

Pegasus-III Experiment

Initial Results from the New Pegasus-III Experiment

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Denver, CO, Presentation BO08.00007
30 October 2023
Work Supported by US DOE Grant DE-SC0019008



Department of Nuclear Engineering & Engineering Physics
UNIVERSITY OF WISCONSIN–MADISON

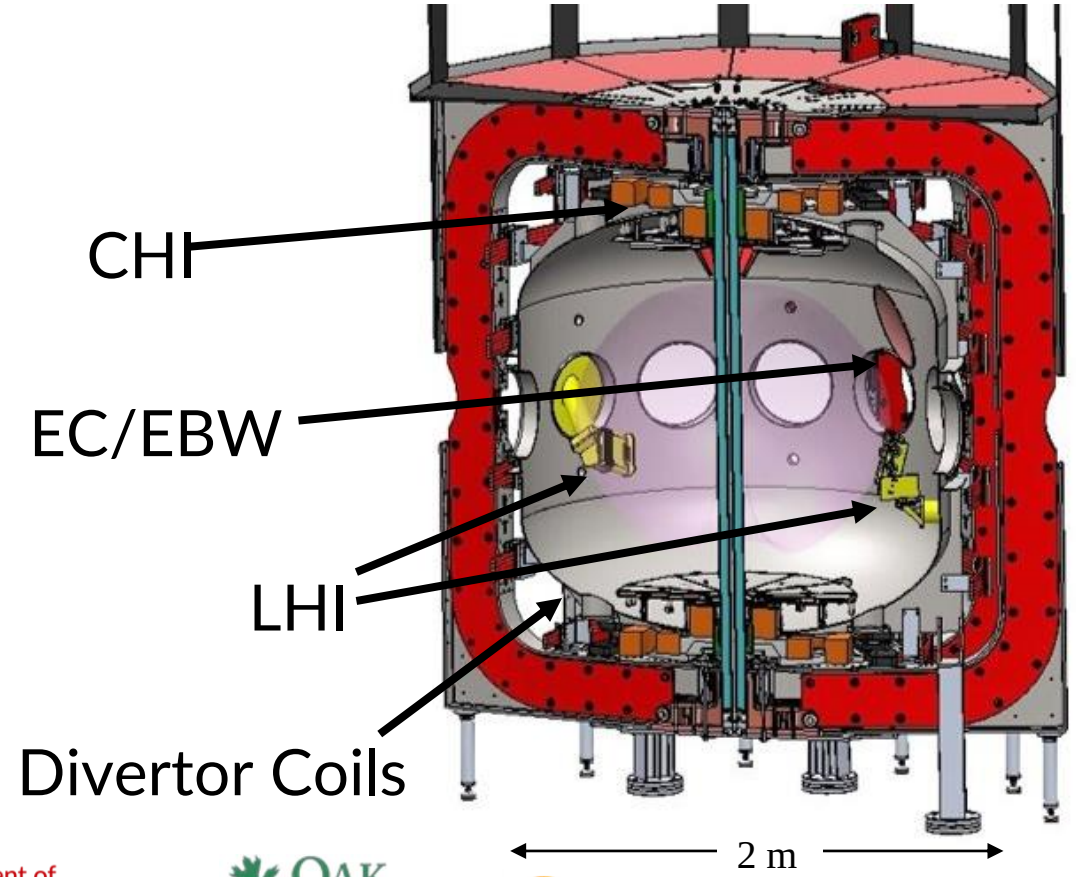
Pegasus-III: Bold Test of Non-Solenoidal Startup Using Power Plant Relevant Technology

- Future ST designs call for solenoid-free operation
  - Minimize/no OH due to shielding/cost
- New Pegasus-III facility: Developing validated physics & tech basis for MA startup
  - Advanced Local Helicity Injection (LHI)
  - Floating Coaxial Helicity Injection (CHI)
  - Microwave assist, sustainment and startup
- Research program provide predictive understanding of solenoid-free techniques
  - Extrapolatable techniques to MA-class STs and advanced tokamaks

YP11.29, 30, 31, 32

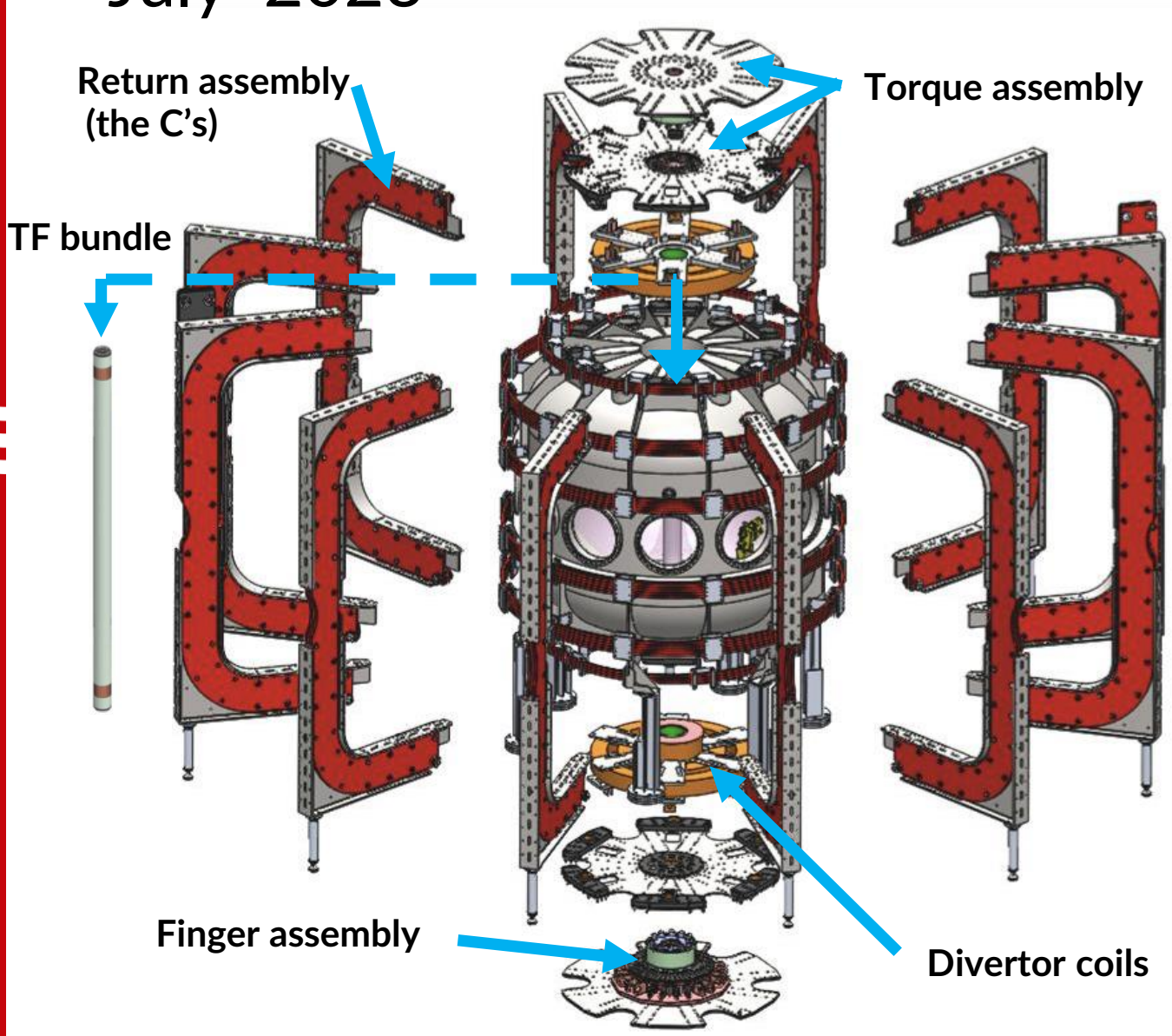
Pegasus- III features:

- **No solenoid**
- B_T < 0.6 T
- Advanced control
- Expanded diagnostics



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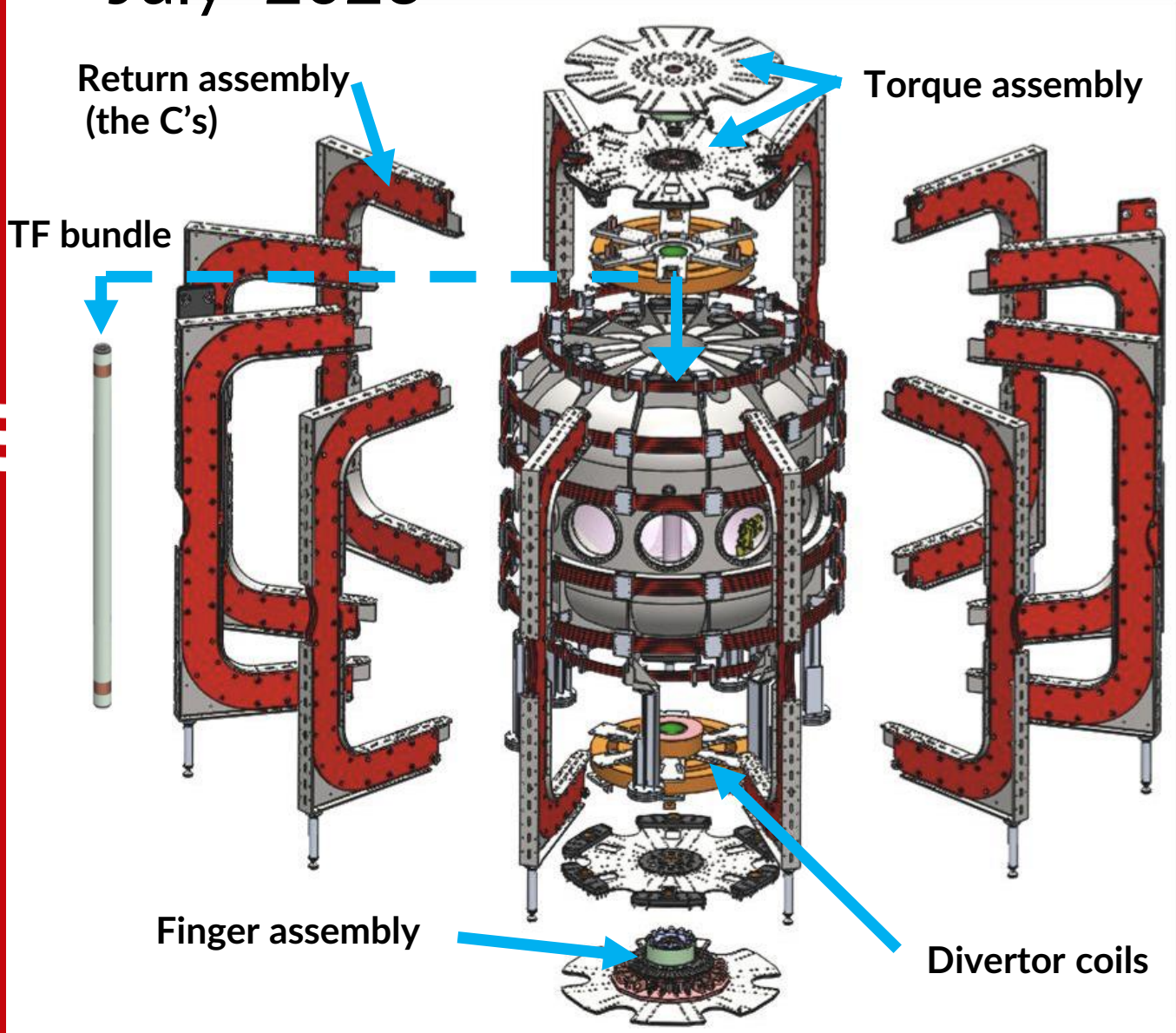
All Major Sub-Assemblies Assembled & Commissioned by July 2023





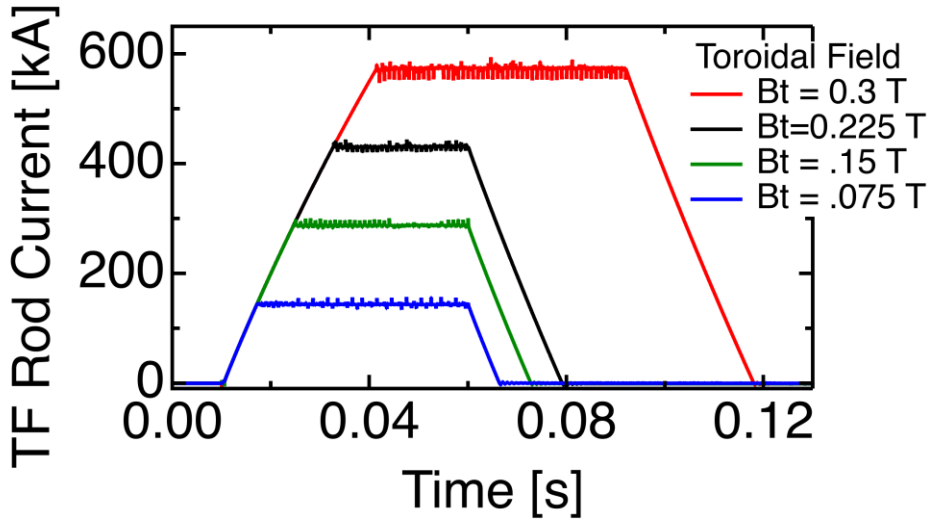
YP11.30

All Major Sub-Assemblies Assembled & Commissioned by July 2023



TF magnet successfully commissioned up to 0.3 T

- No change in strain observed during operation
- No change in strain when operated in conjunction with other magnets

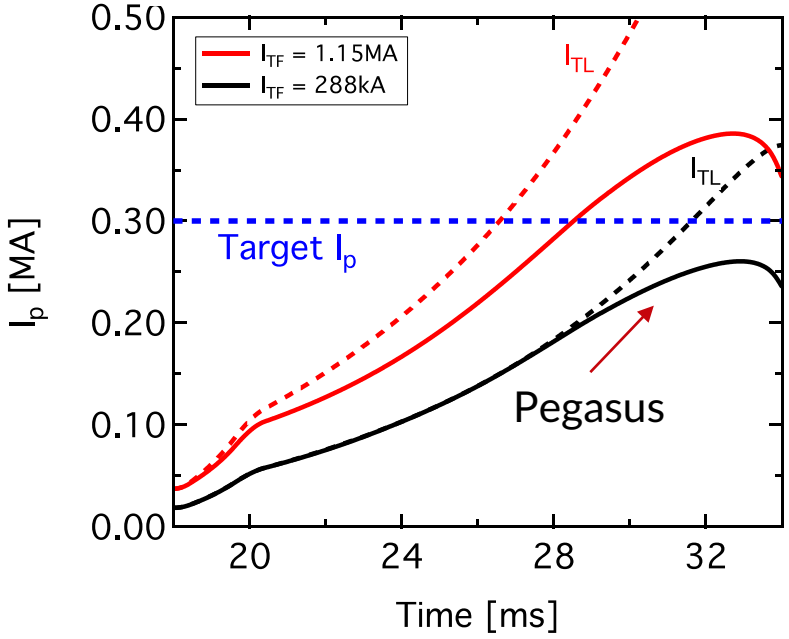


YP11.30, 35

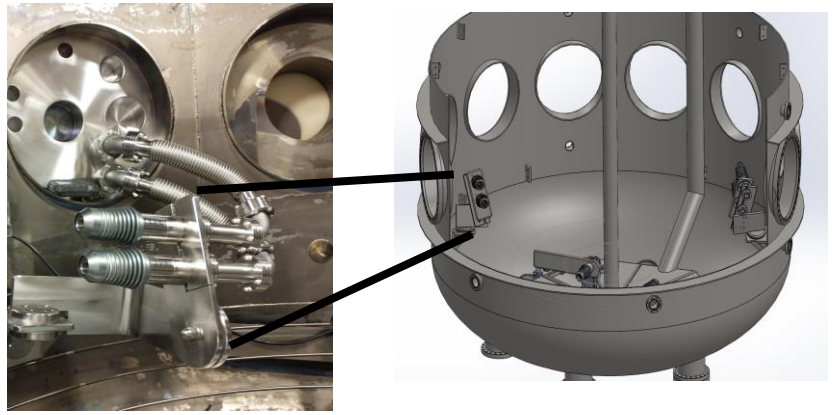
Next-Generation LHI Injectors Tests Performance at Increasing B_T

- Two arrays: 2x4 cm^2 circular injectors commissioned
  - Voltage handling determined by gas load, extracted current
  - Typical operations > 600 V on all four injectors

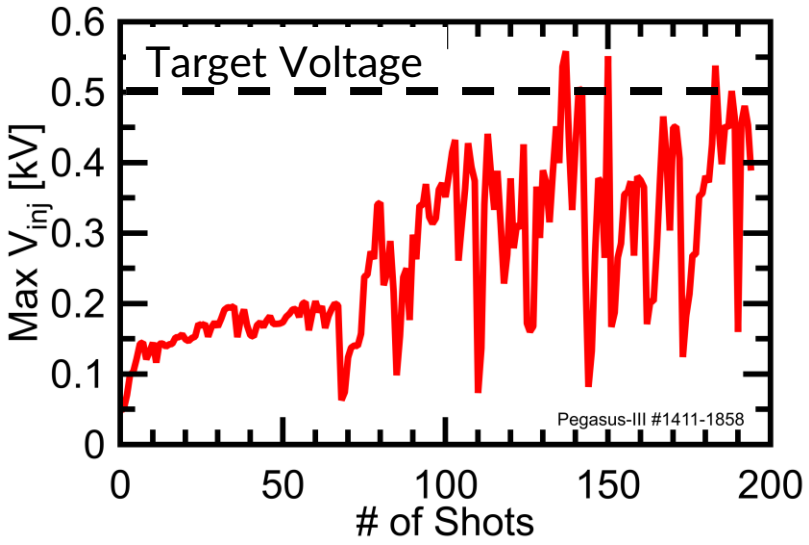
Pegasus-III Projection



Next-Generation LHI Injectors



Conditioning Progress Evident After 100 shots



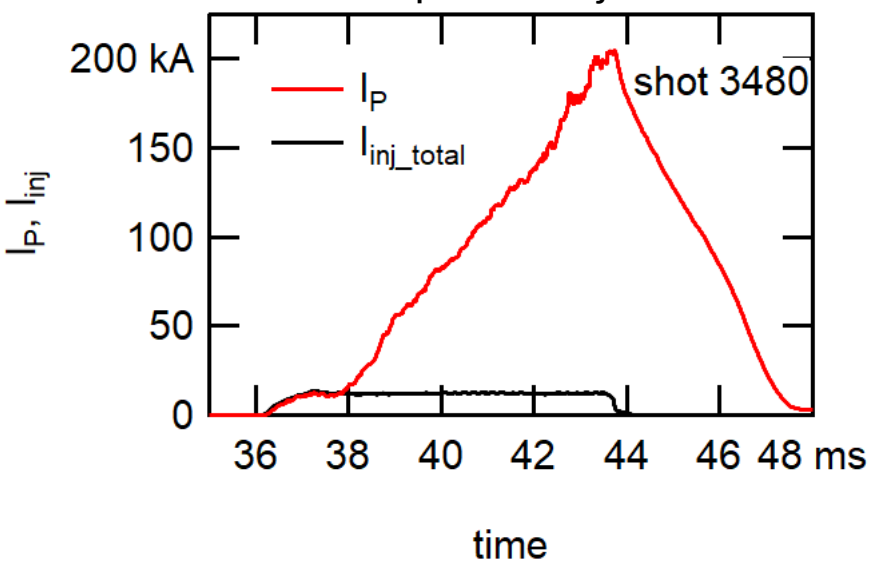
YP11.32, 33, 34

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Pegasus-III LHI System Reliably Produces Solenoid Free High I_p Plasmas

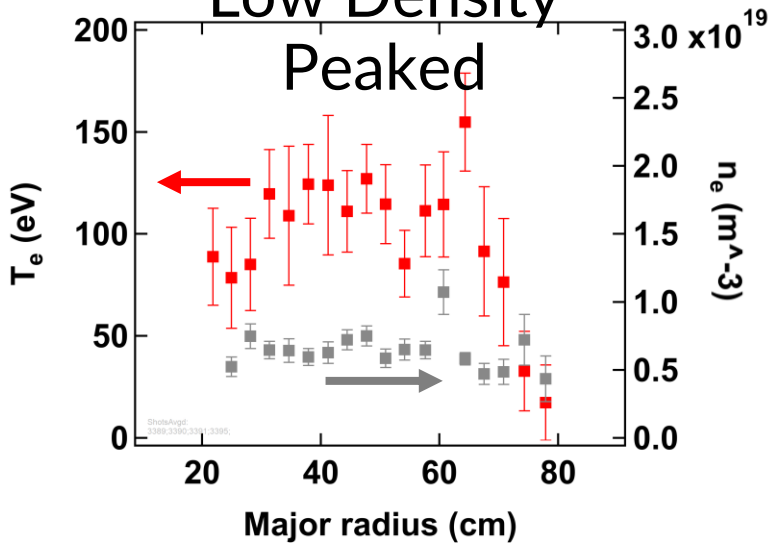
- Initial plasmas exceeds highest I_p for previous Pegasus LFS system with I_p ~ 200 kA
- Determining initial operating point & limits to operational space
  - Fueling currently limiting operations space – known issue to be rectified soon
  - Injector coupling of multiple arrays & effective current layer width being studied

Pegasus-III plasma
$I_p >> I_{inj}$

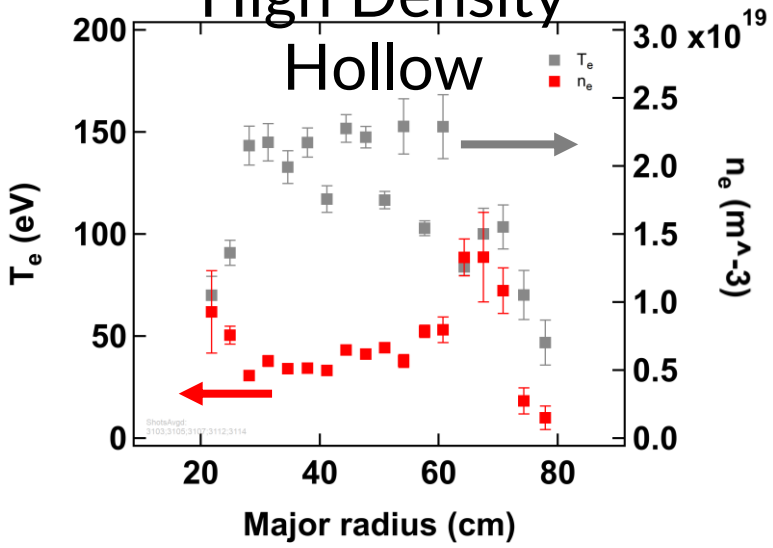


First Thomson Scattering Profiles from Pegasus-III

Low Density
Peaked



High Density
Hollow



YP11.32, 40

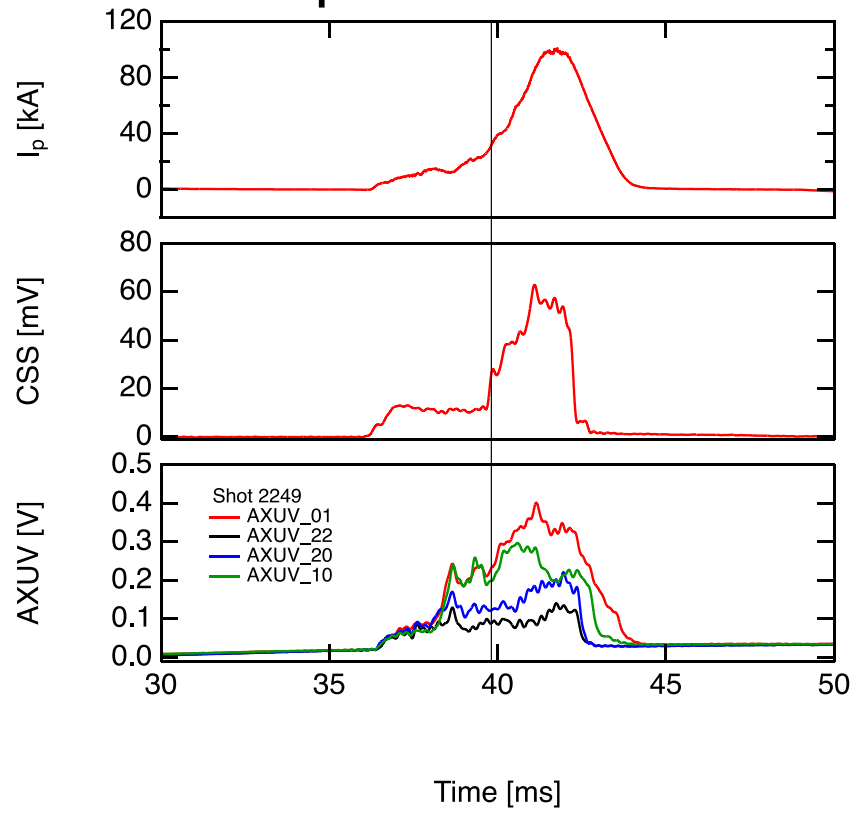
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Diagnostics, Modeling Coming On Line to Support Physics Operations

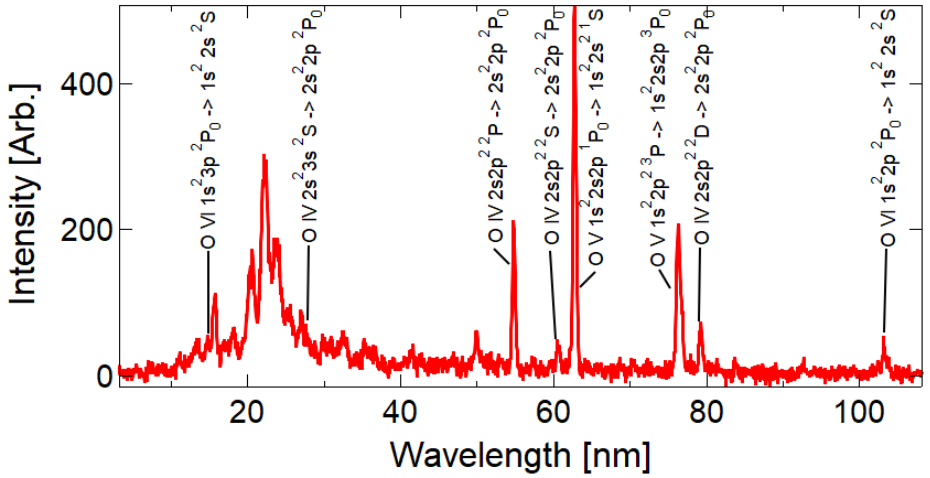
- Multiple diagnostics being commissioned

Diagnostics: YP11.35, 38, 39, 40
Modeling: YP11.36, 37, 41

AXUV Diode Array & Cathode Spot Detection



SPRED VUV Spectroscopy

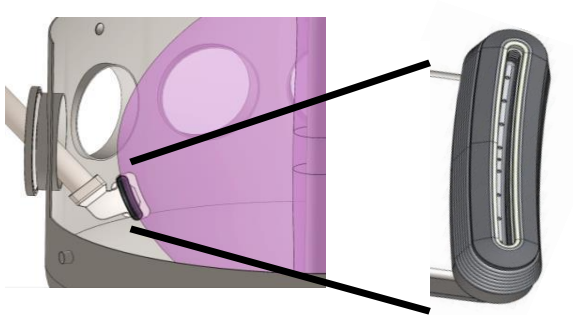


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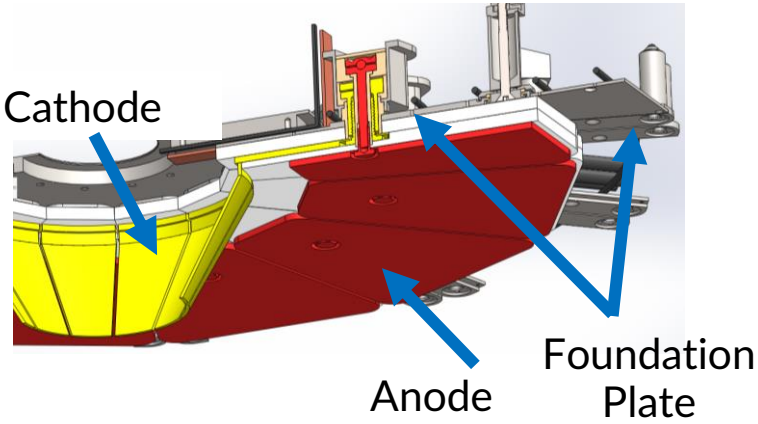
Initial Circular Injector Campaign Leads to CHI/Non-Circular Operations

2024: $B_T \rightarrow 0.6$

Advanced Non-circular Injector in PEGASUS-III



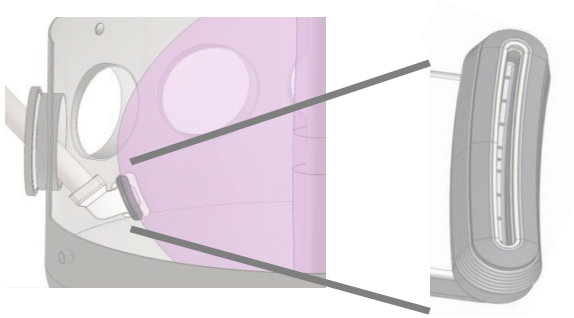
Novel CHI system



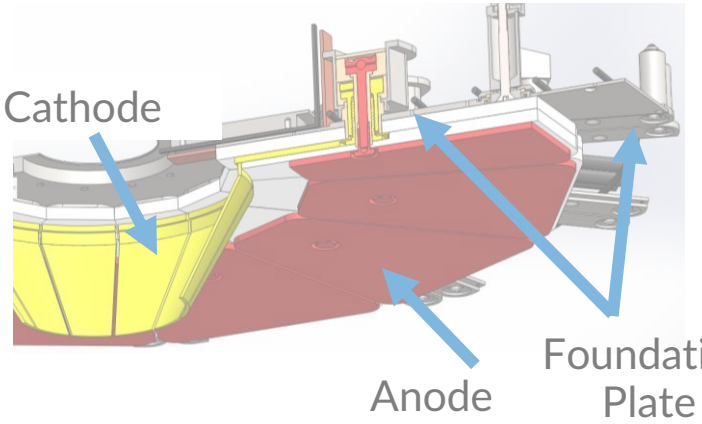
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Novel CHI system



2025

SAMI (EBE) installed 2023 in-preparation



UNIVERSITY of York

YP11.39

28 GHz microwave injection for EBW/EC

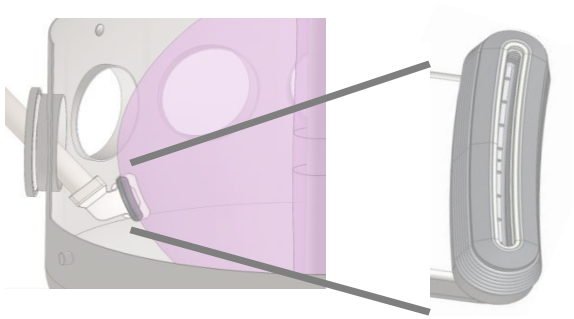


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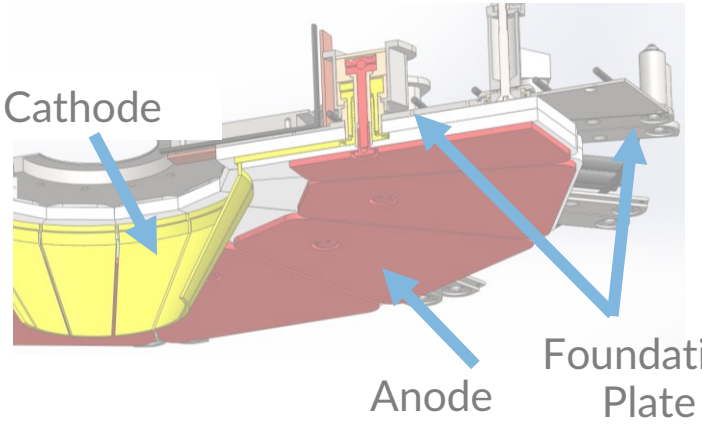
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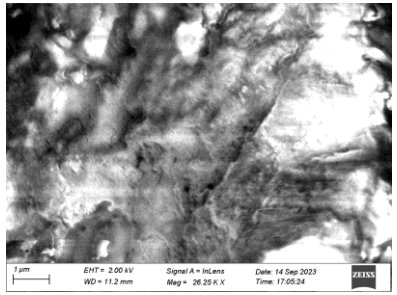


UNIVERSITY of York YP11.39

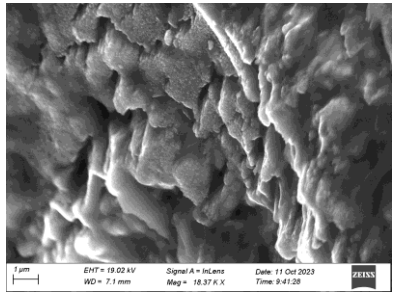
New initiatives:

Affects of **materials** choices on component lifetimes being studied: **Mo frustum shield**

Before Use



After Use



Open and FAIR Fusion for Machine Learning Applications

MIT PSFC Plasma Science and Fusion Center

WILLIAM & MARY

THE UNIVERSITY of WISCONSIN MADISON

AUBURN UNIVERSITY

The HDF Group

Department of Nuclear Engineering & Engineering Physics UNIVERSITY OF WISCONSIN-MADISON

CP11.33, funded by Howard Beale

US DOE Grant DE-SC0024475

Elimination of Solenoid Greatly Simplifies ST Design, Requires Non-Inductive Startup Pathway

Pegasus-III in operations



Friday AM Poster Presentations:

YP11.00029 – J.A. Reusch
YP11.00030 – J.A Goetz
YP11.00031 – M.W. Bongard
YP11.00032 – A.C Sontag
YP11.00033 – A.S. Rajendra
YP11.00034 – A.L. Ferris
YP11.00035 – M.D Nornberg
YP11.00036 – J.D. Weberski
YP11.00037 – M.W. Aslin
YP11.00038 – R.K Sassella
YP11.00039 – J.K Peery
YP11.00040 – T.N. Tierney
YP11.00041 – A.D Ingram

Presentations at: https://pegasus.ep.wisc.edu

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