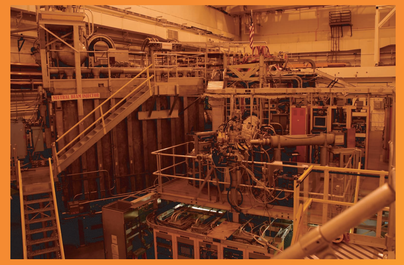
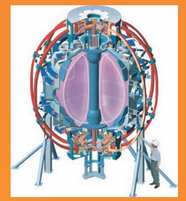
LoWEUS, the Long Wavelength Extreme Ultraviolet Spectrometer, on the NSTX tokamak

J. K. Lepson[a], P. Beiersdorfer[a,b], M. Bitter[c], L. Roquemore[c], G. Zimmer[c]

[a] Space Sciences Laboratory, University of California, Berkeley CA 94720
[b] Lawrence Livermore National Laboratory, Livermore CA 94550
[c] Princeton Plasma Physics Laboratory, Princeton, NJ 08543
lepson@ssl.berkeley.edu





OVERVIEW

LoWEUS (pronounced "Lois" or "Lowe-us") is the Long Wavelength Extreme Ultraviolet Spectrometer from Lawrence LIvermore National Laboratory, which was installed on the National Spherical Torus Experiment in spring 2008. LoWEUS is designed to provide broad-band coverage of the extreme ultraviolet spectrum, and covers approximately a 150-170 Å spread. Its range can be set to as low as 25 Å and as high as 400 Å. It is thus complementary to the XEUS and SPRED spectrometers. LoWEUS also has considerably "cleaner" images than XEUS because the latter is subject to large amounts of hard x rays from the adjacent neutral beam injector, while LoWEUS is shielded by NSTX itself. Although operation of LoWEUS for the 2008 run was cut short by a valve problem on NSTX before we were able to get the instrument fully focused, it still enabled a survey of intrinsic impurities in the NSTX plasma.

LoWEUS was designed and built at LLNL and is based on the XEUS spectrometer at NSTX, which covers the 10-60 Å range, and which was used for laboratory astrophysics at the Livermore electron beam ion traps EBIT-II and SuperEBIT before being moved to Princeton. Because the NSTX plasma has an electron density approximately 2 orders of magnitude greater than EBIT plasmas, LoWEUS provides an important complement to the EBIT laboratory astrophysics program.

The spectral range covered by LoWEUS encompasses a number of emission lines from ions that are diagnostically important for plasma conditions inside NSTX, as well as for laboratory astrophysics. The strong line of hydrogenic lithium at 135 Å is of particular interest for NSTX diagnostics, especially relative to other impurities, notably oxygen and carbon. Emission lines of iron, particularly the Fe L-shell 2->2 transitions in the 88-135 Å region and the Fe M-shell 3->3 transitions in the 170-220 Å region, are important density diagnostics for solar and stellar astrophysics. Other important diagnostic lines include the O IV-VI group at 170 210 Å (see poster TP6:00094 by Penka Wilcox et al.) and C III and C IV in the 250 - 400 Å range.

Fig. 1) CCD image from LoWEUS, showing the region of interest and large number of lines, including very strong O and Fe.
Shot 129583, 03 June 2008

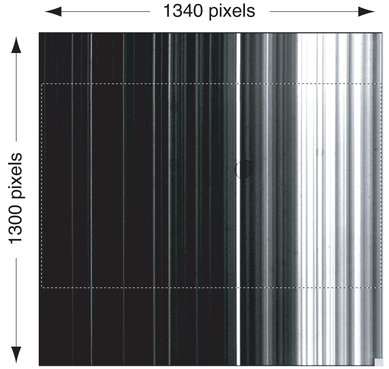


Fig. 1a) Spectrum from the above image.
Shot 129583, 03 June 2008

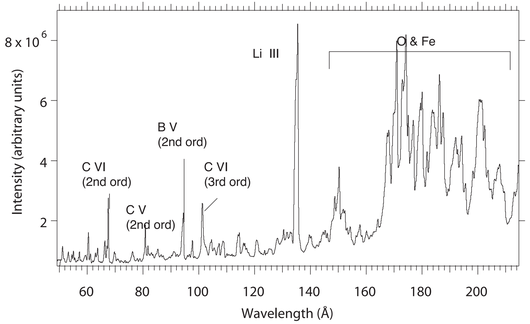


Fig 2a) Spectrum from the sum of shots 129339 - 129349, 21 May 2008. Moderate amounts of oxygen and iron are visible.

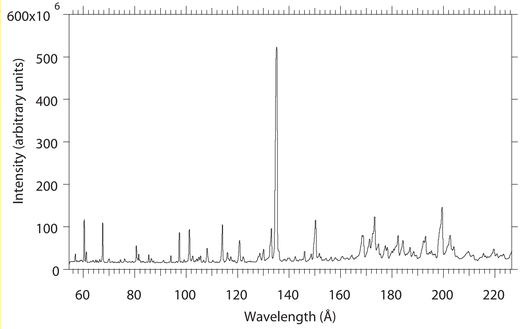


Fig. 2b) Inset of above spectrum with impurities identified.

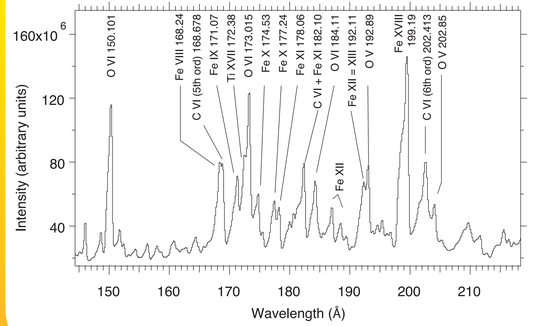
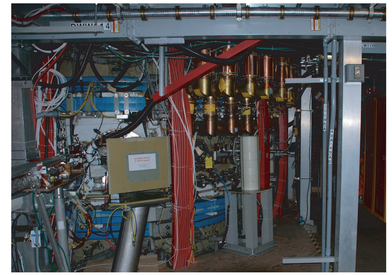


Fig. 3) Location of LoWEUS port on NSTX. LoWEUS is currently undergoing calibration and focusing at LLNL and will be re-installed in NSTX for the 2009 run.



Specifications:

Variable spacing grating spectrometer, mean 1200 lines/mm, 3º blaze angle

LN_2 cooled, 1340 x 1300 pixel CCD chip, ~1 cm^2

Functional range 25 - 400 Å; ~150 Å spread

Line width ~.3 Å FWHM;
Resolving power ~200 at 60 Å to ~500 at 150 Å

Automated camera operation and remote control capability