Gaussian process regression for density profile reconstruction from interferometry and reflectometry measurements

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Gaussian process regression for density profile reconstruction from interferometry and reflectometry measurements

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INTRODUCTION

Objective:

- development of the WEST data pre-processing tool using Bayesian methods for fitting the density profiles.
- Complete reconstruction of density profiles using interferometry and reflectometer measurements.
- Study the L-H transitions in the shot for a better understanding of physics behind pedestal

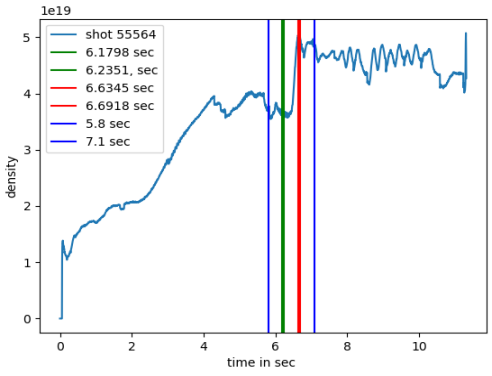
Summary:

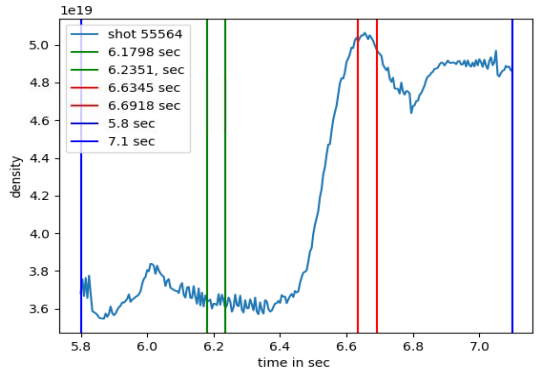
- Development of a user friendly function that deals with most profiles
- Fitting and saving for n_e from mixing btw reflectometer and interferometer
- Possible L-H transition was observed in the shot 55564 and the formation of the pedestal is shown

Fitting Procedure

Reference Data

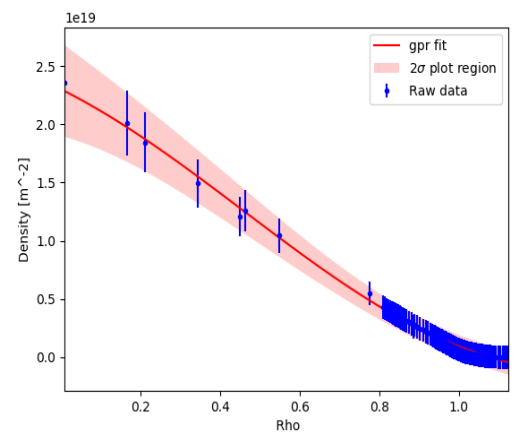
- To validate the Fitting procedure, several shots were taken to study the L-H transition and n_e density profile
- Two different diagnostics are considered to have the complete reconstruction of the density profile
- We assign an 10% uncertainty on the density with a minimum of 5*10^17 and 10% of radial uncertainty
- Time window [5.8, 7.2] to study the L-H transition and pedestal formation with L-transition around 6.2s and H-transition around 6.65s

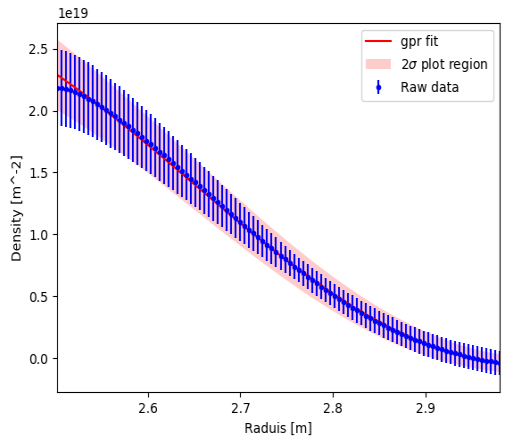




Date Preparation :

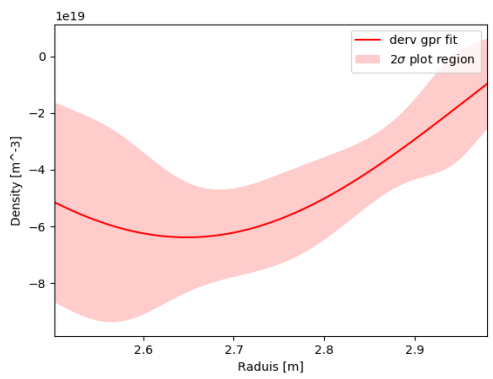
- The reconstruction routine is based on the Gaussian process regression (GPR1D) techniques(2)
- Data are taken from LOS, then interpolated to equilibrium time reference
- Rho is evaluated at the mid plane where each local point represent the integrated density measured by the LOS crossing the plasma
- Measurements from reflectometer are integrated and added to Interferometry measurements.
- Data are mapped from rho to meters, with rho evaluated at mid plane, because GPR1D evaluates the gradient
- grad(n_e) is now the input of final fit function, that will give the derivative of the data along R
- Derivative from the previous step is taken and mapped back in Rho and then the reflectometer measurement are added.

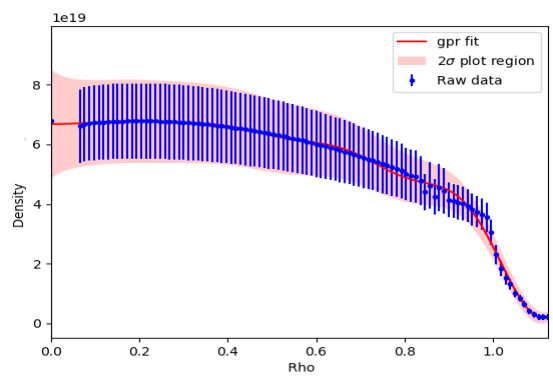




(2) A. Ho et al 2019 Nucl. Fusion 59 056007

Fitting Data Procedure

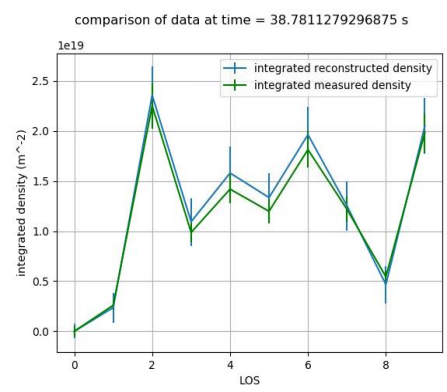




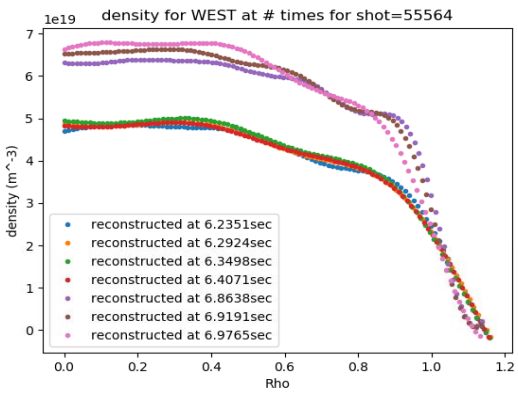
- An artificial point was added at zero to constraint the fit, The final step was to input the derivative profiles to the fit function and have the outputs
- Final data fit interferometer + reflectometer profiles are plotted and then saved for WEST

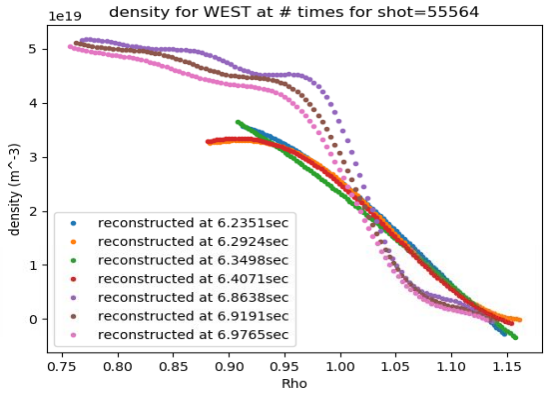
Crosscheck and Validation:

- reconstructed interferometer profiles versus the real profile taken from LOS, with the error bars.
- Under estimation of the density at the edge and over-estimate it the core, and this is under investigation
- measured data are within the reconstructed density error bars.



L-H transition:





- The output profiles are saved to edge profiles and interferometer with higher occurrence.
- Presentation of the evolution of Formation of the pedestal near the edge for shot 55564 between 5.8&7.1 sec
- Formation of a pedestal, associated with a significant increase in central density

CONCLUSION

- Developed function that fits profiles based on GPR1D method
- Tested on different profiles and is promising for future tasks
- User friendly function that deals with most profiles
- Fit and save for n_e from a combination of reflectometer and interferometer experimental data