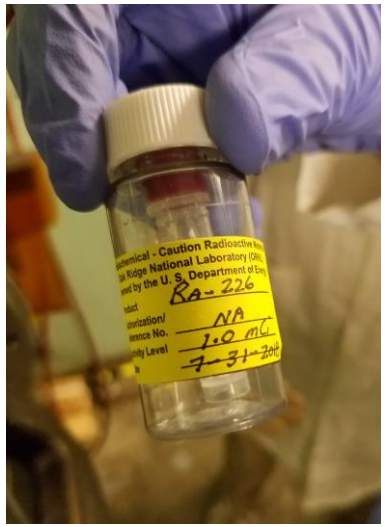
How to distribute short-lived isotopes?

^{68}Ga

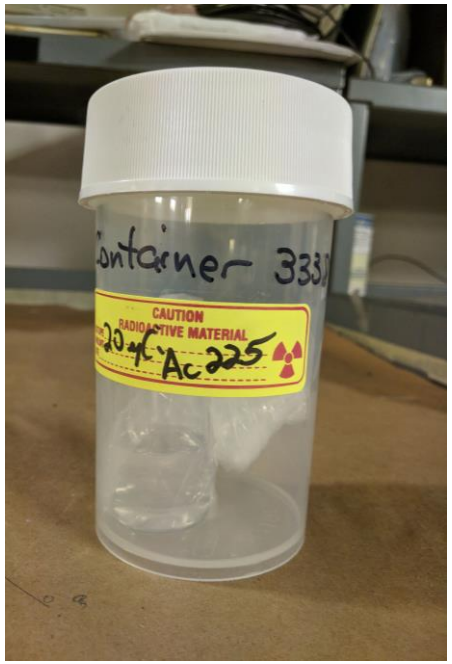
^{69}Se 27.4 s	^{70}Se 41.1 m	^{71}Se 4.74 m	^{72}Se 8.4 d	^{73}Se 7.15 h	^{74}Se	^{75}Se 119.78 d	^{76}Se
^{68}As 151.6 s	^{69}As 15.2 m	^{70}As 52.6 m	^{71}As 65.3 h	^{72}As 26 h	^{73}As 80.3 d	^{74}As 17.77 d	^{75}As
^{67}Ge 18.9 m	^{68}Ge 270.93 d	^{69}Ge 39.05 h	^{70}Ge	^{71}Ge 11.43 d	^{72}Ge	^{73}Ge	^{74}Ge
^{66}Ga 9.304 h	^{67}Ga 78.2808 h	^{68}Ga 67.845 m	^{69}Ga	^{70}Ga 21.14 m	^{71}Ga	^{72}Ga 14.025 h	^{73}Ga 4.86 h
^{65}Zn 243.93 d	^{66}Zn	^{67}Zn	^{68}Zn	^{69}Zn 56.4 m	^{70}Zn	^{71}Zn 147 s	^{72}Zn 46.5 h



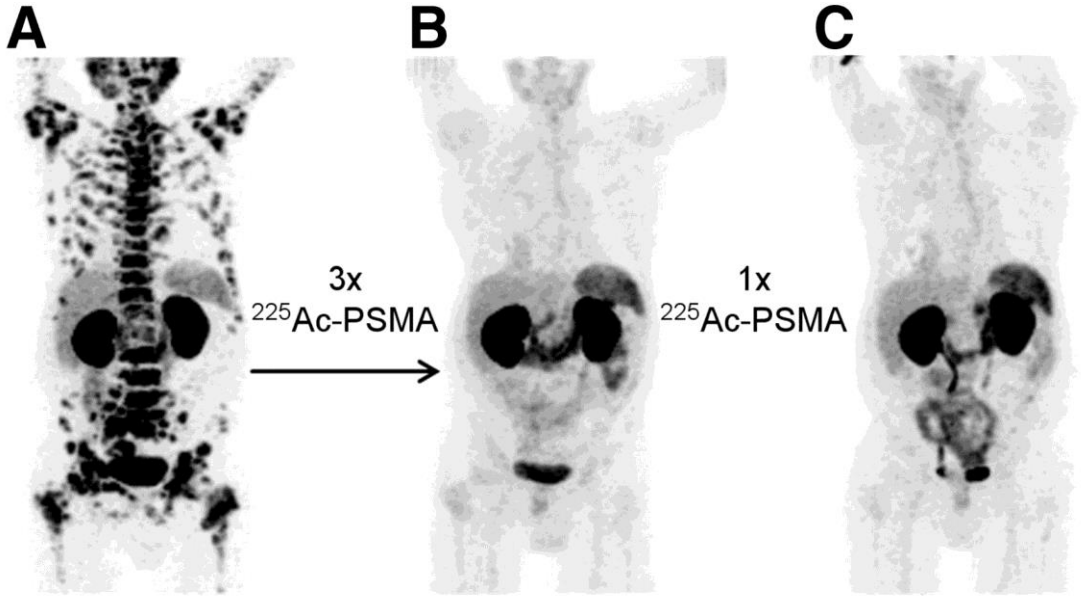
J.Nuc.Med 57.12 (2016)



The “Holy Grail” of Radiopharmaceuticals



J. Morrell

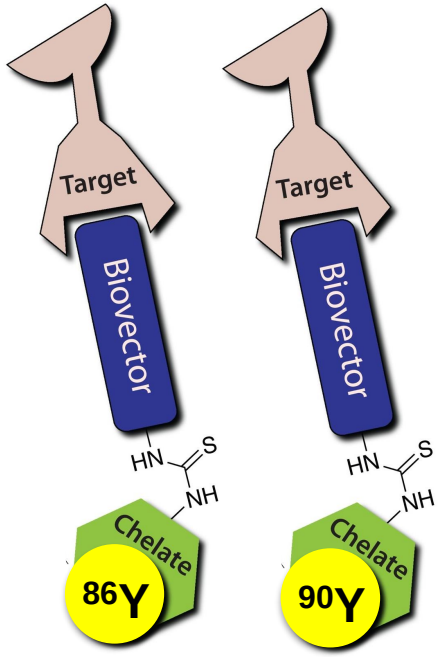


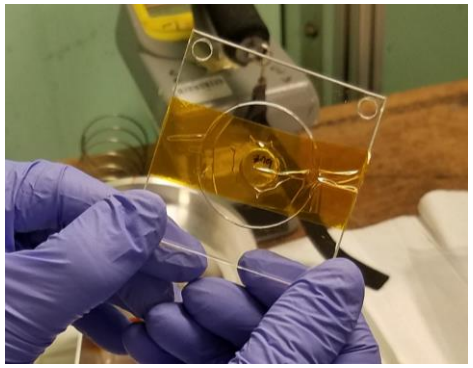
47/55 patient survival @1 year after <8 weeks prognosis

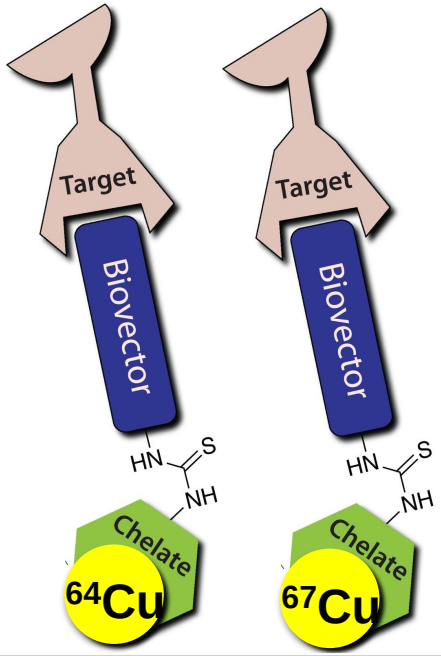
Global production: <1,800 doses/yr
We can make 6,500 doses/**week**

J.Nuc.Med 57.12 (2016).
Eur J Nucl Med Mol Imaging (2019) 46

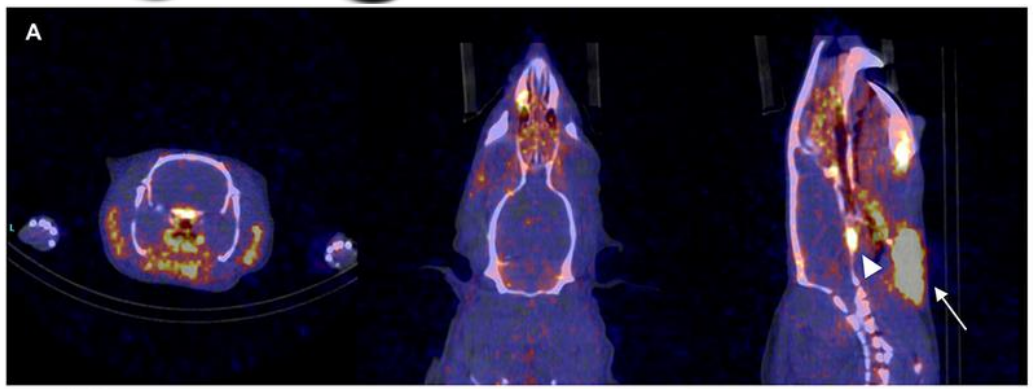
Theranostics: simultaneous imaging and therapy





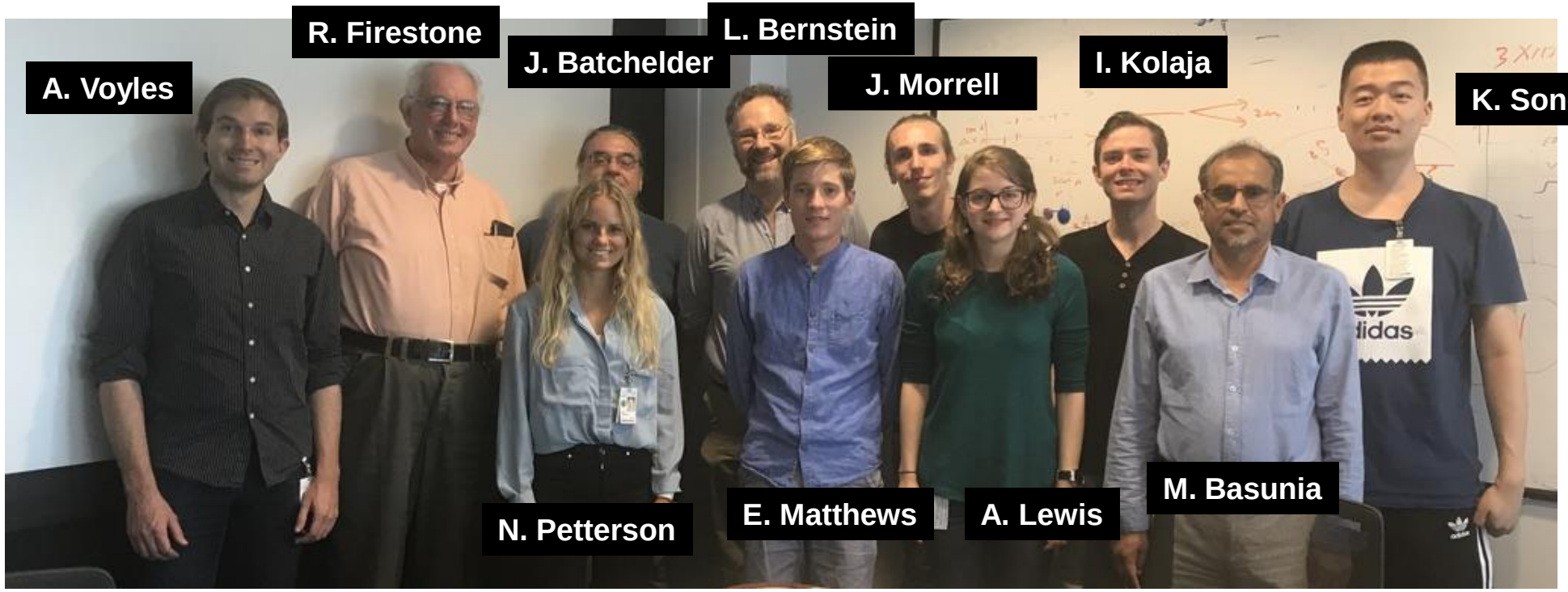


^{193m}Pt: DNA-level therapy



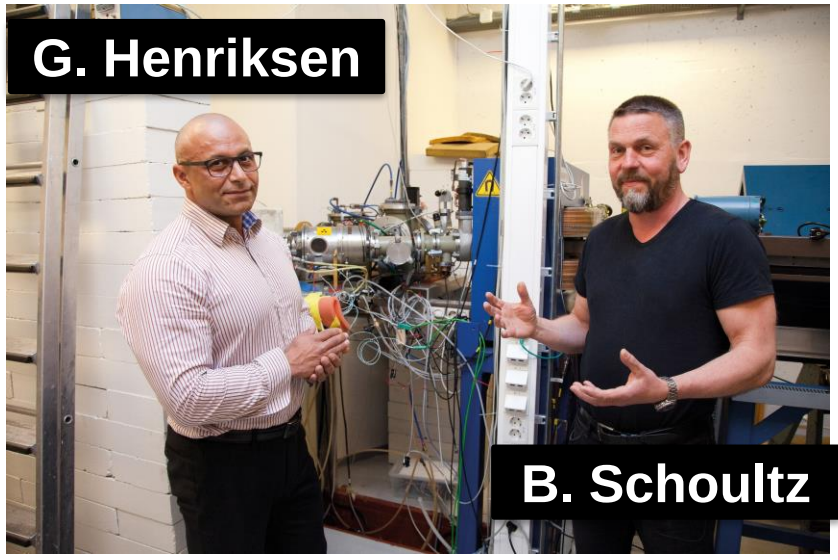
^{52}Mn: Metabolic and single-neuron PET imaging

Science doesn't happen in a vacuum: it's done by PEOPLE!




J. Engle


LBNL Bio-Actinide Chemistry



Questions?