Production of Pb-203

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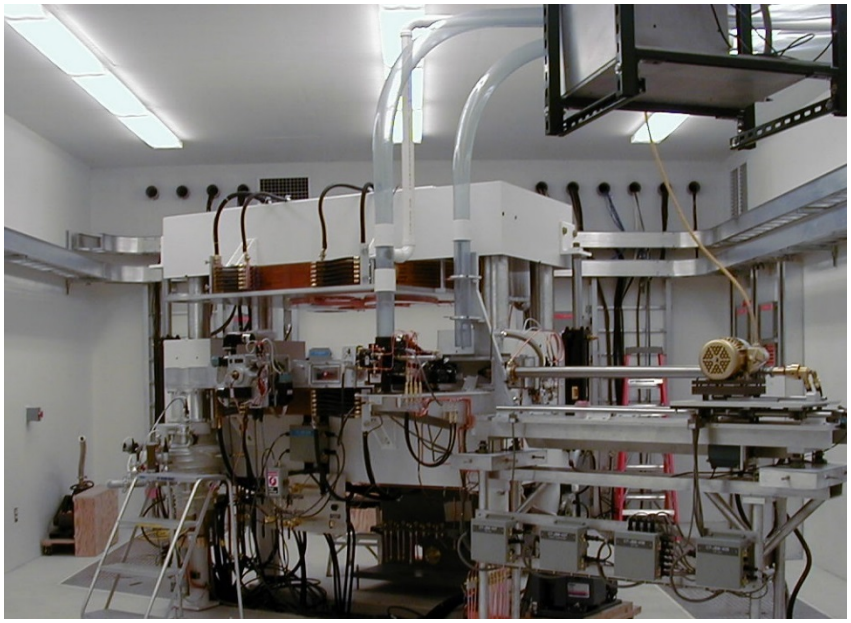
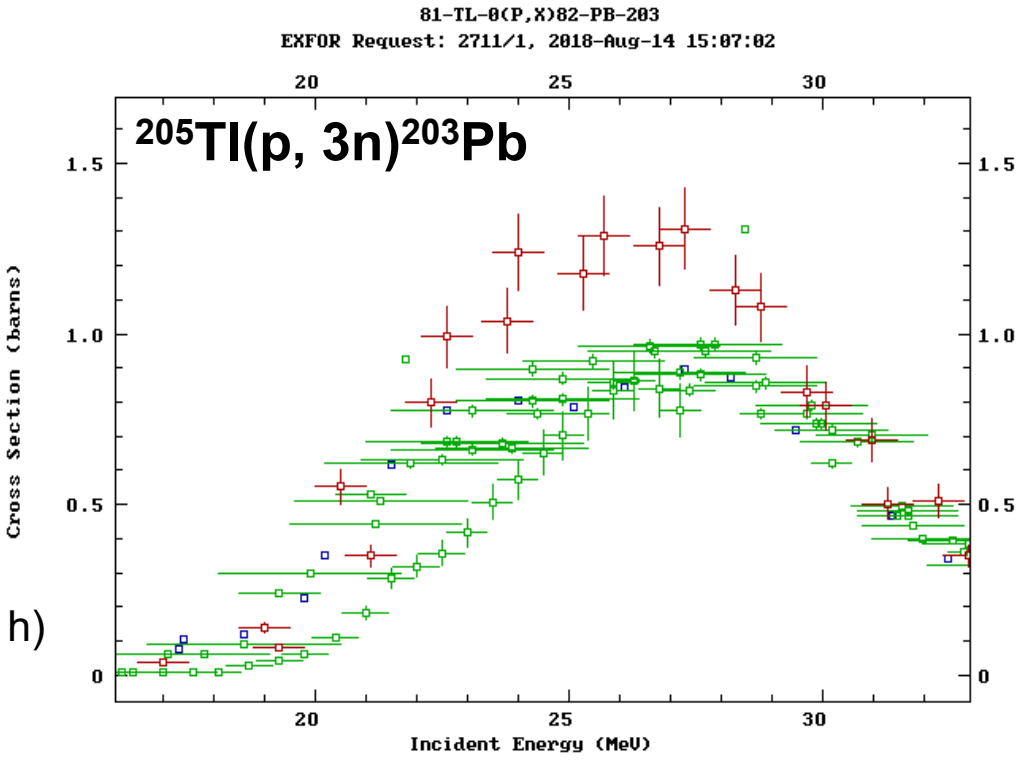
Production Infrastructure

- **Cyclotrons**
  - 5 internal beam Cyclotron, Inc. C-28
    - Fixed energy 21 – 28 MeV H^+
    - Beam currents = 150-450 µA
  - 1 external beam IBA Cyclone® 30
    - Variable energy 14 – 30 MeV protons
    - Beam currents up to ~350 µA
    - 3 target vaults
  - 7^{th} cyclotron under construction
- **30,000 ft^2 radiological space**
  - 20+ lead enclosed processing cells with CRL tele-manipulators and fume hoods
  - Pneumatic target transfer system
  - Finished radio-pharmaceutical activities occur in separate buildings



Lead-203

- **Physical properties of ^{203}Pb**
  - $t_{1/2}$ = 51.92 h
  - E_γ = 279.2 keV; 80.9%
- **Production routes**
  - ^{205}Tl(p, 3n)^{203}Pb
    - E ≈ 27.5 MeV
    - σ_{max} ≈ 1000 mb
- **Radioimpurities**
  - ^{203}Tl(p, 2n)^{201}Pb → ^{201}Tl ($t_{1/2}$ = 72.91 h)
    - $t_{1/2}$ = 9.33 h
    - E ≈ 29 MeV
  - ^{205}Tl(p, p2n)^{204m}Pb → ^{204}Pb (stable)
    - $t_{1/2}$ = 1.12 h
    - E ≈ 20 MeV



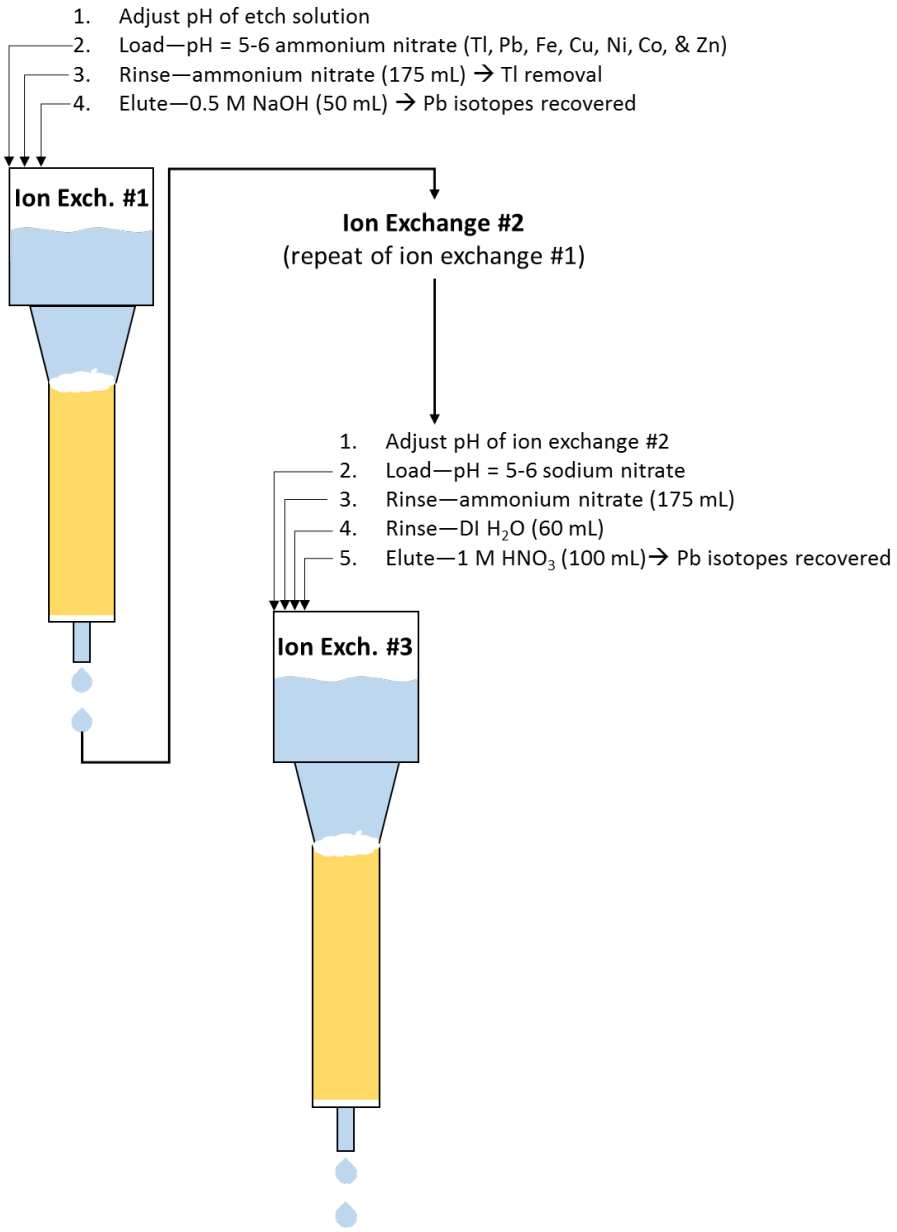
Irradiation

- **^{nat}Tl/^{203}Pb**
  - Cyclotron, Inc. C-28 or IBA Cyclone® 30
    - Nominal energy of **25 MeV**
    - Cooling water
    - Irradiated on an angle
  - Decay ^{201}Pb (90 hours)
  - Process

Target ID	Mass ^{nat}Tl (g)	I (μA)	T_{irr} (h)
^{nat}Tl-1	2.94	147	13.8
^{nat}Tl-2	2.91	152	13.4
^{nat}Tl-3	3.12	149	9.3
^{nat}Tl-4	2.88	146	15.8
^{nat}Tl-5	2.88	159	13.9
^{nat}Tl-6	3.18	154	13.5

Chemistry $^{nat}Tl/^{203}Pb$

- **Acid etch**
  - Hot acid
  - Filter through glass wool, and rinse w/ acid
  - Adjust to pH = 5-6 w/ conc. NH_4OH
- **Ion Exchange #1**
  - Column ID x L = 1.5 cm x 12 cm
    - 7.9 cm resin
    - BV = 14 mL
- **Ion Exchange #2**
- **Ion Exchange #3**



^{nat}Tl/^{203}Pb

Target ID	A_{EOP} GBq (Ci)*	^{203}Pb Specific Activity GBq/g (Ci/g)
^{nat}Tl-1	21.1 (0.571)	3.46 x 10^5 (9361)
^{nat}Tl-2	22.7 (0.613)	3.28 x 10^5 (11564)
^{nat}Tl-3	10.0 (0.271)	3.01 x 10^5 (8132)
^{nat}Tl-4	19.0 (0.513)	5.88 x 10^5 (15891)
^{nat}Tl-5	19.1 (0.516)	4.86 x 10^5 (13140)
^{nat}Tl-6	20.3 (0.548)	2.79 x 10^5 (7546)
***EOP is ~5 days post EOB**		

-recent work has resulted in specific activities of >15,000 Ci/g.

- **Conclusions**
  - Equal to or higher than specific activity achieved compared to literature
- **Commercial Availability/Future work**
  - Approximately 1 production run/month on demand
  - Assessing requirements of various customers

***information in these slides is from an expanded detailed presentation given at WTTC17 (17th Workshop on Targetry and Target Chemistry), Coimbra, Portugal; August 2018.**

Thank you

Questions?