Developing and Optimizing Resources for an Upgrade to 3-Shift Operation: The Experience at the NC State University PULSTAR Reactor

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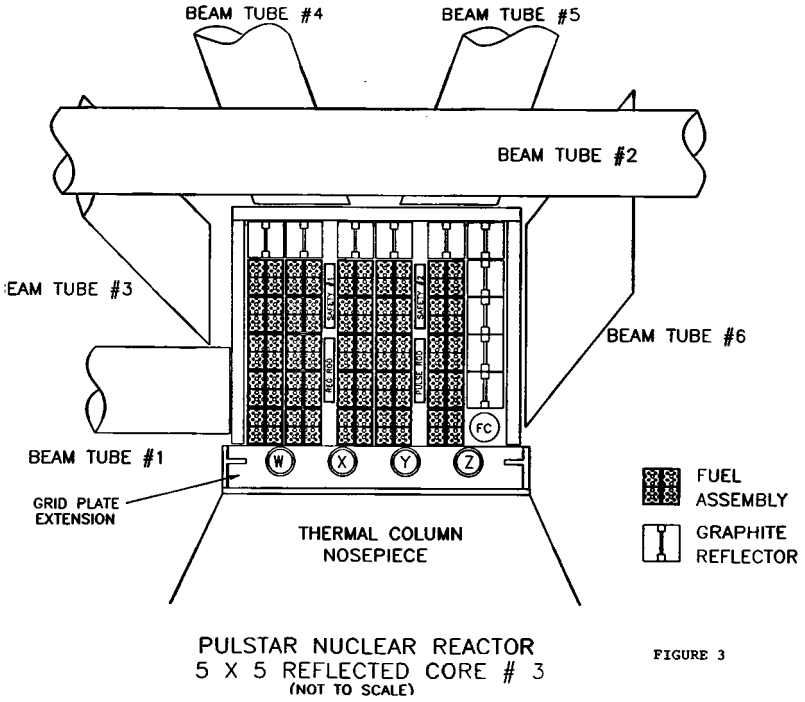
Outline

- *Basis for Upgrade to 3-Shift Operations Schedule (starting July '05)*
- *Staffing Issues*
- *Fuel Management Issues*
- *Scheduling Issues*
- *Results and Status*

N.C. State PULSTAR Reactor

- 1-MW thermal power
- 4% enriched UO_2 fuel
- 25 fuel assemblies
- 6 x 6 grid plate
- Graphite, Beryllium (& water) reflected
- 6 beamports + thermal column



Basis for (temporary?) Upgrade to 3-Shift Ops.

Increased demand for reactor availability for:

- Research – INIE/MUSIC Projects
- N.C. State Academic Labs
- Internet-based PULSTAR Reactor Labs
- Extension activities

PULSTAR Operations Staffing Specifications:

- Senior Reactor Operator (SRO) - on call
- Reactor Operator (RO) - @ console
- Reactor Health Physicist (RHP) - on call
- Reactor Operator Assistant (ROA) – available within 5 minutes

Staffing Requirements

3-Shift Operations requires:

- **336** operator-hours of coverage/week (2 RO/SRO's on duty)
- 9 FTE SRO/RO's @ 40 hrs/week each minimum

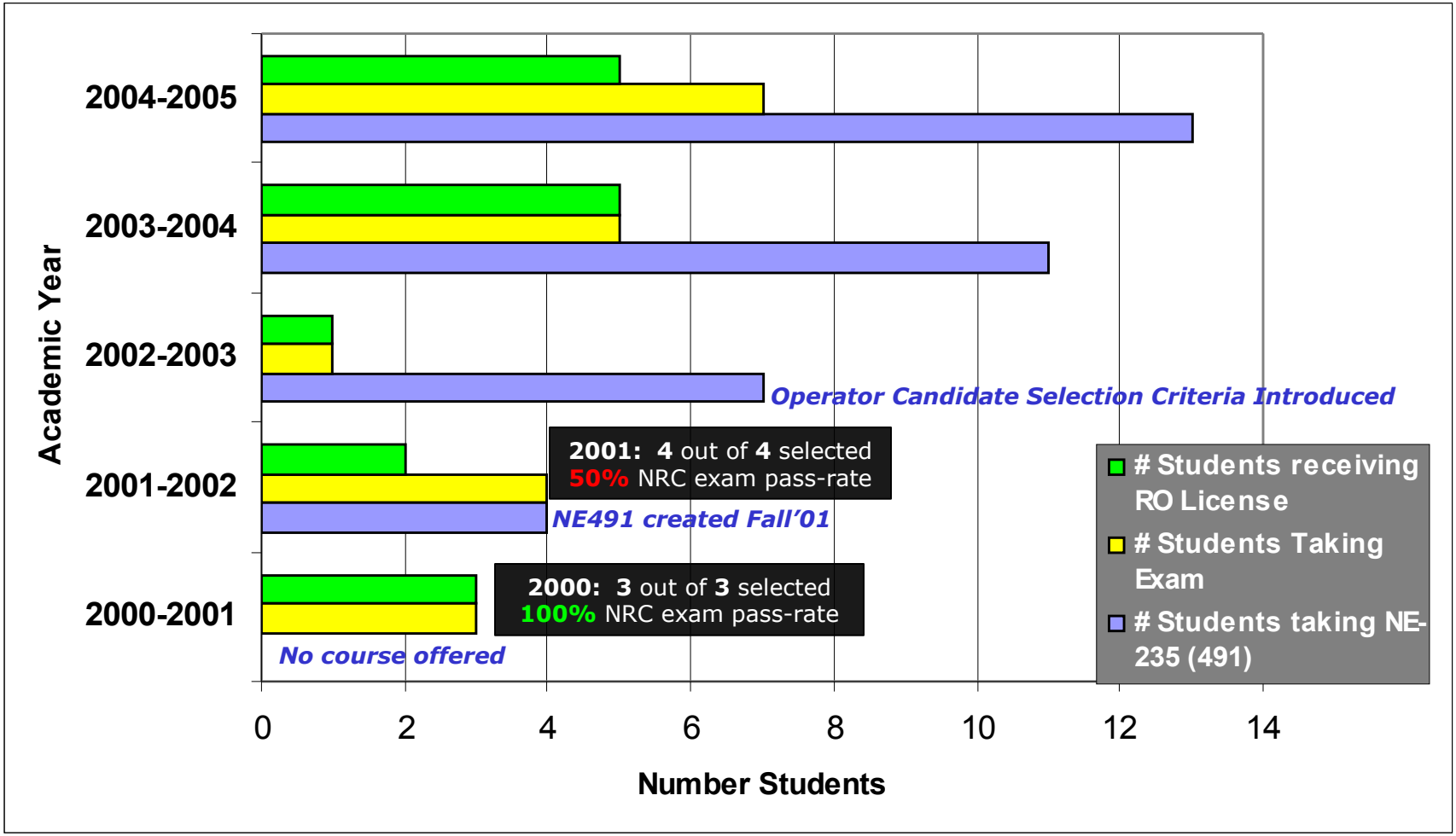
Staffing as of Spring'04:

- 4 FTE SRO's
- **6** part-time student RO's
  - 1 RHP

(280 hours/week avail.)

→ Operator Candidate Selection & Training

N.C. State
Student Operator Training Stats



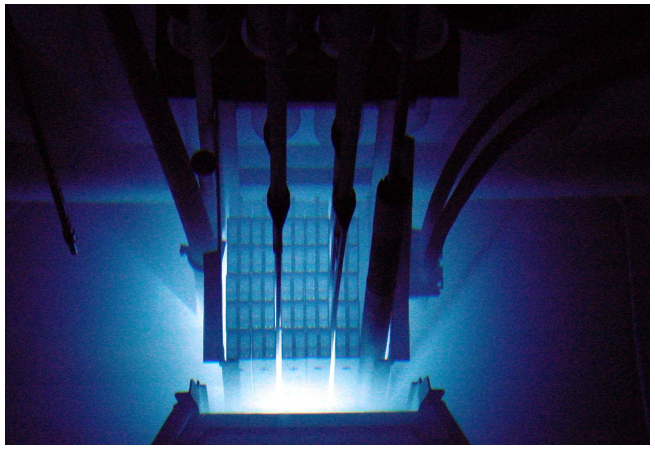
Quality Candidate Selection

Operator Candidates Must:

- Pass operations course (NE491/235) with ≥ A-
- Maintain ≥ 3.0 GPA *(overall and in major)*
- Be willing to serve program ≥ 1 year as a licensed RO *(no "Trophy" licenses)*
- Demonstrate a mature and professional attitude.
- Pass medical examination per NRC req.

Student Operator Training

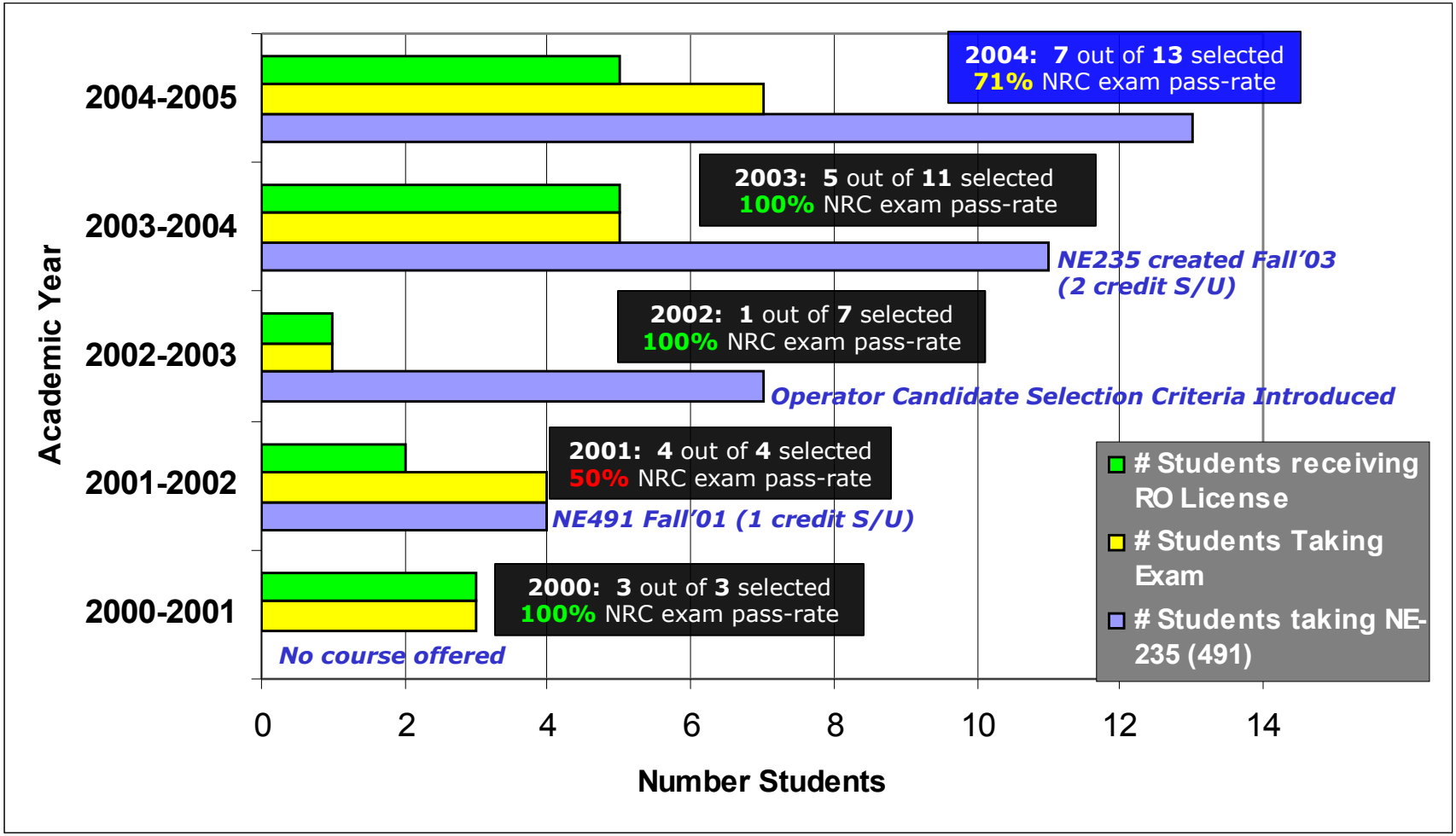
Created new academic course within NE Dept. as a feeder for the licensing program - starting in Fall'04:



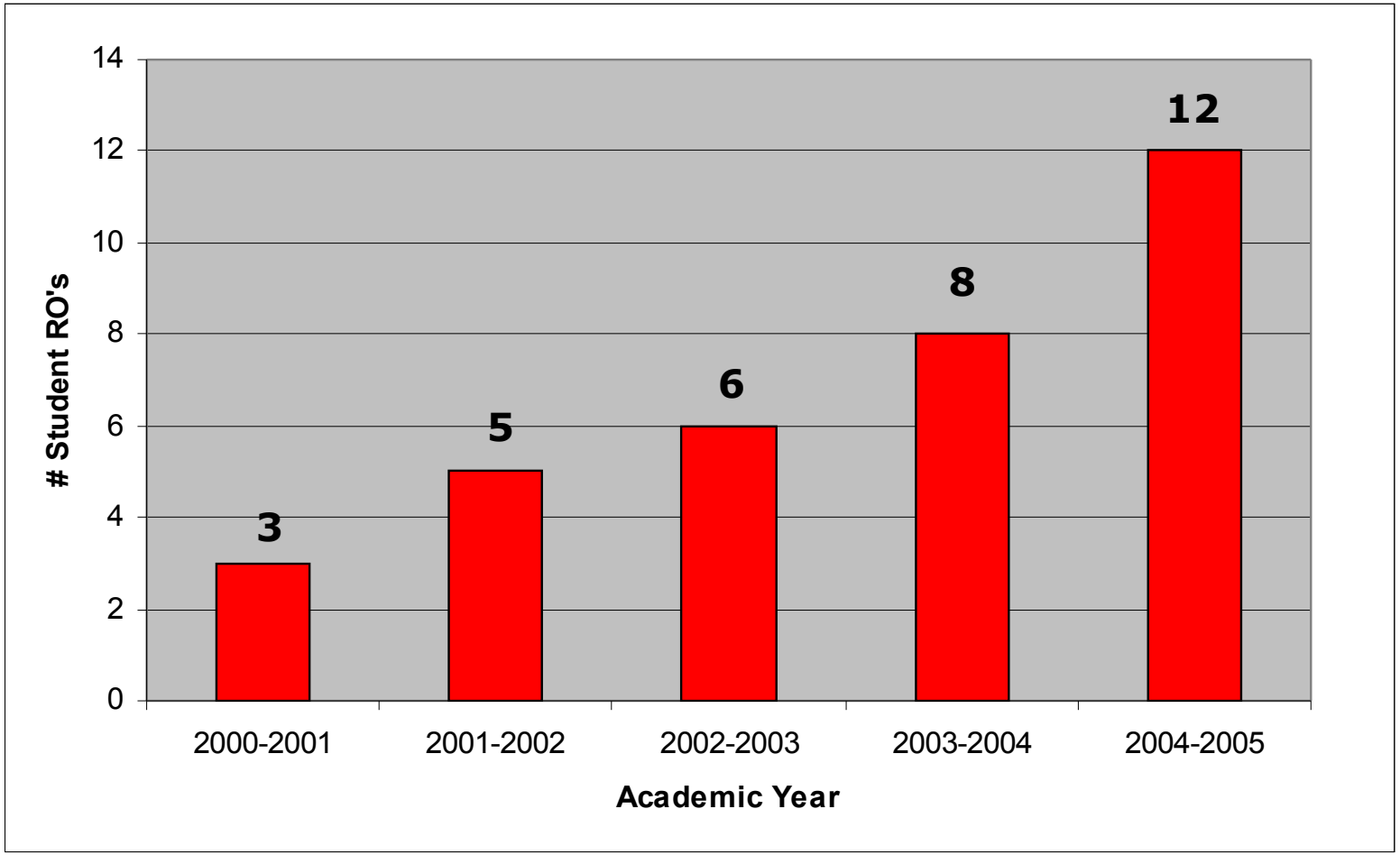
NE235 - "Reactor Operations Training" *(2 credits, S/U)*

- 1 hr lecture per week
  reactor theory
- 3 hr lab per week
  reactor plant systems
  operating characteristics
  technical specifications

Student Operator Training Stats



Total Number of Licensed Student RO's



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  - 1 RHP

(280 hours/week avail.)

Operator Candidate Selection & Training

Staffing as of Fall'05:

- 4 FTE SRO's
- **12** part-time student RO's
  - 1 RHP + part-time HP tech.

(400 hours/week avail.)

Fuel Management Issues

Resources:

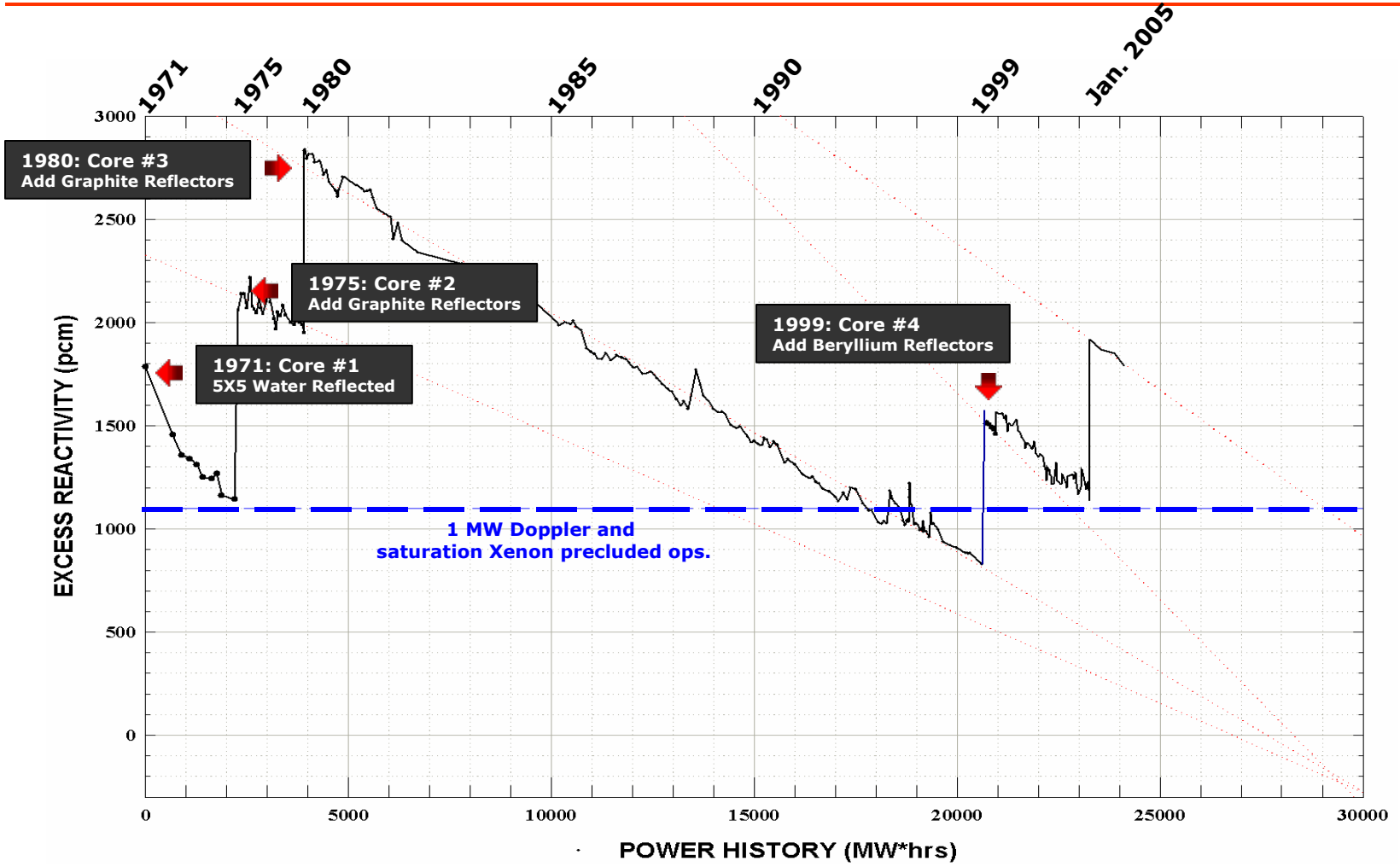
- Highly burned original 4% fuel 1971 core load (total excess = 0.0120 $\Delta k/k$ as of May '05)
- 9 un-irradiated 4% fuel assemblies
- 6% Fuel pins (enough for 8 assemblies) – *possession only*

Core Loading Requirements

Increase leakage to key experimental facilities

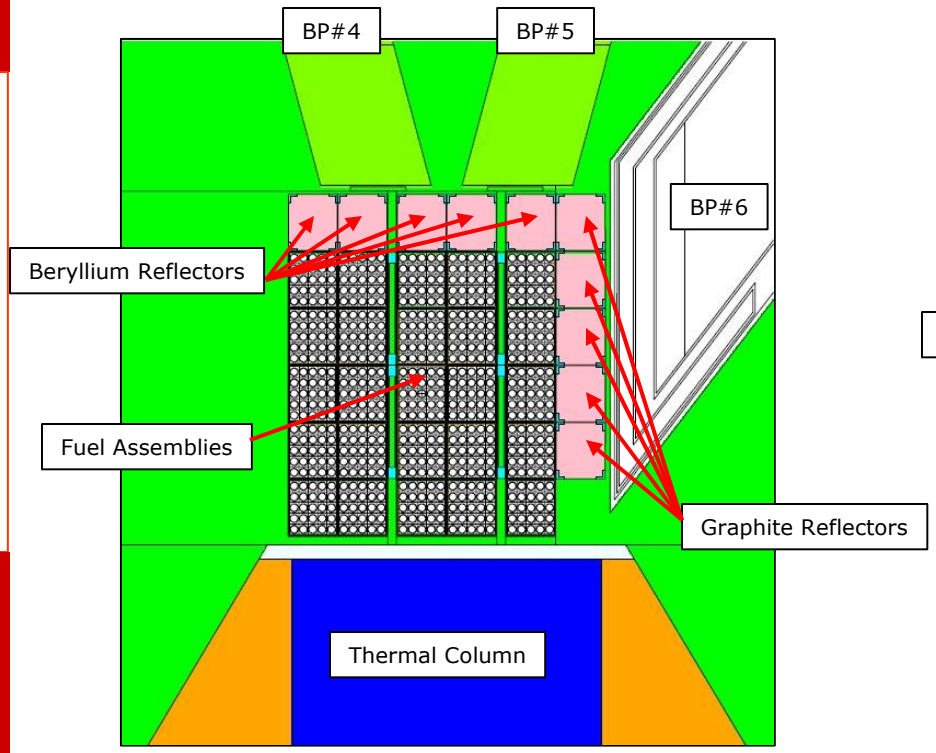
Optimize excess for extended operations

Excess Reactivity (pcm) -vs- Power History (MW-hrs)
PULSTAR Reactor Core Loading

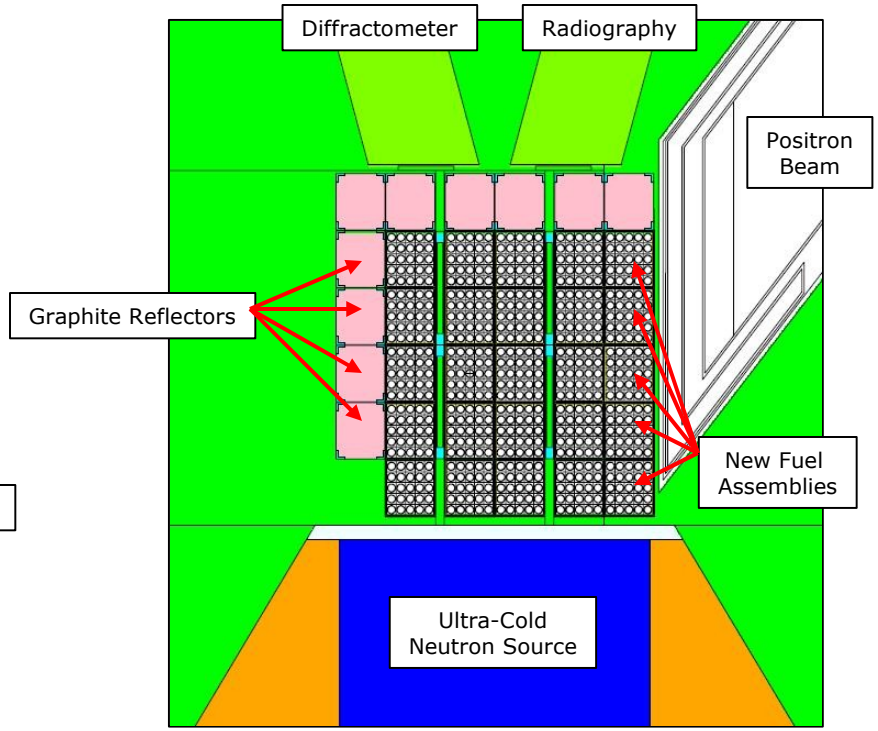


Core Loads #4 and #5

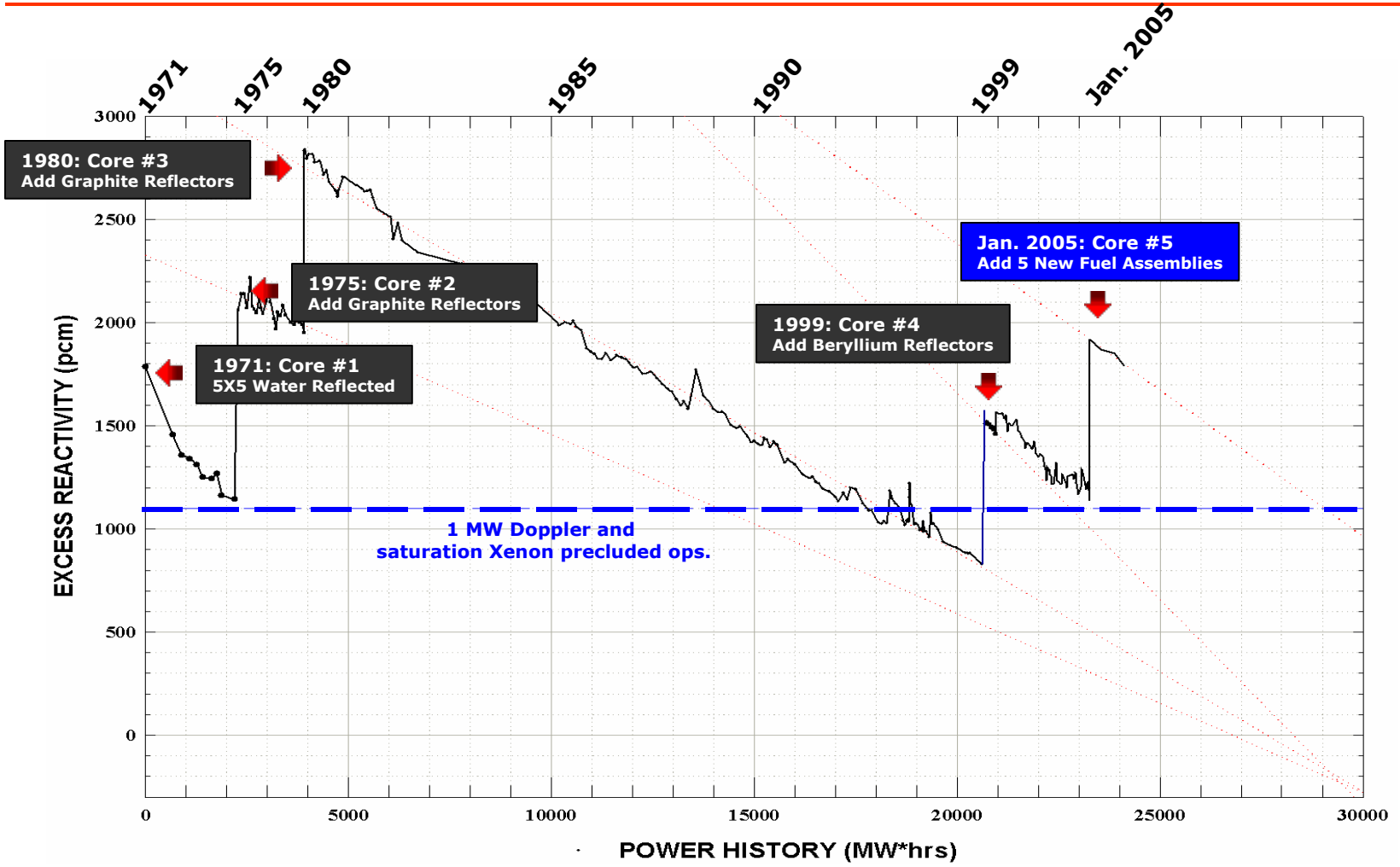
Core Load #4



Core Load #5



Excess Reactivity (pcm) -vs- Power History (MW-hrs)
PULSTAR Reactor Core Loading



Core Loading Requirements

Increase Leakage to Key Experimental Facilities

Optimize Excess for extended operations

Added 5 new 4% Assemblies
Retired 5 heavily burned

Flux at beam-port #6 entrance to positron facility increased by:

X 2

- Excess @ 0.020 Δk/k (increase of 0.008 Δk/k)
- Enough for ~4800 FPH of operation.

Scheduling

Goal #1: Continue to accommodate all reactor facility users.

Maintain ability to accommodate low power ops.

Goal #2: Accommodate student schedule.

Shutdown for 1st week of classes, student holidays, exam week, etc…

3-Shift Operations Calendar
November 2005

November 2005

SHIFT	HOURS	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		30-Oct-05	31-Oct-05	1-Nov-05	2-Nov-05	3-Nov-05	4-Nov-05	5-Nov-05
THIRD	MIDNIGHT-0800	SHUTDOWN	SHUTDOWN	SHUTDOWN	SHUTDOWN	900kW	900kW	SHUTDOWN
	MIDNIGHT-0800					Irradiations	Irradiations	
FIRST	0800 - 1600		Surveillance	Surveillance	NE 235 Startup's			
	0800 - 1600				1:30 - 2:30			
SECOND	1600-MIDNIGHT		NE 301 Rod Cal Lab		NE 301 Rod Cal Lab			
	1600-MIDNIGHT		3:40 - 5:30		3:40 - 5:30			
		6-Nov-05	7-Nov-05	8-Nov-05	9-Nov-05	10-Nov-05	11-Nov-05	12-Nov-05
THIRD	MIDNIGHT-0800	SHUTDOWN	SHUTDOWN	SHUTDOWN	SHUTDOWN	900kW	900kW	900kW
	MIDNIGHT-0800					Irradiations	Irradiations	Irradiations
FIRST	0800 - 1600		Maintenance	Beamport Mod.	Beamport Mod.			
	0800 - 1600							
SECOND	1600-MIDNIGHT		NE301 Core Temp		NE301 Core Temp			
	1600-MIDNIGHT		3:40 - 5:30		3:40 - 5:30			
		13-Nov-05	14-Nov-05	15-Nov-05	16-Nov-05	17-Nov-05	18-Nov-05	19-Nov-05
THIRD	MIDNIGHT-0800	900kW	900kW	900kW	900kW	900kW	900kW	900kW
	MIDNIGHT-0800	Irradiations	Irradiations	Irradiations	Irradiations	Irradiations	Irradiations	Irradiations
FIRST	0800 - 1600							
	0800 - 1600							
SECOND	1600-MIDNIGHT							
	1600-MIDNIGHT							
		20-Nov-05	21-Nov-05	22-Nov-05	23-Nov-05	24-Nov-05	25-Nov-05	26-Nov-05
THIRD	MIDNIGHT-0800	900kW	900kW	900kW	900kW	SHUTDOWN	SHUTDOWN	SHUTDOWN
	MIDNIGHT-0800	Irradiations	Irradiations	Irradiations	Irradiations			
FIRST	0800 - 1600						Thanksgiving Break	
	0800 - 1600							
SECOND	1600-MIDNIGHT							
	1600-MIDNIGHT							

Summary

- Took ~ **1-1.5 years** lead time to accomplish move from 1 to 3 shift ops.
- Utilizing student operators resulted in **50-60%** savings in staffing costs.
- From July 1st, 2005 to date (9/16/05), we've operated for **1100 FPH's** (*previously averaged **400 FPH/year***)