

Automated Radiochemistry Efforts at LLNL

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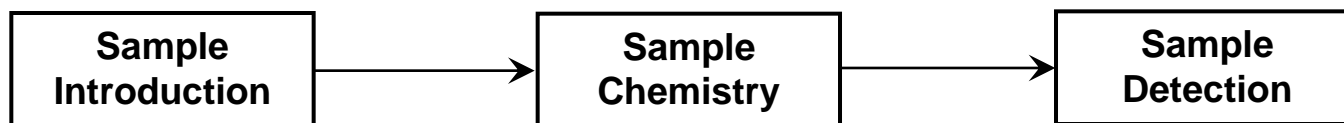
* Los Alamos National Laboratory

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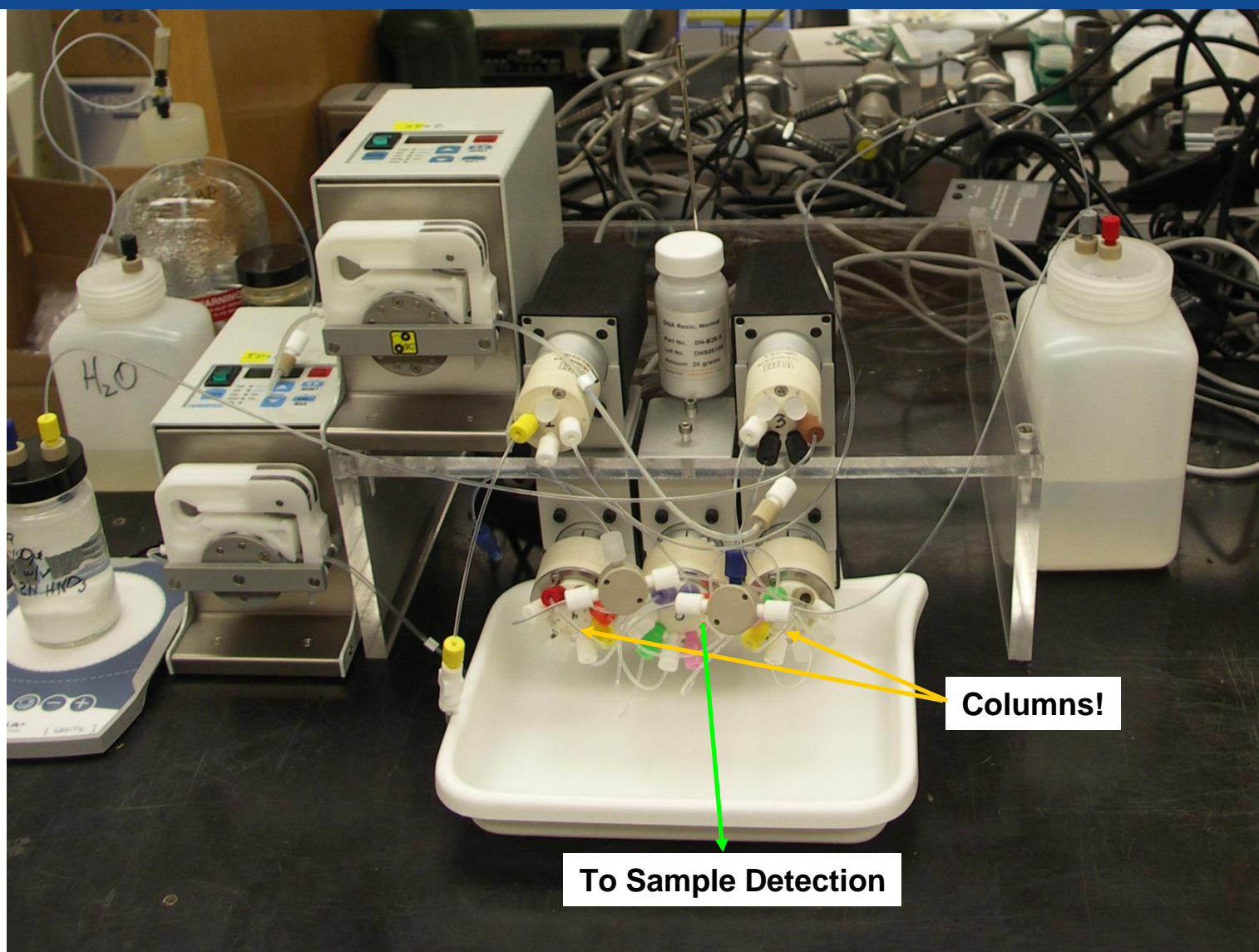
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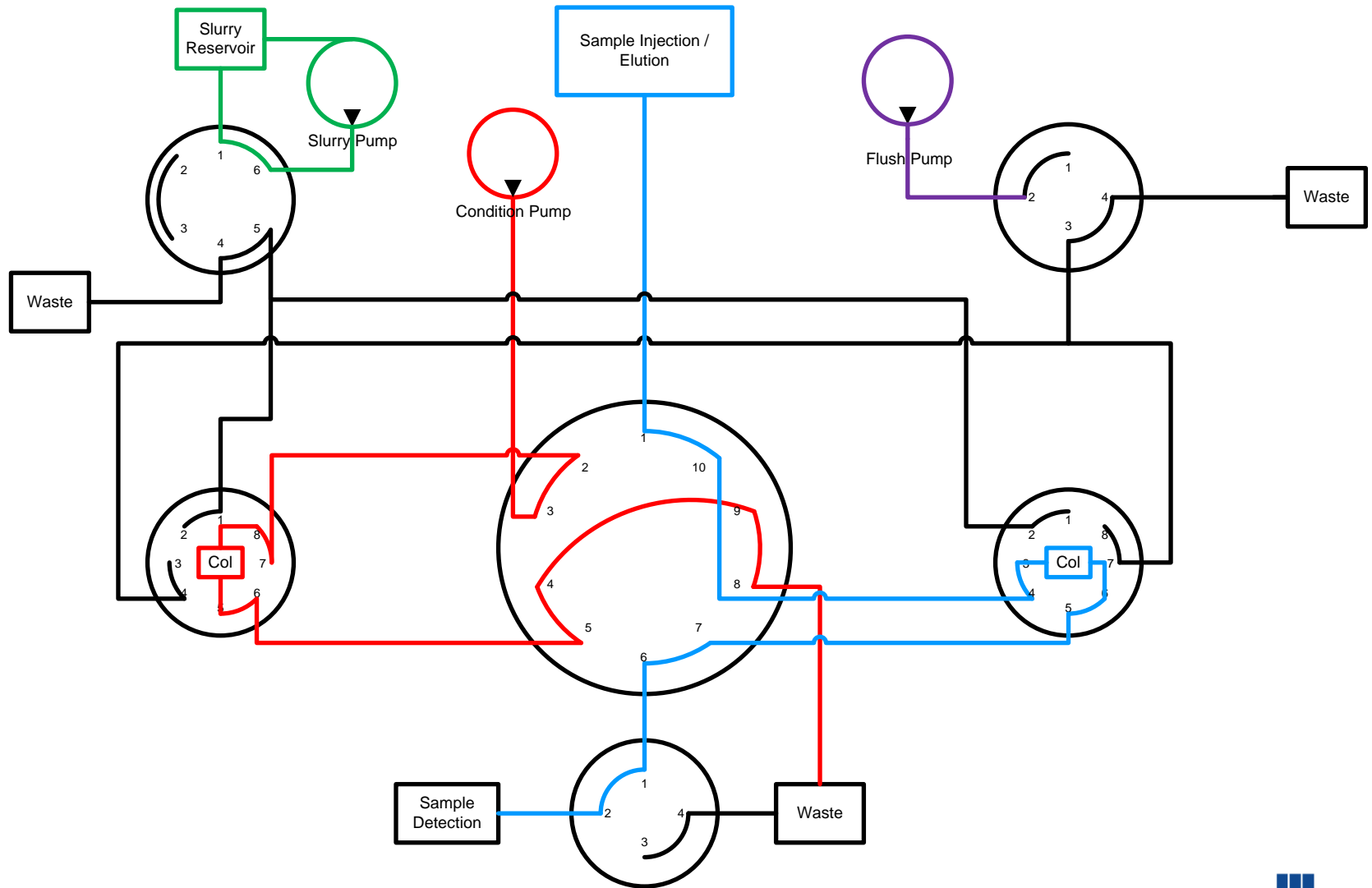
- Chemistry Desires for Automation
 - Speed
 - Reproducibility
 - Lower Dose to Operators
- Begin with a Heavy Element application
 - Single Column chemistry
 - Automated column regeneration
 - Long operating periods (months!)
- Conceptual Design – SHELA – Super Heavy Element Liquid Automation



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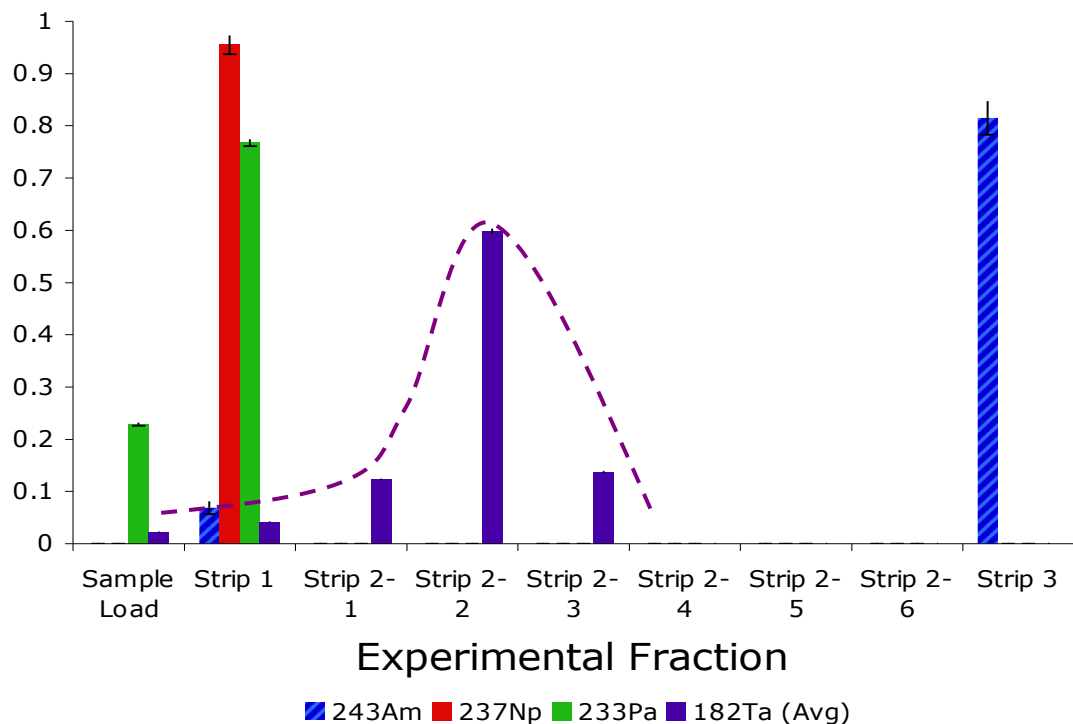
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- System Components
 - Cheminert valves, PEEK material, micro-electric actuation
 - ISCO peristaltic pumps
 - Tubing durability – time until it must be replaced?
 - Tubing – FEP – ID = 0.762 mm
 - Columns – FEP tubing, 10 cm length
 - Volumes
 - 0.762 mm tubing – 45.6 μ l
 - 0.508 mm tubing – 20.3 μ l
 - 0.254 mm tubing – 5.1 μ l
 - Frits (for column support)
 - PEEK, 0.5 μ or 2 μ Frit-In-A-Ferrule™
- LabView Control



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MS-4 Fractional Radionuclide Activity Distribution



Sample Loading:

0.4 M HNO₃/ 0.02 M HF, 1 mL

Strip 1 (Pa):

0.4 M HNO₃/0.1 M HF, 5 mL

Strip 2 (Ta):

8M HNO₃/0.1 M HF, 6 x 5 mL

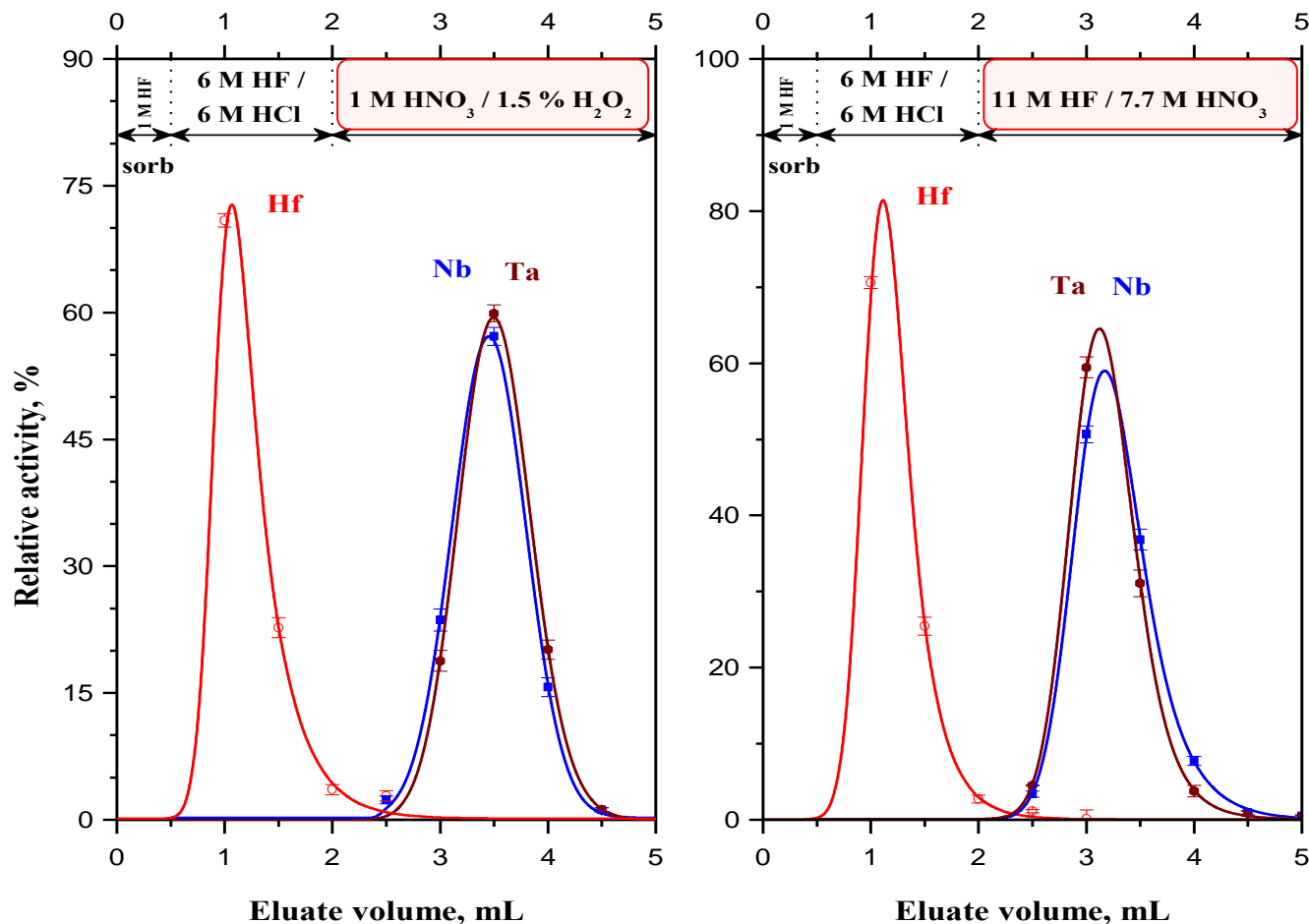
Strip 3:

0.1 M Ammonium Bioxalate, 5 mL



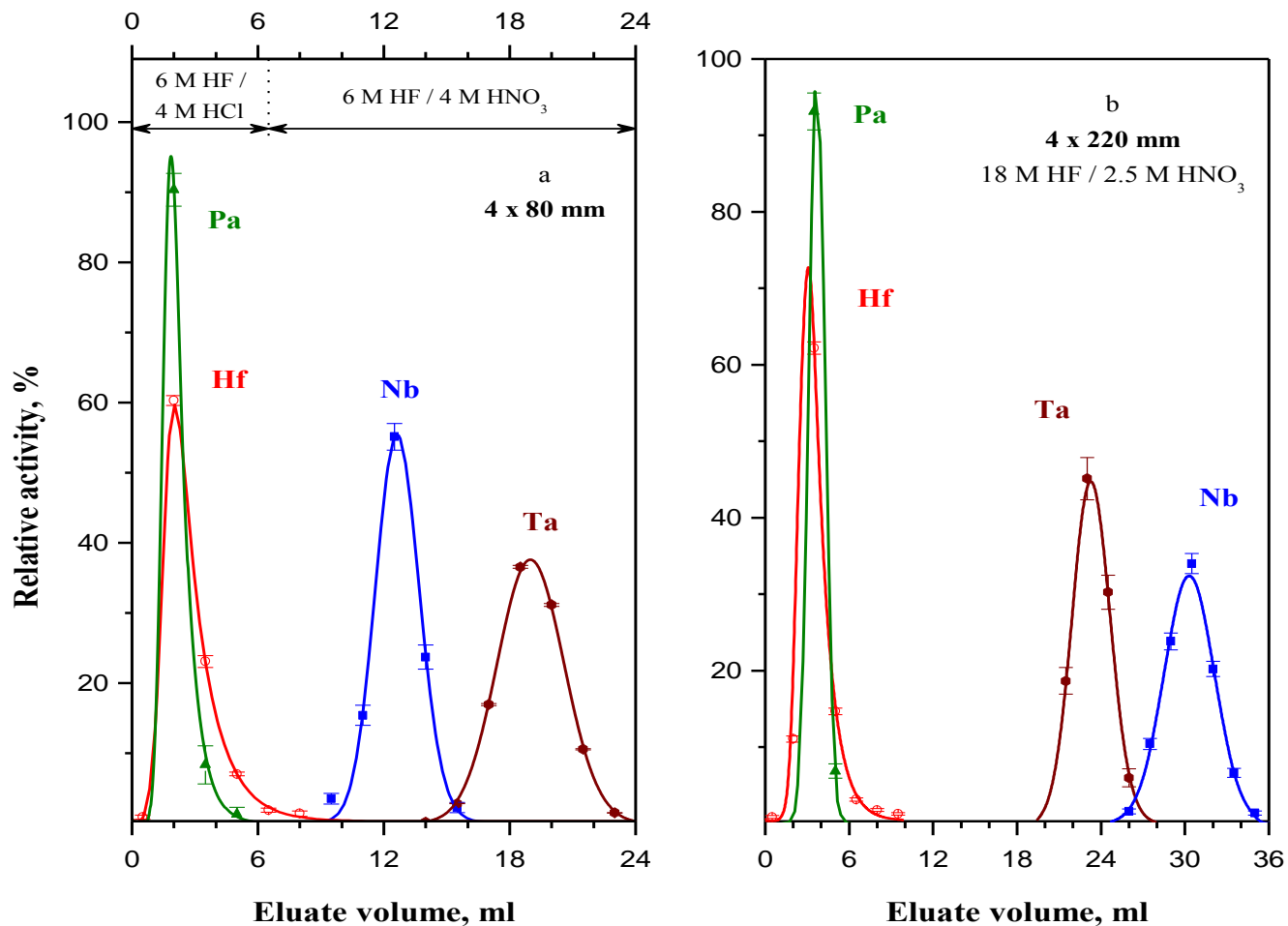
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Group IV, V separation using Dowex 1x4, -400 mesh, 4x16 mm



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Separation of Hf, Pa, Nb, and Ta using Dowex 1x4, -400 mesh

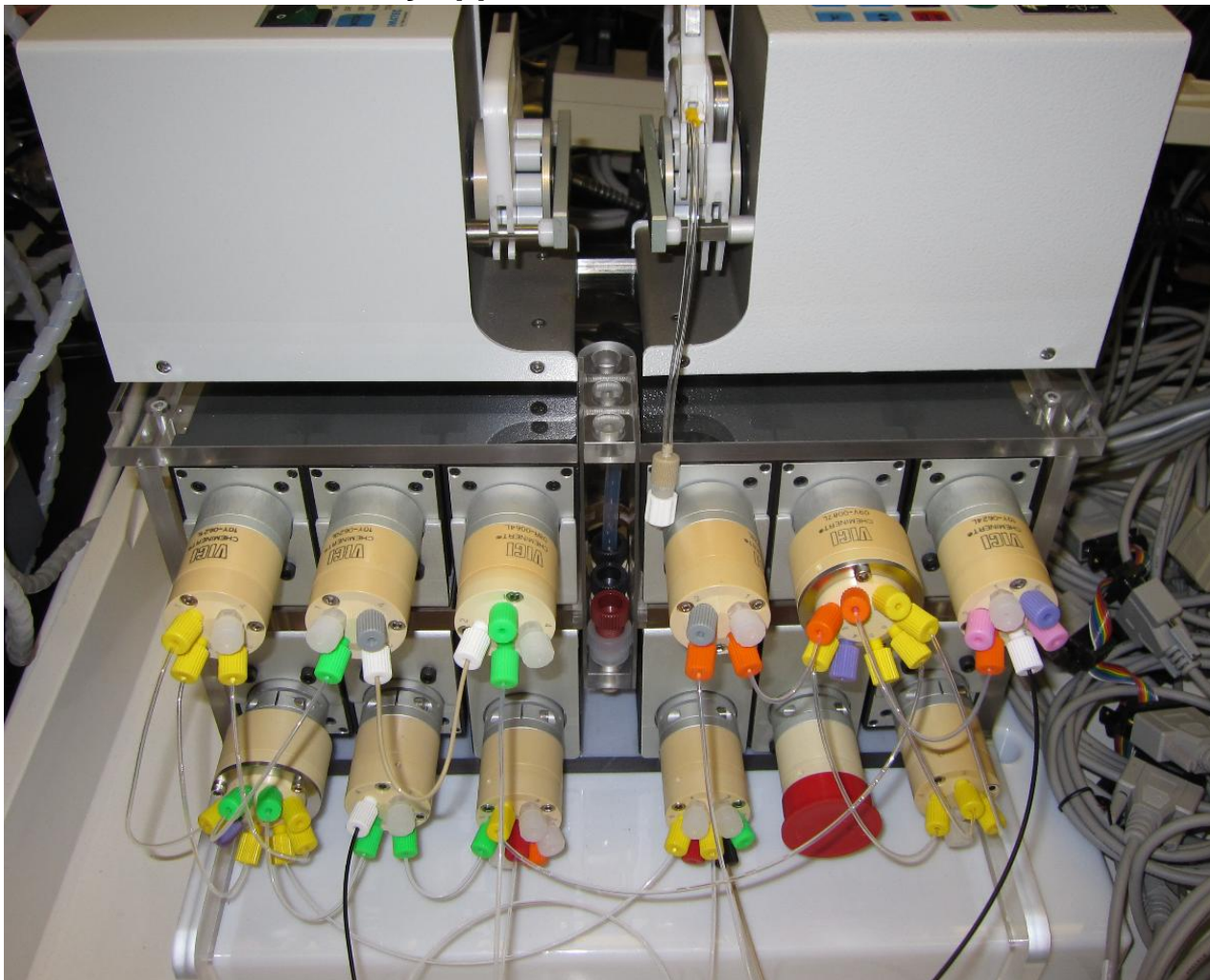


Tereshatov E.E. et al. (2010) J Radioanal Nucl Chem 286, pp. 9-16



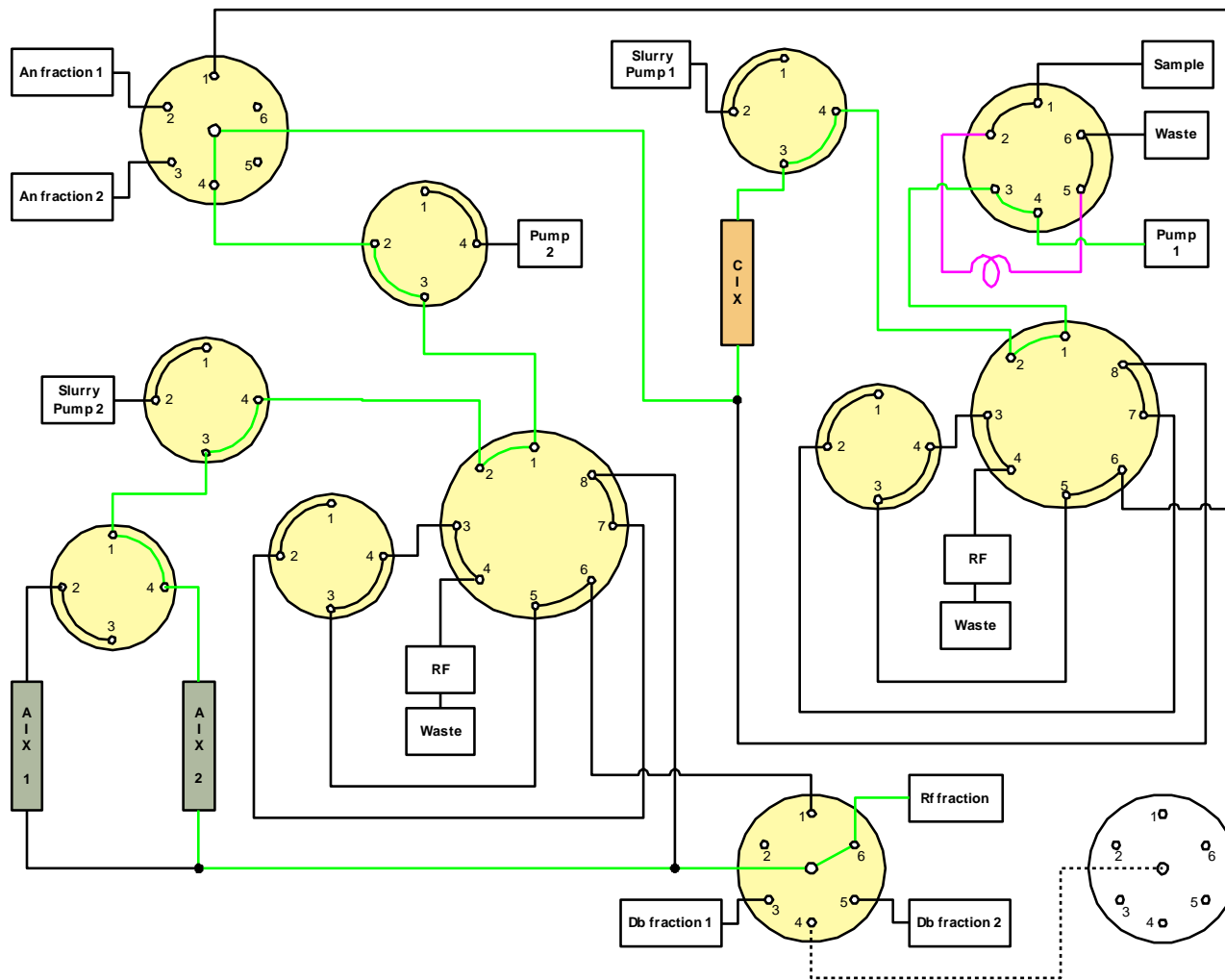
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The newest automated chemistry apparatus – hardware view



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The newest automated chemistry apparatus – ‘wiring’ diagram



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- System Components
 - Cheminert valves, PEEK material, micro-electric actuation
 - ISCO peristaltic pumps – resin slurry only
 - Tubing durability – time until it must be replaced?
 - Tubing – FEP – ID = 0.762 mm
 - Columns – Variable Size
 - Main Pump – Dionex Dual Quaternary Gradient Pump
 - Four eluants into each of two final outputs
 - Chromeleon™ Express controlled
- LabView Control
 - Communications issue with Chromeleon
 - Use ActiveX controls from LabView to tell Chromeleon how to run the pump



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- Sample production
 - Sample introduction system
 - Current design at engineering for SolidWorks digital prototyping
 - Three station system - GLITTAR
 - Gas jet collection of a frit
 - Sample removal from the frit
 - Rinse / replace the frit



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Final steps...

- Source Preparation
 - Traditionally a time consuming step of evaporating a solution onto a suitable substrate
 - LANL Functionalized Surface technology
 - CMP (carbamoylmethylphosphonate) ligand functionalized glass or silicon substrates (Initially for Pu⁺⁴ work)
 - Other ligands possible for different projects
 - Alpha spectra are comparable to the best electroplated sources
 - FWHM = 22 keV for ²⁴²Pu, ^{239/240}Pu
 - Investigating polymer substrates to improve detection efficiency and be able to detect both fission fragments
 - Fast – absorption from solution is rapid
- Detection
 - Array of PIPs detectors for alpha / SF detection

