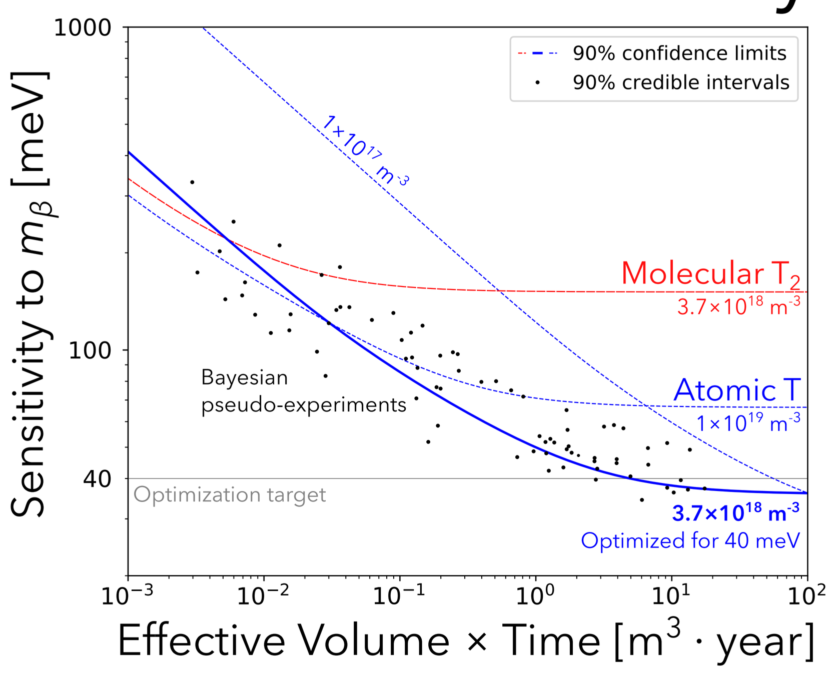
Demonstrating Atomic Tritium for Project 8

Alec Lindman for the Project 8 Collaboration

ν Mass Sensitivity



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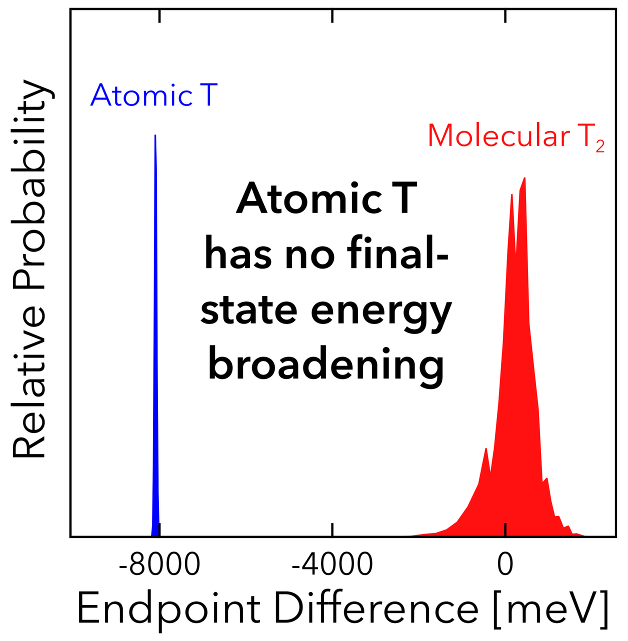
β Decay Final State Spectra



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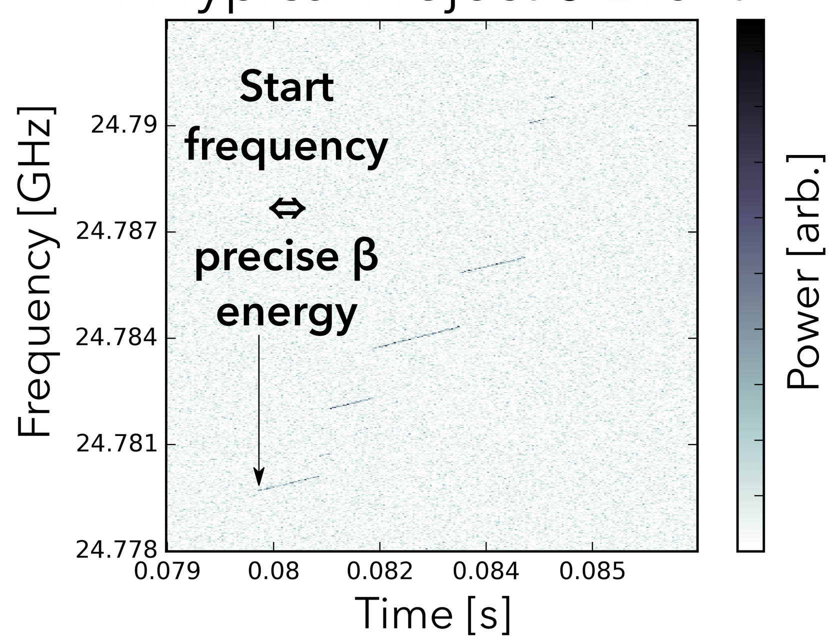
A Typical Project 8 Event



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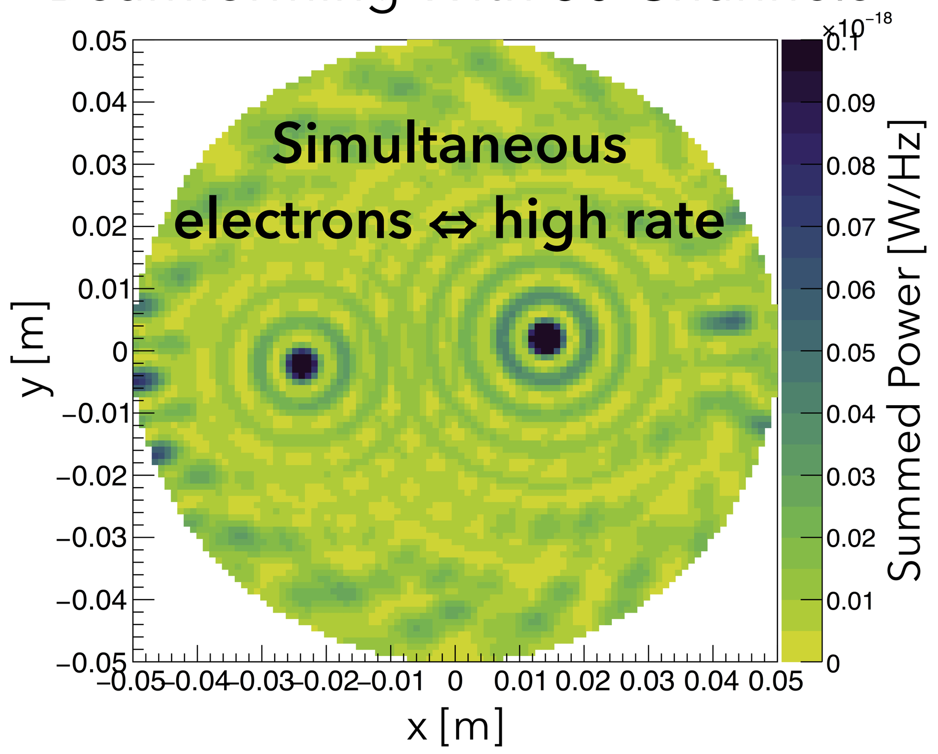
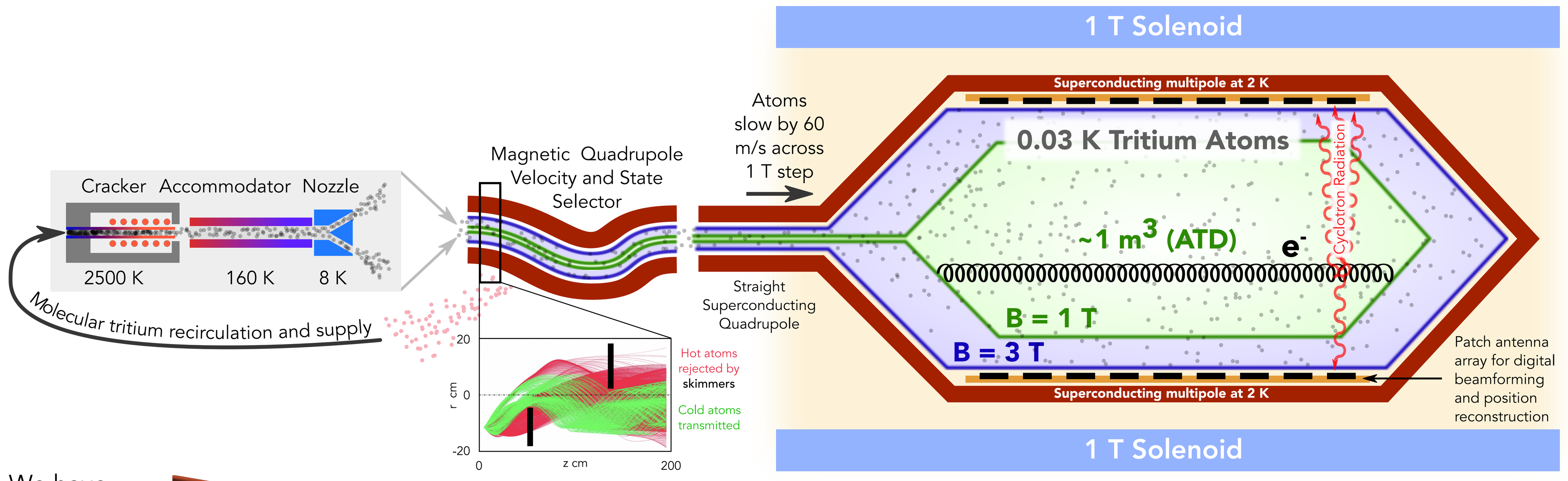
Beamforming With 30 Channels

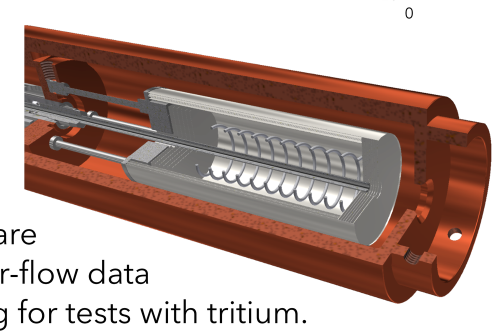


See posters by C. Claessens, M. Fertl, W. Pettus, Y.-H. Sun, P. Surukuchi, A. Telles, T. Weiss

Atomic tritium is required to measure neutrino masses below 100 meV. Project 8 is working on an Atomic Tritium Demonstrator to prove we can produce and store atomic T at scale.

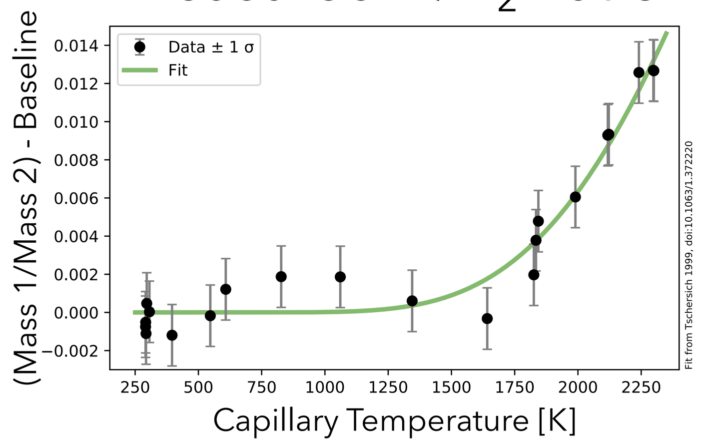


We do not plan to make a neutrino mass measurement with the ATD, so it will likely include few, if any, CRES antennae.

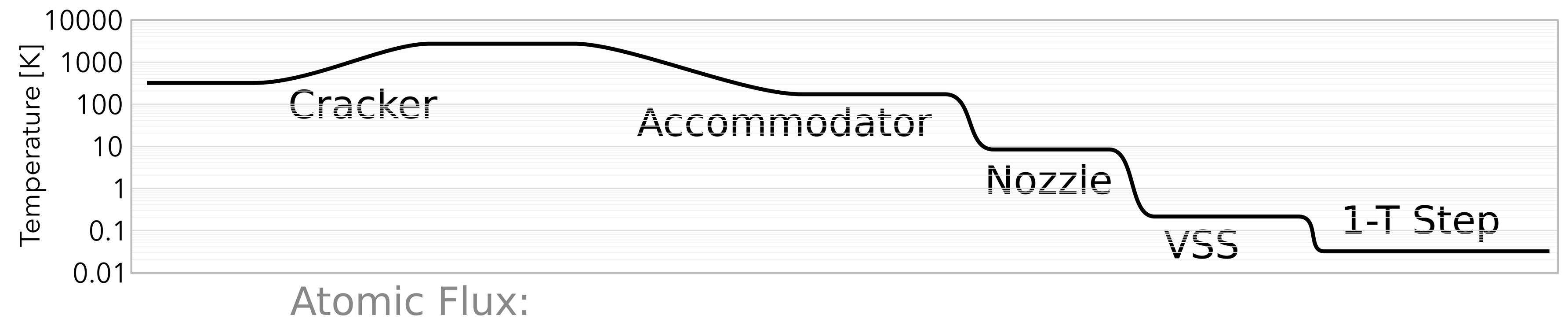


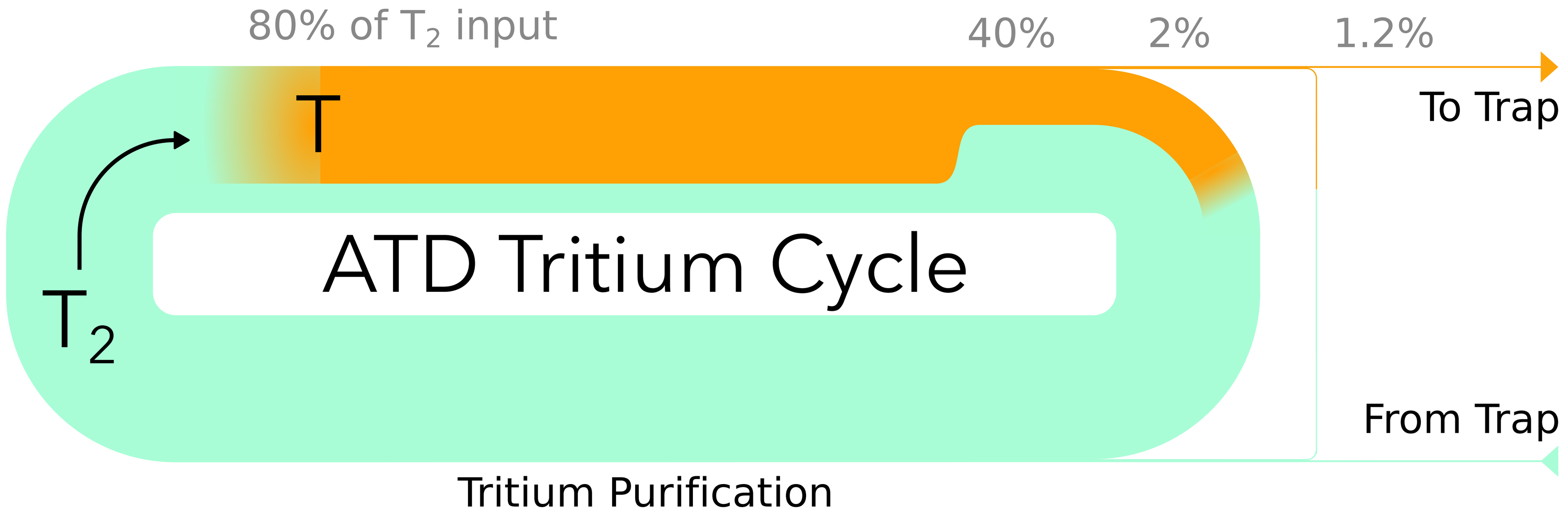
We have produced hydrogen atoms with a thermal cracker. We are taking higher-flow data and planning for tests with tritium.

Measured H/H_2 Ratio



Tritium enters the cracker as T_2 at room temperature, and leaves as mostly T at ~2500 K. We cool it with an accommodator and nozzle, then strip away all T_2 and the hot T before loading the cold T atoms into the trap. The tritium system operates as a closed loop.

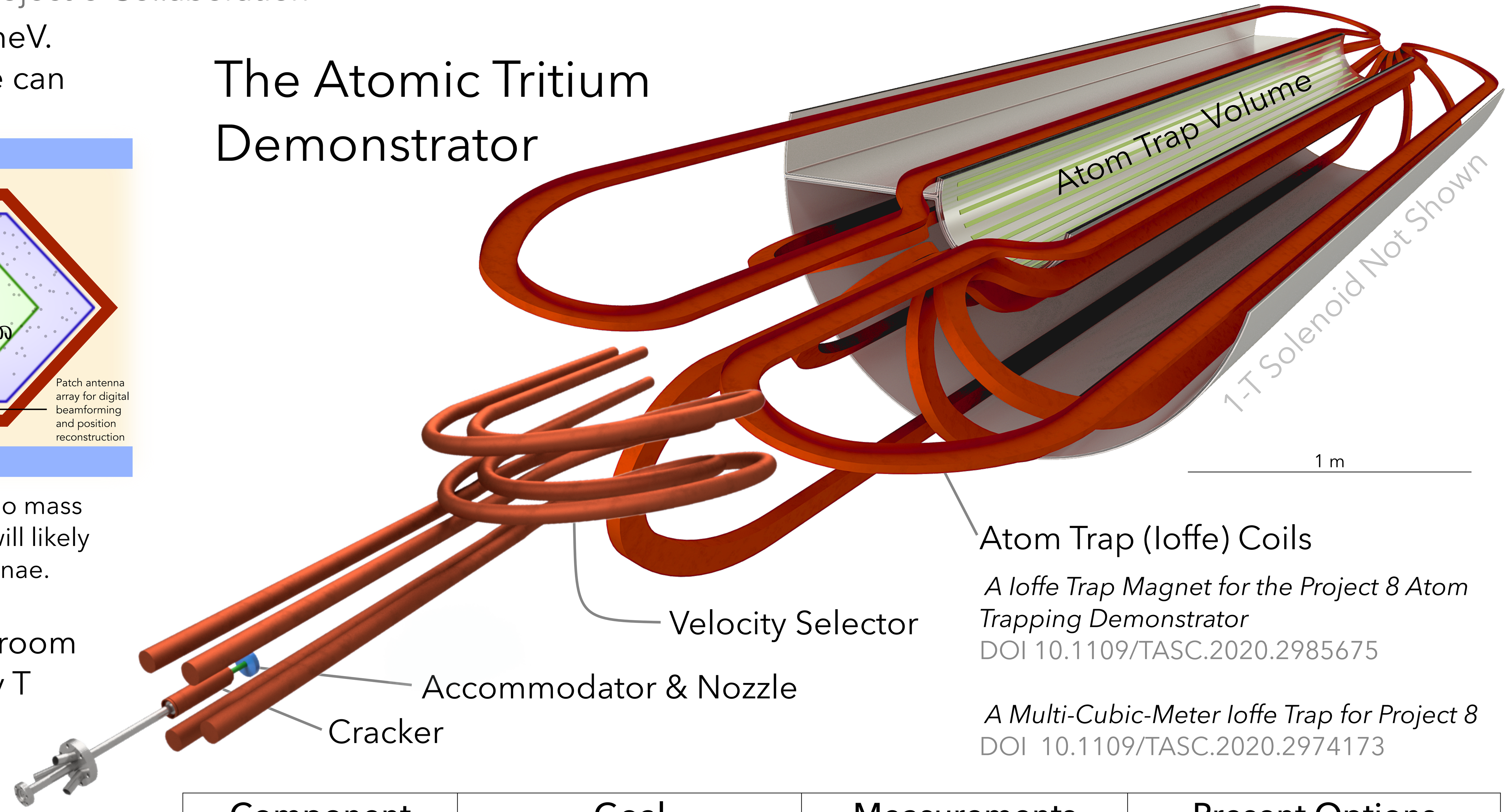




We will instrument the ATD with a variety of probes to confirm that we have met the goals shown in the table above right. Three test stands studying elements of the ATD are shown below right. Design, construction, and operation of the ATD will proceed once we have chosen a baseline technology for each component of the ATD.

When we are satisfied with both major elements of Phase III—the ATD and the Free-Space CRES Demonstrator—we will move on to designing the final Phase IV experiment to reach 40 meV sensitivity.

The Atomic Tritium Demonstrator

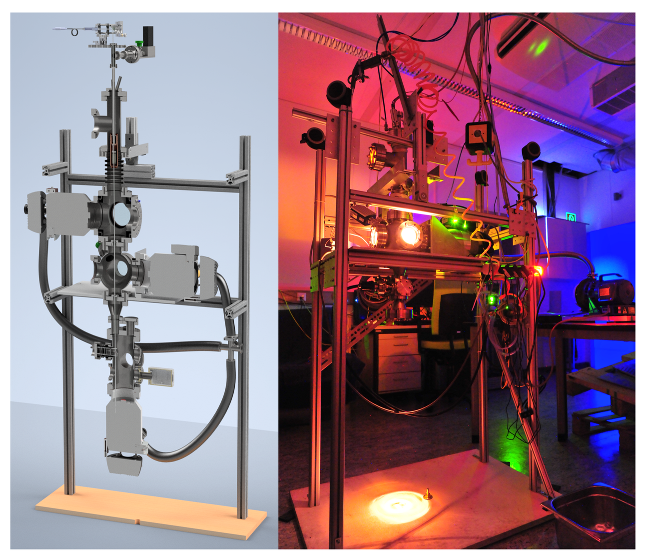


A Ioffe Trap Magnet for the Project 8 Atom Trapping Demonstrator
DOI 10.1109/TASC.2020.2985675

A Multi-Cubic-Meter Ioffe Trap for Project 8
DOI 10.1109/TASC.2020.2974173

Component	Goal	Measurements	Present Options
Cracker	Produce sufficient flux of tritium atoms	Atom flux, atom/molecule ratio	Commercial or coaxial tungsten capillary
Accommodator and nozzle	Minimize atom temperature and recombination	Atom flux, atom/molecule ratio, atom temperature	Aluminum or silica tube and single-scatter nozzle
Velocity and state selector	Transmit all trappable atoms, but no molecules or hot atoms	Atom flux, atom/molecule ratio, atom temperature	Quadrupole or thin-lens magnetic separator
Atom trap	Hold atoms at target density	Trapped-atom lifetime and density	Superconducting Ioffe or permanent-magnet Halbach trap
Tritium recirculation system	Minimize tritium inventory; supply cracker	Tritium purity, flow rate, inventory	Under study

JGU Mainz



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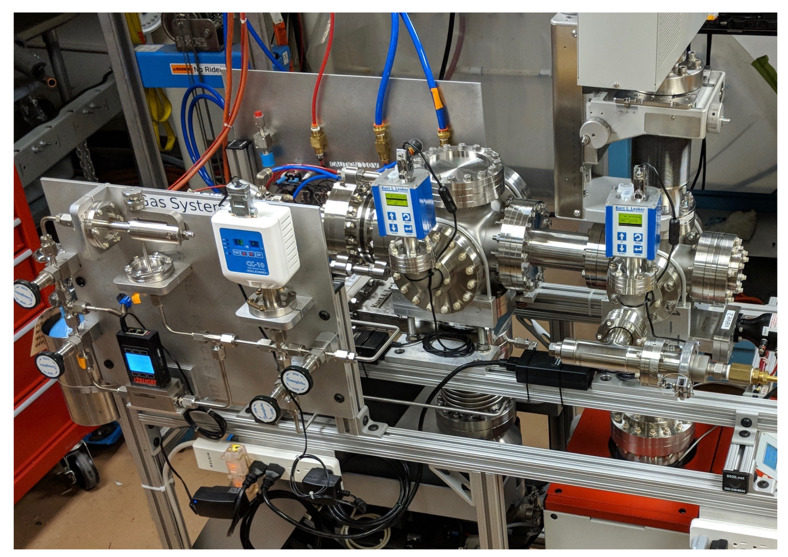

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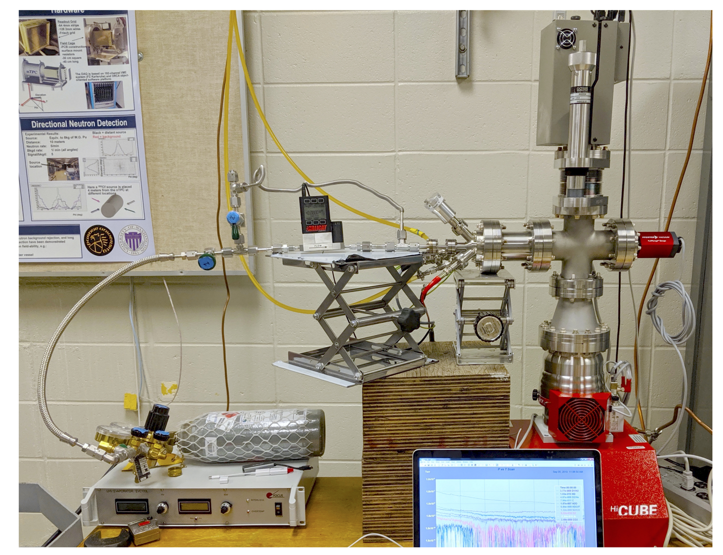

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