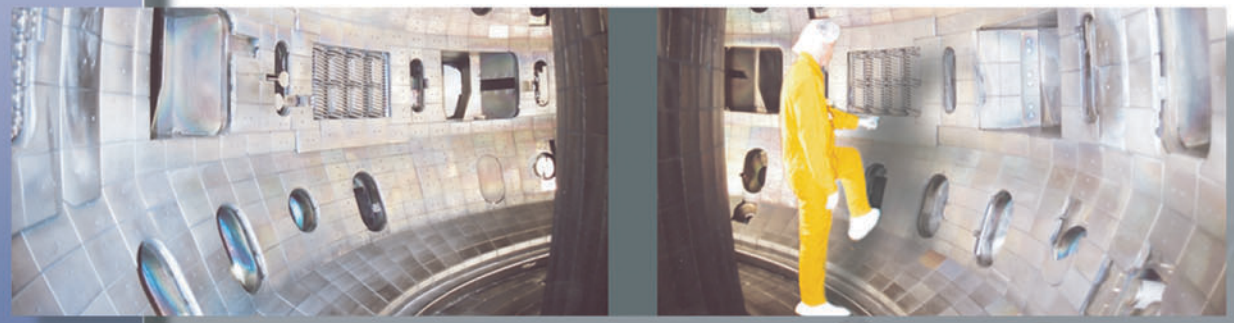
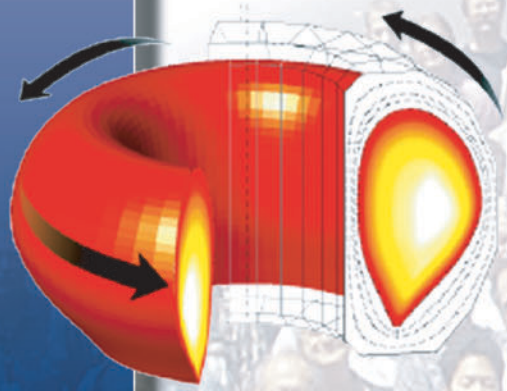
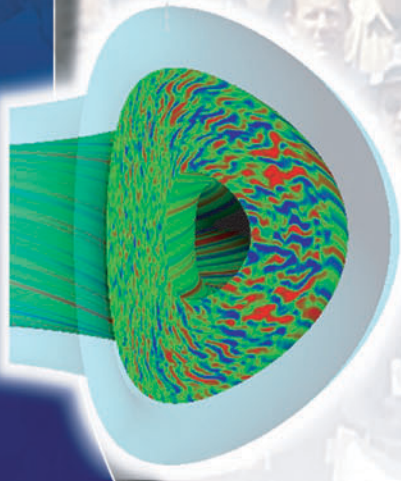






DIII–D National Fusion Program

by
R.D. Stambaugh

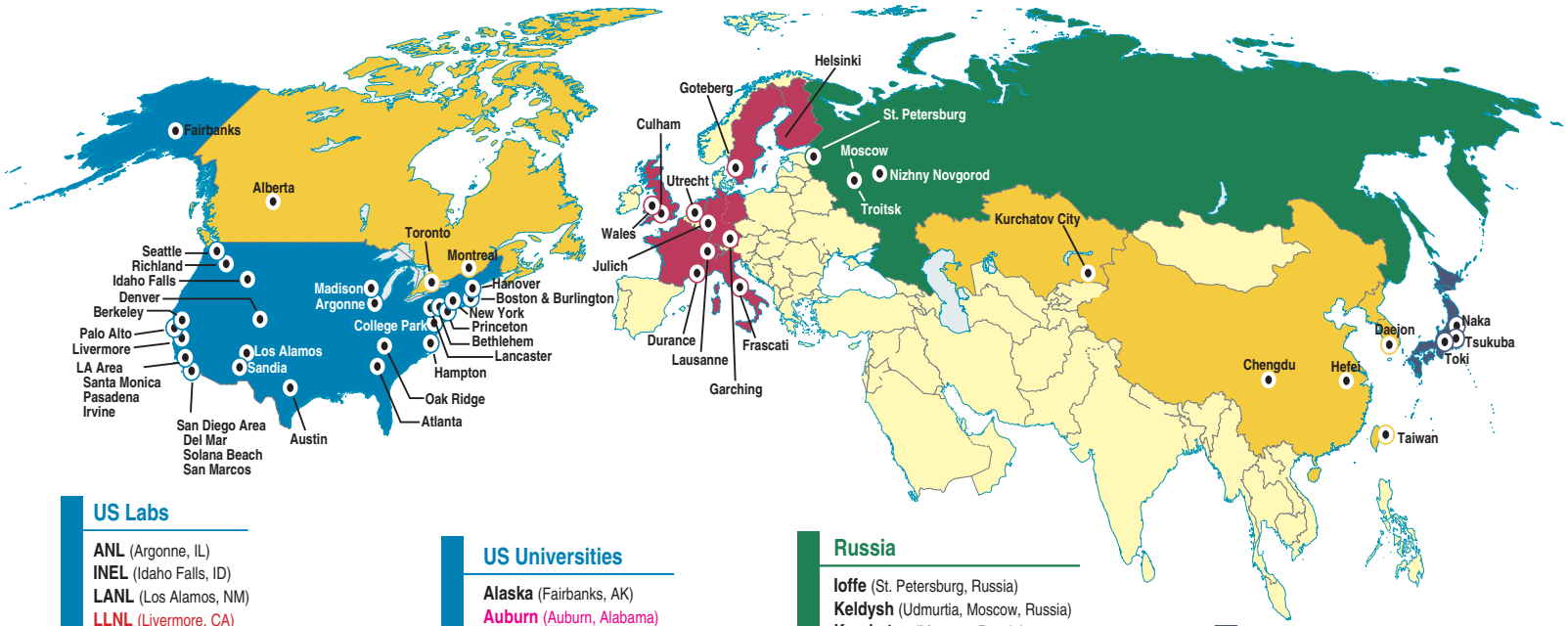
Presented at
Office of Fusion Energy Science
FY06 Budget Planning Meeting
Washington, DC

March 16–17, 2004

DIII–D
NATIONAL FUSION FACILITY
SAN DIEGO

065-04/RDS/rs

THE DIII–D INTERNATIONAL TEAM



US Labs

ANL (Argonne, IL)
INEL (Idaho Falls, ID)
LANL (Los Alamos, NM)
LLNL (Livermore, CA)
ORNL (Oak Ridge, TN)
PNL (Richland, WA)
PPPL (Princeton, NJ)
SNL (Sandia, NM)

US Industries

CompX (Del Mar, CA)
CPI (Palo Alto, CA)
Creare (Hanover, NH)
Digital Finetec (Ventura, CA)
FAR Tech (San Diego, CA)
HiTech Metallurgical (San Diego, CA)
IR&T (Santa Monica, CA)
Orincon (San Diego, CA)
SAIC (La Jolla, CA)
Surmet (Burlington, MA)
Thermacore (Lancaster, PA)
TSI Research (Solana Beach, CA)

US Universities

Alaska (Fairbanks, AK)
Auburn (Auburn, Alabama)
Cal Tech (Pasadena, CA)
Colorado (Boulder, CO)
Columbia (New York, NY)
Georgia Tech (Atlanta, GA)
Hampton (Hampton, VA)
Lehigh (Bethlehem, PA)
Maryland (College Park, MD)
MIT (Boston, MA)
Palomar (San Marcos, CA)
New York U. (New York, NY)
Texas (Austin, TX)
UCB (Berkeley, CA)
UCI (Irvine, CA)
UCLA (Los Angeles, CA)
UCSD (San Diego, CA)
U. New Mexico (Albuquerque, NM)
Washington (Seattle, WA)
Wisconsin (Madison, WI)

Russia

Ioffe (St. Petersburg, Russia)
Keldysh (Udmurtia, Moscow, Russia)
Kurchatov (Moscow, Russia)
Moscow State (Moscow, Russia)
Triniti (Troitsk, Russia)
Gycom (Nizhny Novgorod, Russia)

European Community

Cadarache (St. Paul-lez, Durance, France)
Consorzia RFX (Padua, Italy)
Culham (Culham, Oxfordshire, England)
Frascati (Frascati, Lazio, Italy)
FOM (Utrecht, The Netherlands)
IPP (Garching, Germany)
JET-EFDA (Oxfordshire, England)
KFA (Julich, Germany)
Lausanne (Lausanne, Switzerland)
Chalmers U. (Goteberg, Sweden)
Helsinki U. (Helsinki, Finland)
U. Naples (Naples, Italy)
U. Strathclyde (Glasgow, Scotland)
U. Wales (Wales)

Japan

JAERI (Naka, Ibaraki-ken, Japan)
JT-60U
JFT-2M
Tsukuba University (Tsukuba, Japan)
NIFS (Toki, Gifu-ken, Japan)
LHD

Other International

Australia National U. (Canberra, AU)
ASIPP (Hefei, China)
KAIST (Daegon, S. Korea)
KBSI (Daegon, S. Korea)
National U. (Taiwan)
Nat. Nucl. Ctr. (Kurchatov City, Kazakhstan)
SWIP (Chengdu, China)
U. Alberta (Alberta, Canada)
U. of Kiel (Kiel, Germany)
U. Toronto (Toronto, Canada)

DIII–D
NATIONAL FUSION FACILITY
SAN DIEGO

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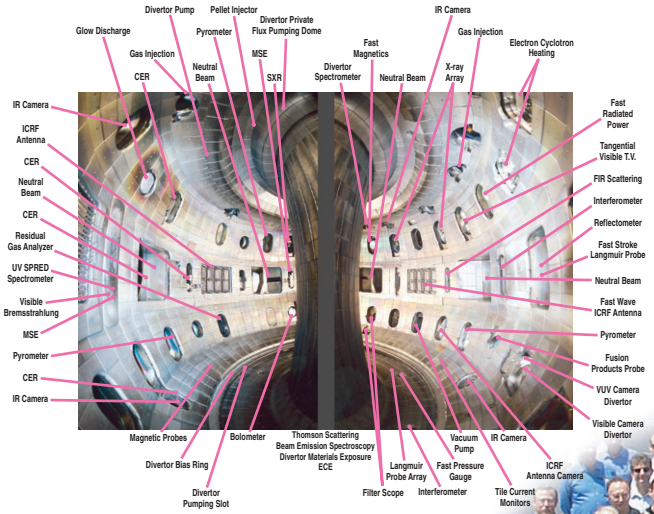
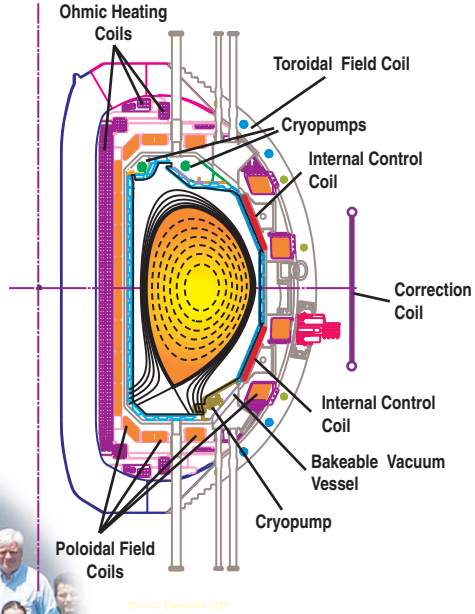
DIII–D – A NATIONAL FUSION RESEARCH PROGRAM TO CARRY FUSION FORWARD TO BURNING PLASMAS

Physics Measurements



Flexibility

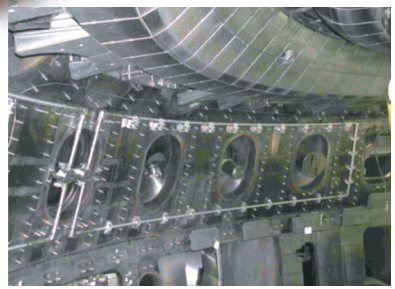


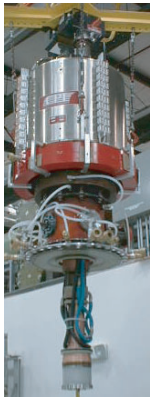
International Research Team

Partnerships and Leadership

- Collaborating Exp.
- ITPA
- TTF
- Theory/Modeling
- Burning Plasmas

Plasma Control





GENERAL ATOMICS

266-02/RDS/jy

FY04 STATUS

- Budget is $55,965K after $700K rescission
- DIII–D is up and running
  - 18 run weeks planned
  - I–coil feeds strengthened
  - Neutral beam pole shield repaired
  - Arc in OH coil leads repaired
- Contract placed for three CPI long pulse gyrotrons to replace three short pulse Russian units
  - One Russian tube has failed
  - 4th steerable launcher being built (PPPL)
- Some neutral beam ion source refurbishment
- Bare-bones effort to resume fast wave operation
  - Upgrade of ABB tetrodes moved to incremental
- Support of university turbulence diagnostics
  - UCLA FIR
  - Wisconsin BES
  - MIT PCI
  - UC-Irvine fast ion profile prototype

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

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PROPOSED EC SCHEDULE

		FY02	FY03	FY04	FY05	FY06	FY07
2 s	GYCOM #1	0.7 MW, 2s		Vacuum leak			
	GYCOM #2	0.7 MW, 2s					
	GYCOM #3	0.7 MW, 2s					
10 s	CPI-P1	1.0 MW, 10s					
	CPI-P2	1.0 MW, 10s					
	CPI-P3		1.0 MW, 10s				
	CPI-P4					1.0 MW, 10s	
	CPI-P5					1.0 MW, 10s	
	CPI-P6					1.0 MW, 10s	
	DVLT				1.5 MW, 10s		
	VLT #1						1.5 MW, 10s
	VLT #2						1.5 MW, 10s
EC	Waveforms (MW)				Run / Construct	Run	
	Nominal Tube Power	5.1 / 3.8 / 3.0	5.1 / 3.8 / 3.0	4.4 / 3.5 / 3.0	5.9 / 4.7 / 4.5 / 3.6	6.0 / 4.8	9.0 / 7.2
	Power into Plasma	2.4	2.4	2.4			

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RTS/rs

45th ANNUAL MEETING OF THE DIVISION OF PLASMA PHYSICS

- 106 Presentations
  - 7 Invited, 15 orals, 84 posters,

APS REVIEW AND INVITED PAPERS

M.S. Chu	Modeling of Feedback Stabilization of Resistive Wall Mode in Rotating Plasmas BI1.004
C.M. Greenfield	Steady-State, High Performance Advanced Tokamak Regimes for Next-Step Experiments BI1.001
F.L. Hinton	Electromagnetic Turbulence Effects in the Neoclassical Ohm's Law FI1.006
T.C. Luce	High Performance Stationary Discharges in the DIII–D Tokamak FI1.001
C.C. Petty	Beta Scaling of Transport on the DIII–D Tokamak: Is Transport Electrostatic or Electromagnetic? UI1.006
R. Prater	Heating and Current Drive by Electron Cyclotron Waves JR1
E.J. Strait	Resistive Wall Mode Stabilization With Internal Feedback Coils in DIII–D BI1.006

DIII–D NATIONAL FUSION FACILITY SAN DIEGO

065-04/RDS/rs

FY04 — 18 RUN WEEKS FOR 6 THRUSTS AND ENDURING TOPICAL SCIENCE AREAS

- Topical science areas provide broad scientific base
- Research thrusts are chosen to focus efforts on critical scientific issues and integrated scenario development

2004 Research Thrusts and Leaders

	#1 Edge Pedestal	#4 Wall Stabilization	#6 High ℓ_i	#8 Advanced Scenario Development	#9 QH–Mode QDB	#10 Hybrid Scenarios
Topical Area Manager	M. Fenstermacher P. Snyder	M. Okabayashi H. Reimerdes	T. Luce J. Ferron	C. Greenfield A. Garofalo	P. West E. Doyle	M. Wade J. Jayakumar
Stability physics E. Strait	✓	✓	✓	✔	✓	✓
Confinement, transport physics K. Burrell	✓		✓	✓	✓	✓
Boundary physics S. Allen	✓			✓	✓	✓
Heating and current drive physics R. Prater	✓		✓	✔		✓

Table shows areas of strong overlap

DIII-D NATIONAL FUSION FACILITY SAN DIEGO

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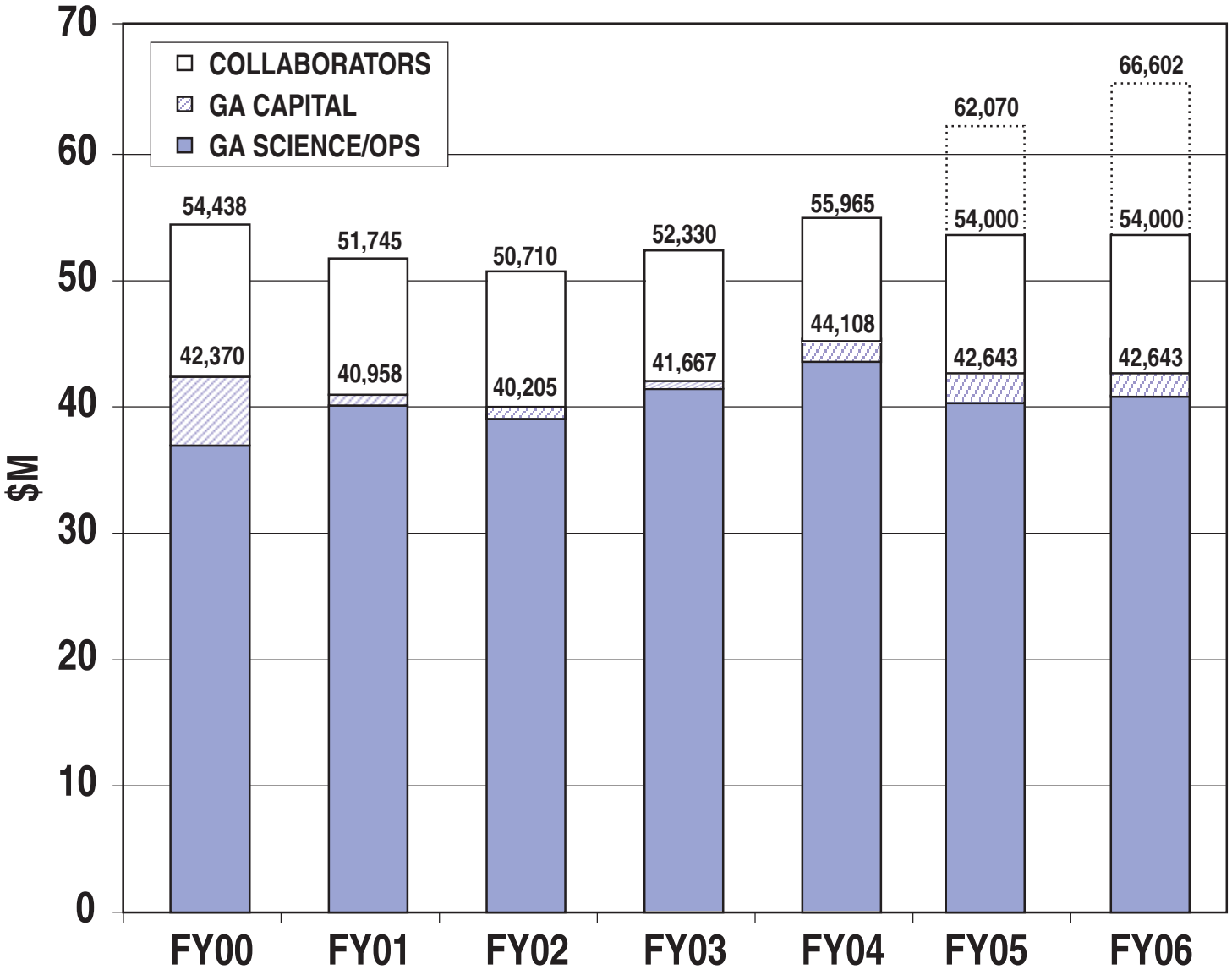
FYO4, 05, AND 06 BUDGETS ARE MAJOR SHORTFALLS WITH RESPECT TO THE 5-YEAR PLAN (2004–2008)



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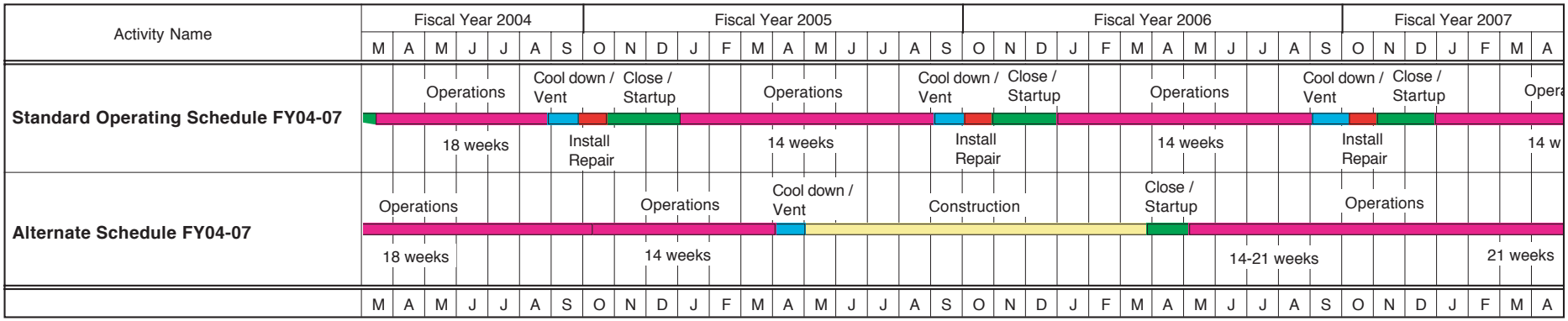
MAJOR ELEMENTS OF THE FIVE YEAR PLAN

- 21–25 Run weeks per year
- Acquire three new CPI 110 GHz/1 MW long pulse gyrotrons for 6 MW/10 s capability
- Add two ECH transmission lines to continue use of two Russian gyrotrons and eventual use of two 1.5 MW/10 s depressed collector gyrotrons from the development program
- Acquire two 1.5 MW/10 s gyrotrons
- Rotate one beamline for a counter-injection capability
- Modify lower divertor outer baffle to pump high triangularity double nulls
- Modify the upper outer baffle for higher triangularity
- Add two high voltage power supplies for gyrotrons/NBI and increase the capacity of the prime high voltage system (larger transformers)
- Divertor CER diagnostic

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

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

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