Cyclotron Production of ^{61}Cu using an Enriched ^{64}Zn Target

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Copper-61 (^{61}Cu)

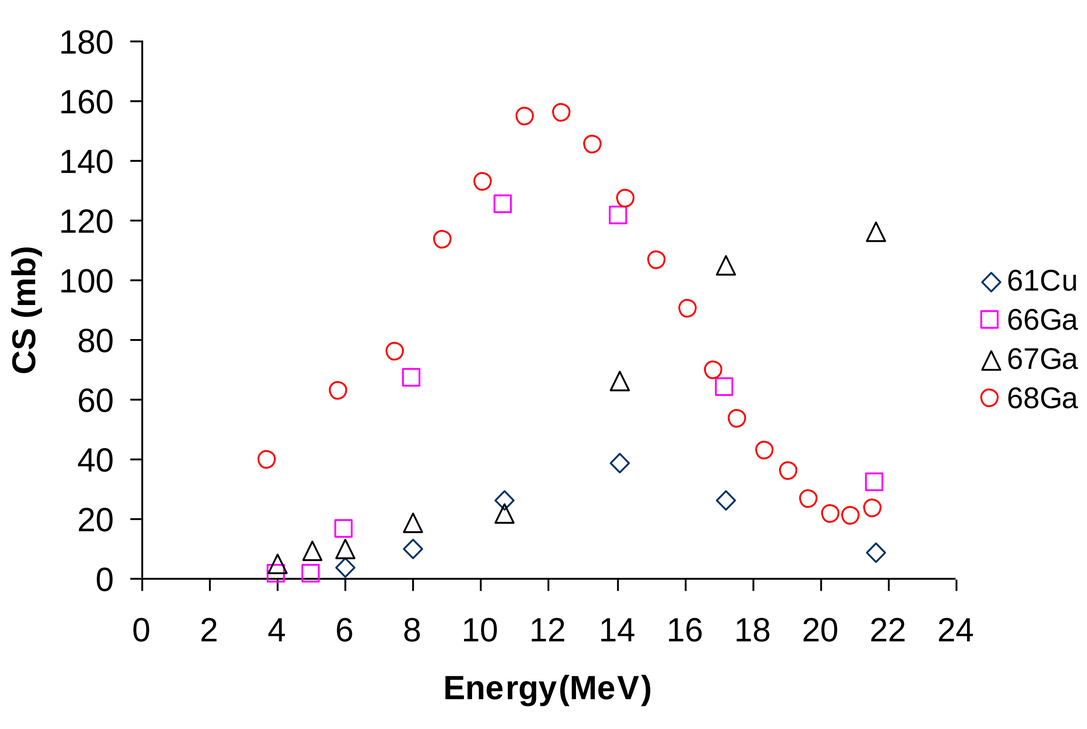
- The radiometal ^{61}Cu is a short-lived ($T_{1/2}$ = 3.4h) positron emitting isotope (β^+: 61.4%, EC: 38.6%) which is suitable for use in labelling hypoxic agents [1].
- It also has two important gamma ray transitions; 282keV (12.2%) and 656keV (10.77%) that are used for characterisation with gamma spectrometry.
- ^{61}Cu can be produced by proton bombardment using several nuclear reactions, including ^{62}Ni (p, 2n)^{61}Cu; ^{61}Ni (p, n) ^{61}Cu; & ^{64}Zn (p, α) ^{61}Cu.
- This study investigates the low-energy proton reactions of ^{nat}Zn (p, x) ^{61}Cu & ^{64}Zn (p, α) ^{61}Cu, using protons from an 18 MeV isochronous cyclotron.

Study Aim

To evaluate & compare the production of ^{61}Cu from enriched ^{64}Zn and natural Zn (^{64}Zn nat. abund., 48.6%) targets and to optimise the methods of product separation & purification.

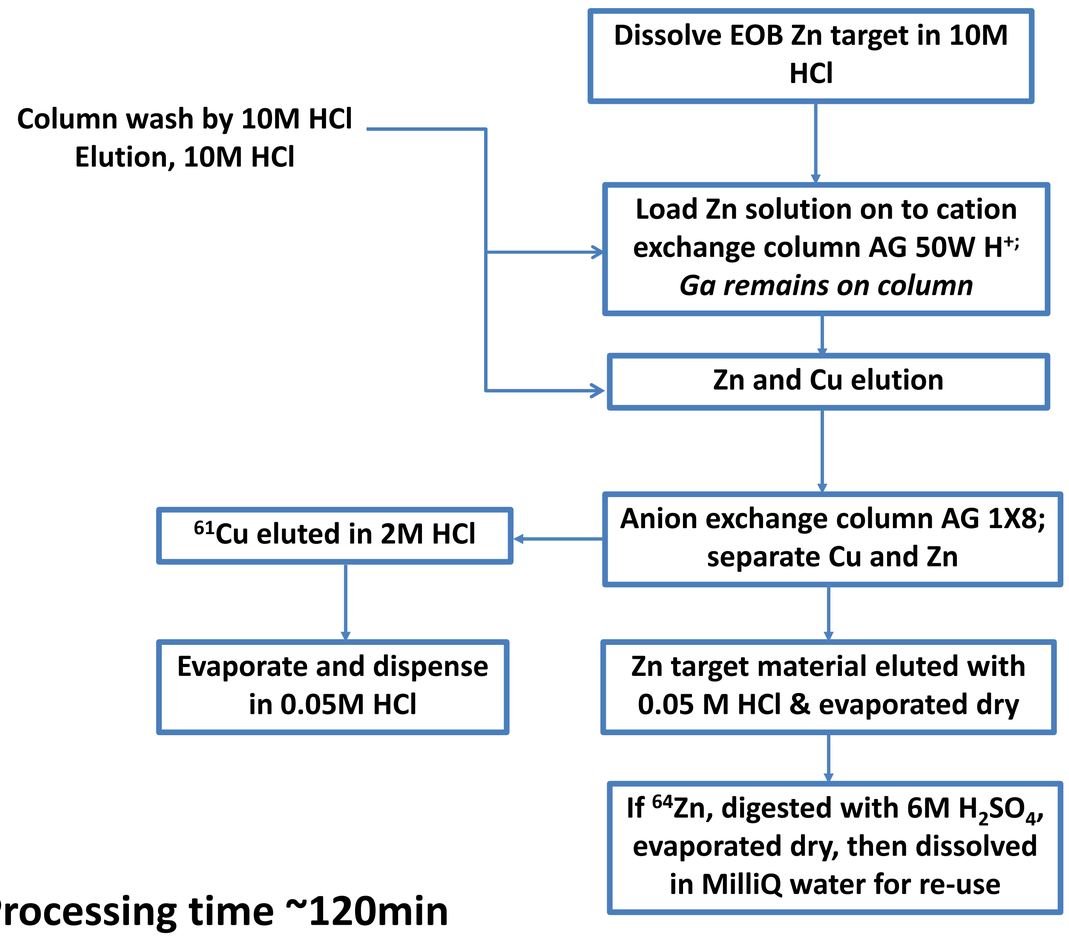
Target Irradiation

- Proton energies : 11.7, 14.5 & 17.6MeV
- Targets: ^{64}Zn electroplated on to backing plate, *or* ^{nat}Zn disc. (See Table for target masses)
- Beam line: External, in-house designed & constructed, suitable for normal-incidence bombardment & foil/disc targets
- Beam current : 30μA
- Irradiation time: 30 – 60min
- Beam degraders : Graphite or aluminium
- Target backing materials: Au (foil), Ag (foil) & Al (disc) used at proton energies of 11.7, 14.5 & 17.6MeV, respectively.



Cross sections for protons on natural Zn target [2,3]

Product Separation & Purification



- Processing time ~120min
- Radiochemical and chemical purities > 95%

Results

	^{nat}Zn	^{64}Zn	^{nat}Zn	^{64}Zn	^{nat}Zn	^{64}Zn
Proton Energy (MeV)	11.7	11.7	14.5	14.5	17.7	17.7
Irradiation time (min)	30	30	30	60	30	30
Zn target (mg)	63	15	61	15	58	18
^{61}Cu activity (MBq)	162.21	75.77	95.29	195.16	62.8	91.8
Yield (MBq/uA.hr)	13.08	5.05	6.35	6.50	4.18	6.12
Cu (μg) [ICP-MS]	0.79	1.35	0.30	2.87	0.257	0.47
ICP-MS Cu/Zn ratio	0.88	2.25	0.03	0.92	0.04	0.53
ICP-MS-based Specific activity (GBq/μmol)	12.96	3.57	20.02	4.31	15.49	12.40

Summary & Discussion

- Highest production yield for ^{61}Cu was from enriched ^{64}Zn target using 14.5 MeV protons
- Cu vs. Zn ratio by ICP MS shows separation method was consistent and high yielding
- Radiochemical (>95% at 2 hours EOS) and chemical (< 8.6 ppm of Zn < 2.9 ppm of Cu) purities were acceptable
- Zn target is a cost-effective ($2.70/mg; $15/50μm foil) alternative for production of research activities of ^{61}Cu and a viable alternative to ^{61} Ni (nat. abundance 1.14% , $30+ /mg)

References

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