

GOMTRAIIC

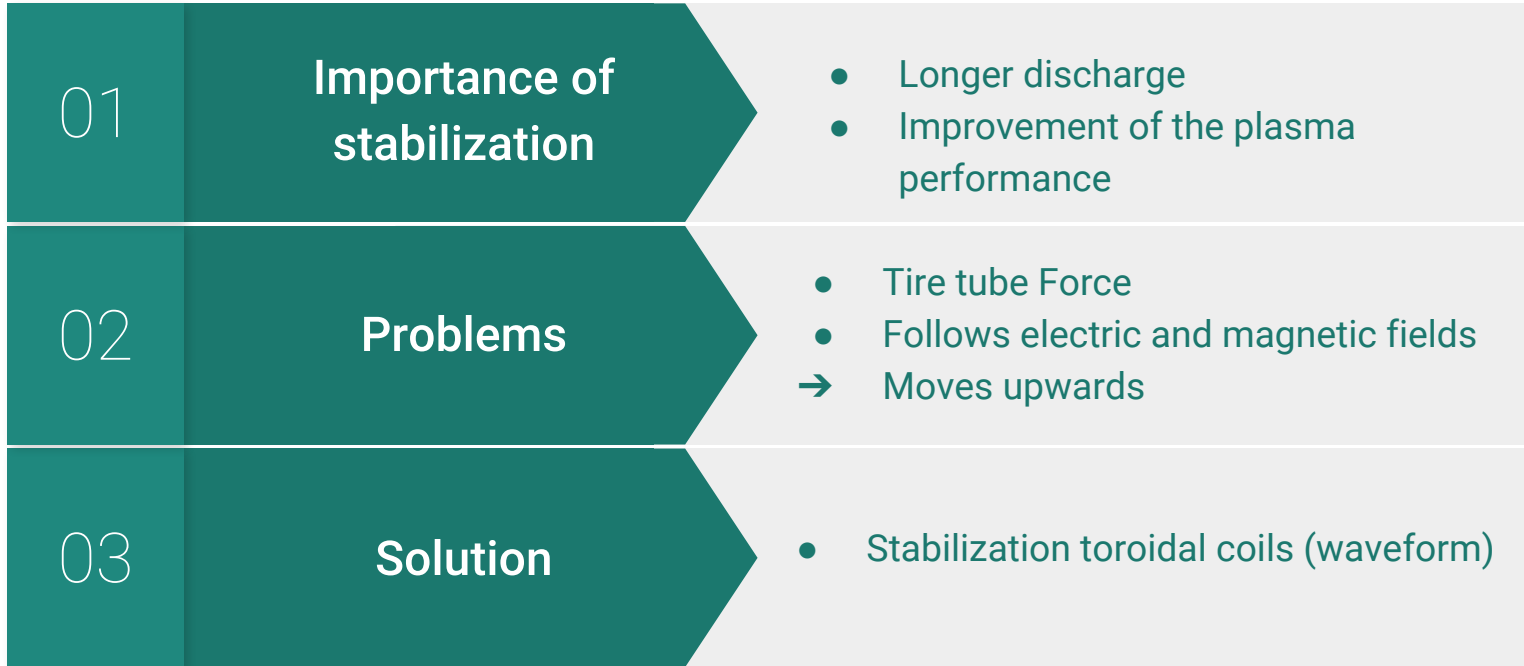
Plasma Stabilization

08/03/2019

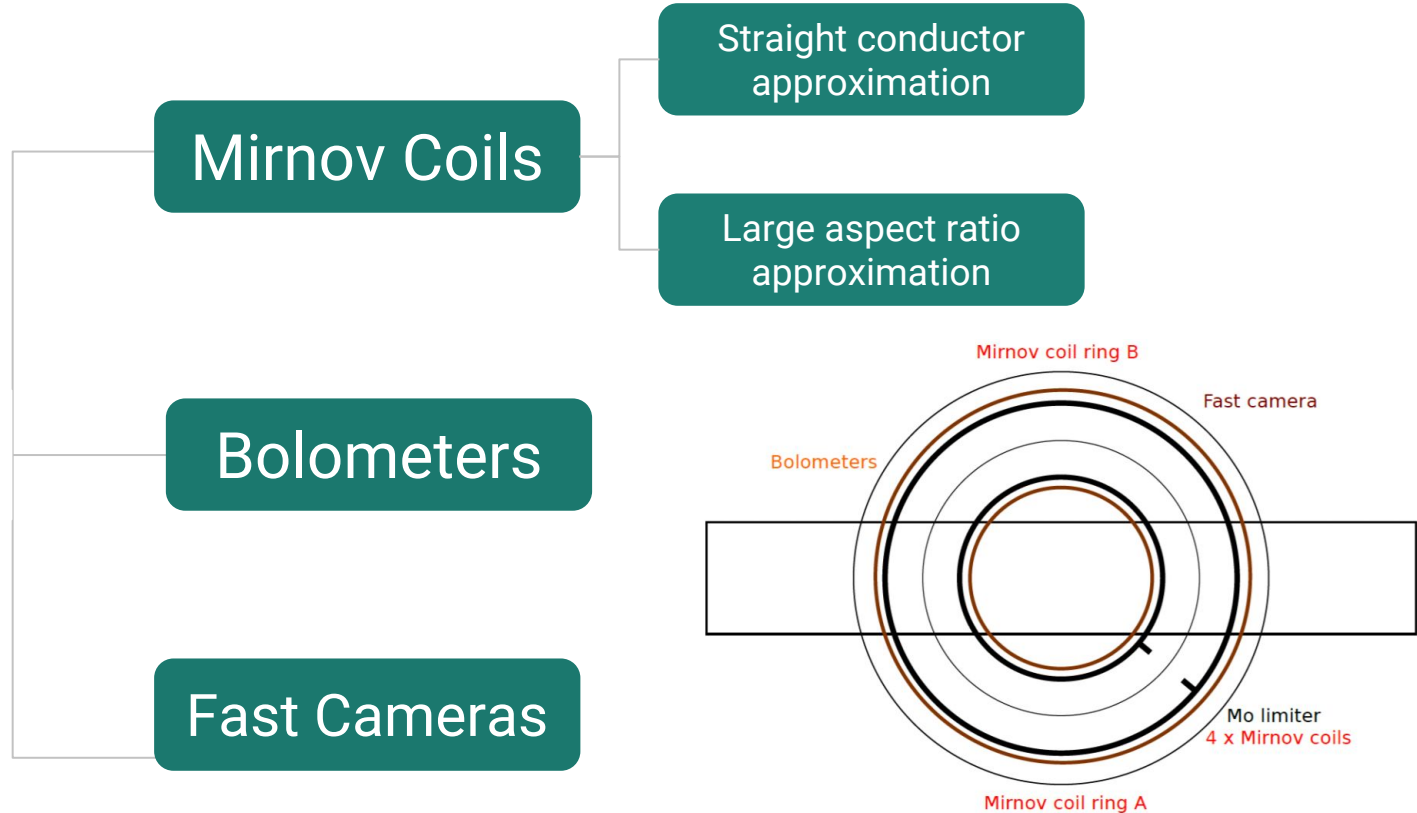


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Maria Morbey
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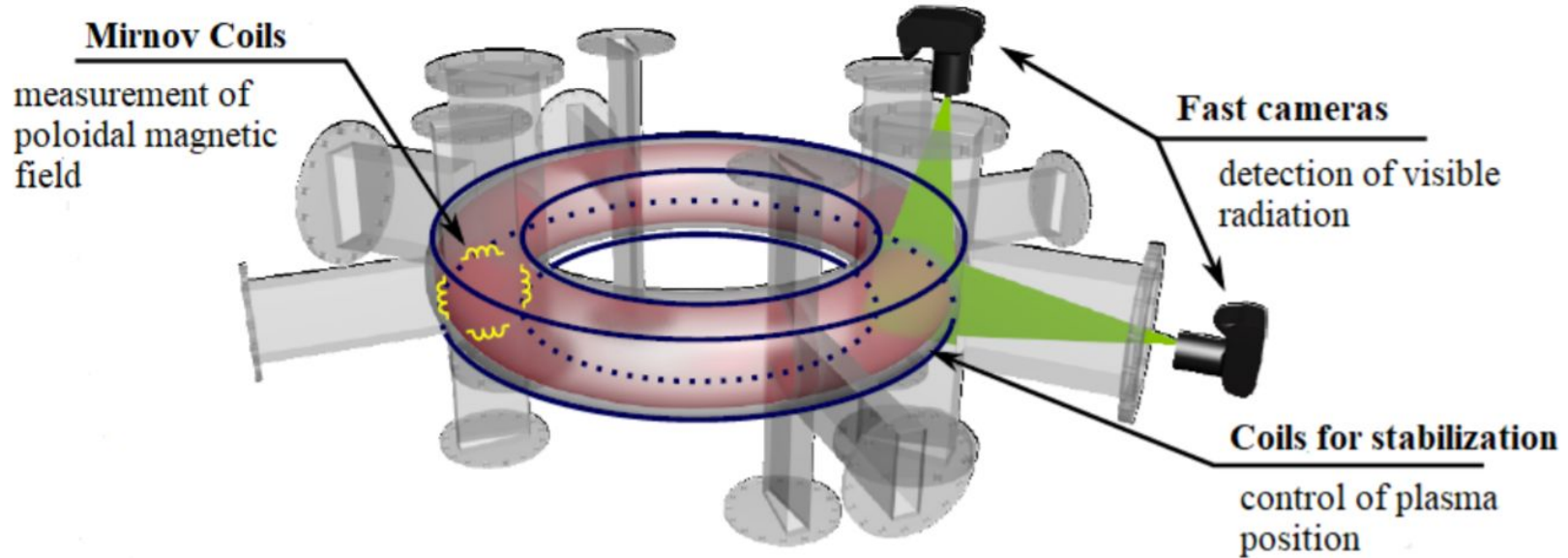
Motivation



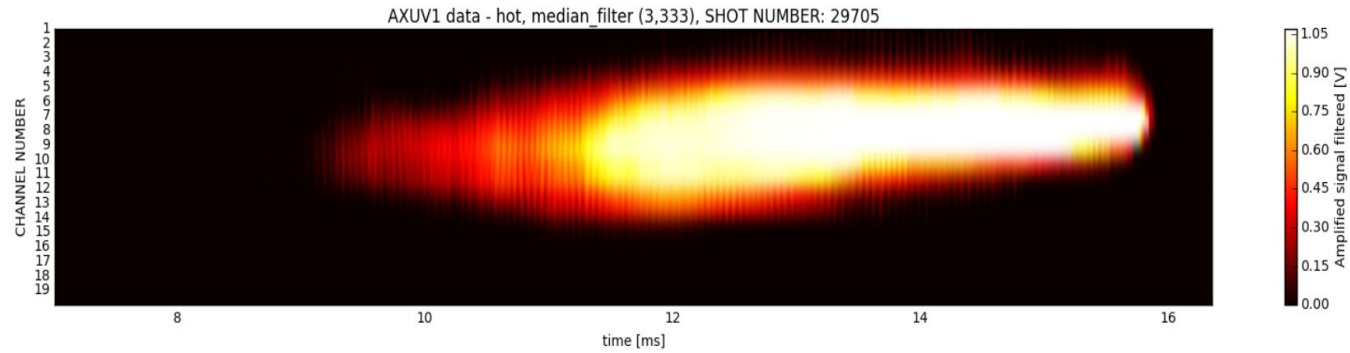
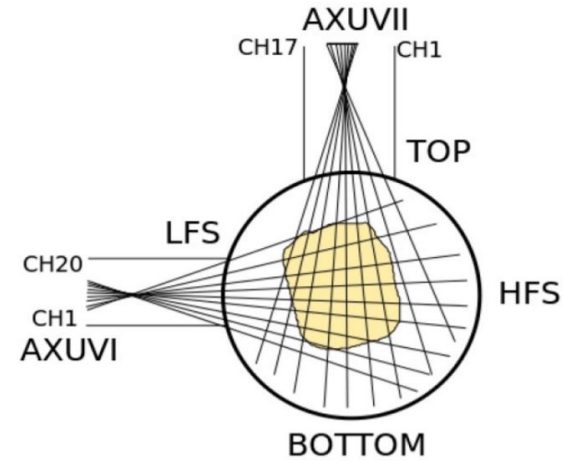
How to measure plasma position



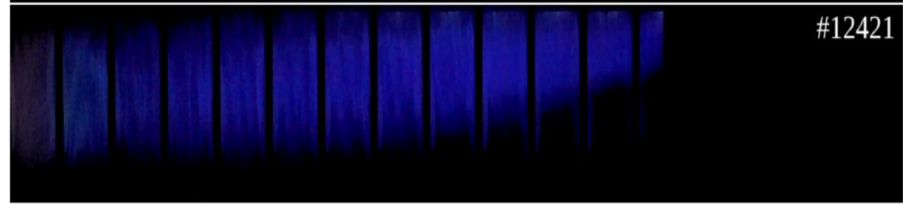
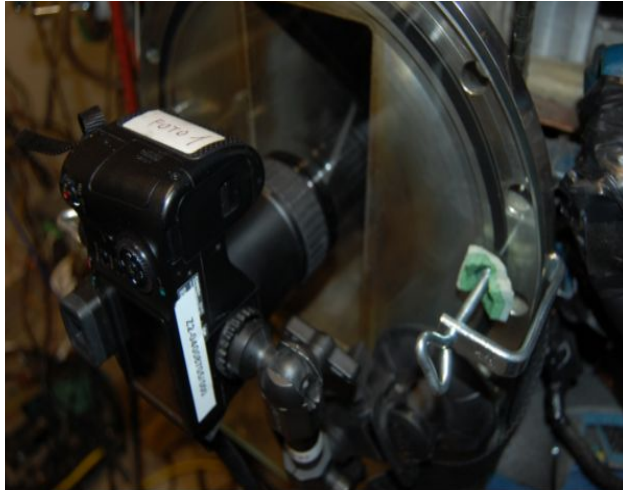
How to measure plasma position

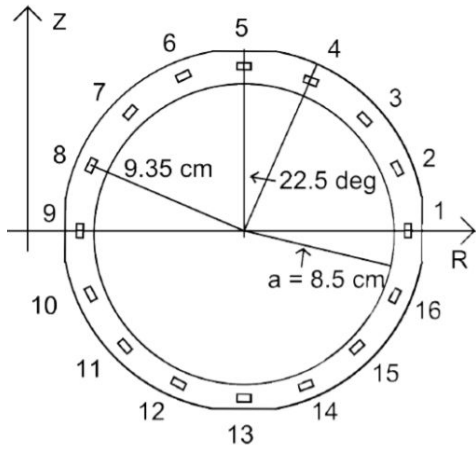


Bolometers

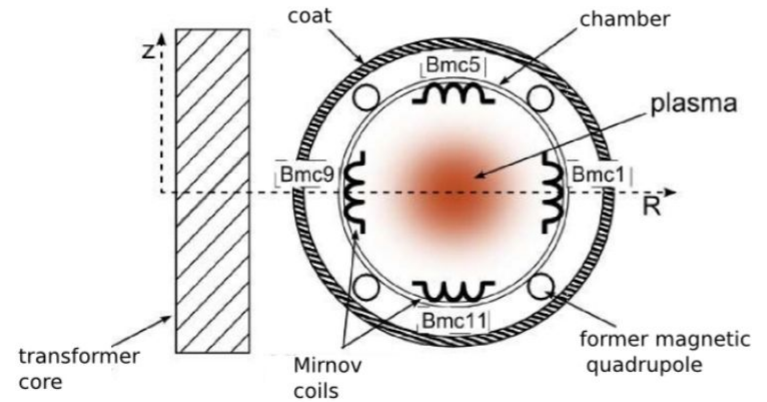
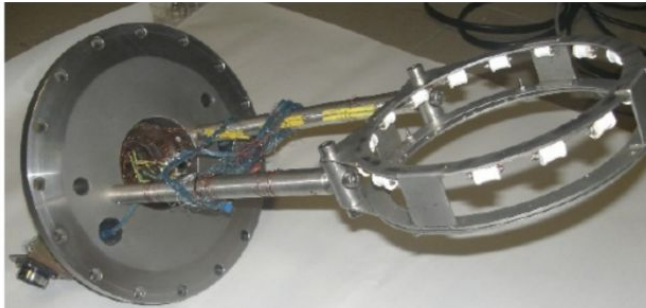
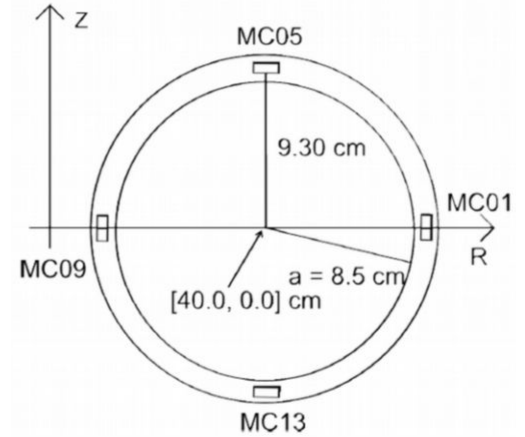


Fast Cameras

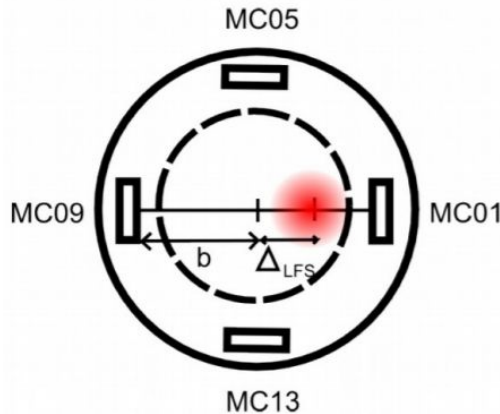




Mirnov Coils



Equations for the Straight conductor approximation



$$\Delta_{LFS} = b \frac{B_1 - B_9}{B_1 + B_9}$$

$$\Delta_{TOP} = b \frac{B_5 - B_{13}}{B_5 + B_{13}}$$

Δ_{TOP} = vertical displacement of plasma column

Δ_{LFS} = horizontal displacement of plasma column

b = distance between center of ch. and sensor

Equations Large aspect ratio approximation

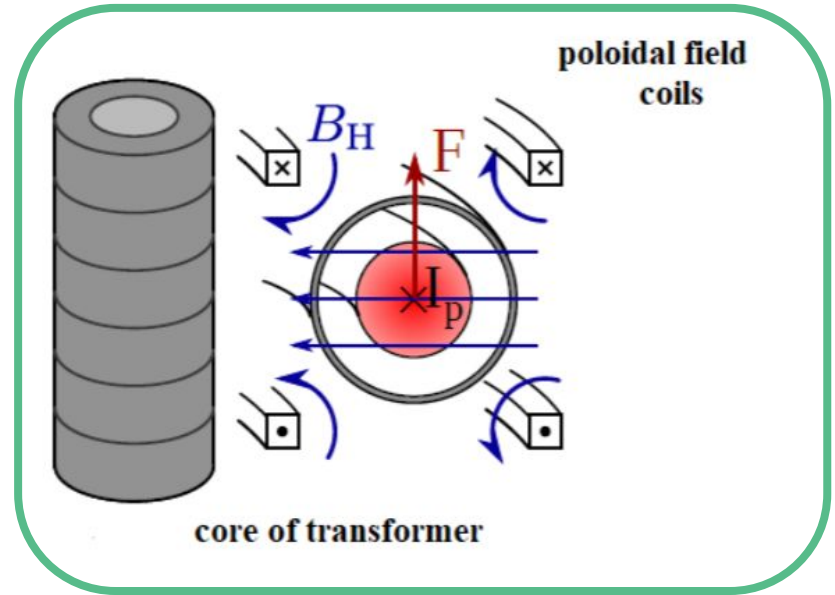
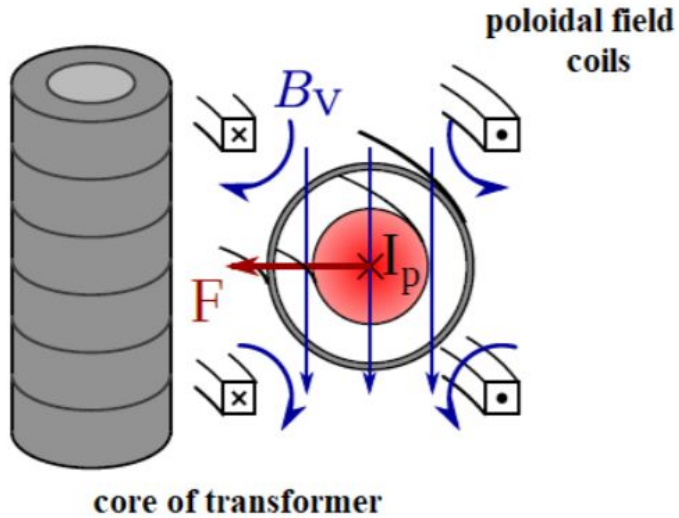
$$\Delta_{HFS} = \frac{B_9 - B_1}{2B_0} b - \frac{1}{2} \left[\ln \frac{b}{a} - 1 + \left(\Lambda - \frac{1}{2} \right) \left(1 + \frac{a^2}{b^2} \right) \right] \frac{b^2}{R},$$

$$\Delta_{BOT} = \frac{B_{13} - B_5}{2B_0} b,$$

$$\Lambda = \left(\frac{B_9 - B_1}{2} - \bar{B}_z \right) \frac{R}{B_0 b} - \ln \frac{b}{a} + 1,$$

$$a = a_L - \sqrt{\Delta_{HFS}^2 + \Delta_{BOT}^2}.$$

How to change the plasma position - Toroidal coils



$$\vec{F} \approx \vec{I}_p \times \vec{B}$$

Set-up of the toroidal coils



Coil of Vertical Stabilization Field

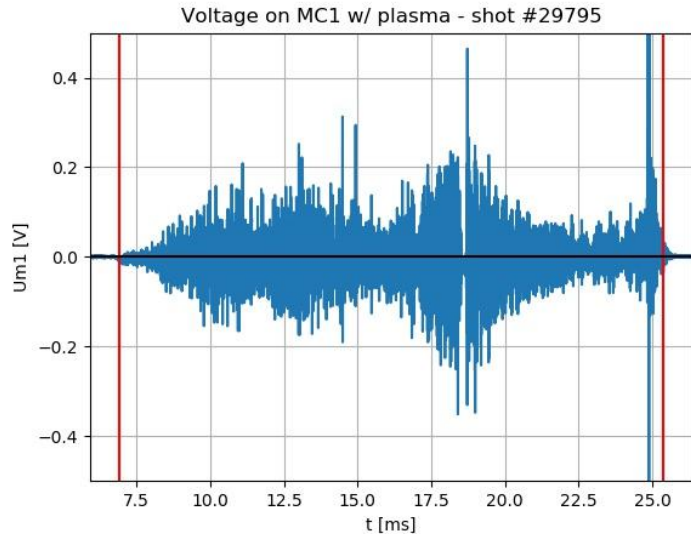
Coil of Horizontal Stabilization Field

Coil of Toroidal Magnetic Field

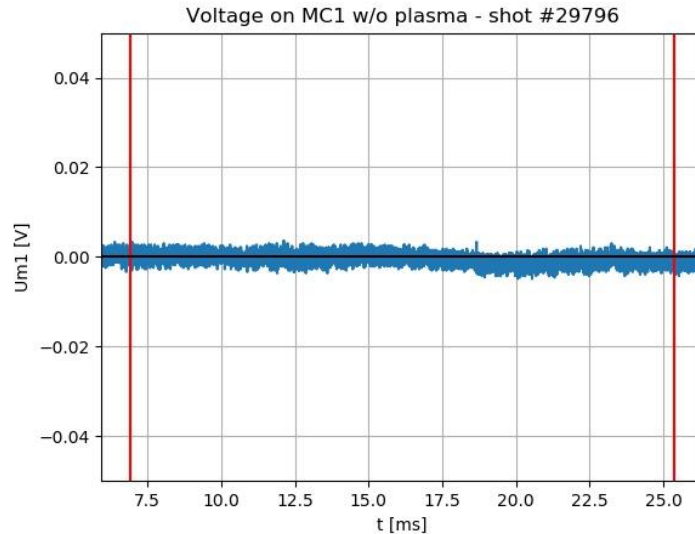
Signal processing

Collect the signal from Mirnov coils

Shot with plasma



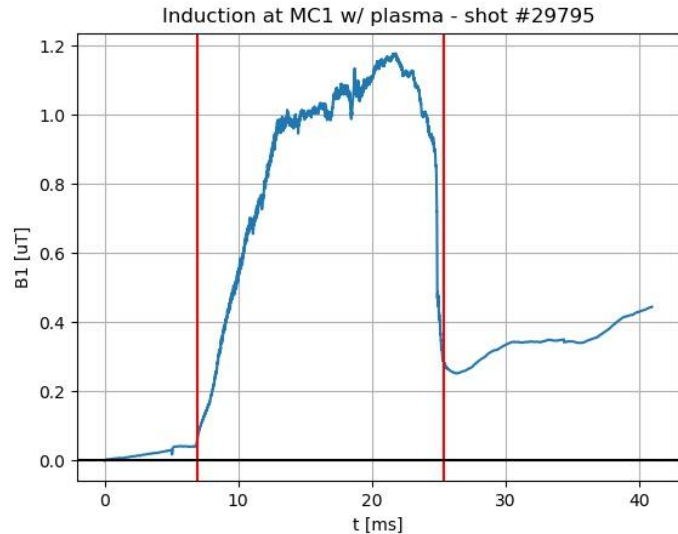
Vacuum shot



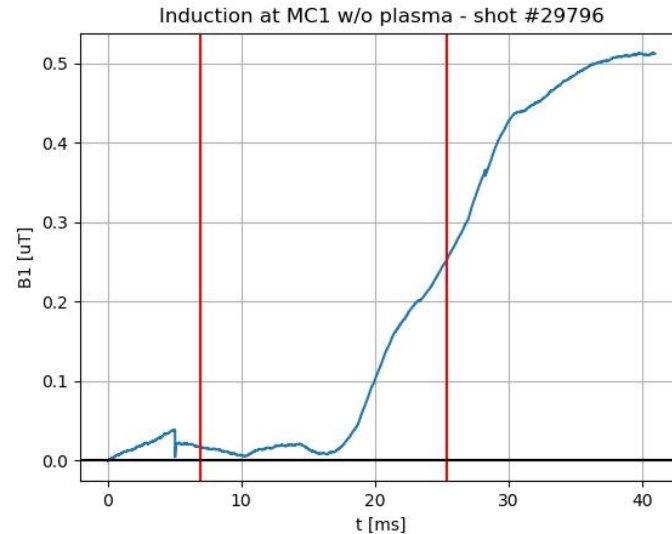
Signal processing

Integrate to obtain the fields

Shot with plasma



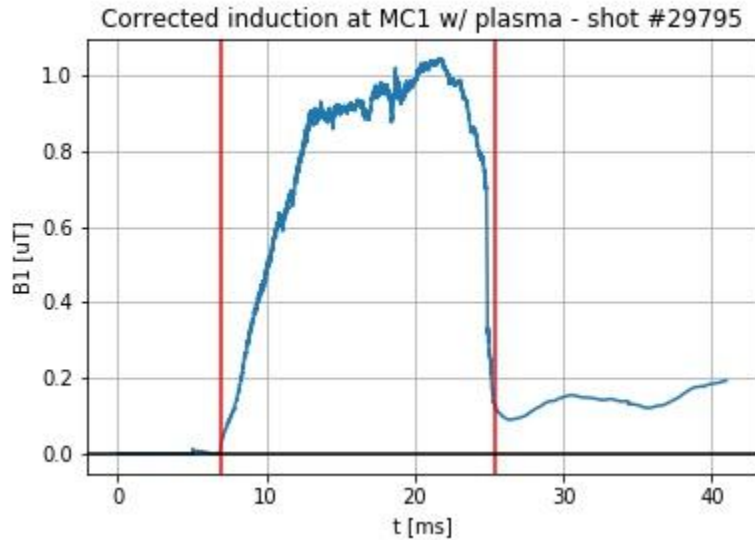
Vacuum shot



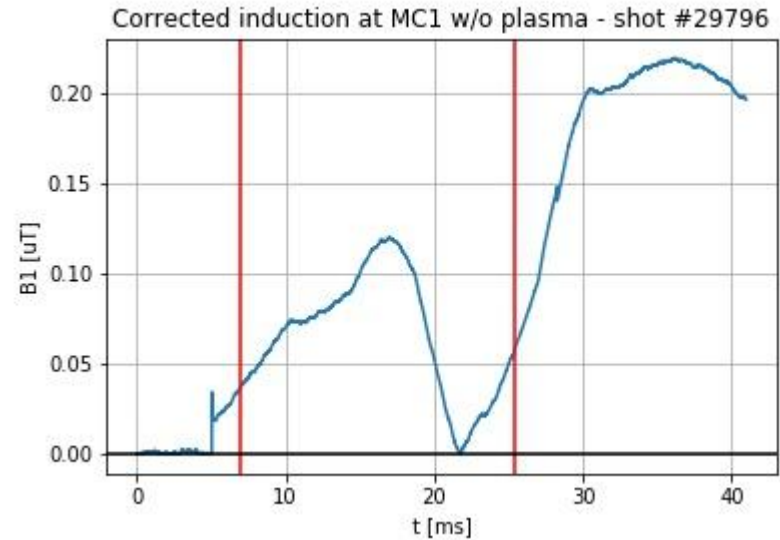
Signal processing

Correct for the offset

Shot with plasma

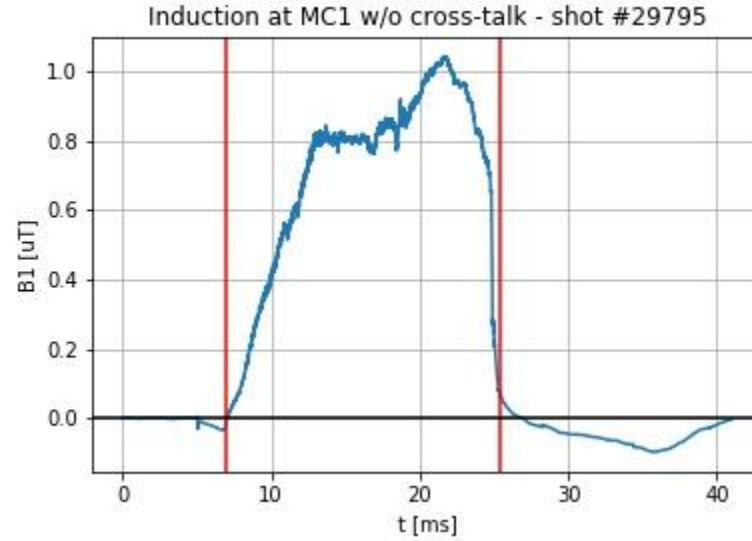


Vacuum shot



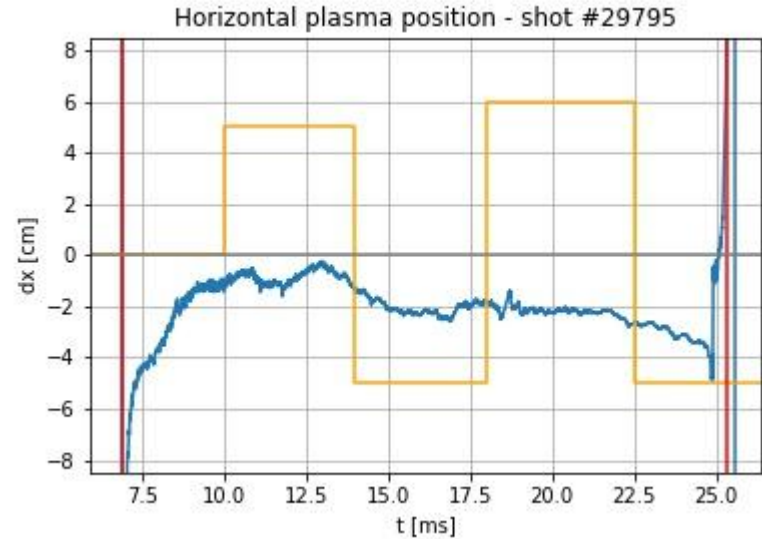
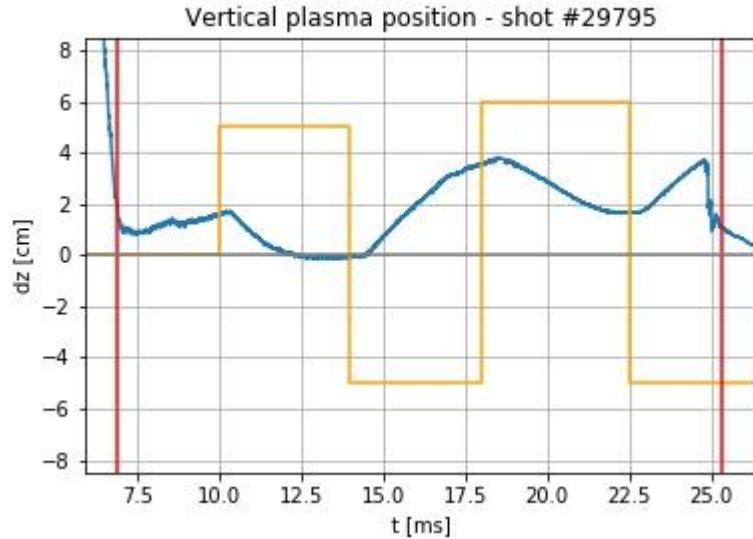
Signal processing

Subtract the cross-talk to obtain the induction of the plasma



Signal processing

Using the values obtained from Mirnov coils calculate the position (SCA)



Golem

Plasma shifts upwards

- 16 ms
- Needs to go down

Apply a Waveform (only changes vertically)

- By chance
- See results
- Modify according to the analysis
- Better stability → more similar to a log function
- Send different log forms

Best stability

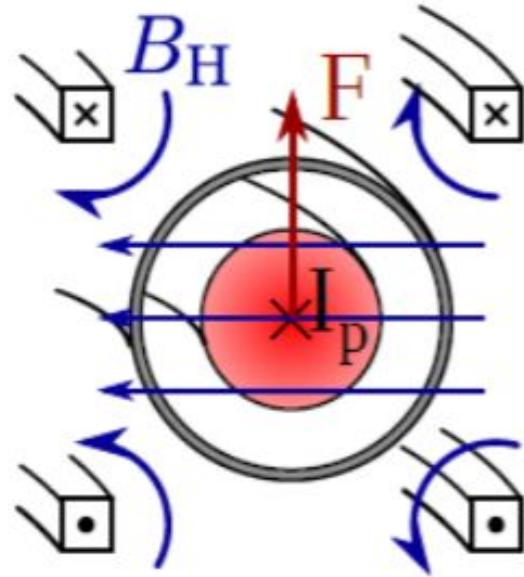
- 21 ms

Applying Feed Forward Control

The top coils wired in series

Bottom coils wired in anti-series

Create a “wave-form” of that is the applied voltage for these coils

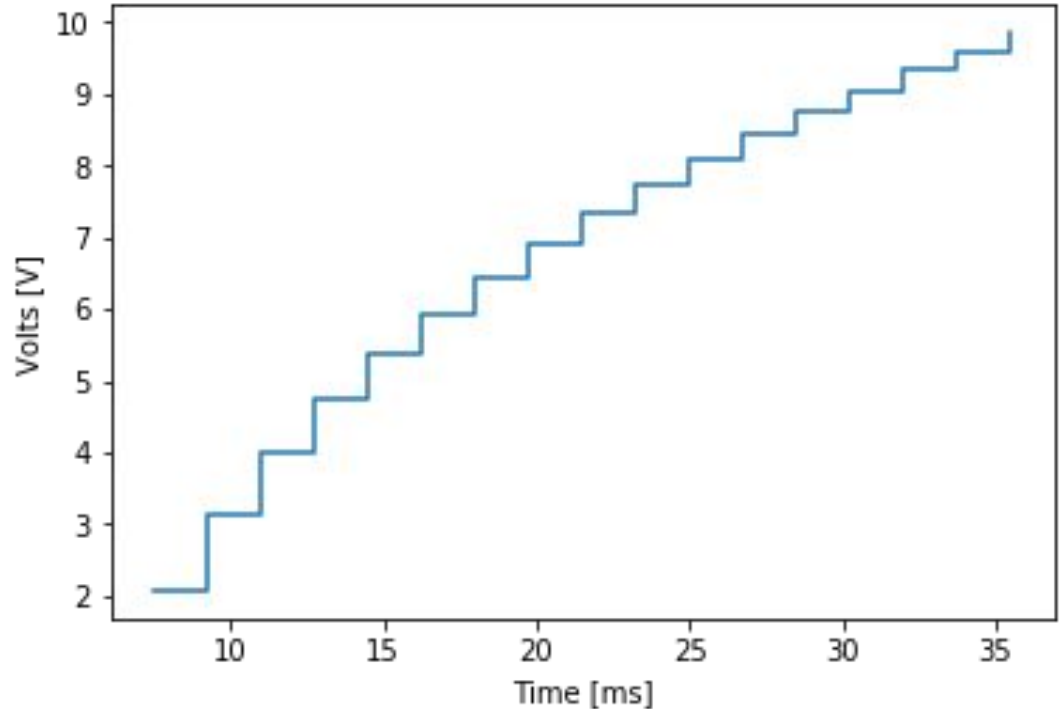


Applying Feed Forward Control

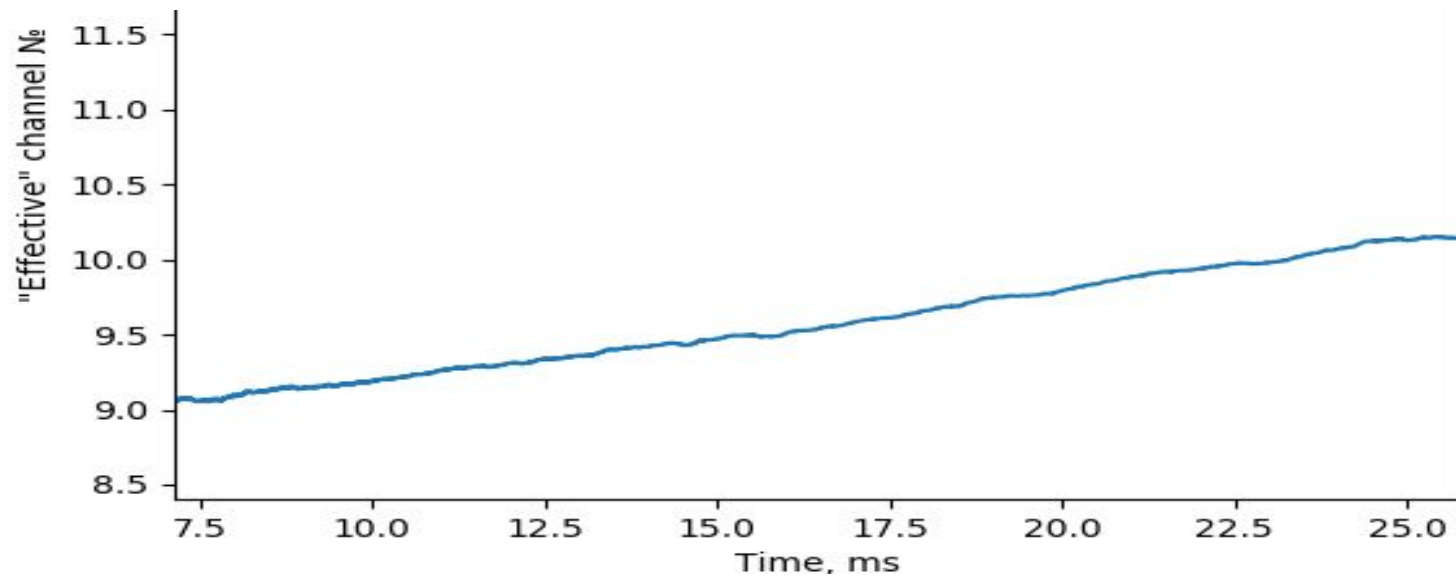
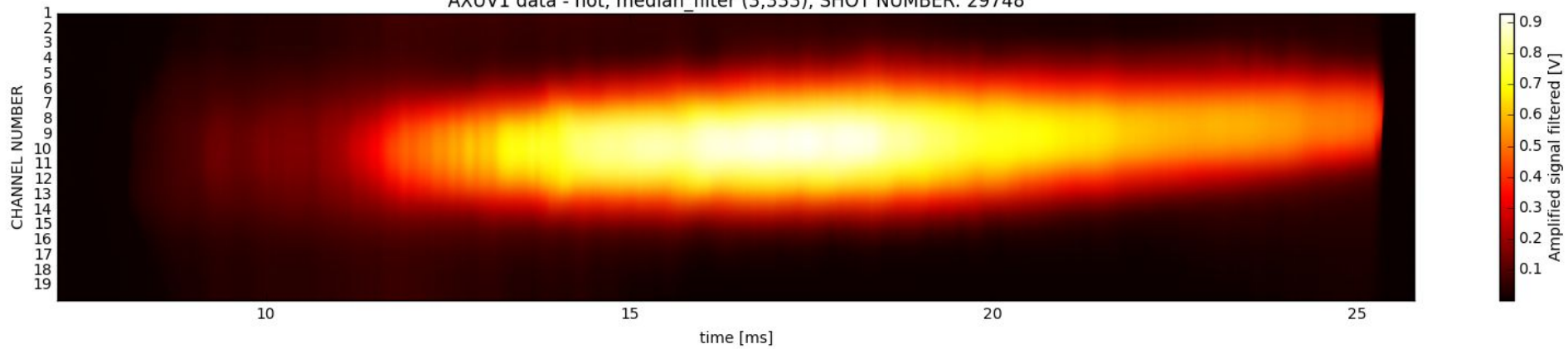
Time	Voltage
7.50	2.074515
9.25	3.123118
11.00	3.989476
12.75	4.727656
14.50	5.370743
...	...

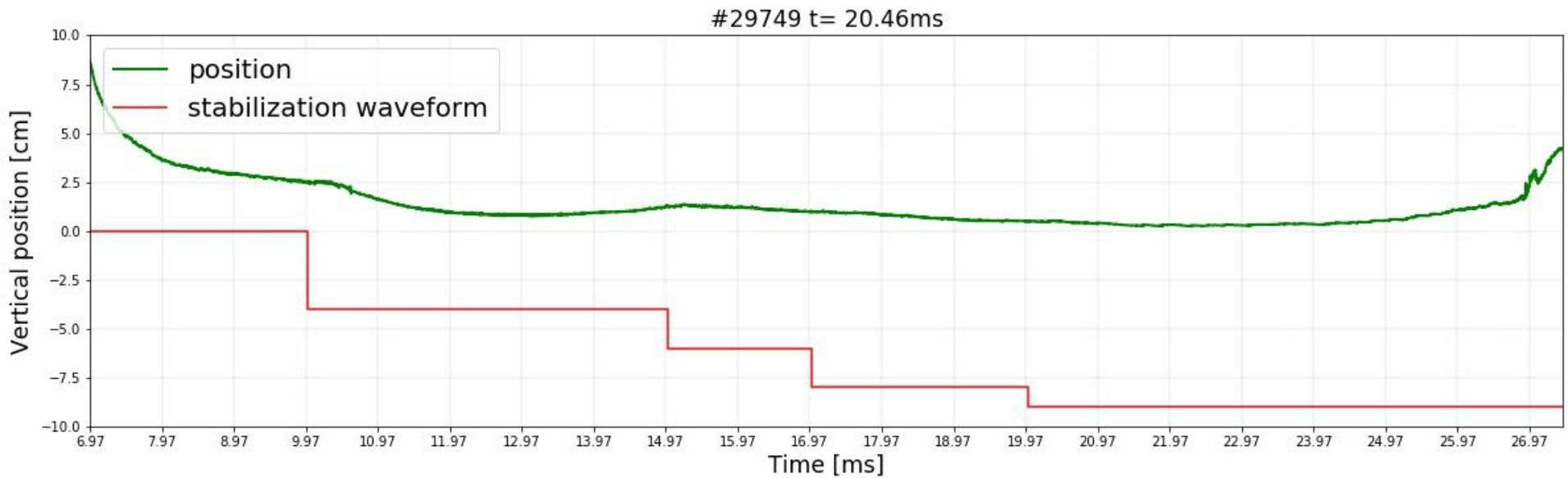
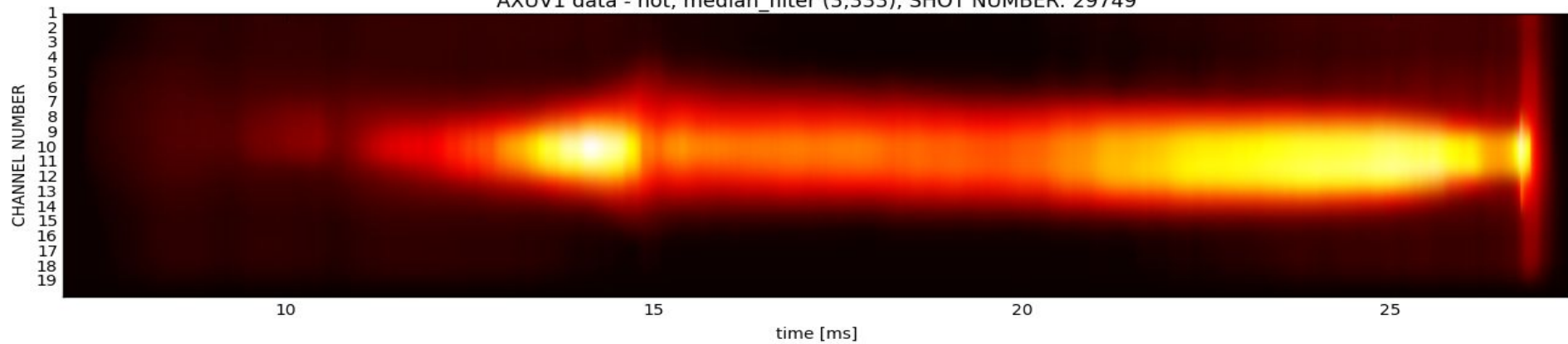
But, what “wave-form”
should we use?

Trial and Error

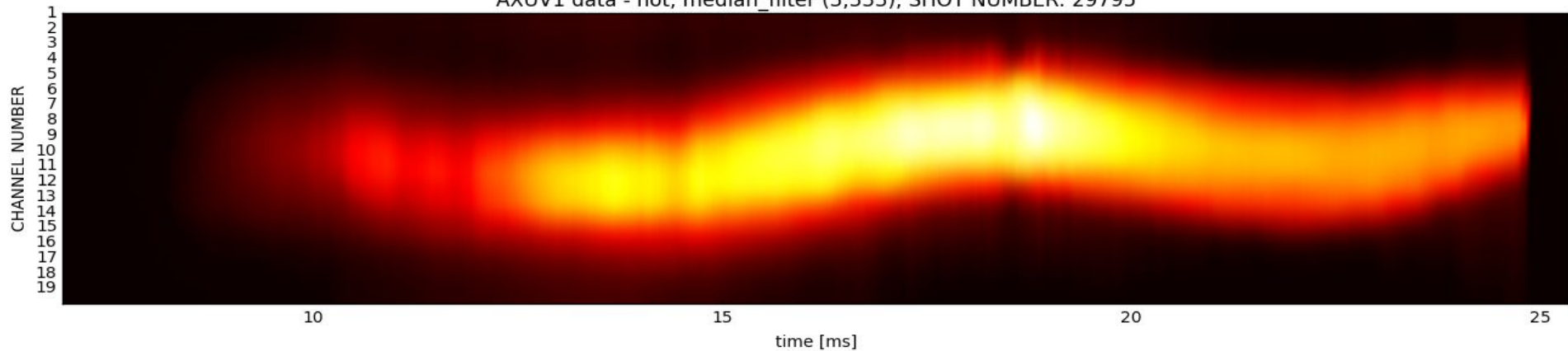


AXUV1 data - hot, median_filter (3,333), SHOT NUMBER: 29748

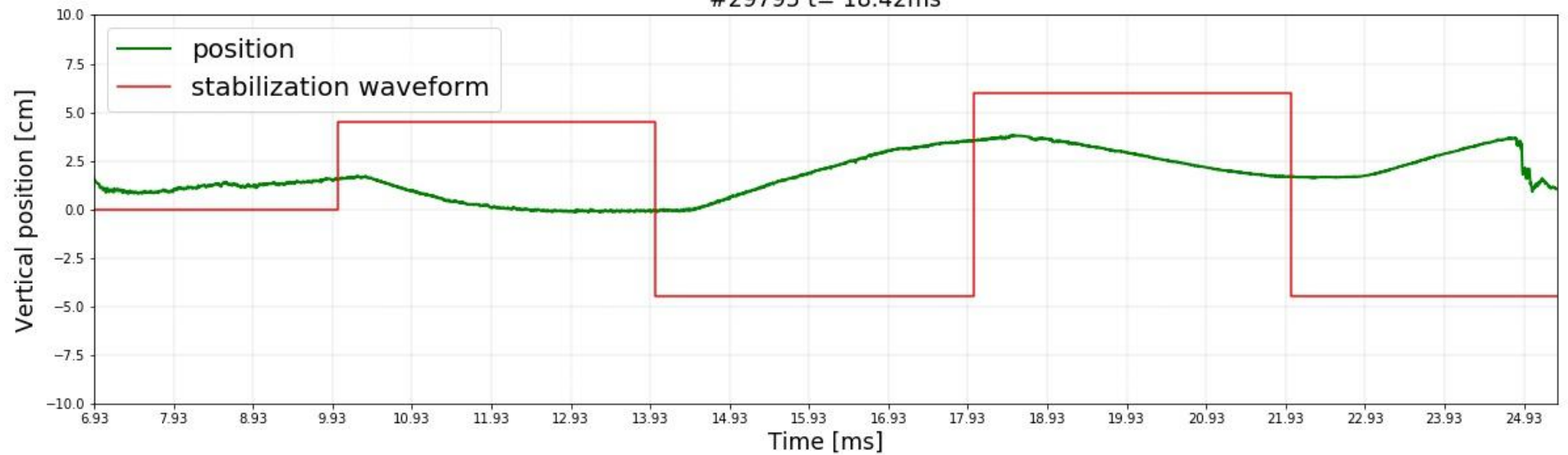




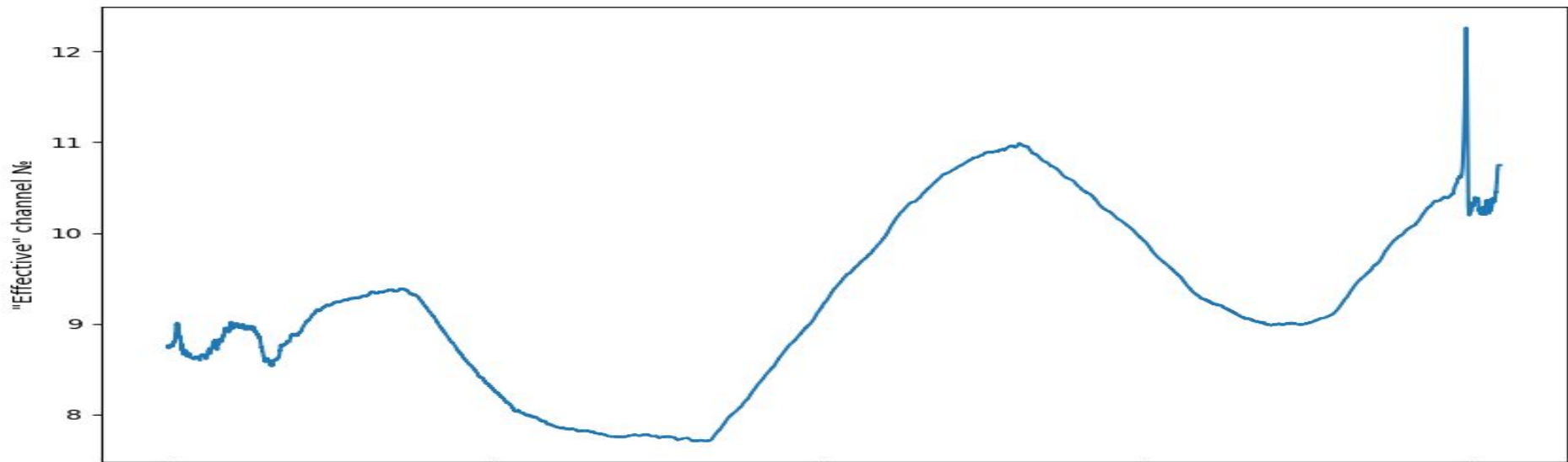
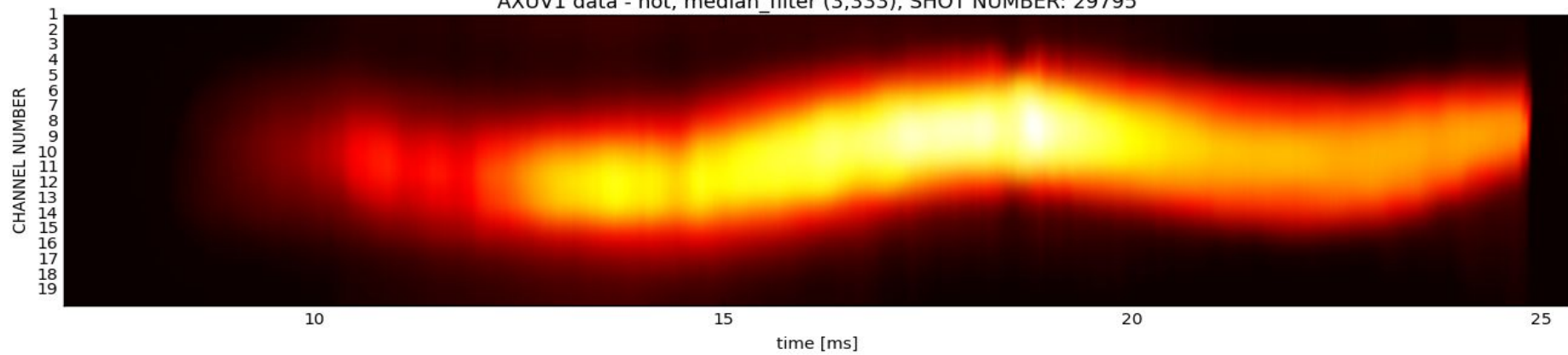
AXUV1 data - hot, median_filter (3,333), SHOT NUMBER: 29795



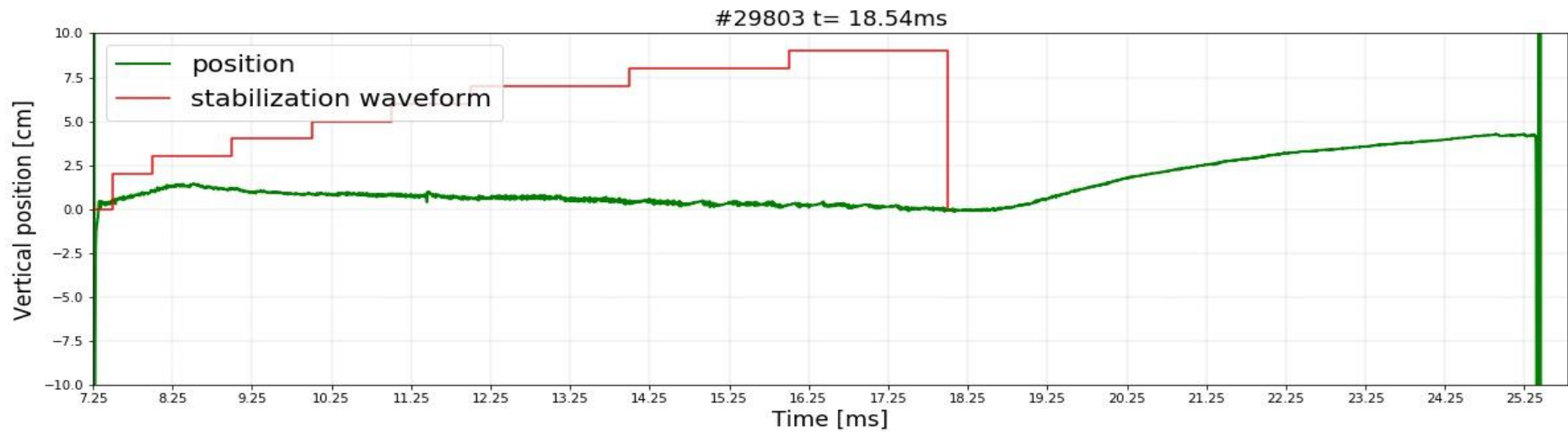
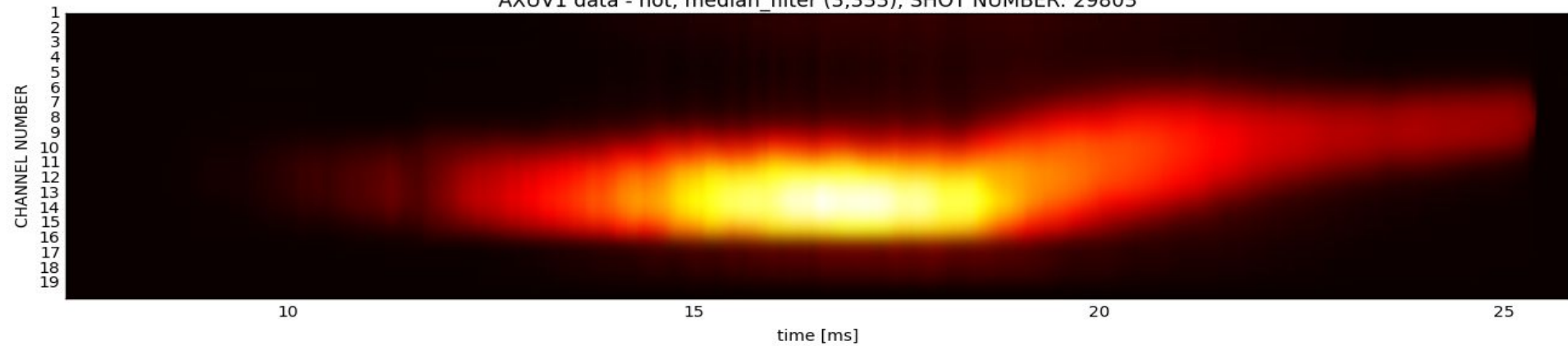
#29795 t= 18.42ms

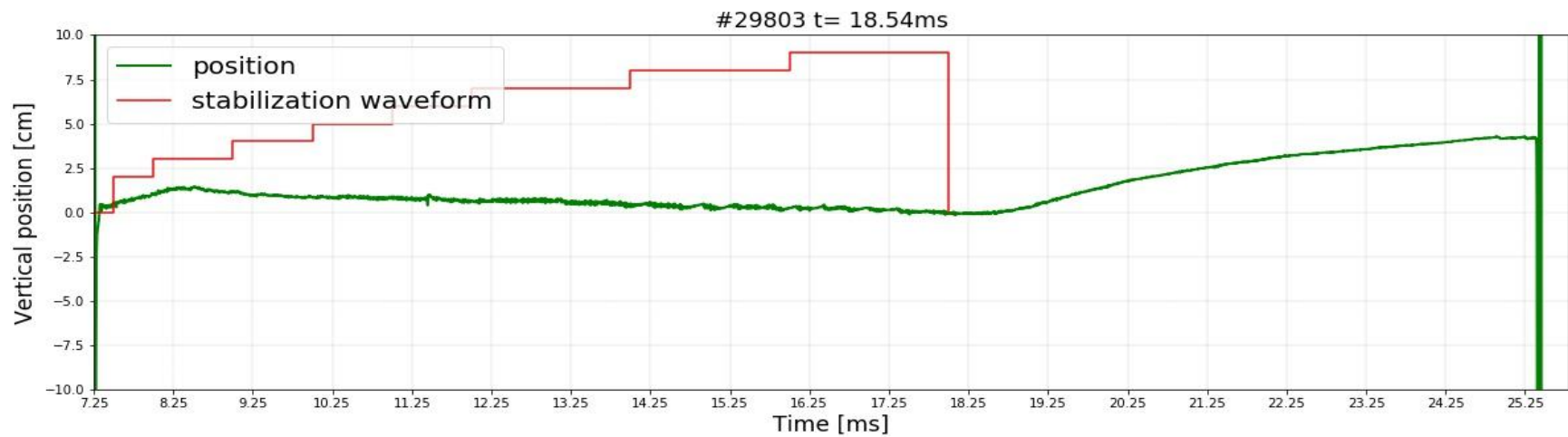
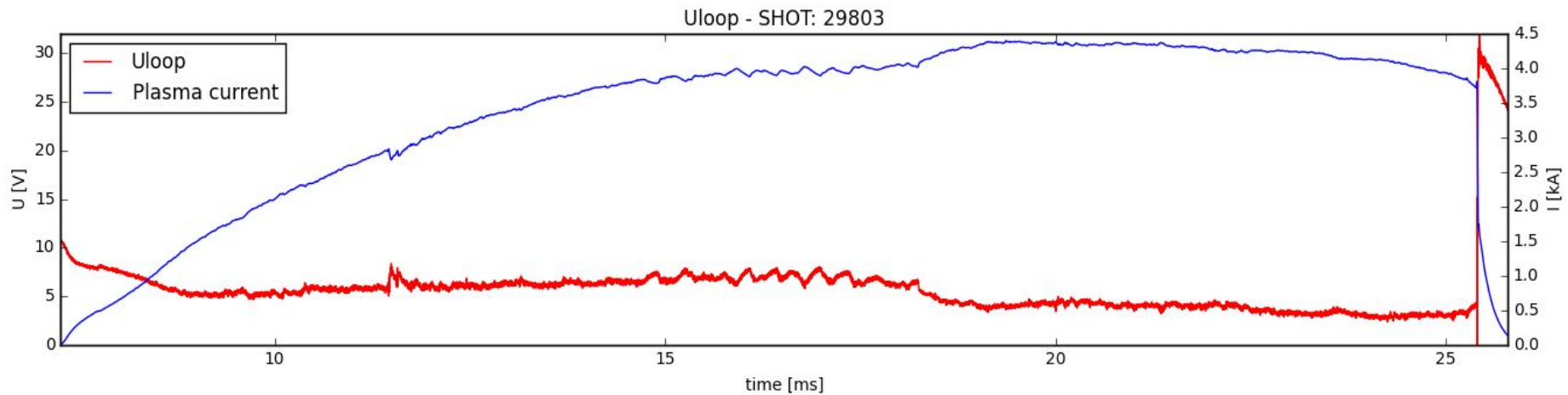


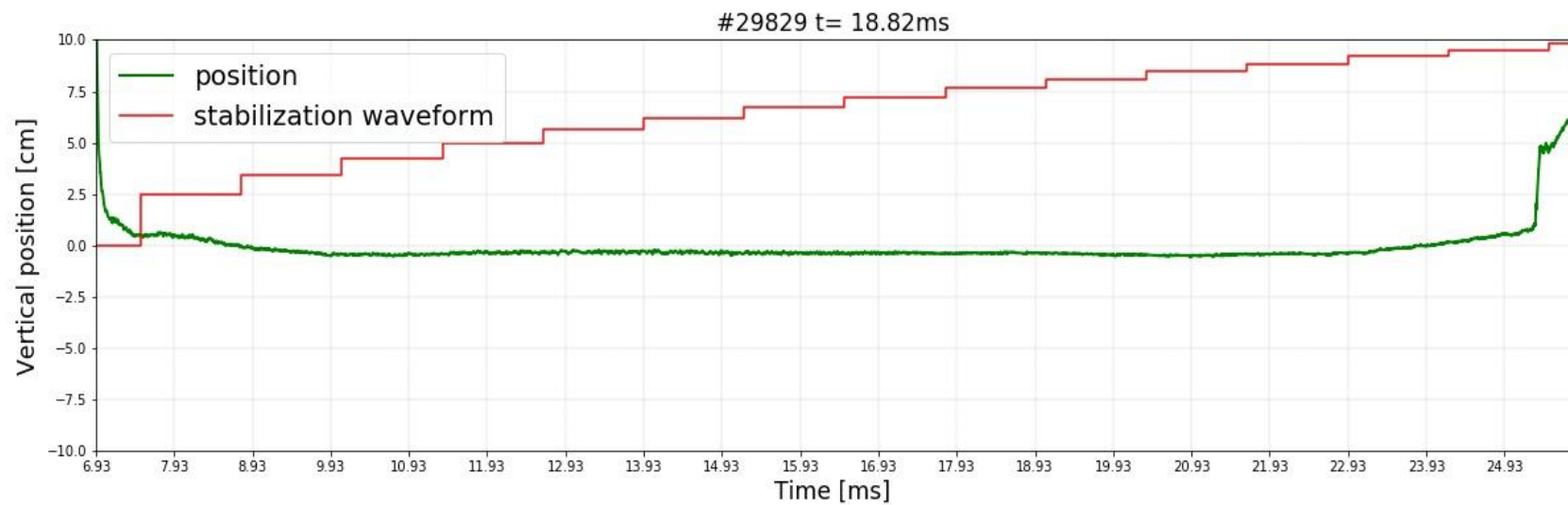
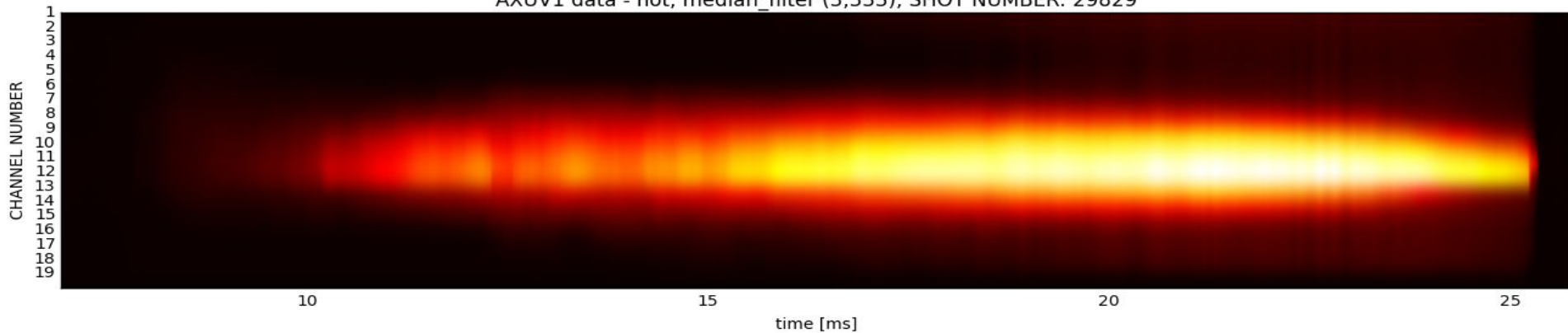
AXUV1 data - hot, median_filter (3,333), SHOT NUMBER: 29795

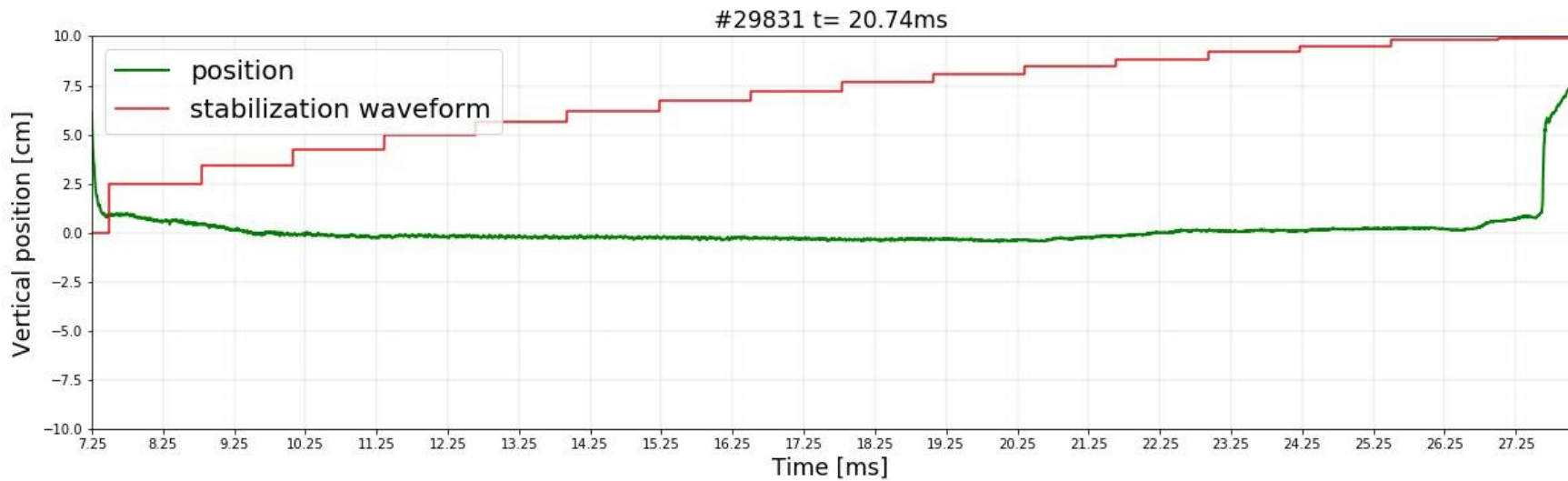
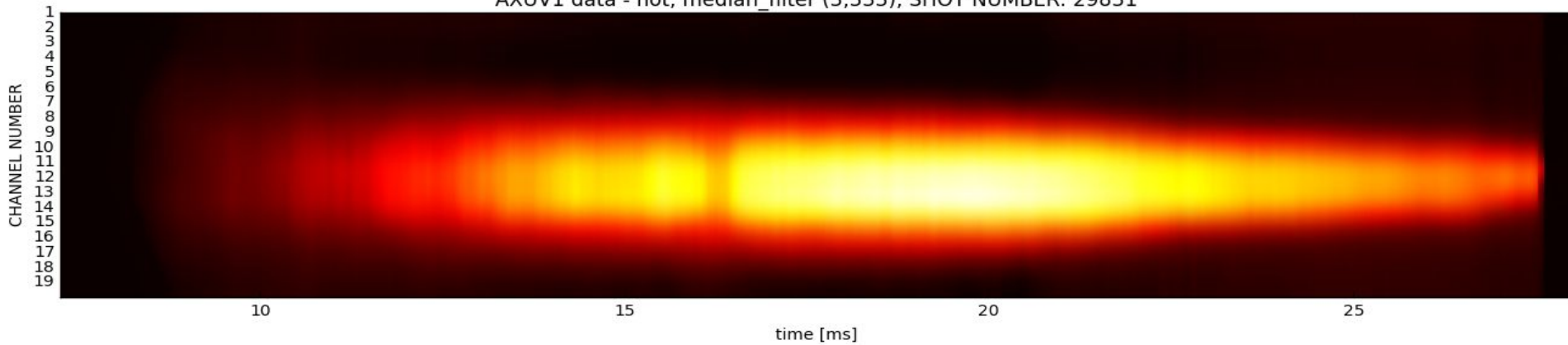


AXUV1 data - hot, median_filter (3,333), SHOT NUMBER: 29803

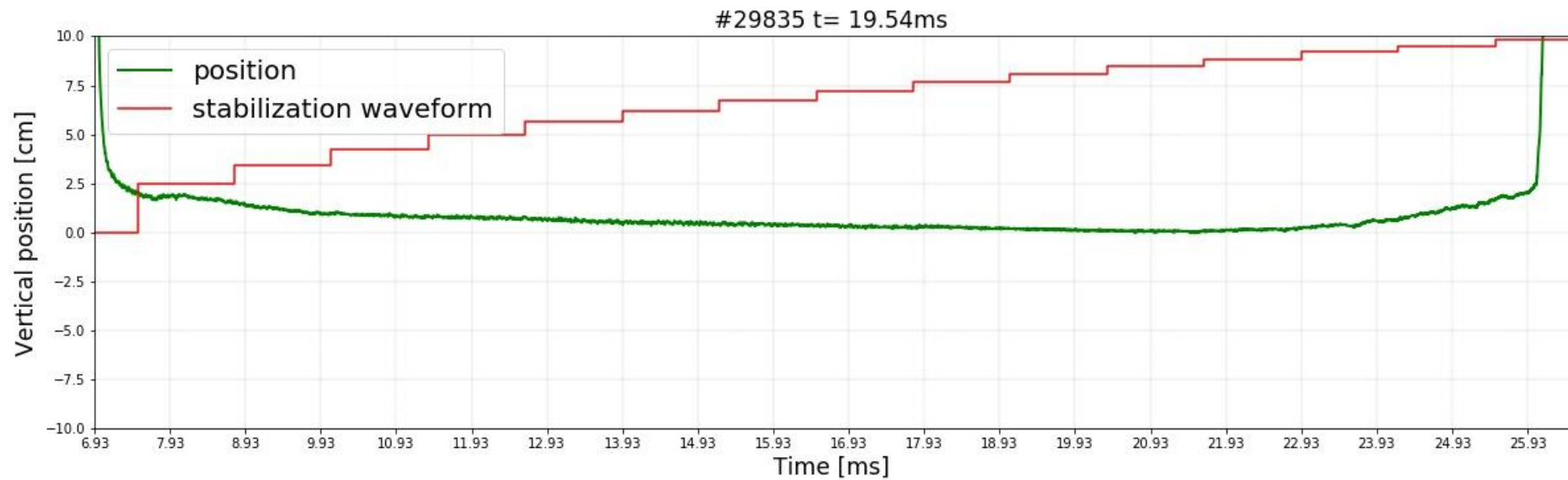
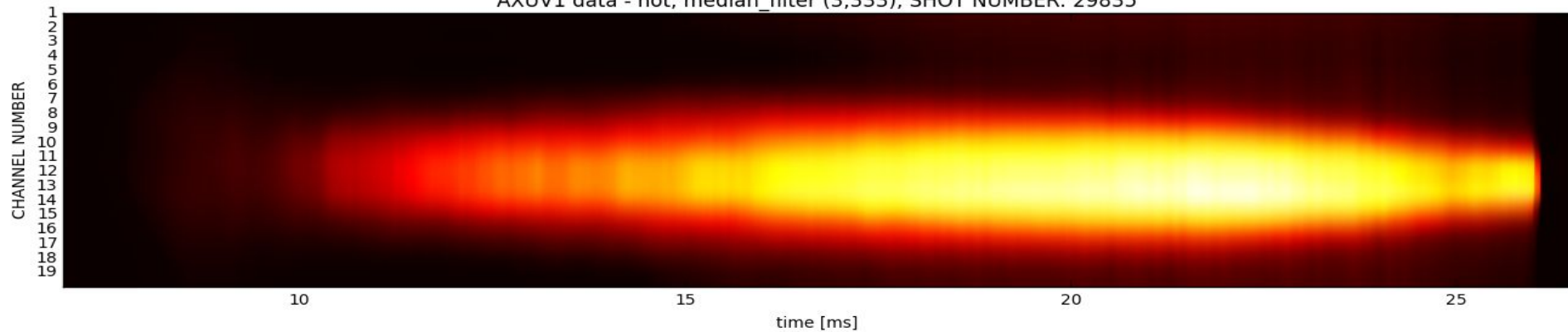




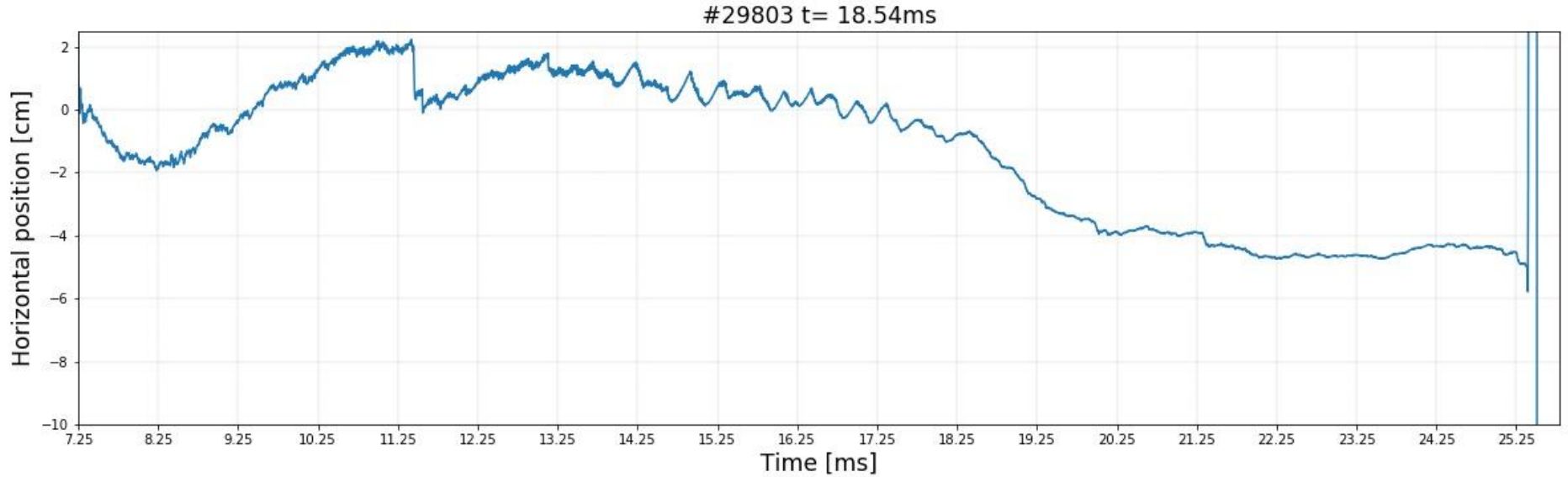




AXUV1 data - hot, median_filter (3,333), SHOT NUMBER: 29835



Why do the plasmas die?



How to improve?

- More trial and error to find the correlation between dR and dZ
 - Script the shots
- Possibly reducing voltage towards the end
- Use more Mirnov coils to confirm motion
 - The 16 ring that GOLEM already has
- Get Bz to use large aspect ratio approximation
- Decoupling the control coils
- Feedback control

Acknowledgements

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Questions?

