

# Pinned, optically-aligned diagnostic dock for use on the Z facility\*

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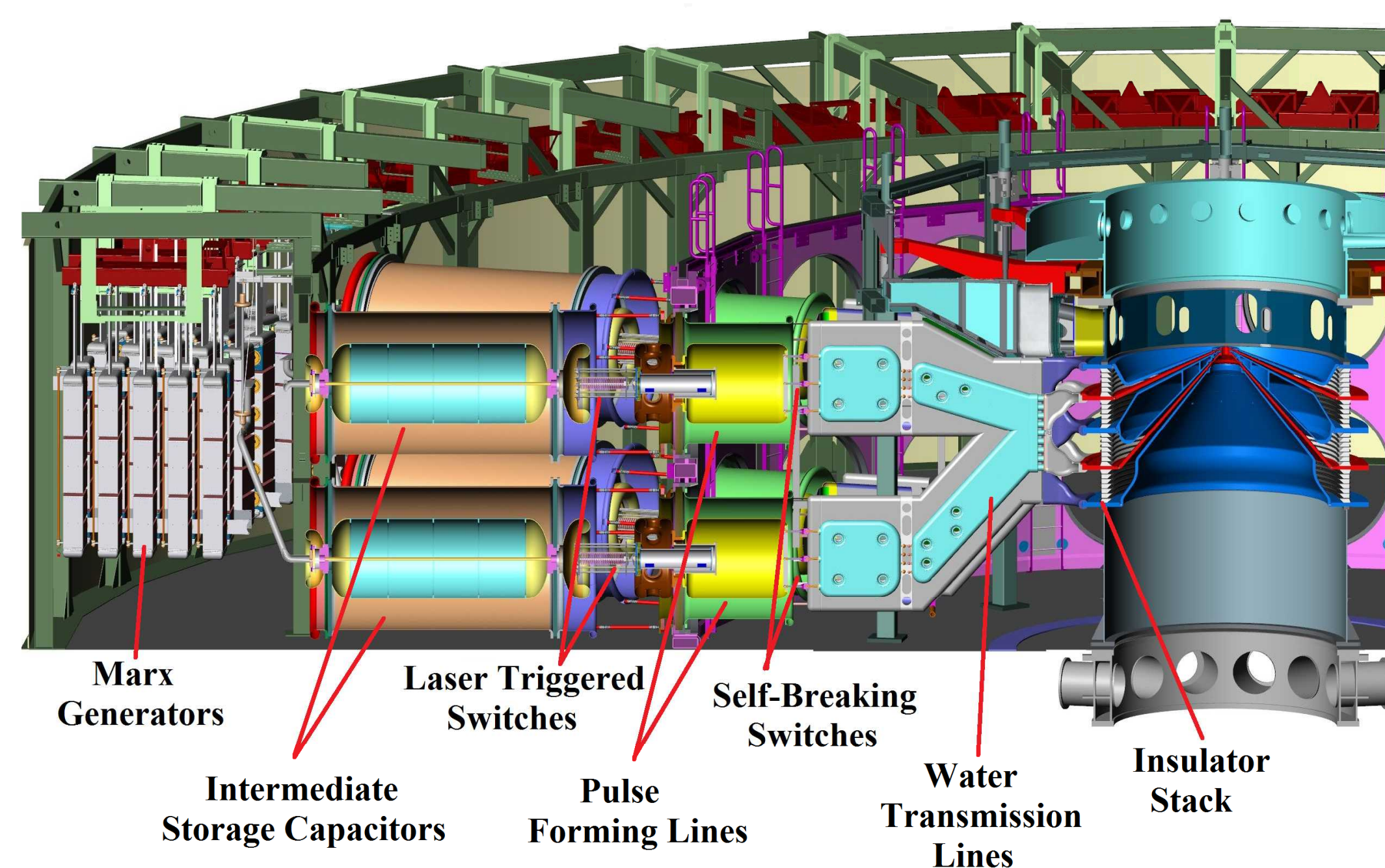
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## Abstract

The Pinned Optically-aligned Diagnostic Dock (PODD) is a multi-configuration diagnostic platform designed to measure x-ray emission on the Z facility. The PODD houses two Plasma Emission Acquisition (PEA) systems, which are aligned with a set of precision machined pins. The PEA systems are modular, allowing a single diagnostic housing to support several different diagnostics. The PEA configurations fielded to date include both time-resolved and time-integrated, 1D spatially resolving, elliptical crystal spectrometers, and time-integrated, 1D spatially resolving, convex crystal spectrometers. Additional proposed configurations include time-resolved, monochromatic mirrored pinhole imagers and arrays of filtered x-ray diodes, diamond photo-conducting diode detectors, and bolometers. The versatility of the PODD system will allow the diagnostic configuration of the Z facility to be changed without significantly adding to the turn-around time of the machine. Additionally, the PODD has been designed to allow instrument setup to be completed completely off-line, leaving only a refined alignment process to be performed just prior to a shot, which is a significant improvement over the instrument the PODD replaces. Example data collected with the PODD are presented.

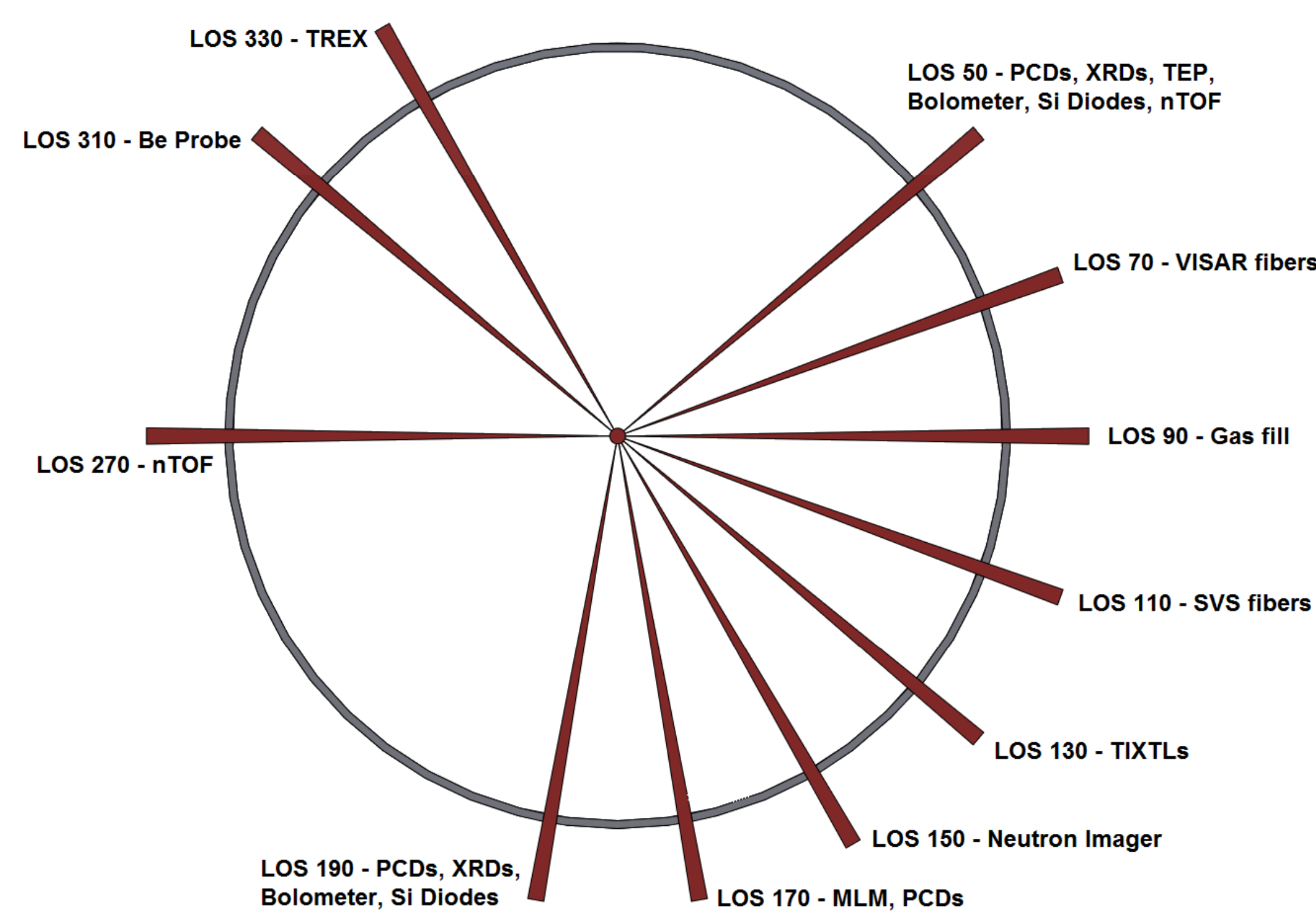
## Z Machine

The Z machine is a 25 MA, 100 ns risetime pulsed power driver used primarily to drive dynamic materials experiments and z-pinch plasma radiation sources. The Z machine radiation pulse is used for several applications including inertial confinement fusion, radiation effects, and laboratory astrophysics.



## Diagnostic Lines of Sight (LOS)

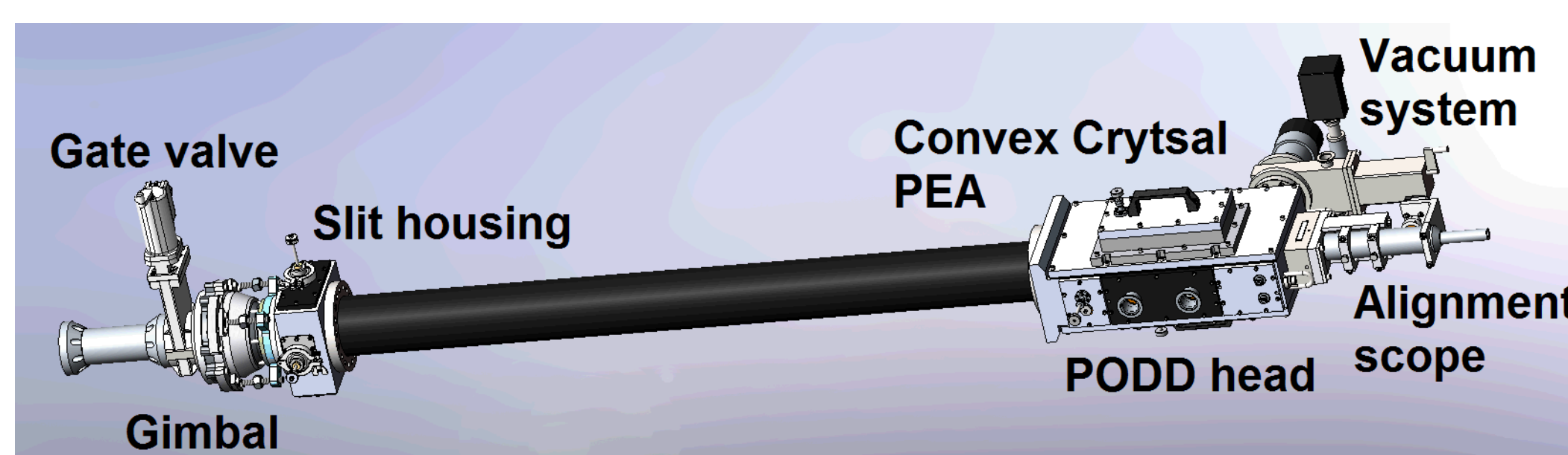
The x-ray intensity as a function of wavelength is of interest to all of these applications, thus x-ray spectroscopy has a large emphasis at the Z facility. The Z facility x-ray diagnostic suite includes instruments that provide information about the timing, location/spatial extent, and/or spectrum of the x-ray source, the ability to measure which may be unique to that diagnostic. Presently, each diagnostic has its own Line-Of-Sight (LOS) at the Z facility.



The Z chamber has diagnostic LOS at 0 degrees, 12 degrees, 81 degrees and 90 degrees from horizontal. The majority of the diagnostics fielded on Z use a 12 degree LOS. The PODD was designed to be compatible with the 12 degree LOS, the 81 degree LOS, and the 90 degree LOS. Plans to replace the TIXTLs at LOS 130 with a PODD are underway. The TREX at LOS 330 and the MLM at LOS 170 are other possible candidates for the PODD to replace.

## Pinned, Optically-aligned Diagnostic Dock (PODD)

The Pinned, Optically-aligned Diagnostic Dock (PODD) was designed to standardize the x-ray diagnostics fielded on Z. Each diagnostic, or Plasma Emission Acquisition system (PEA), can be mounted into the PODD, thus all of the PEAs can be easily interchanged. The PODD has two diagnostic bays, which allow two different instruments to be fielded on the same LOS.

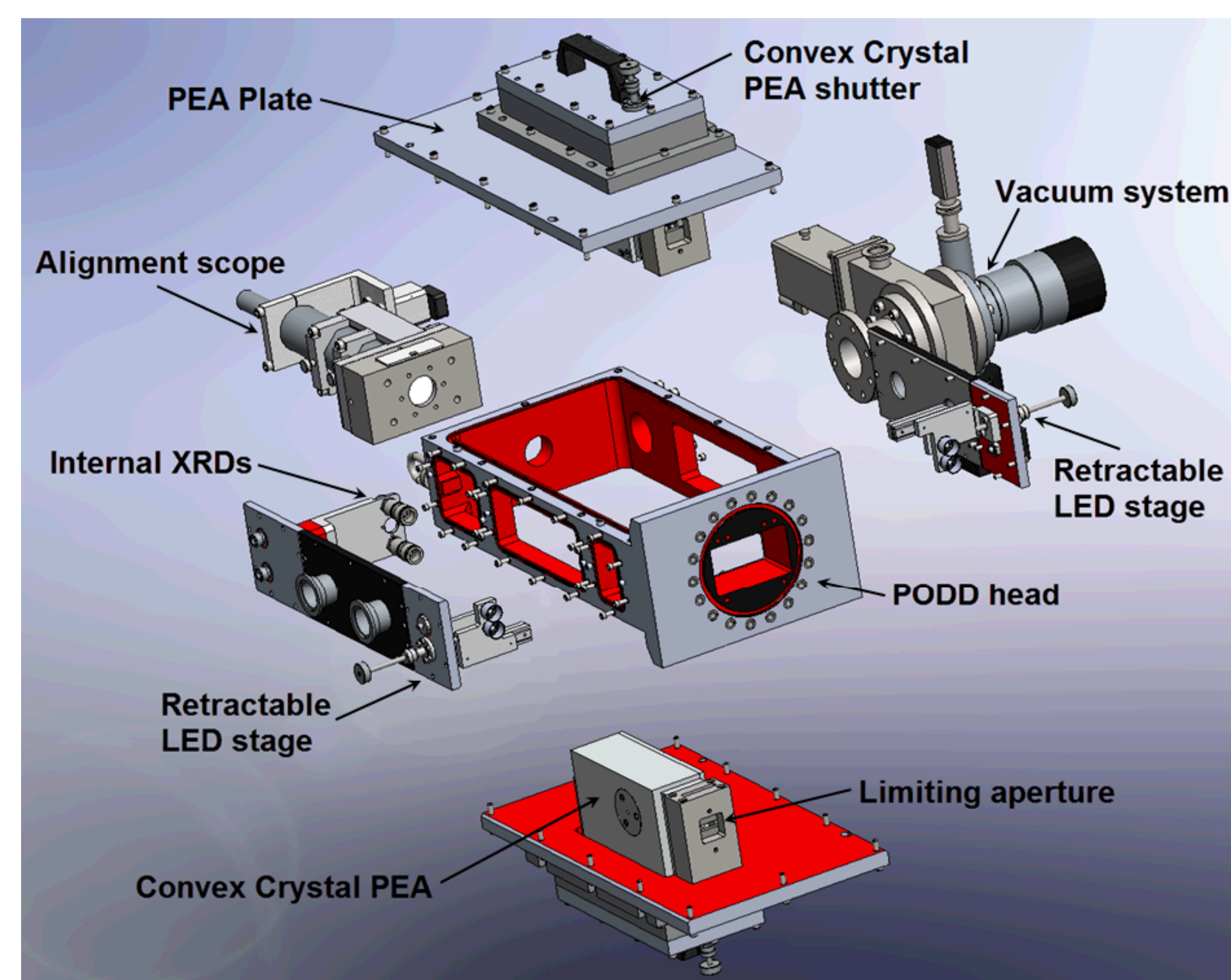


The PODD has been successfully fielded on axis on Z in both the standard axial package configuration and in the Gated Re-entrant Axial PinHole Imaging Camera (GRAPHIC) housing. Plans to field three PODDs on axis are underway.

## Plasma Emission Acquisition (PEA) systems

The PODD head contains the two PEAs, a pair of XRDs, an alignment cross hair, retractable LED stages, and an optical alignment scope. The PEAs are entirely contained on a PEA plate, which mounts to the PODD head.

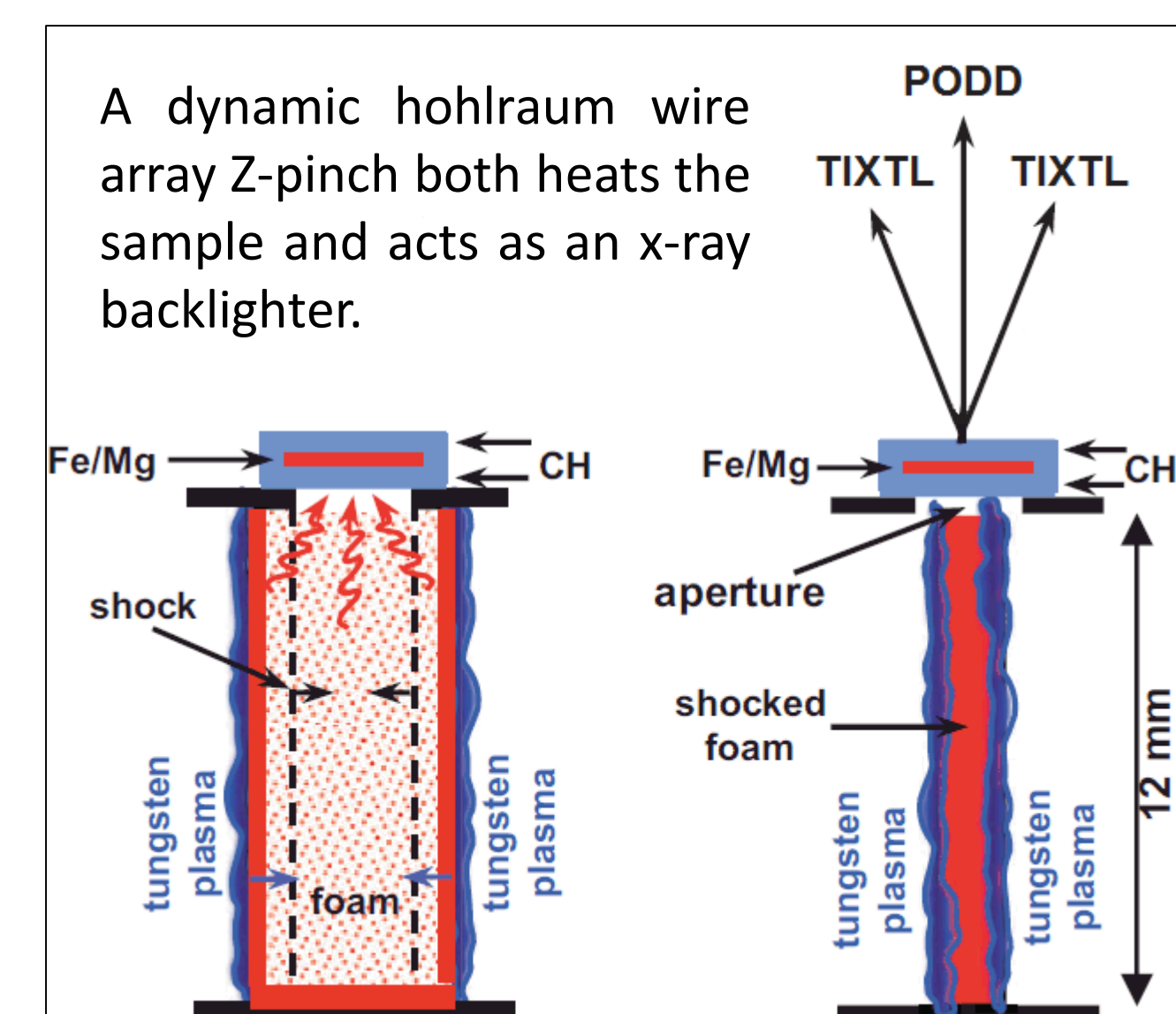
Experiments requiring axial x-ray spectroscopy have driven the development of elliptical crystal and convex crystal PEAs, which have been successfully fielded on Z. Additional proposed configurations include time-resolved, monochromatic mirrored pinhole imagers and arrays of filtered x-ray diodes, diamond photo-conducting diode detectors, and bolometers.



The Convex Crystal PEAs were designed such that 6 spectra could be collected per PEA per shot (a total of 12 spectra per LOS per shot). This is a factor of 3 improvement in data return over the axial TIXTL that the PODD replaced.

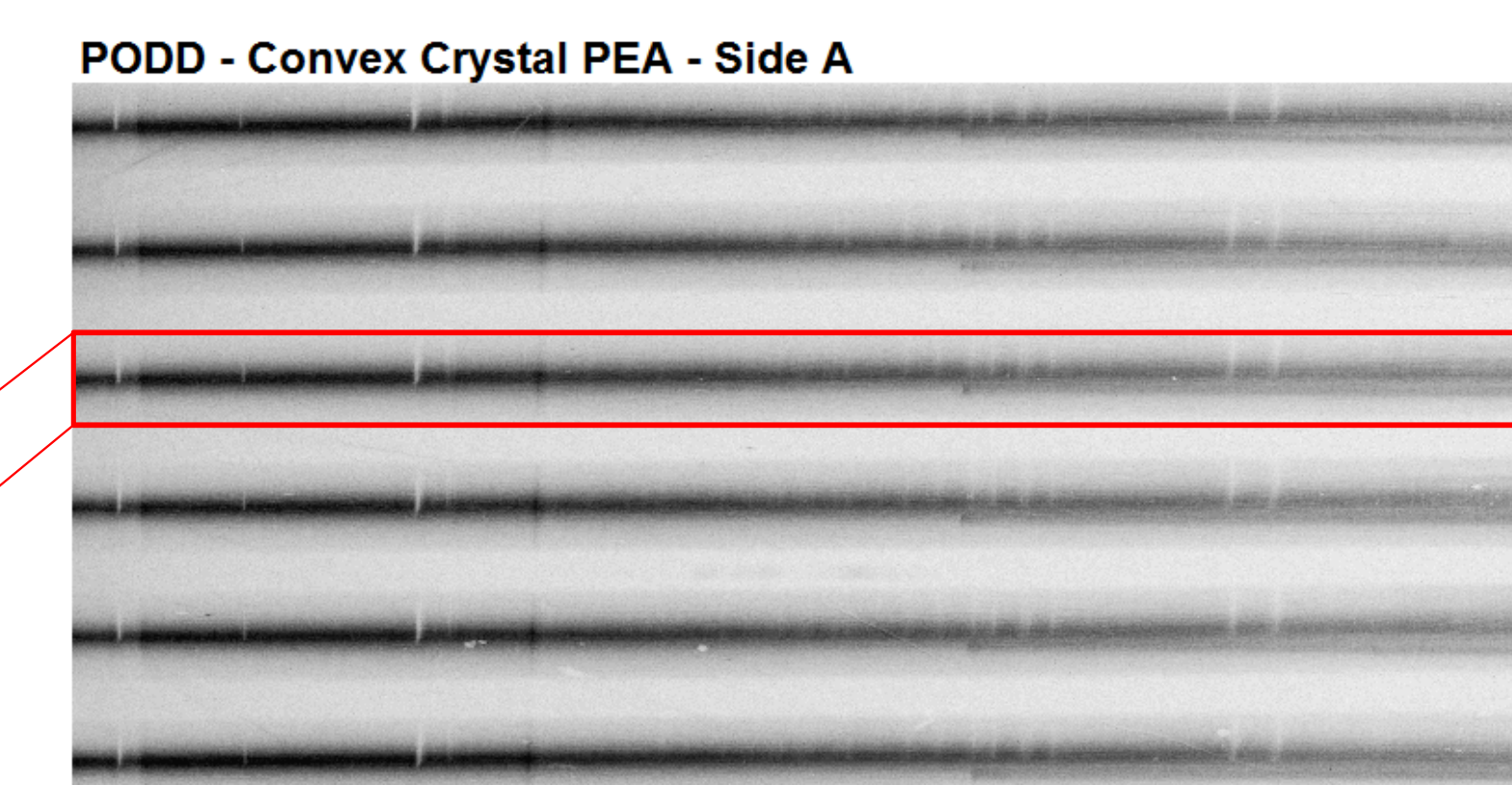
## Sample Data

A dynamic hohlraum wire array Z-pinch both heats the sample and acts as an x-ray backlighter.

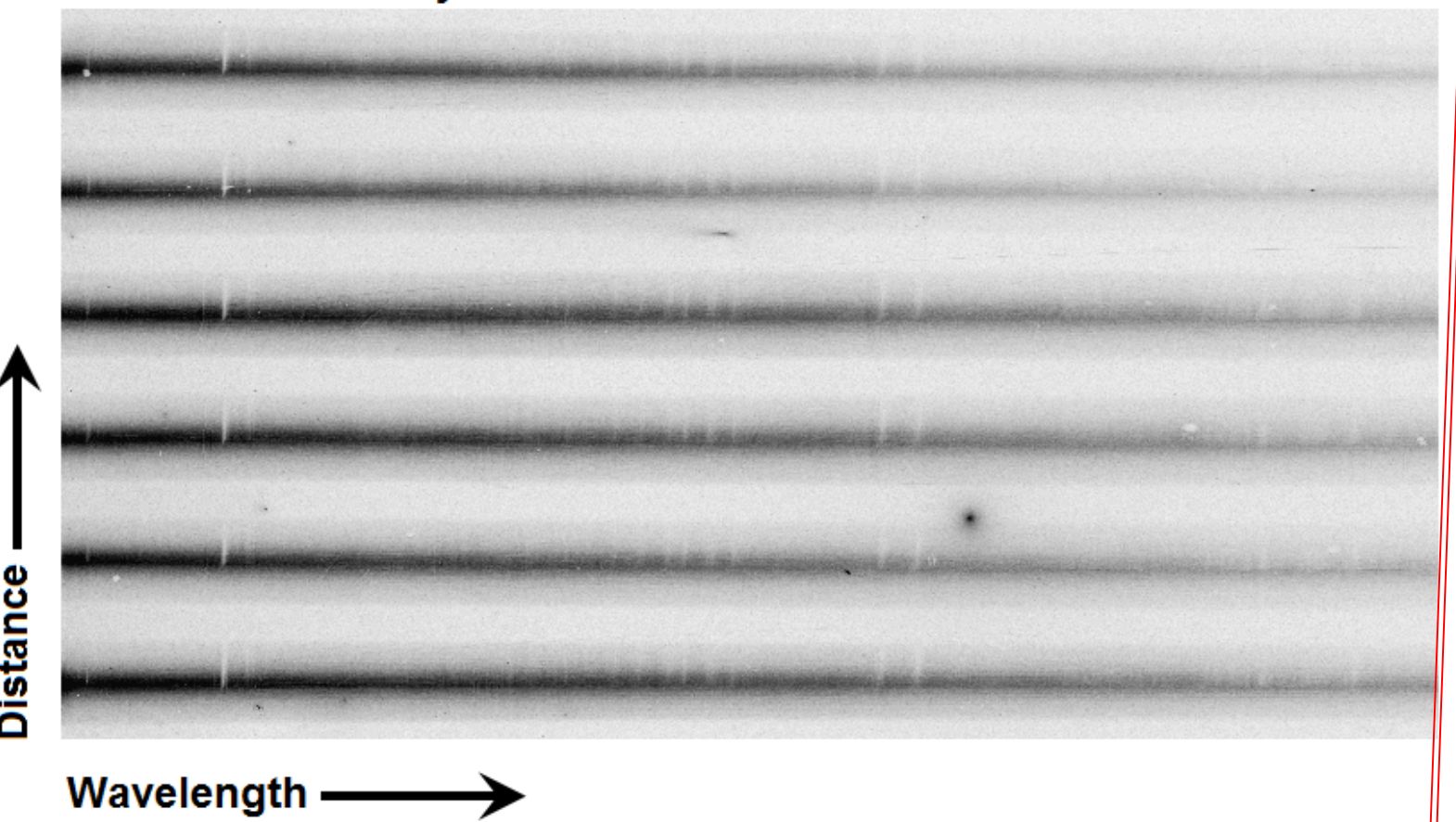


In addition to the greater volume of data, the convex crystal PEA collects better quality data because it can be fielded with a cylindrical crystal with larger radius of curvature than possible with the TIXTL.

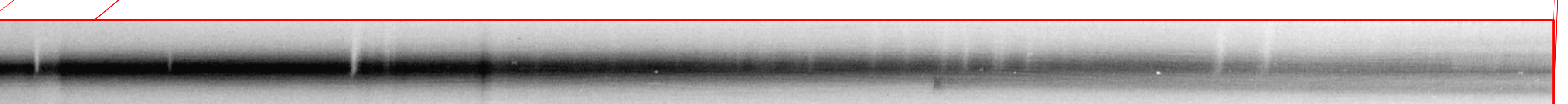
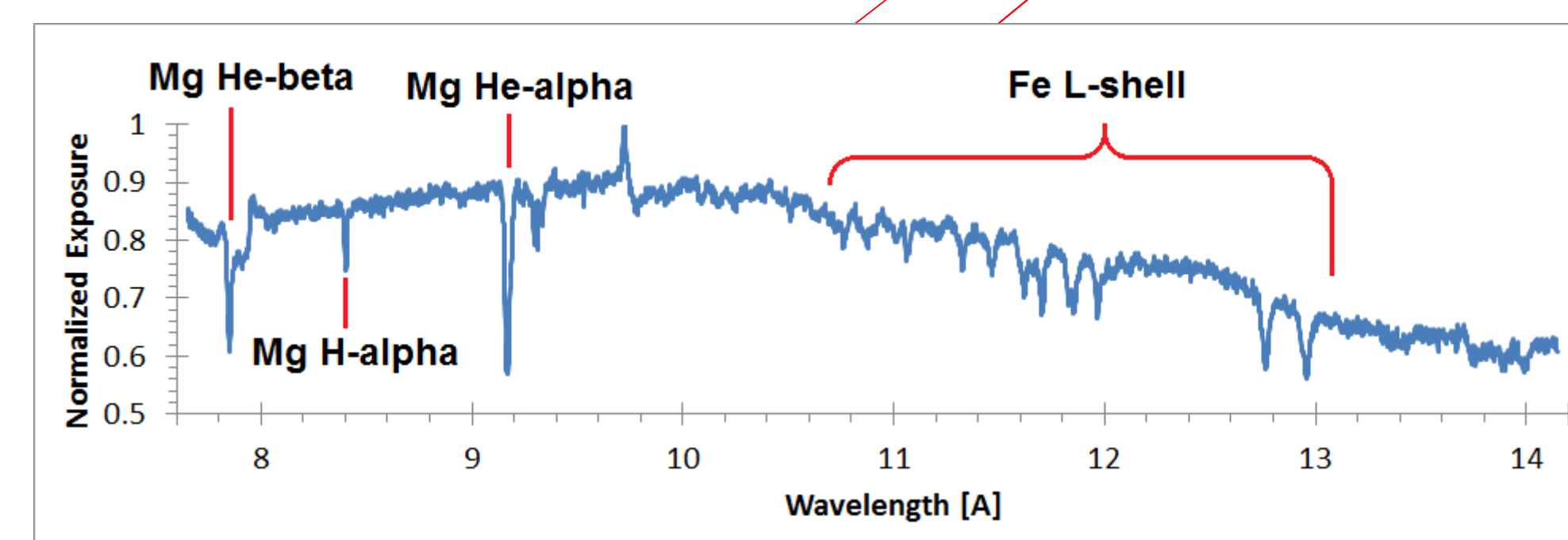
These 12 spectra were collected with the PODD on shot z2301 on a single LOS. In contrast, two LOS utilizing TIXTLs were able to collect a total of 8 spectra on the same shot.



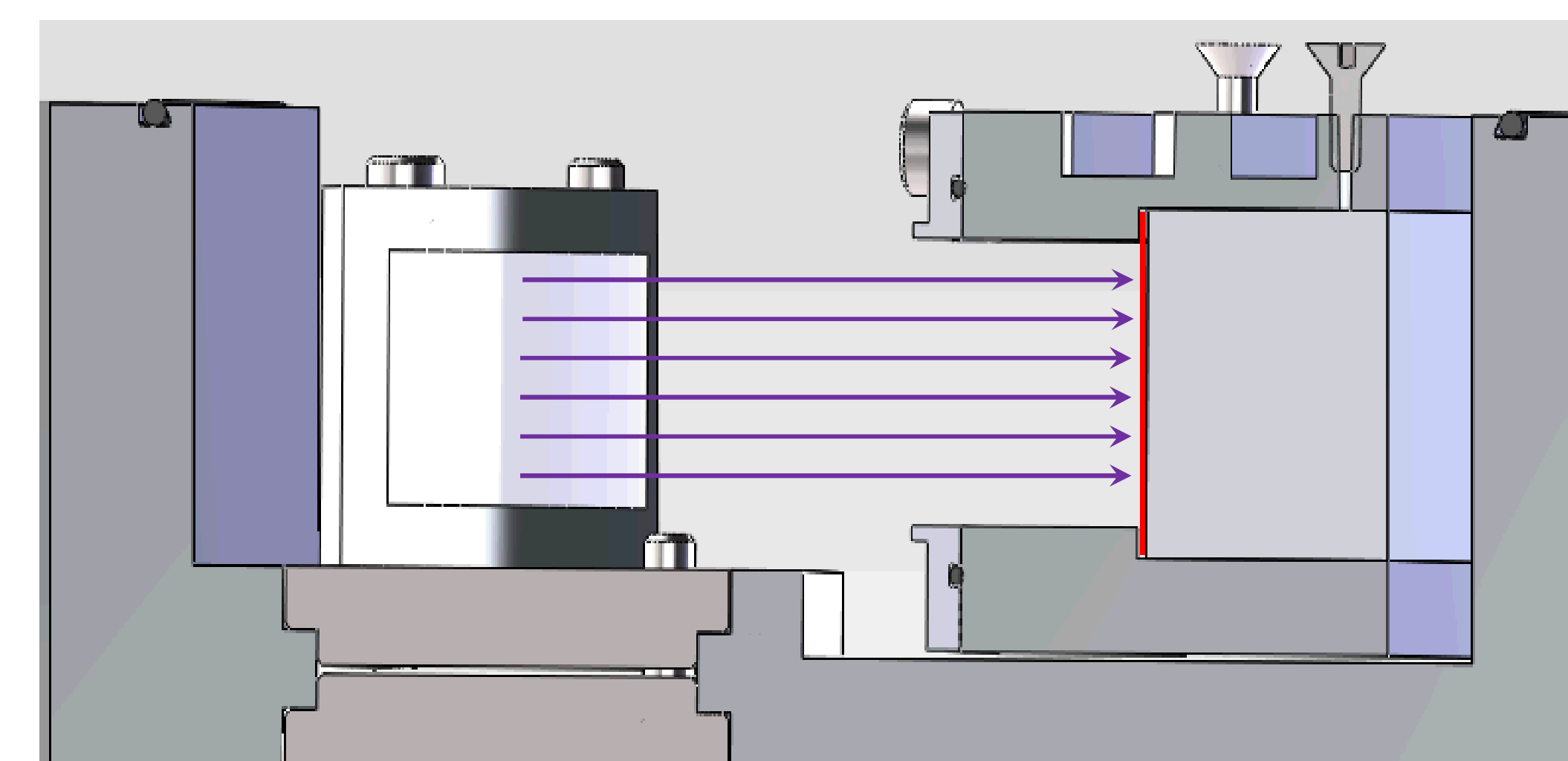
PODD - Convex Crystal PEA - Side B



Typical Plasma Parameters:  
 $T_e \sim 150 \text{ eV}$  and  $N_e \sim 10^{22} \text{ cm}^{-3}$



## PODD Alignment



6 spectra are imaged onto the film

Film is partially obscured by the film holder

The alignment reproducibility of the PODD was determined by comparing the location of the peak intensity of the 1<sup>st</sup> spectrum relative to the shadow cast by the film holder. The value was determined from the data collected with PODD A over a series of 10 shots. The average distance from the edge of the film holder to the center of the first spectrum was 3.8 mm +/- 0.2 mm.

