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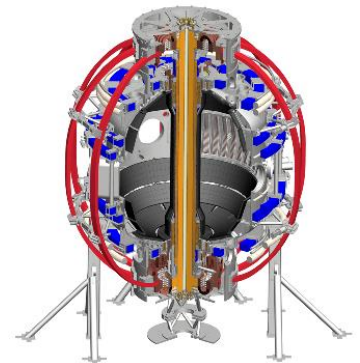
Observation of stationary filaments with Resonant Magnetic Perturbations in NSTX

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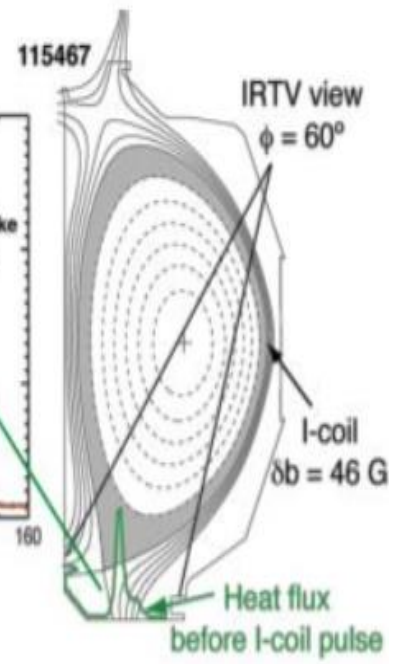
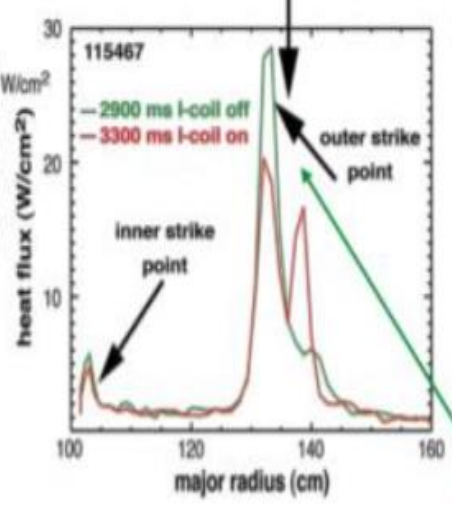
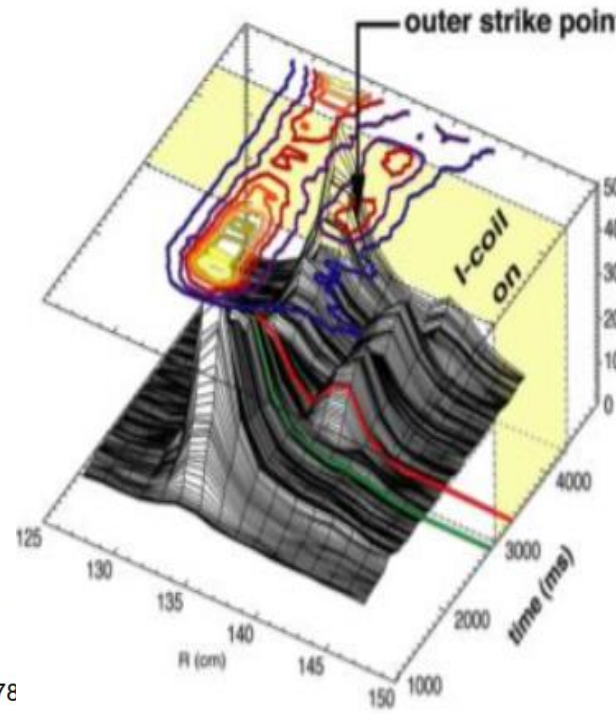
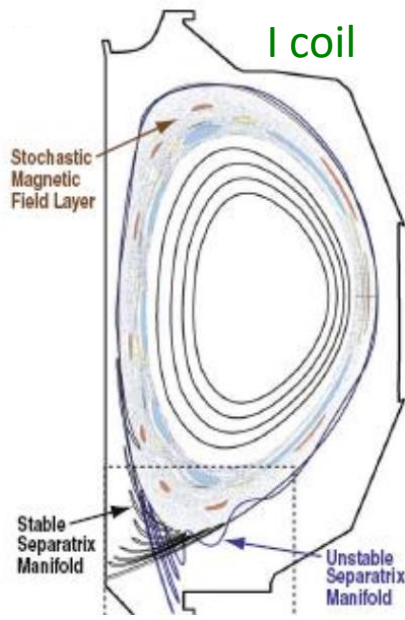
NSTX-U Science Meeting
May 20, 2024



Outline

- Physics Background: strike point splitting with RMPs
- Introduction: Heat flux striation with filaments and RMPs
- Observation of stationary 3D filaments with $n=3$ RMPs
- Field line tracing results and discussion
- Summary

Physics background for strike points splitting with RMPs

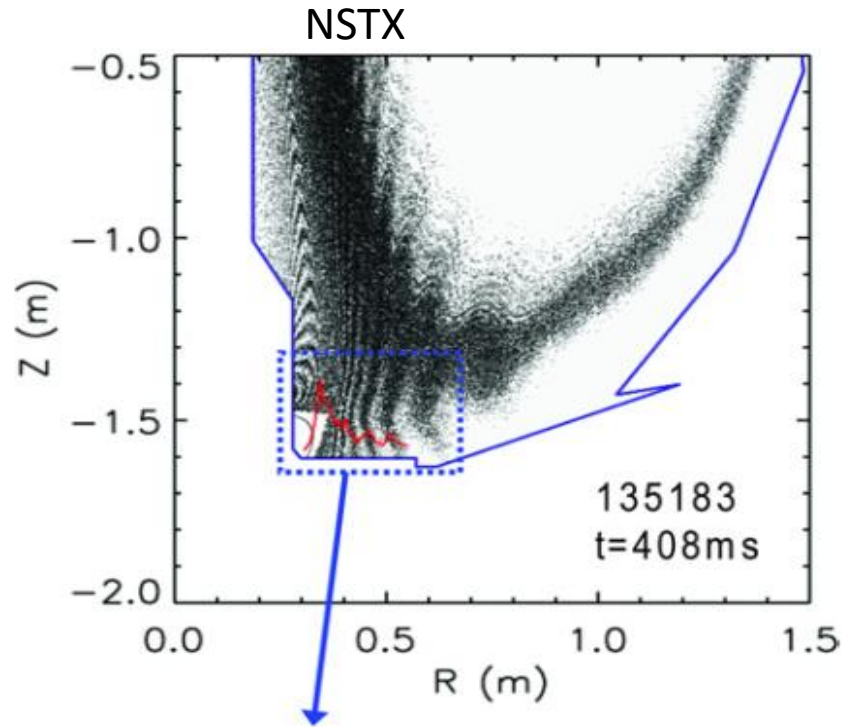


T.E. Evans, J. Nucl. Mater. 390-391 (2009), 78

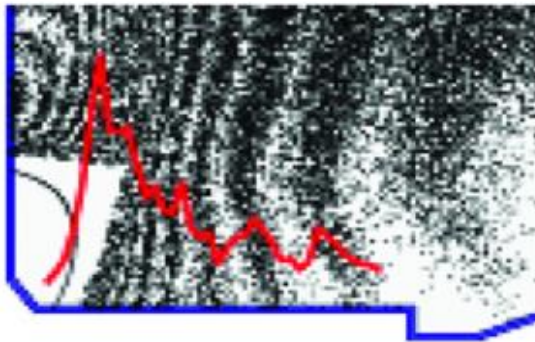
[T. E. Evans J. Phys.: Conf, 2005]

- The perturbed field lines with RMPs induce the lobe structure.
- The lobe structure causes the strike point splitting.

Previous observation in NSTX



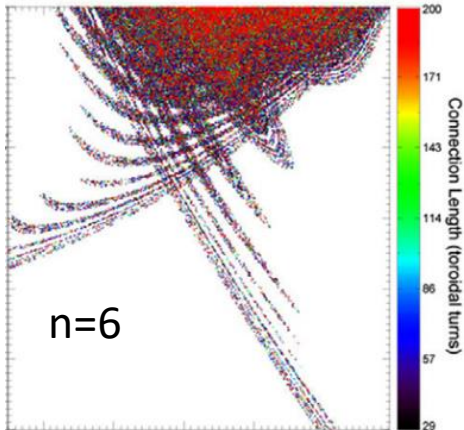
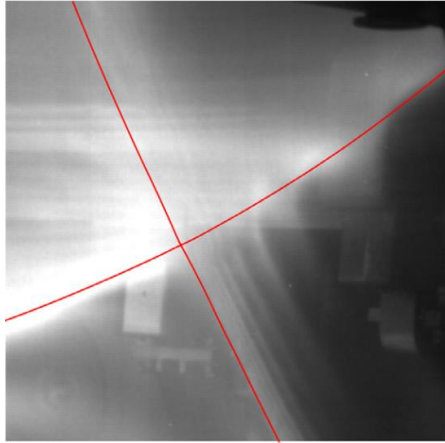
3-D fields cause divertor profile splitting, largely consistent with vacuum field line tracing



[J.W. Ahn, NF 2010]

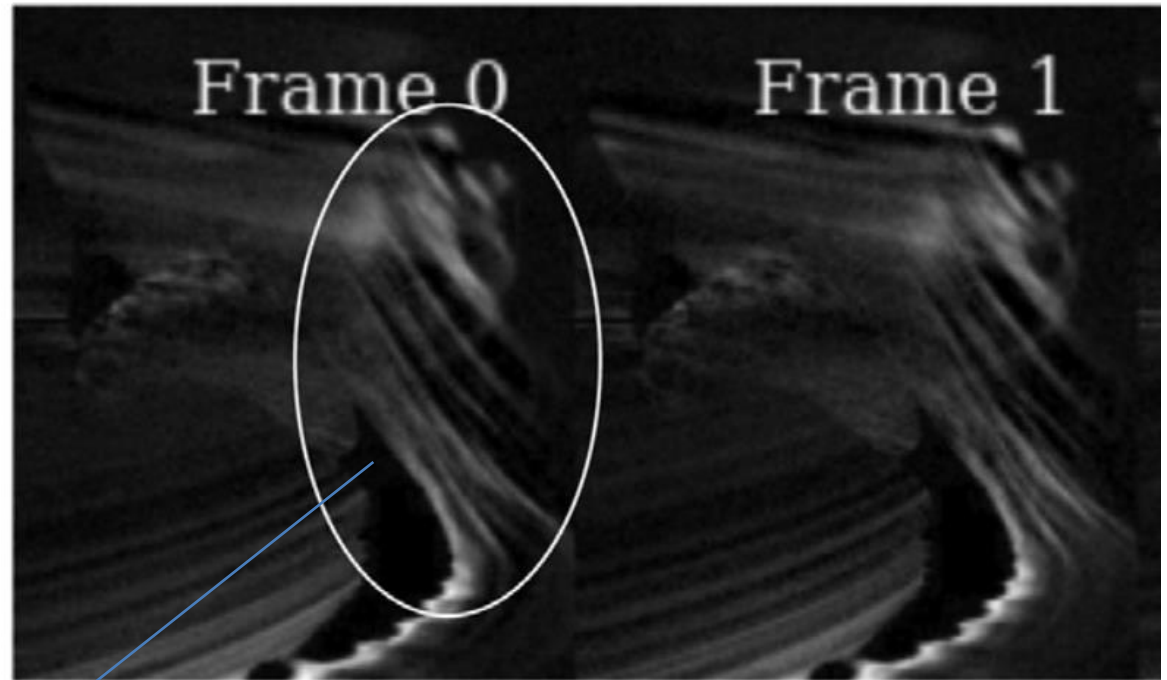
Lobe structure observation with RMPs in MAST

Visible image with $n=6$ RMPs



[J.R. Harrison, NF 2014]

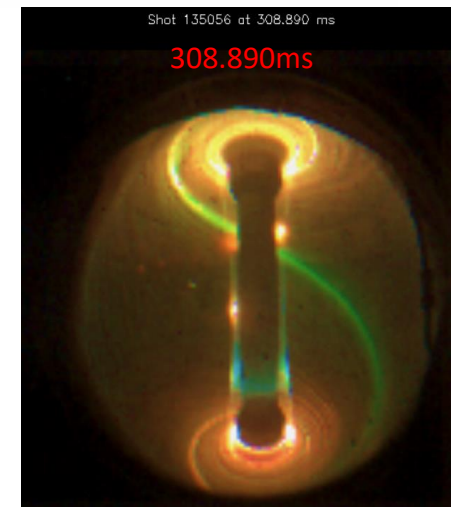
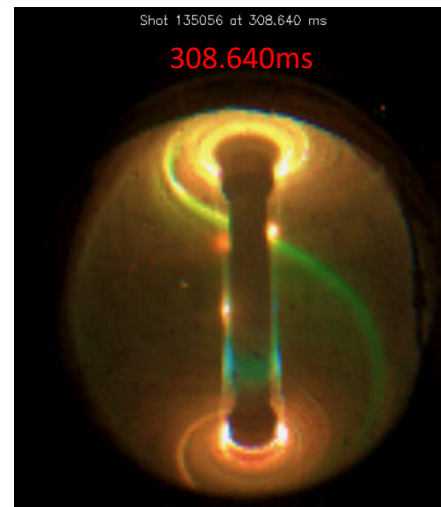
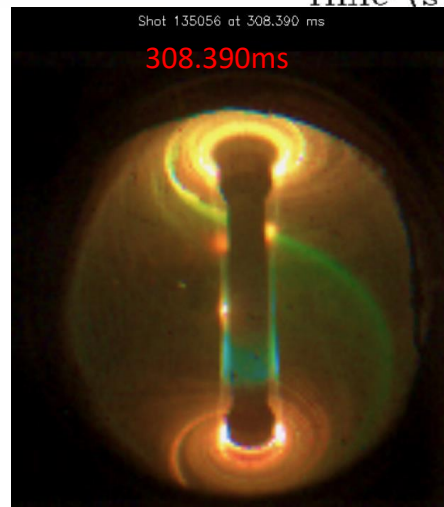
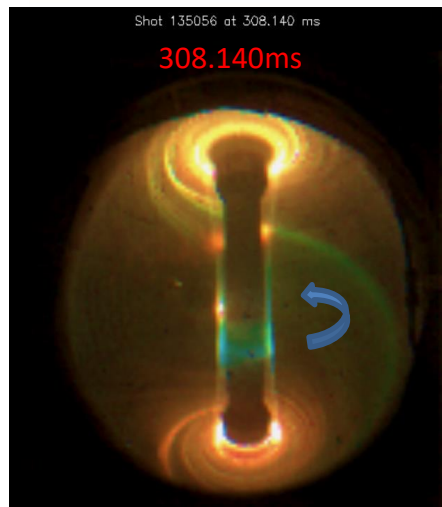
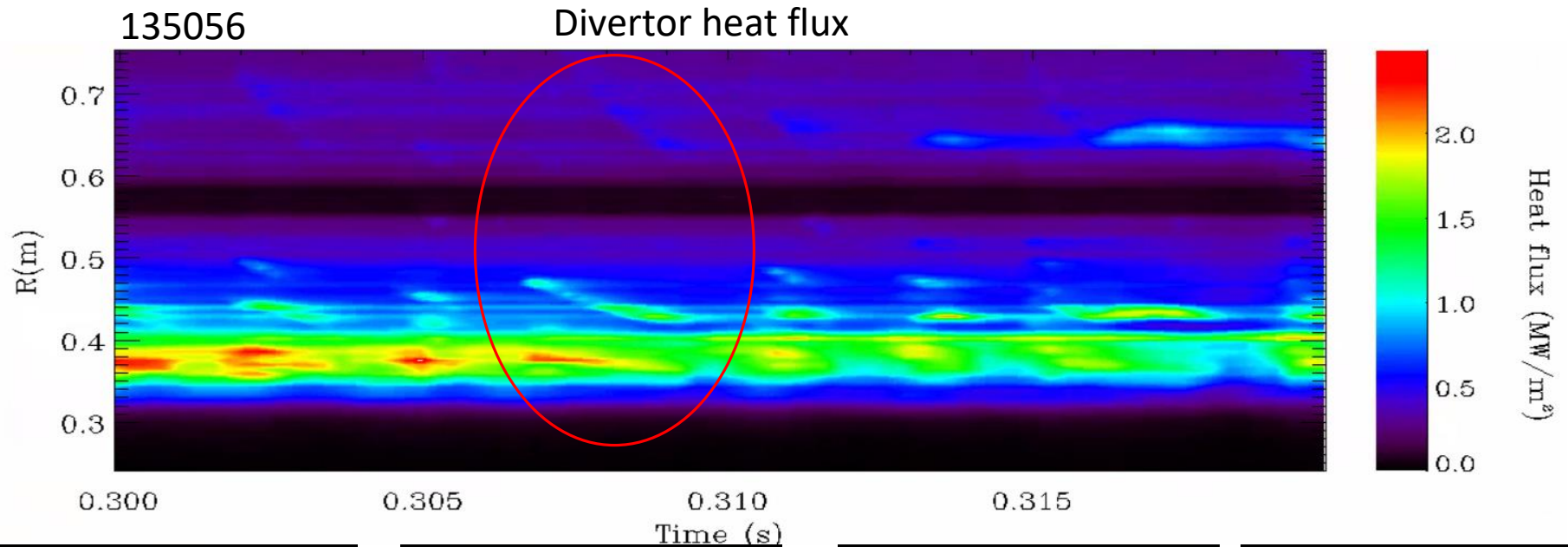
Filaments observation near the x-points



[N.R. Walkden NF 2014]

The “lobe-like” structure also existed on the visible image with filaments

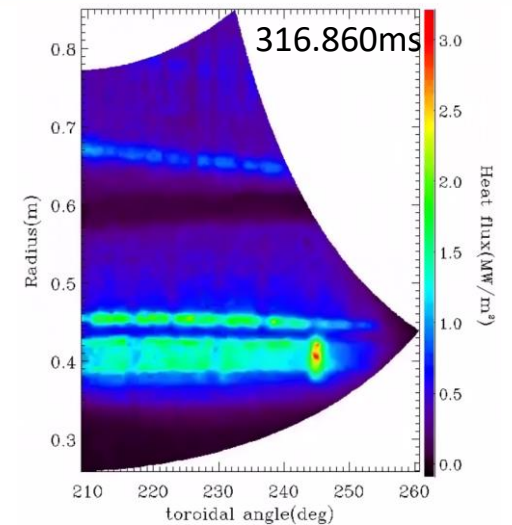
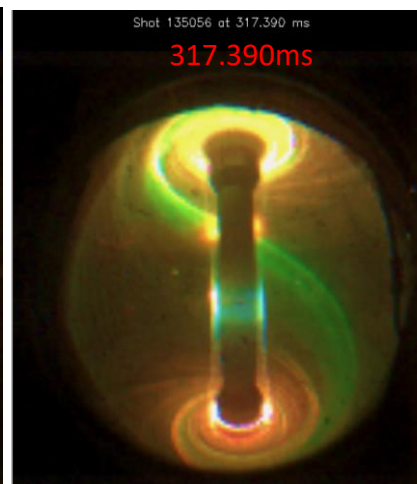
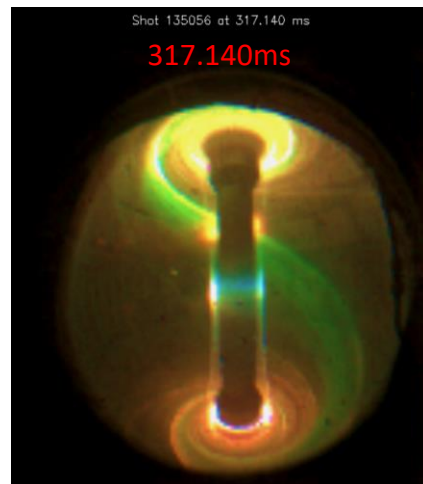
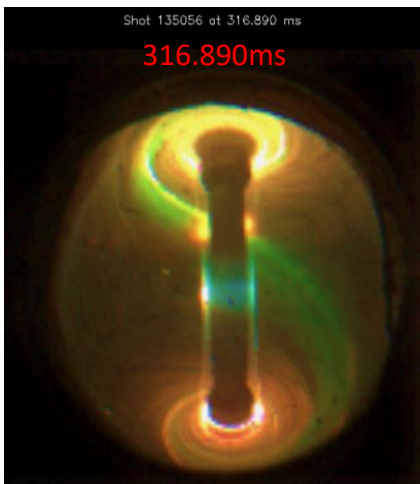
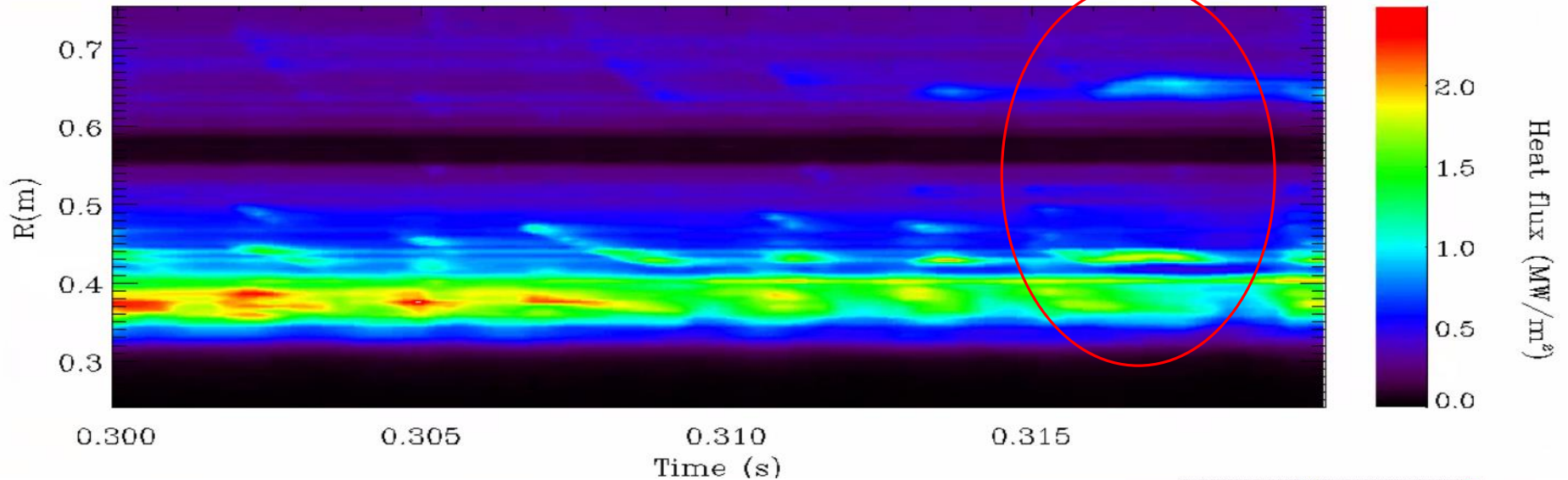
The effect of rotated filament on divertor heat flux



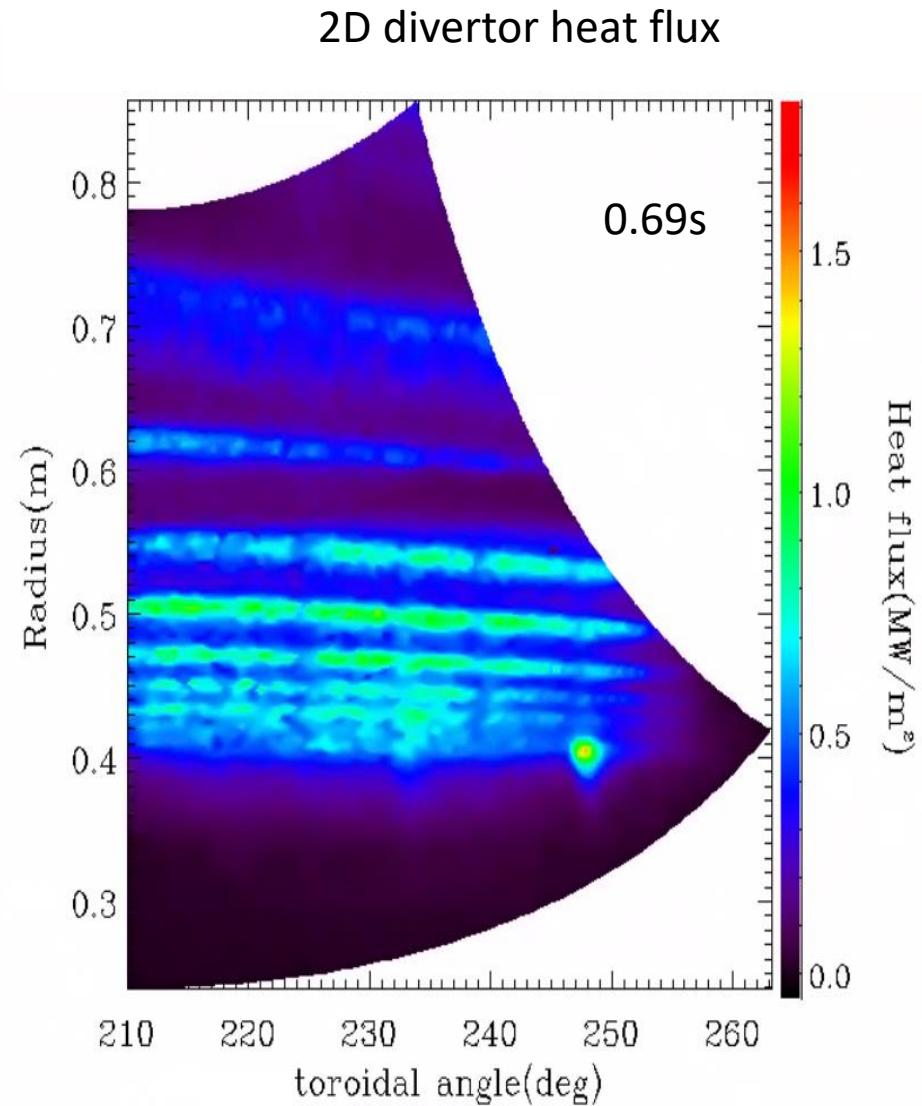
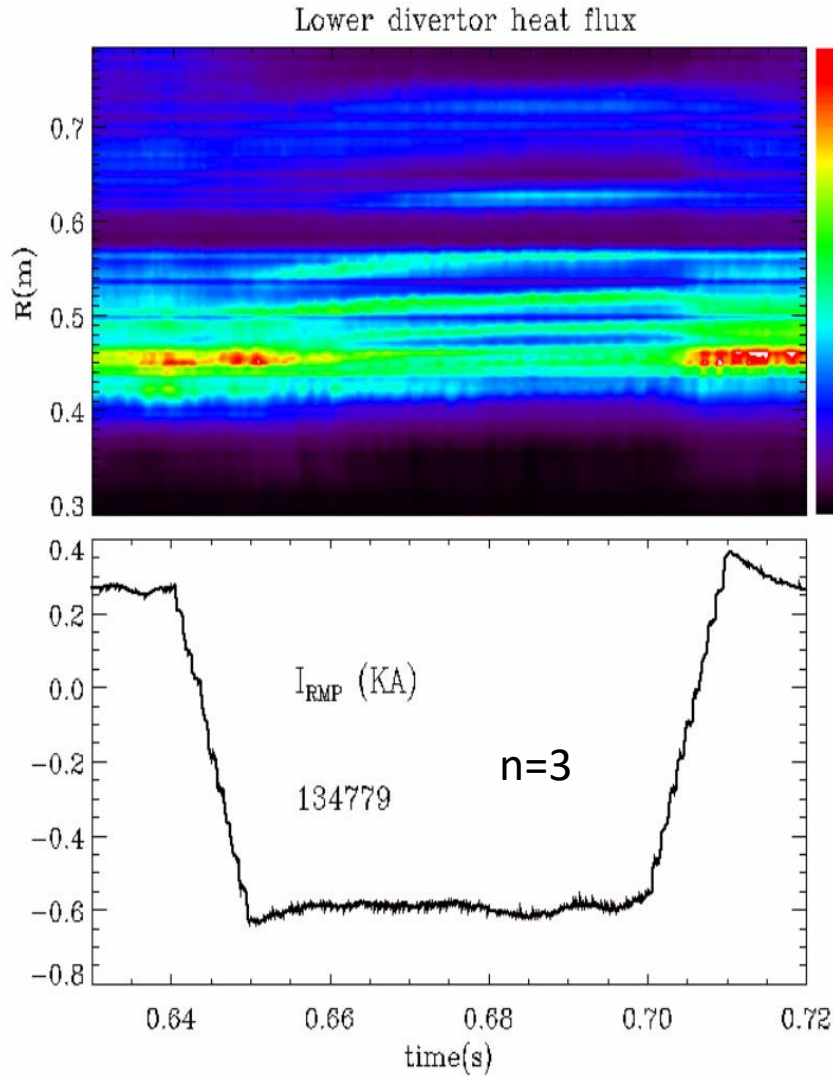
Stationary heat flux striation with stationary filaments

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Divertor heat flux

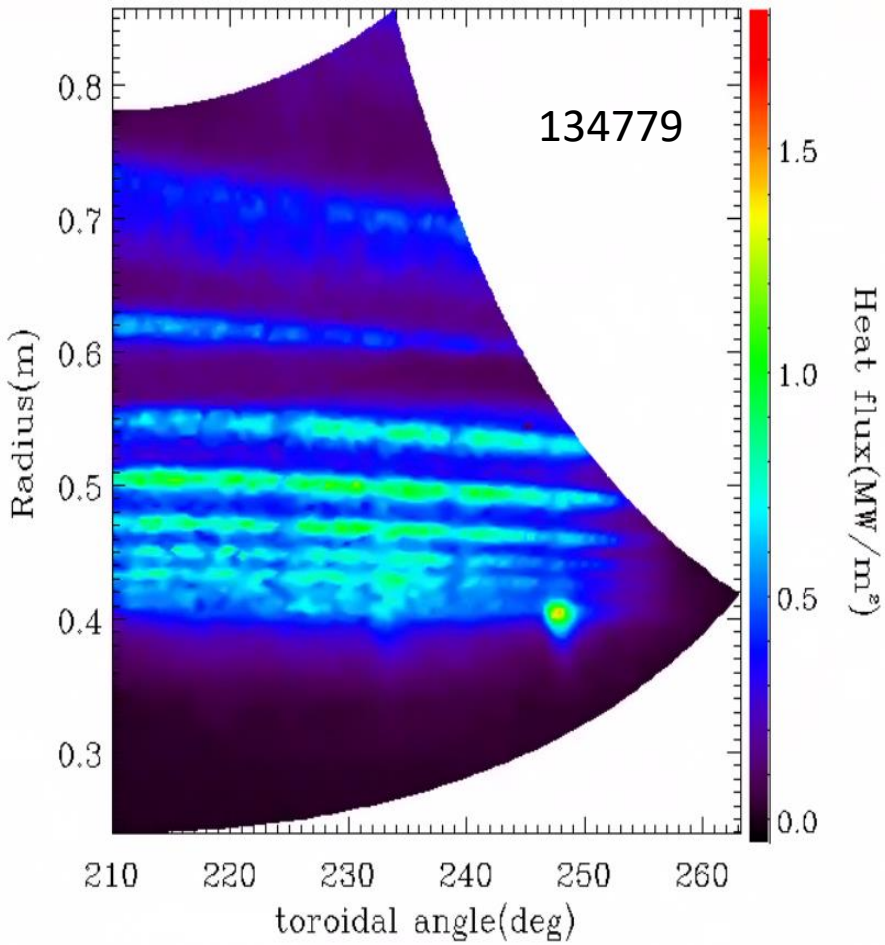


Heat flux striation with $n=3$ RMPs

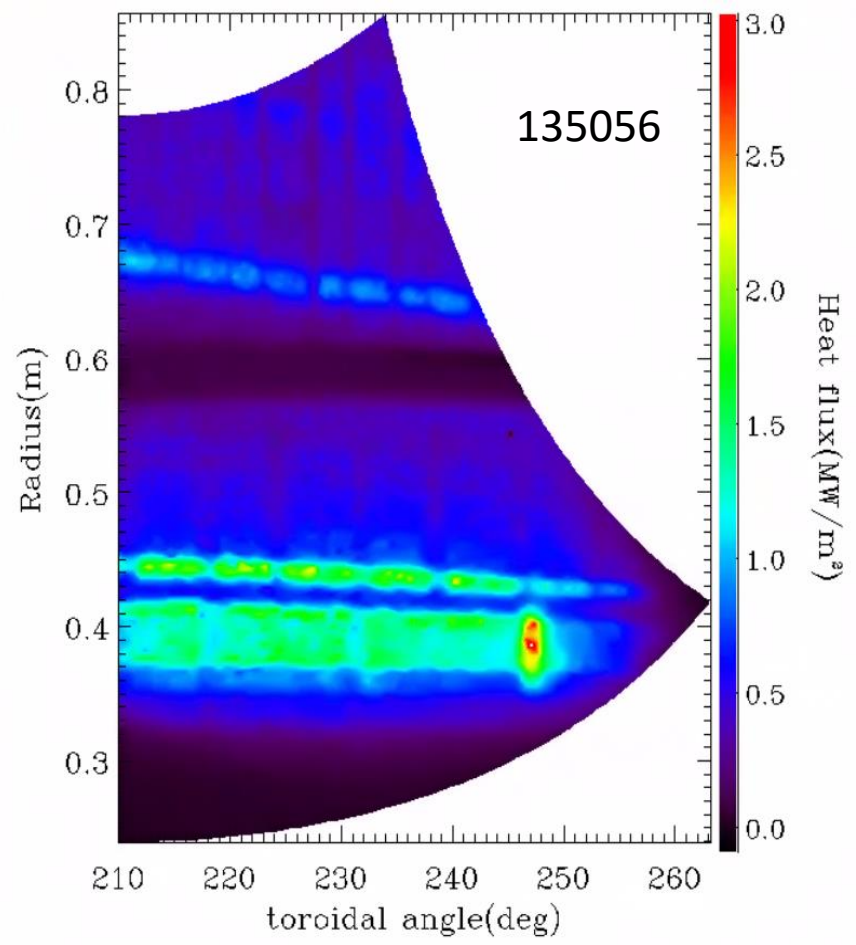


Similar heat flux structure with filament and RMPs

Divertor heat flux with n=3 RMPs



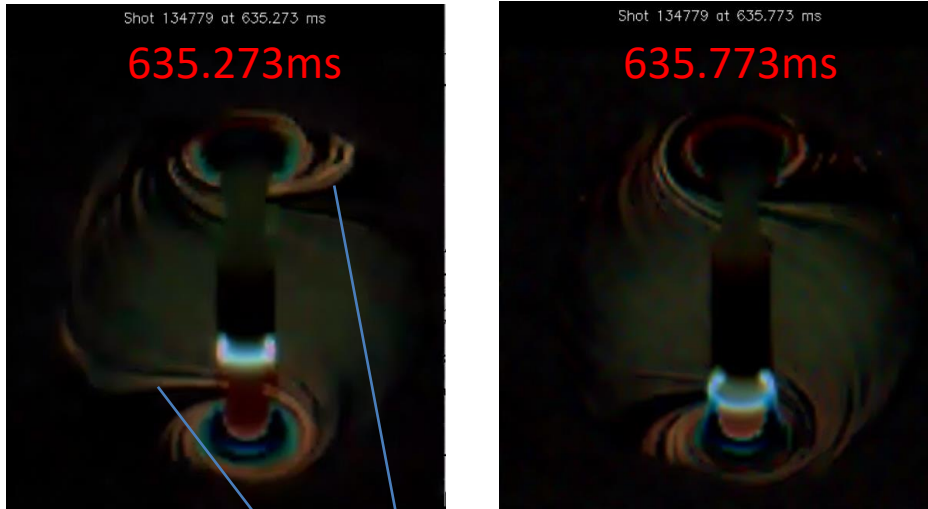
Divertor heat flux with single filaments



Both the RMPs and filaments can cause the heat flux striations on the divertor

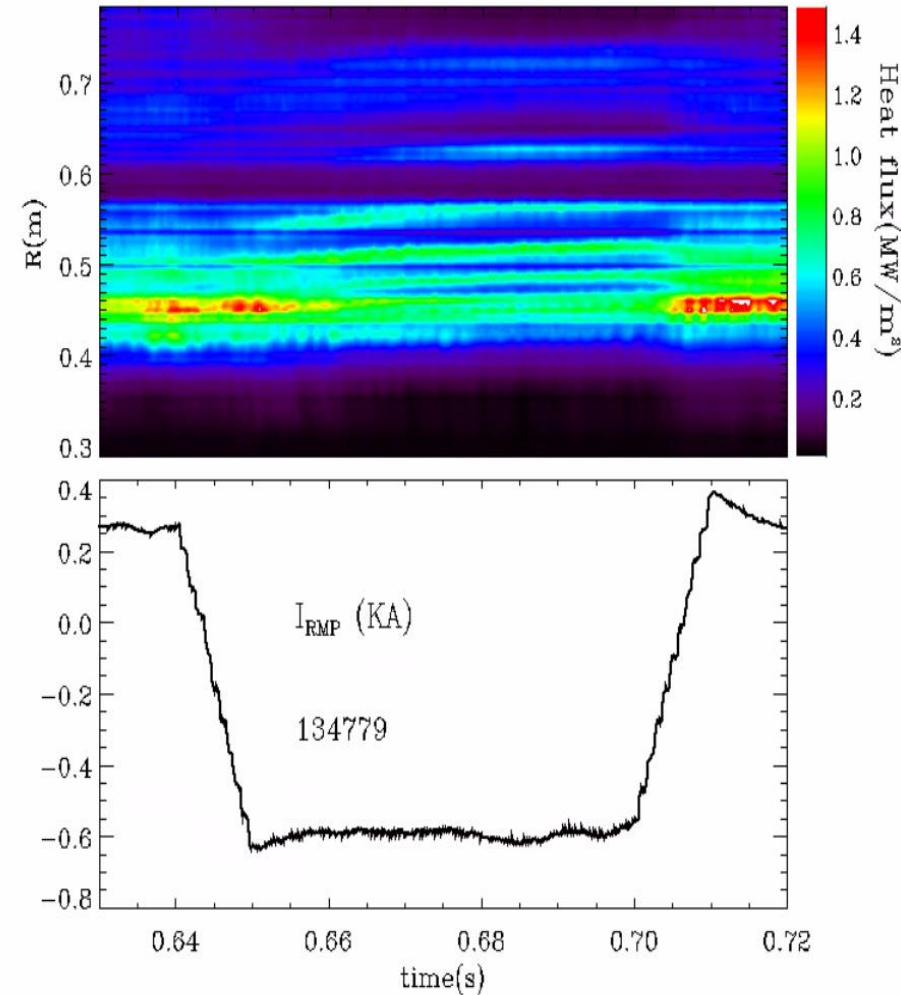
Visible image before the RMPs

Before RMPs



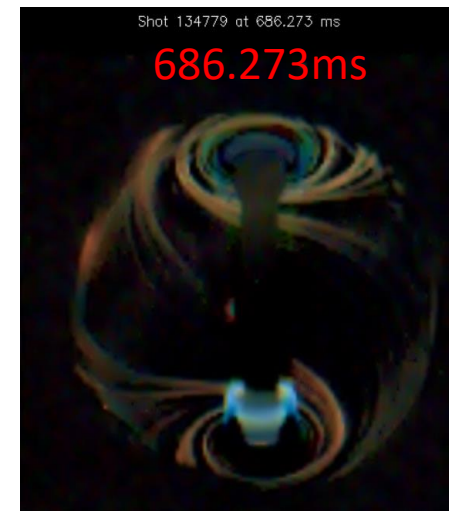
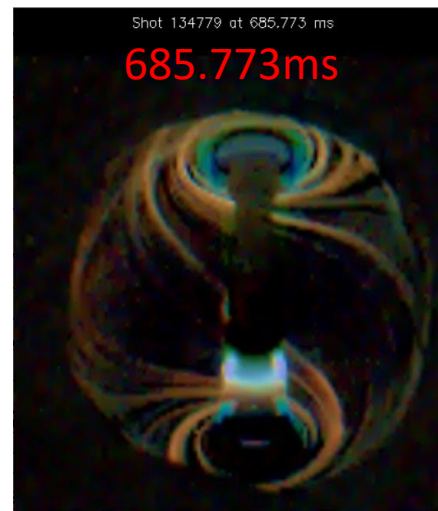
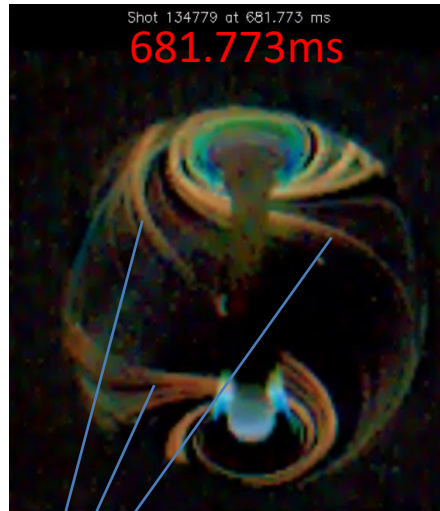
The filaments are unstable before the RMPs

Lower divertor heat flux

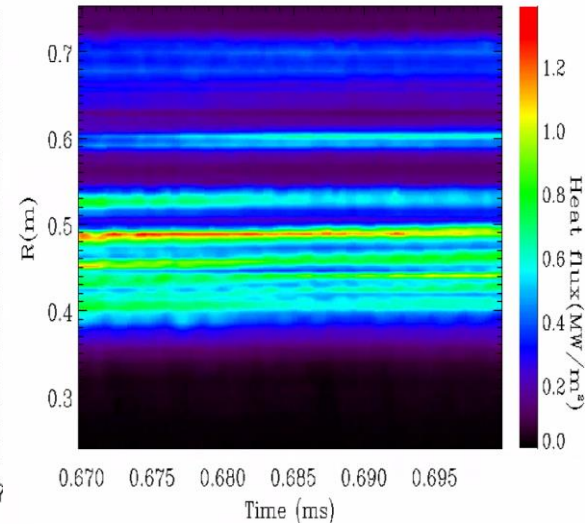
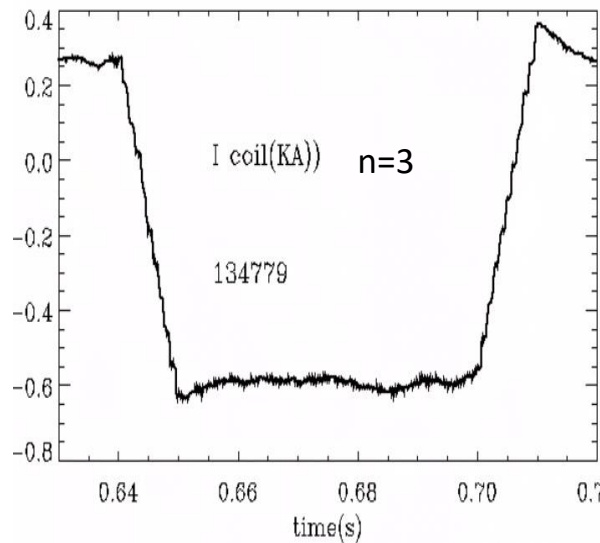


Visible image with $n=3$ RMPs

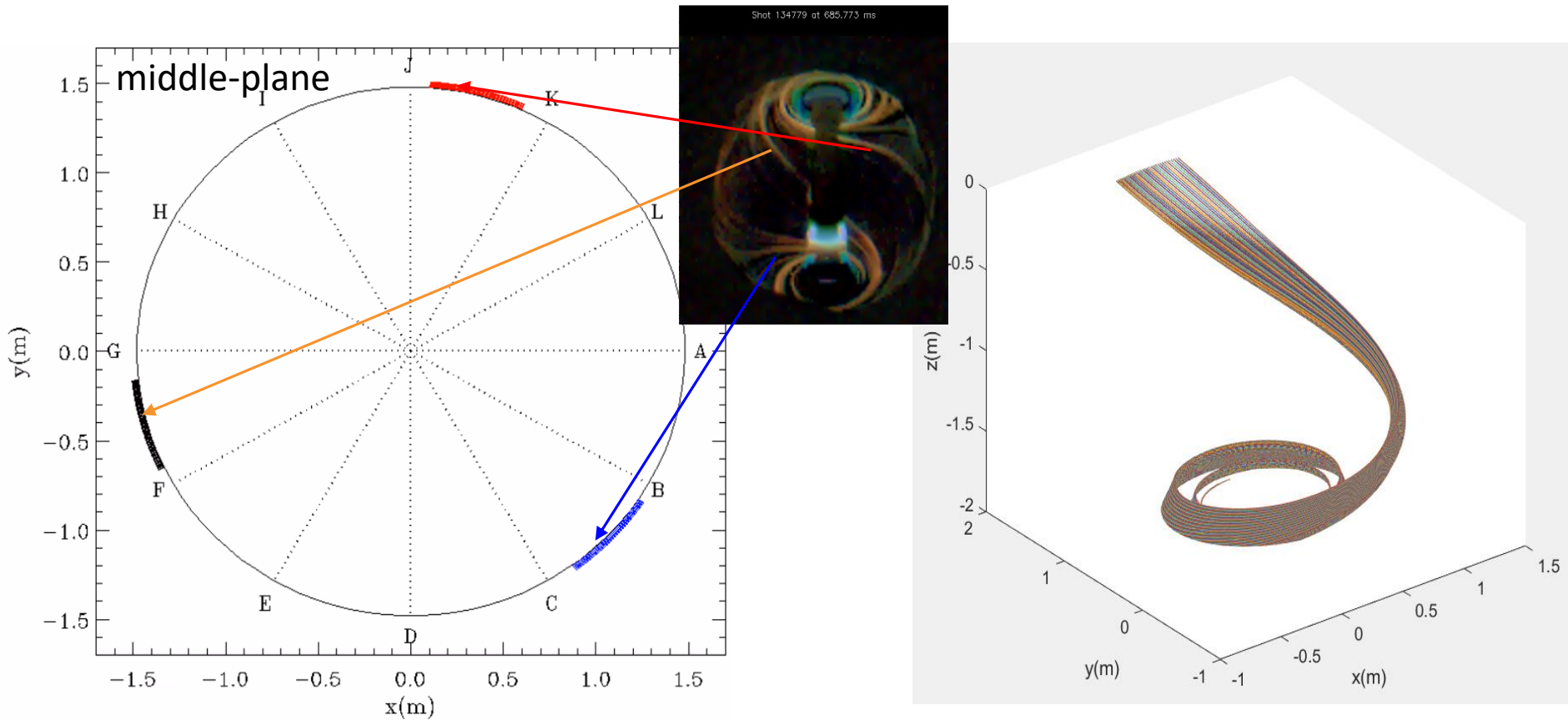
During 3D field



Three stationary 3D filaments were observed with the $n=3$ RMPs application



3D field line tracing

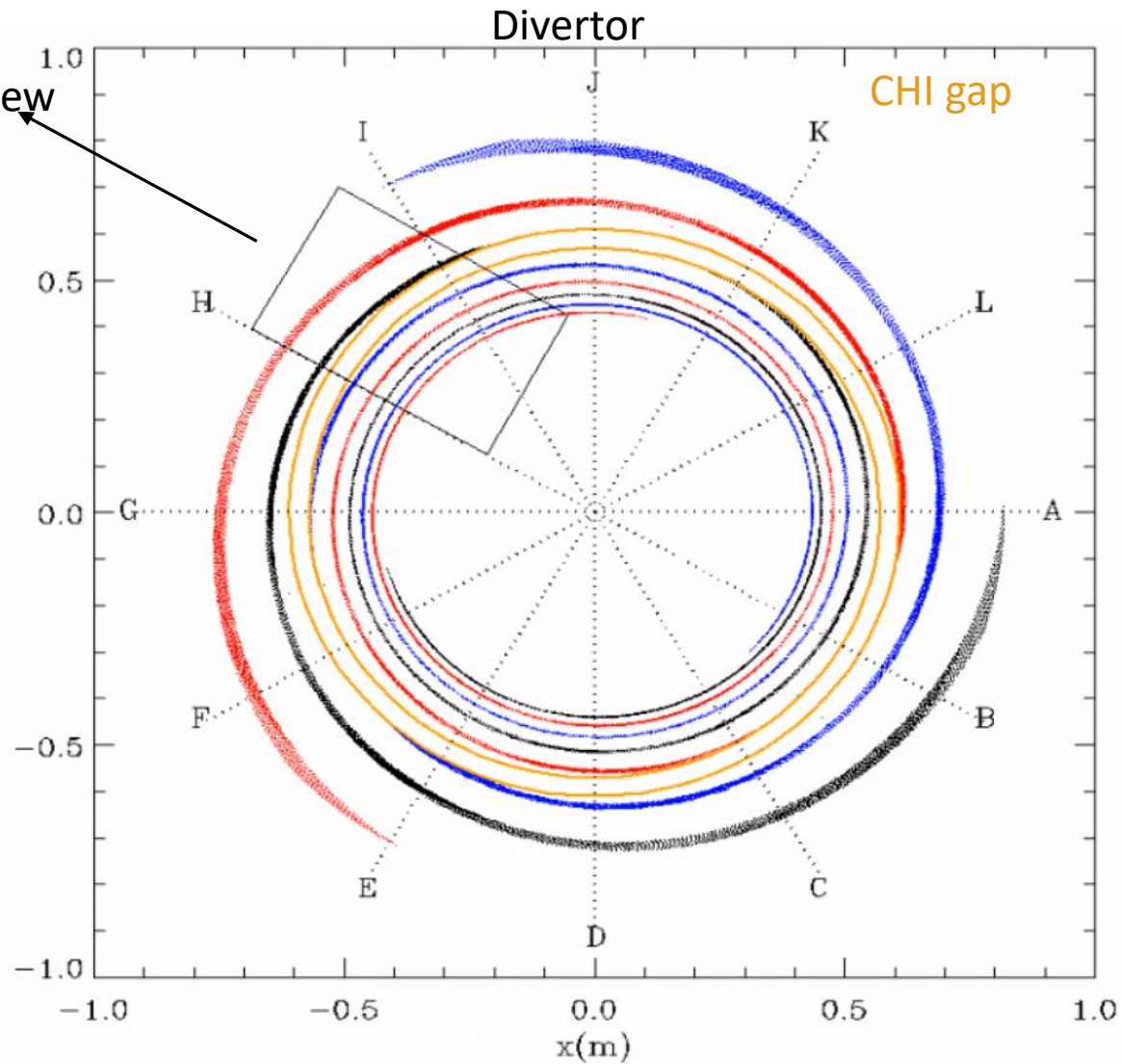
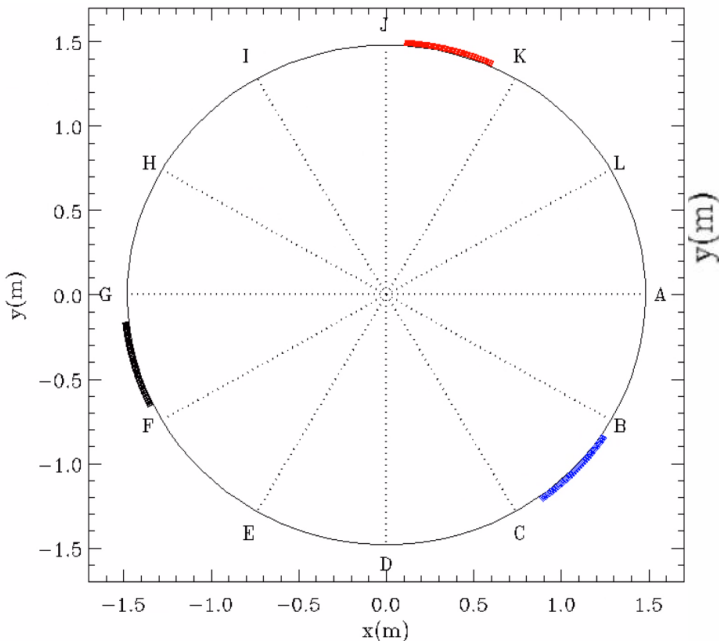


Assume 3 filaments (separated by 120°), trace the field line from middle-plane ($R_{sep}+1\text{mm}$ - $R_{sep}+31\text{mm}$), until it strikes the divertor.

Footprint of intersection points between field lines and divertor

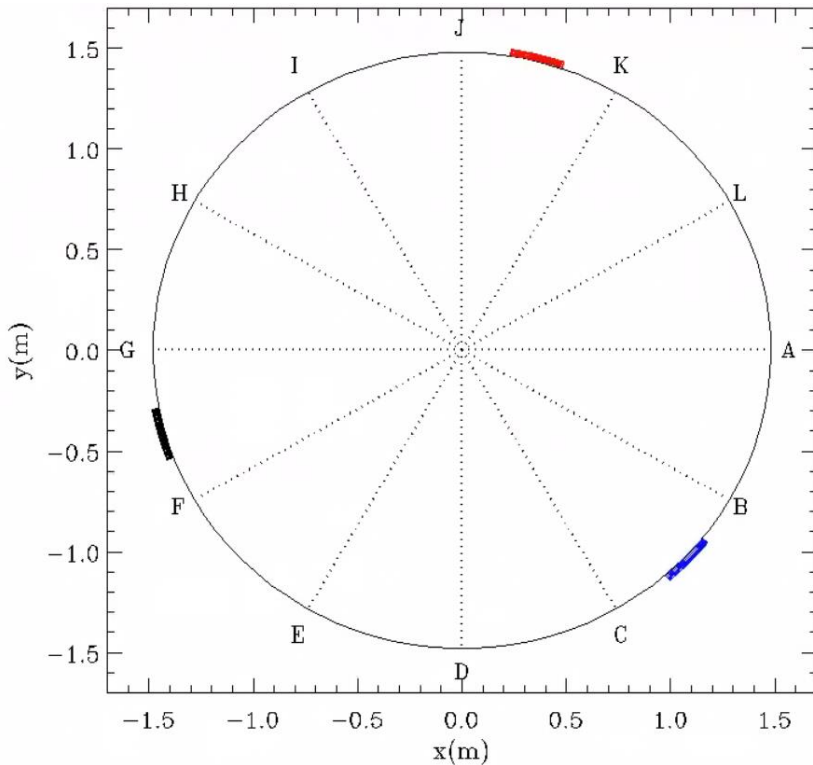
IR field of view

20° filaments on the middle-plane

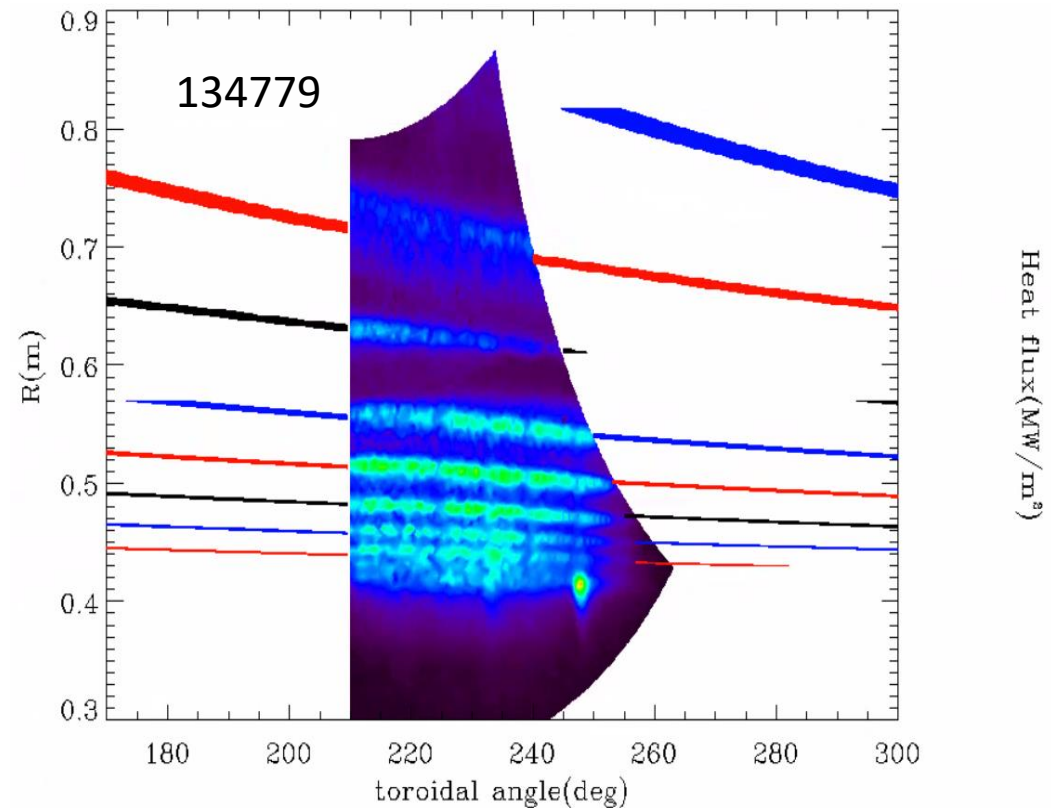


Footprint comparison between simulated filaments on the divertor and divertor heat flux

10° filaments on the middle-plane



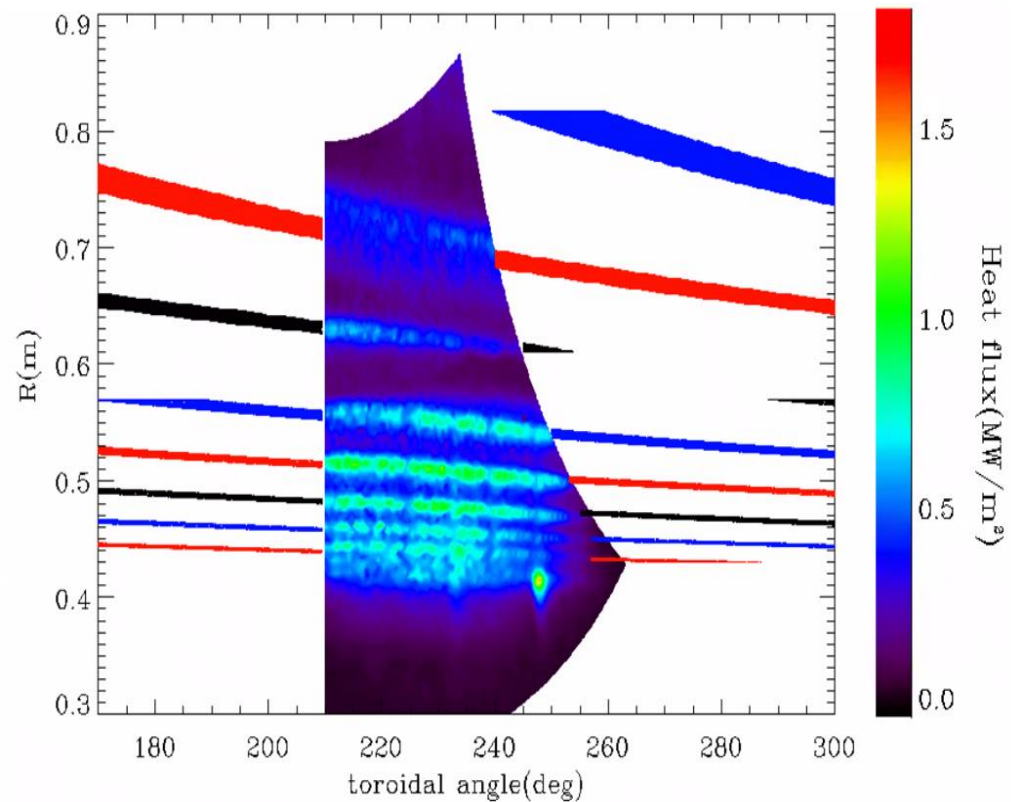
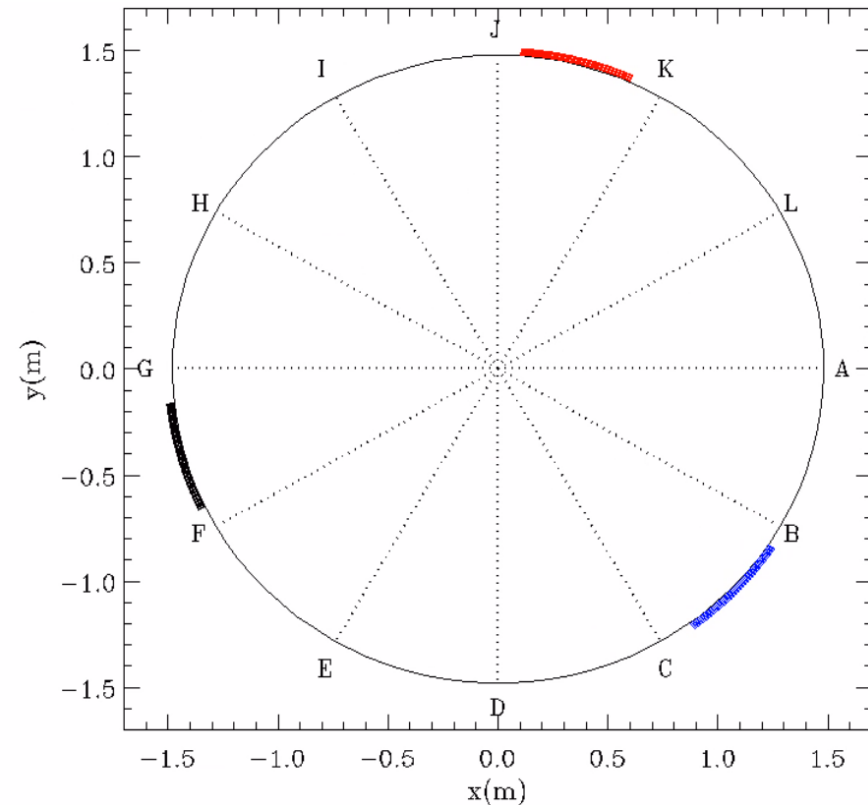
Divertor heat flux



The field line tracing from the mid-plane of the three filaments to the divertor are well consistent with the quantity, the radial and toroidal location of striated heat fluxes.

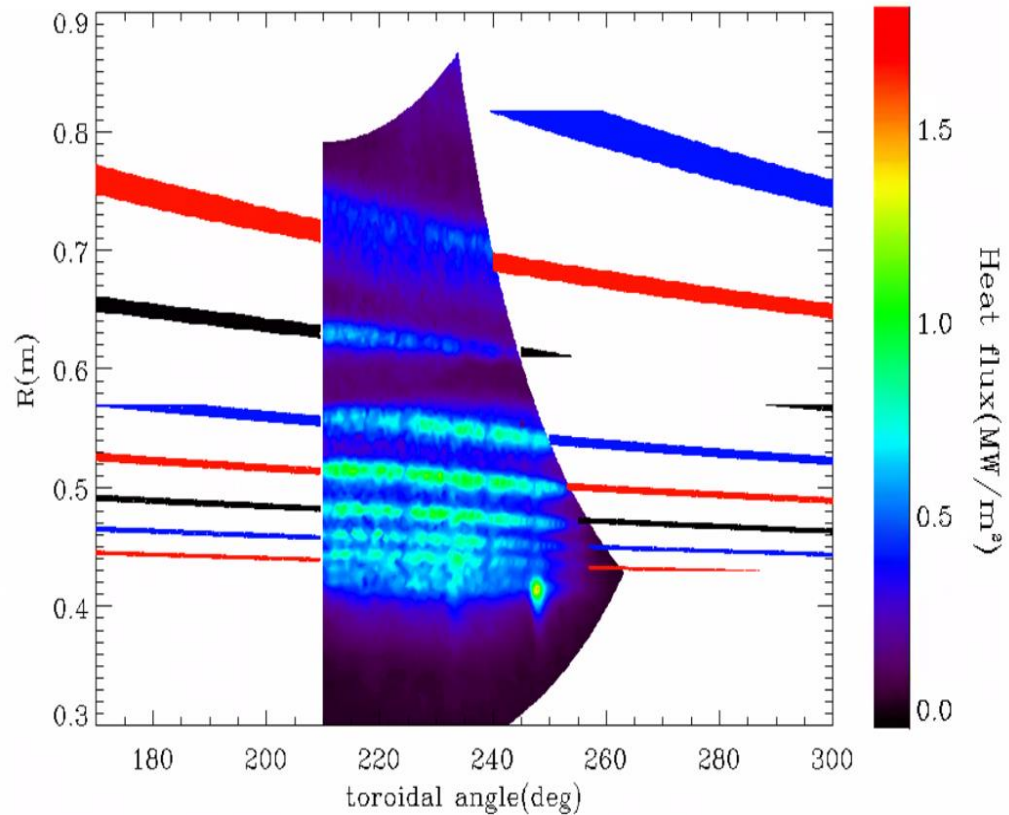
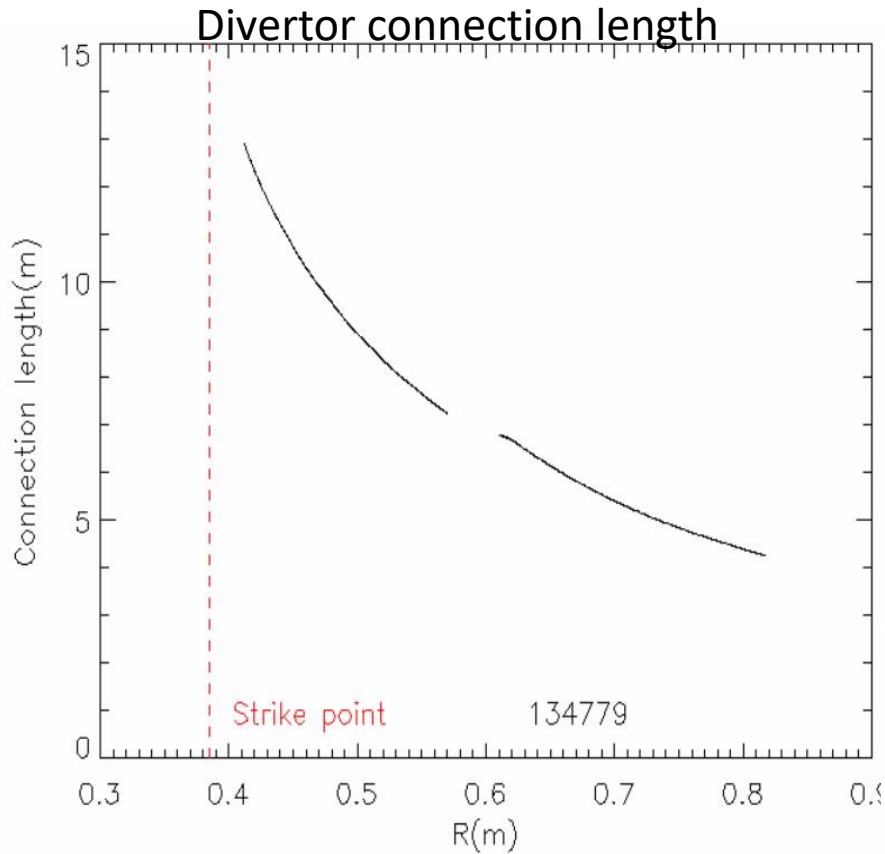
Footprint comparison between simulated filaments on the divertor and divertor heat flux

20° filaments on the middle-plane



- The footprint of simulated filaments on the divertor is hard to match with the width of Striated heat flux.

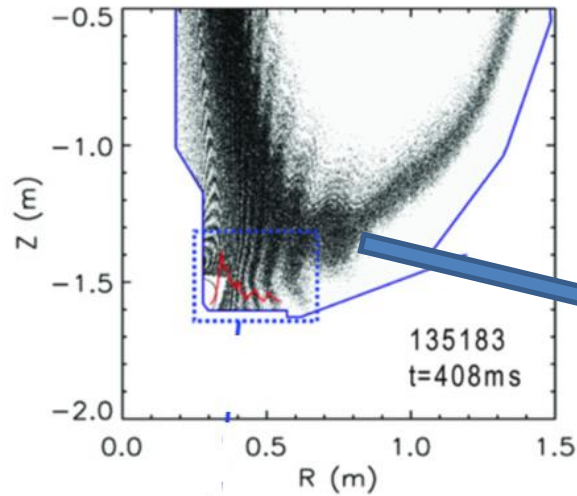
Radial transport broadens the heat flux striation



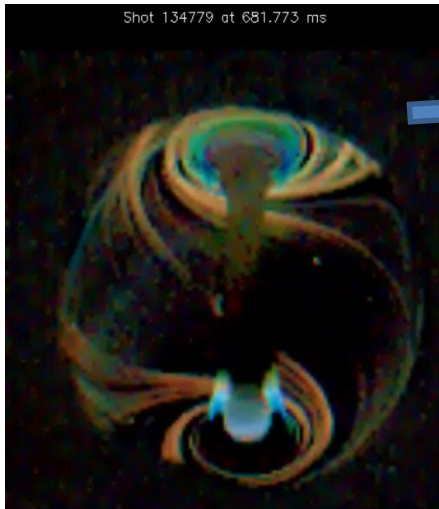
- The connection length increases with decreasing distance along the target from the strike point.
- The radial transport probably causes wider heat flux striation than the footprint of simulated filaments on the divertor.

Question: which mechanism causes the heat flux striations with RMPs?

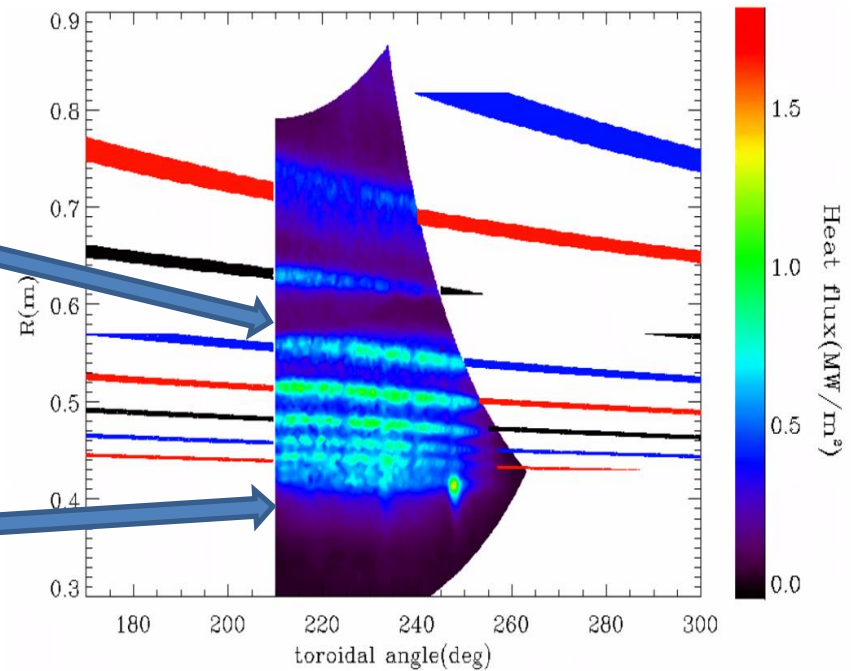
Lobe structure with $n=3$ RMPs



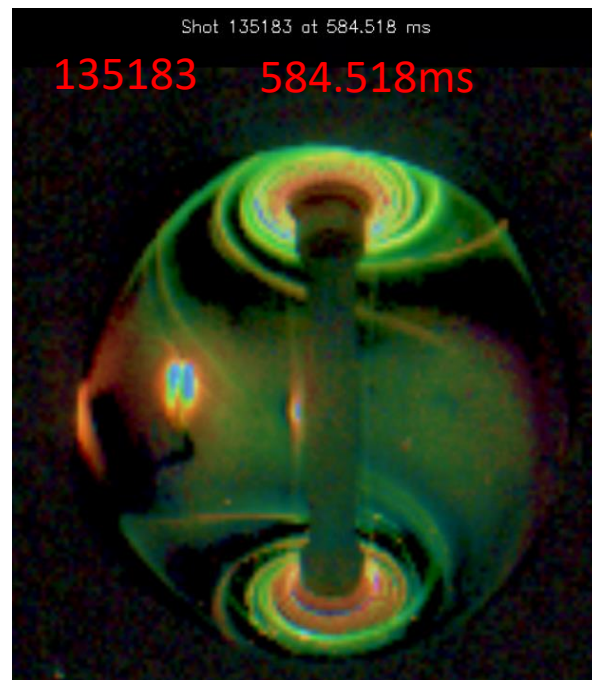
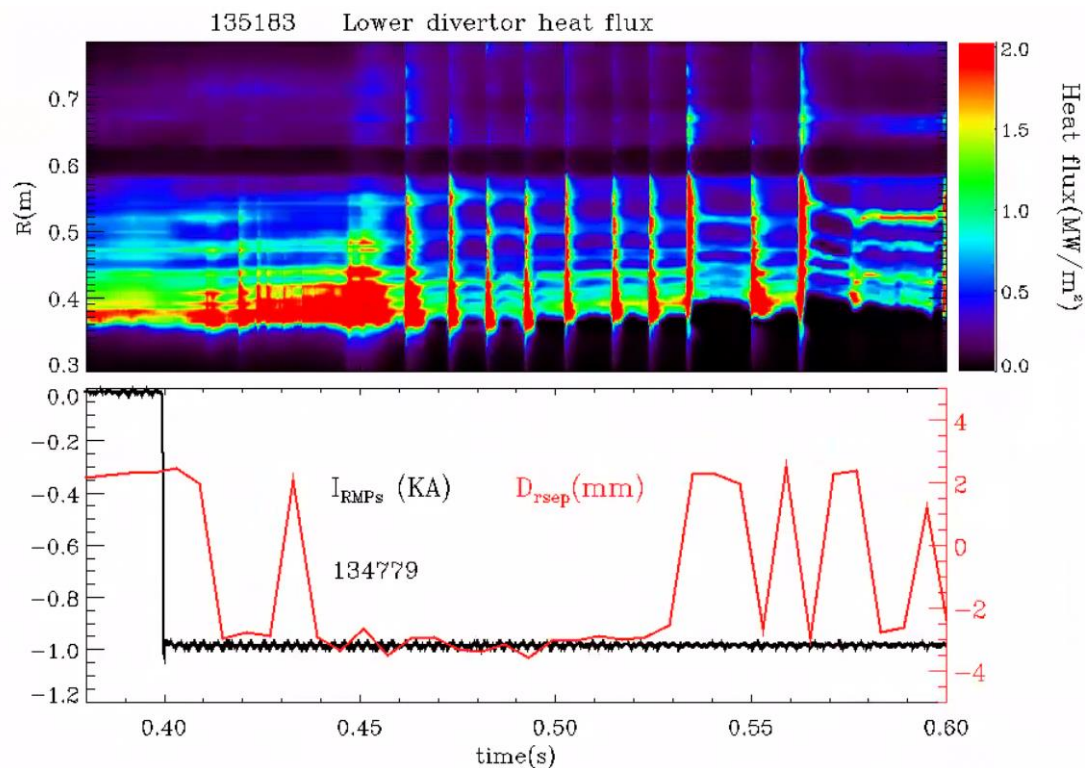
Filaments with $n=3$ RMPs



OR

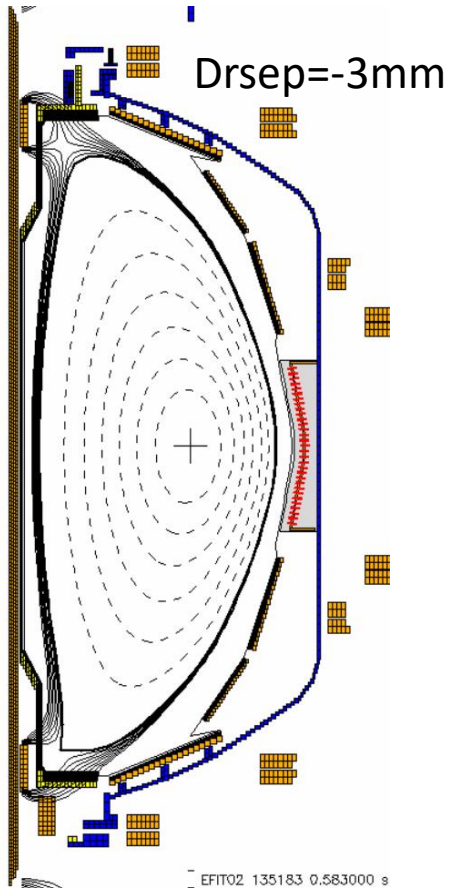
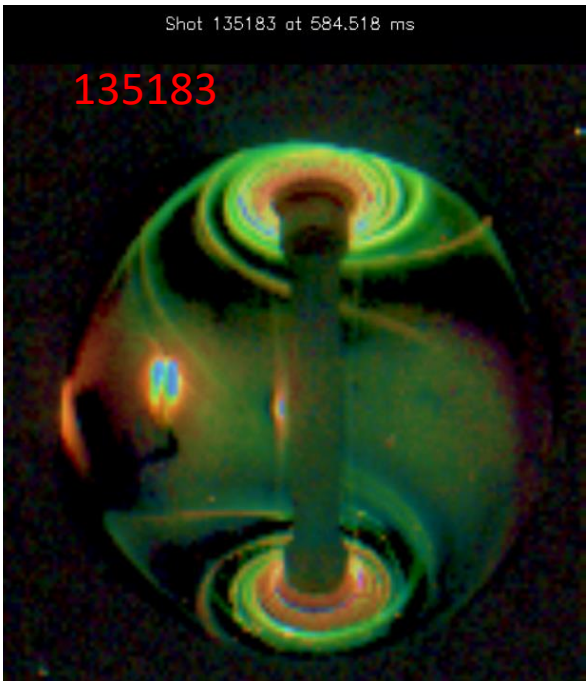
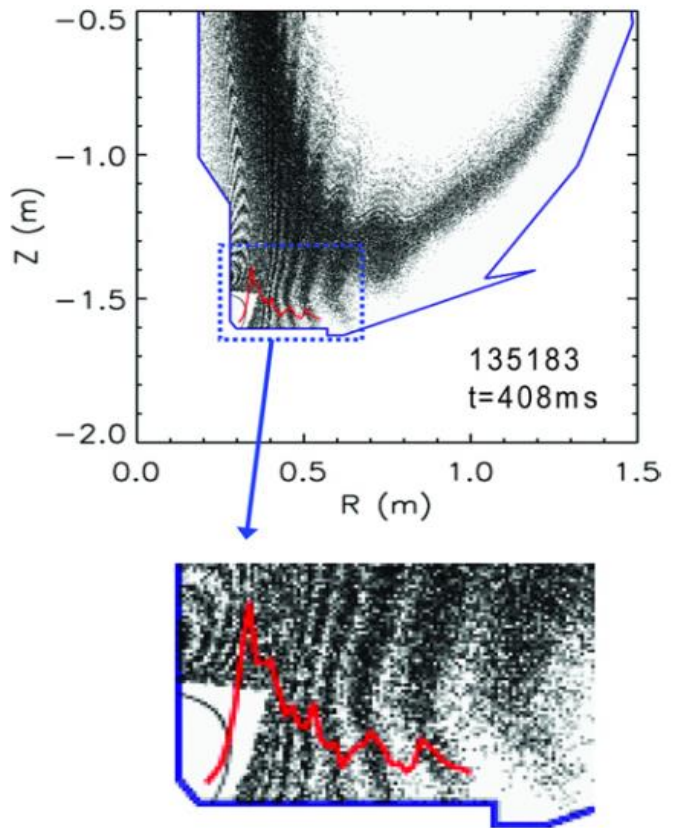


Discussion: When do the stationary filaments appear with RMPs



The stationary filaments were only observed with heat flux striation during RMPs

Discussion: no heat flux striation on the inner target plate



- Lobe structure existed near the inner divertor target
- No heat flux striation appears on the inner divertor target
- Filaments can not transport to the inner divertor target since the $Dr_{sep} \sim -3\text{mm}$

Summary

- Three stationary 3D filaments were observed with the applied $n=3$ RMPs
- The field lines tracing from the mid-plane of the three filaments to the divertor are well consistent with the quantity, the radial and toroidal location of heat flux striations.
- In NSTX, the heat flux striations with $n=3$ RMPs are probably induced by the filaments

