Production of ^{38,39}Cl for Botany Tracer Studies

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Botany and the Need for Chlorine Radiotracers

- Chlorine is an essential micronutrient for plants
- Often accumulates in soils to levels much higher than required for optimal plant growth
- Salt tolerance in plants has become a major research concern
- Little is known about the primary acquisition mechanisms of Cl^-

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Mode of Production

- Proton irradiation of natural Argon gas
- Chlorine isotopes produced as ions and stick to target walls (similar to ^{18}F – F_2 production in ^{18}O-O_2 gas targets)
- Chlorine ions washed off target walls with water

Isotope Production By Proton Irradiation Of Argon

Reaction	Isotope	Half-Life	Decay Mode
$^{40}Ar(p,3n)$	^{38}K	7.63 m	β^+
$^{40}Ar(p,2pn)$	^{38}Cl	37.2 m	β^-
$^{40}Ar(p,2p)$	^{39}Cl	55.6 m	β^-

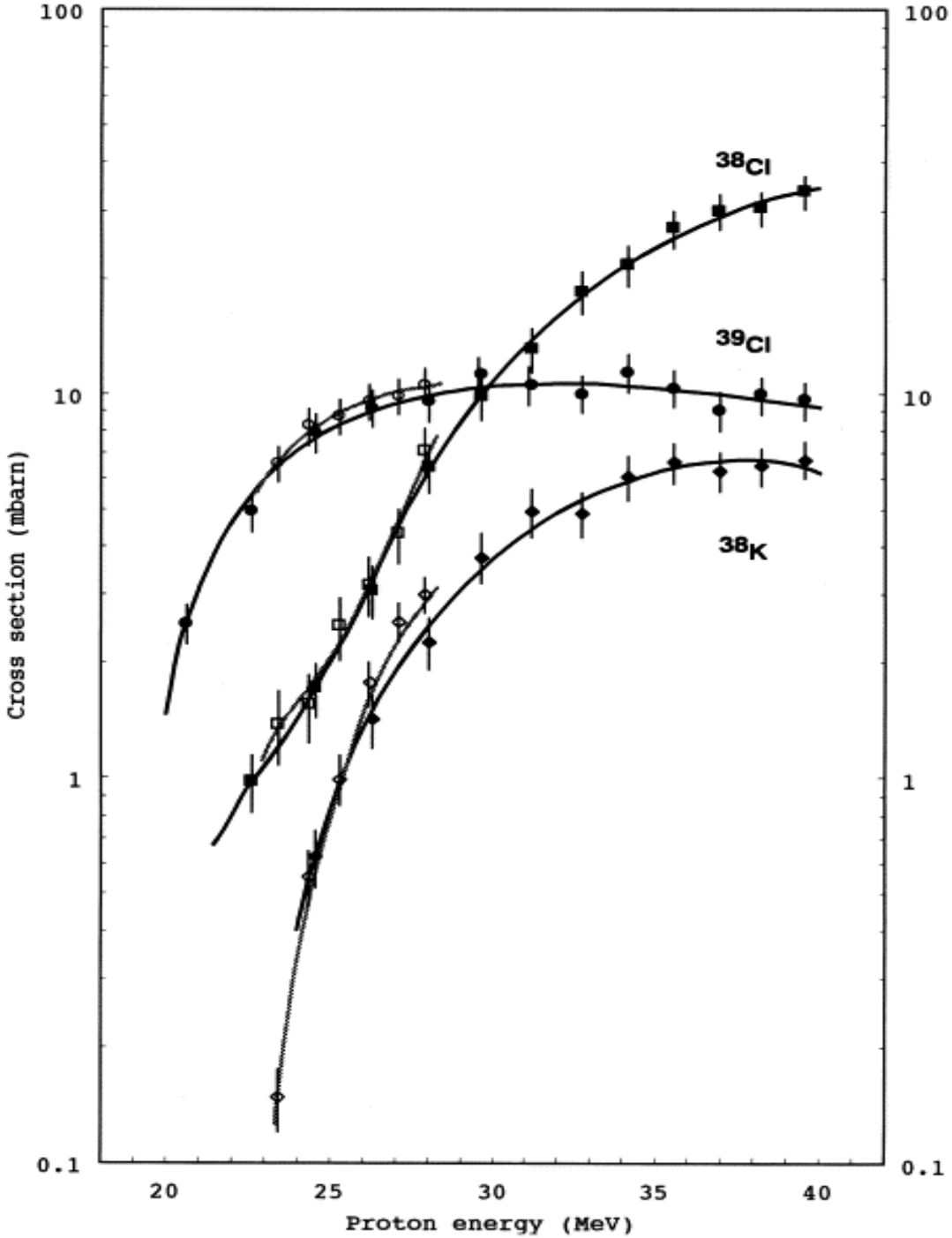


Figure 1.
Excitation Functions of $^{40}Ar(p,3n)^{38}K$, $^{40}Ar(p,2pn)^{38}Cl$ and $^{40}Ar(p,2p)^{39}Cl$ reactions

From: K. Nagatsu, A. Kubodera, K. Suzuki. Excitation function measurements of $^{40}Ar(p,3n)^{38}K$, $^{40}Ar(p,2pn)^{38}Cl$ and $^{40}Ar(p,2p)^{39}Cl$ reactions. Appl. Radiat. Isot, 50 (1999) 389-396

^{38,39}Cl Production Target

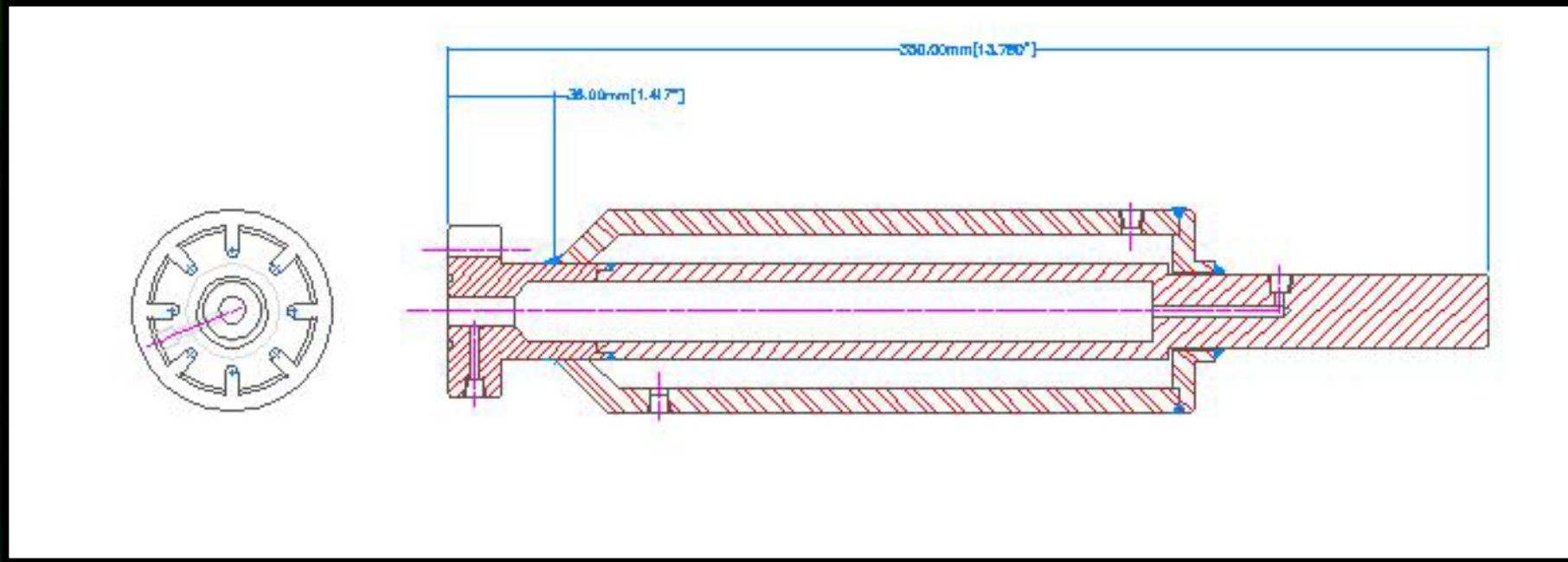
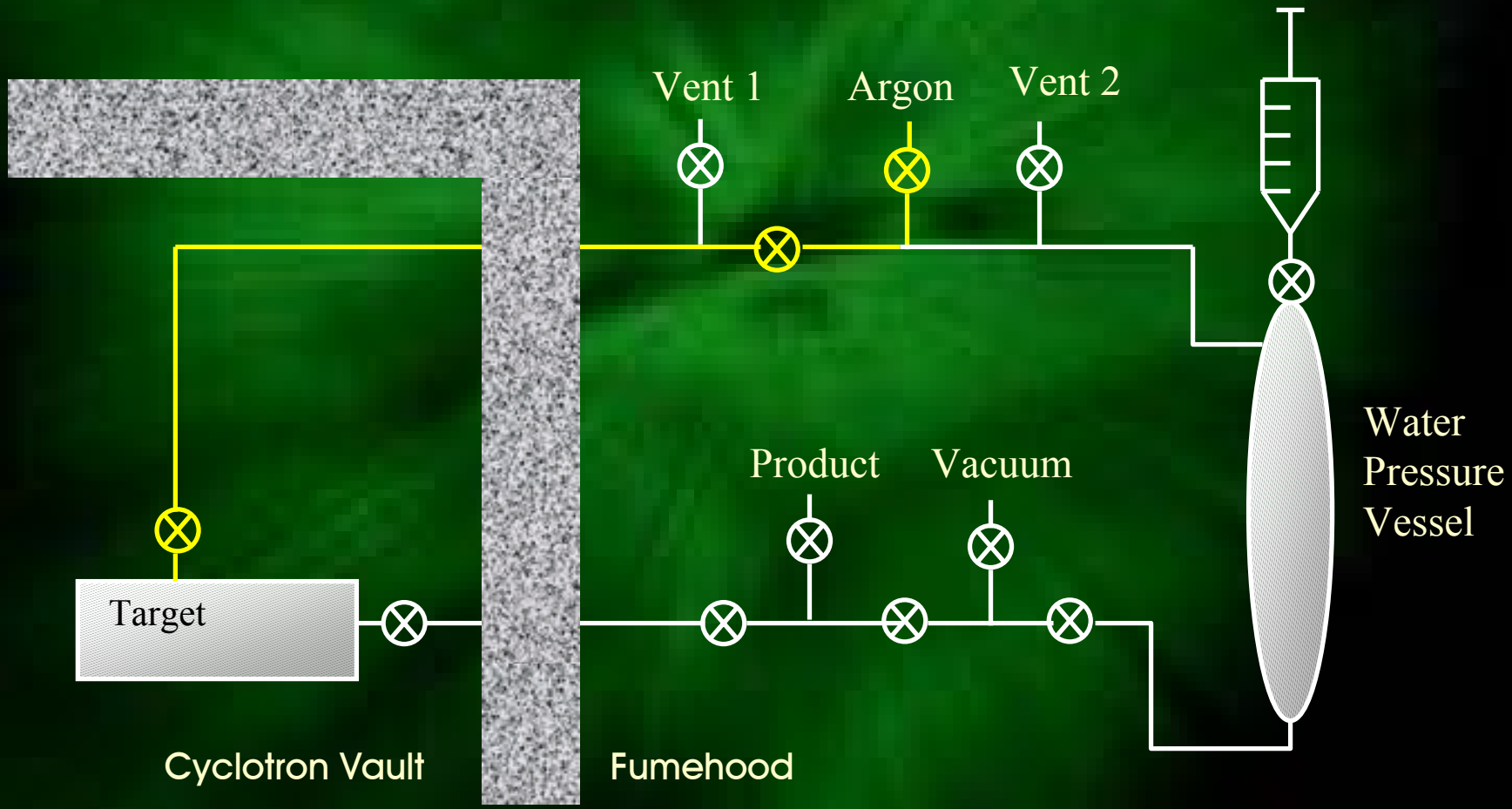


Figure 2. Aluminum Target Chamber

^{38,39}Cl Production System



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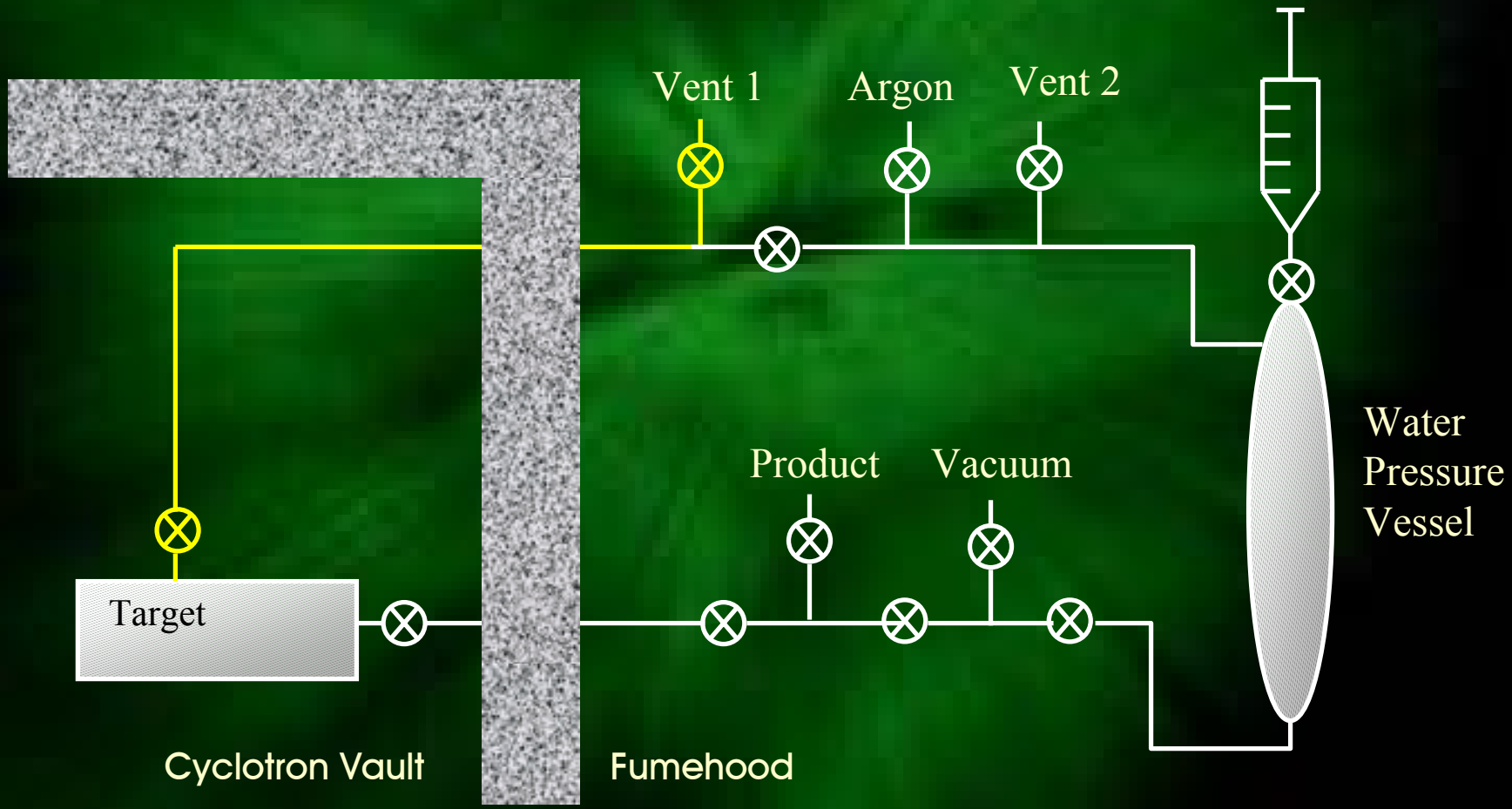

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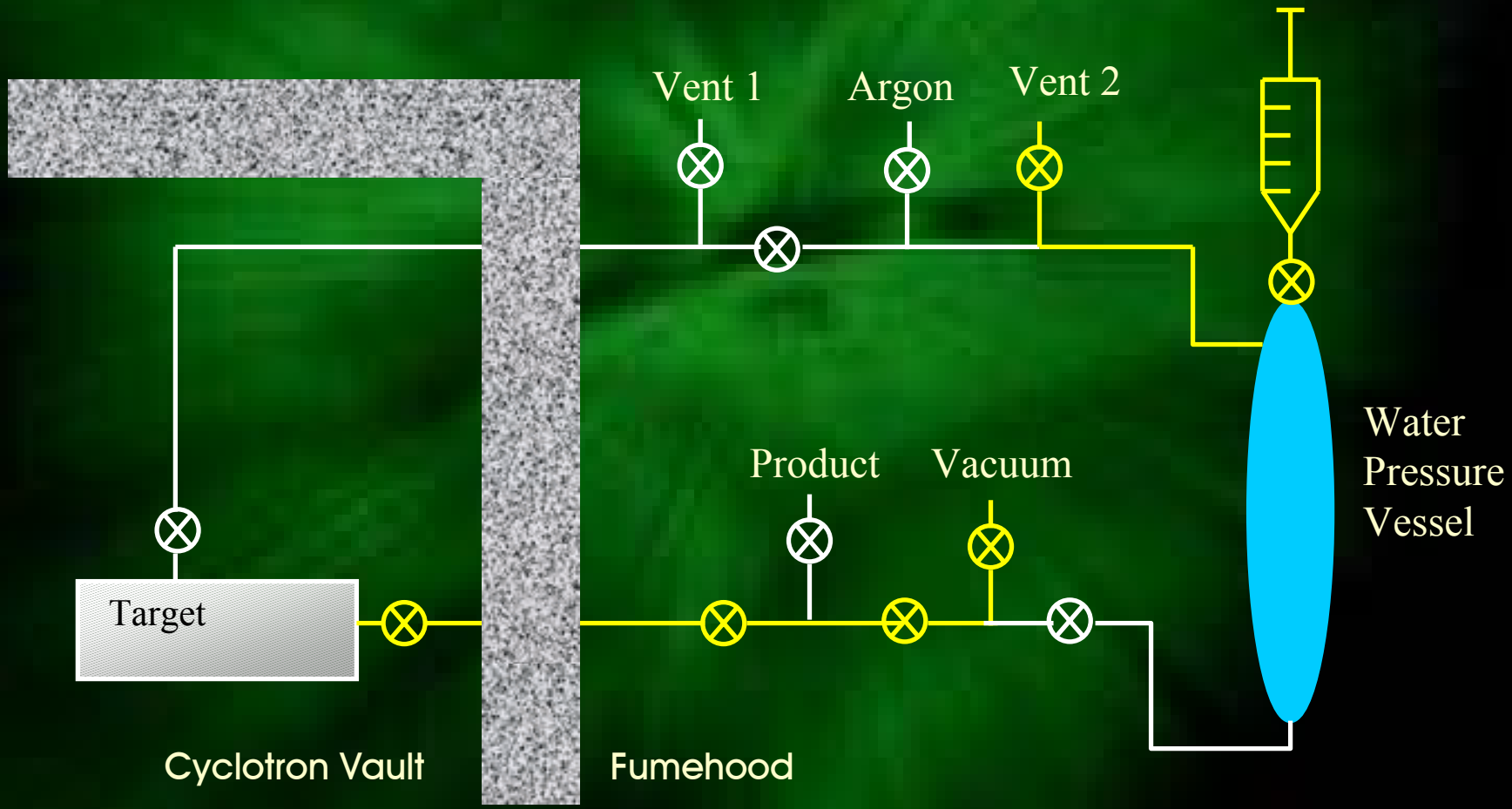

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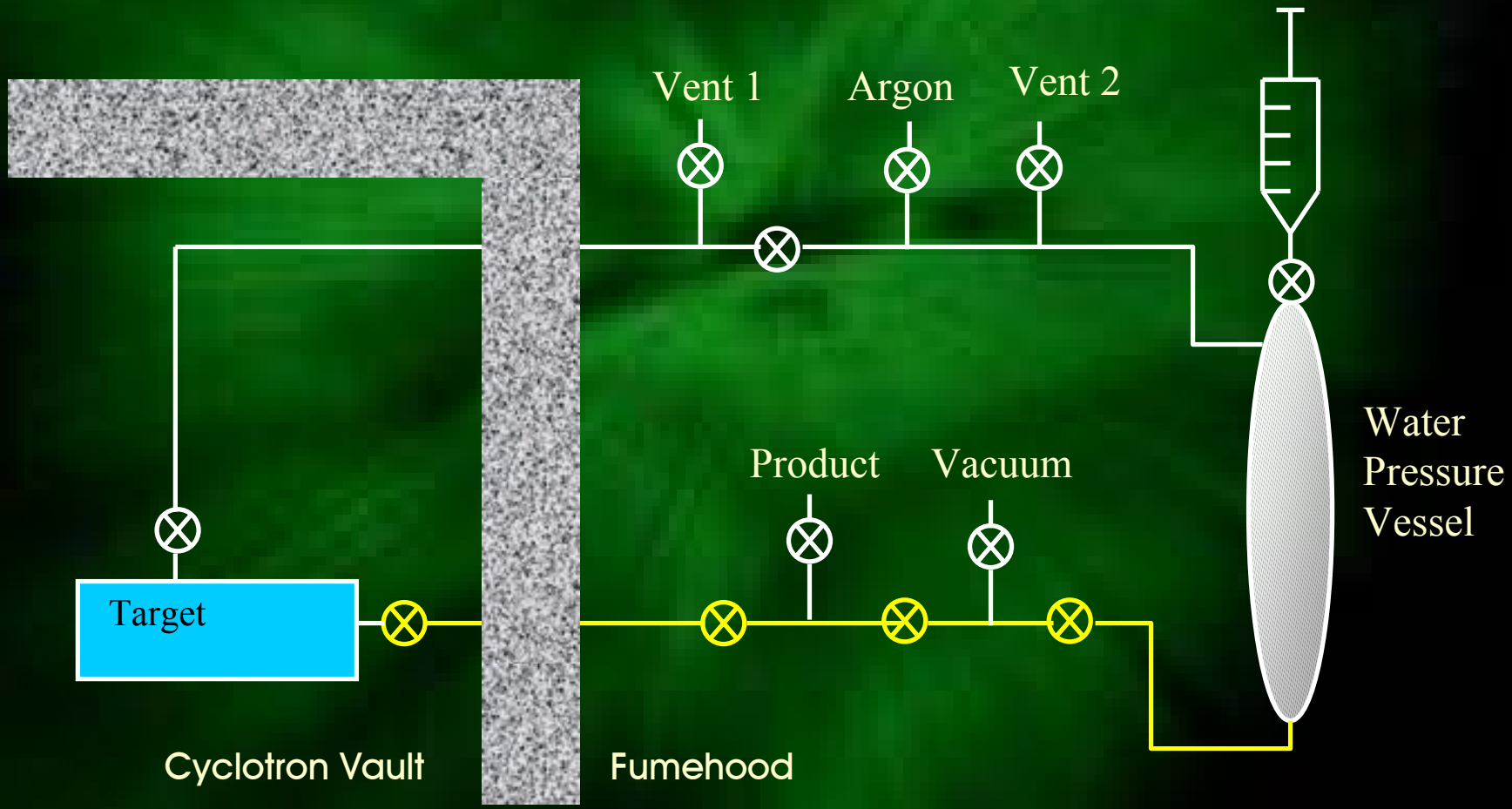
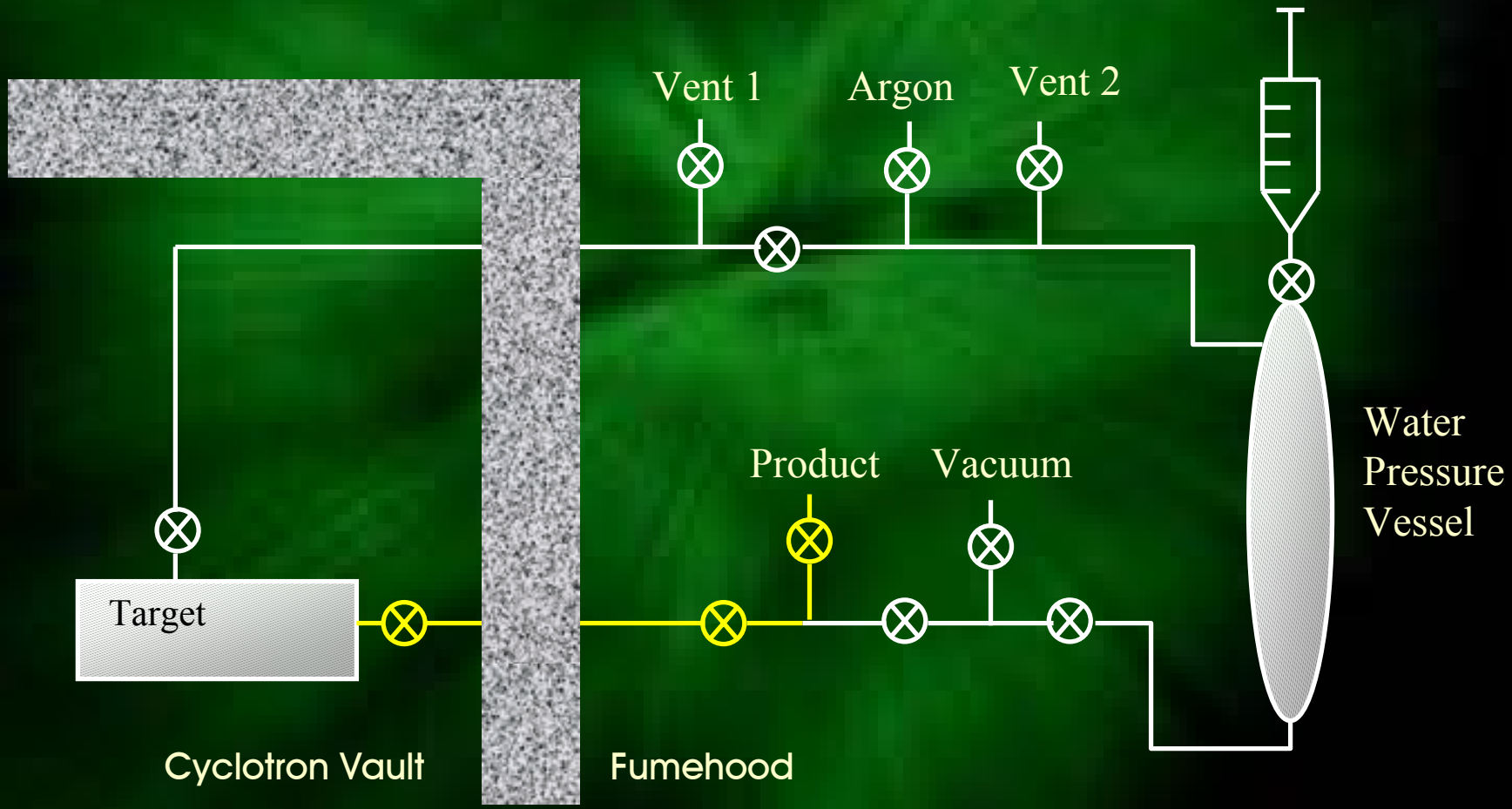


^{38,39}Cl Production System



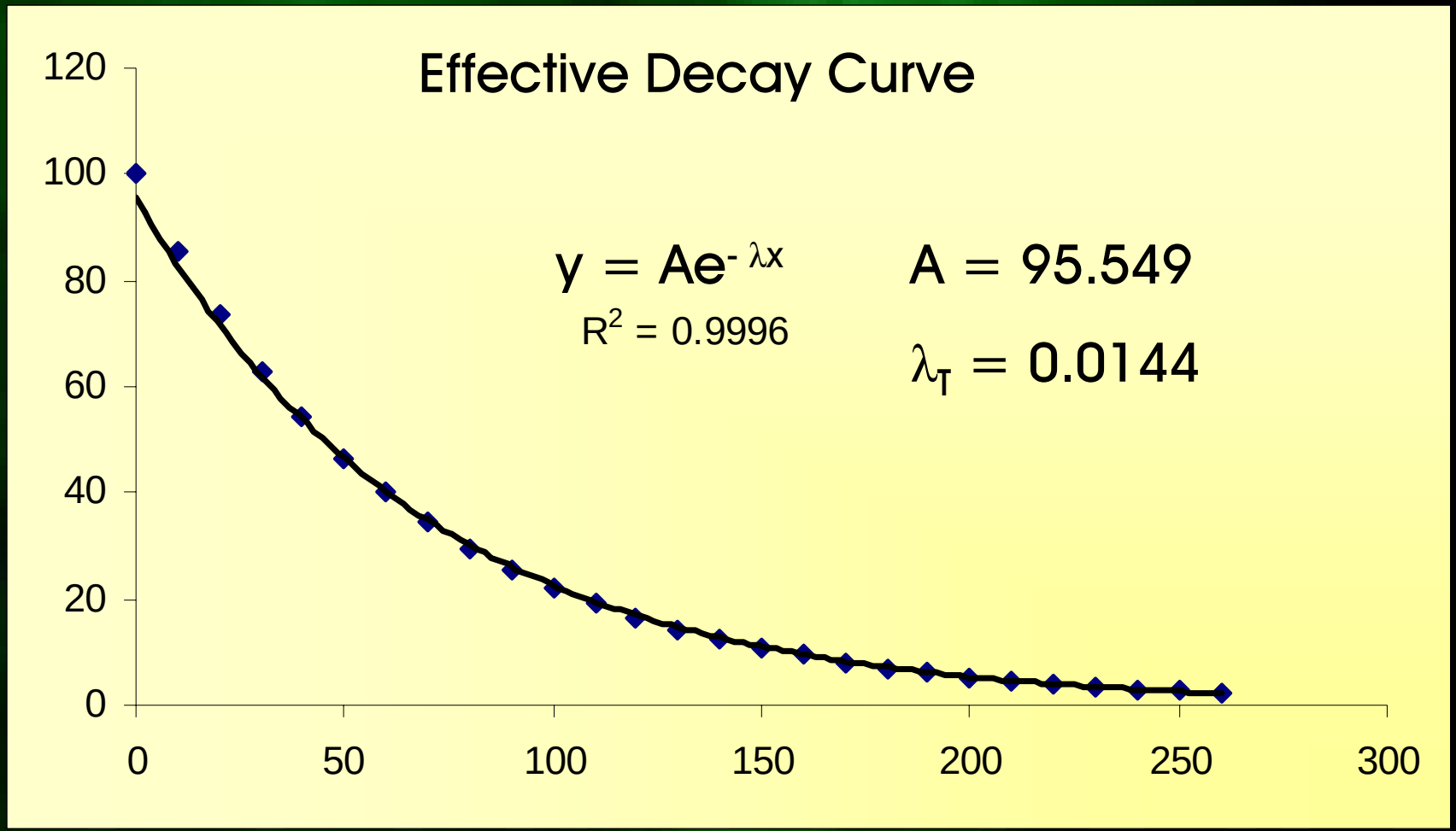
Irradiation Parameters and Chlorine Recovery

- 250 psi Argon
- Irradiated with 5-7 μA of 41 MeV protons for 30 minutes
- Target rinsed with very slightly basic solution
- Chlorine isotopes trapped on a Sepak anion exchange column
- Potassium isotopes passes through

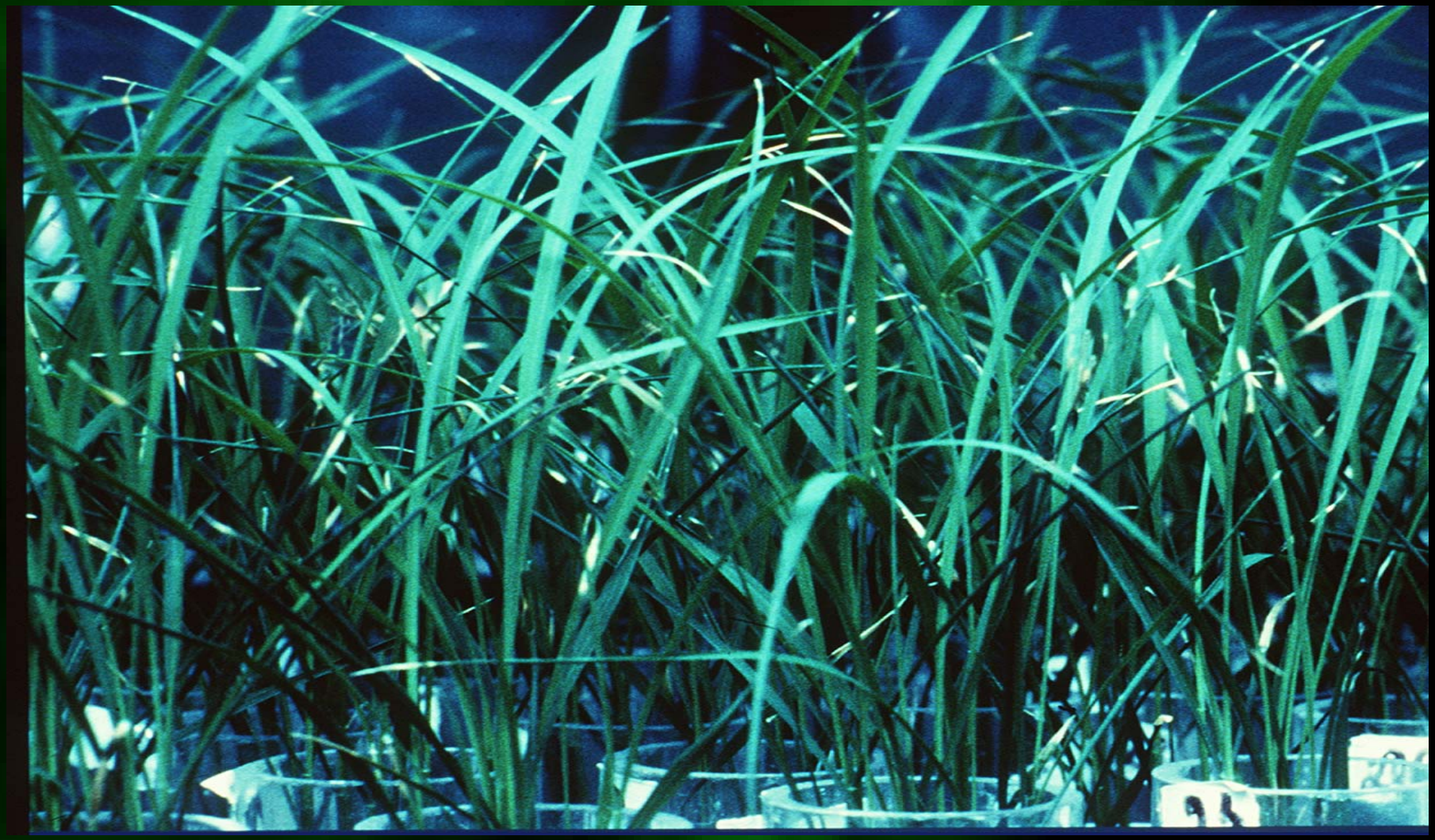
Yields

- Typically produced 15-20 mCi at 10 minutes EOB (75% ^{38}Cl, 25% ^{39}Cl)
- 10% of theoretical recovery
- Losses probably from incomplete washing of the target chamber

Effective Half-Life



Botany Experiments



Botany Experiments

Botany Experiments

- Cl isotopes were eluted from the exchange column with 20 ml of 10 mM $CaSO_4$
- Barley seeding were transferred into the Cl loading solutions for a predetermined time to allow for uptake of the isotopes
- Efflux was measured by desorbing radioactivity from the roots into fresh solutions
- Radioactivity in roots, shoots and eluates was counted

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Results

- Using the tracers in the intact barley seedlings various transport systems were investigated using different salinity concentrations and nitrogen sources.
- First evidence of a saturable Cl^- low-affinity transport system responsible for translocation of Cl^- to the shoot

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