GLAST Large Area Telescope:

Project Status

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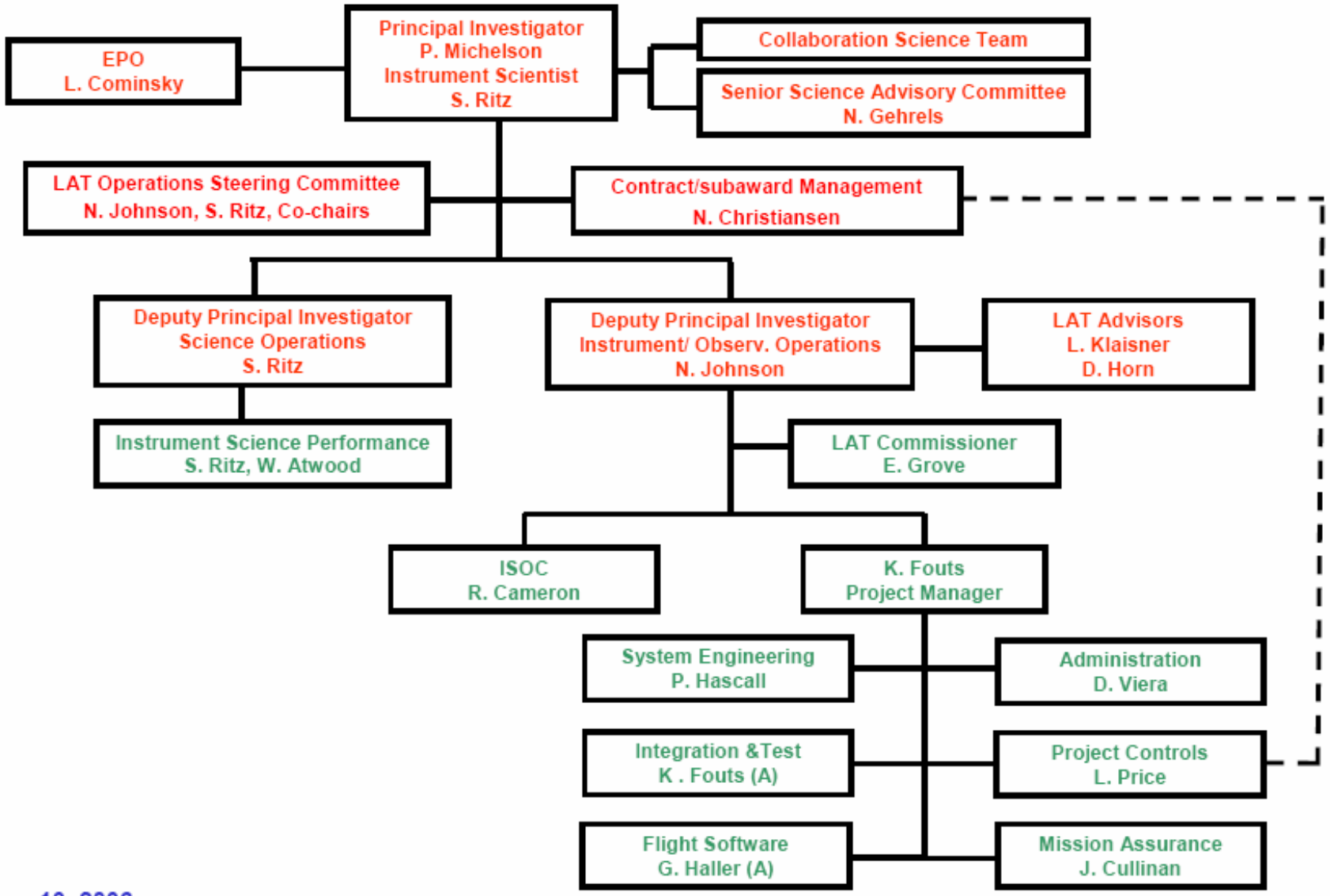
Rev. B

Master Schedule

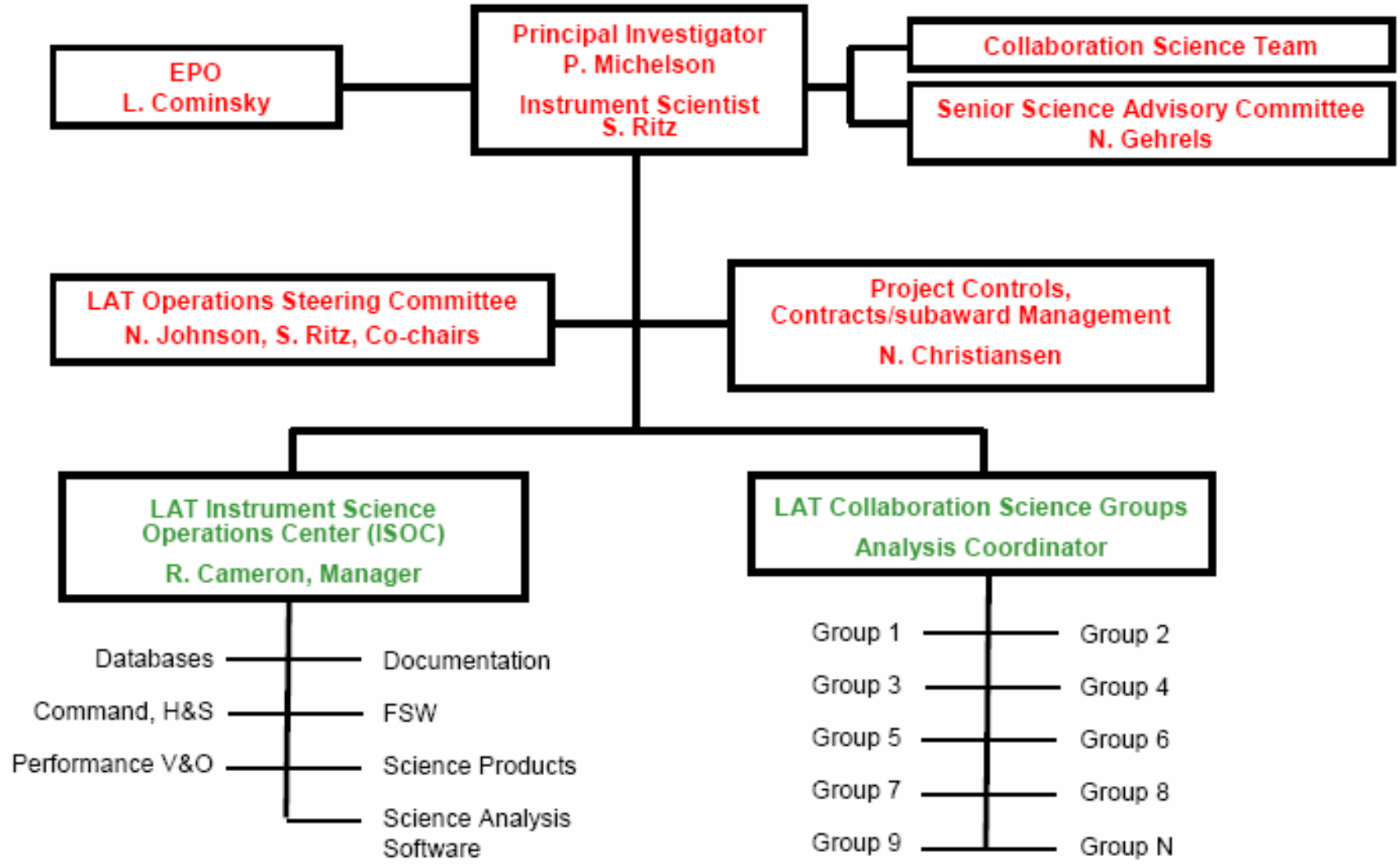
- LAT complete and tested April 2006
  - To Naval Research Laboratory for environmental testing
- Delivery to Observatory Integration September 2006
  - Mate with spacecraft and GBM and test
- Launch October 2007
  - Kennedy Space Center

Spitzer Launch on a Delta Rocket

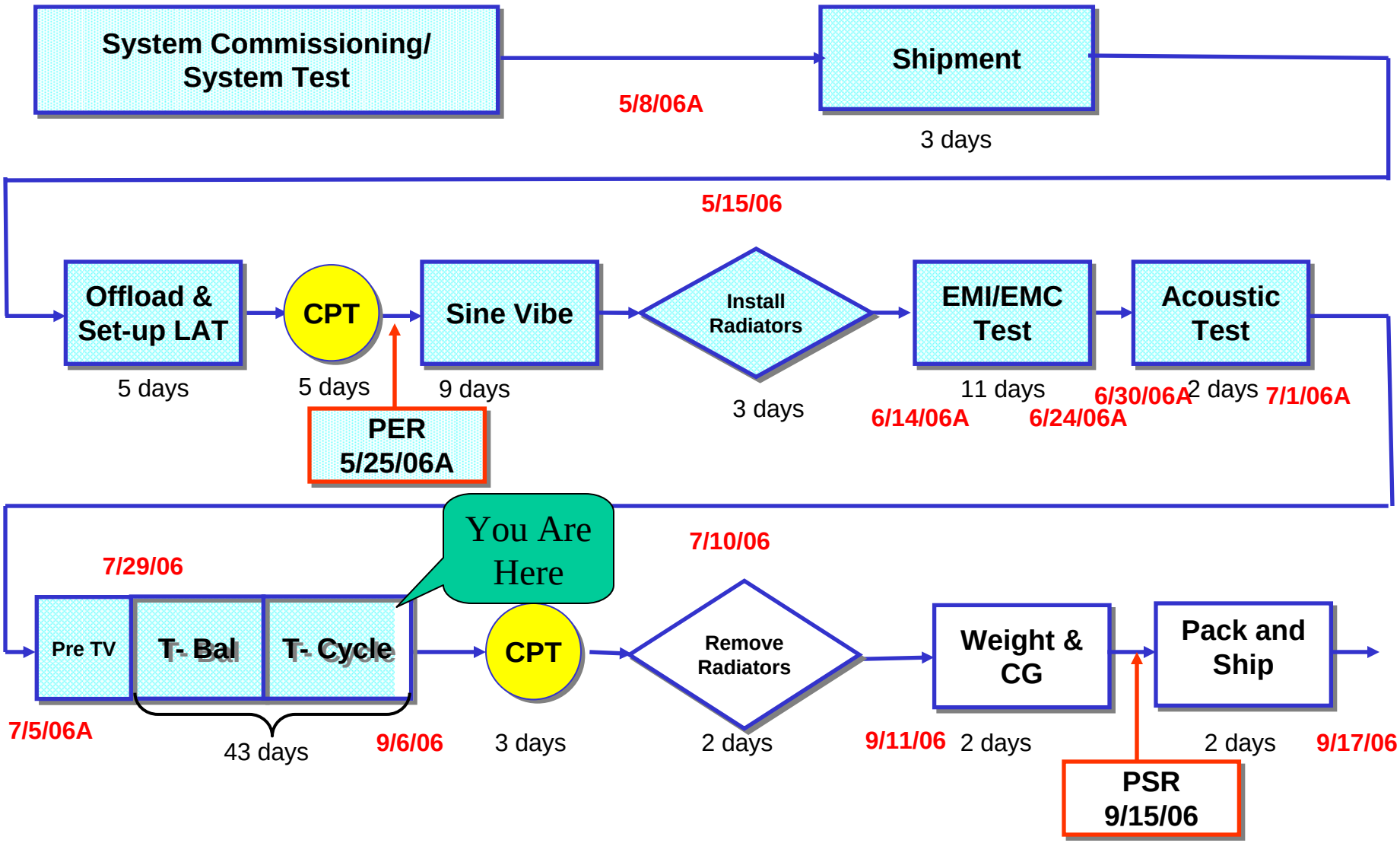
LAT Organization Chart: to launch + 60 days



LAT Organization Chart: science operations



LAT Test Flow – 9/2/06



LAT before installing the ACD

LAT on Shipping Container Base

Closing up the shipping container

Loading LAT on the "IceBreaker"

The IceBreaker

Arrival at NRL's Naval Center for Space Technology

Moving to Vibe Lab

Lift on to Vibe Table

On Vibe Table for Z-axis Test

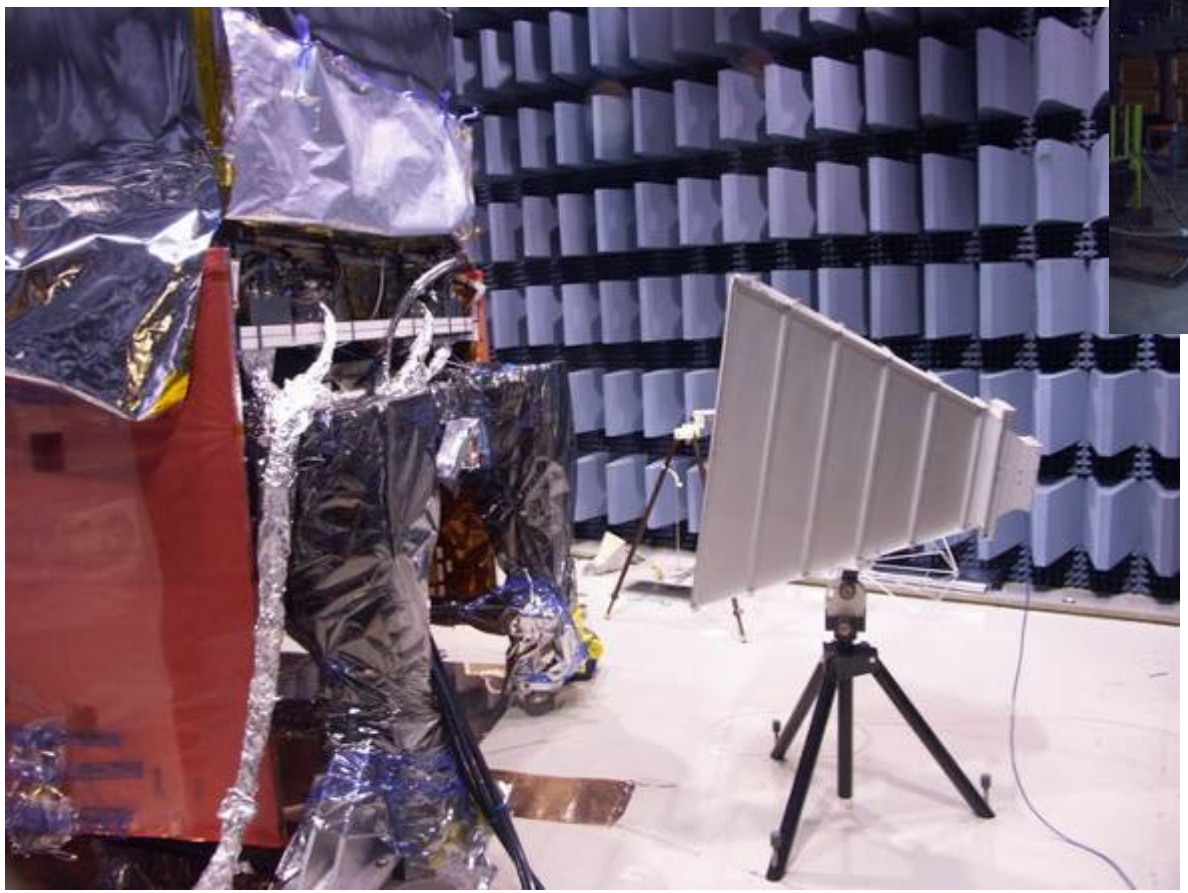
LAT on Test Stand

Install Radiators

1st time that LAT is completely assembled!

EMI Testing – Anechoic Chamber

Radiated Emissions – 100 MHz band



LAT just fits in the door to the anechoic chamber

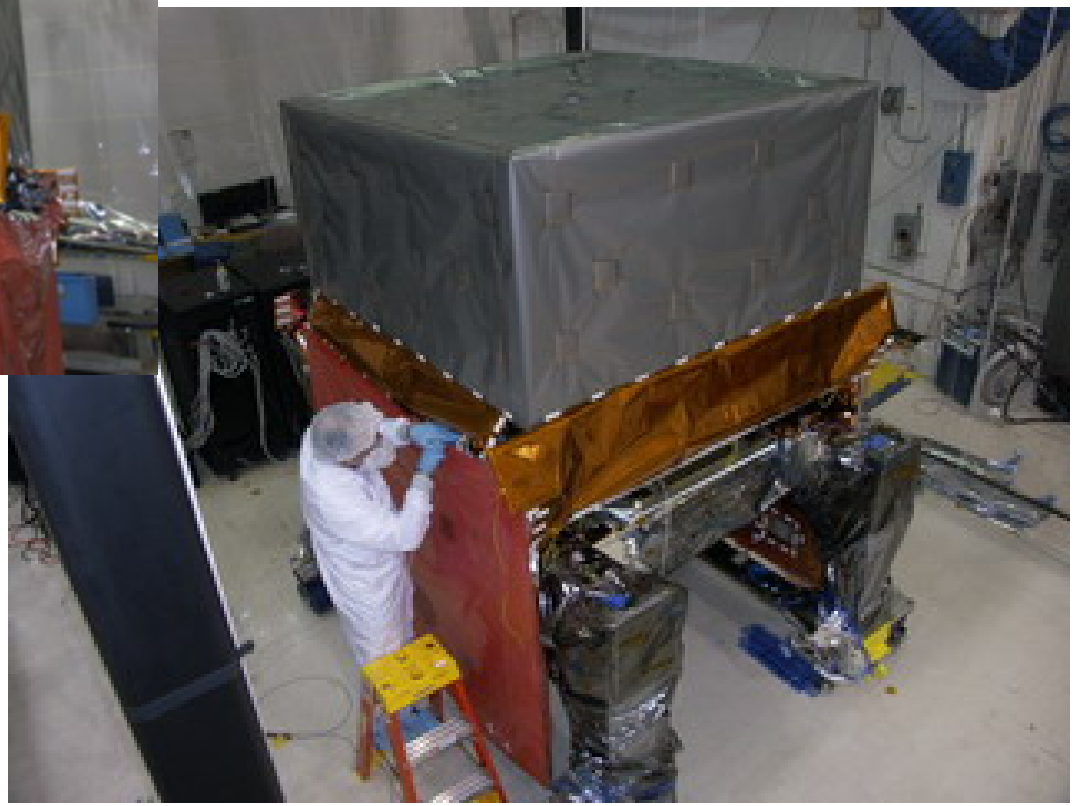
ACD w/ Micrometeorite shield

Prior to MLI blanket installation – exposed micrometeorite shield

Installing the MLI Blankets

Final LAT dressing –

2 tone MLI blankets

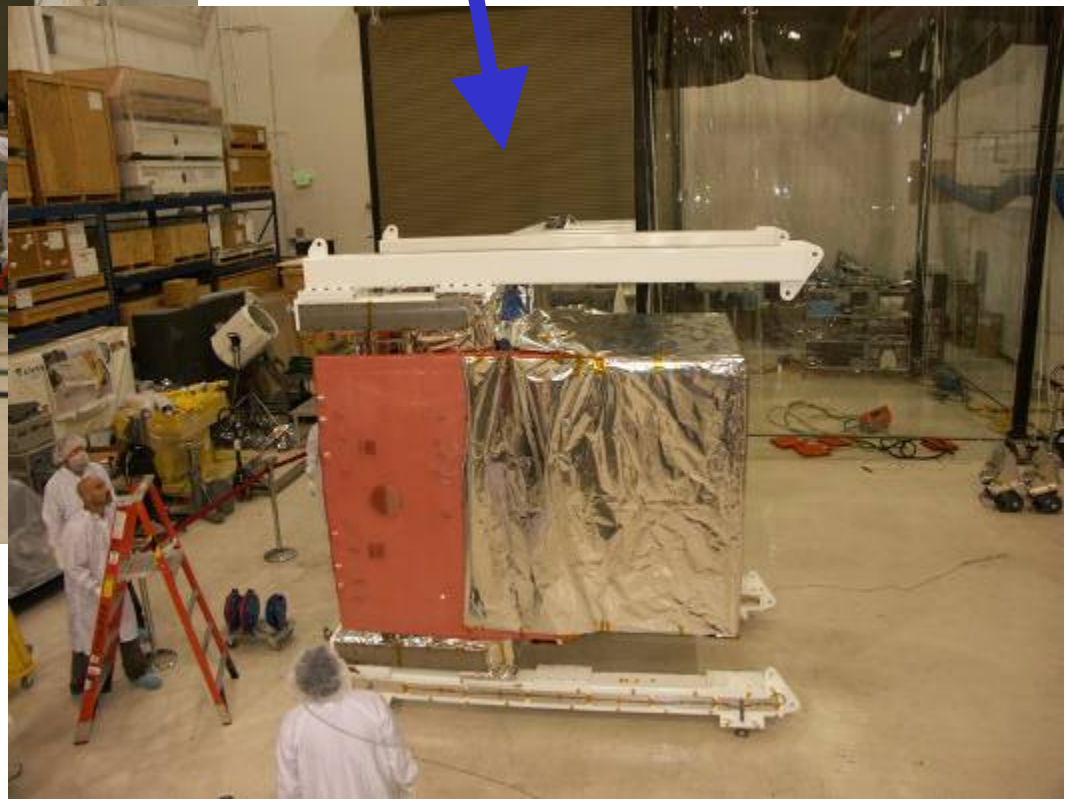


Now, 1002 uses for duct tape (actually Ge coated Kapton outer ACD MLI blanket)

Acoustic Test Chamber

Prep for TVAC

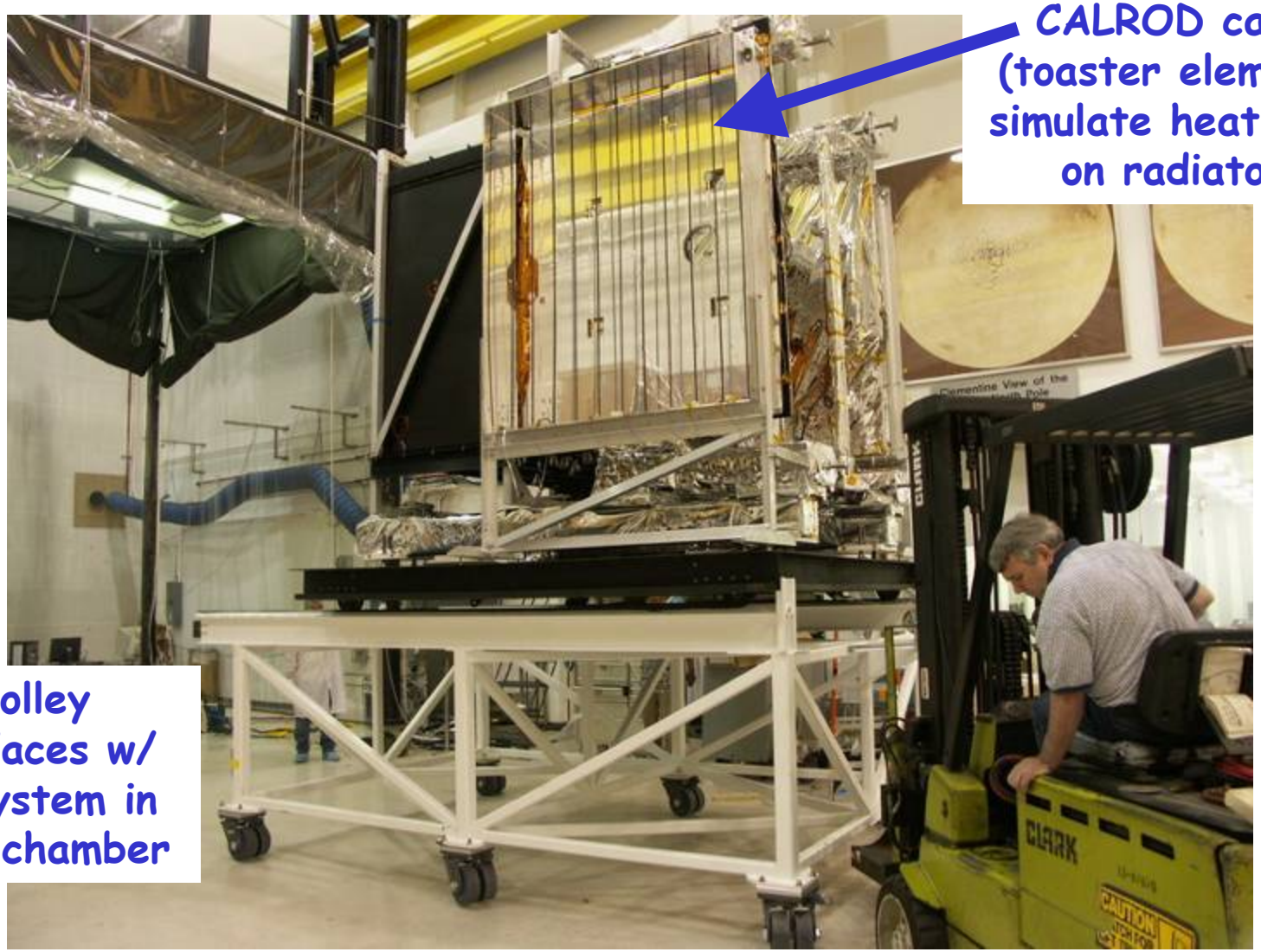
Need to rotate from +Z vertical orientation to +X vertical orientation



VCHP need to be horizontal to operate w/ gravity for TVAC

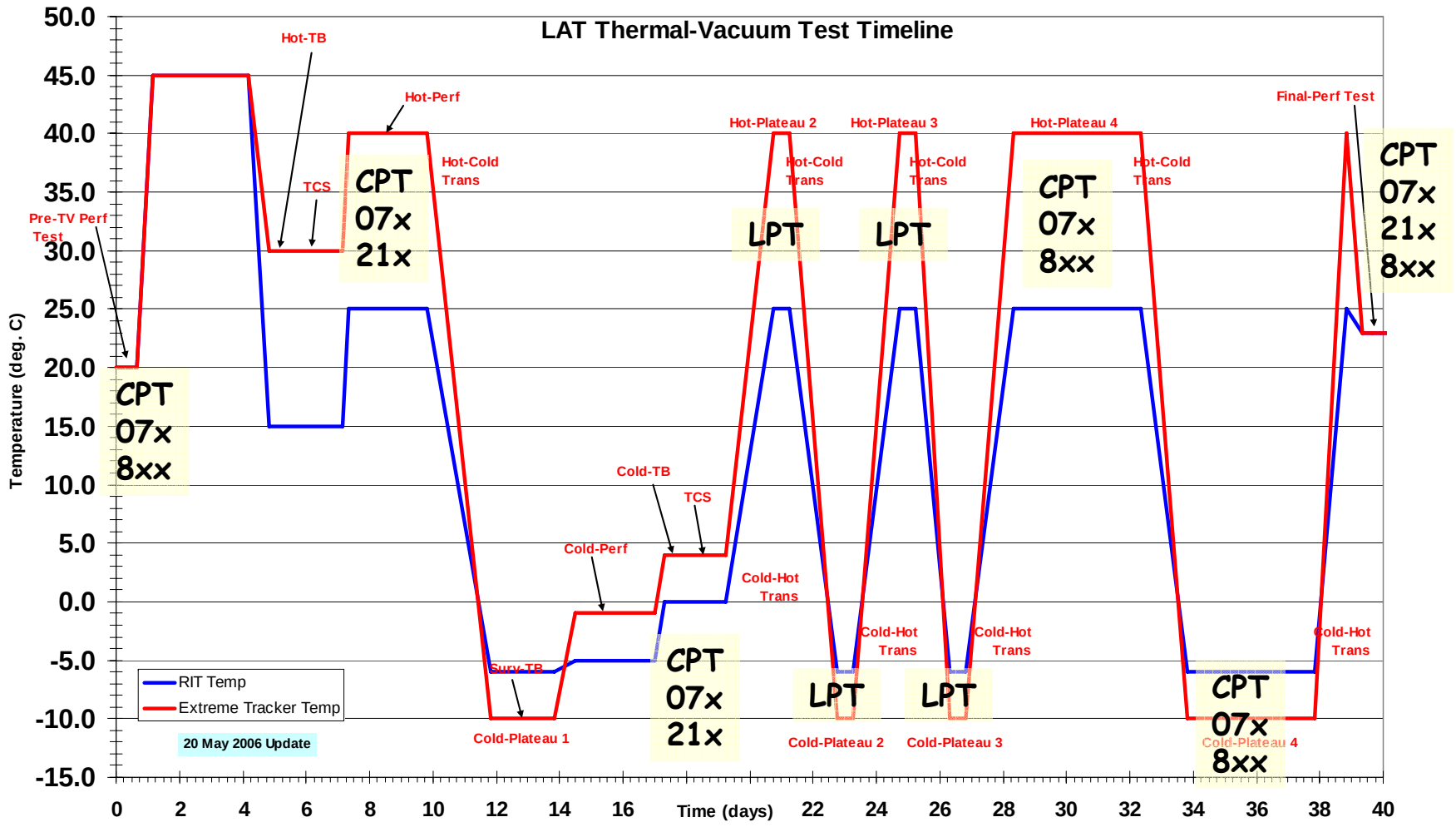
LAT Pirouette

Move to TVAC


CALROD cages (toaster elements) simulate heat loads on radiators
Trolley interfaces w/ rail system in TVAC chamber
CLARK

LAT Installed in “Big Blue” TVAC

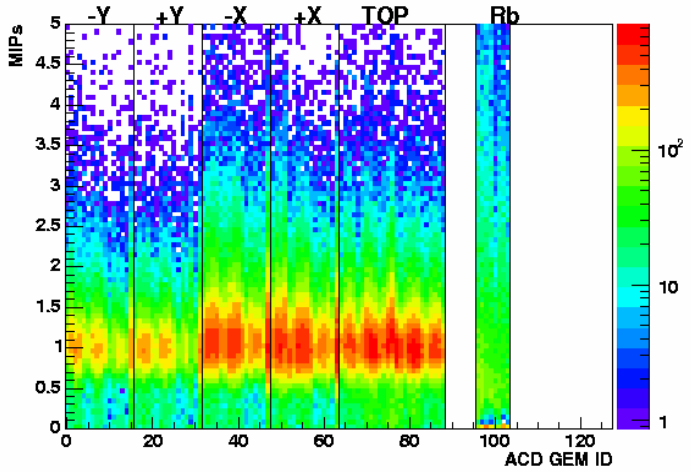
TVAC Test timeline

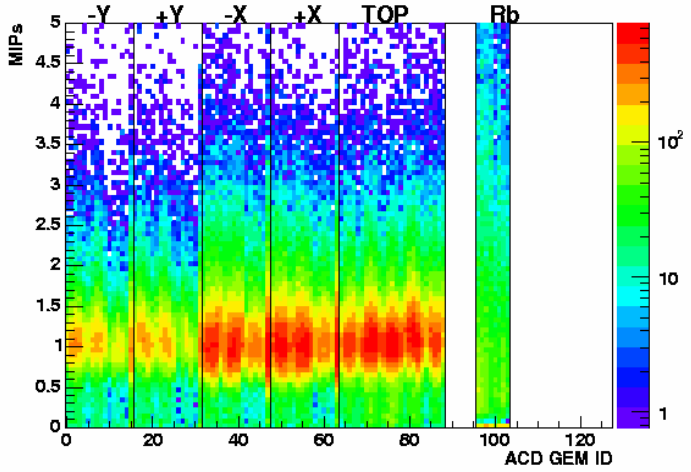


Performance

LVP105/LPS586 – LAT Calibration

- **ACD calibration**
  - If ACD is calibrated, muon peak will be at 1 MIP in each tile
  - Both figures are 2D histograms of ACD spectra for all tiles
    - Run ID 77007673
    - Upper panel = PMT A
    - Lower panel = PMT B
  - Calibration constants were derived from data taken May 06
    - Consistent with constants derived from July 06 data
  - Muon peak appears at 1 MIP, as expected

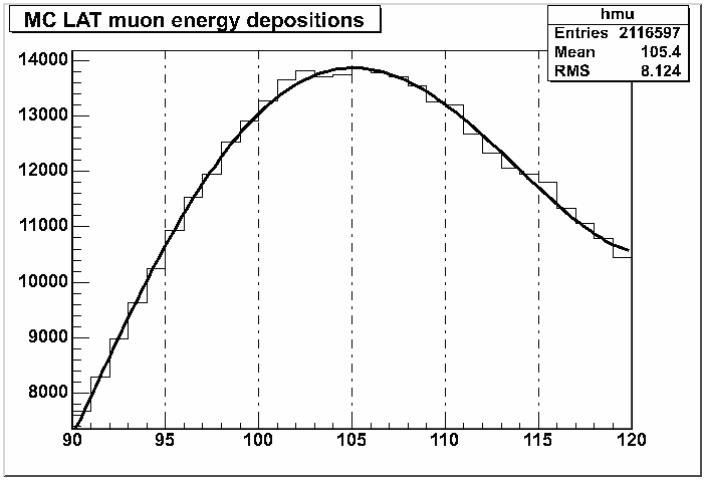


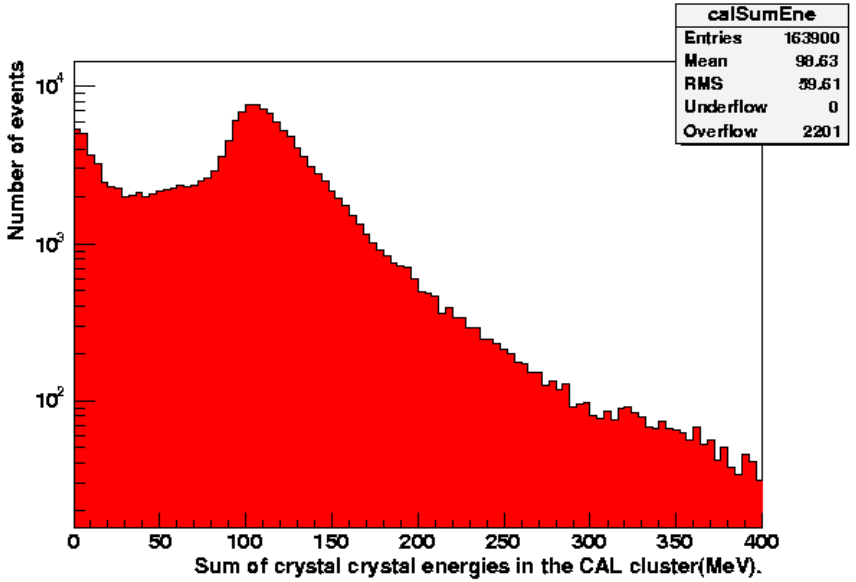


Thanks to Eric Charles

LVP105/LPS586 – LAT Calibration

- CAL calibration
  - If CAL is calibrated, the most-probable total energy deposited in CAL by muons will be 105 MeV
    - Upper panel = MC simulation
  - Lower panel is histogram of total energy deposited in CAL
    - Run ID 77006594
  - Calibration constants were derived from July 06 data
  - Muon peak is at 105 MeV, as expected

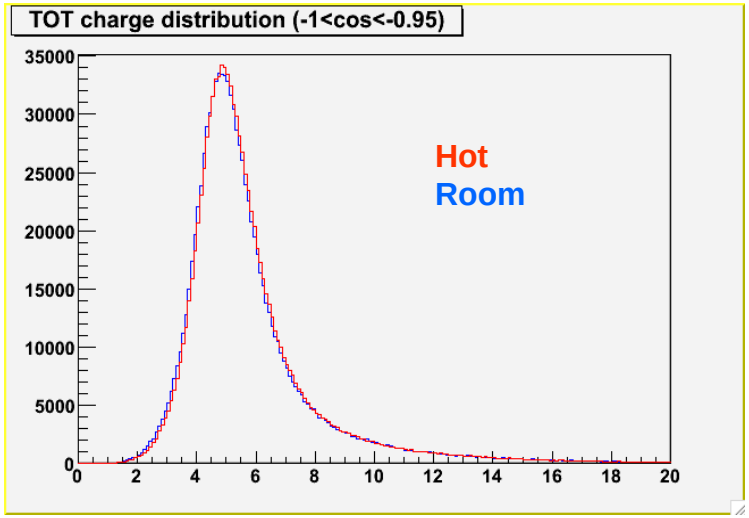


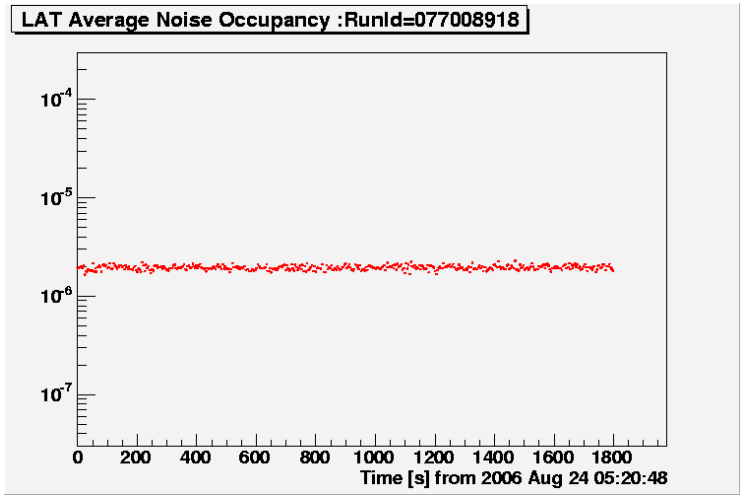


Thanks to Sasha Chekhtman, Zach Fewtrell

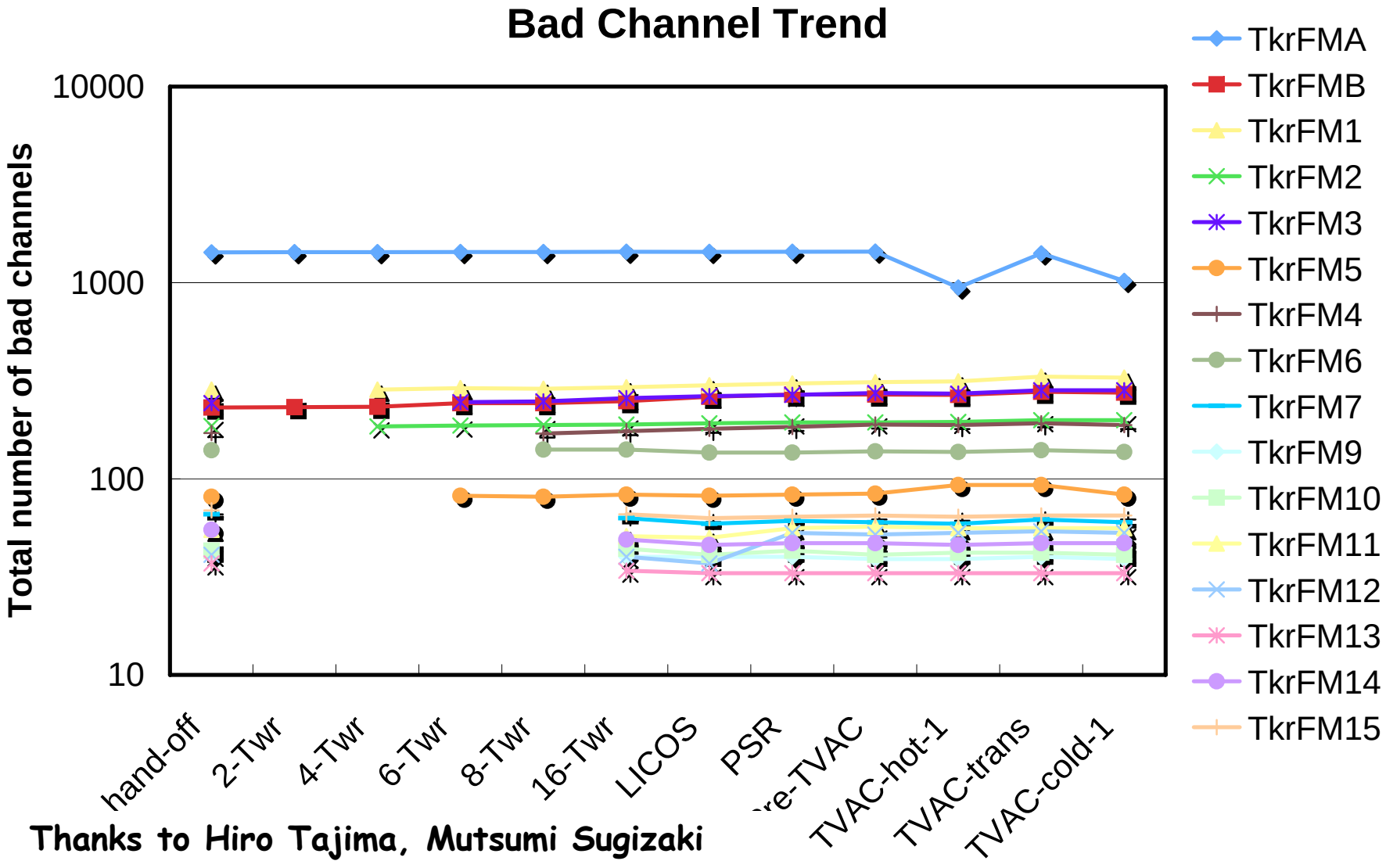
LVP105/LPS586 – LAT Calibration

- **TKR calibration**
  - If TKR is calibrated, the muon peak will be at 4.9 fC, and the average noise occupancy will be $<10^{-4}$
  - Calibration constants were derived from July 06 data.
    - TOT Gain: Run ID 77006756
  - Upper panel is comparison of muon peak between pre-TVAC and TVAC hot soak.
    - No significant change observed.
    - Muon peak = 4.6 fC
  - Bottom panel is LAT-avg noise occupancy during TVAC
    - Mean occupancy = 2×10^{-6}





TKR Performance

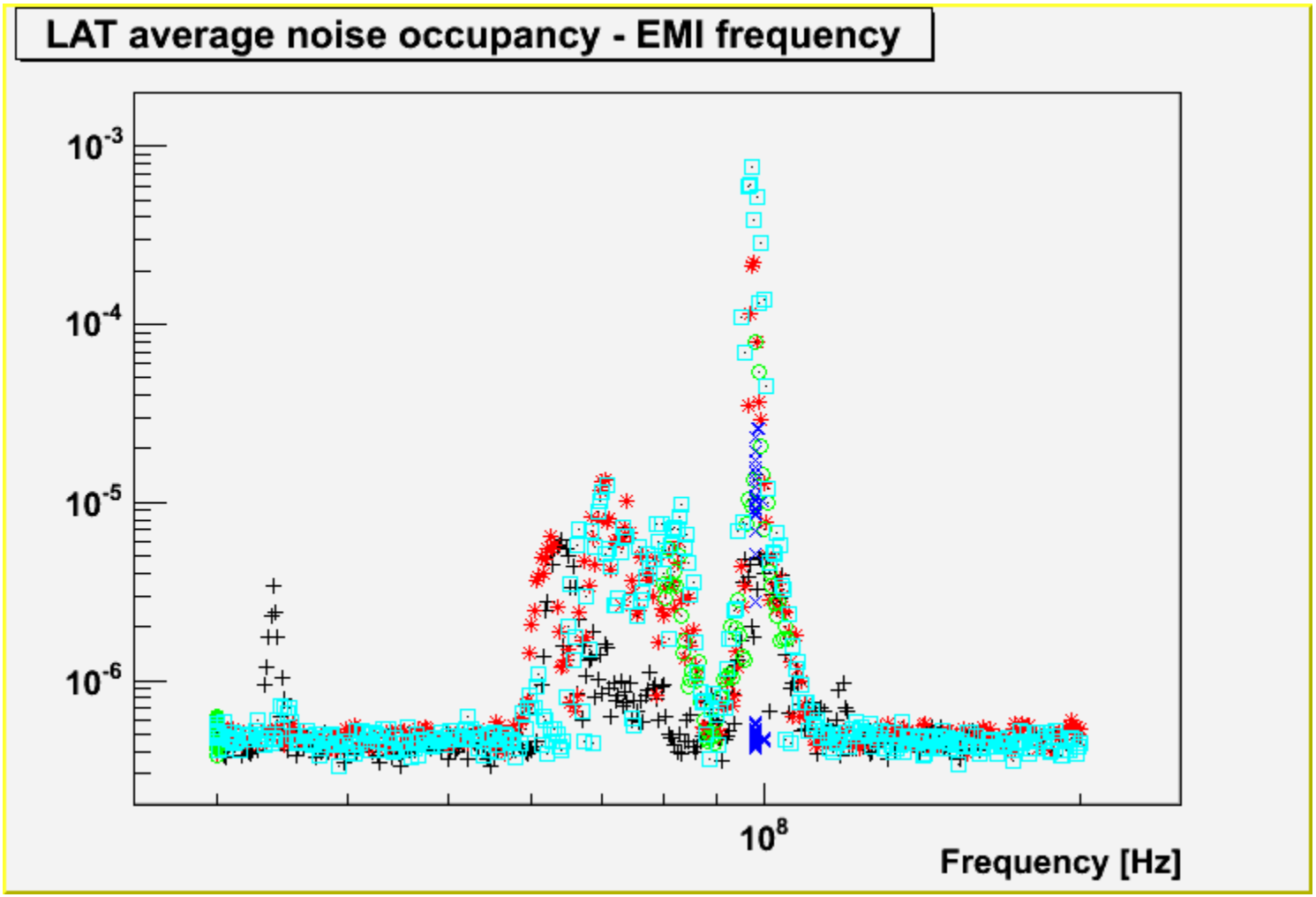


Thanks to Hiro Tajima, Mutsumi Sugizaki

Issues

- EMI: Tracker shows minor susceptibility to 30 - 100 MHz radiated emissions.
  - GLAST has no such sources. No problem, waiver needed
- EMI: Thermal sensors (RTDs) show susceptibility to conducted noise in 30 – 100 MHz range.
  - Data filtering gives correct temperature measurement, no problem.
- TVAC: Rad750 CPU in EPU0 runs ~ 25 deg C hotter than other Rad750s.
  - Believe that it lost its heat sink connection.
  - No problem, temperature remains below 110 deg C max.

RS103 susceptibility in TRK noise occupancy



Thanks to Hiro Tajima, Mutsumi Sugizaki, Michael Lovellette

LAT Remaining Work

- Flight Software Development is not Complete
  - LAT running FSW B0.6.9
    - Missing GRB processing infrastructure
    - Compression
  - Build B0.7.0 will be installed on LAT (~ Oct ’06) after arrival at General Dynamics
    - Includes all requirements except internal GRB detection algorithm
  - Build B1.0.0 will be installed on LAT (~ Nov – Dec ’06) before observatory environmental testing
    - All requirements and critical updates included.

Instrument Science Operations Center

- Operations Facility construction starting in Sept
- Ground test support: ISOC data processing infrastructure simultaneously supporting LAT Environmental Testing at NRL and Beam Test at CERN
- Very successful Data Challenge 2, March – May 2006
  - Simulation and analysis of 55 days of GLAST data
- GRT5 conducted successfully on Aug 24-25
  - First test of full automated LAT science data processing: Missing Operations Center -> Instrument Science Operations Center -> GLAST Science Support Center

ISOC Plan through Launch

- Transition of FSW from development to maintenance after FSW build B1.0.0 is installed on LAT (Dec 2006)
- ISOC Operations Facility
  - Construction complete in Jan 2007
    - Houses LAT Calibration Unit after beam tests
  - Goal: support ETE1B (11 Jan 2007) in Ops Facility
- Flight Operations
  - 6 End To End tests during Jan – Aug 2007
  - 2 Launch & Early Orbit simulations
  - 2 "Day in the life" tests with Mission Operation Center and GLAST Science Support Center
- Science Operations Testing: Service Challenges
  - Derived from successful Data Challenge model
  - Extended to include exercising ISOC science operations

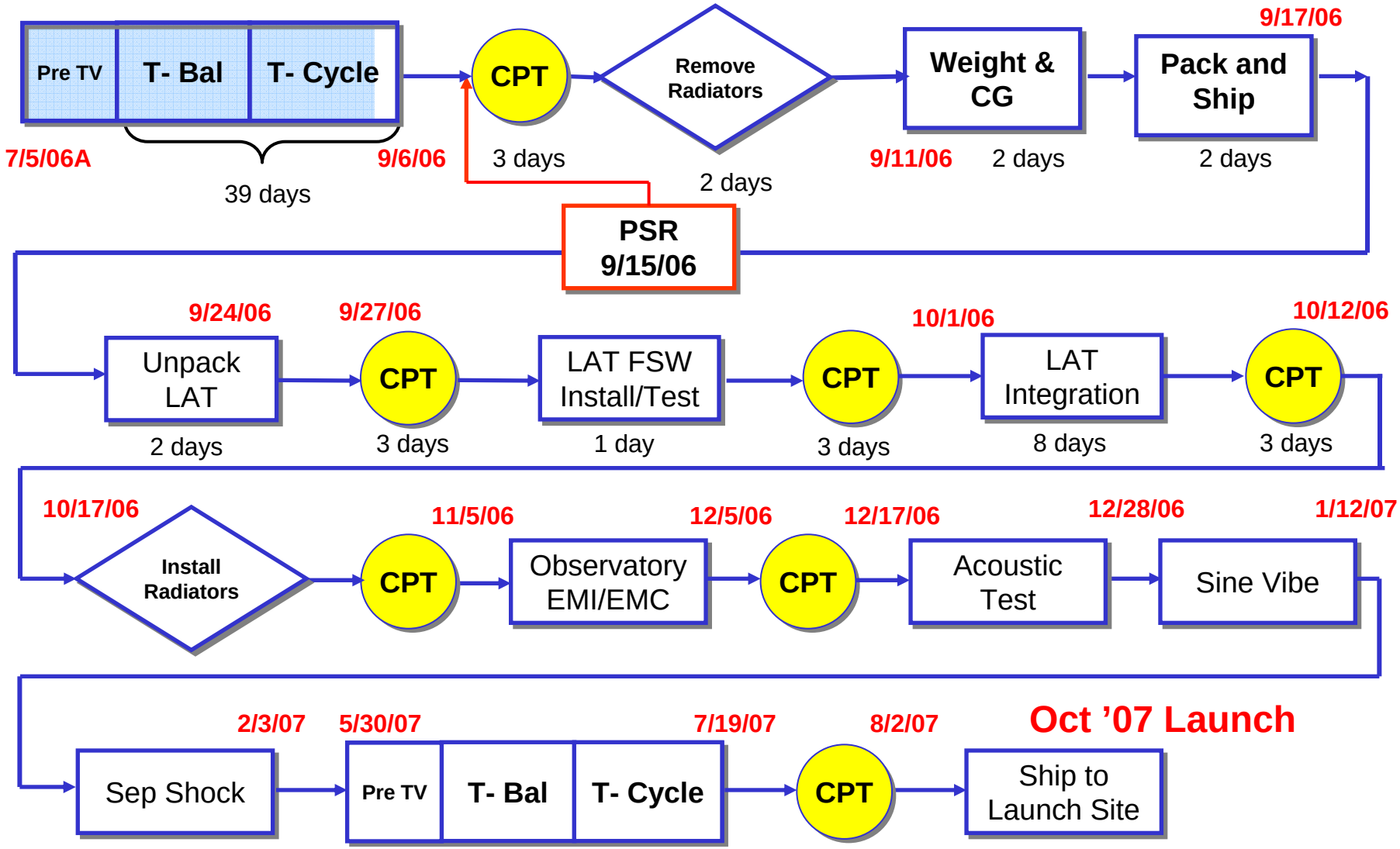
Calibration Unit Beam Test Status

- Motivations for a CU beam test campaign
  - Validate LAT MonteCarlo on beam test data from a Calibration Unit (2 complete towers + 1 CAL + 5 ACD tiles from flight spare modules)
  - Directly measure CU performance on most of the spectrum
- CU beam test campaign
  - CERN-PS/T9, low E beam of (γ,e,e+,p,π), E<10GeV, 26/7-23/8
  - CERN-SPS/H4, high E beam of (e,p,π), 10-300GeV, 4-15/9
  - GSI, C ion beam few GeV, 16-17/11
- Current status
  - CERN-PS/T9 – COMPLETED
    - Program completed despite ½ time eaten by CERN problems
    - Large clean data samples of γ, e, and most important background for LAT (e+ annihilation, π^0 production from p)
    - Preliminary results very encouraging
    - Team well trained and motivated
  - CERN-SPS/H4 - next
  - GSI, ready to start in time

LAT Status

- The LAT is complete and essentially thru its environmental test program.
  - No significant anomalies detected to date
  - No performance anomalies detected. Trending shows same instrument throughout assembly and test program.
- LAT meets its performance goals over the TVAC temperature extremes
  - TKR bad strip issues are stable
  - CAL, ACD noise floors and trigger levels stable
- The LAT Flight Software is essentially complete.
  - Missing GRB detection algorithm and event filter additions
    - Neither particularly relevant for ground testing.
    - Development will continue on the test bed at SLAC.
- Next big thing
  - Pre Ship Review, Sept 15th, where we summarize our demonstrated performance and requirements sell off to NASA review team.

LAT Future – General Dynamics and beyond



Next Steps

- 2006 – Complete and test instrument and hand off to NASA
- 2007 – Support observatory testing and establish instrument ground systems including the ISOC at SLAC
- 2008 – Begin science with an all sky survey
- 2009 through 2017 – Continue discovery-based science

International Contributions Chart

- This is the last presentation of this chart
- The chart will be used to estimate the total cost of the LAT
- It will include the International Contributions through CY06
- Please get any updates to me by the end of the year
- Thank you all for your hard effort to support the construction of the LAT with funds, manpower, intellectual support and creativity (scientific, technical, and funding)

International Contributions

Calendar Year	2001 [a]	2002	2003	2004	2005	2006	Total
Funding for the GLAST-LAT Project (in thousands, USD)							
France - IN2P3	2,520	1,450	1,725	830	350	380	7,255
France - CEA	1,477	1,474	939	206	241	211	4,548
Italy - ASI			1,260	4,038	2,172	416	7,886
Italy - INFN	2,100	4,319	1,801	1,333	1,150	917	11,620
Japan	1,140	1,040	880	730	150	100	4,040
Sweden	300	900	1,000	300	100	200	2,800
US - DOE Project	10,709	8,288	8,658	8,780	8,566		45,000
US - DOE Ops & Science [b]	4,224	3,385	4,123	5,141	6,853	7,683	31,409
US - NASA	11,161	16,316	28,913	34,191	25,860	16,540	132,980
						Total	$247,537
Scientific and Technical FTE's supporting the GLAST-LAT Project							
France - IN2P3	FTEs included in the funding above.						
France - CEA	0.9	1.5	1.5	1.7	2.2	2.2	
Italy - INFN	14.4	37.6	47.8	43.2	49.5	43.8	
Italy - ASI	FTEs included in the funding above.						
Japan	4.0	4.5	3.5	3.5	3.5	1.5	
Sweden	6.3	7.5	5.6	5.0	2.6	3.2	
US DOE & NASA	FTEs included in the funding above.						
*Shading indicates revisions since Oct 05 IFC.							
(a) The 2001 column includes funds from prior years.							