Pellet ELM Pacing Developments – DIII-D December Experiment Highlights

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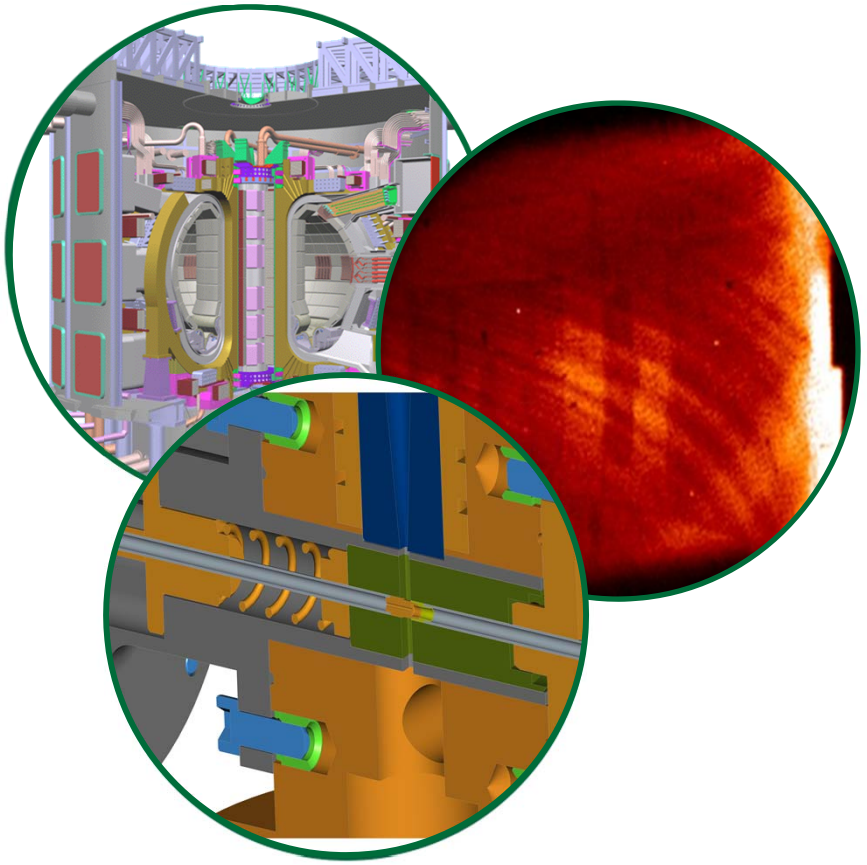

VLT Conference Call
21-Dec-2011

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
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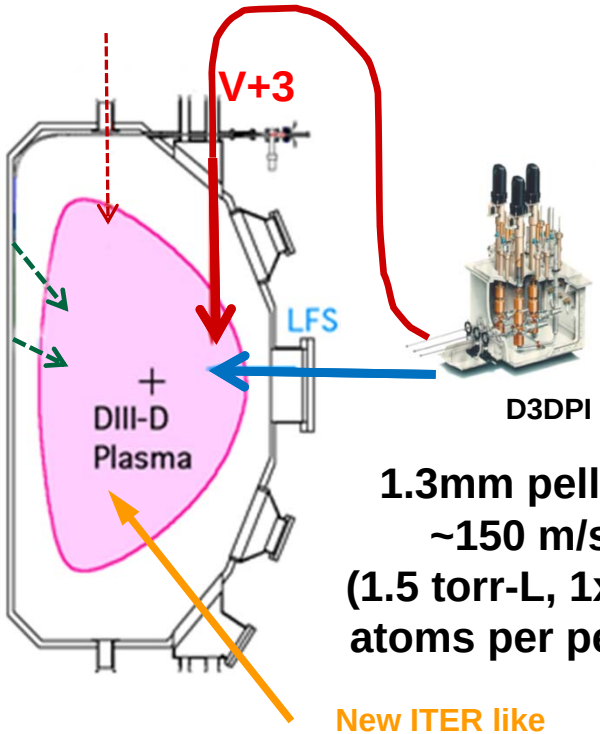
Overview

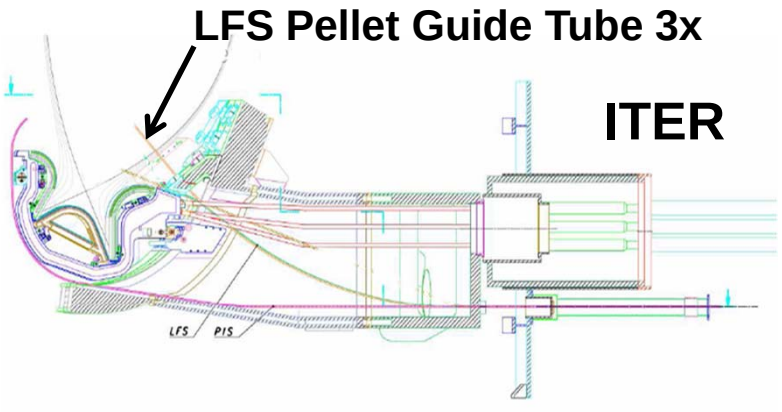
- **Projected erosion of divertor materials by type I ELMs is a serious issue for ITER. ELM Pacing has been shown to reduce the ELM size.**
- **In support of ITER, the pellet injector gun design has been modified to produce small pellets at slow speeds.**
- **The new injector gun design has been successfully tested in the lab and at DIII-D, where a new LFS injection line was installed that mimics the ITER plan for pellet ELM pacing.**
- **New data from this trajectory confirms ELMs are triggered before the pellet reaches the top of the Te pedestal.**
- **Pellets injected at 60 Hz into plasma. Pacing observed at 5 - 10x the natural ELM frequency.**

DIII-D Pellet ELM Triggering Experiment Performed with D_2 Pellets Injected from Low Field Side



1.3mm pellets
~150 m/s
(1.5 torr-L, 1x10^{20} atoms per pellet)

New ITER like Injection line for 2011



- New ITER like LFS injection line installed and tested on DIII-D. 1.3mm pellets injected appear to trigger ELMs.

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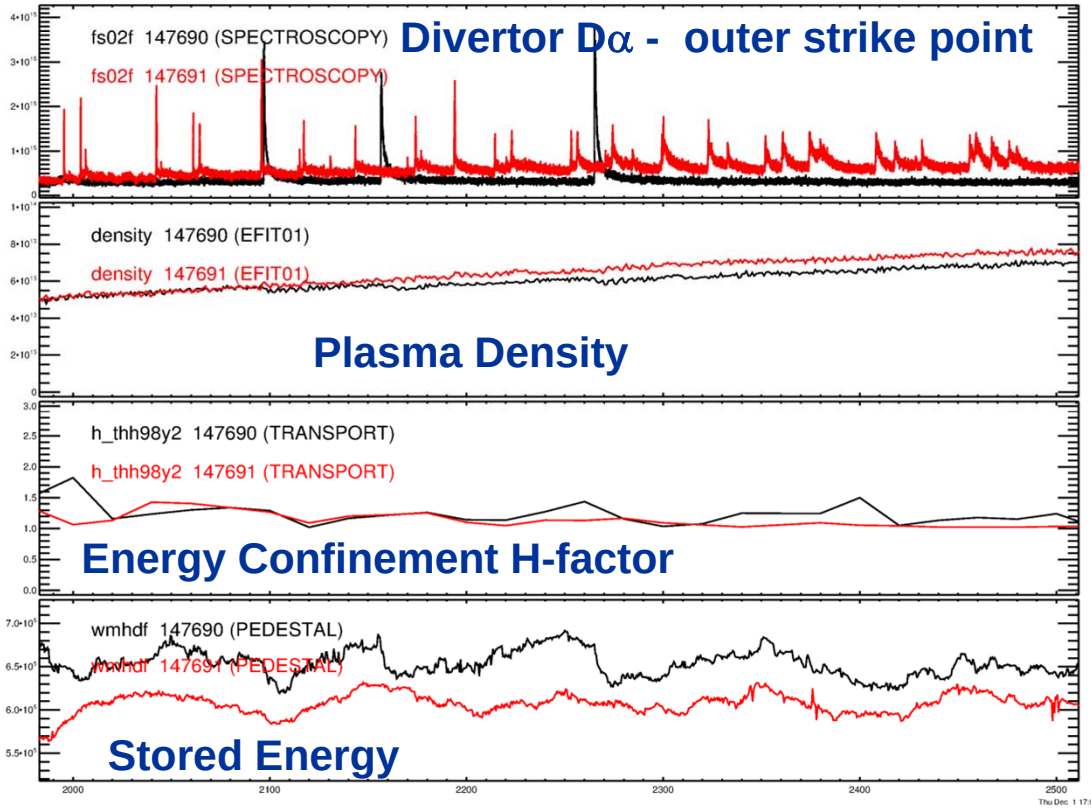
Demonstration of ELM Pacing by 60 Hz Pellets

Pellet Shot **Non- Pellet Shot**



- ELM Pacing demonstrated at ~10x the natural ELM rate.
- ITER Shape with ITER β_N~1.8
- 60 Hz 1.3mm pellets injected from LFS midplane and divertor at 150-200 m/s.
- Much smaller ELMs observed from the pellets. Large stored energy drops with natural ELMs.
- Only modest fueling and reduction in H-factor observed.

Preliminary – not for Distribution

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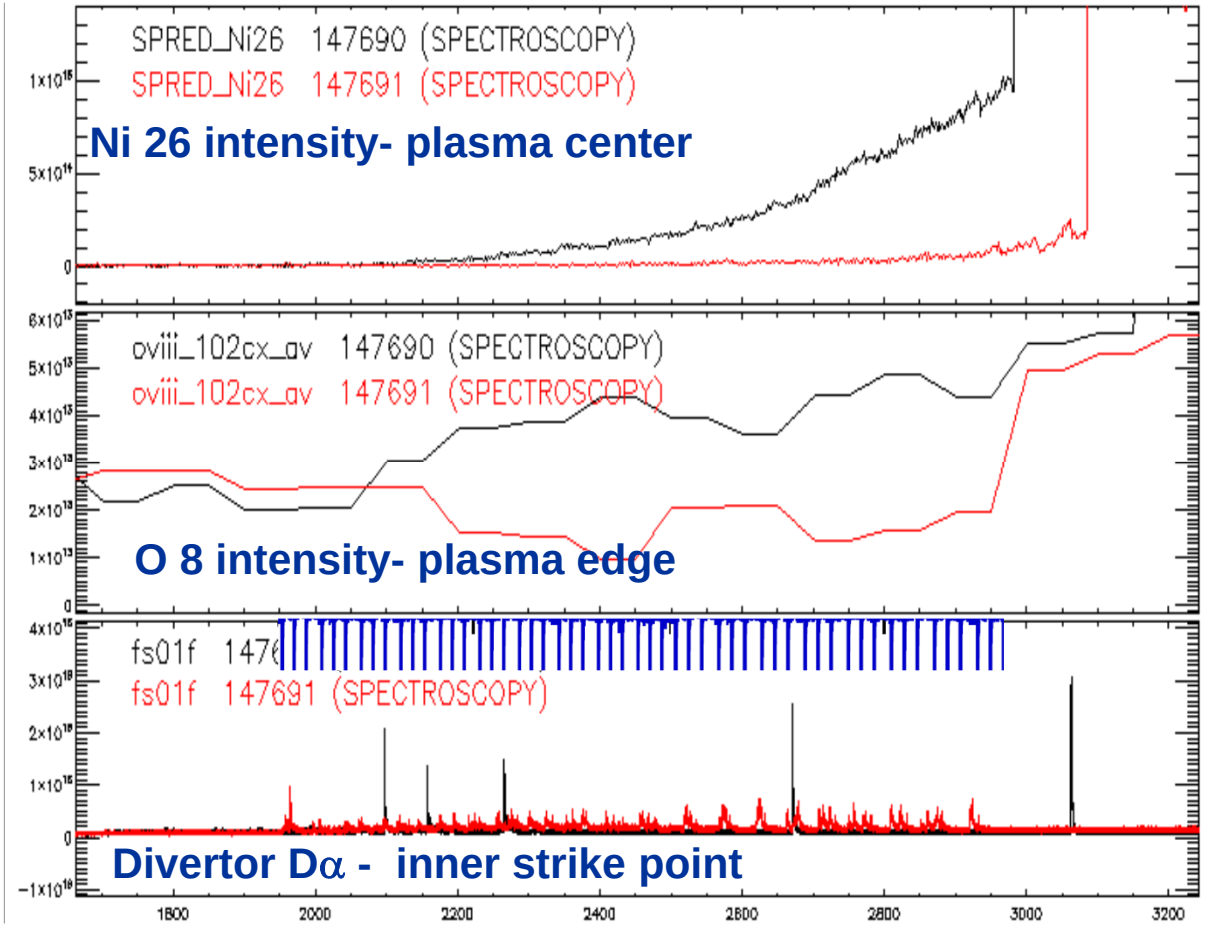
Reduction of Impurity Emission Intensity Observed with Pellet ELM Pacing

Pellet Shot **Non- Pellet Shot**



- ELM Pacing demonstrated at ~10x the natural ELM rate.
- ITER Shape with ITER β_N~1.8
- 60 Hz 1.3mm pellets injected from LFS midplane and divertor at 150-200 m/s.
- Much smaller ELMs observed from the pellets.
- Reduced high-Z and lower Z impurity signal intensity in the plasma core during the ELM pacing phase.

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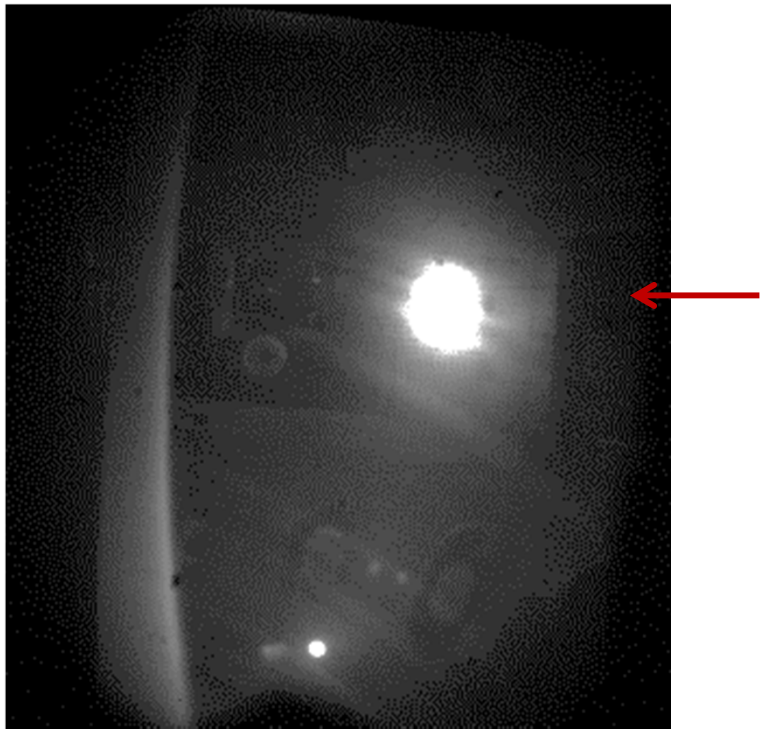
Fast Camera Images of Pellets that Trigger ELMs

R-2 Pellet



LFSmid Pellet

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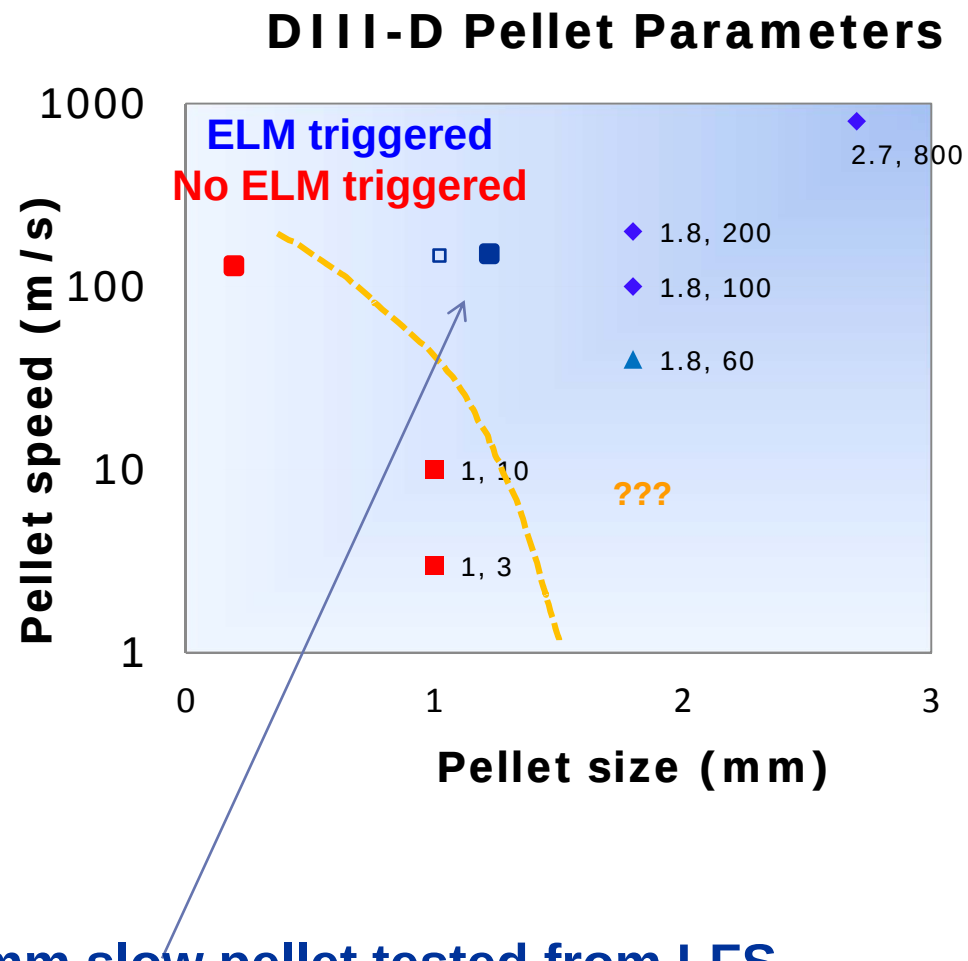
Future Plans for DIII-D Pellet ELM Pacing

- What are the minimum pellet size and speed requirements to reliably trigger ELMs ?
- DIII-D is investigating this in concert with JET and ASDEX-U (ITPA PEP24).
- In 2012 we plan to tested 1.3x1.0mm pellets (~20% reduction in size).
- Also will investigate inner wall fueling combined with LFS ELM pacing pellets.



New 1.3mm slow pellet tested from LFS