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XMP: Develop optimal SGI parameters for perturbative particle transport experiment

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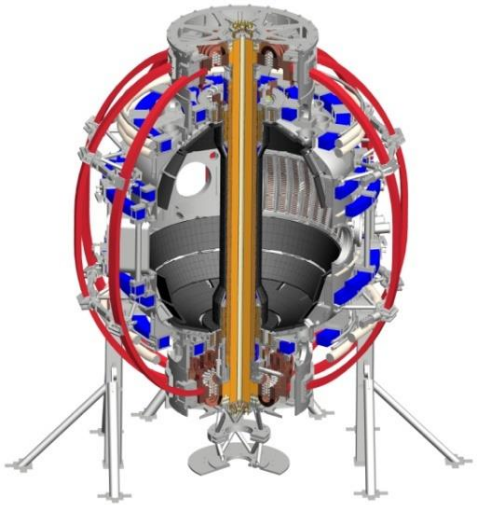


Background and Motivations

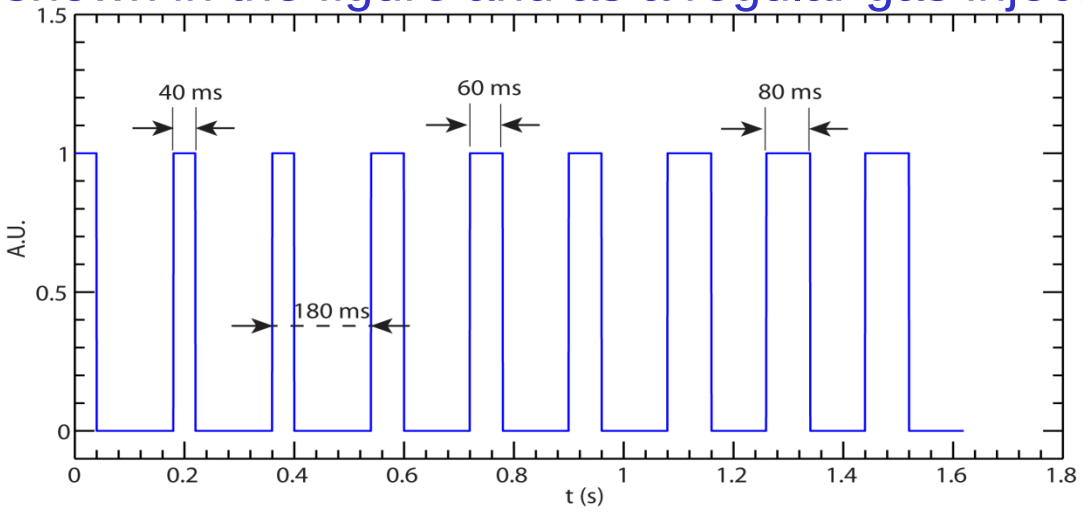
- Particle transport in STs not well understood
  - Neoclassical or turbulent?
  - Particle balance analysis not able to separate diffusion and pinch
- Perturbative particle transport measurement used on other tokamaks
  - Use fast gas injection system coupled with profile reflectometer or Thomson scattering for density measurement
- The goal of this XMP is to develop optimal SGI parameters to achieve suitable density perturbation
  - Cycle time and duty cycle of SGI
    - Cycle time not too short to avoid density accumulation and to have enough Thomson measurement points in a cycle
    - Not too long to have enough cycles for Fourier analysis
    - Gas puff time not too long to avoid too much perturbation (n-tilt/n~<10%)
  - Regular gas puff or supper sonic gas puff and the amount of gas puff
    - Enough density modulation and not too perturbative

SGI XMP Requirement, Constraints and Options

- Establish quasi-stationary MHD quiescent NBI-heated L-mode plasma, hopefully from a dedicated XMP for L-mode scenario development
  - Use NBI source 1A at 90 kV for MSE and CHERS measurement
- SGI cycle time is determined to be at least 128 ms
  - 16 ms Thomson scattering time resolution
  - To at least resolve the 2nd harmonic of the perturbation and to avoid aliasing from higher harmonics to the fundamental and 2nd harmonic
  - We start with 180 ms SGI cycle time and will adjust according to experimental result
- SGI can be used as regular gas injector or supersonic injector and SGI calibration is needed
  - Presumably better penetration with supersonic configuration (will test)

SGI XMP Experimental Plan

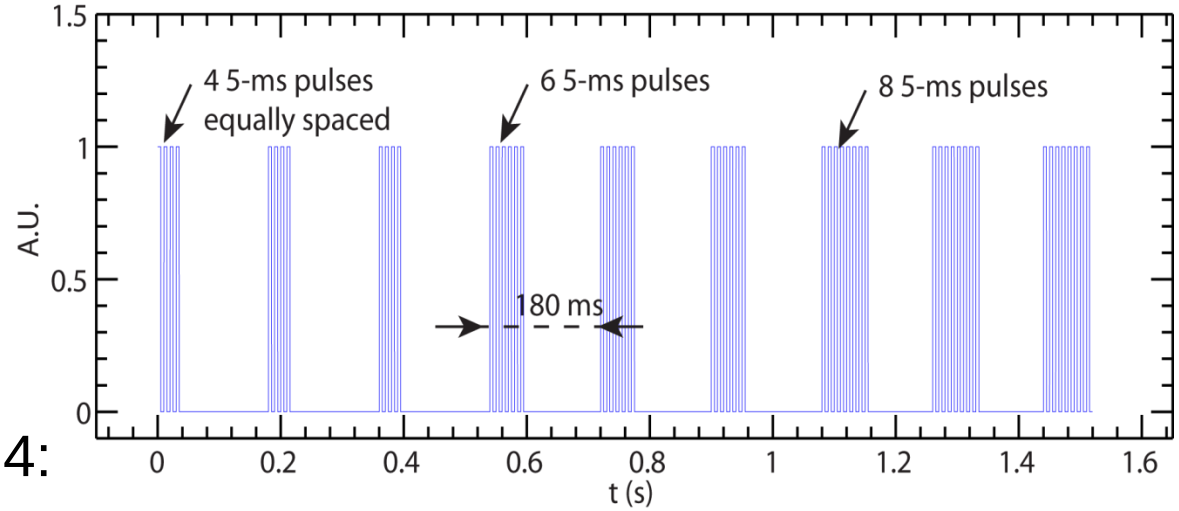
- Shot 1:
  - SGI as shown in the figure and as a regular gas injection system



- Shot 2:
  - If density perturbation drops fast, increase gas duration to 90/100/110 ms
  - If gas puff time cannot be increased (n-tilt/n ~ 10%), reduce perturbation cycle time to observed density perturbation cycle time.
  - If observed cycle time is <128 ms, reduce SGI plenum pressure and increase puff time to 90/100/110 ms (plenum pressure reduced with the amount gas puff kept constant).
  - If density accumulation occurs, increase cycle time to 220 ms with the same gas puff time

SGI XMP Experimental Plan

- Shot 3:
  - SGI as shown in the figure and used as supersonic injector



The numbers of 5 ms-pulses are used to match the amount of gas puff in shot 1 and 2

- Shot 4:
  - If density perturbation drops fast, increase to 9/10/11 5-ms pulses
  - If gas puff time cannot be increased (n-tilt/n is large), reduce perturbation cycle time to observed density perturbation cycle time.
  - If observed cycle time is <128 ms, reduce SGI plenum pressure and increase gas puff time to 9/10/11 5-ms pulses (plenum pressure reduced with the amount gas puff kept constant).
  - If density accumulation occurs, increase cycle time to 220 ms with the same gas puff time

Diagnostic Needs and Analysis

- Must-have diagnostics:
  - BES, reflectometer
  - CHERS, MPTS, MSE
  - Magnetics
  - other diagnostics required for conducting TRANSP analysis

- Planned analysis
  - LRDFIT, TRANSP, GS2, GYRO, GTS, XGC1