Cu-67 as a Medical Isotope

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PHY 802 Final Presentation
5/3/16

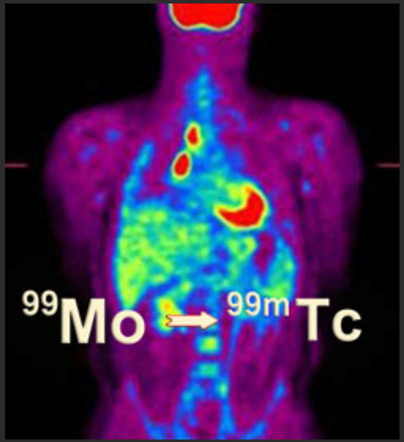
Cu-67 as a Medical Isotope

- Copper 67 is a great candidate for a medical isotope because of its compatibility with biology, it's relatively short half-life, and it's dual purpose of treatment and imaging.

Medical Isotopes: Where to look

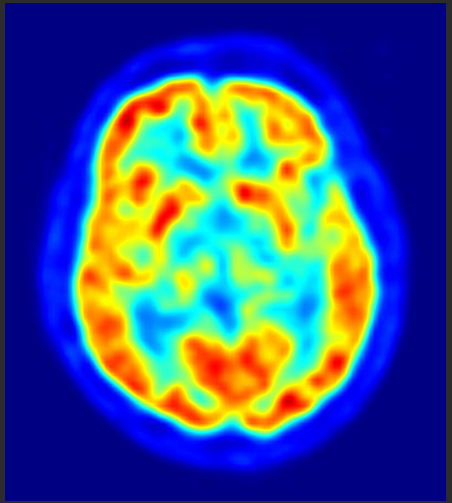
Medical isotopes need to be:

- Non-toxic to humans
- Have decay modes that we want
- Have a half-life that's not too short, but not too long
- Be feasible to make, transport, and administer to a patient in a reasonable time



^{99m}Tc as a radioactive tracer

Image from a PET (positron emission tomography) scan



Possibilities for Medical Isotopes:

- Different radionuclide possibilities
- Alpha and Beta decay both physically break up tissue
- Range varies with energy of emitted particle
- Alpha emitters are generally rare and very expensive to make

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Radionuclide	Energy (MeV_{max})†	Range†	Half-life
β			
^{90}Yttrium	2.28	11.3 mm	2.7 days
^{131}Iodine	0.61	2.3 mm	8.0 days
^{177}Lutetium	0.50	1.8 mm	6.7 days
^{188}Rhenium	2.12	10.4 mm	0.7 days
^{67}Copper	**0.58**	**2.1 mm**	**2.6 days**
α			
^{213}Bismuth	8.3	60–85 µm	0.8 h
^{211}Astatine	6.8		7.2 h
^{225}Actinium	6.8		10 days

Copper 67: why is it cool?

Copper 67 is a unique isotope:

- It is non-toxic
- Short half life around 2 and a half days
- It can be produced through various reactions with Zinc (Right)
- It can also be produced using rare isotope beams like at the NSCL (3)

Parent Nucleus	Parent E(level)	Parent Jπ	Parent $T_{1/2}$	Decay Mode	GS-GS Q-value (keV)	Daughter Nucleus		
$^{67}_{29}Cu$	3463.6	15/2+	< 2.4 ns	IT: 100 %		$^{67}_{29}Cu$	Decay Scheme	ENSDF file

Parent Nucleus	Parent E(level)	Parent Jπ	Parent $T_{1/2}$	Decay Mode	GS-GS Q-value (keV)	Daughter Nucleus		
$^{67}_{29}Cu$	0.0	3/2-	61.83 h *12*	β^-	561.7 *15*	$^{67}_{30}Zn$	Decay Scheme	ENSDF file

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Reactions:

$^{70}Zn(p,\alpha)^{67}Cu$,
$^{68}Zn(p,2p)^{67}Cu$,
$\boxed{^{68}Zn(\gamma,p)^{67}Cu\ \ (1),}$
And $^{67}Zn(n,p)^{67}Cu$

How do we make Cu-67?

Using Electron Linac(1):

- e^- accelerated
- e^- hit Foil -> Bremsstrahlung Radiation
- $^{68}Zn(p,2p)^{67}Cu$
- Chemically Separate, recycle ^{68}Zn
- Pure ^{68}Zn costs $$$

At the NSCL(3):

- ^{76}Ge primary beam created
- Fragmented and separated by the A1900 fragment separator
- 77% pure ^{67}Cu beam created
- Liquid water target set up to capture incoming beam
- Chemically Separated
- FRIB would be able to effectively produce ^{67}Cu

Citations

1. Email Conversation(s) w/ Dr. Dan Dale, Idaho State University (April 2016)
2. Brookhaven National Lab, "Chart of Nuclides," NNDC <www.nndc.bnl.gov> (April 2016)
3. T. Mastren, *et al.*, "Feasibility of Isotope Harvesting at a Projectile Fragmentation Facility: ^{67}Cu," Scientific Reports, **4**, Article number: 6706 (2014)