Experiments on ECWs Scattering

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Main purposes

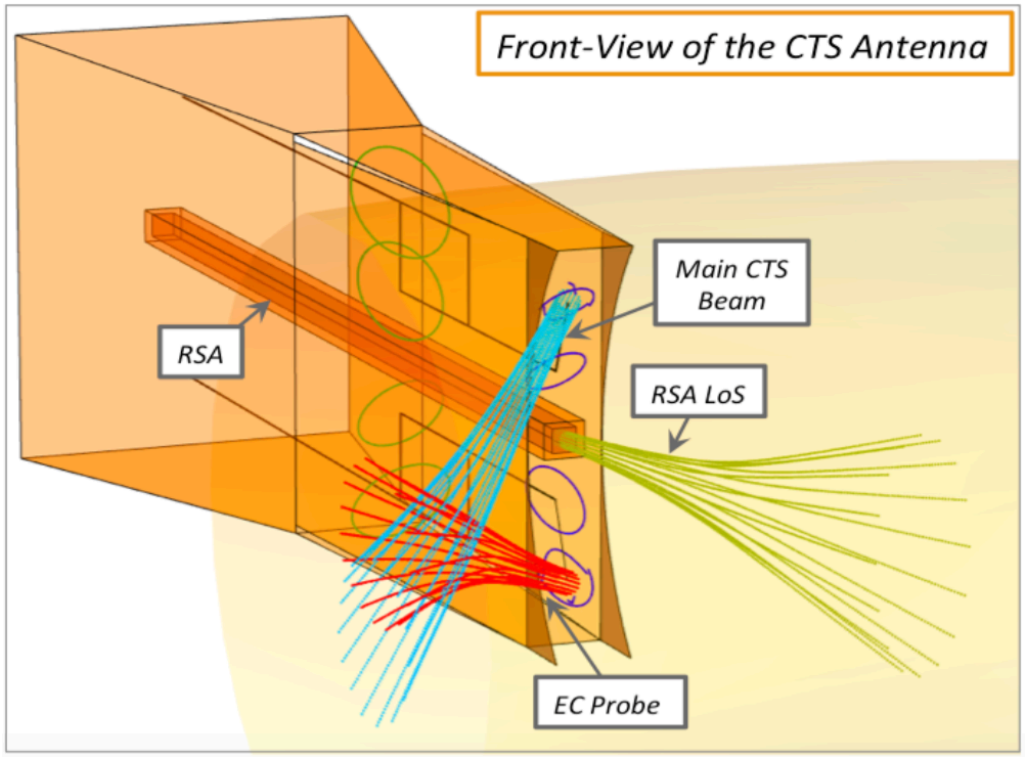
1- **Demonstrate the recently envisaged low power threshold Parametric Decay Instabilities of EC waves at non-monotonous density profile locations**

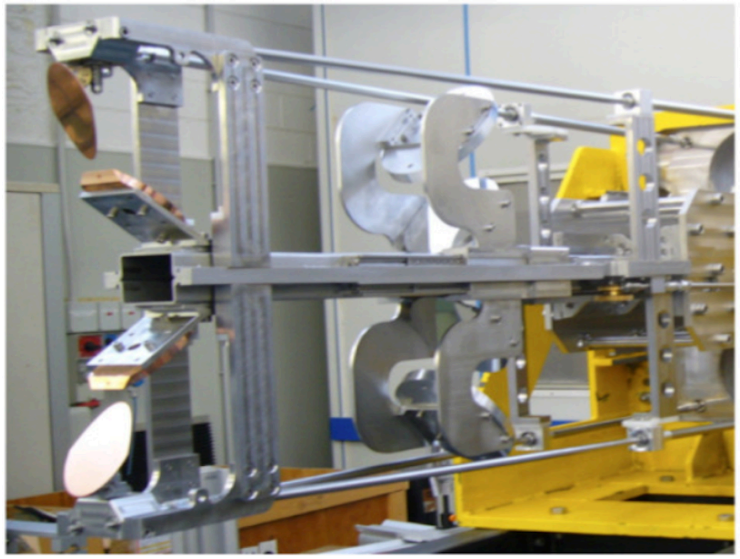
2- **Demonstrate for the first time in FTU the measurement of the thermal bulk ions distribution function with Collective Thomson Scattering measurements**

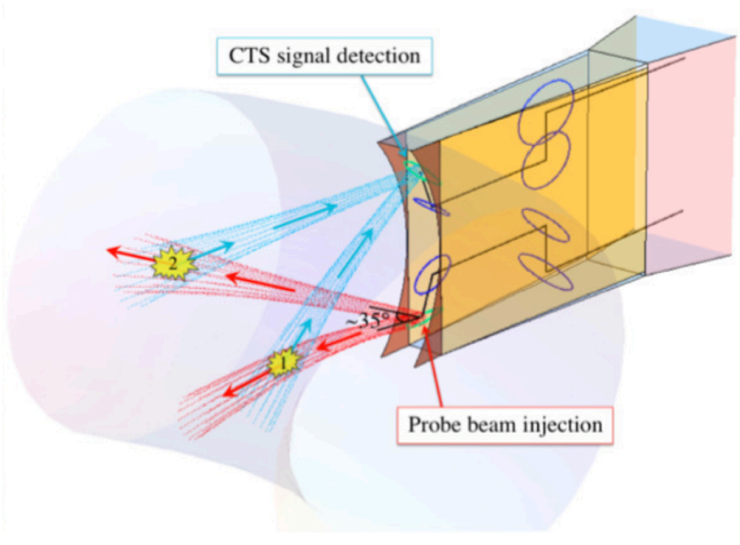
- FTU is relevant because it allows operating (for B > 7.0 T) sub-harmonic as in ITER

- Work started in 2014 but only in 2014 we could perform only some preliminary tests at 7.2 T. All the other campaigns had to be carried out at lower field

Scattering Layout







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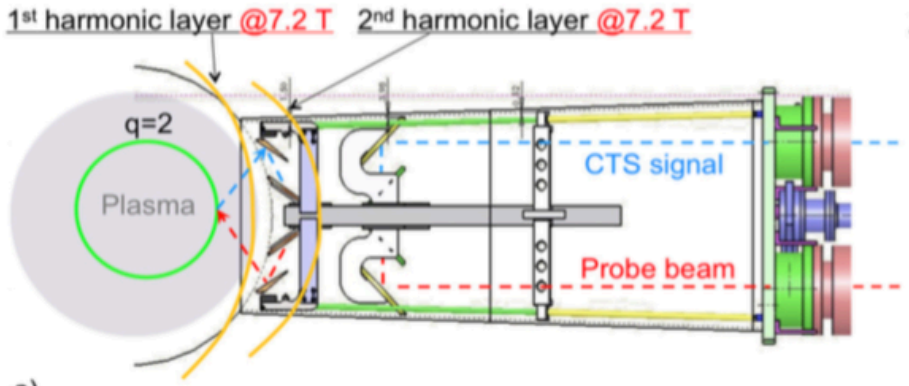
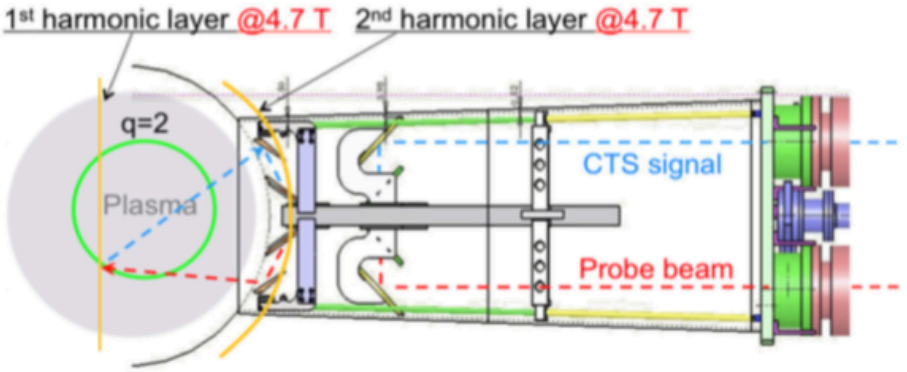
Scattering Layout



a)



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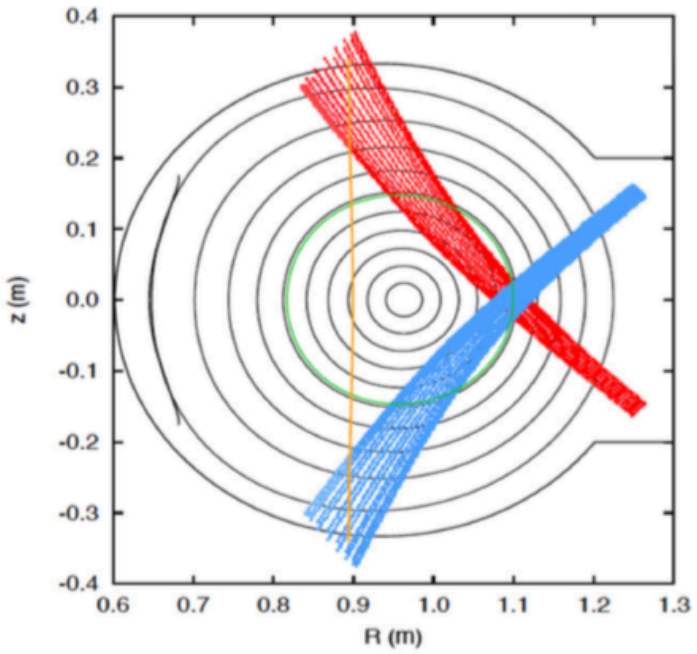

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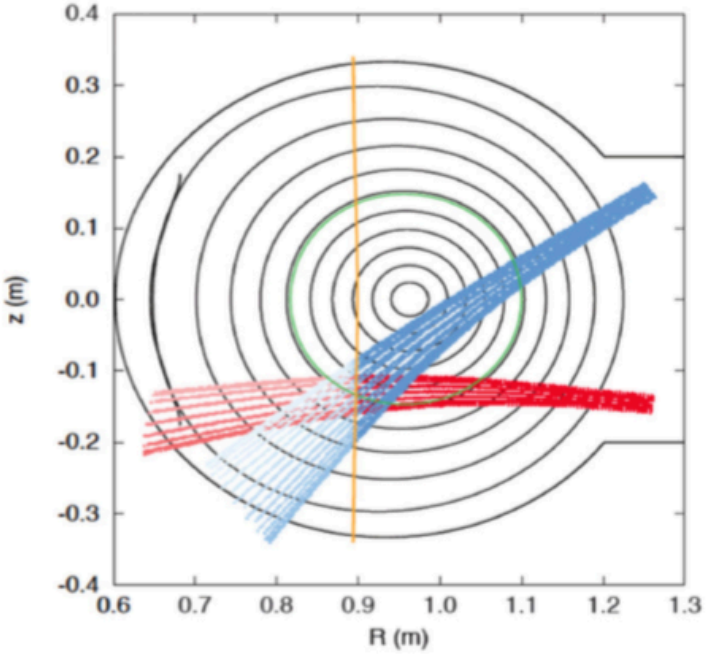


d)

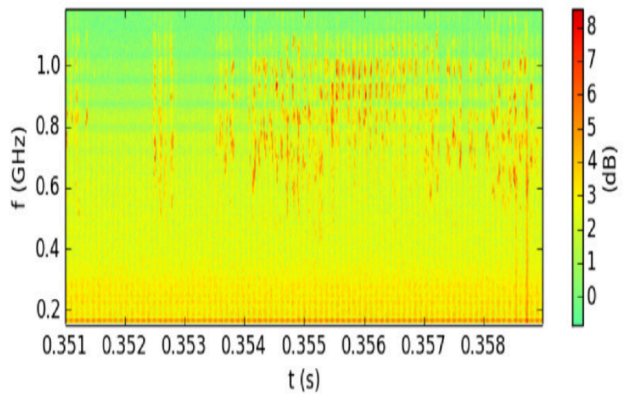
Low Power Threshold PDIs

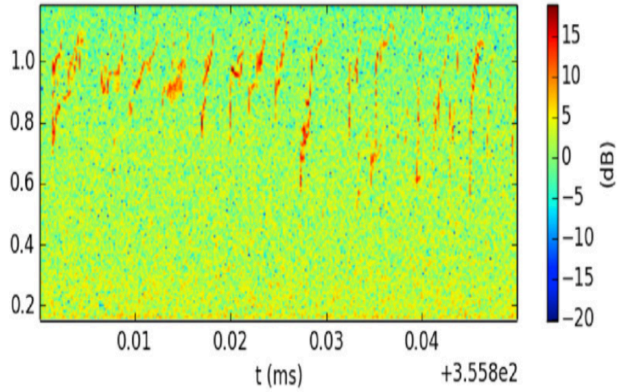
The possibility of using setup to investigate the occurrence of non-linear phenomena, such as Parametric Decay Instabilities (PDIs), has been advanced during the last years. This was stimulated by a **newly envisaged family of low-power threshold PDIs**, still to be demonstrated with certainty and whose mechanism would be explainable only by **recent theoretical models**. The low-threshold sufficient for triggering non-linear phenomena may become compatible with the typical EC power level applied for heating and current drive.

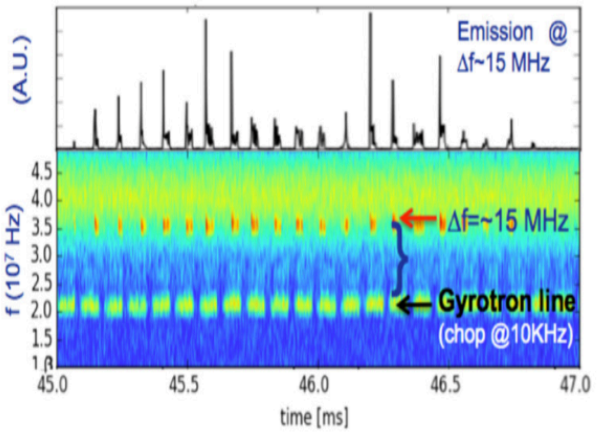
Up to now, **anomalous scattering** have been reported during routine CTS measurements in different fusion devices, such as TEXTOR, ASDEX and FTU and **anomalous ion heating**, possibly explainable as consequent dumping of parametrically driven low-frequency daughter waves, was highlighted in the ECRH experiments in TJ-II and TCV.

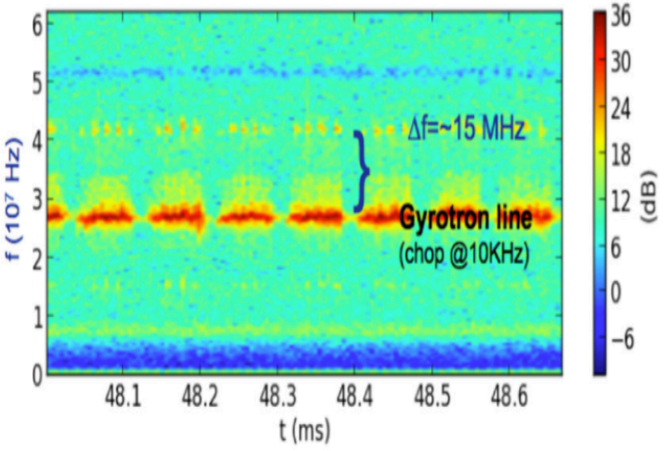
Low Power Threshold PDIs

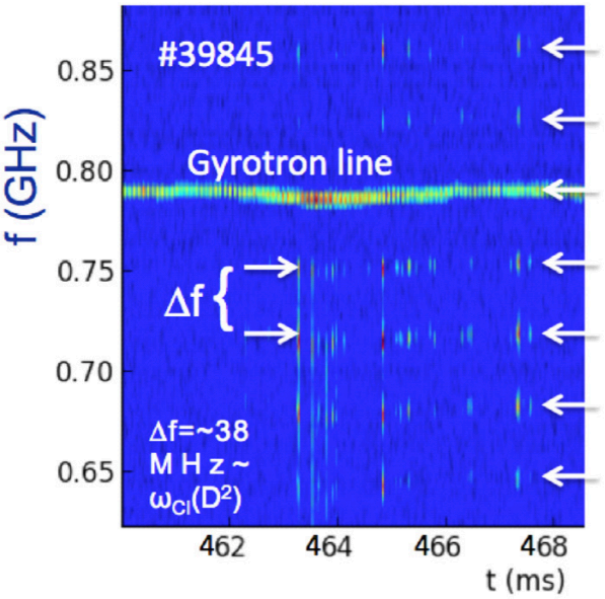
Several evidences of anomalous emissions in the spectra were measured during the last years, since 2014



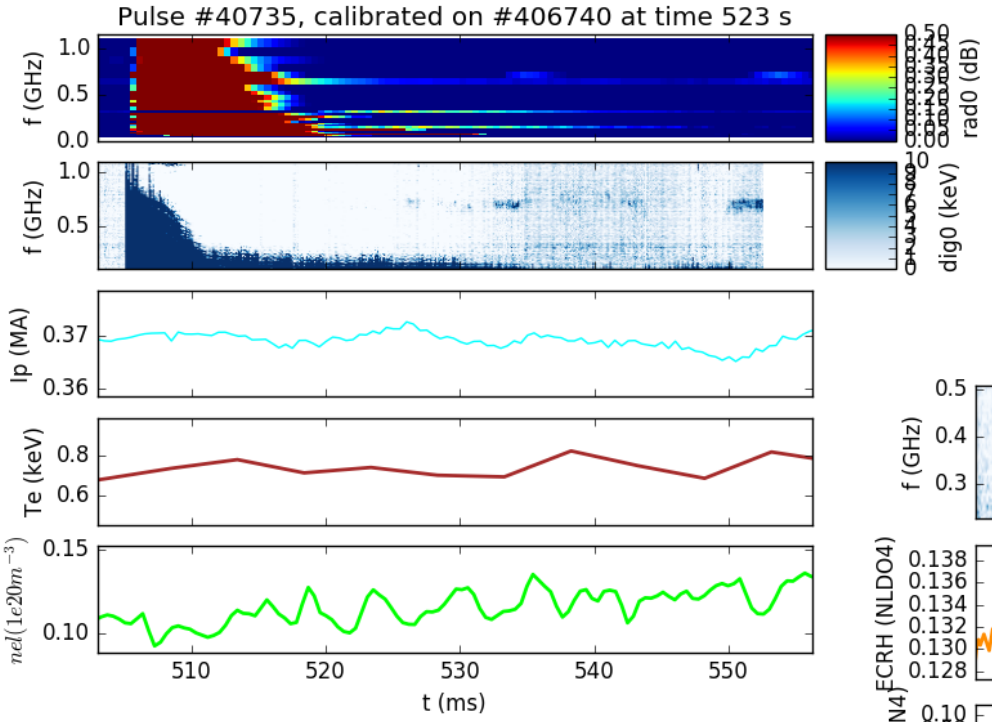


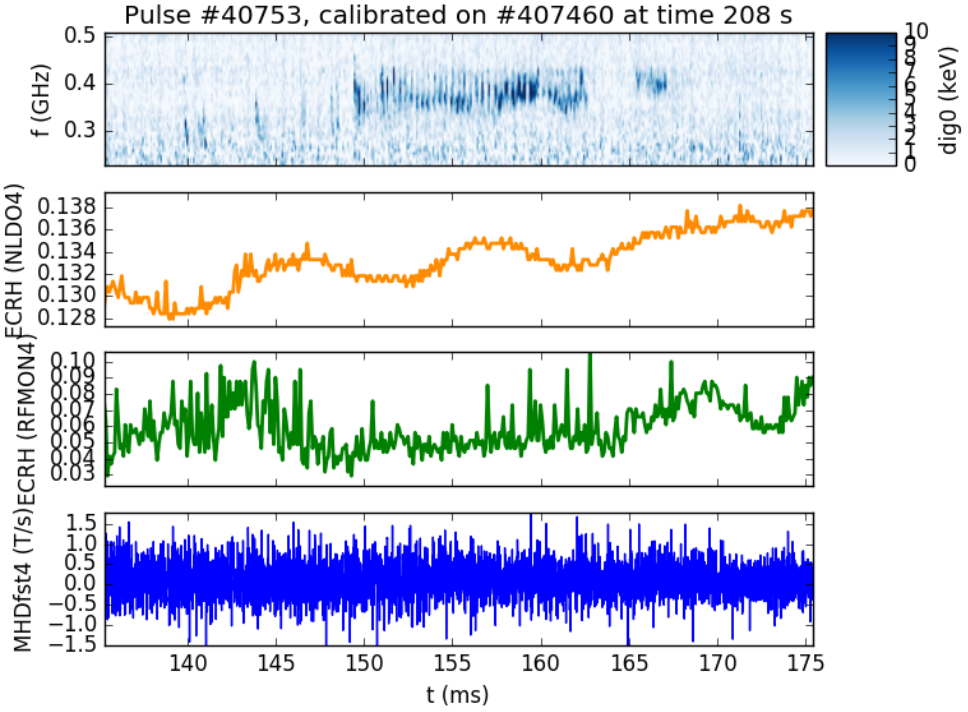






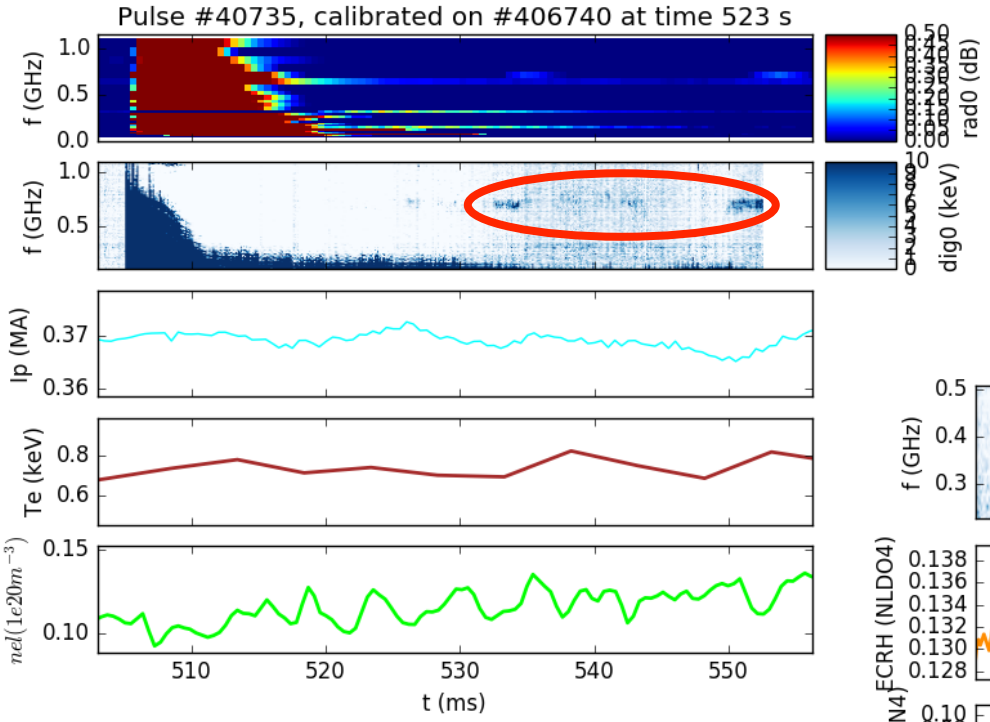
Low Power Threshold PDIs



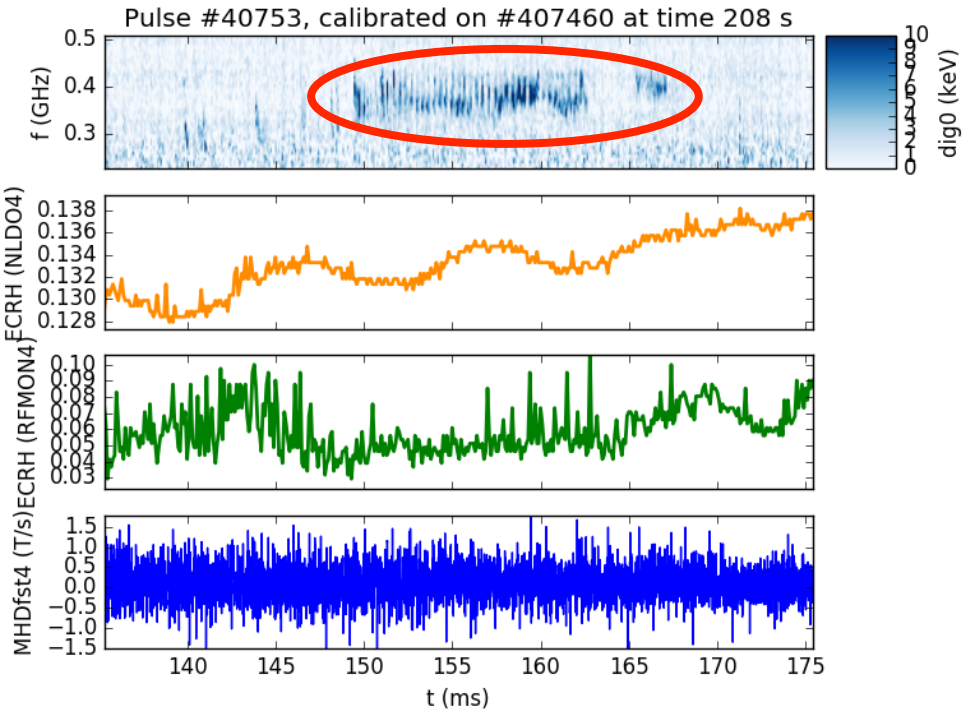


More recent examples of anomalous emissions

Low Power Threshold PDIs



More recent examples of anomalous emissions

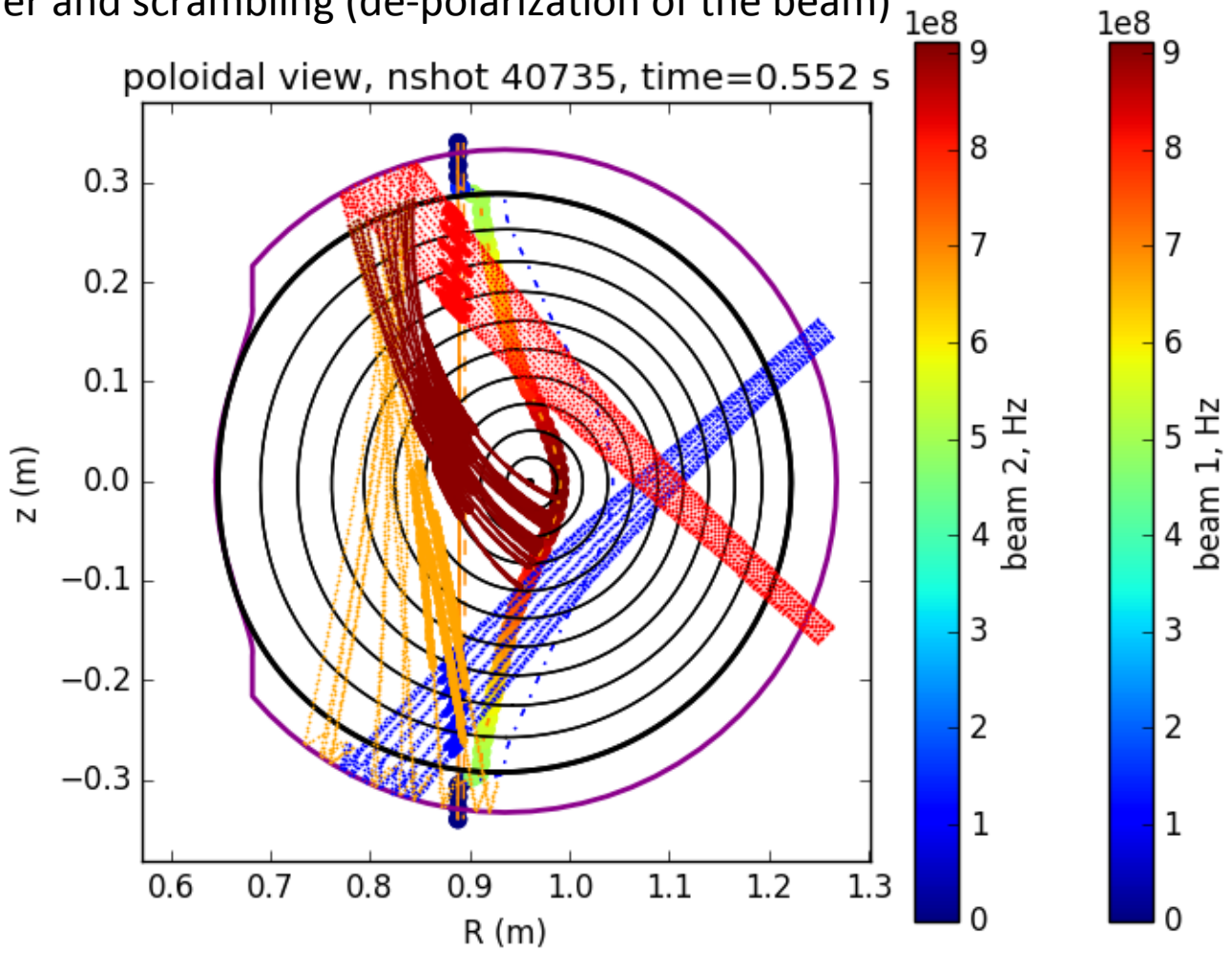


Theoretical studies focused on FTU:

*E. Z. Gusakov et al. PPCF **59** (2017)*
*E. Z. Gusakov et al. PoP **25** (2018)*
*E. Z. Gusakov et al. PPCF **61** (2019)*

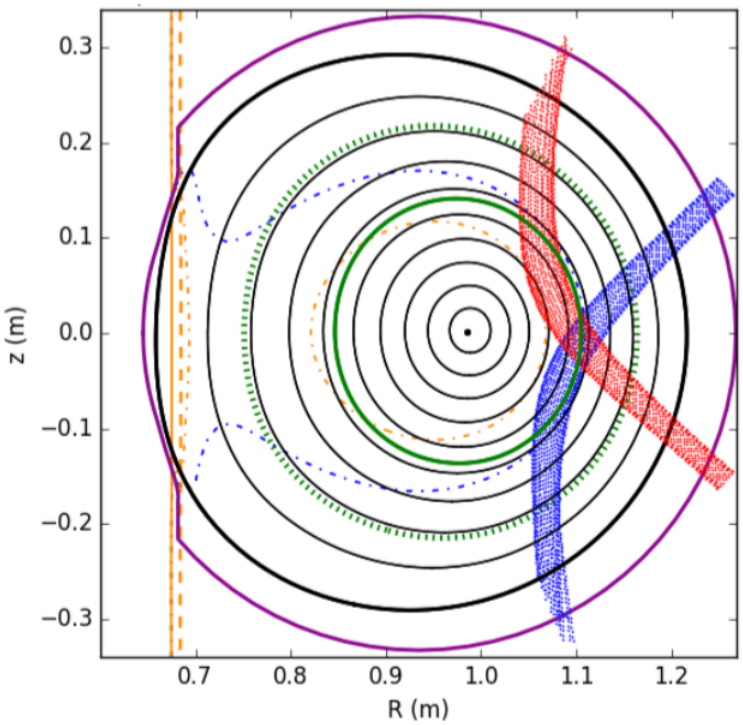
Low Power Threshold PDIs

Multi-reflections simulations → different possible decay scenarios due to multi-reflection, stray power and scrambling (de-polarization of the beam)

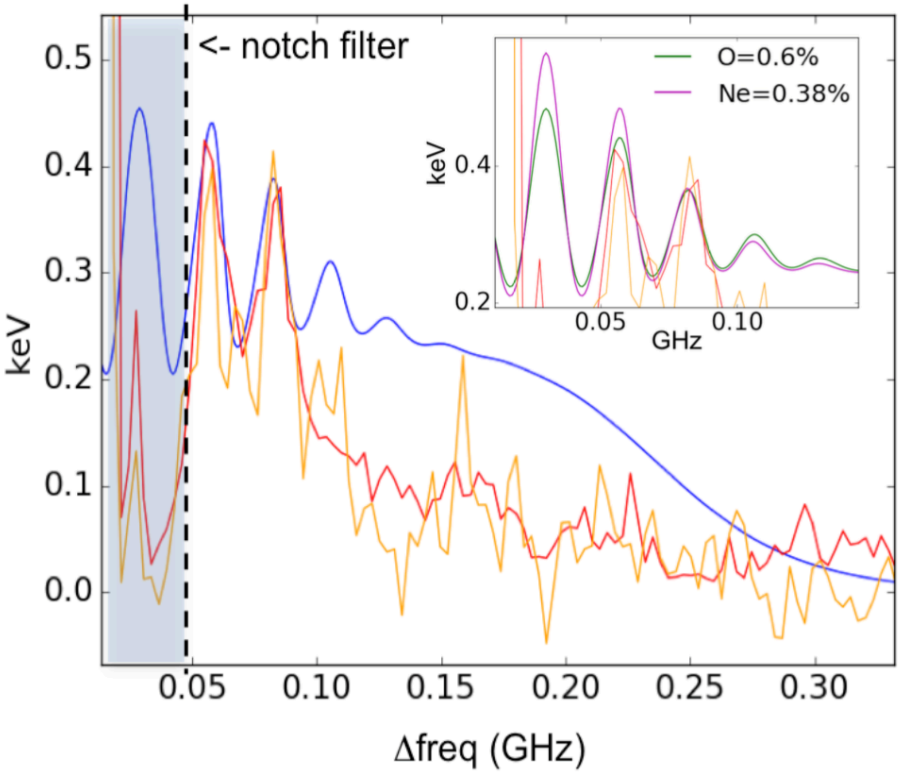


Example of simulation with multi-reflections

Thermal CTS



Poloidal view of O-polarized beam launched (red) and received (blue) in the FTU shot #40282 at time 0.505 s. The q=2 (3) rational surface is the green solid (dotted) line, the Upper Hybrid layer and X-mode right cut-off are the dash-dotted lines (yellow and blue respectively)



#40282 – 3.6 T

First draft CTS measurement ever performed in FTU

Next Experiments

- Continuing the investigation of non-linear decay wave process by 140 GHz probe beams at high toroidal field (possibly while properly fitting the interferometric density measurement with the CTS beams cross) → **with islands**

- Continuing the study of thermal spectra and bulk ions distribution function with **no use of neon injection and no islands**.

Strategy:

Different beam scans and crosses layouts, mostly performed in plasma scenarios at 7.2 T/ 500 kA (and 700 kA), receiving signals with two different radiometric systems in cross-polarized configuration on the same line on sight