

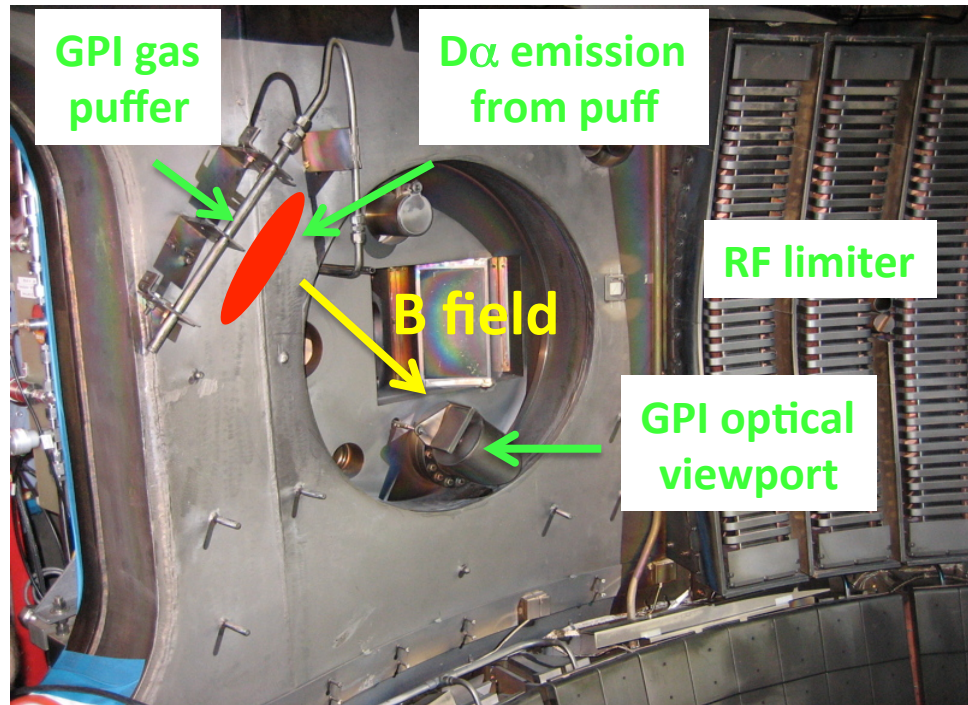
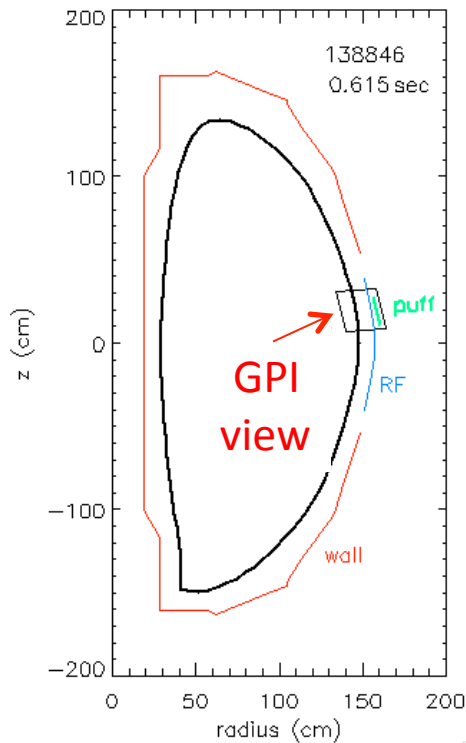
# Gas Puff Imaging (GPI) in NSTX-U

S.J. Zweben, F. Scotti (LLNL), D.P. Stotler, A. Diallo, B. Davis, N. Mandell, J.L. Terry (MIT), W. Han (MIT)

- Previous GPI in NSTX (up to 2010)
- New GPI hardware for NSTX-U
- GPI results from 2016 run
- Planned XPs and analysis

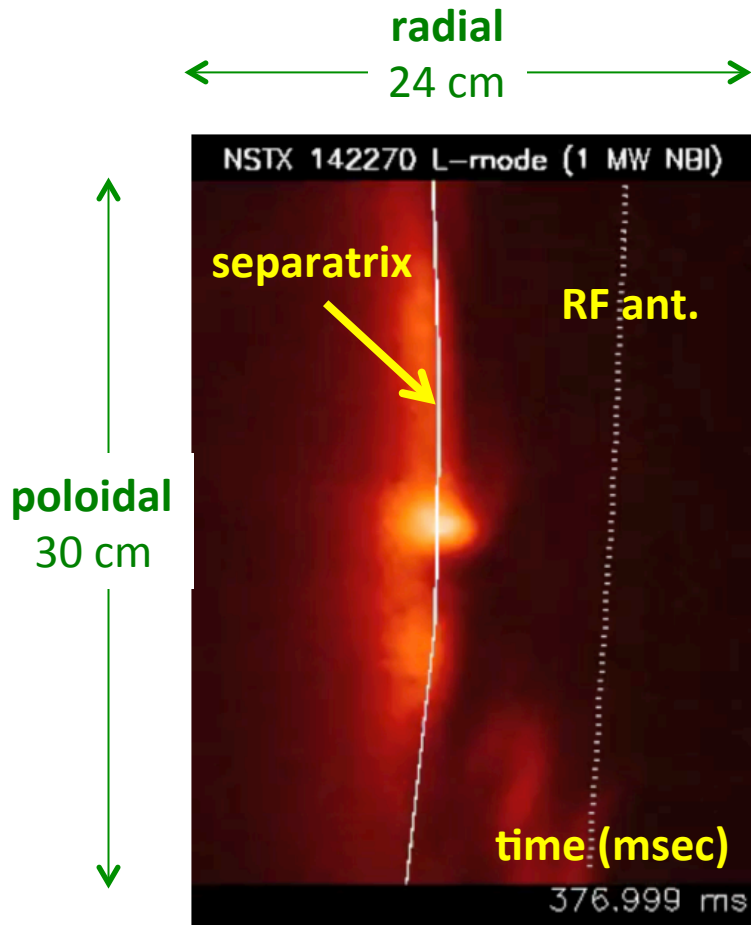
# Gas Puff Imaging (GPI) Diagnostic on NSTX

- $D_2$  gas puffed from GPI manifold on outer wall above midplane
- $D\alpha$  light emission from gas puff viewed from along local B field
- Fluctuations in  $D\alpha$  light emission interpreted as  $\tilde{n}$  turbulence

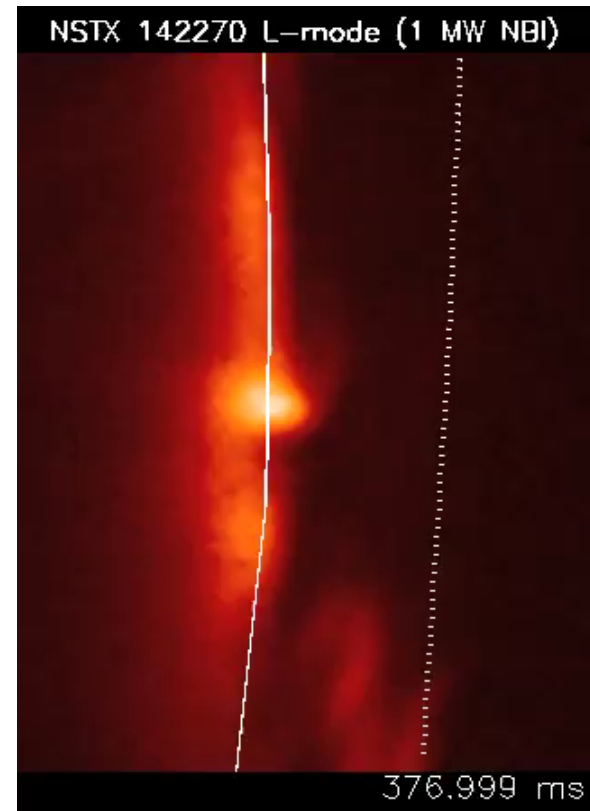


# Example of NSTX GPI Data

- Exposure time/frame =  $2.1 \mu\text{sec/frame}$  @ 400,000 frames/sec



1 msec movie



# Analysis of Previous GPI Results

- We have outstanding database of GPI data from 2010 run, including ~320 good shots (thanks to R. Maqueda)
- Many papers have been written to describe this data and to compare the results with theory (thanks to J. Myra et al)
- The results are similar to many other devices, e.g. MAST

**Yet the GPI data on edge turbulence is still not well understood, so further measurements and comparisons with theory and simulation (e.g. XGC-1) are appropriate**

# New GPI Hardware for NSTX-U

- New coherent imaging bundle (x3 larger signal)
- New  $D_\alpha$  optical filter (x2-3 larger signal)
- New zoom lens (from ~5 mm to ~1 mm optical resolution)

⇒ look for possible small-scale structure in edge turbulence

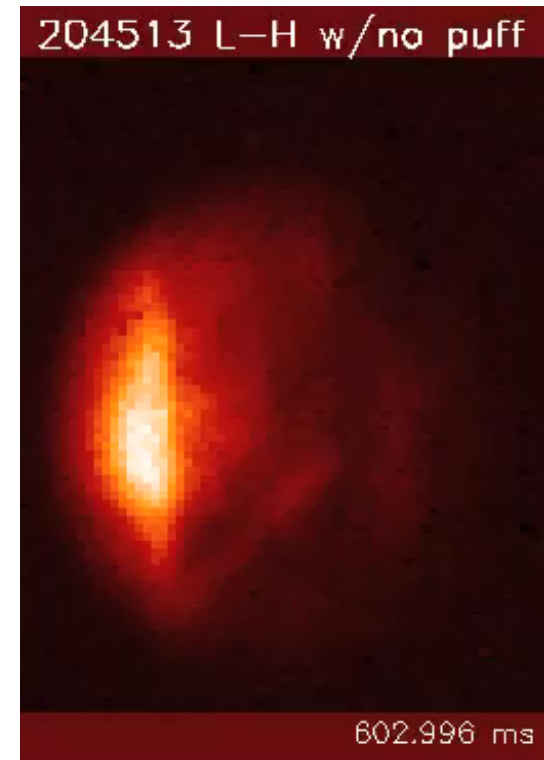
⇒ reduce GPI gas puff rate for lower edge perturbation

⇒ increase GPI gas puff length when needed to  $\geq 1$  sec

# GPI Results from 2016 Run

- No GPI gas puff (piezo not connected), but rest of GPI system worked well
- Can see good signal in  $D\alpha$  background light at 100 kHz (vs. 400 kHz in NSTX)
- Edge turbulence looks as expected, but difficult to analyze due to 3-D effects
- Signal useful for comparison with ENDD neutral measurement (Stotler, Scotti)

4 msec movie



# Planned GPI Hardware for NSTX-U

- 9x10 APD array for higher S/N in GPI (brought from C-Mod)
- Fast camera view of GPI puff from across machine (Scotti)
- Helium line ratio measurement of edge  $T_e$  and  $n_e$  profiles using GPI view, initially at  $f \leq 1$  kHz (Wisconsin/Padova)

## Future:

- Additional GPI view(s) for measuring 3-D filament structure
- Better collimated gas manifold for higher spatial resolution
- Remote control of GPI pan/zoom for small-scale structure

# Planned XPs for NSTX-U

- Search for small-scale edge turbulence structure at  $k_{\text{pol}}\rho_i \sim 1$  (Mandell, Ren, Guttenfelder)
- Correlation of edge turbulence with heat flux SOL width and XGC-1 results (Gray, Chang)
- Continue study of L-H transition (Diallo, Stoltfus-Dueck)
- Measure edge  $q(r)$  from turbulence filament tilt angle using GPI + side view fast camera, like SAMI (Scotti)

*Analyze 2010 GPI database for effects on edge turbulence of: divertor geometry, divertor detachment, RF fields, and RMP perturbations, to motivate other possible XPs for next run*