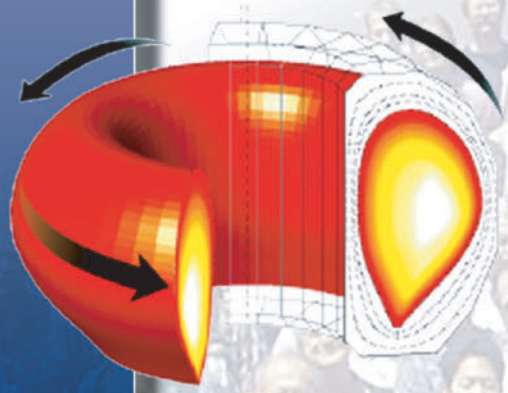
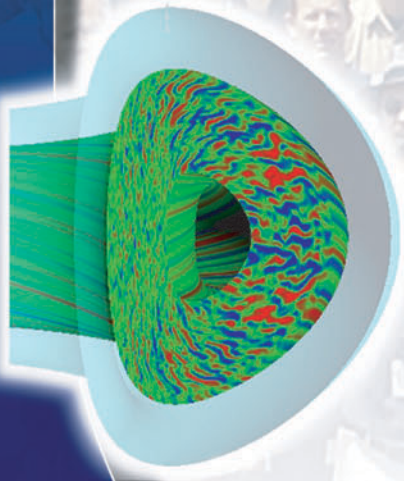




DIII–D National Program Budgets

by
R.D. Stambaugh

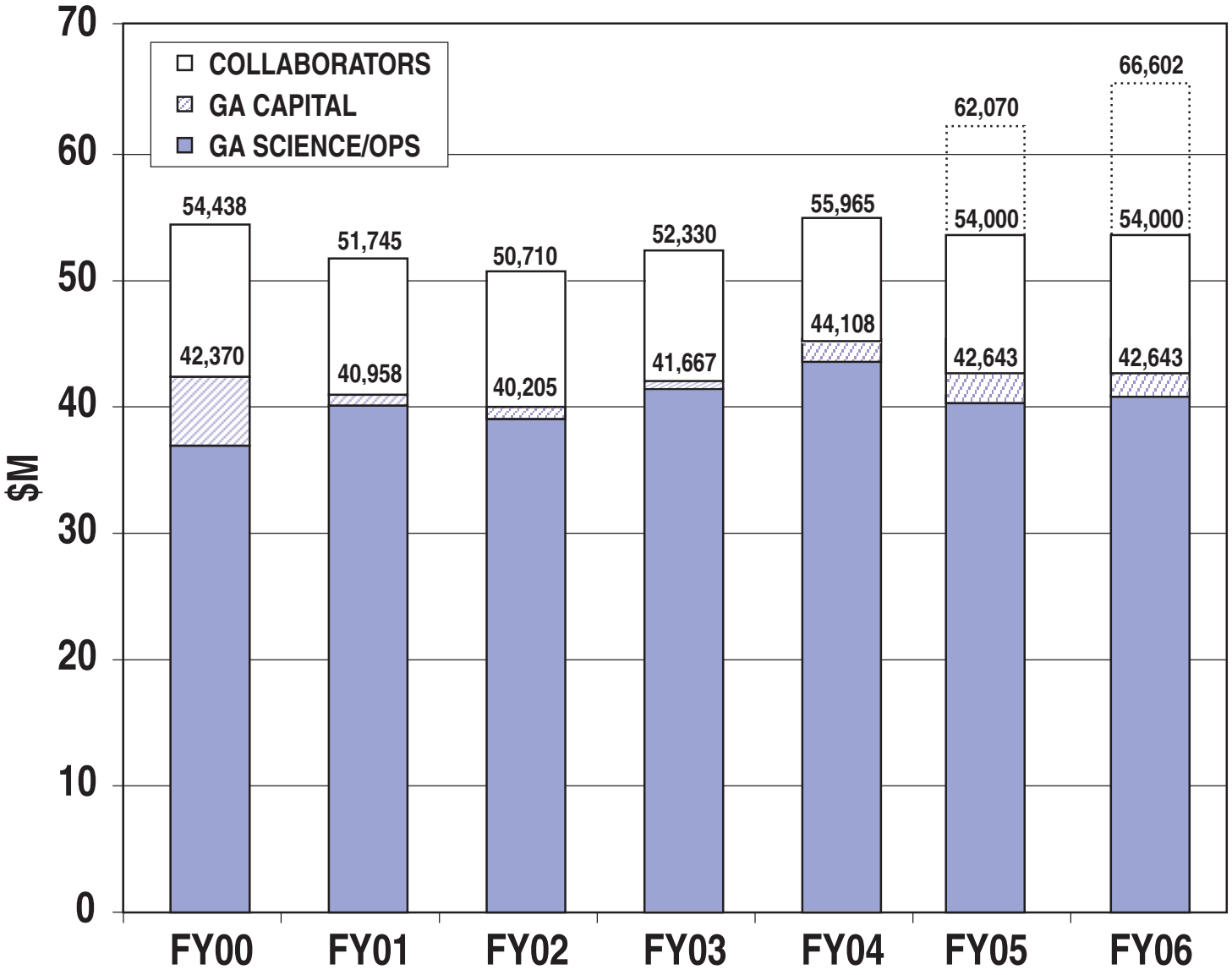
Presented at
Office of Fusion Energy Science
FY06 Budget Planning Meeting
Washington, DC

March 16–17, 2004

DIII–D
NATIONAL FUSION FACILITY
SAN DIEGO

065-04/RDS2/rs

FYO4, 05, AND 06 BUDGETS ARE MAJOR SHORTFALLS WITH RESPECT TO THE 5-YEAR PLAN (2004–2008)



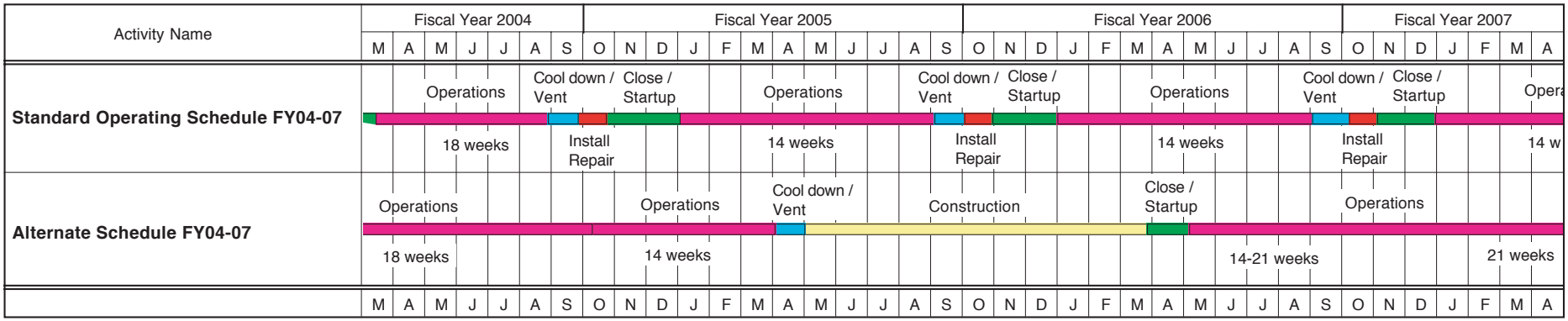
DIII-D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

WE ARE PROPOSING AN ALTERNATE OPERATING SHEDULE FOR DIII–D IN FY05–07

- Collects three vent periods (4 months each) into one 12 month torus opening
- Enables effective use of existing staff to take on some major projects
- Preserves run time
  - FY05 (14 weeks)
  - FY06 (14 weeks extendable to 21 at 1.5 shifts/day
  - FY07 (21 + run weeks – new capabilities

Alternative DIII–D Facility Schedules (04–07)



- Enables us to take on
  - ECH 6 MW upgrade
  - Lower divertor modification
  - 210 degree counter beamline and diagnostics
  - Cooling water tower
  - MG refurbishment
  - TF belt bus and diodes for 10 second ops

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

064-04/RDS/rs

DETAILED OPERATING SCHEDULES FOR FY05–07

PROPOSED DIII-D FY2005 OPERATIONS SCHEDULE

Oct 04						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Nov 04						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Dec 04						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Jan 05						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Feb 05						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	H	15	16	17	18	19
20	21	22	23	24	25	26
27	28					

Mar 05						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Apr 05						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

May 05						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	H	31				

Jun 05						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Jul 05						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Aug 05						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Sep 05						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Plasma physics Startup Vent Commissioning Contingency

PROPOSED DIII-D FY2006 OPERATIONS SCHEDULE

Oct 05						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Nov 05						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

Dec 05						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Jan 06						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Feb 06						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	H	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

Mar 06						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Apr 06						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May 06						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	H	30	31			

Jun 06						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Jul 06						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Aug 06						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Sep 06						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Plasma physics Startup Vent Commissioning Contingency

PROPOSED DIII-D FY2007 OPERATIONS SCHEDULE

Oct 06						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Nov 06						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

Dec 06						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Jan 07						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Feb 07						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	H	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

Mar 07						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Apr 07						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

May 07						
S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	H	29	30	31		

Jun 07						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Jul 07						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Aug 07						
S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Sep 07						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Plasma physics Startup Vent Commissioning Contingency

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

A STRONG COLLABORATION WITH ASIPP–HEFEI WILL BENEFIT BOTH SIDES GREATLY

GA (DIII–D) to ASIPP (EAST)

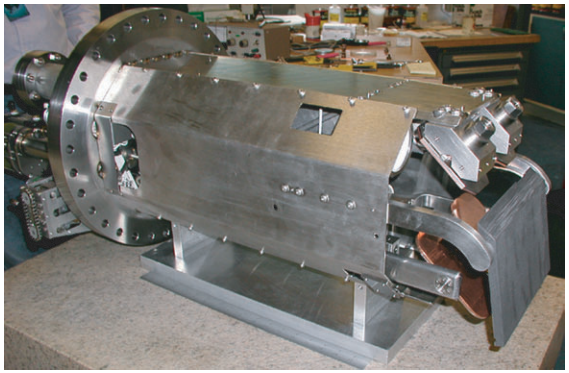
1. Train ASIPP scientists on DIII–D plasma control system
2. DIII–D plasma control system for EAST
3. GA assists in designing the EAST divertor
4. GA leads design of cryopumps for EAST
5. GA provides two new ion sources for EAST
6. GA assists ASIPP in RWM coil design

ASIPP (EAST) to GA (DIII–D)

1. ASIPP provides three operations support persons to DIII–D
2. ASIPP provides engineers to help design the DIII–D lower divertor modification
3. ASIPP fabricates parts for the lower divertors
4. ASIPP fabricates parts to refurbish eight DIII–D ion sources
5. ASIPP provides main HV substation (138 kV–12,47 kV, 110 MVA) transformers
6. Possibly ASIPP fabricates new NBI pole shields

PURSUIT OF CUTTING EDGE PHYSICS DRIVES MODIFICATIONS TO HEATING AND CURRENT DRIVE SYSTEMS

PPPL Launcher

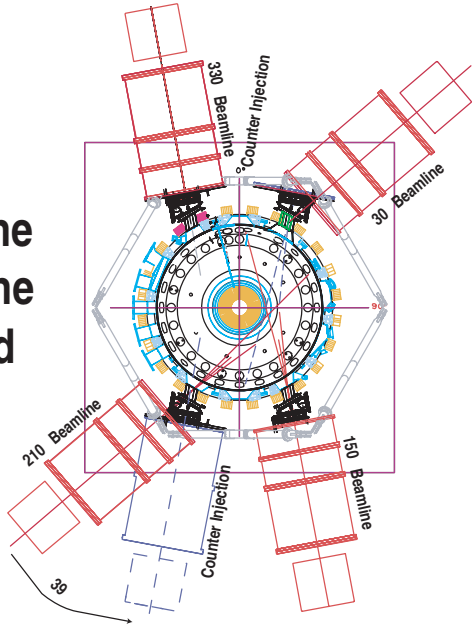


CPI Gyrotron Installation

Build up the EC (110 GHz) power

Resume fast wave (117 MHz) operation

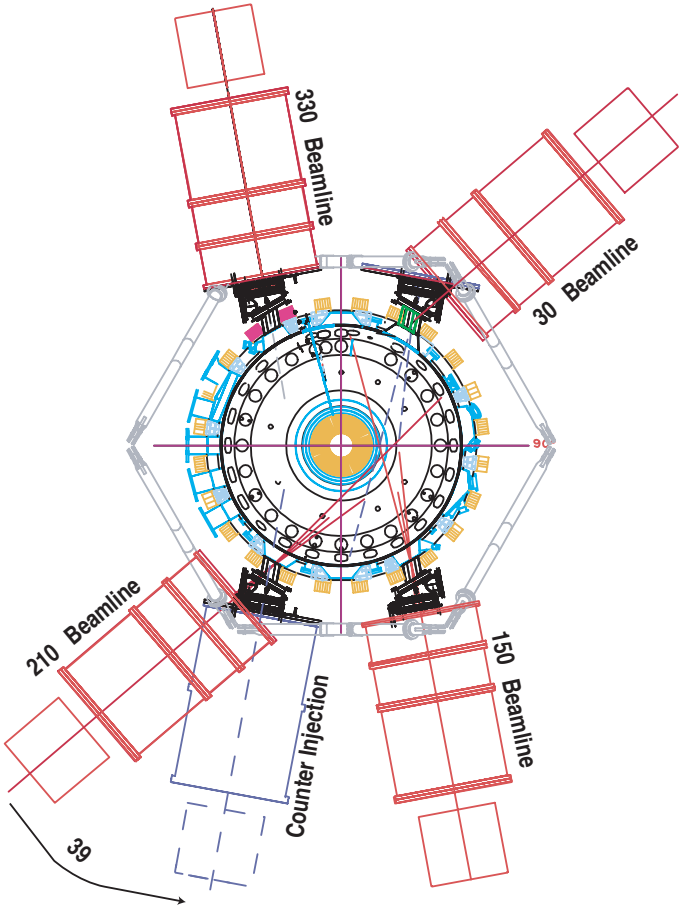
Turn one beamline around



DIII-D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

A BEAMLINE REVERSAL IS NECESSARY FOR NEW PHYSICS STUDIES AND IMPROVED PLASMA MEASUREMENTS

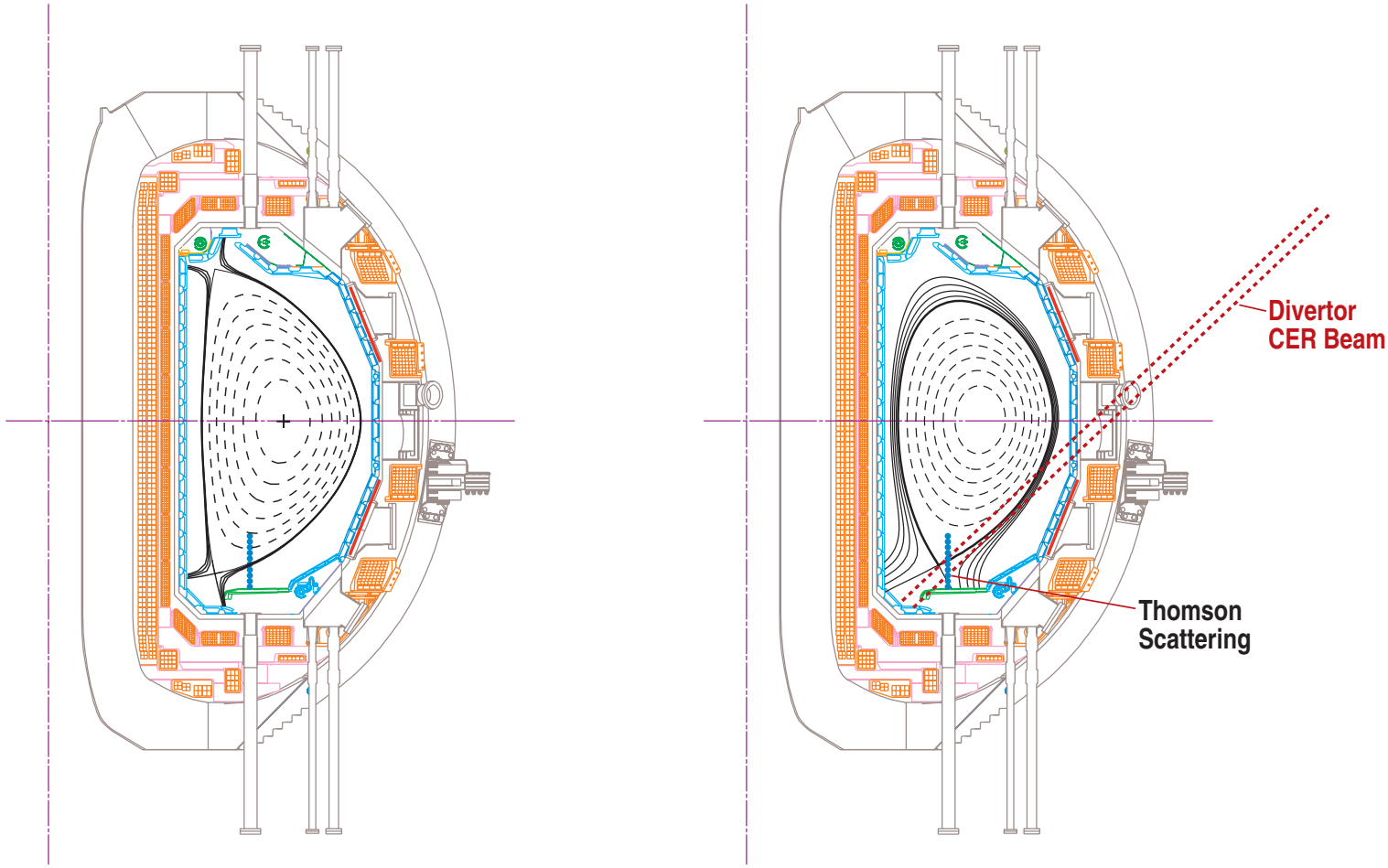


- QDB regime with central co-rotation
- Understanding physics of rotation
- RWM stability with low rotation
- NTM stabilization with modulated rf
- Transport barrier control (separate E×B and Shafranov shift effects)
- Separate E_r and J(r) in MSE measurement
- Co and counter CER

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

0065-04/RTS/rs

A SIMPLE LOWER DIVERTOR MODIFICATION WILL ENABLE DENSITY CONTROL IN OUR MOST PROMISING HIGH PERFORMANCE PLASMAS AND IMPROVE DIVERTOR RESEARCH



DIII-D
NATIONAL FUSION FACILITY
SAN DIEGO

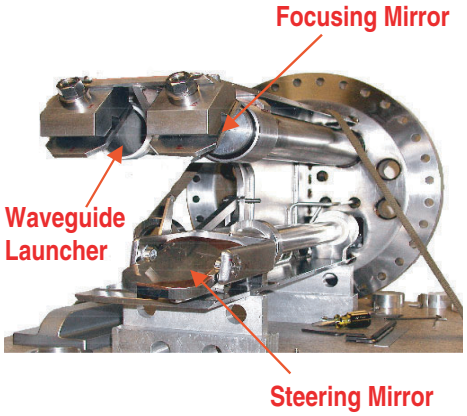
037-04/RTS/rs

DIII–D LONG PULSE CAPABILITY NEEDED IN SUPPORT OF FESAC/IPPA 10-YR GOAL GPA: TO STUDY PHYSICS ON TIME SCALES LONGER THAN THE CURRENT DIFFUSION TIME

Increased heating power

10 s, 1 MW CPI Gyrotron

EC Antenna (PPPL)

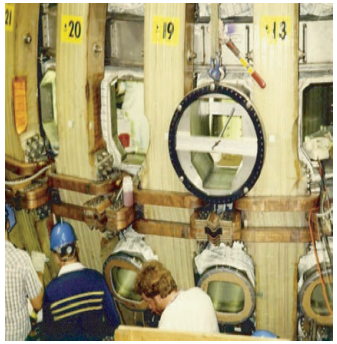


10 s, FW Antenna (ORNL)

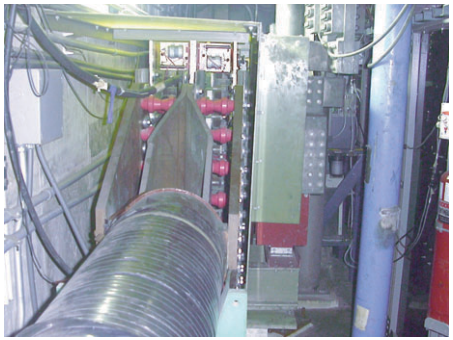
Power infrastructure

138 kV substation

Toroidal Coil Beltbus



Toroidal Coil Freewheeling Diodes



FESAC/IPPA: Assess the attractiveness of extrapolable, long-pulse operation of the Advanced Tokamak for pulse lengths much greater than the current penetration time

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

FY05 RESEARCH GOALS

- Milestone 156: Comparing poloidal dependence of edge turbulence measurements with edge turbulence predictions
- Milestone 157: Comparing initial high k turbulence measurements with code predictions
- Milestone 158: Controlling the spatial distribution of electric current in tokamak plasmas
- Milestone 159: Characterizing erosion and re-deposition of carbon with implications for the tritium retention issue
- Milestone 160: Assessing control of the edge pedestal with stochastic boundary layers

FY06 RESEARCH GOALS

- Milestone 161: Initial operation of DIII–D with co plus counter neutral beam injection
- Milestone 162: Compare high pressure gas jet penetration for disruption mitigation with theoretical predictions
- Milestone 163: Assessment of density control in pumped, balanced double-null plasmas
- Milestone 164: Assess the synergistic effect of plasma rotation and feedback control of plasma instabilities

DIII–D NATIONAL FUSION PROGRAM

INSTITUTIONAL BUDGET DISTRIBUTION ($000)
SCIENCE & OPERATIONS
FY04-06

	FY04	FY05	FY05(I)	FY06	FY06(I)
DIII-D PROGRAM	**56.0**	**54.0**	**8.1**	**54.0**	**12.6**
SCIENCE	24,629	22,572	4,453	22,843	5,799
FACILITY OPERATIONS	31,336	31,428	3,617	31,157	6,803
SCIENCE	**24.6**	**22.6**	**4.5**	**22.8**	**5.8**
GA DIII-D FUSION SCIENCE RESEARCH	**15,796**	**13,501**	**2,419**	**13,601**	**3,867**
GA	**13,204**	**11,704**	**1,792**	**11,796**	**1,858**
COLLABORATION SUPPORT FROM GA CONTRACT	**2,592**	**1,797**	**627**	**1,805**	**2,009**
UCLA	511	TBD	TBD	TBD	TBD
U. MARYLAND	30	TBD	TBD	TBD	TBD
U. IRVINE	97	TBD	TBD	TBD	TBD
U. TORONTO	135	TBD	TBD	TBD	TBD
OTHER GA COLLABORATOR SUBCONTRACTS	79	TBD	TBD	TBD	TBD
GA COLLABORATOR SUPPORT	1,740	1,129	509	1,137	1,887
COLLABORATORS	**8,833**	**9,071**	**2,034**	**9,242**	**1,932**
PPPL	2,783	3,121	378	3,292	367
LLNL	2,610	2,510	1,155	2,510	1,055
ORNL	1,677	1,677	100	1,677	150
UCSD	690	690	275	690	234
U. TEXAS	374	374	126	374	126
COLUMBIA	266	266		266	
SNL	156	156		156	
U. WISCONSIN	151	151		151	
GEORGIA TECH.	126	126		126	
FACILITY OPERATIONS	**31.3**	**31.4**	**3.6**	**31.2**	**6.8**
GA	**28,312**	**29,142**	**3,095**	**29,042**	**5,819**
COLLABORATORS	**3,024**	**2,286**	**522**	**2,115**	**984**
PPPL	1,655	1,217	125	1,046	417
LLNL	483	483	217	483	167
ORNL	886	586	180	586	400

852 668 118 668 122

SCIENCE: All Physics activities, Collaboration Subcontracts and Support, and construction of new Diagnostics.
OPERATIONS: Base Tokamak, Heating Systems, Diagnostics, Data Systems Operations & Maintenance and Operations Support

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

THE $2M GUIDANCE BUDGET REDUCTION IN FY05 AND FY06 WILL REQUIRE DIFFICULT STAFF REDUCTIONS

	FY04	FY05	FY06
	($K)	($K)	($K)
DIII–D National Budget	56,665 (55,965 after recission)	54,000	54,000
FTE Total DIII–D	190.3	175.1	173.3

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

SUBSTANTIAL STAFF REDUCTIONS IN SCIENCE

	FY04	FY05	FY05(I)	FY06	FY06(I)
Total Program	190.3	175.2	20.6	173.4	32.2
Total Science	90.9	82.4	11.7	80.9	15.3
Total Operations	99.4	92.8	8.9	92.5	16.9
GA Science	45.9	38.5	8.0	37.7	10.3
Collaborator Science	45.0	43.9	3.7	43.2	5.0
GA Operations	89.7	85.0	6.8	85.0	14.1
Collaborator Operations	9.7	7.8	2.1	7.5	2.8

DIII–D NATIONAL FUSION PROGRAM

INSTITUTIONAL STAFFING DISTRIBUTION (FTE'S)
SCIENCE & OPERATIONS
FY04-06

	FY04	FY05	FY05(I)	FY06	FY06(I)
DIII-D PROGRAM	190.3	175.2	21.7	173.4	33.4
SCIENCE	90.9	82.4	12.8	80.9	16.5
FACILITY OPERATIONS	99.4	92.8	8.9	92.5	16.9
SCIENCE	90.9	82.4	12.8	80.9	16.5
GA STAFF	45.9	38.5	8.0	37.7	10.3
COLLABORATORS	45.0	43.9	4.8	43.2	6.2
GA CONTRACT SUPPORTED	6.1	5.0	1.1	4.9	1.2
UCLA	3.5	TBD	TBD	TBD	TBD
U. MARYLAND	0.1	TBD	TBD	TBD	TBD
U. IRVINE	0.8	TBD	TBD	TBD	TBD
U. TORONTO	1.0	TBD	TBD	TBD	TBD
OTHER GA COLLABORATOR SUBCONTRACTS	0.7	TBD	TBD	TBD	TBD
DOE DIRECT SUPPORTED	38.9	38.9	3.7	38.3	5.0
PPPL	10.8	11.2	0.1	11.4	0.1
LLNL	10.5	9.5	1.5	9.0	2.0
ORNL	4.7	4.6	0.5	4.5	1.0
UCSD	4.2	4.9	1.1	4.7	1.4
U. TEXAS	2.8	2.8	0.5	2.8	0.5
COLUMBIA	2.0	2.0		2.0	
SNL	1.0	1.0		1.0	
U. WISCONSIN	2.5	2.5		2.5	
GEORGIA TECH	0.4	0.4		0.4	
FACILITY OPERATIONS	99.4	92.8	8.9	92.5	16.9
GA	89.7	85.0	6.8	85.0	14.1
COLLABORATORS	9.7	7.8	2.1	7.5	2.8
PPPL	4.3	3.4	0.6	3.4	0.8
LLNL	2.0	2.0	1.0	1.8	1.0
ORNL	3.4	2.4	0.5	2.3	1.0

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

SCIENCE: All Physics activities, Collaboration Subcontracts and Support, and construction of new Diagnostics.
OPERATIONS: Base Tokamak, Heating Systems, Diagnostics, Data Systems Operations & Maintenance and Operations Support

065-04/RDS/rs

GA FTE LEVELS DURING OPERATING AND CONSTRUCTION PERIODS

- Eleven person science reductions and eight person operations reductions from FY04 into the construction period will be very difficult

	FY04	FY05 (average)	FY05 (1st half)	FY05 (2nd half)	FY06 (1st half)	FY06 (2nd half)	FY06 (average)
			Operate	Construct	Construct	Operate	
GA FTE	135.6	123.5	130.0	118.8	118.2	129	122.7
GA Science	45.9	38.5	42.0	35.0	34.4	41.0	37.7
GA Operations	89.7	85.0	88.0	82.0	82.0	88.0	85.0

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

IMPACT OF A 10% BUDGET CUT IN THE DIII–D NATIONAL FUSION PROGRAM IN FY05

The following actions would be taken in the order listed (some staff reductions are associated with listed items)

1. Reduce run weeks from 14 to 7
2. Stop the fast wave program
3. Abandon diagnostics connected with the counter beamline
4. Abandon diagnostic modifications connected with the lower divertor
5. Cancel 4th steerable launcher
6. Truncate gyrotron order
7. Further reduce staff by 13 FTE

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

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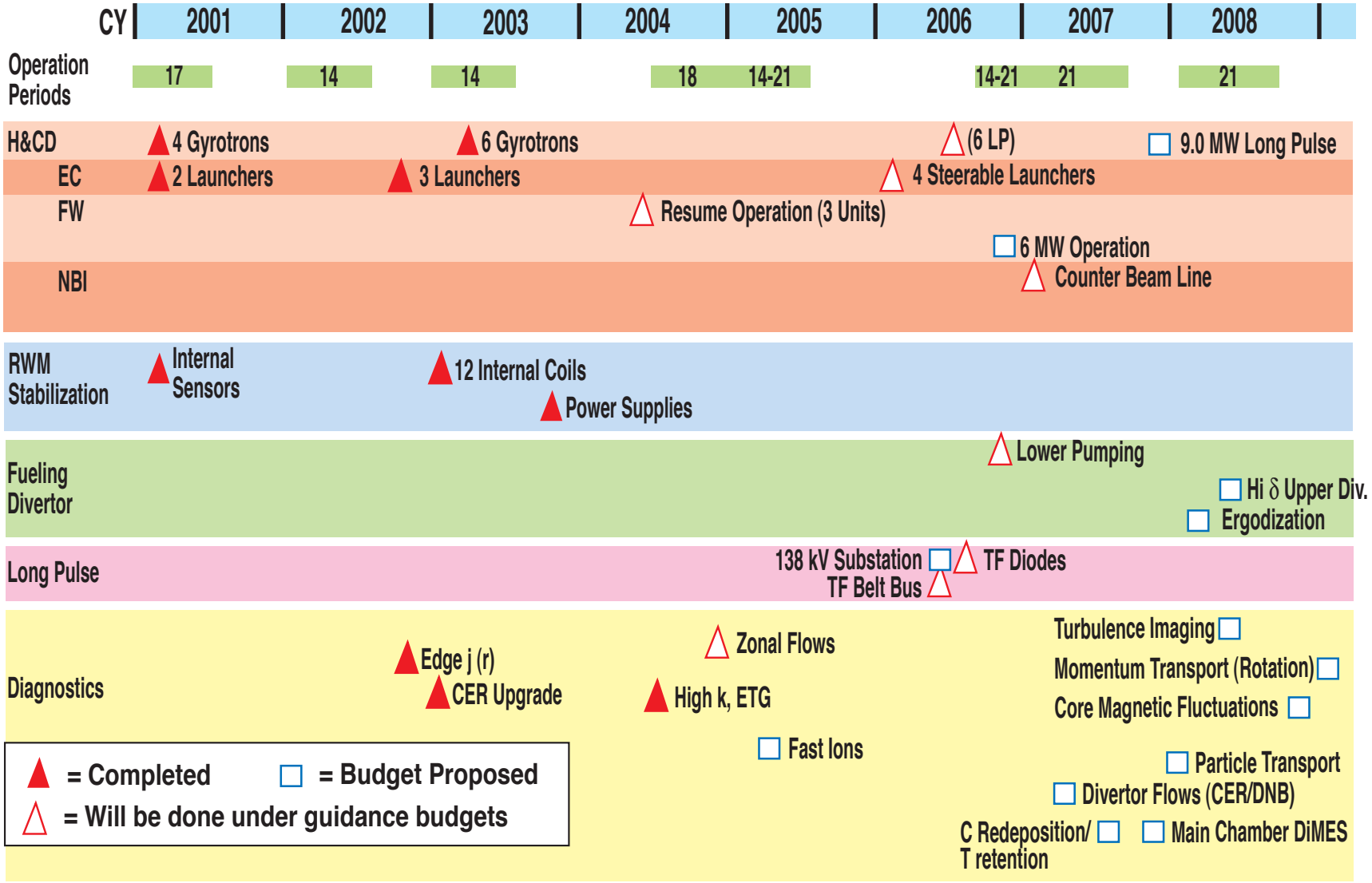
SUMMARY OF INCREMENTAL BUDGET REQUESTS

	FY05		FY06	
Retain Scientific Capability	**$2,788K**		**$3,031K**	
Retain Scientific Capability	GA	$2,095K	GA	$2,174K
Retain Scientific Capability	COLLABORATORS	$693K	COLLABORATORS	$857K
Increase Operating Time	**$2,075K**		**$2,108K**	
21 Weeks of Operation	GA	$2,075K	GA	$2,108K
Power Systems	**$327K**		**$1,172K**	
High Voltage Distribution			GA	$1,172K
Serial Highway to Ethernet	GA	$327K		
Neutral Beam Refurbishments	**$1,017K**		**$1,627K**	
Power Supply Local Control Stations	GA	$1,017K	GA	$952K
Replace Damaged Pole Shields			GA	$675K
ECH	**$125K**		**$1,503K**	
ECH / NBI HV Supply			GA	$1,247K
P2005 Steerable Launcher / Steering Upgrades	PPPL	$125K		$256K
Diagnostic Refurbishments / Upgrades	**$833K**		**$667K**	
Fast ELMS Data Acquisition Upgrade	LLNL	$100K	LLNL	$100K
Divertor Spectrometer Refurbishment	LLNL	$50K		
Fast MSE Data Acquisition Upgrade	LLNL	$40K		
CER Poloidal Rotation Upgrade	PPPL	$378K	PPPL	$367K
DISRAD II	UCSD	$100K	UCSD	$50K
Mid-Plane / X-Point / Inner Wall Probes	UCSD	$65K	UCSD	$50K
Pellet Injector Upgrade	ORNL	$100K	ORNL	$100K
FAST WAVE	**$180K**		**$611K**	
RF & Long Pulse Antenna	ORNL	$180K	ORNL	$450K
117MHz ABB Conversion			PPPL	$161K
New Diagnostics	**$725K**		**$1,883K**	
Divertor CER			GA	$1,358K
Divertor CER Diagnostic	LLNL	$650K	LLNL	$450K
MSE for Counter Neutral Beam	LLNL	$75K	LLNL	$75K
TOTALS	**$8,070K**		**$12,602K**	

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

DIII–D MAY BE ABLE TO START UP IN MID 2006 WITH EXCITING NEW CAPABILITIES



DIII–D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RTS/rs

SUMMARY

The new capabilities on DIII–D will enable

- Definitive demonstrations of the physics of steady-state high performance operation of the tokamak

- Resolution of key issues for ITER
  - RWM at low rotation
  - NTM stabilization
  - QH–mode or other ELM free operation

- Fundamental transport understanding

The incremental request will enable retention of scientific capability, increased run time, and more efficient machine operation