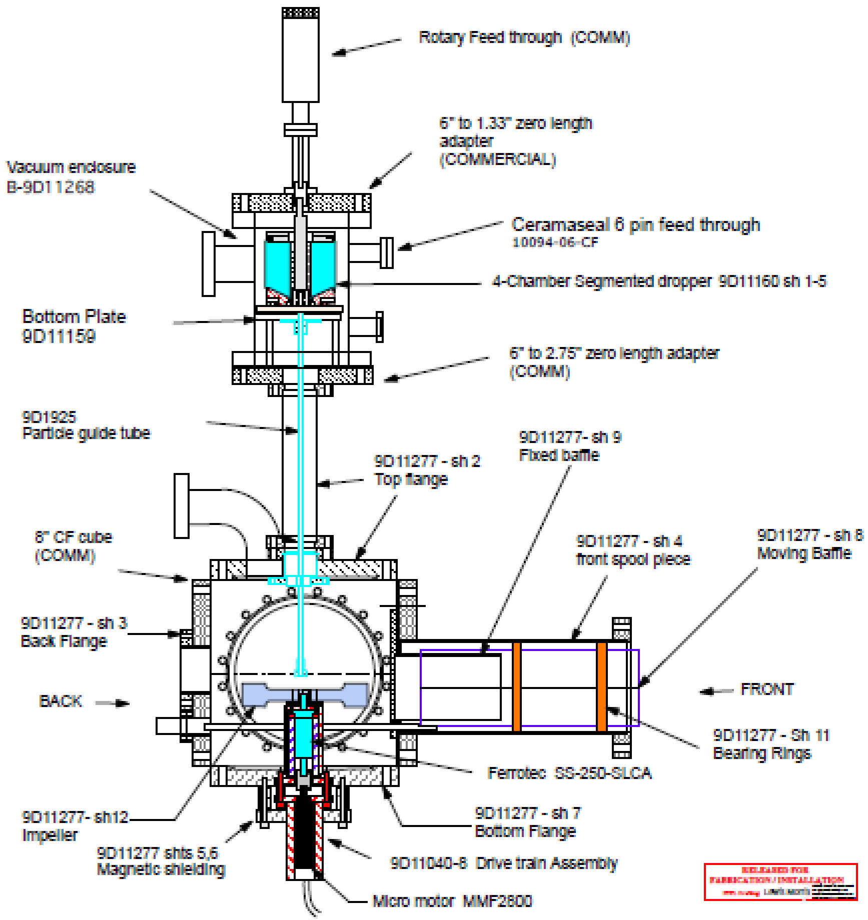
NSTX-U Granule Injector Status & Availability



Current projection is for the NSTX-U granule injector to be a "Day 1" capability

Available pellet sizes (approximate)
900μm, 700μm, 500μm, 300μm*

Proposed Pellet Composition
Lithium, Boron Carbide*, Graphite*

Pellet Injection Velocity
50 – 150 m/sec

Pellet to Pellet Injection Frequency
100 – 500 Hz

(* Capabilities may not be available on Day 1, but are planned or proposed for FY2015 run)

Successful lithium pellet pacing experiments on EAST and DIII-D

Nucl. Fusion 53 (2013) 113023 D.K. Mansfield *et al*

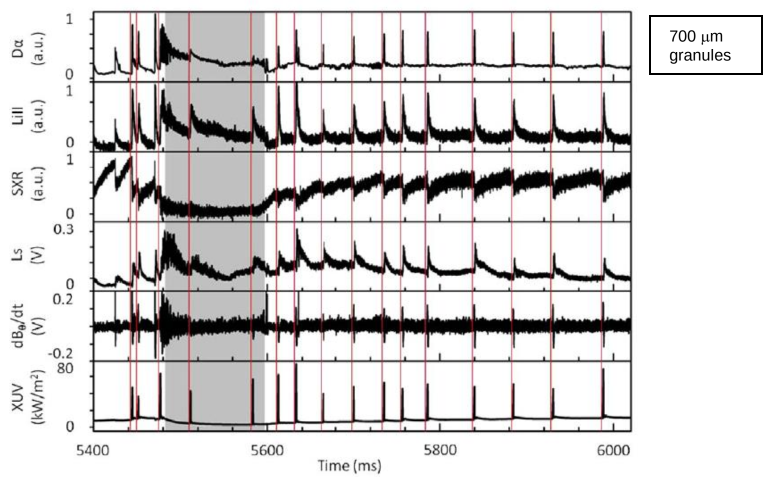
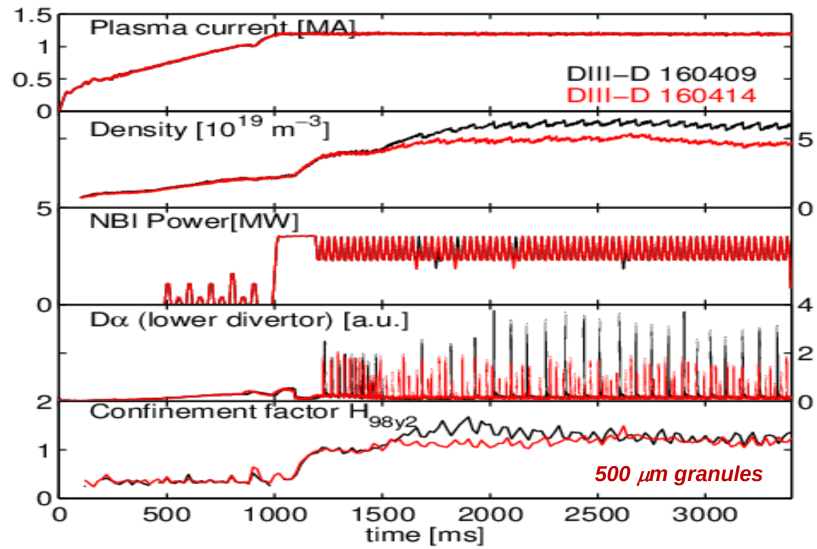


Figure 4. An expanded view of the granule injection phase during shot 42477. Included are traces of multiple diagnostics typically used to establish the presence or absence of ELM activity. They are in descending order: D-alpha emission, Li II emission, edge soft x-ray emission, divertor Langmuir probe signal, Mirnov coil signal and edge XUV emission. Red vertical lines have been drawn from the leading edge of each edge XUV emission event (bottom trace) and superimposed over all other data. The use of this signal for such timing purposes is based on the fact that sharp XUV emission was observed to correspond with the entry of a granule into the plasma edge whether or not the discharge was in the H- or L-mode. Granules 17 and 18 are not shown in this diagram. The grey area encompasses the H–L–H transition brought on by the third injected granule.



By ***A.Bortolon for the LGI team***
Presented to ***NSTX-U group at PPPL Jan 5th 2015***

Granule injector design as will be implemented on NSTX-U has been shown to successfully generate and pace ELMs at 3 – 4x natural ELM frequency. The DIII-D experiment also showed a clamping of high Z impurity accumulation.

Granule Injector : Capabilities and Limitations

- What we can do
  - Controlled mass injection
  - Confirmed edge destabilization
  - Line of sight viewing of pellet injection and ablation
  - Shot selectable pellet size and composition

- What we can't do
  - Precision Targeting
  - Core Penetration
  - Synchronized Delivery
  - "Pellet on Demand"

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Think "Shotgun"

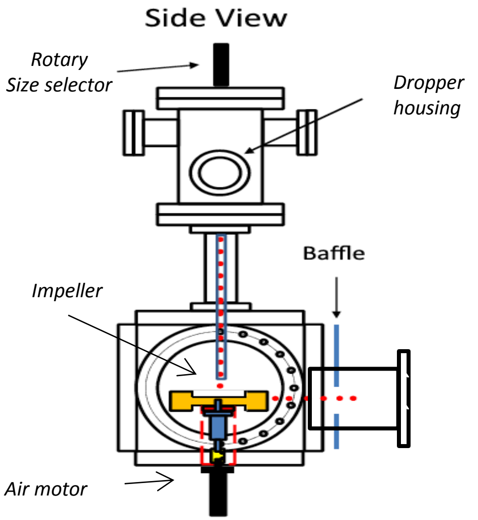
Not "Sniper Rifle"

Efforts are ongoing for upgraded capabilities in 2016

Early XP: Granular Boron Carbide triggered ELM events within Boronized Discharges (Backup)

Goal : Test granular injection of ITER adjacent material and compare to Lithium injection results

- Identify NSTX-U discharges with low natural ELM frequency
- Inject 300 μm, 500 μm and 850 μm pellets to determine pacing efficacy and impurity transport
- Compare characteristic fingerprints of spontaneous and stimulated ELMs



	Lithium	Beryllium	**Boron Carbide**	Carbon (graphite)
Sublimation Energy	1.6 eV	3.3 eV	**5.3 eV (B)**	7.5 eV
Density	.534 g/cm ^{3}	1.85 g/cm ^{3}	**2.52 g/cm ^{3}**	2.09 – 2.23 g/cm ^{3}

Boron Carbide Pellets (300, 500, 850 μm sizes)	**B_4C**
Grade	**CG (Ceramic) (% values)**
B + C min.	**99**
B (Boron) min.	**77**
C (Carbon) max.	**22.5**
B2O3	**0.10**
Fe (Iron) max.	**0.10**
Si (Silicon)	**0.01**
N (Nitrogen)	**0.01**
B + C min.	**99**

Incremental Physics: The segmented granule chamber allows for injection of Li pellets at the end of the boronization campaign for direct species specific comparison.