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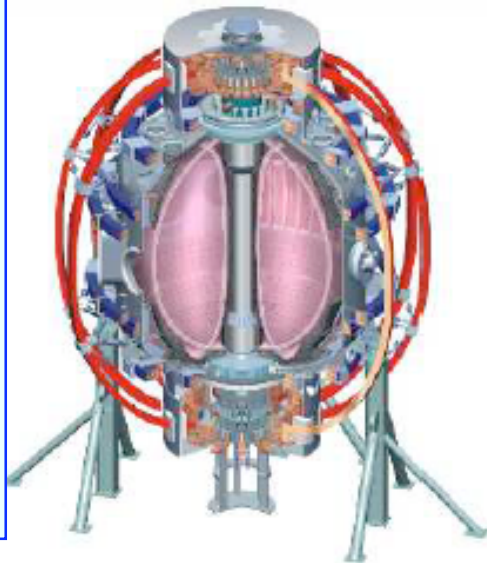
NSTX Project Facility, Diagnostic and Budget Plan

Masayuki Ono

OFES FY 2009 Budget Planning Meeting

Gaithersburg, Maryland, March 13 - 14, 2007

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Comp-X
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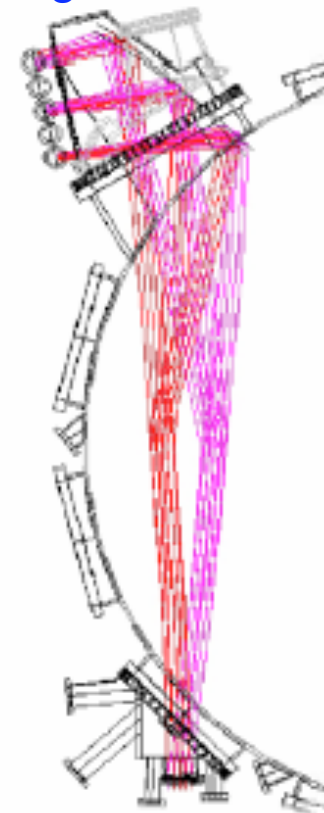
Culham Sci Ctr
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NSTX Facility/Diagnostics in FY'06



- DOE Joule Milestone F(06-1) - Operate for 11 run weeks:
Completed 12.6 run weeks with 1617 plasma discharges
- Milestone F(06-2) - Install and operate a lithium evaporator: *achieved 9 grams of evaporation*
- Milestone D(06-1) - Complete fabrication for interim PCHERS diagnostic: *installed and in commissioning*
- Additional research capabilities implemented:
 - Feedback capability for EF/RWM coils
 - 12 channels for MSE diagnostic for improved $j(r)$
 - Higher voltage for CHI for record current 160 kA
 - High-k (electron-scale) fluctuation scattering system
 - Dual remotely steerable, 8-40 GHz EBW radiometers
 - Routine TF operation extended to 5.5 kG

High-k scattering



FY 2007 run started in Feb. 2007 with new capabilities

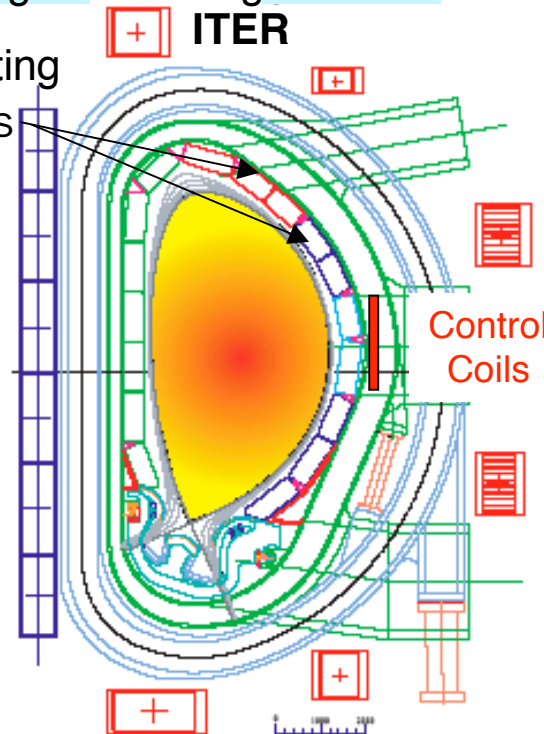
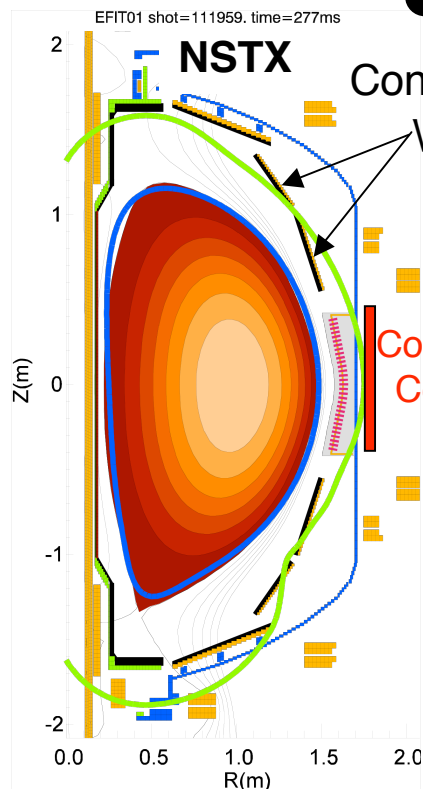
MHD

NSTX Well Positioned for Cutting-Edge EF/RWM Research



	FY 07	FY 08	FY 09
Run Weeks	10	12	12
Base / Request*		8	8
EF/RWM	● EF/RWM Feedback (Columbia)	● PCS Processor Upgrade (GA)	● V_ϕ feedback (Request)
Disruptions	● Fast Multi-Color-Te(r)(0.1ms, JHU)	● β_N feedback	
	● Segmented Rogowski Coils		

*Note: Request is 10% enhancement over the base

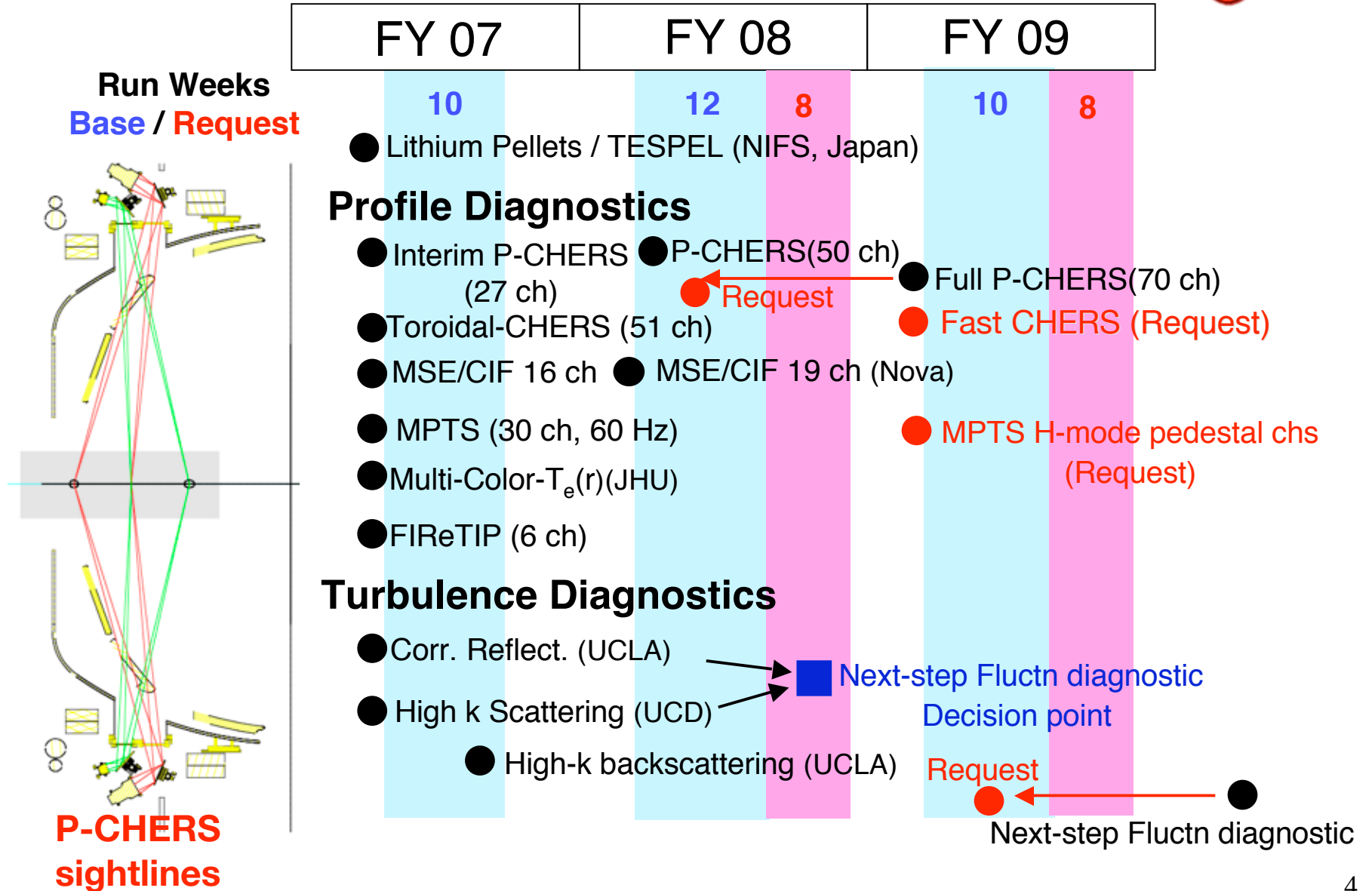


Advanced Plasma Control:

- EF/RWM feedback control successfully implemented in FY 06 experiments.
- PCS Processor Upgrade will provide faster feedback control x 3-10 in FY 08.
- Realtime diagnostic data processing:
 - β_N feedback in FY 08
 - V_ϕ feedback in FY 09 (Request)

Transport and Turbulence

High priorities are Poloidal CHERS and Turbulence Diagnostics



Boundary Physics

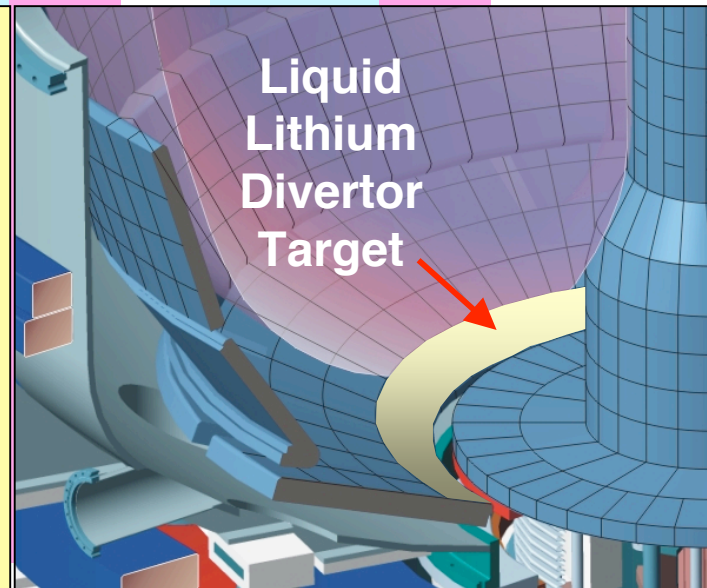
High Priority to test Liquid Lithium Divertor Target in 2009



	FY 07	FY 08	FY 09
Run Weeks	10	12	12
Base / Request		8	8
	<ul style="list-style-type: none"> ● Improved (x10) Li Evaporator ● Lithium Pellet Injector ● SSGI (LLNL) ● Filterscope (~ 30 ch, ORNL) ● Fast probe (UCSD) 	<ul style="list-style-type: none"> ● Fast IR Camera (Request) 	<ul style="list-style-type: none"> ● Liquid Lithium Divertor Target (SNL) ● Divertor Diagnostics (Request)

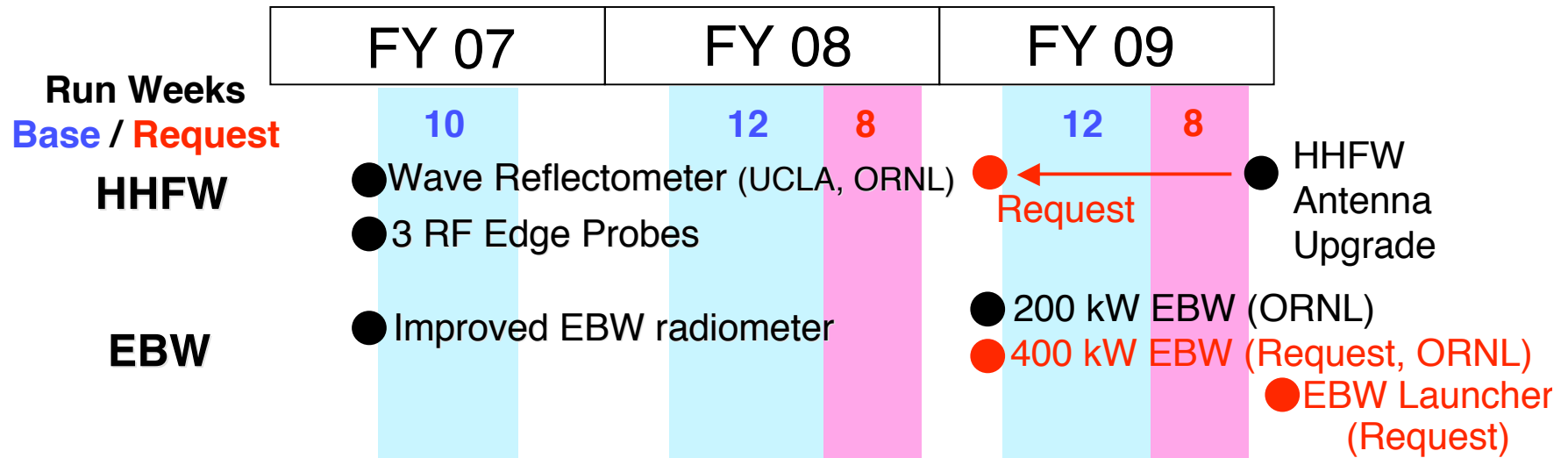
Liquid Lithium Divertor Target:

- Evaporated lithium improved plasma performance
- Surface saturation however limited its effectiveness for longer pulses
- Liquid lithium surface needed to maintain fresh lithium surface for continued pumping
- Heated saturated mesh is a leading candidate
- Design in FY 07, fabricate in FY 08, and install for the FY 09 run (SNL, UCSD).



Waves and Energetic Particles

High priority to implement 200 kW EBW/ECH system



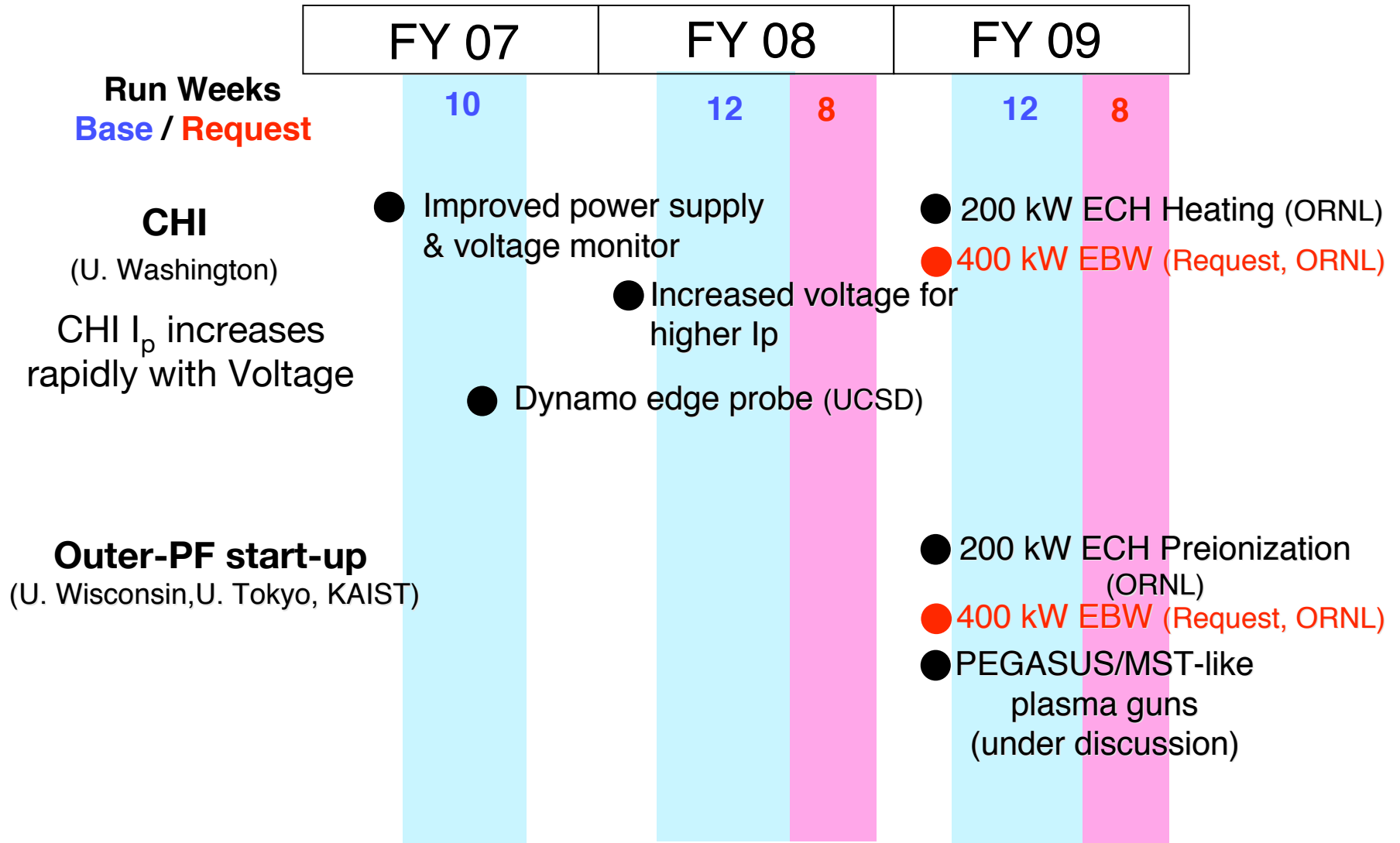
New Direction: 100 - 200 kW (15.3, 28 GHz) EBW/ECH system utilizing existing ORNL and PPPL equipments

- Test EBW heating
- Heat CHI start-up plasma to ~100 eV enabling HHFW heating and CD
- Assist PF-only start-up research

- Energetic Particles**
- Core Reflectometer (UCLA)
 - FIReTIP (4 → 6 ch, 500 kHz UCD)
 - Add. high freq. magnetic sensors
 - FIReTIP (2 MHz UCD)
 - Fast-ion D-alpha camera(UCL)

Solenoid-Free Start-Up

Build upon the Success of Transient CHI



Productive Collaborative Research Team



FY 06 was a very productive year:

- 70 Refereed Journal Paper Publications
- 52 invited papers at major [APS, IAEA, EPS] and topical meetings (HTPD, RF, PSI)
- 6 PRLs on four ITER-relevant key research topics (RWM, Momentum transport, Multi-energetic particle modes, MHD driven fast particle transport) + CTF-relevant solenoid-free start-up with CHI
- 34 post-docs and students

NSTX Research Team*

	PPPL	US Collab	Foreign
Research Staff	50	85*	35
Post Doctoral Staff	0	6	0
Graduate Students**	8	7	7
Undergrad Students		6	

• Includes those funded directly by theory and VLT

** Thirteen Ph.D. Thesis students

NSTX Budget Summary (\$M)



	FY 07	FY 08		FY 09	
Budget cases	Base	Base	Request	Base	Request
Run Weeks	10	12	20	12	20
Facility Ops	18.0	18.7	19.8	19.3	20.4
Facility Upgrades	0.6	0.7	2.0	0.5	2.0
Diag Upgrades		0.5	1.3	0.4	1.3
Facility Total	18.6	19.9	23.1	20.2	23.7
PPPL Research	9.6	10.1	10.4	10.4	10.7
Diag Upgrades	0.7				
Coll Diag Interf	0.7	0.6	0.7	0.6	0.7
Collaborations	5.2	5.5	5.7	5.6	5.9
Science Total	16.2	16.2	16.8	16.6	17.3
NSTX Total	34.8	36.1	39.9	36.8	41.0

- 12 run week base cases in FY 08 and 09 include minimal upgrades.
- Requested budget ~ 10% increase allows ~ 66% increase in facility utilization and acceleration of high priority facility and diagnostic upgrades.

Modest Budget Enhancement (~ 10%) Significantly Increases Science Output



- **Significantly increases Facility Utilization:**
 - 66 % increase in run weeks (from 12 to 20)
- **Accelerate Key Facility/Diagnostic Upgrades:**
 - Full P-CHERS for FY 08 run
 - Enhanced divertor diagnostics in FY 08 - 09
 - Install 2nd EBW tube - x2 power from 200 kW to 400 kW in FY 09
 - HHFW antenna upgrade for FY 09 run
 - Next-step turbulence diagnostic to be commissioned in FY 09
 - Fast CHERS in FY 09
 - EBW launcher for FY 10 run
- **Improves Facility Reliability and Availability**
 - Better Preventive Maintenance and
 - Critical spare parts

10% Budget Cut Case (FY09)



- **50% reduction in runtime (from 12 to 6 weeks)**
- **NSTX staff reduction of ~ 15 FTE relative to the base case**
- **Significantly reduce facility and diagnostic upgrades procurement ~ 50%**
 - **Delay 200 kW ECH/EBW system**
 - **Delay full P-CHERS**
- **Research decreases by 50%**

Exciting Opportunities and Challenges

Optimized Plans Developed for FY 2007 - 2009



- **Productive FY2006 run completed, July, 2006**
- **FY 2007 run started in February**
- **Exciting new capabilities proposed for FY 2007-2009**
 - 200 kW EBW/ECH (Waves, Solenoid-free Start-up) in 2009
 - Liquid lithium divertor target (Boundary) in 2009
 - New faster processors for plasma control system (MHD)
 - Poloidal CHERS (T&T)
 - Increased MSE channels (T&T and MHD)
 - D-alpha fast ion diagnostics (Energetic particles)
- **~10% increase in budget greatly enhances science output**
 - Increase the run by 66%
 - 400 kW EBW/ECH
 - HHFW antenna upgrade in FY 09
 - Accelerate full-CHERS, divertor diagnostics, and MPTS upgrades

- **NSTX is formulating the next 5 year plan: 2009- 2013**
 - We are working with the fusion community to formulate the best possible plan