Production of ^{47}Sc through Isotope Harvesting at the NSCL

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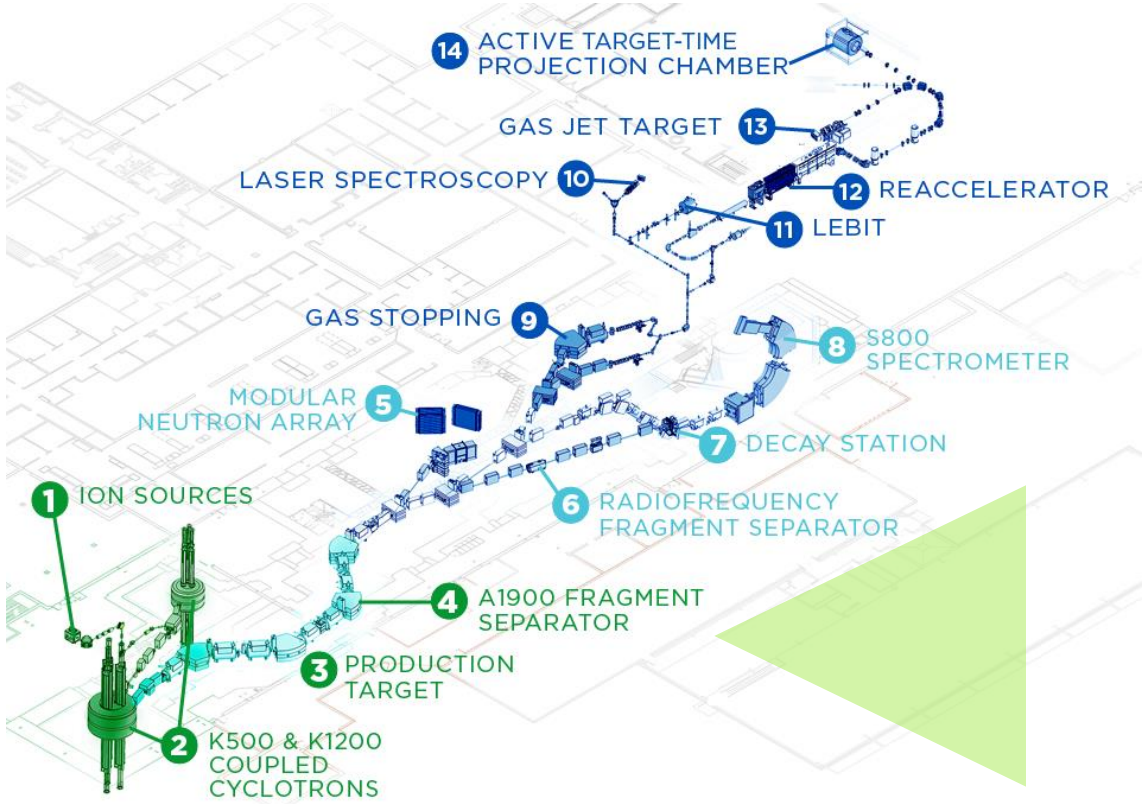
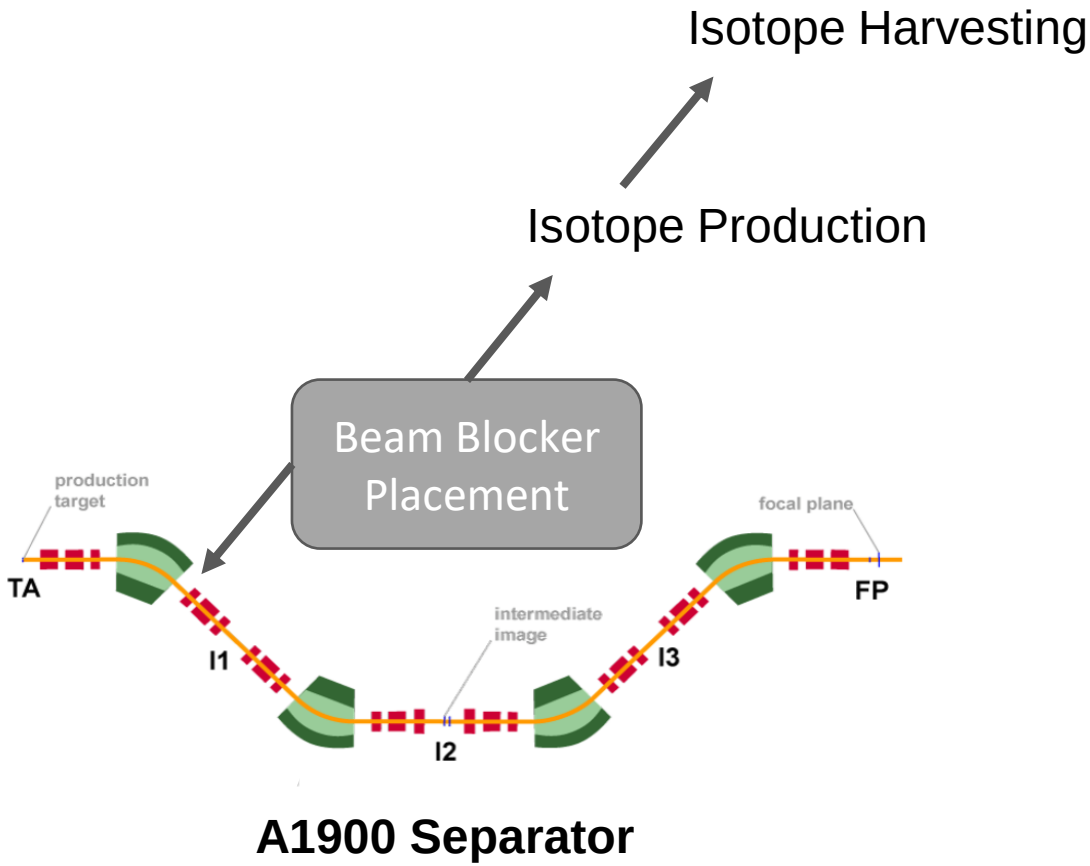
NSCL Beam Stopper

National Superconducting Cyclotron Laboratory (NSCL)





A1900 Separator

NSCL: Virtual Tour, https://www.nscl.msu.edu/public/virtual-tour.html (accessed 30 March 2018).
A1900 Fragment Separator. https://groups.nscl.msu.edu/a1900/overview/schematic.php (accessed March 29, 2018)

Isotope Harvesting

- Way to use “left-over” accelerated beams for isotope production

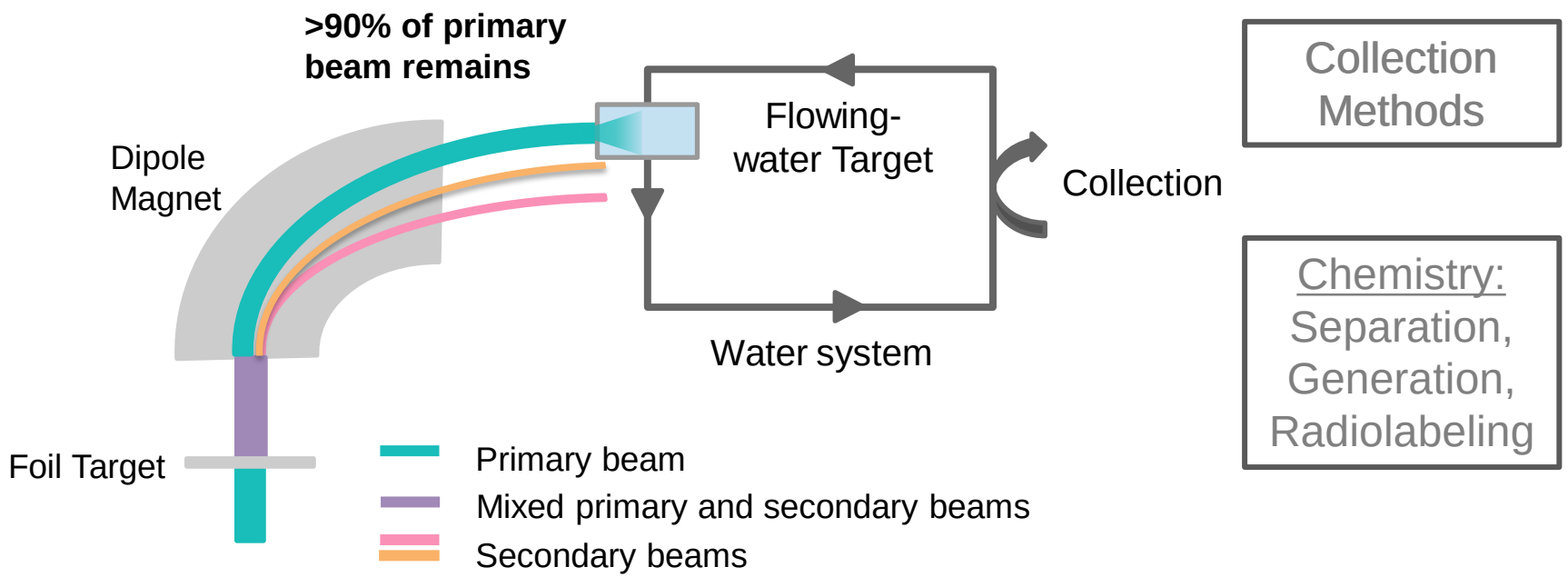
Isotope Harvesting at the NSCL:

Testing Durability of Target

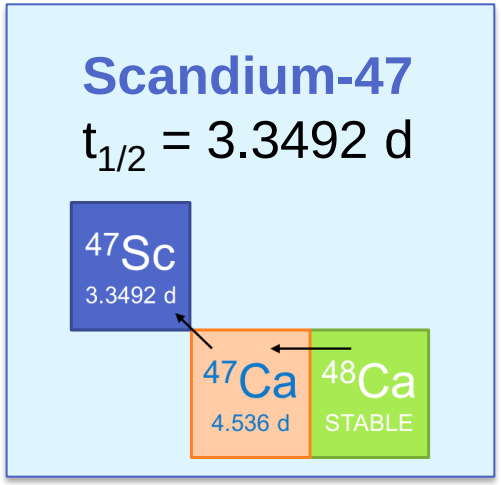
Designing Water System

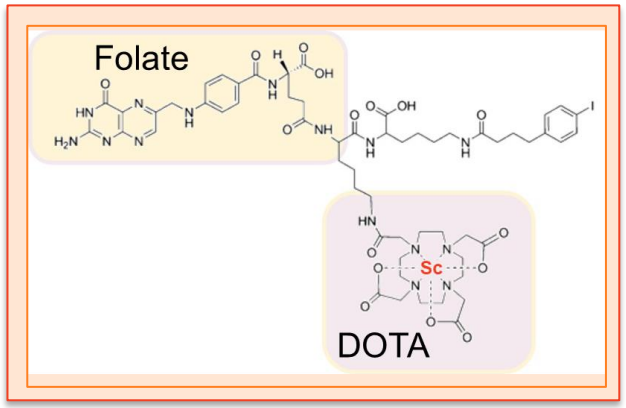
Collection Methods

Chemistry: Separation, Generation, Radiolabeling



Preclinical Testing with ^{47}Sc

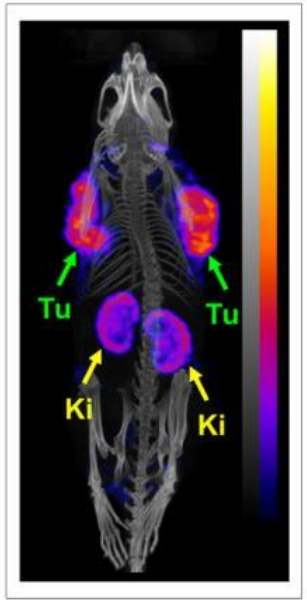




Diagnosis

γ : 159.4 keV

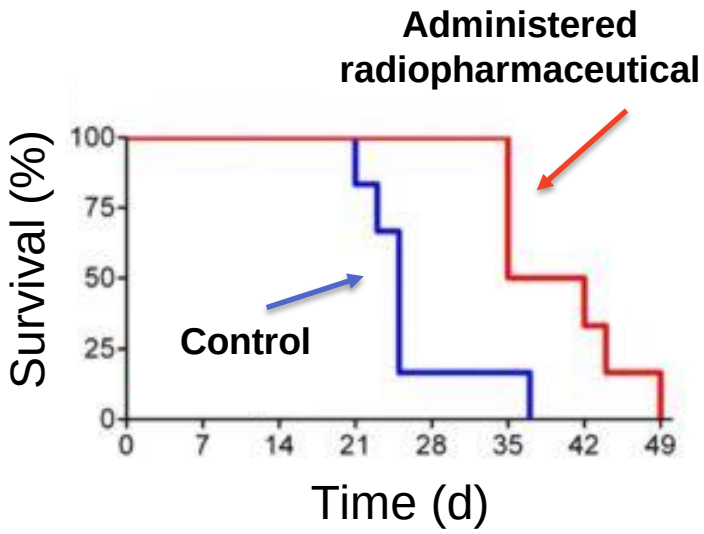
SPECT/CT



Therapy

β^- : 162 keV

Survival Time

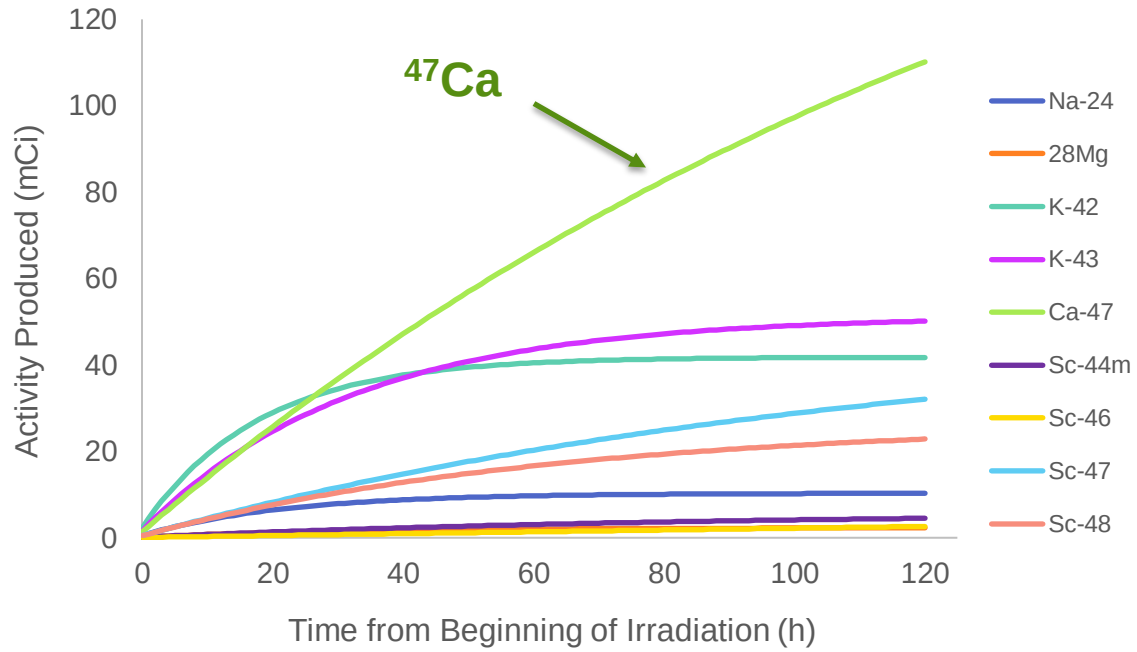


B. Singh, J. Chen, Nuclear Data Sheets **126**, 1 (2015).
C. Müller, et al, Journal of Nuclear Medicine **55**, 1658 (2014).

Isotope Production

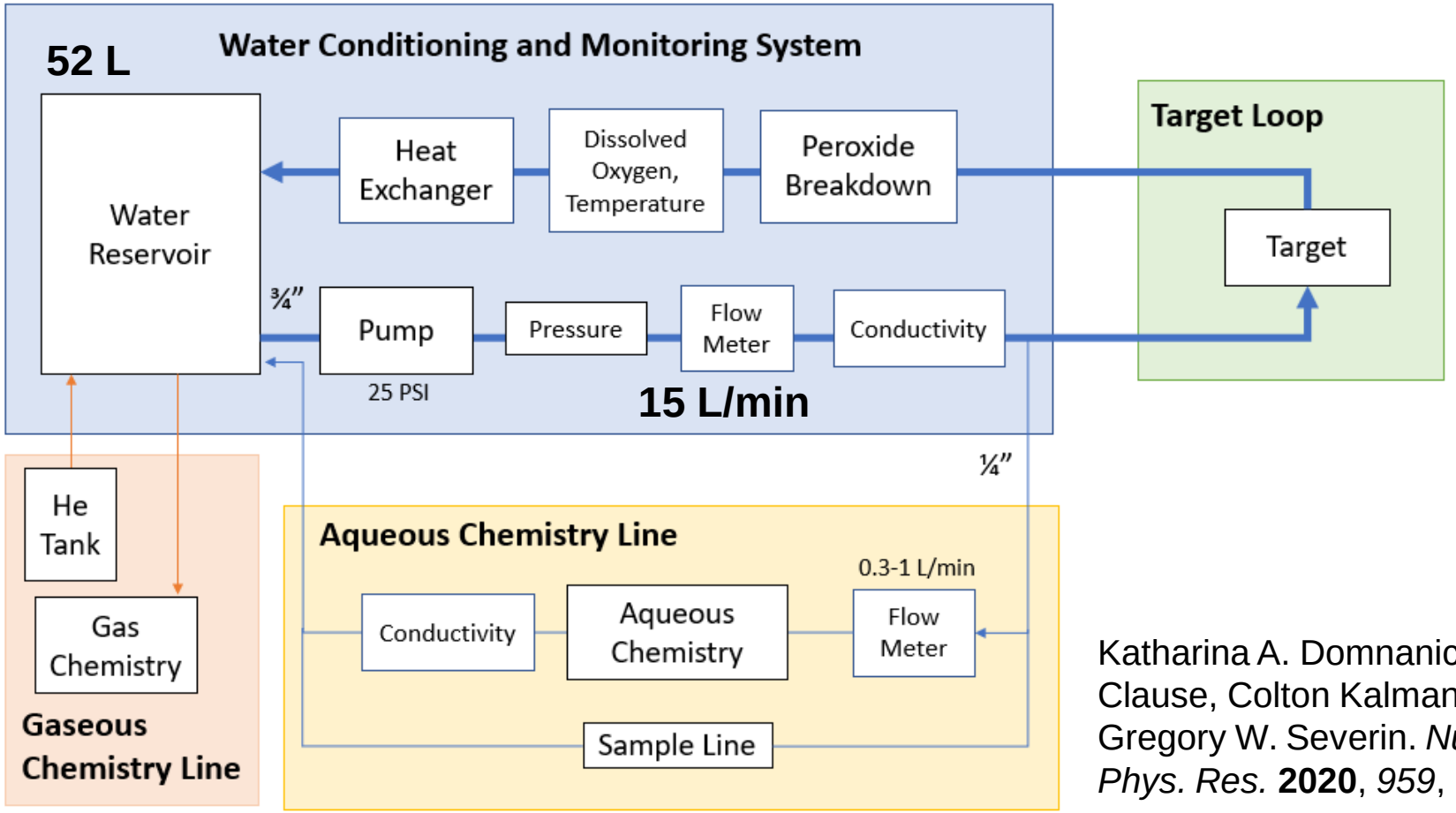
- Measured ^{48}Ca production rate at NSCL: 1.69% beam conversion
- NSCL ^{48}Ca beam (140 MeV/u, 80 pnA)
  - 120-hour experiment: 110 mCi (4 GBq)

Comparison: ≤ 0.5 mCi/mouse (20 MBq/mouse) for preclinical studies



S. Haller et. al., Journal of Nuclear Medicine and Molecular Imaging **6**, 1 (2016).

Harvesting System at NSCL



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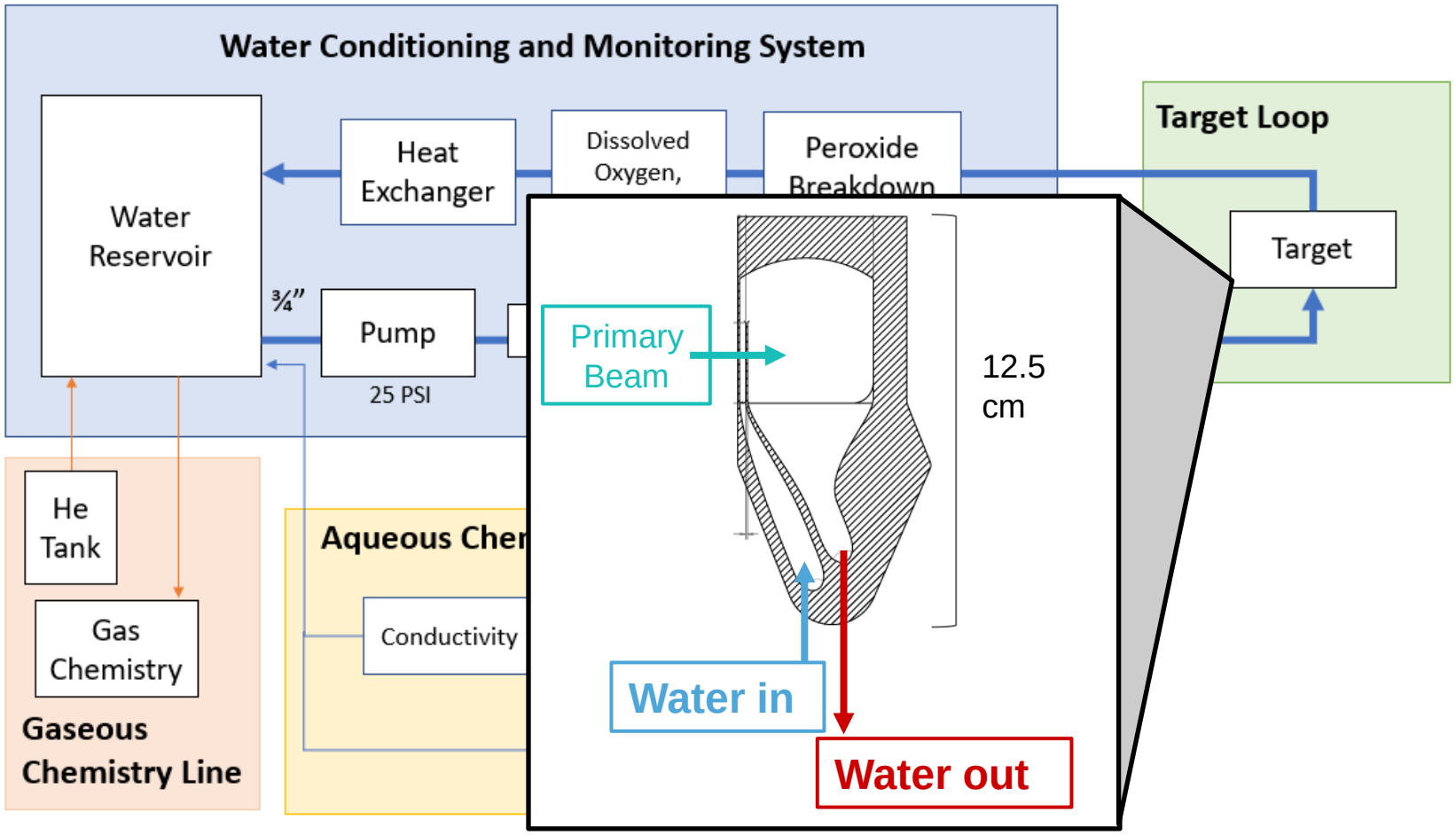
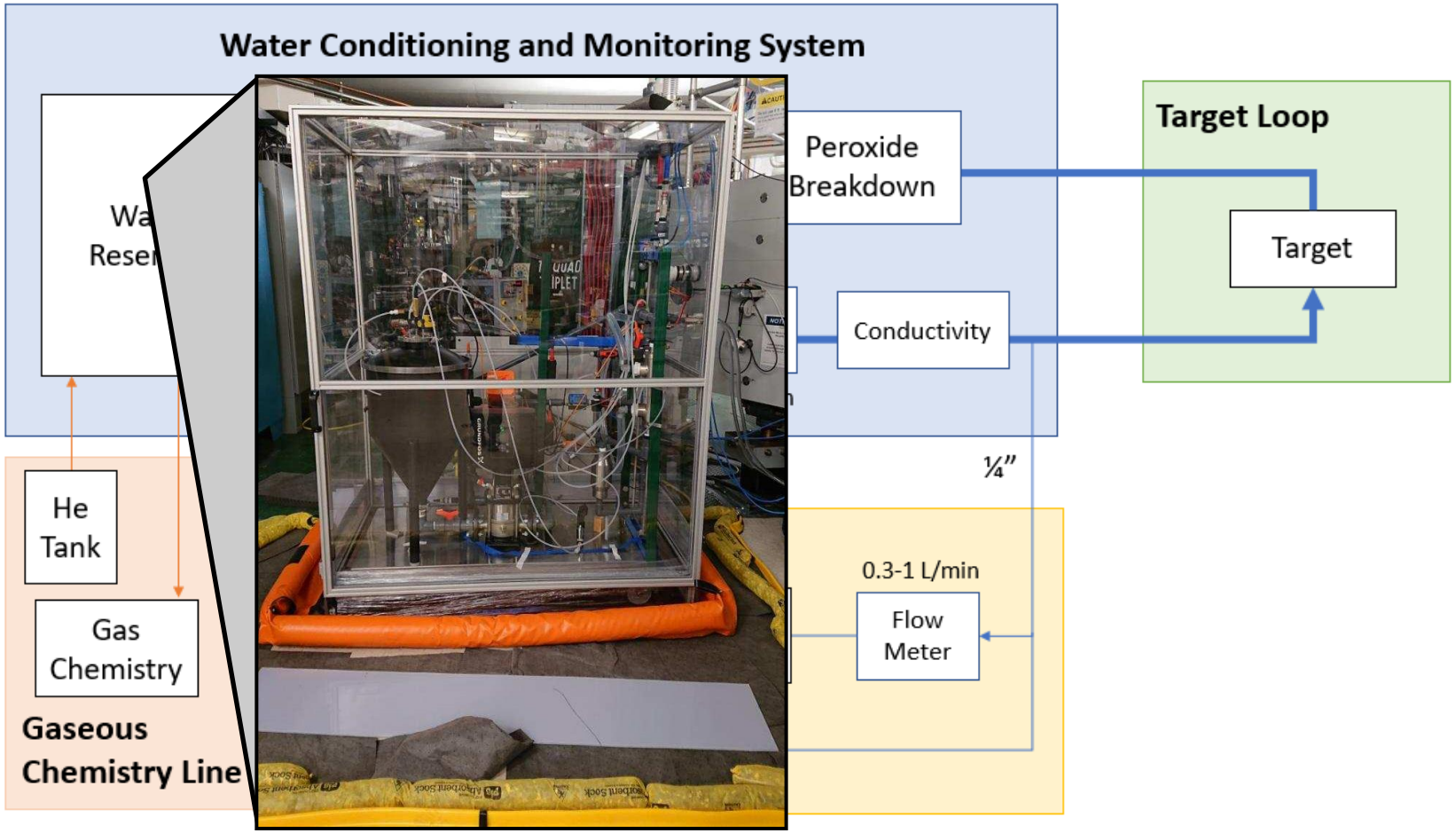
Harvesting System at NSCL



Harvesting System at NSCL



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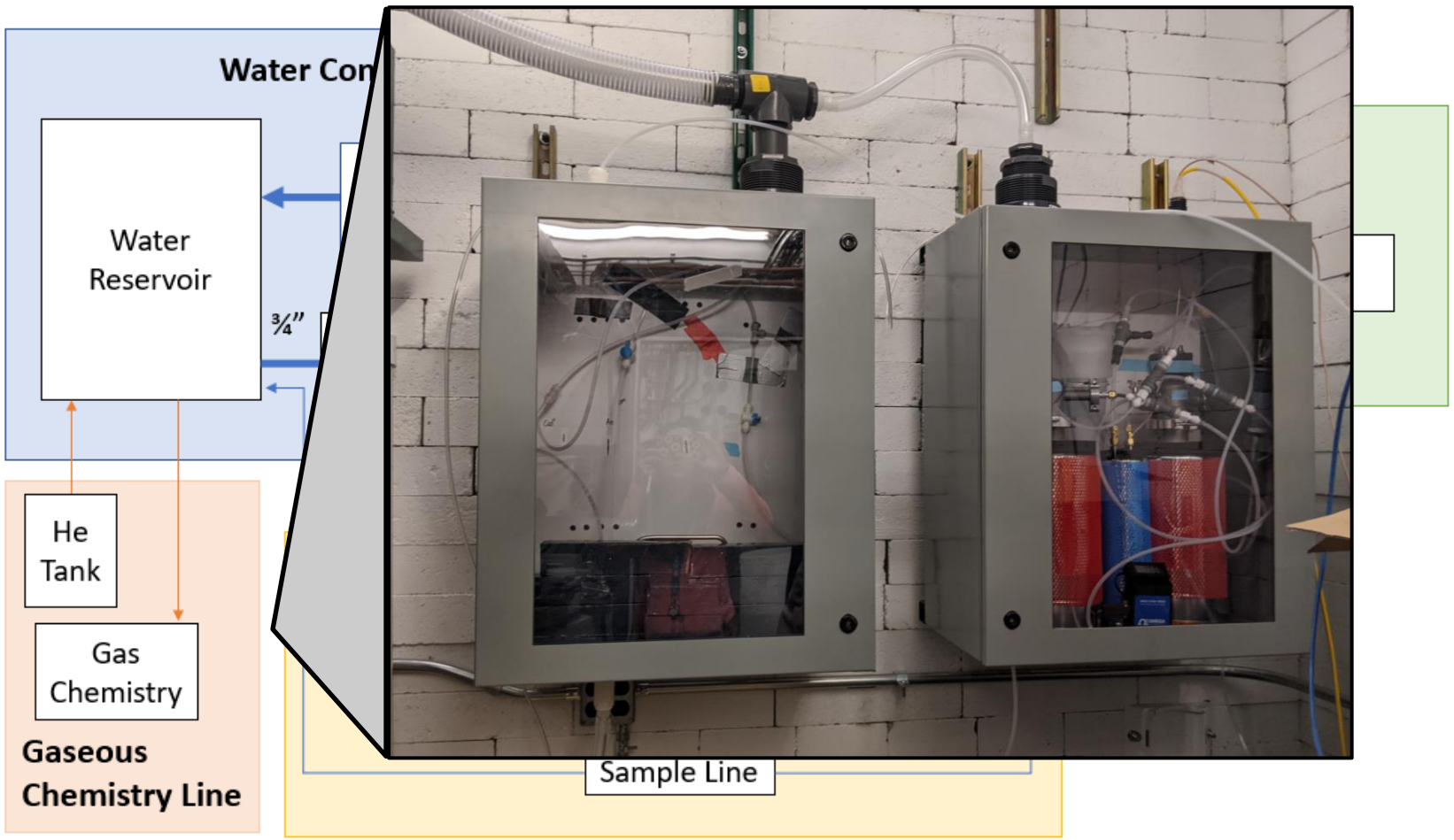

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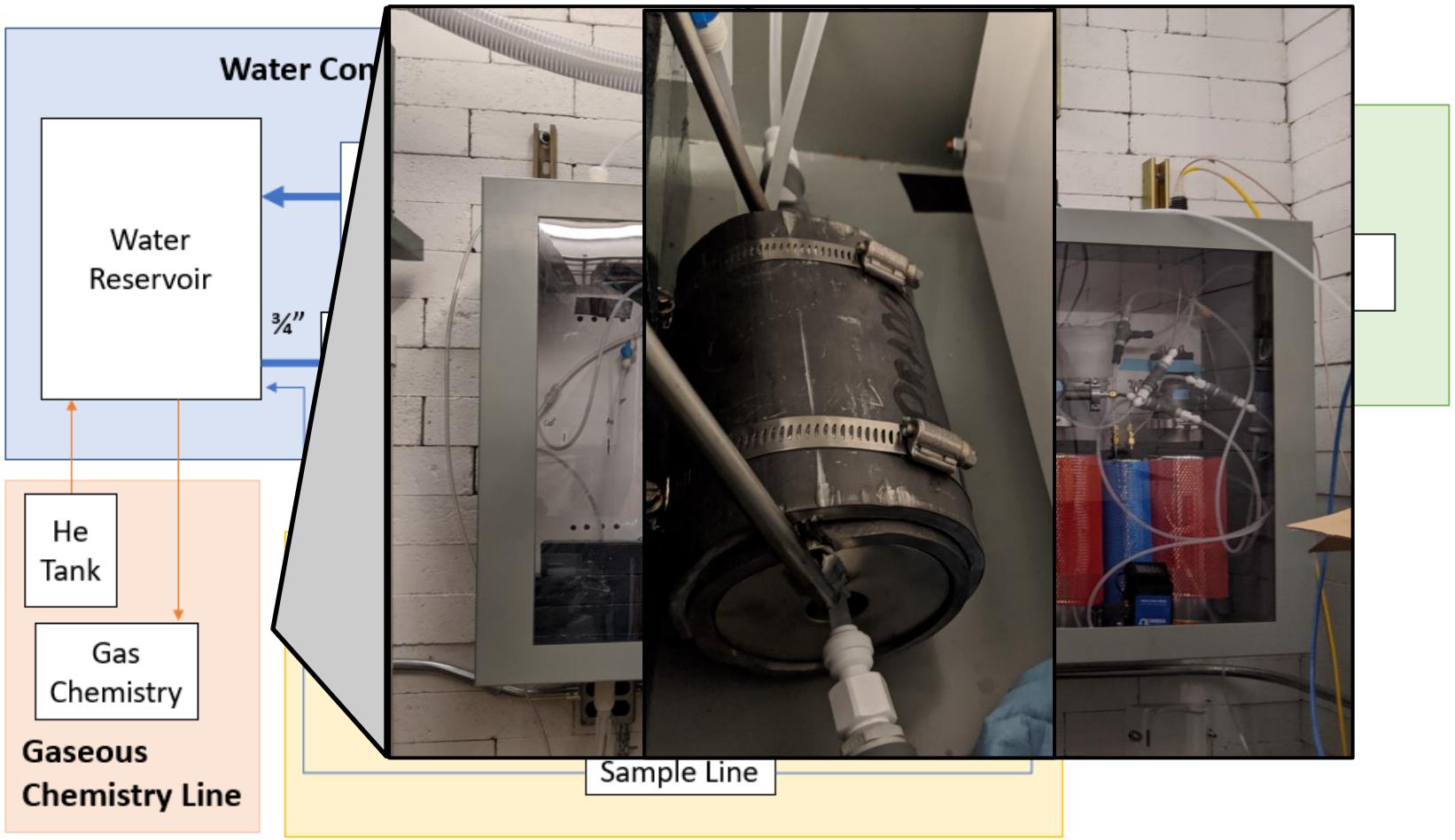
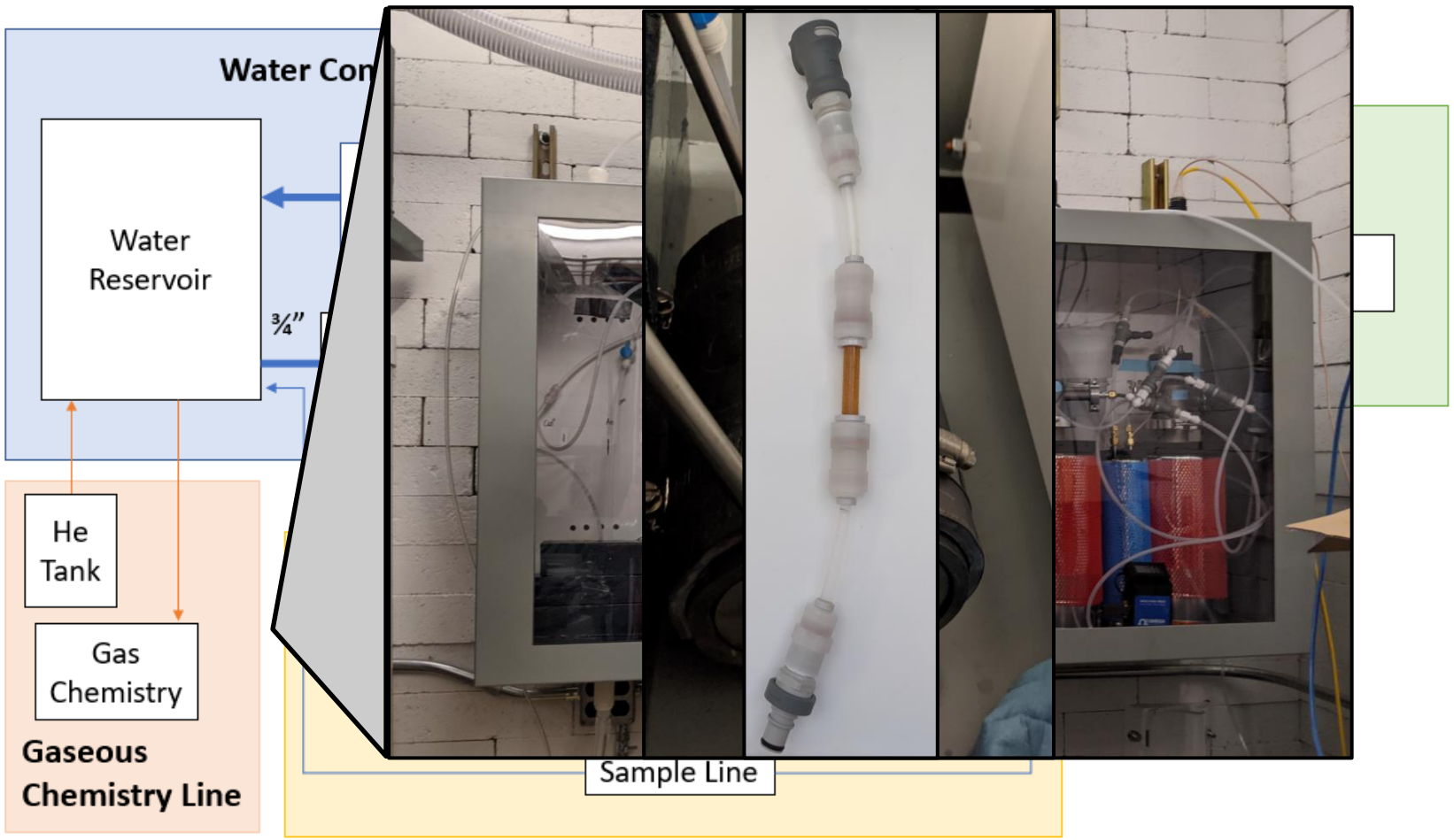
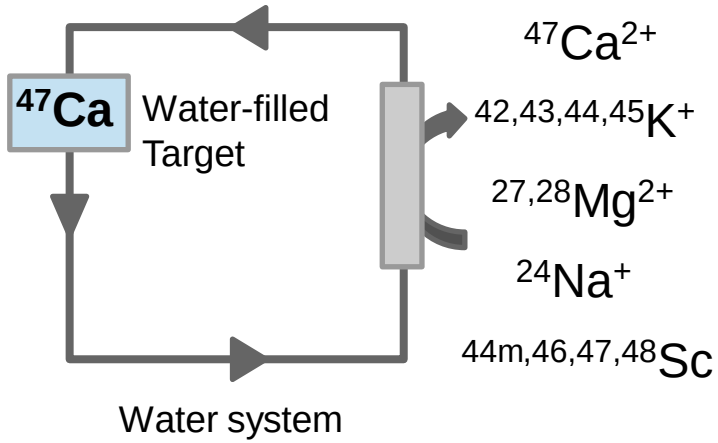


Harvesting System at NSCL

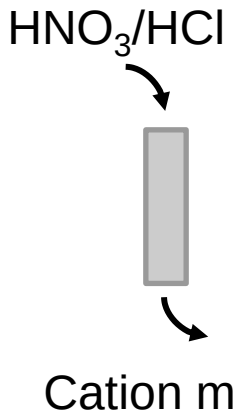


Collection and Recovery

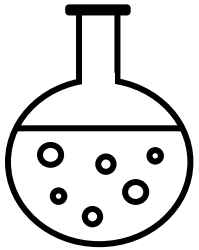
Collection on Cation Resin "Harvesting"



Recovery from Collecting Resin



Preparing Load Solution



Irradiation No.	Collection (%)	Recovery (%)
1	82(6)	92(4)
2	92(5)	81(5)
3	95(9)	86(9)

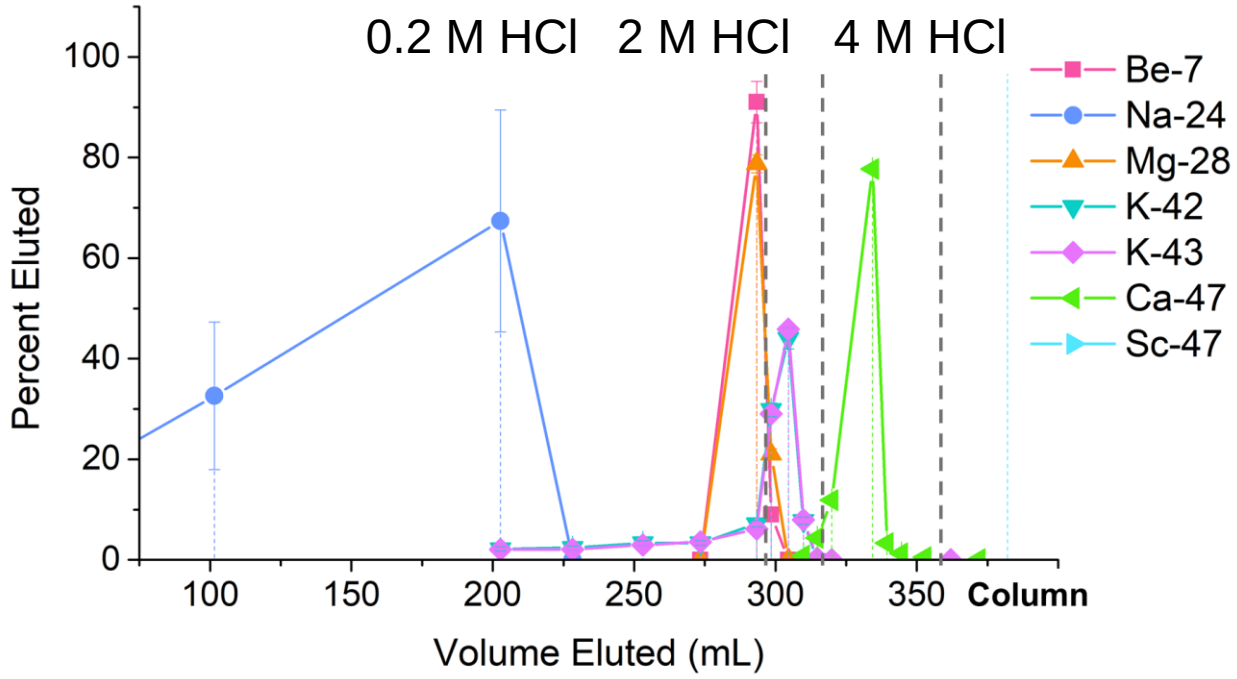
Purification of ^{47}Ca

AG MP-50 cation exchange resin with hydrochloric acid (HCl):

Procedure:

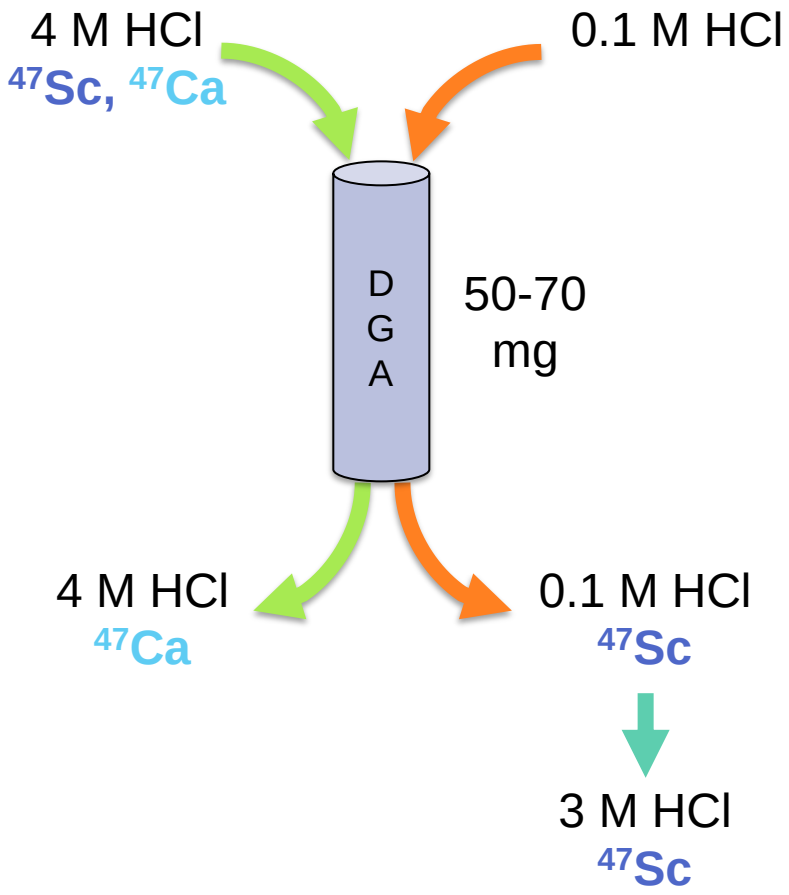
Column: 2 g resin, 11 cm
Load solution: 0.2 M HCl (250 mL)
Rinse step 1: 0.2 M HCl (40 mL)
Rinse step 2: 2 M HCl (26 mL)
Elution step: 4 M HCl (30 mL)

Total Separation Yield: 97(1)%
Radionuclidic Purity: 99.9(6)%
Total Recovery Yield: 80(1)%

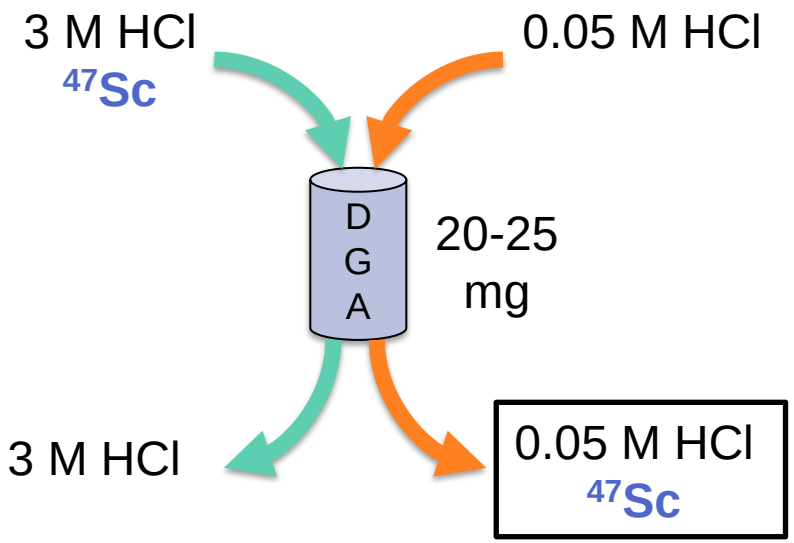


$^{47}Ca/^{47}Sc$ Generator

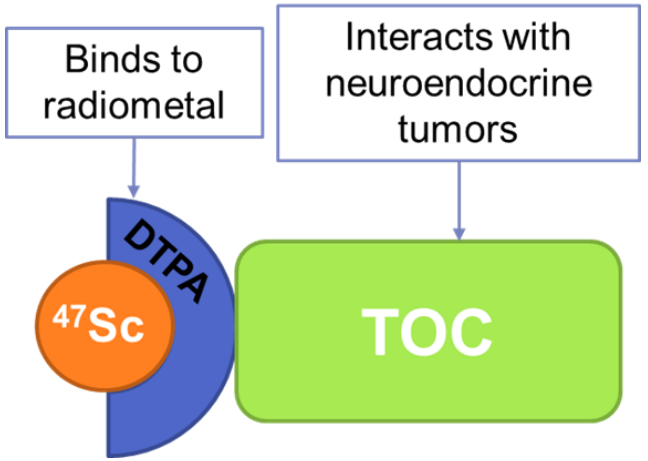
Purification of ^{47}Sc



Concentration of ^{47}Sc

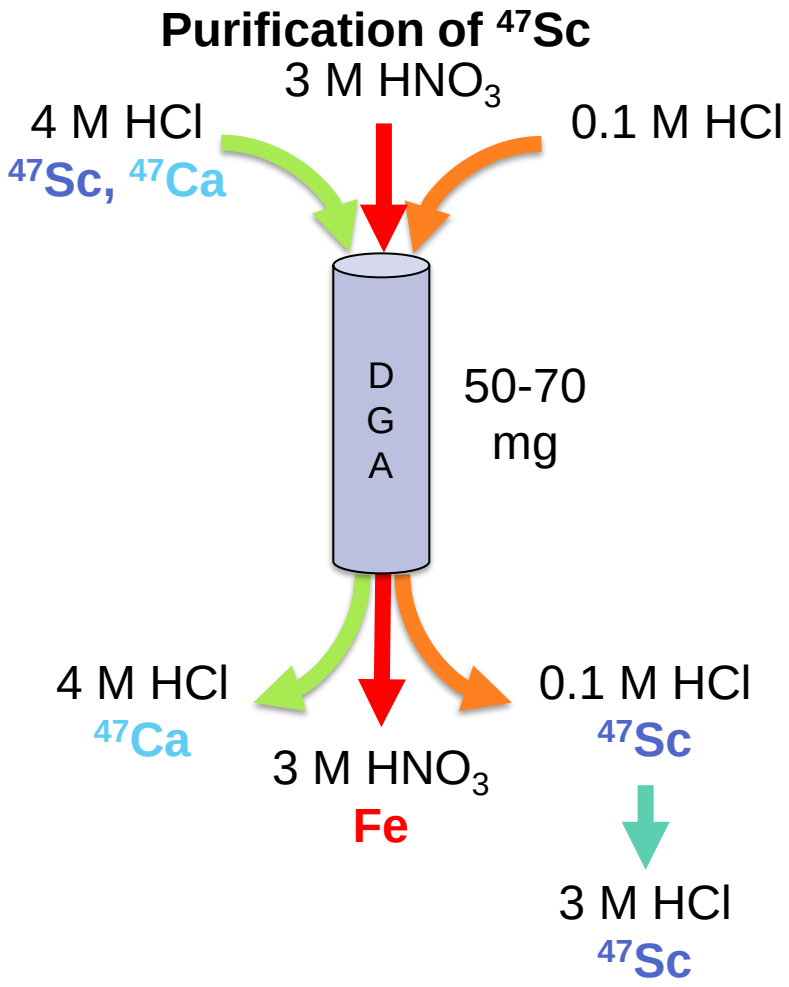


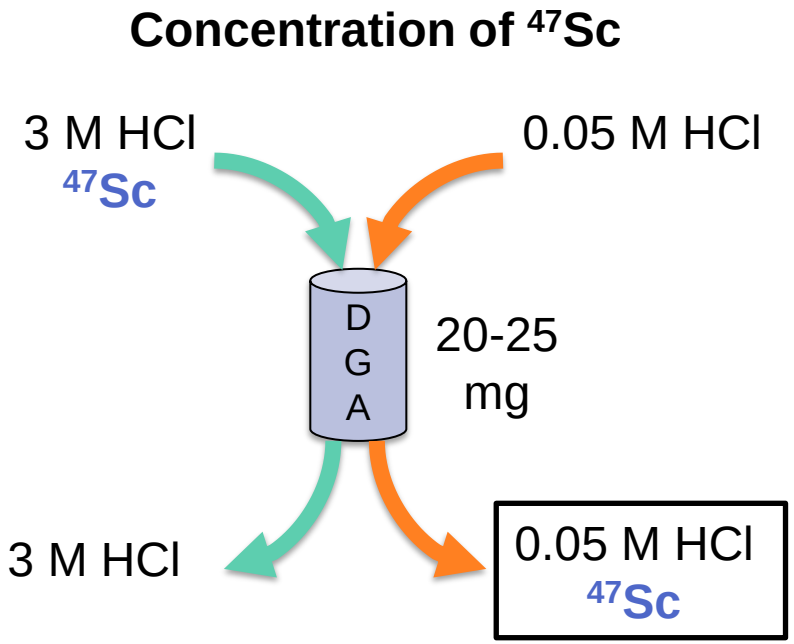
Radiolabeling with ^{47}Sc

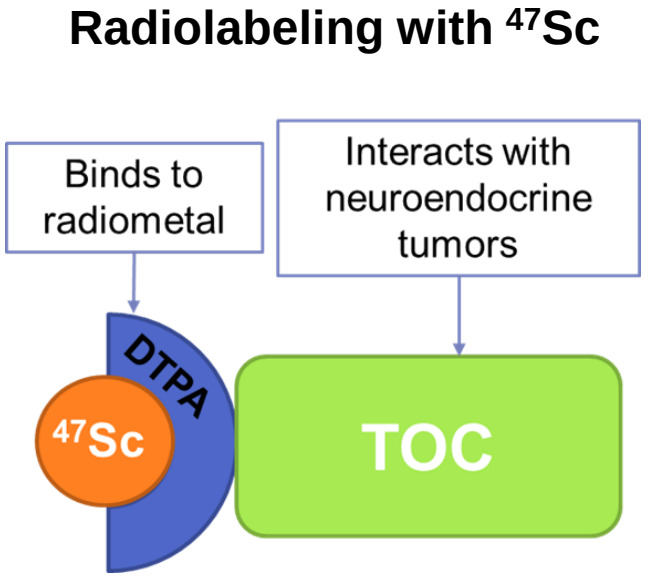


Domnanich, K.A., et al. EJNMMI radiopharm. chem. 2, 5 (2017).

$^{47}Ca/^{47}Sc$ Generator







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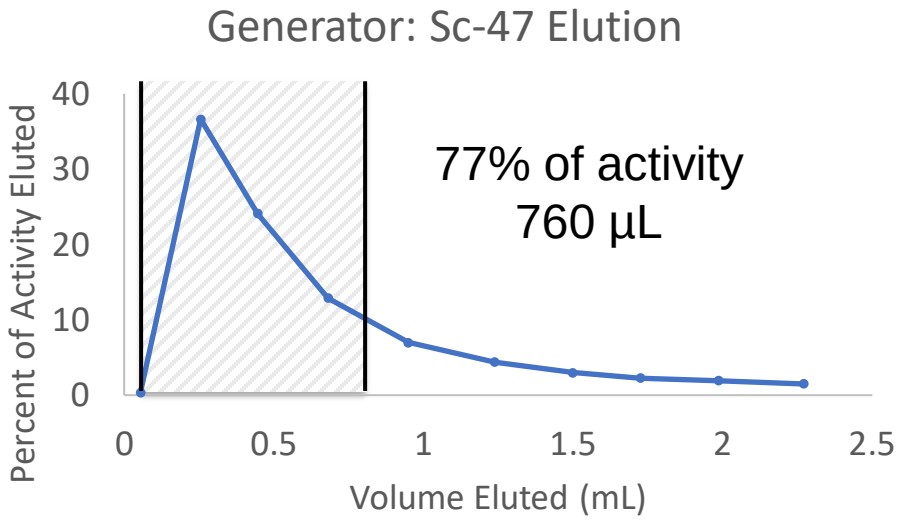
$^{47}Ca/^{47}Sc$ Generator Results

- **Goal:** Highest activity in small volume for best radiolabeling results



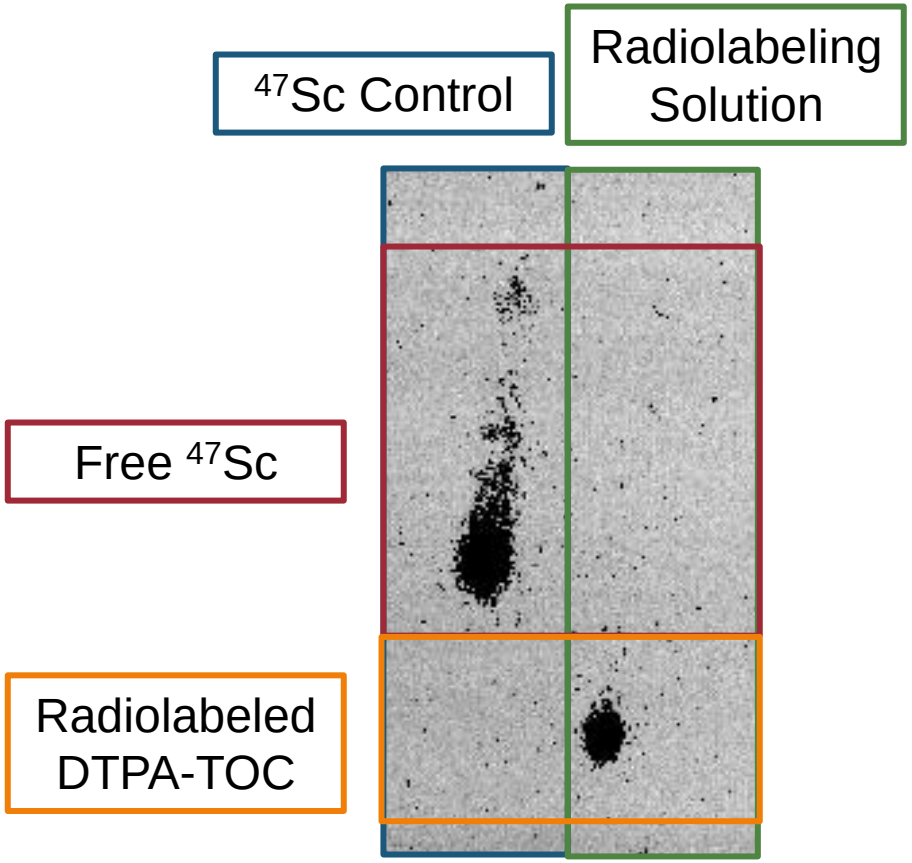
Generator #	Optimized Fraction		
	Activity (mCi)	Recovery after Purification (%)	Recovery after Concentration (%)
1	2.76(2)	94.9(8)	68.6(6)
2	1.36(1)	94.6(8)	82.3(9)
3	0.661(5)	99.7(9)	53.1(7)

Radiolabeling Results

- Radiolabeling DTPA-TOC with ^{47}Sc
- Specific activity: 10 MBq/nmol (270 µCi/nmol)

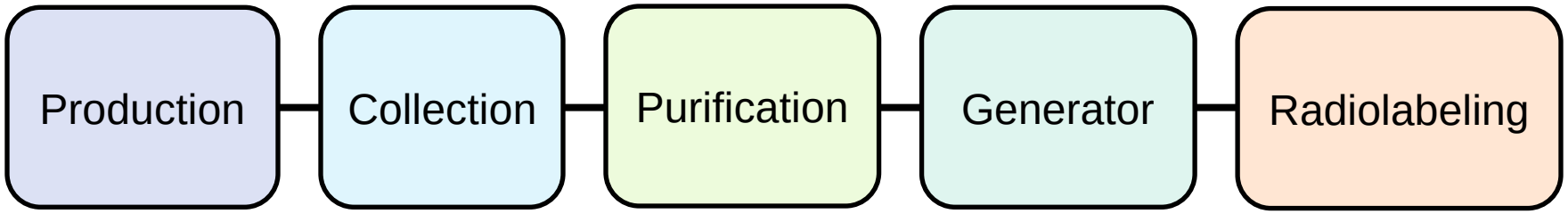
Generator No.	Activity (mCi)	Radiolabeling Yield (%)
1	2.76(2)	96.5
2	1.36(1)	99.1
3	0.661(5)	100

Quality Control: TLC



Conclusions and Outlook

- Conclusion:
  - Successfully developed and integrated methods for production through radiolabeling
  - Reproducibly radiolabeled a medically relevant compound with high specific activity
- Outlook:
  - Next step: Translation of these methods FRIB
    - » Adapt methods for true conditions at FRIB
    - » Ex: more challenging stable ion mixture
  - Regular ^{47}Sc supply from FRIB for preclinical research
    - » 400 x beam power compared to NSCL
    - » 24-hour irradiation could produce >14 Ci ^{47}Ca



Acknowledgments

- Harvesting Group:
  - Greg Severin
  - Hannah Clause
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  - Samridhi Satija
  - Katharina Domnanich
  - Chirag Vyas
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  - Todd Barnhart
  - Frederique Pellemoine

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