PPPL PRINCETON PLASMA PHYSICS LABORATORY

PRINCETON UNIVERSITY

Advanced Projects Research Activities

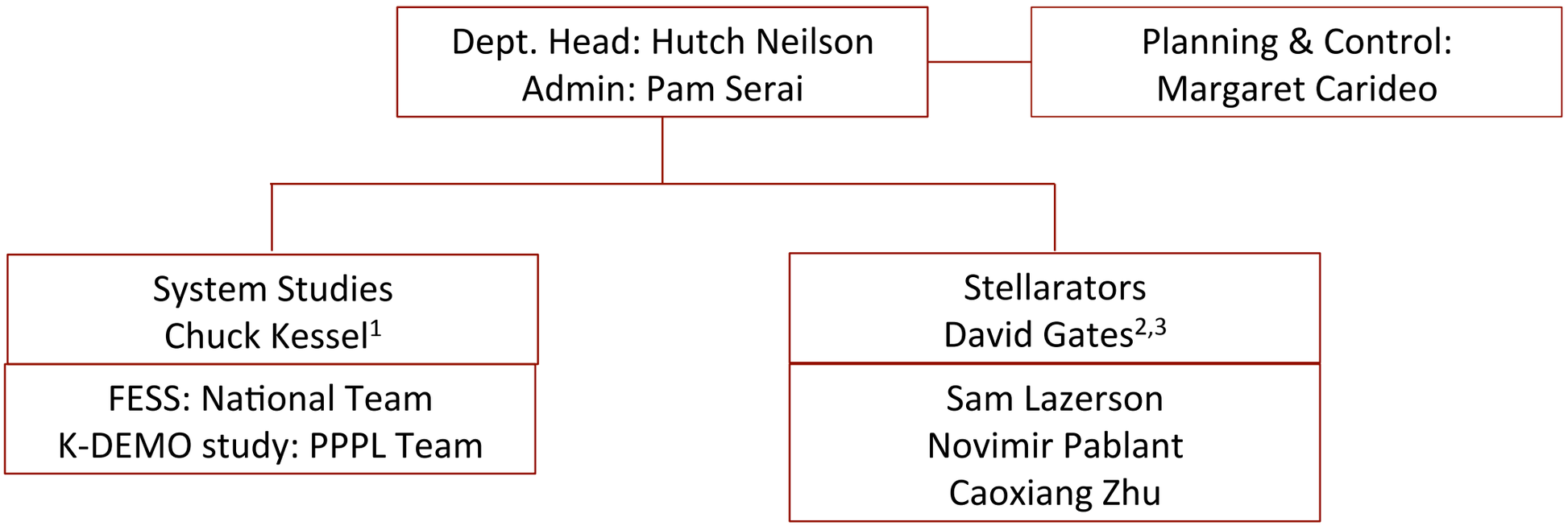
Hutch Neilson

Department Head

NSTX-U Meeting

30 July 2018

Advanced Projects Team



Notes:

1. Leader of national Fusion Energy System Studies (FESS) program, C. Kessel
2. Co-chair of National Stellarator Coordinating Committee, D. Gates
3. U.S. Technical Coordinator for W7-X collaboration, D. Gates

Fusion Energy Systems Studies (FESS)
The Integrating Component of the Virtual Laboratory for Technology

FESS provides advanced design studies that integrate multiple disciplines and guide R&D priorities, with a focus on next step facilities

Present work: Liquid Metal Plasma Facing Components ($1,500k/yr. nationally)

- Study is responsive to 2015 PMI Community Workshop and considers:
  - Liquid metal layer, Solid substrate, First wall & divertor concept
  - Integration in a fusion machine, e.g. FNSF
- Study will finish at the end of CY2018, but is already influencing research choices:
  - Corrosion experiments (ORNL); Lithium PFC research priorities (PPPL)

PPPL Scope

- National team leadership
- Systems and core physics analyses
- Liquid metal properties and analyses
- Other engineering analyses

FESS has been examining Liquid Metal Plasma Facing Components – response to 2015 PMI Community Workshop

* We are considering thin liquid metal approaches (0.1-5.0 cm thick layers), imagine these PFCs on top of a normal blanket or divertor.....Use FNSF design as baseline for analysis

Liquid Metals	Losses, temperature range Impurities Nuclear properties Hydrogen pickup, solubility, hydriding		LM specific R&D
Solid Substrates & Interactions	Require fusion relevant materials Must eliminate liquid metal embrittlement failure Static corrosion tests on-going at ORNL Refractory coatings, insulator coatings		Offline experiments for specific concept
LM PFC Concepts: FW Divertor	Flowing LM	Li vapor box divertor	Simulation needs to advance R&D
	Capillary system	Tub divertor	
LM PFC Integration Aspects	Tritium extraction Back-end loop, tritium and impurity concentrations Thermal conversion Flow around FW penetrations		Need for confinement facility testing

PPPL Supports the Community Vision for U.S. Stellarator Research

- Base: W7-X physics
- Enhancements 2018-20:
  - W7-X pellet injector (partner)
  - W7-X enhancements in staff and equipment
  - LHD opportunities

- Next step:

  Transition from current LDRD-funded optimization activity to a leading center of a proposed national stellarator optimization initiative.

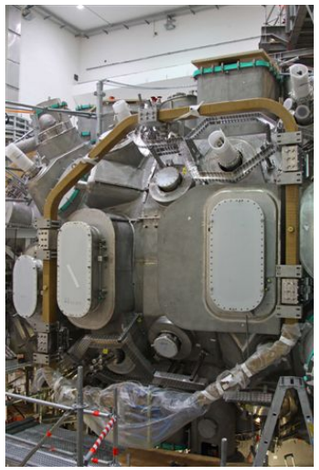
- The future:
  - World-leading QS stellarator experiments.
  - Start preparing now. Be ready for opportunity.

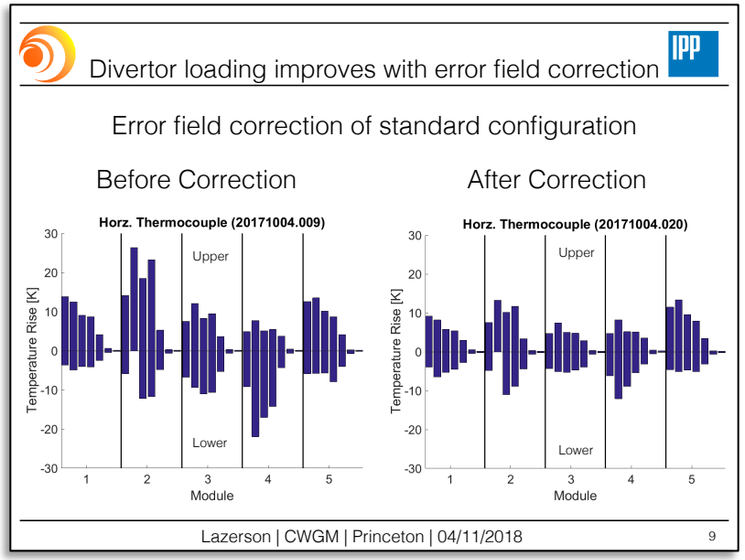
Program Vision for Stellarator Research in the US

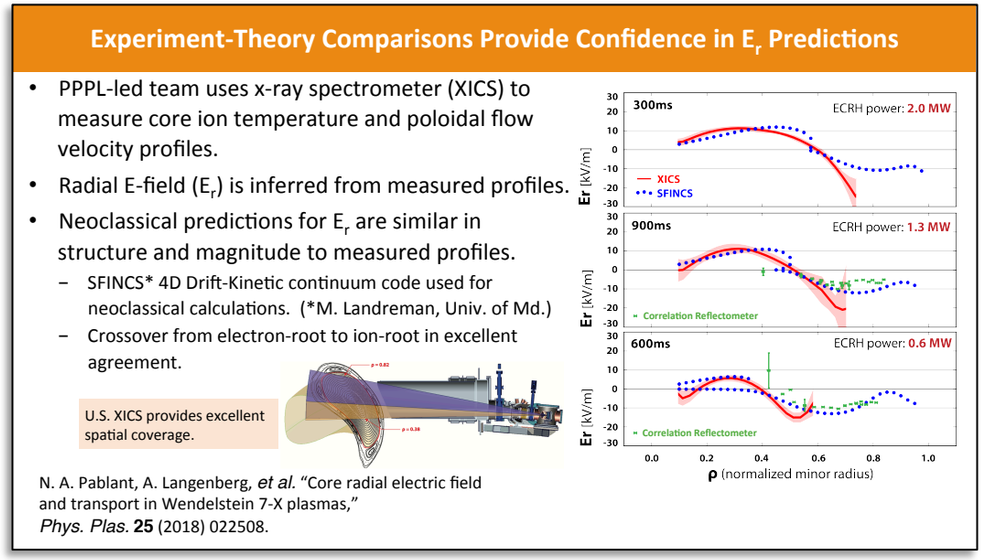
- Strategic goal: position the US as a leader in quasi-symmetric stellarator research
  - Exploit international collaborations to verify the physics of current optimization strategies
  - Develop concepts based on advanced optimization for high performance maintainable fusion confinement
  - Implement a select design at the mid-scale and verify the physical assumptions underlying the optimizations
  - Prepare for a major experimental initiative in ITER era

NSCC

PPPL Physicists and Equipment Play Key Roles in W7-X Research







Plasma control: S. Lazerson

- Control of divertor heat-load balance with trim coils.
- Field error measurements, effects, and correction.

Core transport physics: N. Pablant

- X-ray imaging crystal spectrometer operation & upgrades.
- Collaboration with IPP, Auburn Univ. NIFS

Leadership

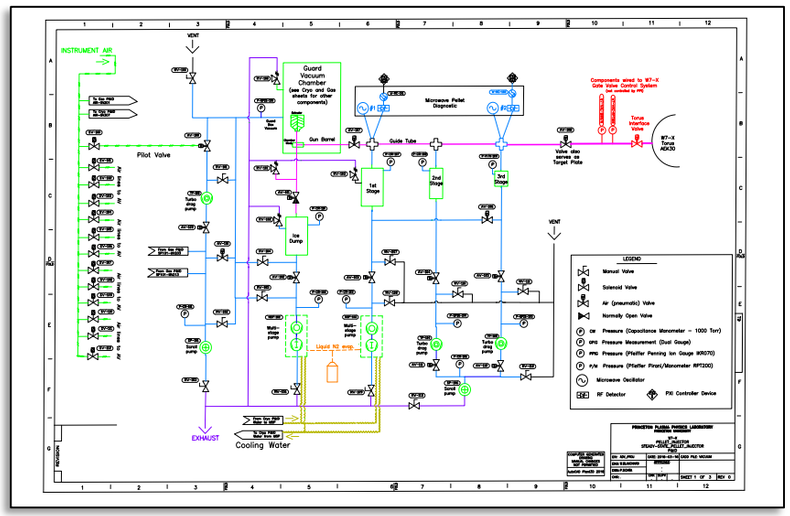
- U.S. W7-X Technical Coordination: D. Gates
- W7-X Scenarios Task Force Leader: S. Lazerson
- U.S. National Stellarator Coordination: D. Gates

Now through FY-2020

- Complete the OP1.2 campaign
- **Collaborate in analysis and publication of OP1.2 results**
- Explore opportunities with LHD
- Prepare for OP2

We are a partner with ORNL and IPP in the W7-X Pellet Project

Support structure



PPPL-designed vacuum pumping instrumentation and control layout.

PPPL responsibilities:

- Support structure
- I&C engineering (in collaboration with ORNL & IPP)
- Vacuum pumping design optimization
- Deputy project manager (HN), W7-X management interface.