

PLASMA REGIME OPTIMIZATION IN GOLEM TOKAMAK



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2024

OUTLOOK



- **Introduction to plasma positioning**
- **Plasma positioning in GOLEM**
- **Experimental setup**
- **Experimental analysis**
- **Explanation of the experimental results**
- **Conclusion and future perspective**

WHY POSITION PLASMA?



Why plasma positioning is important for fusion?

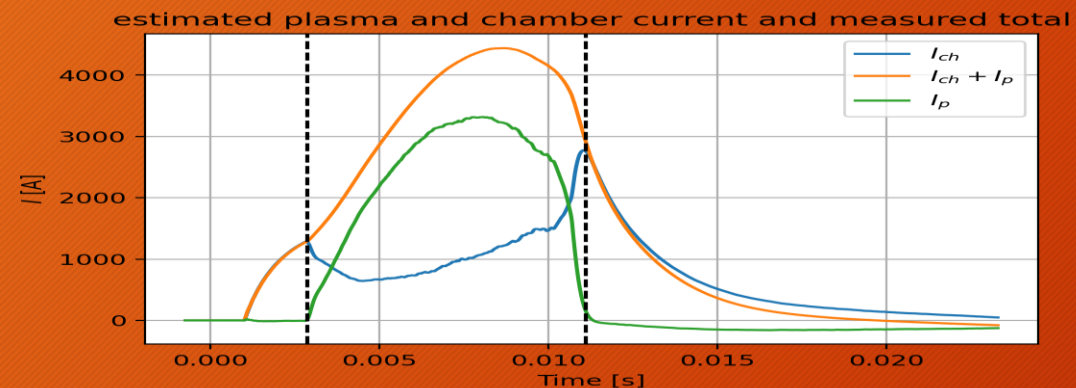
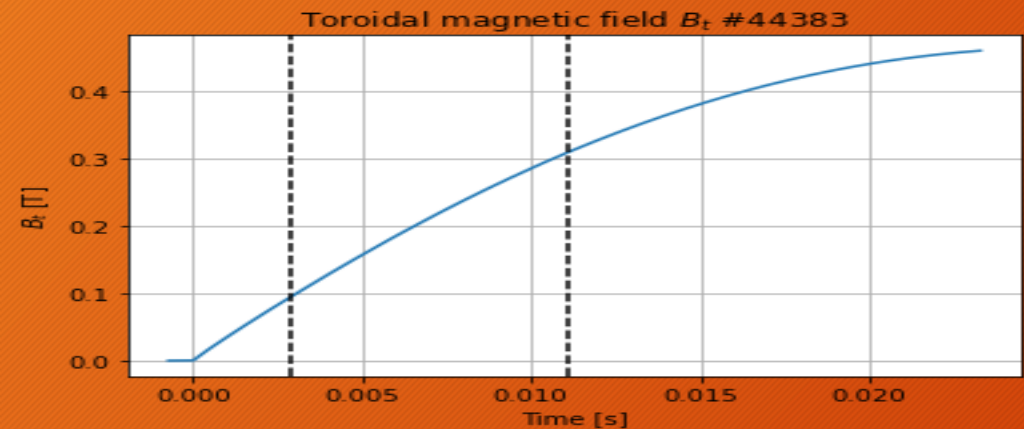
- **Loss of confinement and plasma contact with walls is destructive**

Why plasma moves?

- **Toroidal force balance (hoop force + tyre tube force + $1/R$ force = outward force on plasma**
- **Vertical displacement event**

TOKAMAK GOLEM- Basic parameters

Major Radius	R	0.4m
Minor Radius	a	0.085m
Max Plasma Current	I_p^{max}	< 8kA
Max Toroidal Field	B_T^{max}	< 0,5T
Typical Electron density	$\langle n_e \rangle$	$(0,2 - 3) \cdot 10^{19}m^{-3}$
Max. Electron Temperature	T_e^{max}	< 80eV
Max. Discharge Duration	τ_p^{max}	< 25ms



Basic Diagnostic Results from GOLEM:
 U_{loop} [V], B_T [T], I_p [kA] (#44343)

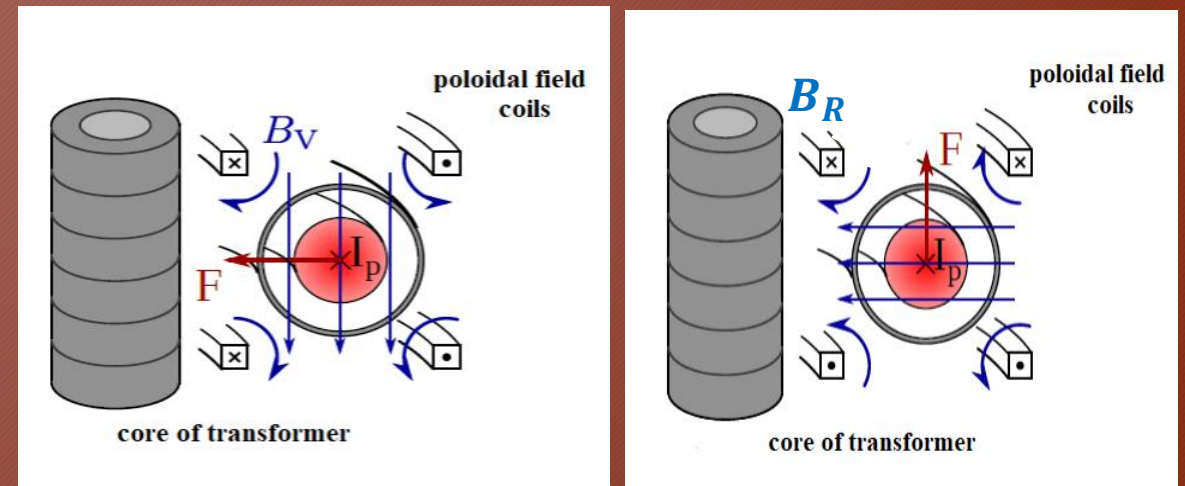
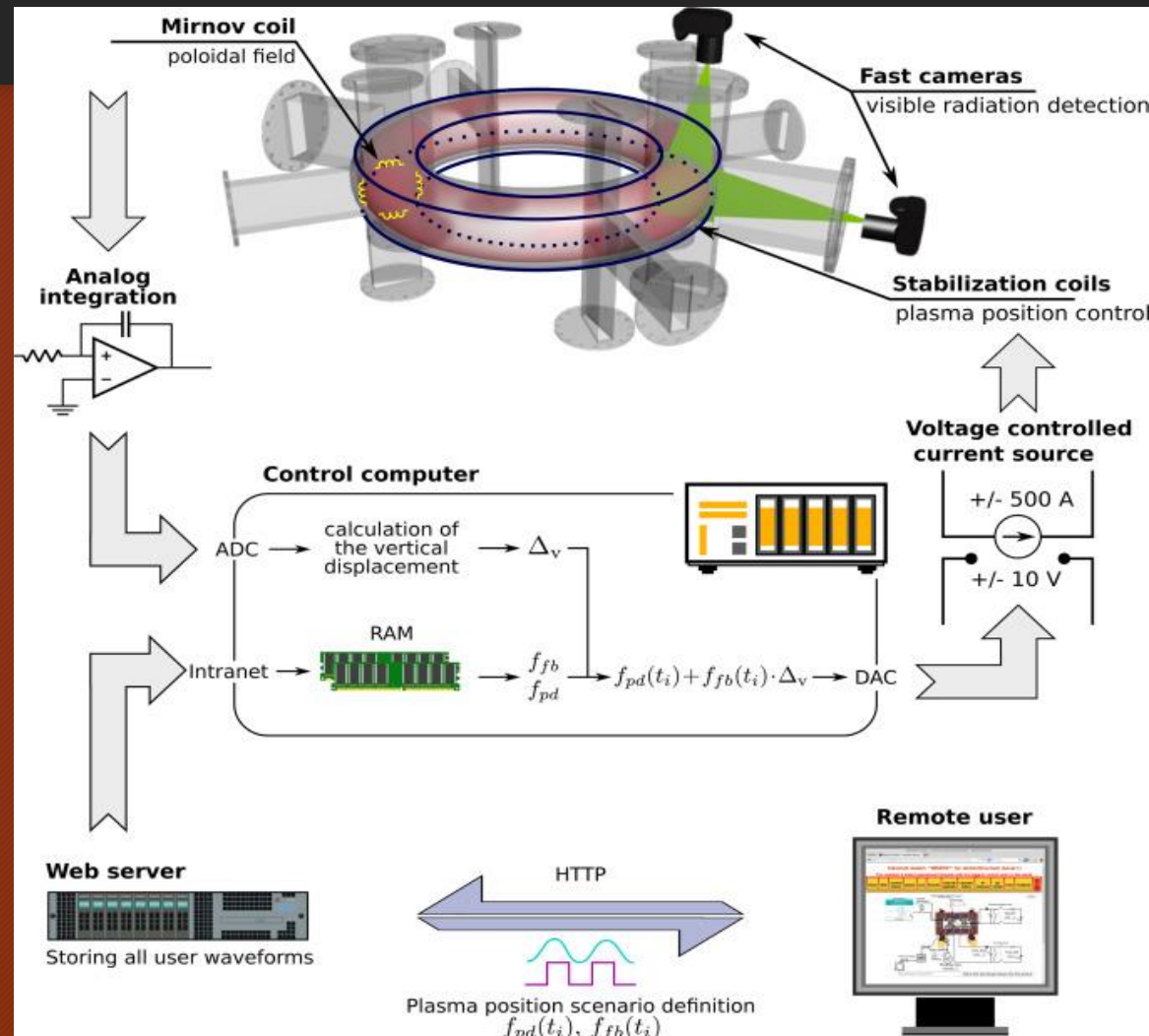


Experimental Setup



SO, WE NEED STABILIZATION. HOW?

- We use vertical and radial transformer coils.
- Vertical and radial magnetic forces are created due to the presence of magnetic fields.
- These forces restrict the plasma hence stabilizes position.

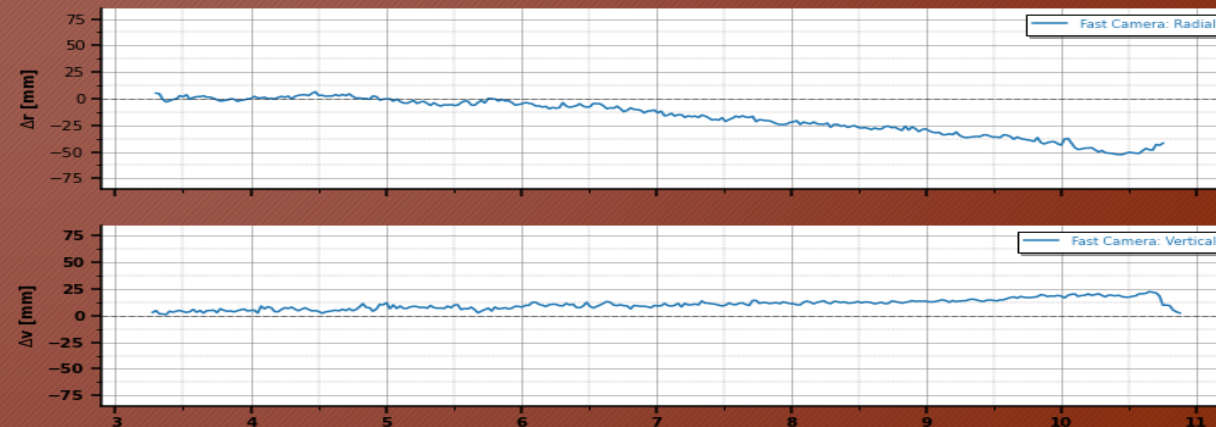
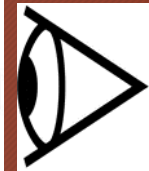
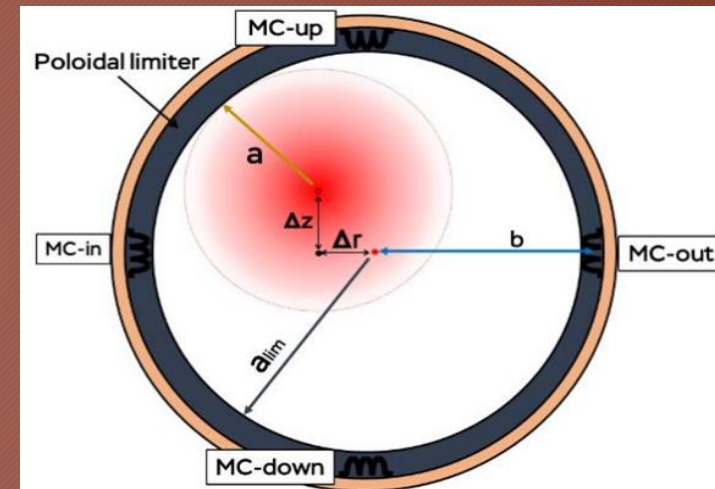
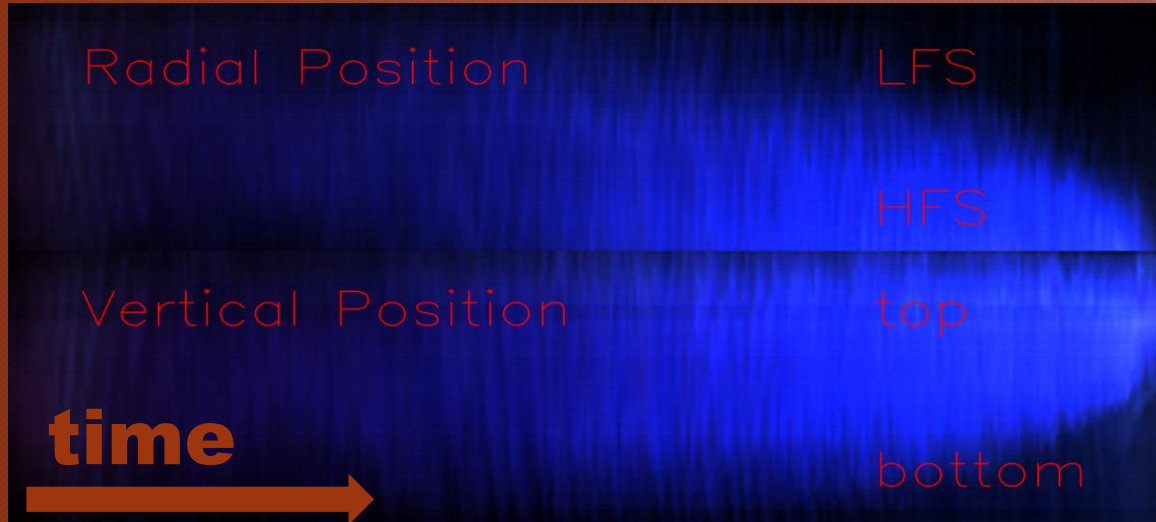


Stabilization coils

Visualization

Two fast cameras at (top & LFS) are being used to determine plasma position

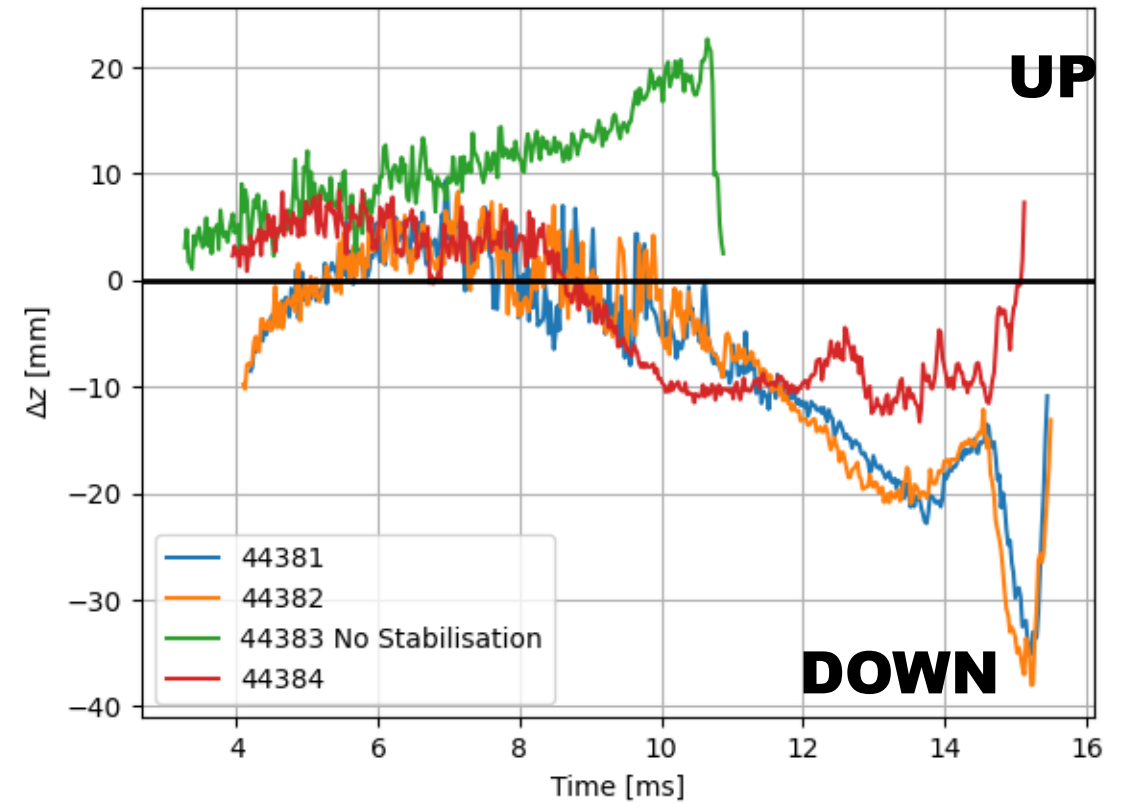
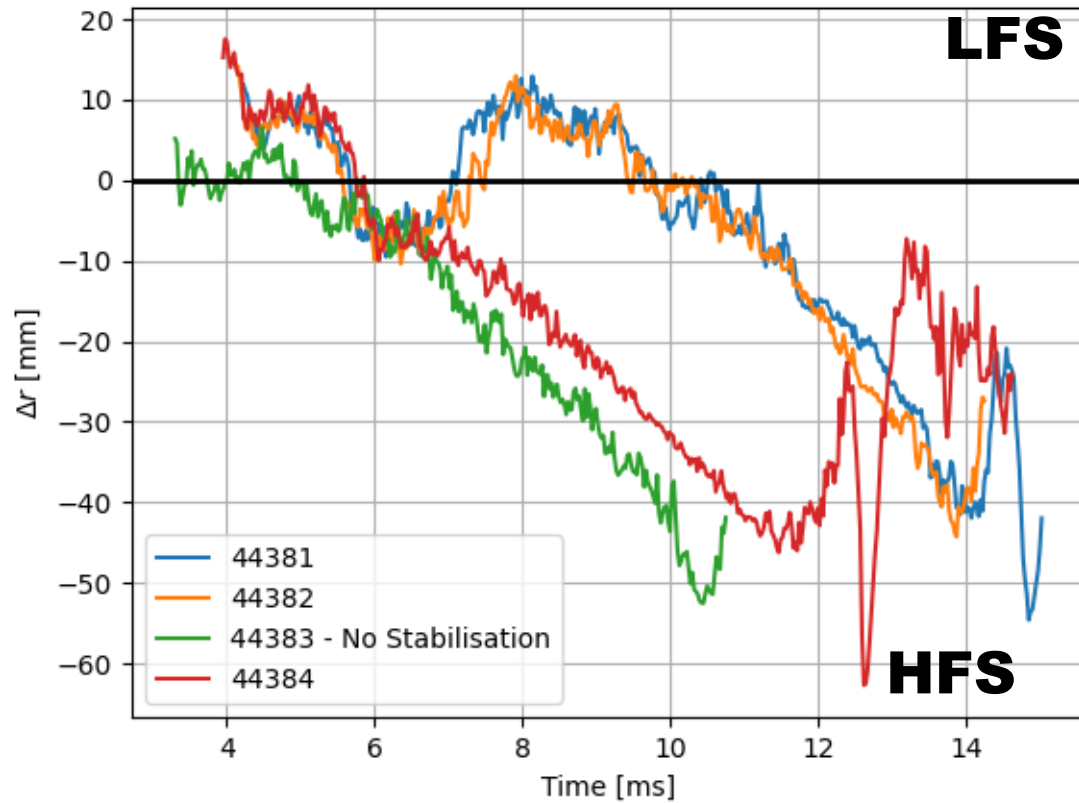
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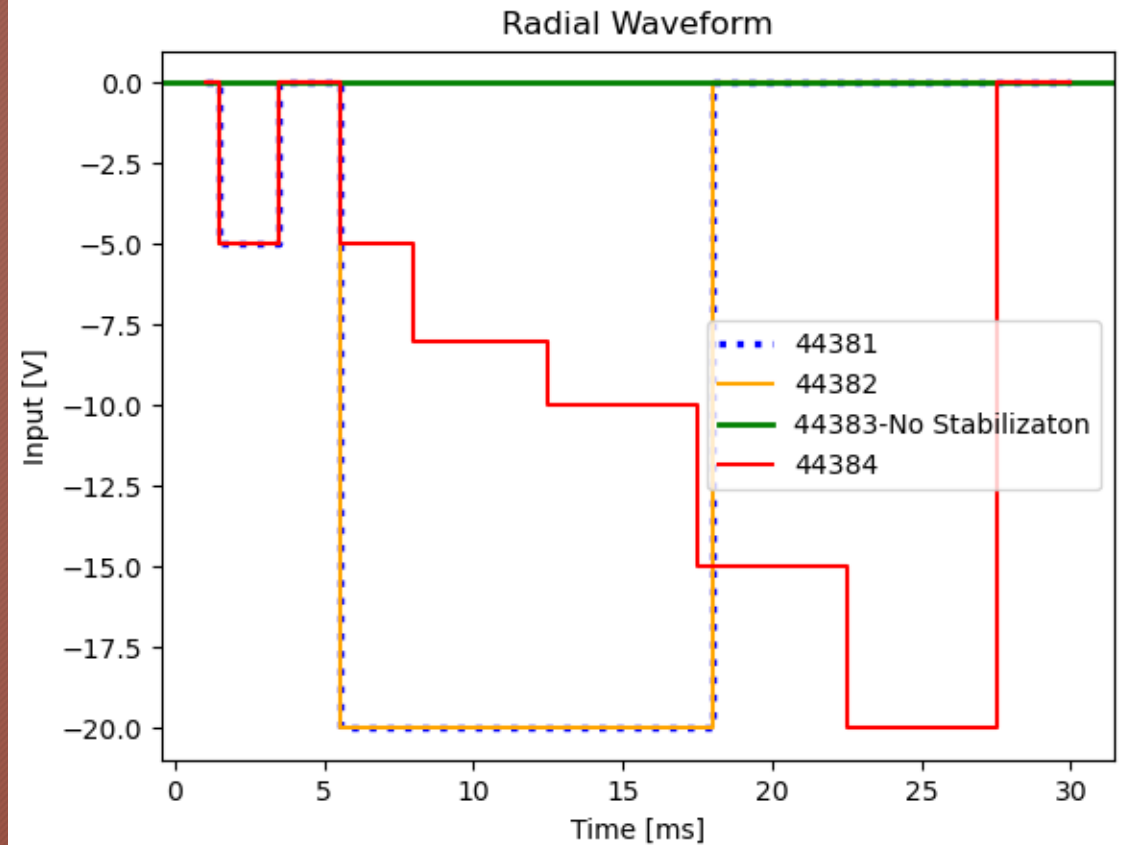
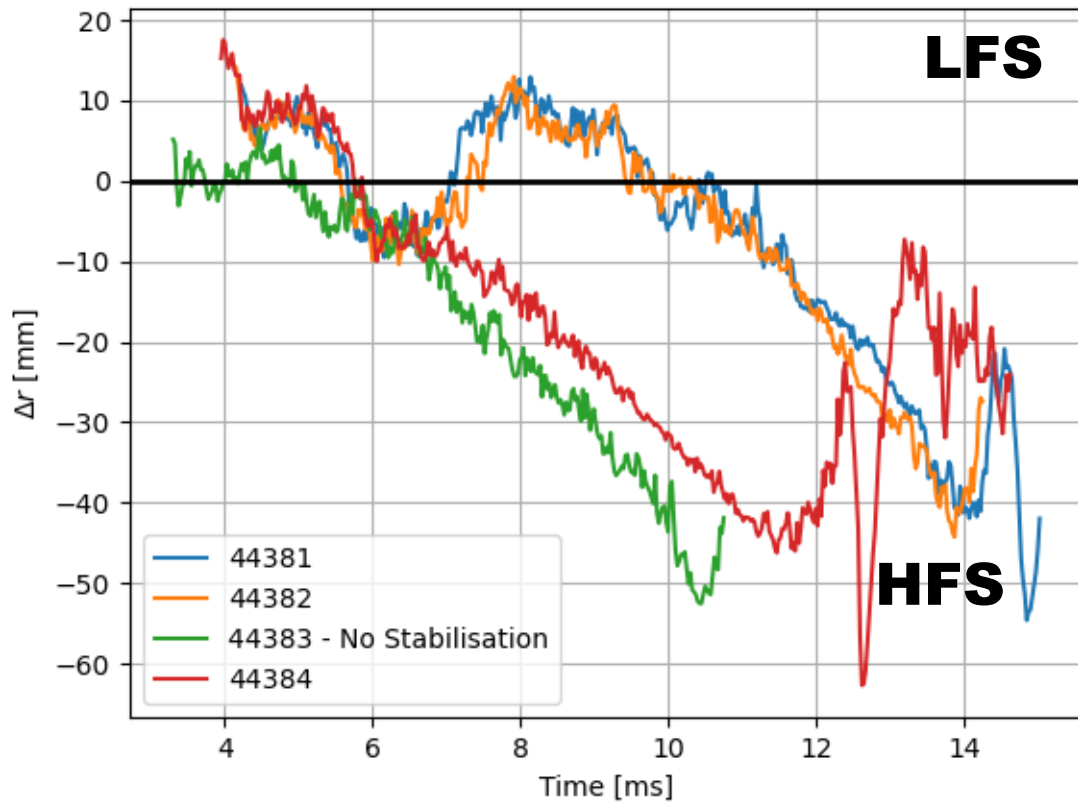
Experimental Analysis- Better stability vs Worse stability



$U_{bt} = 800V$
 $U_{cd} = 500V$

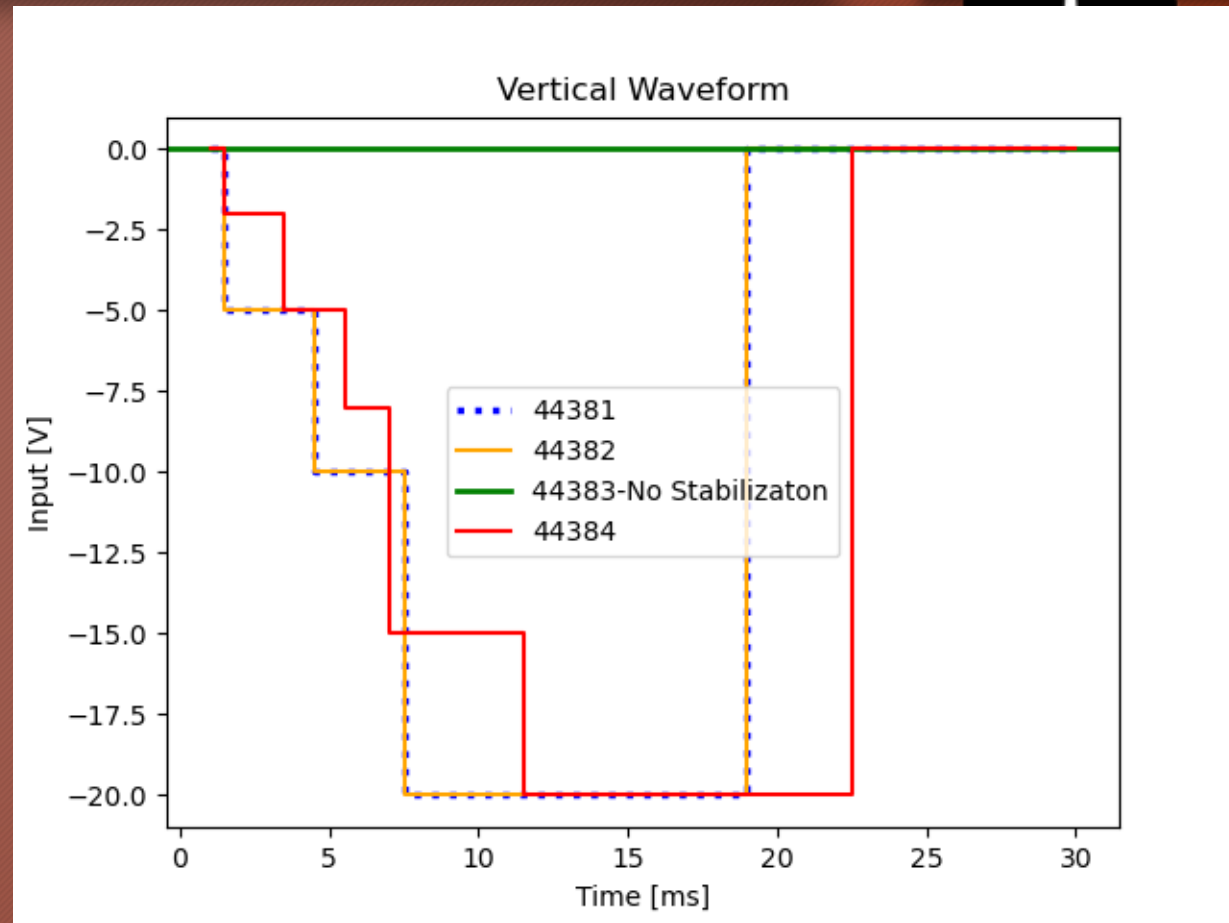
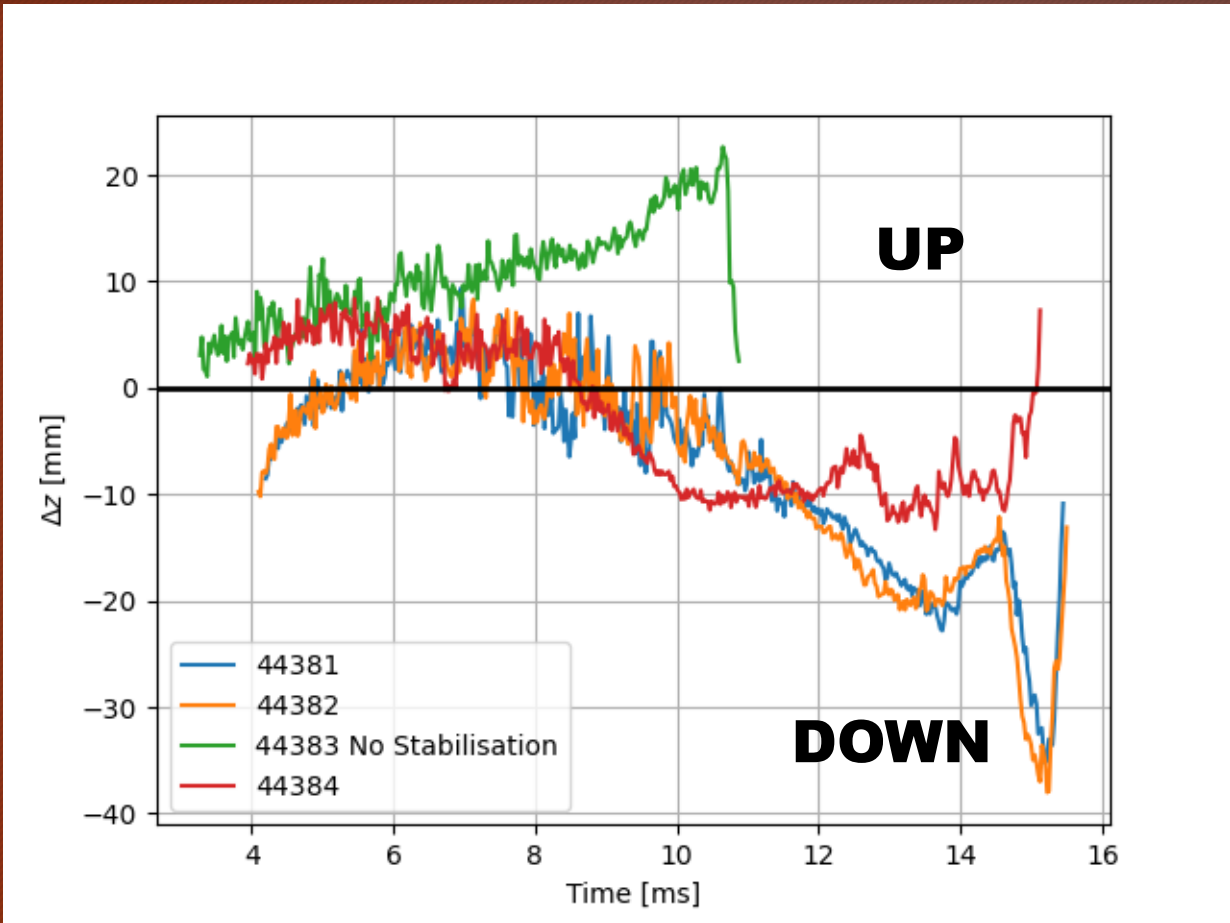
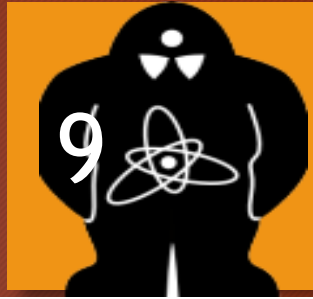


Experimental Analysis- Better stability vs Worse stability



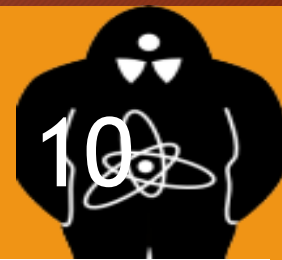
Steps are GOOD. But WHAT STEPS?

Experimental Analysis- Better stability vs Worse stability

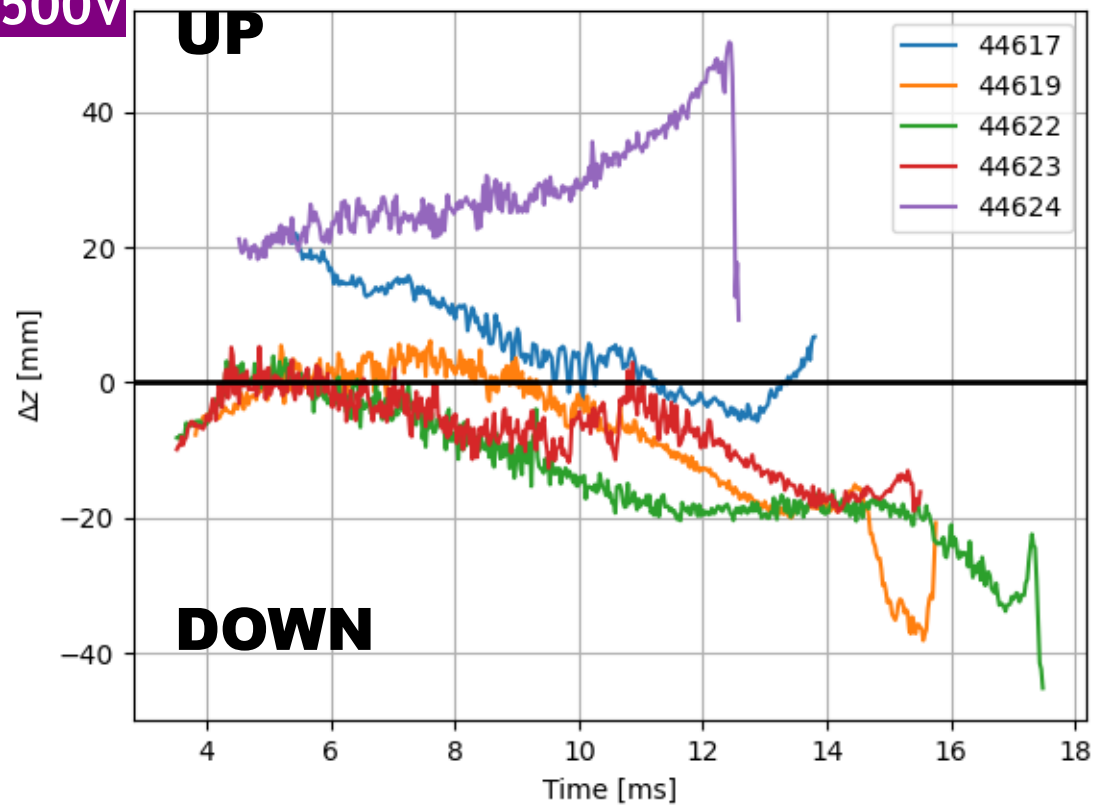
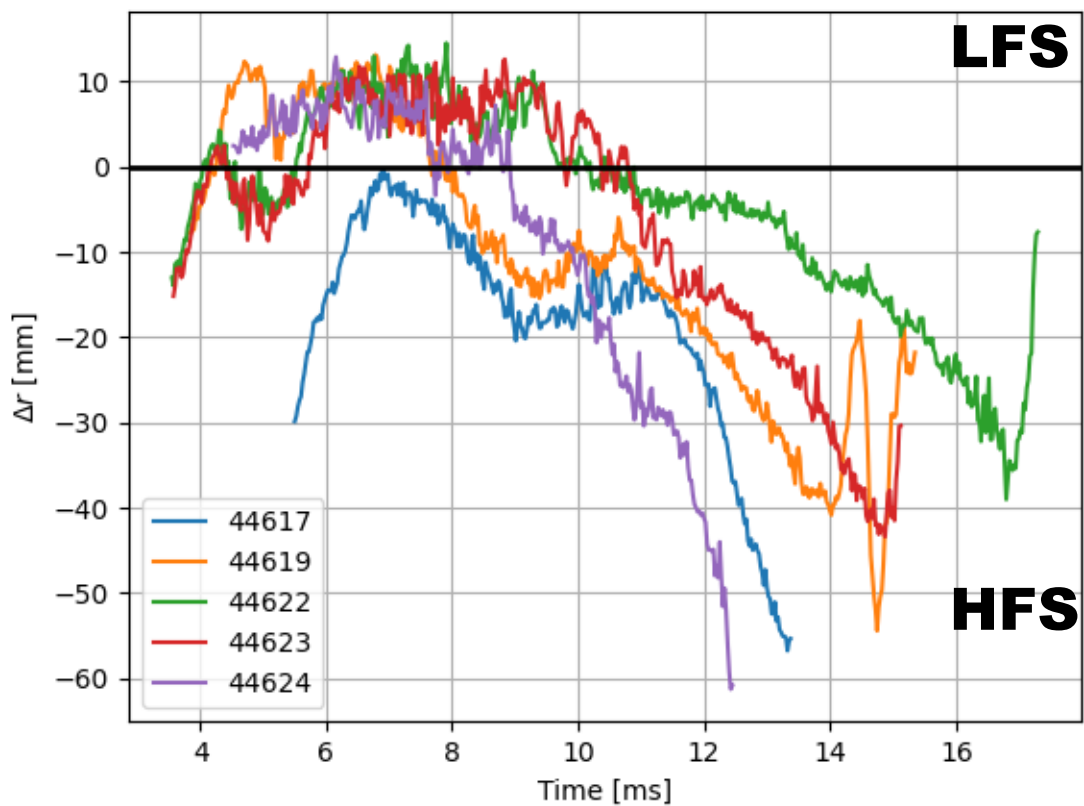


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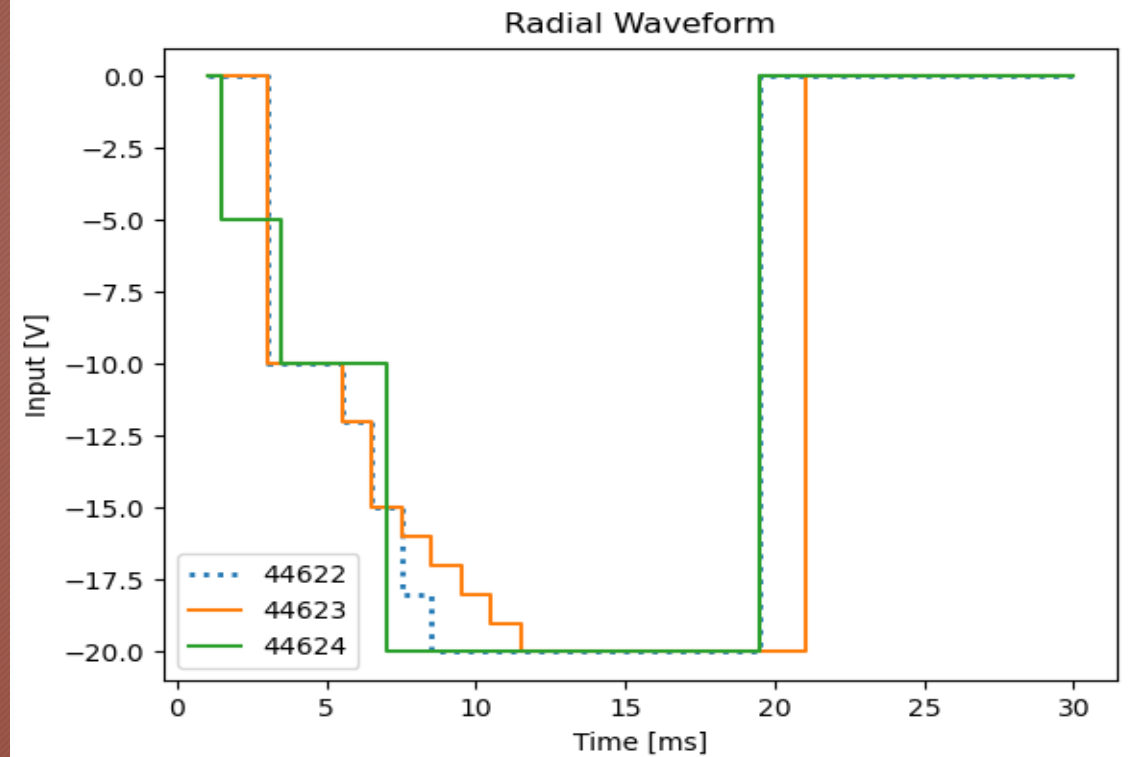
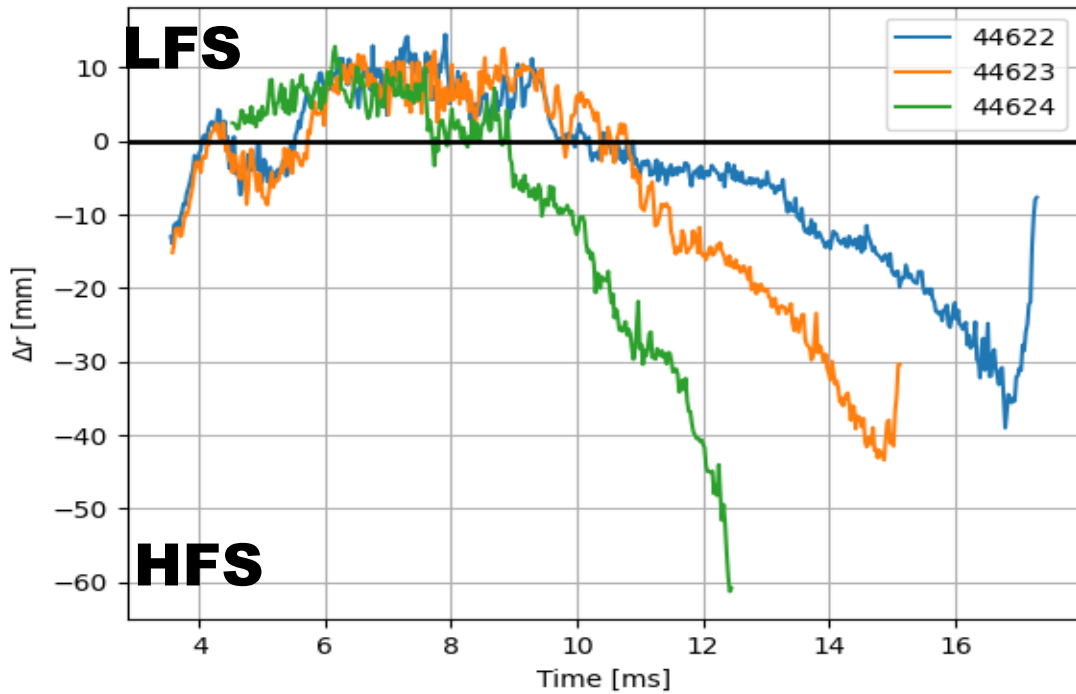
Experimental Analysis



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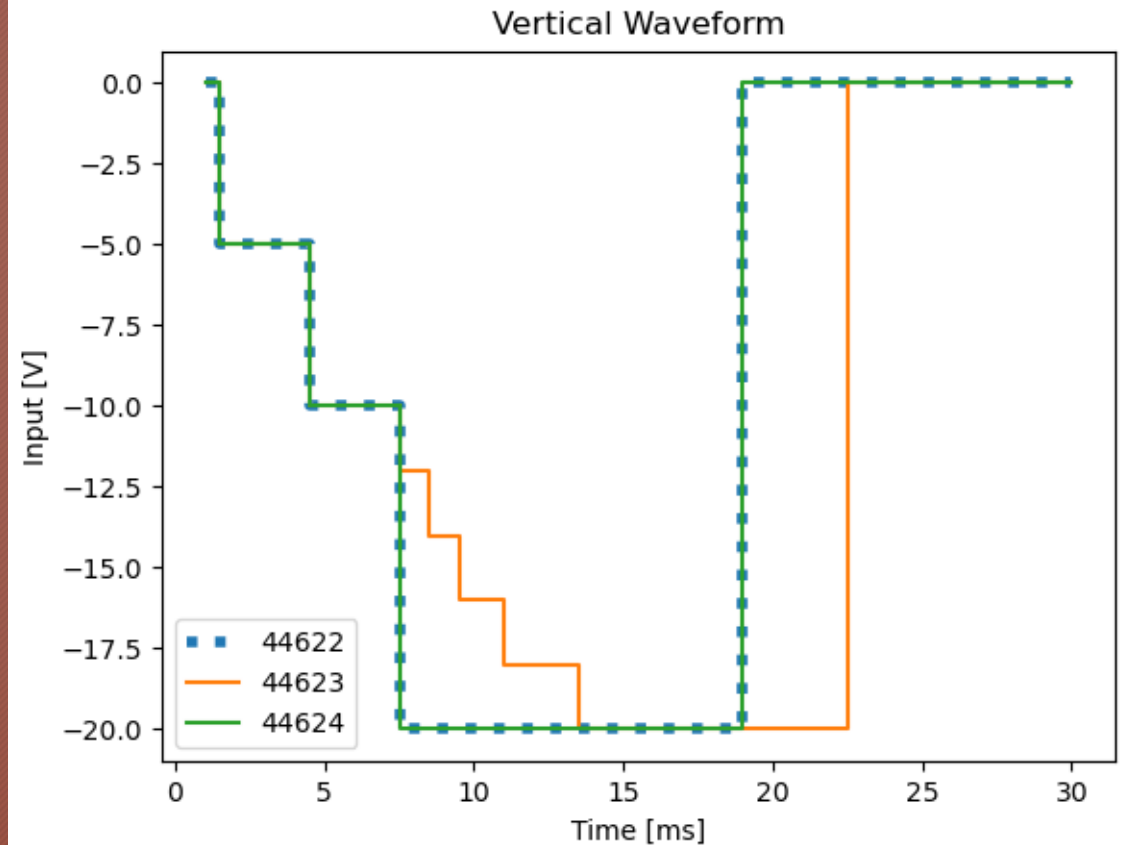
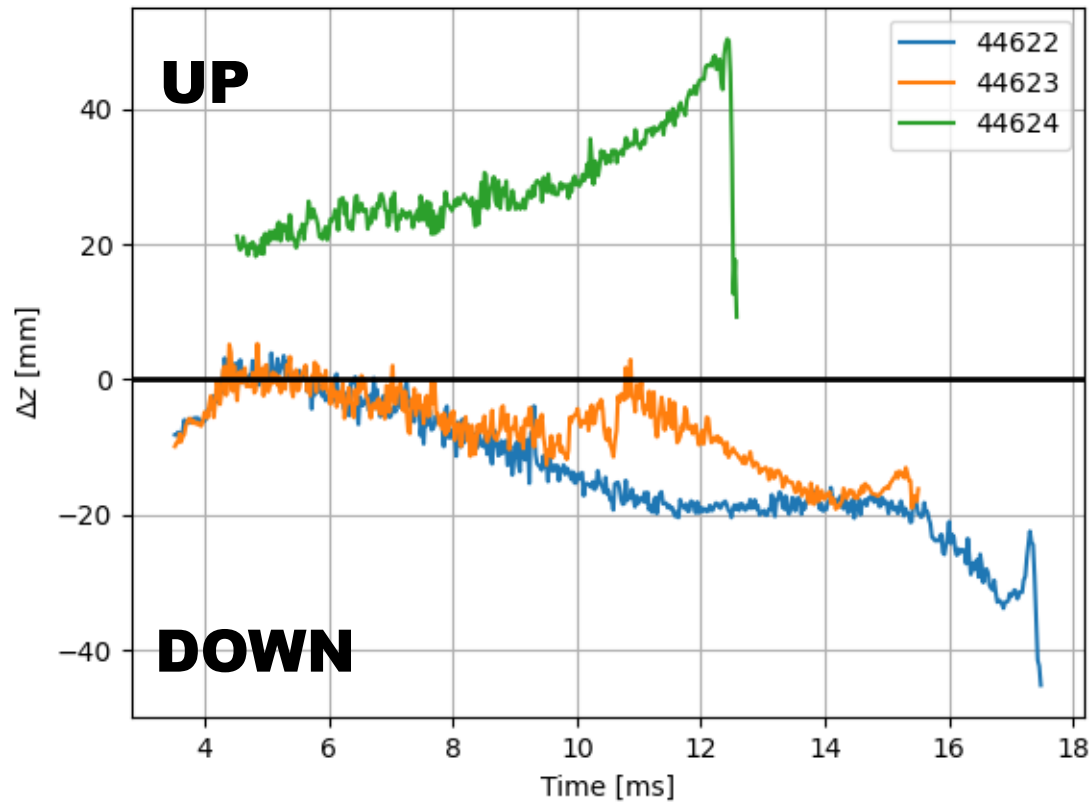


Experimental Analysis



Medium STEPS of 2-3V.

Experimental Analysis- Better stability vs Worse stability



Conclusions



- Stabilization is necessary for Plasma positioning at GOLEM
- Medium steps of 2-3V give better stabilization

References



1. GOLEM Tokamak Wiki. Tokamak Parameters (2016).
2. Svoboda, Vojtech & Kocman, J. & Grover, Ondřej & Krbec, J. & Stockel, J.. (2015). Remote operation of the vertical plasma stabilization @ the GOLEM tokamak for the plasma physics education. Fusion Engineering and Design. 96. [10.1016/j.fusengdes.2015.06.044](https://doi.org/10.1016/j.fusengdes.2015.06.044).
3. Bervas, Peedika et al., 2023 (EMTRAIC)
4. Ali, Mounir et al., 2024 (FUSION EP Winter Event)