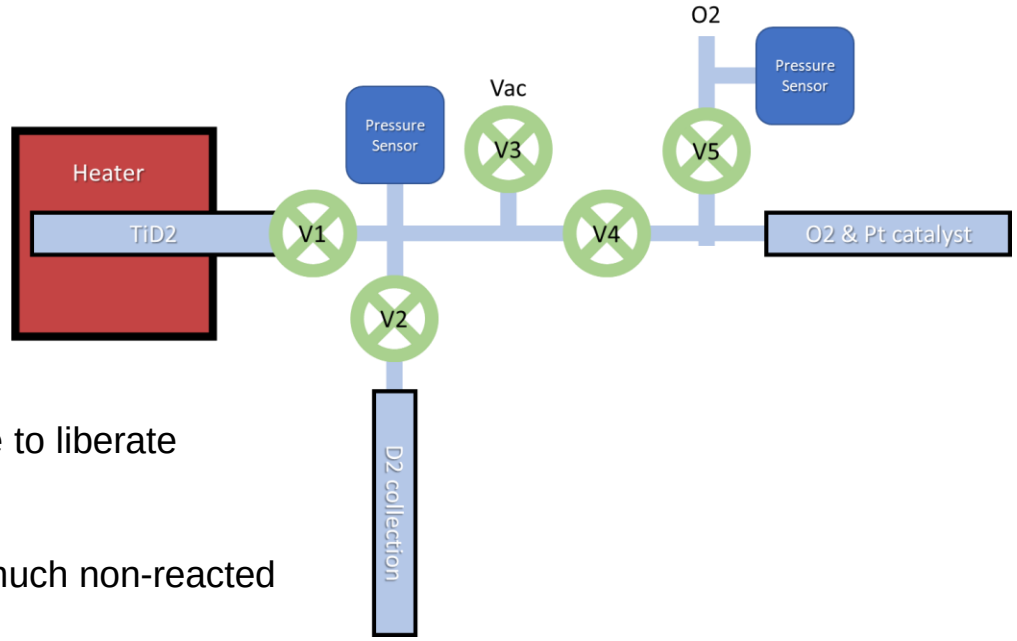
After Irradiation: Gas Extraction (I)

Tritium collection process

Volumes and masses are measured.
(masses of sample & H_2O for rinsing)
Pressures and temperatures measured
in each zone throughout experiment



Evacuate manifold and O_2 line
Heat TiD_2 chamber past decomposition temperature to liberate D_2 T, & any residual gases

Chill D_2 collection chamber with LN_2 to capture as much non-reacted gas as possible
Close V1 before letting system return to room temperature

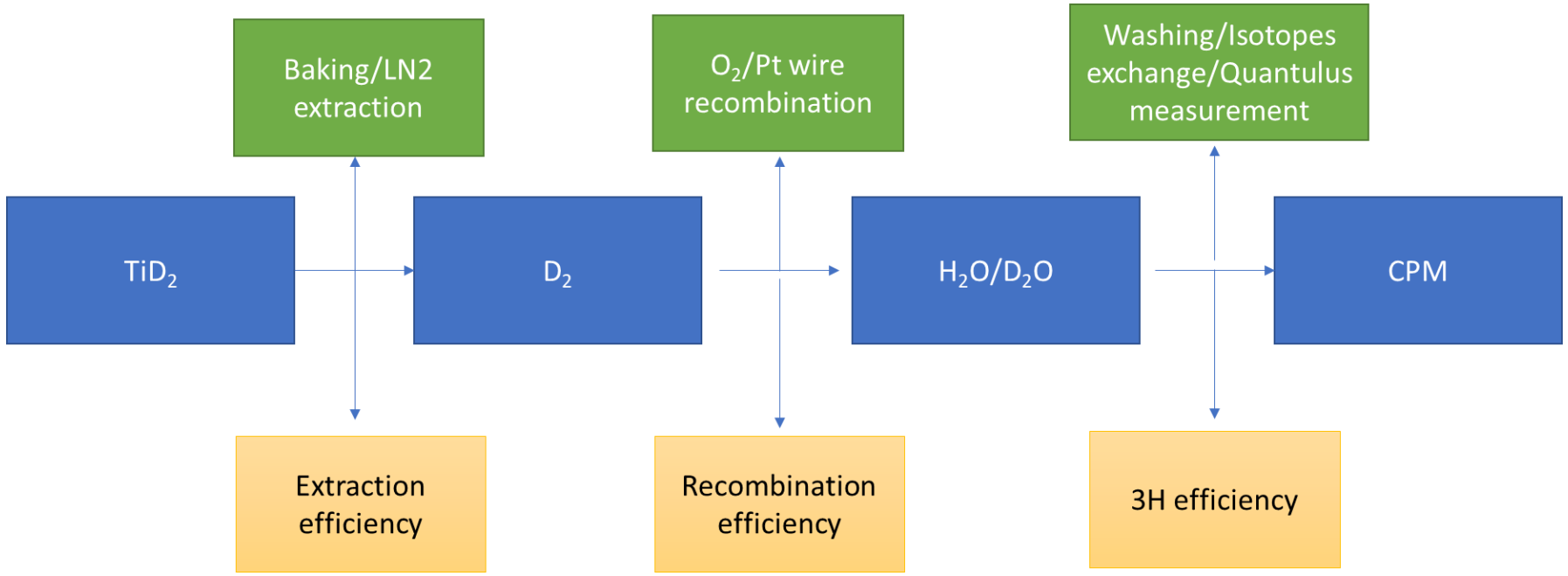
Fill O_2 chamber with as much O_2 as D_2 in D_2 chamber,
over 1:1 stoichiometric ratio (This ratio has shown best results for quick and complete reaction)

Close V5. Open V4 to let D_2 diffuse and react at catalyst, and then isotope exchange with H_2O. D_2 will form D_2O & the D_2O will diffuse into the much larger added mass of H_2O for ease of collection by rinsing.

Use H_2O to rinse the chamber and then collect H_2O. For samples with T, typically the chamber is rinsed three times until no signal is observed in Quantulus.

Gas Extraction (II)

Collection efficiency of each step



Gas Extraction (III)

Summary of the processing efficiencies

	Sample	Collection Efficiency	Recombination Efficiency	3H Efficiency	Total
H_2	Ti-17P 001 2 min radiation	64%	87%	60%	33%
	Ti-17P 002 4 min radiation	65%	93%	59%	36%
	Ti-17P 003 6 min radiation	63%	94%	60%	36%
D_2	Ti-15D 001 2 min radiation	65%	84%	60%	33%
	Ti-15D 002 4 min radiation	55%	87%	60%	29%
	Ti-15D 003 6 min radiation	61%	91%	60%	30%
D_2	TiD_2 #1 50h radiation	65%	90%	60%	35%
	TiD_2 #2 50h radiation	73%	84%	60%	37%
	TiD_2 #3 50h radiation	38%	89%	60%	20%
	TiD_2 #4 50h radiation	45%	90%	60%	24%

Quantulus: Quantifying Triton Generation (I)

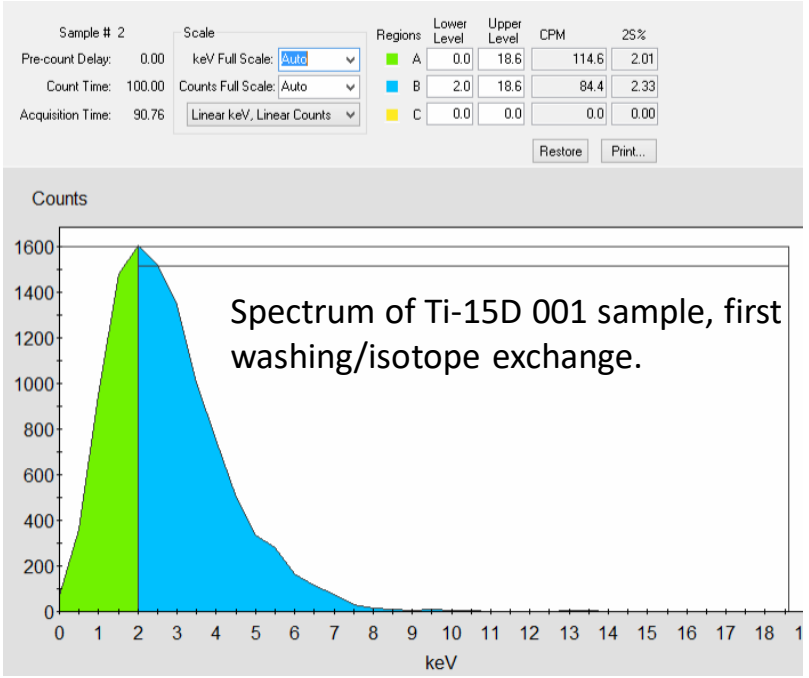
2009 Quantulus GCT 6220 operation

Allows counting nuclides in sample

For each sample in assay, the instrument:

- Measures activity in a sample vial as Counts Per Minute (CPM).
- Determines quench level via one of the Quench Indicating Parameters (QIPs).
- Determines counting efficiency from a quench curve (plots% Efficiency vs. QIP).
- Calculates DPM, where DPM = CPM / Efficiency.

Ultima Gold is used to calibrate the activity before and after the sample measurements.



Quantulus: Quantifying Triton Generation (II)

For 1 MBq, (1 M DPS)

$$N = \frac{(-dN/dt)}{\lambda} = \frac{10^6/\text{sec}}{\lambda}$$

$$\lambda = \frac{0.693}{t_{1/2}} = \frac{(0.693)}{(12.33yr)(\pi \times 10^7 \text{ sec}/yr)} = 1.789x10^{-9}\,\text{sec}^{-1}$$

$$N = \frac{A}{\lambda} = \frac{(10^6/\text{sec})}{(1.789)(10^{-9}/\text{sec})} = (5.59)(10^{14})\,nuclei$$

1 DPM → 9.3 x 10^6 nuclei

	Sample	Quantulus Counts Per Minutes	Total Triton produced (nuclei)
H_2	Ti-17P 001 2 min radiation	0	0
	Ti-17P 002 4 min radiation	0	0
	Ti-17P 003 6 min radiation	0	0
D_2	Ti-15D 001 2 min radiation	117	3.3 x 10^9
	Ti-15D 002 4 min radiation	236	7.6 x 10^9
	Ti-15D 003 6 min radiation	412	11.5x10^9
D_2	TiD_2 #1 50h radiation	186879	5.0 x 10^{12}
	TiD_2 #2 50h radiation	208963	5.8 x 10^{12}
	TiD_2 #3 50h radiation	113843	5.3 x 10^{12}
	TiD_2 #4 50h radiation	146110	5.6 x 10^{12}

Conclusion From Experiment:

Between 5 – 6 x10^{12} t in original sample

Half life of tritium is ~12.3 yr. Experiments took place soon after radiation