Subject: Structure of blob/filaments after from the outboard midplane

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Group: Edge/Divertor

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1. Purpose of Experiments
Include immediate goal of the experiments, scientific importance and/or programmatic relevance. Refer to any relevant program milestones.

Exploit C-Mod’s unique capability to study and understand the structure of blobs/filaments in regions away from the outboard midplane. Examine the parallel correlation length of the filaments at length ~2x that of the only previous study [1].

2. Background
Discuss Physics Basis of the proposed research. Prior results at Alcator or elsewhere, and any related work being carried out separately.

Research on C-Mod has played a leading role in elucidating the structure and dynamics of the blobs/filaments the exist in the outboard SOL. This phenomenon is the dominant mechanism for perpendicular particle transport there. Previous turbulence imaging near the outboard midplane has shown that the cross-field cross-section of the blobs is approximately circular (at least with a spatial resolution of a few mm) and that there are filaments that are aligned with the magnetic field. Beginning with the present run campaign, a new diagnostic has be installed on C-Mod that allows turbulence imaging in a region just outboard of the location of the typical LSN X-pt. The view is approximately along the local magnetic filed with a poloidal X-section that is shown in Fig. 1. There is a capillary just under the view to supply the local gas puff. Movies of edge turbulence in this region, obtained using a fast-framing (150,000 frame/s) camera, show structures that highly elongated in the (approximately) local radial direction as shown in Fig. 2. These structures are observed to move polodially, but only slightly in the elongation direction (outward). Both the structure and the motion of the turbulent structures as imaged in this location are very different than the nearly circular cross-sectioned “blobs” observed near the outer midplane. Field line mapping of circular flux tubes at the midplane show that these are distorted into elongated “fingers” when mapped to the viewing location.
outboard of the X-point, consistent with the observations. This is most likely a result of shearing and flux expansion of the magnetic field. This is one of the things we wish to test in this MP. Another is a measurement of the parallel correlation length.
Figure. 1 – Poloidal X-section of the new “X-pt” view. Also shown are the mappings of the right, left, top, and bottom of the horizontal and vertical arrays of diode views. Thus the purple lines in the detail show the mapped “coverage” of the diode views.
Figure 2. Typical “finger-like” structures observed at the “X-pt” view. Also show is the separatrix.

3. Approach

Describe the methodology to be employed; explain the rationale for the choice of parameters, etc. Describe the analysis techniques to be employed in interpreting the data, if applicable. If the approach is standard or otherwise self-evident, this section may be absorbed into the Experimental Plan.

We propose make the measurements by field-line-mapping the views of the diode arrays (at the outboard midplane) to the new “X-pt” view. The poloidal projection of the mapping for a plasma with Ip=0.300 MA and Bt=5.4 T is shown in Fig. 1. This also shows in the detail the mapping of the horizontal and vertical arrays of diode views (in
purple) into the “X-pt view. The midplane “cross” of array views is distorted in a manner qualitatively consistent with the “X-pt” view images. The toroidal mapping is shown in Fig. 3. For this mapping a very high q is required while maintaining the LSN diverted shape. For $B_t = 5.4$ T a current of 0.30 MA is required. Such conditions have been produced in C-Mod only in some current rampdown phases and early (at about 0.4 s) in the discharges produced for the 1070412 run. Thus we propose to run a discharge similar to 1070412018, but with a somewhat larger outer gap. We will see if the time histories of the diode array signals are time-delayed correlated with the signals from pixels in the fast camera movies. If they are, then we know that the parallel correlation length is at least ~5.4 m. Previously it was shown – by correlating the diode array signals with the F-port scanning probe $I_{sat}$ and $V_{float}$ – that the parallel correlation length of the filaments was at least ~2.7 m [1]. Furthermore we will be able to see how the filaments at the midplane in the diode view locations in fact map into the “X-pt” view locations and see whether or not this has the “finger-like” elongation predicted by the field-line mapping. Unlike the previous filament mapping experiment we will be correlating “apples” with “apples” (light with light) and could potential get a more reliable measure for the parallel correlation length. We will also be correlating the signal for a few tenths of a second (max 0.5 s), rather than for the few ms in the previous experiment. This will also allow for study of correlations of turbulence on closed field lines.

After measuring the correlation between the diode signals and the images of the “X-pt” view, we will ramp the current to 0.60 MA for which the diode views map to the FSP and we will measure the correlations between the FSP signals and the diode array signals at connection length of ~2.7 m, essentially repeating the Grulke experiment of MP 332 and run 1030604.
4. Resources

4.1 Machine and Plasma Parameters

Give values or range for:

Toroidal Field: \(5.4\) T
Plasma Current: \(0.3\) increasing to \(~0.6\) MA
Working Gas Species: D2
Density: \(NL04\sim0.8e20\) m\(^{-2}\)

Equilibrium configuration (if possible, refer to database equilibria):
Similar to 1070412018 at \(0.42\) s, but with an outer gap of \(2.3\) cm.
4.2 Auxiliary Systems

RF Power, pulse length, phasing:
Pellet Injection (species):
Impurity blow-off injection:
Diagnostic Neutral Beam: no – unless diode pick-up from the DNB problem is solved in time
Special gas puffing: NINJA (D₂) for GPI
Non-axisymmetric Coils (Connections, Current);
Other:

4.3 Diagnostics
List required diagnostics, and any special setup or configuration, e.g. non-standard digitization rate.

All standard, but especially GPI midplane diode arrays, GPI “X-pt view”, FSP, and ASP.

5. Experimental Plan
Both sections must be filled in.

5.1 Run sequence Plan
Specify total number of runs required, and any special requirements, such as consecutive days, no Monday runs, extended run period – 10 hours maximum – etc.

1/2 Run – other experiments could occur after ~0.8 s

5.2 Shot sequence plan
For each run day, give detailed specification for proposed shot sequence: number of shots at each condition, specific parameters and auxiliary systems requirements, etc. Include contingency plans, if appropriate.

Start with shot 1070412018 extend time for which the plasma current is 0.30 MA from 0.4 s to 0.6 s. Then ramp the current to 0.60 MA so that the midplane diode array views map to the FSP on a plunge to the separatrix.
NL04=0.8e20.
Repeat for 4 good shots with X-pt” view, diode-array, and FSP data.

6. Anticipated Results
Discuss possible experimental outcomes and implications. Indicate if the program may be expected to lead to publications, milestone completions, improved operating techniques, etc. Indicate if the experiments are intended to contribute to a joint research effort, or an external database.

Elucidation of structure and dynamics of blobs/filaments, and measured for the first time near the X-pt.

7. References
Include references both to external and internal literature or communications which bear on this proposal. See Section 2.