Summary of high-resolution Littrow data analysis

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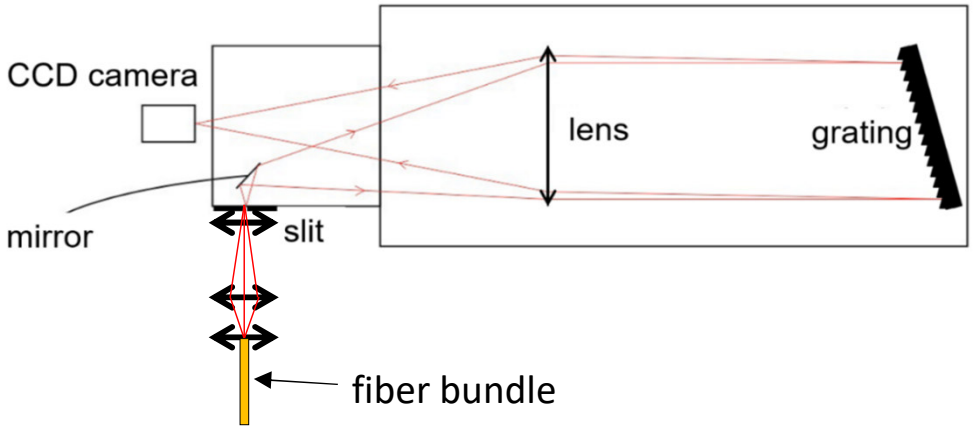
Littrow spectrometer for Balmer-α lines ratio measurement

Spectrometer set-up

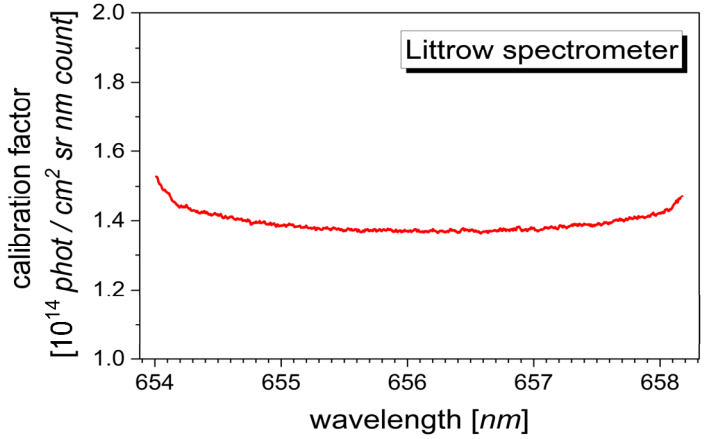


Spectrometer parameters

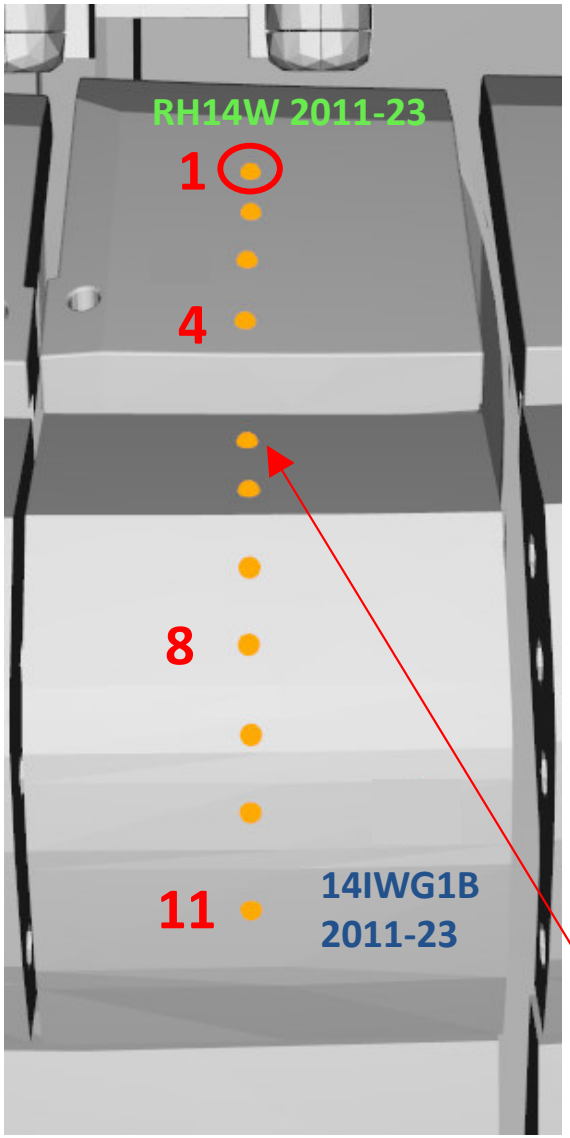
- Focal length 750 *mm*
- Aperture ratio f/5.8
- Grating 1200 *l/mm*, 165x135 mm^2, blaze angle 57.22°
- Dispersion 0.685 *nm/mm* in 2nd order
- Slit 100 *μm* (width) x 10 *mm* (hight)
- Resolving power of 17900 at λ= 656 *nm*
- Line fiber bundle for slit side 46 fibers (∅100 *μm* + 10 *μm* (cladding))
- Etendue 2.4 10^{-4} cm^2 *srad*
- Andor iStar CCD (DH334T-18F-A3) cooled intensified gated camera, 30% < QE <40% at λ= 600 - 700 *nm*, 1024x1024 pix, 16bit, gating down to <5 *ns*

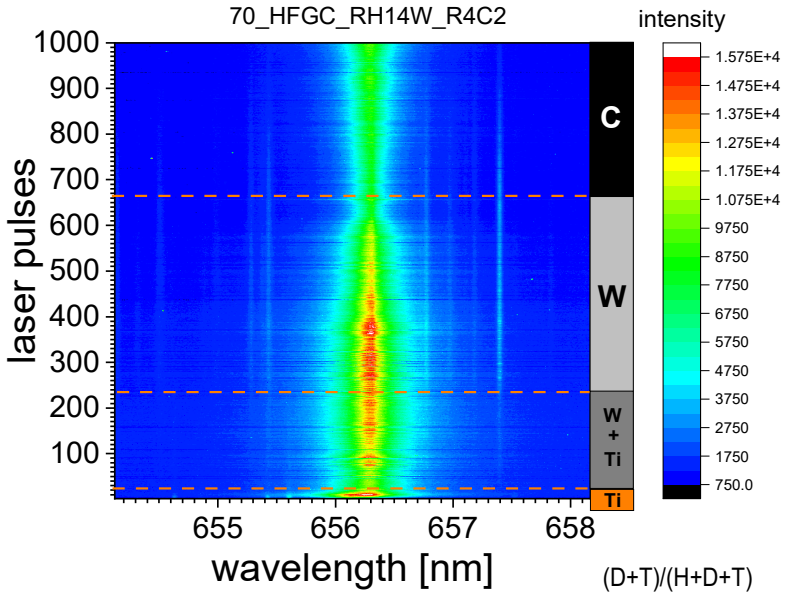
Spectrometer calibration

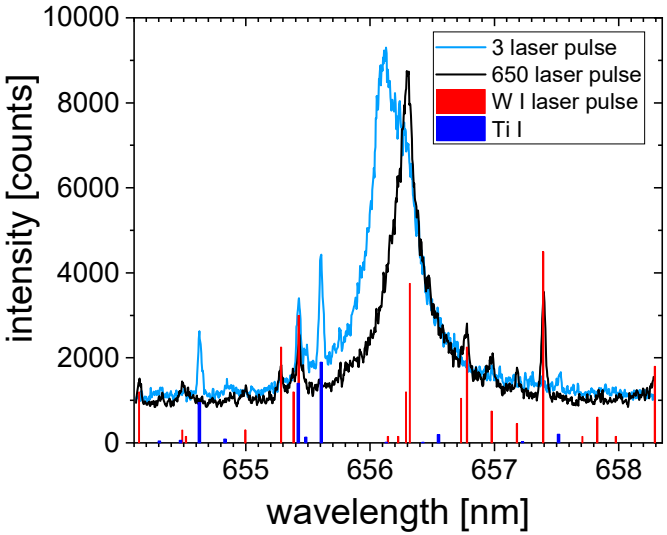
- Wavelength calibration was performed with H_2/D_2 spectral lamp
- Absolute spectral sensitivity in 654-658 nm range was measured by calibrating integrating sphere placed in front of the LIBS tool cone
- Sensitivity curve produce by this calibration procedure is divided by calculated light collection efficiency of LIBS tool optics for 1 *mm* plasma size

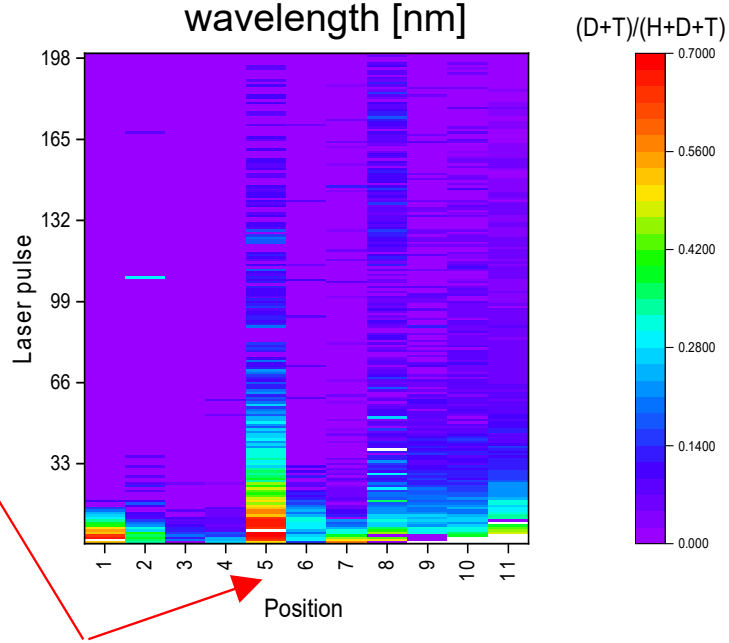


Littrow spectral data





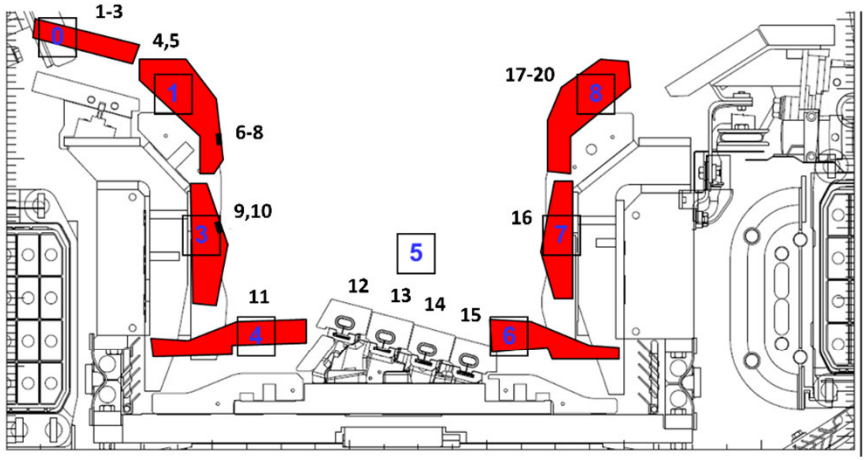




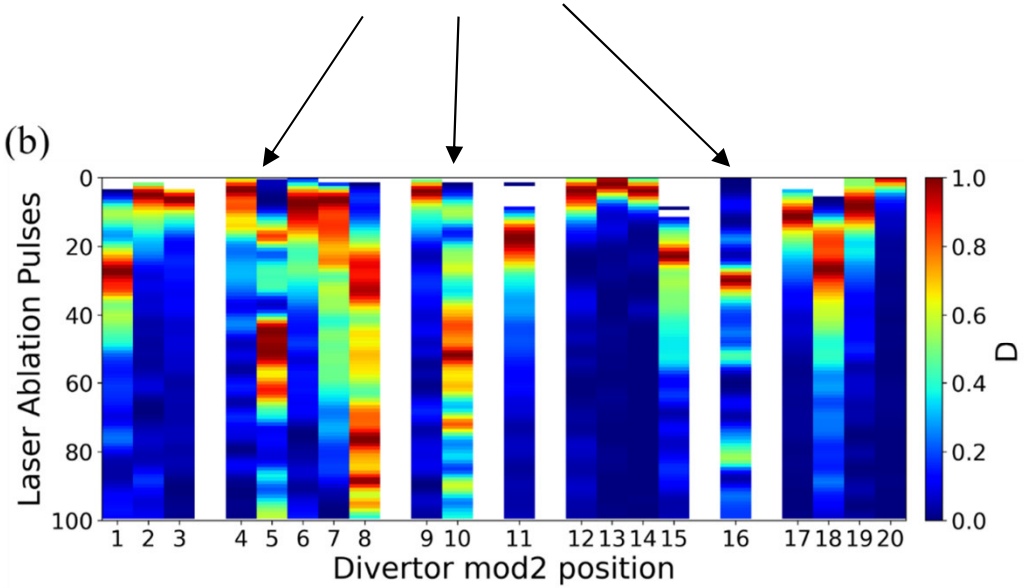
Highest D/H+D ratio

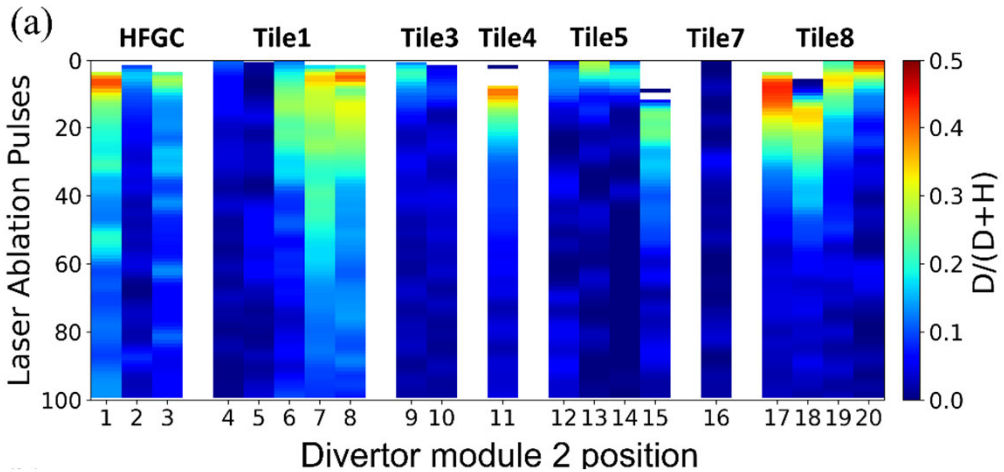
- Voigt fitting function (fixed Gaussian width, Lorentz width shared by H/D/T lines)
- Wavelength 6 pixels deviation
- No fixed initial value for Hα position
- W I line interference make it difficult to find the accurate wavelength for Hα

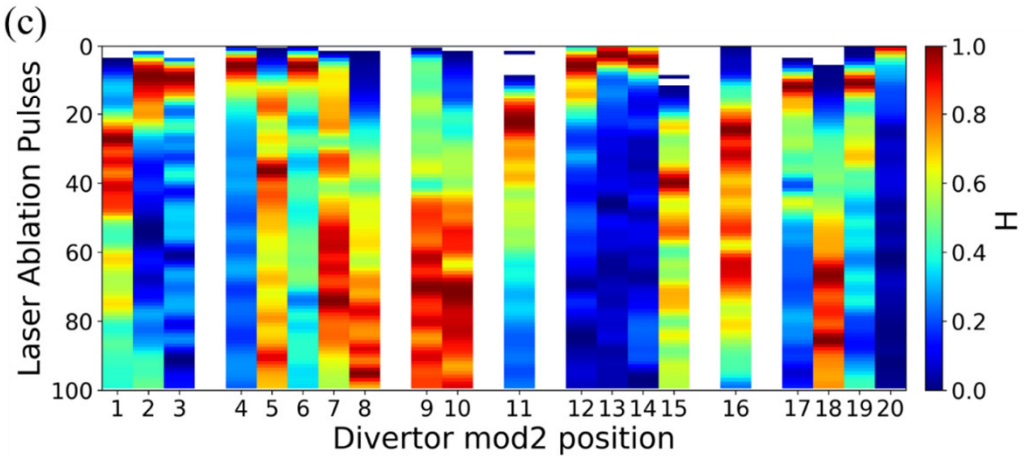
Fuel retention in module 2 divertor(poloidal from HFGC-Tile8)



Too weak D







Improvement of fitting formulae for Balmer-α line

Single Lorentz fit with shift:

$$f(\lambda) = y_0 + \frac{2A_0}{\pi}\,\frac{w_{FWHM}}{4\,(\lambda-\lambda_w)^2+(w_{FWHM})^2}$$

$$\lambda_w = \lambda_0 + a\,(w_{FWHM})^{3/2} \qquad \lambda_0 = 656.2714\ nm \qquad a = 0.05877\ nm^{-\frac{1}{2}}$$

Double Lorentz fit with shift:

$$f(\lambda) = y_0 + \frac{2\,A_0}{\pi}\left(\frac{w\,C}{4\,(\lambda-\lambda_0-a\,w^{3/2})^2+w^2} + \frac{k\,w\,(1-C)}{4\,(\lambda-\lambda_0-a\,(k\,w)^{3/2})^2+(k\,w)^2}\right)$$

$$0 < y_0 \qquad 0 < A_0 \qquad 0 < w \qquad 0 < k < 1 \qquad 0 < C < 1$$

Tile 1 RH14W 2011-23 laser crater 1