Electromagnetic and Particle diagnostics for Transformative Fusion-Energy Concepts

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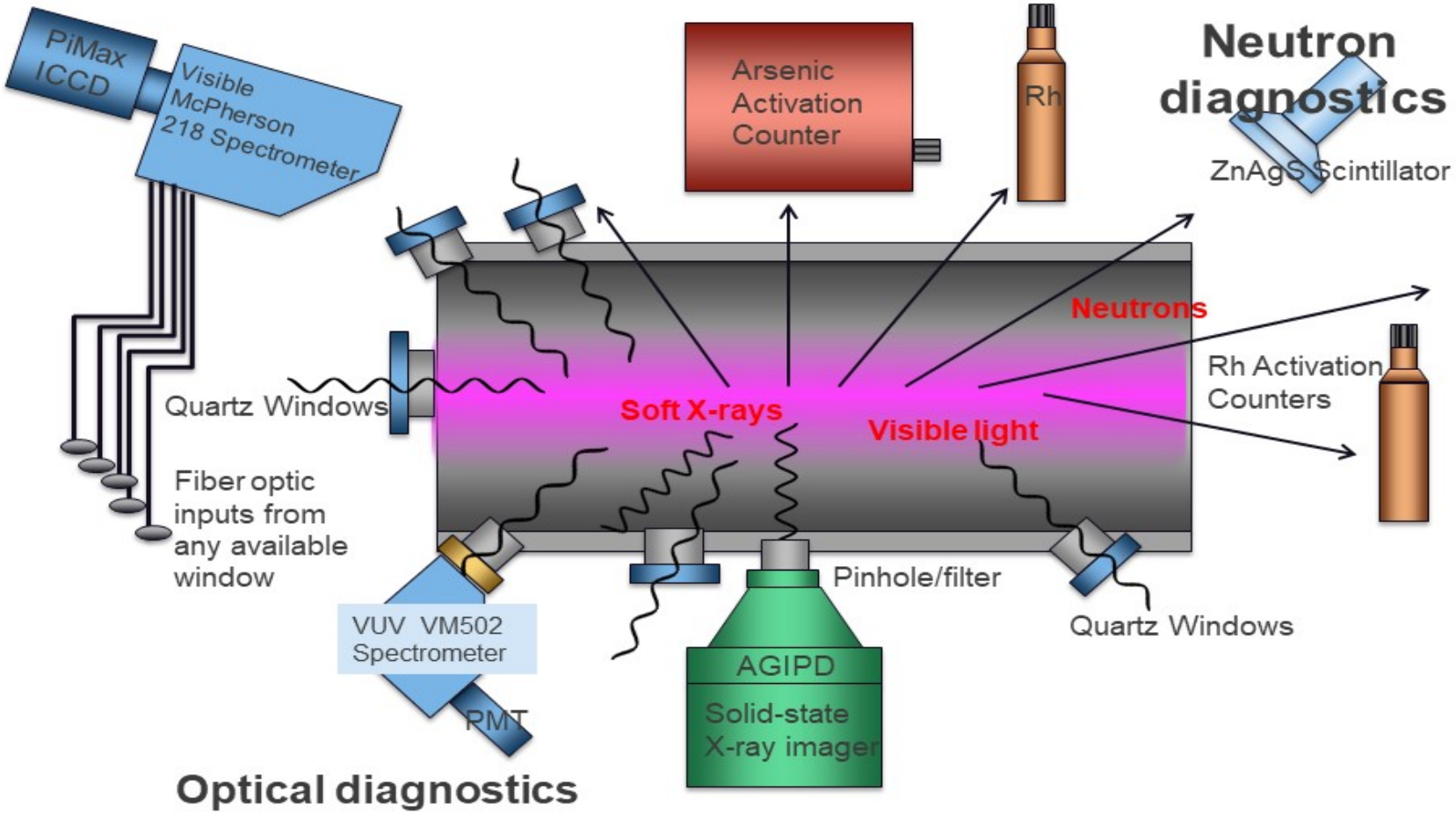
Team members and roles

- Dr. Glen Wurden, LANL PI
- Dr. Jeph Wang, LANL staff
- Dr. Tom Weber, LANL staff
- John Dunn, LANL engineer
- Dr. Joshua Hawke, postdoc
- Prof. Bruno Bauer, UNR co-PI
- Dr. Stephan Fuelling, UNR engineer
- Students

Our initial BETHE proposal included both optical and particle diagnostics *



*Only the optical diagnostics are funded

High-level motivation and goals of the project

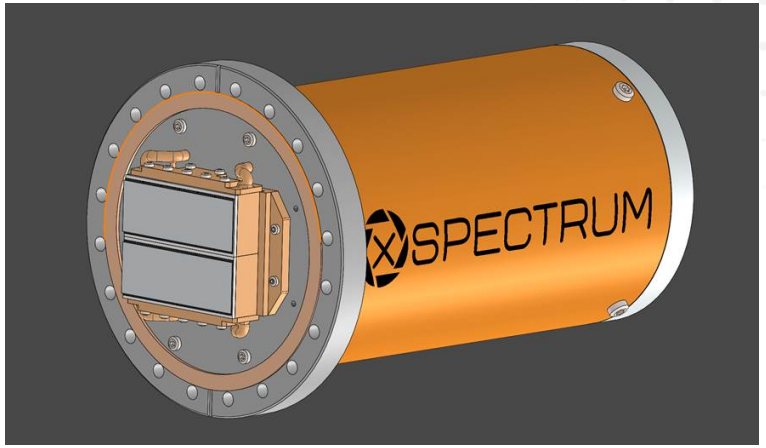
Los Alamos National Laboratory and UNR will provide a suite of proven visible and soft x-ray diagnostics to characterize the performance of a number of lower-cost, potentially transformative fusion-energy concepts.

- LANL will test a German state-of-the-art, solid-state x-ray imager from X-Spectrum, to make soft x-ray movies of the hot plasma core, enabling visualization of the evolution of instabilities.
- Spectral measurements will enable the identification of impurities and their spatial and temporal variation in the plasmas.

- This new18-month Capability Team BETHE project will be on-top of our existing TINA Capability Team effort, bringing two more diagnostics to bear, initially at the ZapEnergy FuZE experiment.
- Note: Particle diagnostics (neutron systems) are not being provided, in this reduced scope project

BETHE Capability Team Major tasks

- We will test a new high-speed solid state “adaptive gain integrating pixel detector” (AGPID) x-ray imager, suitable for multi-frame soft x-ray imaging of all but the shortest duration plasmas. It is capable of taking 352 frames (128x512 pixels) at a rate of 4.5 million frames/second.



- We will make fiber-optically coupled time-resolved impurity measurements using visible spectra at up to 5 simultaneous spatial locations (Model 218 0.3 meter spectrometer with PiMax gated imager), complemented with several PMT based spectrometers.

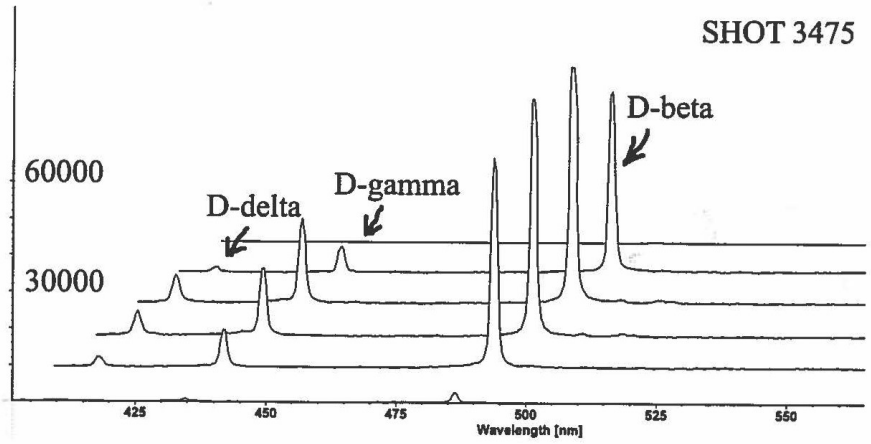


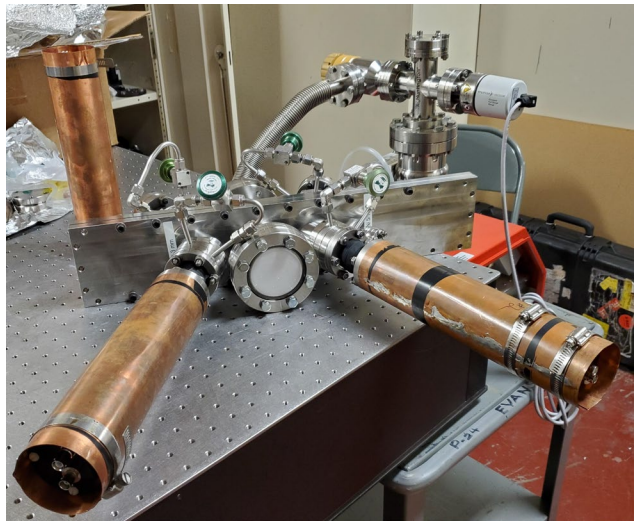
Figure 1: Preionization plasma is clean at early times

Risks

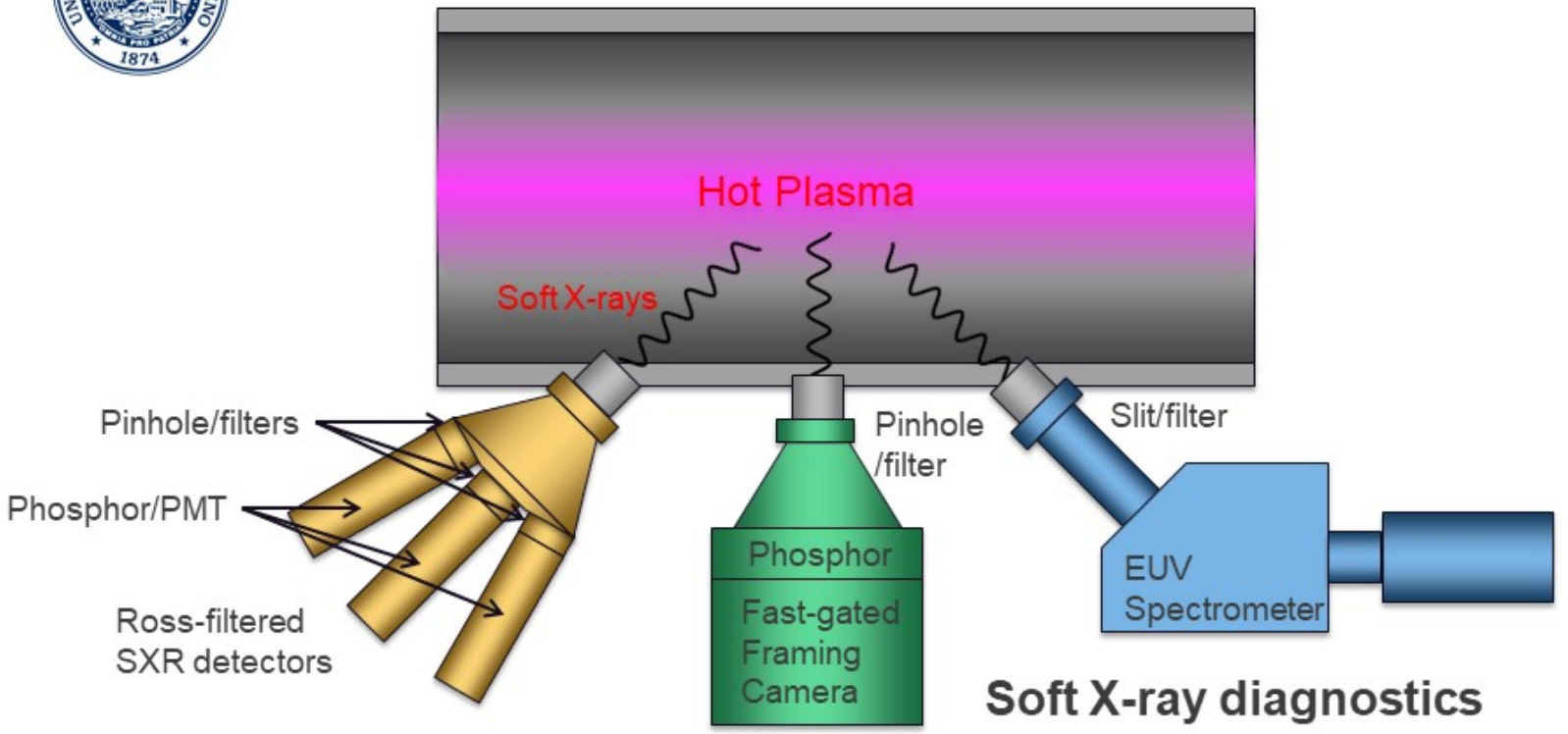
- COVID impact on research and travel is our biggest risk to schedule
- Our plan was to have X-Spectrum bring the new camera to Seattle in early 2021, accompanied by 2 people from the company.
- Now all travel is on hold.

- From a technical point of view, the available (existing right now) x-ray camera is sensitive to x-rays 3 keV and higher. If the target plasma is too cold, there might not be enough signal. A future camera could be fabricated with a thinner dead layer (so that 1 keV lower limit is in principle possible).

Our ARPA-E TINA project is also providing 3 diagnostics



LANL and the University of Nevada, Reno will be providing three soft x-ray diagnostics to one or more ARPA-E transformative fusion facilities, starting with FUZE and ZAP at the University of Washington in 2020. They will provide information on electron temperature, hot spots, and impurity radiation.



Soft X-ray diagnostics