GLAST Large Area Telescope:

Tracker Subsystem WBS 4.1.4

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Outline

- Tower Fabrication Status
  - Tower A
  - Tower B
  - Tower 1
  - Tower 2
  - Tower 3
- Tracker Technical Issues
  - MCM encapsulant delamination
  - Pitch Adaptors and MCM production
  - Ladder Breakage on Heavy Trays
  - Flight Cables
- Cost and Schedule Status

Outline

- Tower Fabrication Status
  - Tower A – integrated into single bay
  - Tower B –RFI at SLAC
  - Tower 1 –starting vibe test at Alenia
  - Tower 2 –tower in assembly in Pisa
  - Tower 3 –trays in assembly in G&A
- Tracker Technical Issues
  - MCM encapsulant delamination –will know soon if resolved
  - Pitch Adaptors and MCM production –in production
  - Ladder Breakage on Heavy Trays –resolved in tower 1
  - Flight Cables – schedule a concern
- Cost and Schedule Status

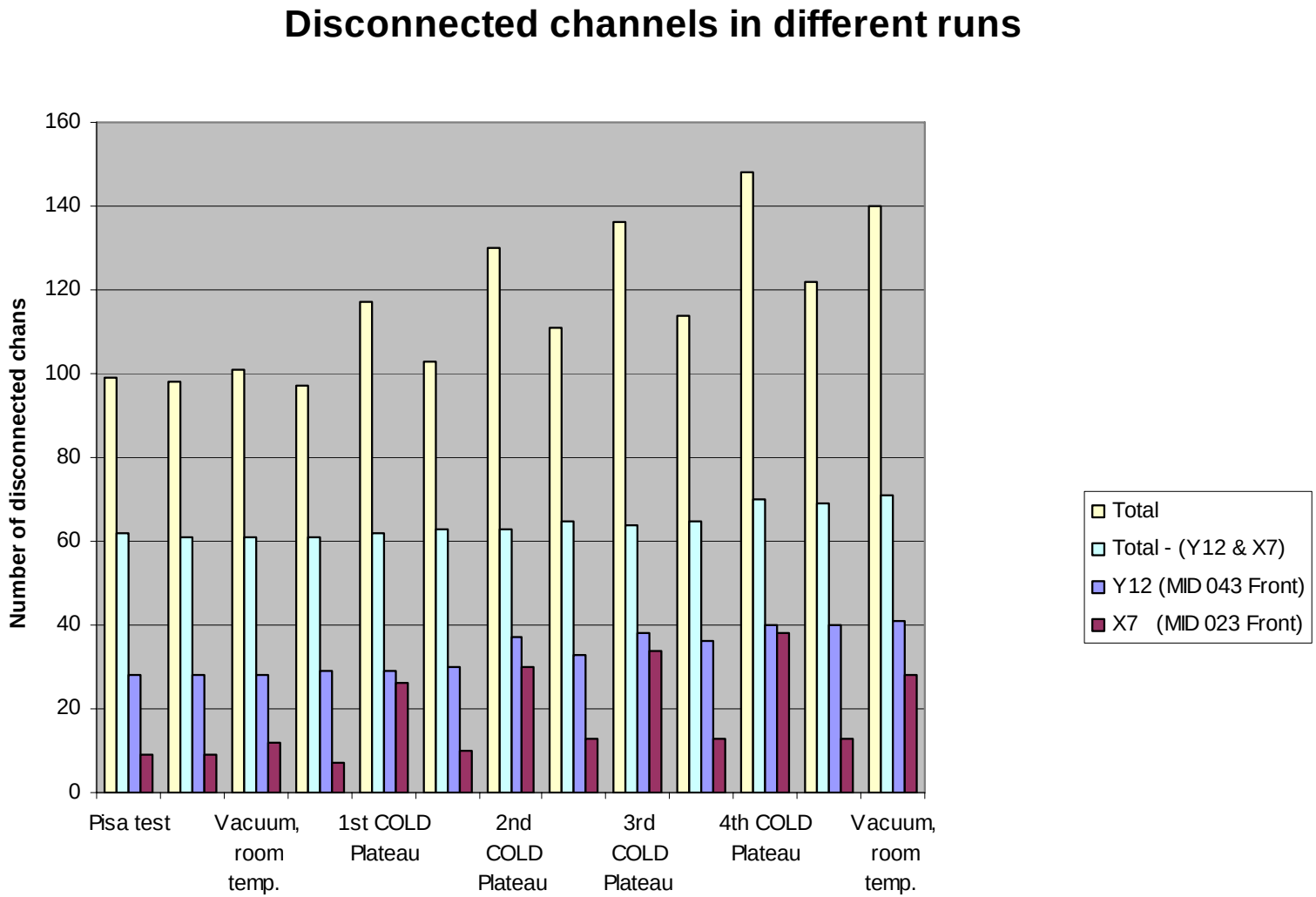
Tracker Technical Issues: MCM Encapsulant Delamination

- MCM Anomaly Found During Tower A Tray Assembly at G&A
- Missing channels due to wire bonds breaking at Pitch Adaptor to ASIC joint under black encapsulation due to delamination of the encapsulation
  - Root cause hypothesized to be silicone contamination from masking tape applied to entire surface of pitch adapter prior to reflow soldering
- Root cause verified:
  - Seen in MCM sectioning
  - "Seen" in C-SAM images
- Electrical Test Procedure at SLAC effectively eliminates all MCMs with more than 15 broken signal wire bonds following thermal cycles.
  - Concern is additional delamination and breaking of bonds during tray and tower assembly and test

Impact on Tower Production

Tower	Layer	SLAC	G&A	T-Cycle	Vibe	T/V
A	X1	0	156	174	177	178
A	X3	4	21	22	22	22
A	Y3	2	128	138	140	128
A	Y6	0	34	36	36	51
A	X0	1	4	6	6	9
B	Y9	7	13	16	16	19
B	Y12	15	17	28	28	41
B	X7	7	8	9	9	28
1	X17	1	0	19		
1	Y3	1	22	23		
1	Y0	0	11	19		

Missing Channels vs T/V cycle for Tower B

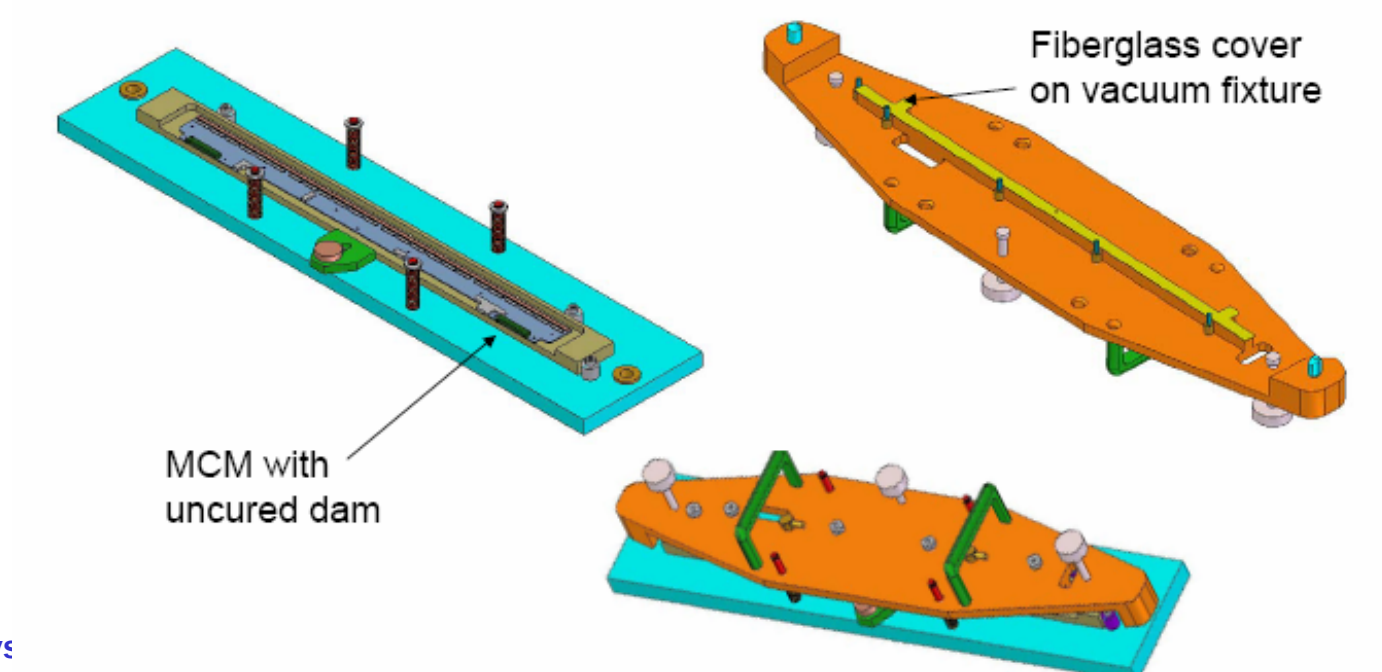


Tracker Technical Issues: MCM Encapsulant Delamination

- For Teledyne restart, used reject MCM's at Teledyne to evaluate new process for delamination
  - CSAM images of 3 MCM's indicate large scale delamination is still present both before and after thermal cycles
  - However, sectioning of these boards shows no evidence of delimination
- Not sure how to interpret results
  - Opinions varied on what we are seeing with CSAM
  - Stay the course and see how first production MCM's turn out
  - Acid test will be electrical testing of all wire bonds after thermal cycles
    - Will happen within the week
  - Continue to pursue mechanical cover option as back up

Tracker Technical Issues: MCM Encapsulant Delamination

- **Drawings are in the shop at SLAC and fixture should be completed this week**
  - **Need to decide whether or not to introduce into production**
    - **Assume will only do if problems with wire bond breaking seen in new production.**



Plan Forward: MCM Encapsulant Delamination

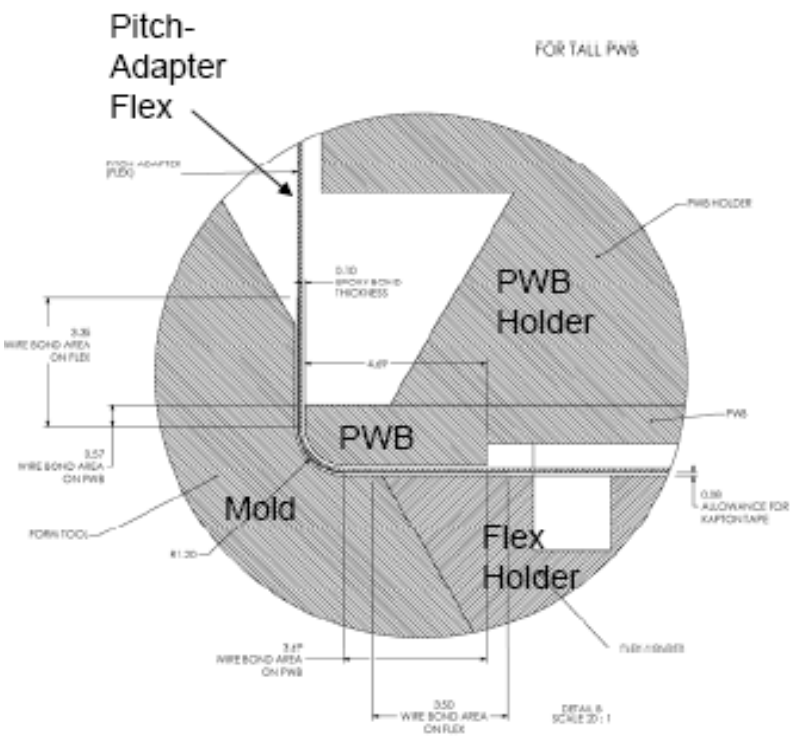
MCM Encapsulant Delamination	Status	Who	Date
1. 100% electrical screening of MCM's at SLAC	1. Done		
2. Process changes during MCM assembly on trays	2. Done		
3. 1/3/05 MRB	3. Done	RPJ	1/3/2005
4. Proceed to put existing MCM's on Tower 1,2,3	4. Done	Pisa	1/5/2005
5. Monitor bad channel rate during assembly and call an MRB if the number is greater than 15	5. Exists	CCY	1/10/2005
6. Use reject MCM's at Teledyne to evaluate new process for delamination	6.Done	CCY	
7. Develop and execute a plan to retire risk on existing MCM sample by thermal cycling and C-SAM to demonstrate that delamination does not propogate.	7. Done; inconclusive results	Kahn	1/31/2005
8. Develop mechanical cover alternative	8. In process	RPJ	3/10/2005
9. Evaluate new process MCM's	9. In process	CCY/RPJ	3/10/2005

Tracker Technical Issues: PA Trace Cracking

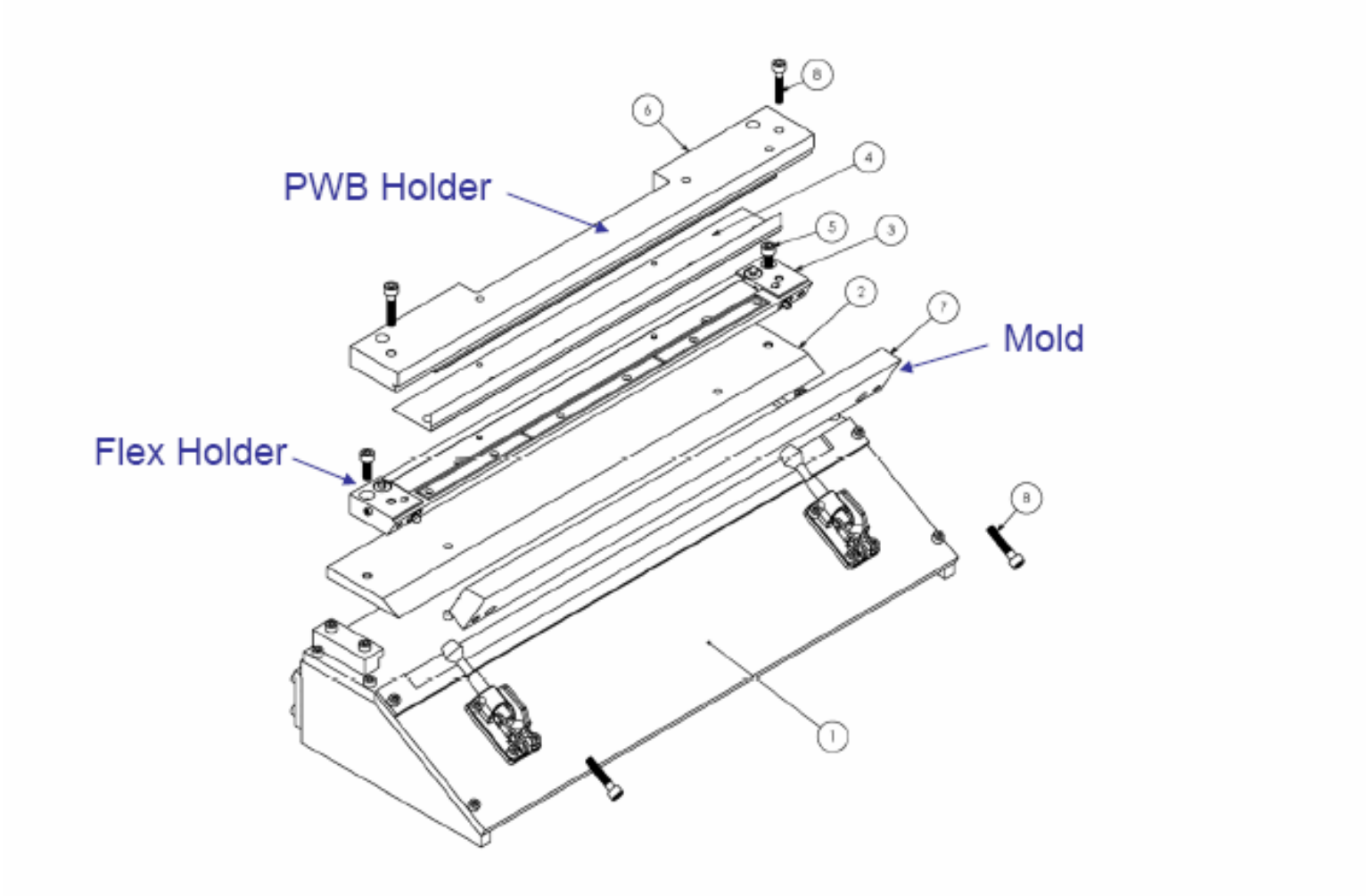
- MCM Production at Teledyne was halted 10/1/04
- Teledyne restarted production 12/20/04
  - Immediately started having trouble with cracking of pitch adaptors
- Thanks to tremendous effort by Robert Johnson and Charlie Young with help from Paul Baird, this problem is solved!
  - Root cause traced to change in nickel plating process on PA
  - New PA in hand and working
  - MCM's in production

Pitch Adaptor Bonding

- In process of PA investigations recognized Teledyne process for bonding PA is not satisfactory
  - Uncontrolled tension
  - Uneven surface for wire bonding in Italy
  - Large incidence of voids that need rework
  - Poor alignment control
- New fixture designed to form bend in mold
- First article test of new fixture in process

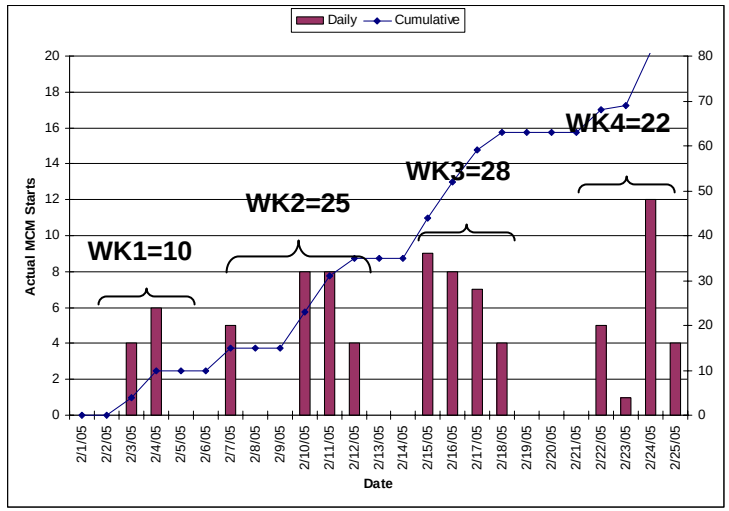


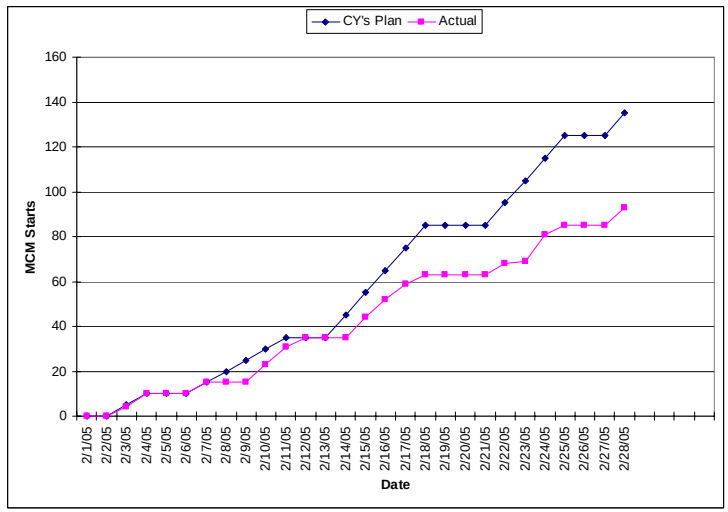
Pitch Adaptor Bonding: New Fixture



Tracker Schedule Issues: MCM Production

- Production restarted 2/3/05
- As of 2/28/05
  - 93 MCM starts
  - 60(7) MCM's have pass(fail) at MIP-1
  - 23(2) MCM's have pass(fail) at MIP-2
  - 6(1) MCM's have pass(fail) at MIP-3
- Charlie's goal:
  - 10 starts/day
  - 6 days/week
    - recall yield is not 100%
- The plan to increase production and yield (both are needed!)
  - Saturday shifts
  - Deploy new bonding fixture
    - to increase yield
    - ease flex bonding bottleneck
  - Hire new operators to get to 12hr/day operations
    - flex bonding and encapsulation is where they are needed





Tracker Schedule Issues: MCM Production

- **Critical path for tracker schedule is through MCM production now**
  - **MCM production critical path for Tower 4, 5, 6**
    - **Aggressively pursuing options to speed up production**
      - **Burn in removed as bottleneck by installing second oven in Bldg 33**
      - **Detailed discussions with Teledyne on how best to improve ramp up**
  - **Current schedule has Tower 4 completed at G&A on 3/31**
    - **Tower 4 MCM's delayed a week from original ramp up plan but…**
      - **We have 5 spare trays that can be used in Tower 4**
      - **We have 8 MCM's (old production) that can be used on Tower 4 trays**
      - **Need only 18 new production MCM's to complete Tower 4**

Tracker Schedule Issues: MCM Production

- To complete MCM's for 18 Towers, need to order more ASIC's
  - 1 order of 20 wafers is being fabricated
  - Second order has been under discussion
- The numbers: For 11 more towers (Tower 4 – Tower 14)
  - Need: 9504 chips
  - Supply: 11714 after new order (10,919 guaranteed—15 wafers)
  - Needed yield: 80%(20 wafers)/87% (15 wafers)
  - Demonstrated yield to date: 60%
  - In addition, 15% unexplained loss of chips at Teledyne
- Recommendation of Tracker Team: place second order for 20 wafers
  - Order is being placed

Plan Forward: MCM Production

MCM Production	Status	Who	Date
1. Make plan for pitch adaptor cracking	1. Done	CCY/RPJ	1/5/2005
2. Order parts to ensure full flight MCM production	2. Done	CCY/RPJ	1/10/2005
3. Restart full production 25/week with goal of getting to 30/week	3. Done	CCY/RPJ	2/14/2005
4. Sonagram a sample of new production MCM's to evaluate delamination and validate process changes	4. Done; Results inconclusive	CCY/RPJ	
5. Extended qual program for at least 2 MCMs	5. TBD with MCM's off CP	CCY/RPJ	
6. Increase production to 30 starts/week	6. In Process	CCY/RPJ	3/4/2005
7. Evaluate and implement options to increase production to 40 starts/week	7. In Process	CCY/RPJ	3/18/2005
8. Introduce new bonding fixture to improve flow and yield	8. In Process	CCY/RPJ	3/31/2005

Tracker Technical Issues: Inter-ladder Strip Breakage on Heavy Trays

- Description
  - 3 different heavy trays belonging to 2 tower A trays showed signal strips interrupted at half their length
- Root cause is very likely the same effect that broke wirebonds between strips and PA and led us to remove encapsulation of those wirebonds
- Used trays as they are for tower A
  - reduce temperature ranges for thermal cycles and thermal-vacuum tests
  - for Tower 1 heavy and bottom trays, fabricate ladders without encapsulation
- For Tower B only one tray shows evidence of this problem
  - Heavy 37 (X5) shows 61 broken channels
- For Tower 1, no trays show evidence of this problem!

Plan Forward: Inter-ladder Strip Breakage on Heavy Trays

Inter-ladder Strip Breakage on Heavy Trays	Status	Who	Date
1. Mine Perugia and Twr B data, including visual inspection of broken ladders from Perugia trays	1.Done	Pisa	1/12/2005
2. Assemble existing analysis to understand root cause for heavy tray problems and margin for mid-trays	2. Done	Ku	1/12/2005
3. 1/12/05 MRB INFN/PI_318/319	3. Done	Pisa	1/12/2005
4. Proceed to make heavy trays for Tower 1 using ladders without encapsulation	4. Done	Pisa	1/17/2005
5. Use analysis and prototype ladders without encapsulation to retire risk	5. In discussion	Kahn	

Tracker Technical Issues: Flight Cables

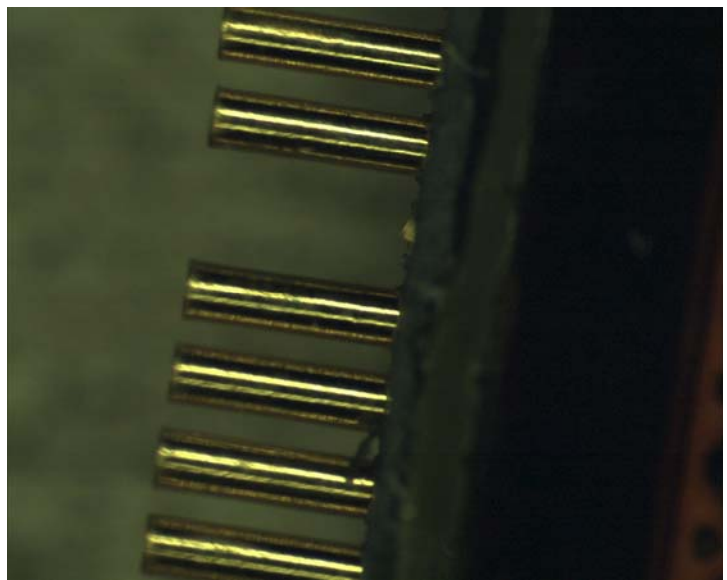
- Technical, workmanship and schedule performance issues have continued to be a problem at Parlex
  - Technical Issues
    - Internal annular ring problems
      - Justification problem with machine
      - Corrective action introduced 2/11
      - Seriousness of the problem depends on where failed coupon is (eg less serious if near TEM side of cable)
    - Foreign material
      - Affecting all multilayer cables produced at the plant
      - Number of recent actions has improved from 63 units/week to 40-50 units/week rejected
  - Workmanship Issues
    - Recent problems
      - Etch defect
      - Crease
      - Cut across two traces
  - Schedule Issues
    - Parlex will work with us to:
      - Optimize production to needs
      - Give more visibility into schedule flow at Parlex
      - Provide accurate tracking at Parlex

Tracker Technical Issues: Flight Cables

- **Tower 2:**
  - **Flight cable set had 2 cables with bad coupons as of 2/28/05**
    - **C4-006 coupon(s) failed for separation of barrel plating and internal layers.**
    - **C6-005 had no plated through holes in the received coupons and could not be evaluated**
    - **Both cables have been fully functionally electrically tested**
  - **The next C4 Parlex shipment is scheduled for 3/11 & next C6 Parlex shipment is scheduled for 3/3.**
    - **Waiting for new cables would incur at least 14-16 days of delay in the assembly of Tower 2**
  - **MRB 2/28/05**
    - **SLAC NCR 00350 opened and maintained until these two Flex Cables have passed Tower level Vibe and Thermal Vacuum Environmental Testing.**
    - **There is only one "failed coupon" Flex Cable on any side of the Tower.**
      - **Therefore, we still have a redundant (good coupon) Flex Cable on these two sides.**

Tracker Technical Issues: Flight Cables

- **Tower 2: Continued**
  - **Late breaking news: pin18 on flight cable C3-008 was found to be broken on the J9 connector**
  - **Hand carry a replacement later this week (bad coupon)**
  - **MRB 3/2/2005..add to NCR 350**
- **Tower 3:**
  - **3 cables with bad coupons, none paired on the same side**



Assy S/N	C0	C1	C2	C3	C4	C5	C6	C7		Need Date in Pisa
Tower A	16	3	4	4	8	7	11	3		Done
Tower B	11	4	14	5	9	5	10	10		Done
Tower 1	18	5	7	7	7	8	13	1		Done
Tower 2	19	7	9	1	6	9	5	6		Done
Tower 3	22	13	6	2/28/05	1	12	6	11		2/22/05
Tower 4	19 rtv	12	8	8	3/11/2005	13	2	12		3/10/05
Tower 5	21 rtv	C1-01	3/14/05	3/21/05	3/11/05	10	3/23/05	13		3/31/05
Tower 6	3/22/05	4/11/05	3/17/05	3/21/05	3/11/05	4/1/05	3/23/05	4/1/05		4/14/05
Tower 7	3/22/05	4/11/05	3/17/05	3/25/05	3/17/05	4/1/05	3/23/05	4/1/05		4/26/05
Tower 8	3/22/05	4/11/05	3/29/05	3/25/05	3/18/05	4/1/05	3/29/05	4/5/05		5/5/05
Tower 9	4/8/05	4/26/05	3/29/05	3/25/05	3/18/05	4/4/05	3/29/05	4/5/05		5/16/05
Tower 10	4/8/05	4/26/05	4/11/05	4/4/05	3/23/05	4/4/05	3/29/05	4/5/05		5/25/05

Path Forward: Flight Cables

Flight Cables	Status	Who	Date
1. MRB to disposition cables for Tower A and B	1. Done	DN/PSD	1/4/2005
2. Complete test program for cables with bad coupons for Twr 1	2.Done	HT	1/7/2005
3. Fully restart Parlex	3. Done	DN/DK	1/7/2005
4. For Twr 1 and beyond use new cables/good coupons as much as possible depending on production schedule	4. Done	SK/DR	1/18/2005
5. Evaluate options for second sources that have been developed and develop a plan to mitigate downstream risk with Parlex	5. In process; needs LAT IPO approval	SK/HS	3/10/2005
6. Order parts to ensure full flight cable production	6. Done	DN/DR	1/31/2005

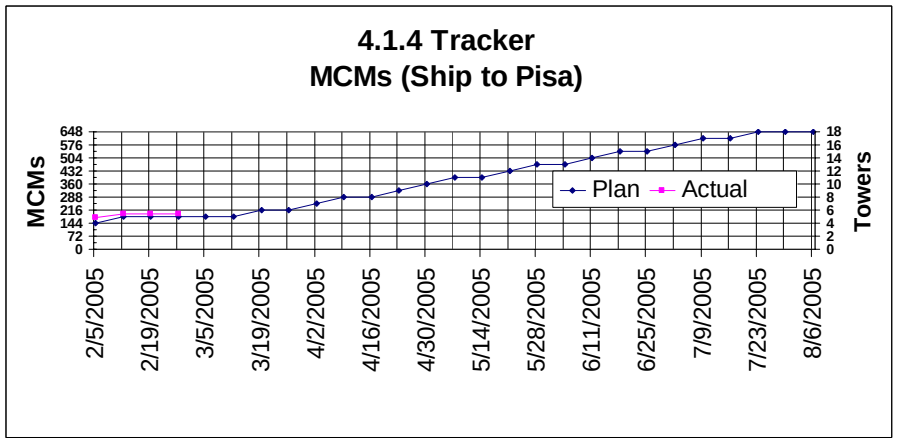
Tracker Costs

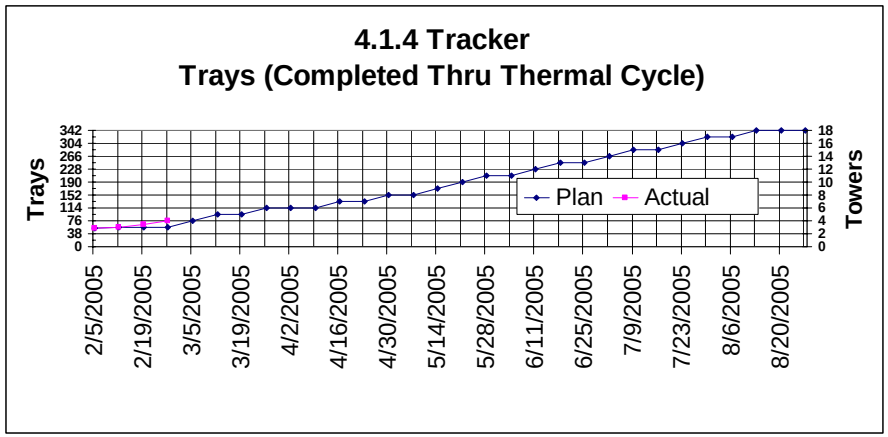
- **On plan with rebaseline proposal except….**
  - **Two expenditures not covered by rebaseline proposal:**
    - **2nd ASIC order ($44K)**
    - **Second source cables (costs being evaluated)**

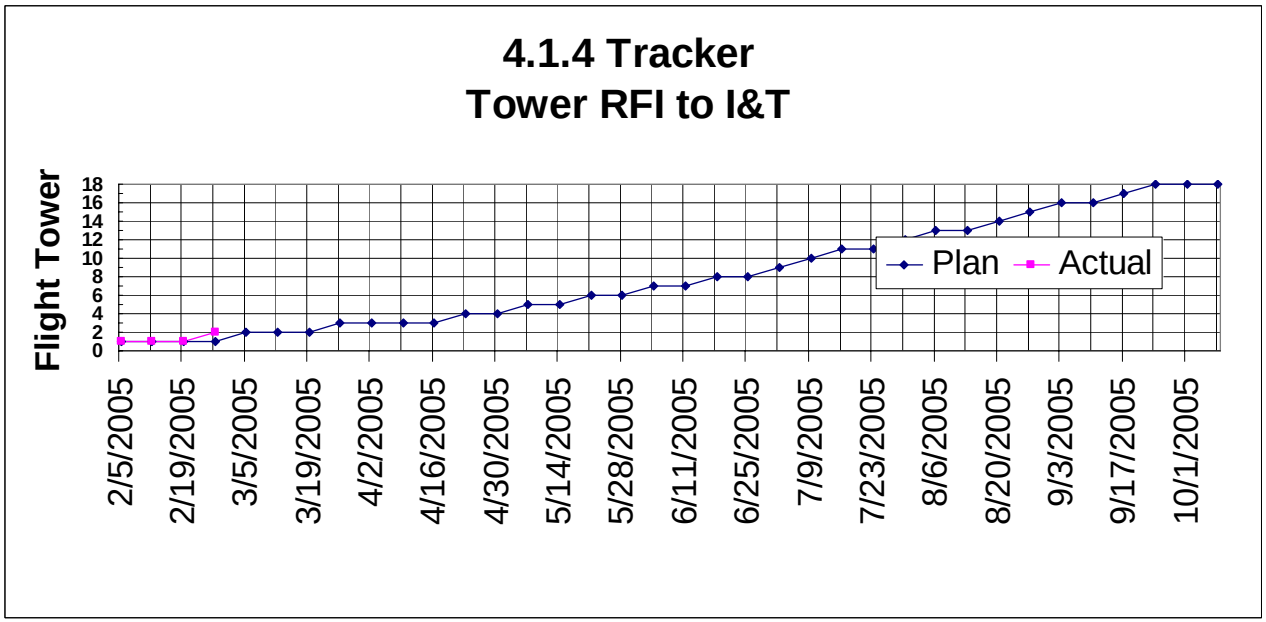
Tracker Fabrication Schedule

- Tracker has held schedule since my last report
  - Tower 14 RFI September 2 assuming no August shutdown in Italy
- MCM Production is on the critical path
  - Affects production at Tower 4
  - MCM's to complete Tower 4 one week behind Jan 31 schedule
    - Fighting to keep delay from propagating to Tower 5, 6, …
    - Focused on 'plugged' pipeline at Teledyne
- Cables are not far behind
  - A concern at Tower 5
- Face Sheet prepreg order to make Trays at Plyform next threat
  - On schedule for drop ship to Italy March 7
- New ASIC order needed for MCM's to complete Tower 12, 13, 14
  - One order (20 wafers) is placed
    - Delivery schedule confirmed
  - Second order (20 wafers) in process

Tracking Tracker Production







Schedule Mitigation Options under Consideration

- Skip tower level environmental testing on last 4 flight towers
  - Will certainly want to do for some towers or we will loose time due to Italian August shutdown
- Skip tray level thermal cycling for last 4-6 towers
- Skip EMI/EMC acceptance testing
- Entire assembly process currently under study to see if there are opportunities to pull in schedule once MCM's and cables are off the critical path
  - Will need to plan in advance to capture the savings
    - identify potential bottlenecks so they can be mitigated

Conclusions

- Tower production going well!!
- Technical issues seem to be behind us
- Working intensively to deal with multiple schedule threats due to manufacturing issues
  - Primarily due to MCM's and cables
- Planning to make last two towers non flight
- Reviewing options to pull in schedule

Back-Up Slides

PMCS Cost and Schedule Variance

- **January: Cumulative Schedule Variance -1,046K**
  - **Didn't change in January but took the hit months ago for MCM and Flex cable delays**
    - **-604K SV for MCM's**
    - **-426K SV for Cables**
- **January: Cumulative Cost Variance -1,706K**
  - **~½ due to overrun of SLAC labor; ~½ due to materials**
  - **Decreased -433K in January**
    - **-93 for labor**
    - **-371 for materials**
      - **corresponds to January orders for materials to support full flight build**
        - » **Carbon-Carbon closeouts**
        - » **Tungsten Converters**
        - » **Prepreg for Face Sheets**
        - » **Flex cable parts**
        - » **MCM parts**