



Status of Mechanical Design and Procurement

USCMS FPIX FNAL PMG

Joe Howell

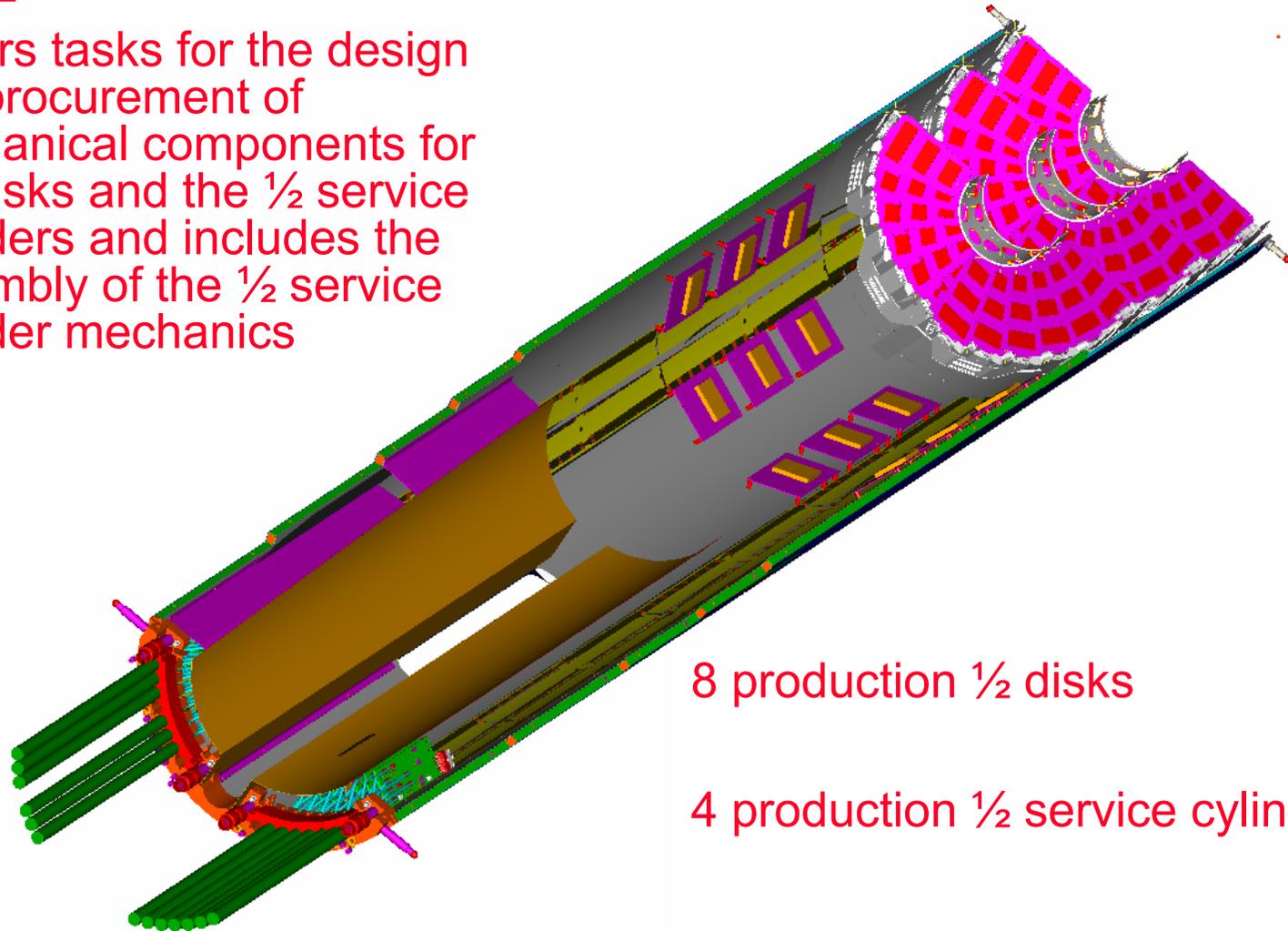
Sept. 29, 2006



Overview of the Detector Mechanics

5.23.2

Covers tasks for the design and procurement of mechanical components for the disks and the $\frac{1}{2}$ service cylinders and includes the assembly of the $\frac{1}{2}$ service cylinder mechanics



8 production $\frac{1}{2}$ disks

4 production $\frac{1}{2}$ service cylinders



Disk mechanics components

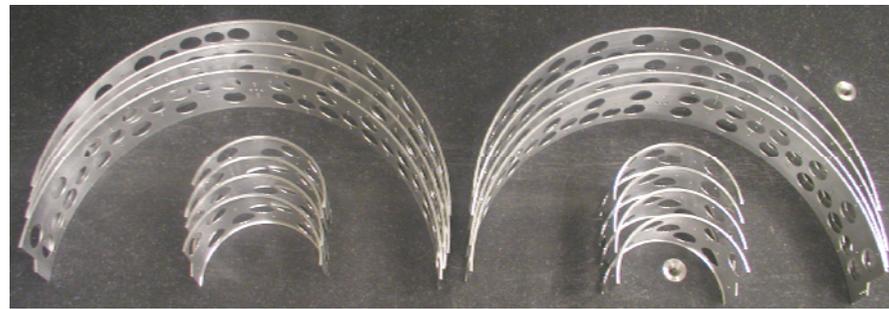


8 half-disks require

- 96 cooling channels
- 8 outer rings
- 8 inner rings
- 80 sleeves
- 32 nipples
- 24 disk mounts
- 80 fiducial balls
- Titanium and PEEK fasteners



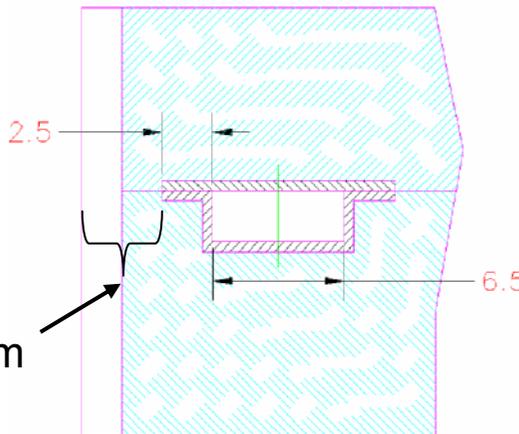
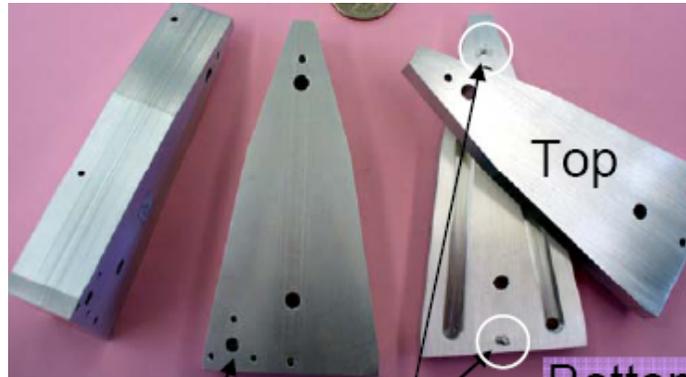
Fiducial balls



Production inner and outer rings (uncoated)



Cooling channel details



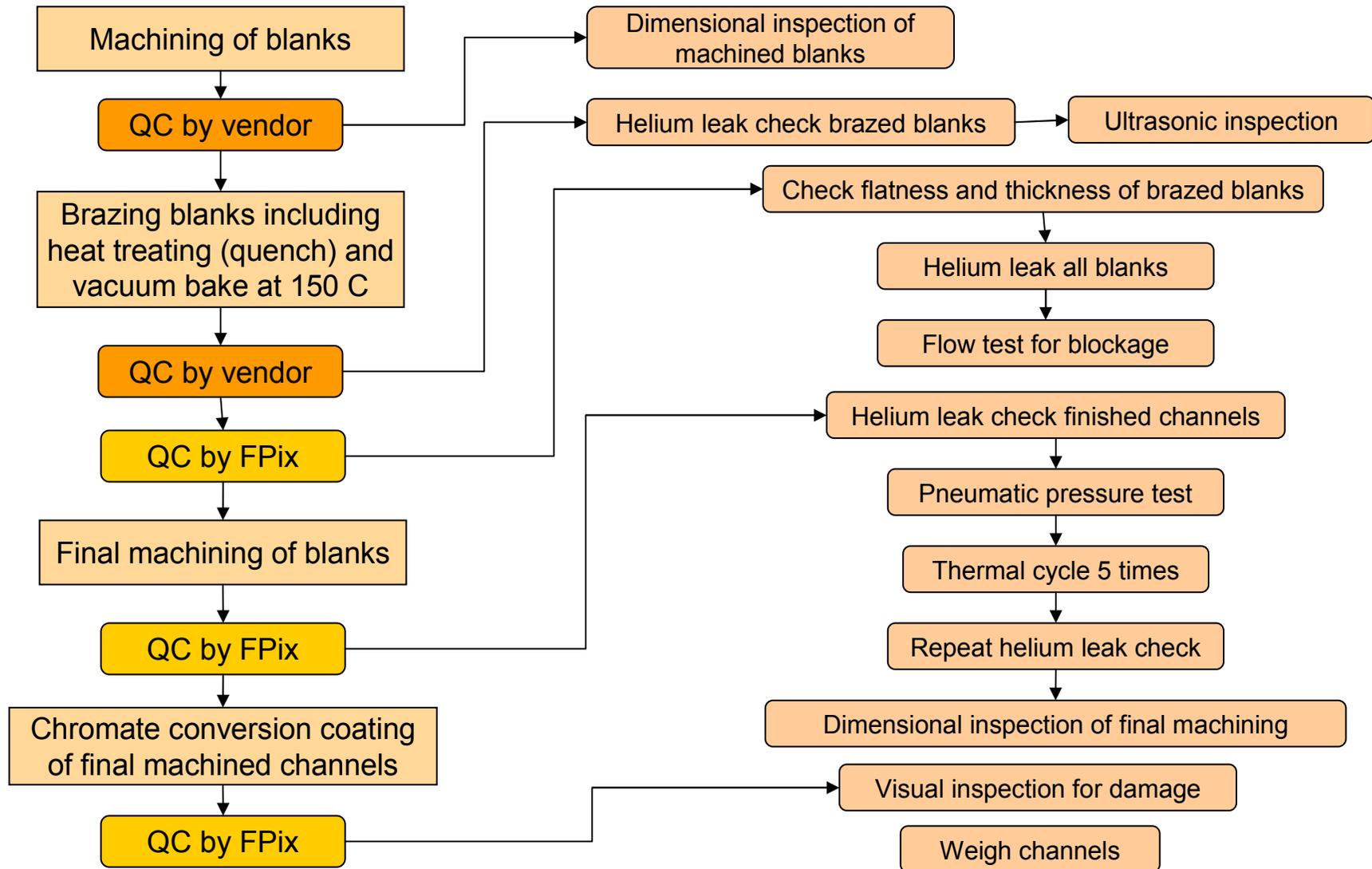
Steps in producing cooling channels

- Machine U-channel and nozzle holes in thick blocks
- Vacuum furnace braze blocks together
- Machine away >90% of the blocks leaving a 0.5 mm wall thickness
- The first two tasks are part of a contract with the vendor that performed the brazing for 18 prototypes
- **The leak tight integrity of the cooling channel is the greatest risk**
- The quality of the braze joint is not fully known until the final machining is complete

96 cooling channels for 8 half-disks
6 different styles

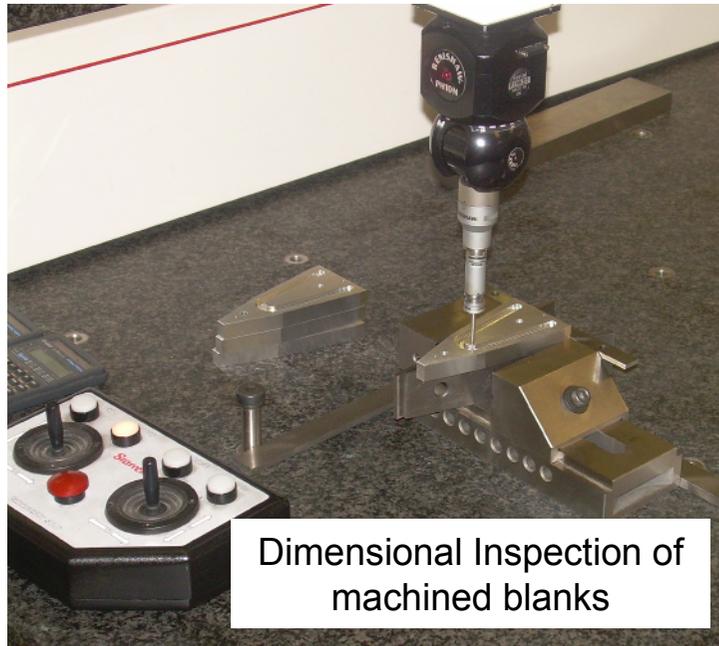


Cooling channel production flow

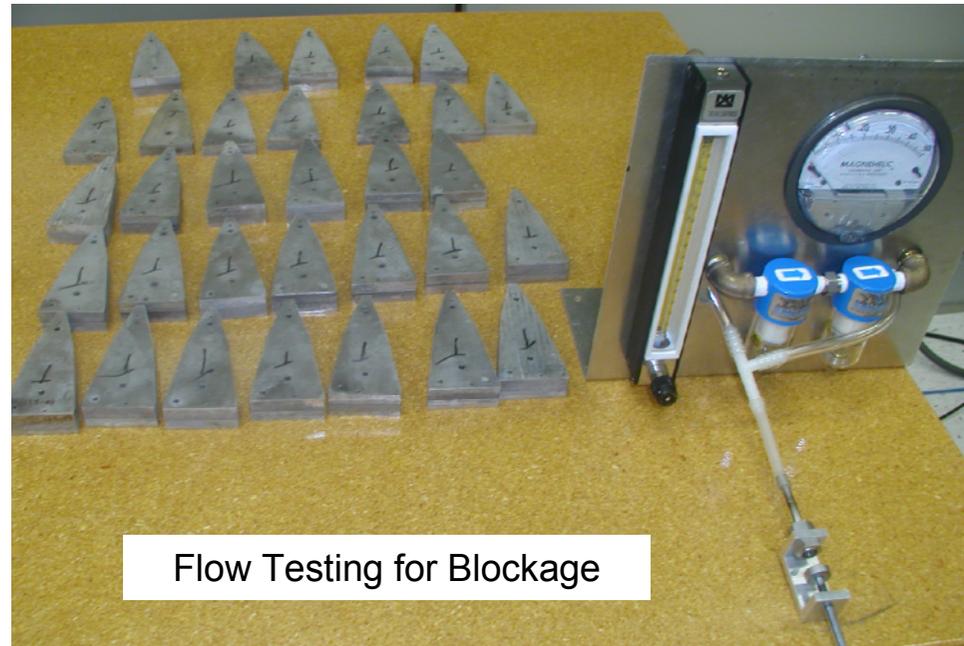




Cooling channel quality assurance



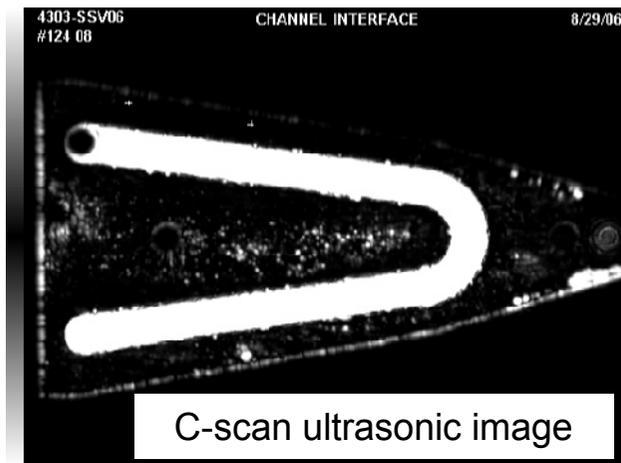
Dimensional Inspection of machined blanks



Flow Testing for Blockage



Helium leak checking brazed blanks



C-scan ultrasonic image



Cooling channel final machining

- FNAL (Technical Division) shops performed final machining for 18 prototypes. For production 3 styles are identical and 3 are a mirror image.
- TD has committed the same machinist and the same machines used for the prototypes for the production run. Cooperation has been excellent.
- The machining of the initial delivery of 46 brazed blanks started ~ two weeks ago. Will complete within one month.
- The perimeter of all 46 have been machined and 6 with marginal ultrasound images were helium leak checked again. All 6 were leak tight.
- 2 parts were found to be out of tolerance with regard to thickness. Missed by vendor QC and now added to our in-house checks
- One corner tore at braze joint during a milling operation. Additional operation added to reduce tool load.
- **Continue to monitor yields closely.** Insufficient statistics at this point to indicate a problem beyond what original spares can accommodate.





Cooling Channel Count

Part type		Channels required for 8 disks	Brazed blanks ordered	Brazed blanks received	Additional blanks expected Oct 6	Channels in final machining process
121	Part types required for +Z disks	32	40	24	6	-
122		8	12	11	1	-
123		8	12	10	2	5
124	Part types required for -Z disks	32	40	28	8	26
125		8	12	5	4	5
126		8	12	8	4	7

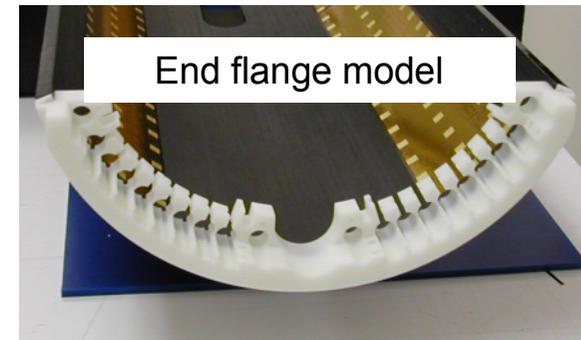
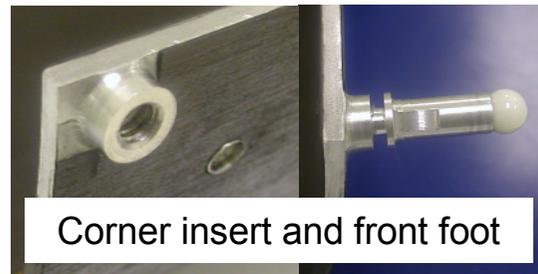
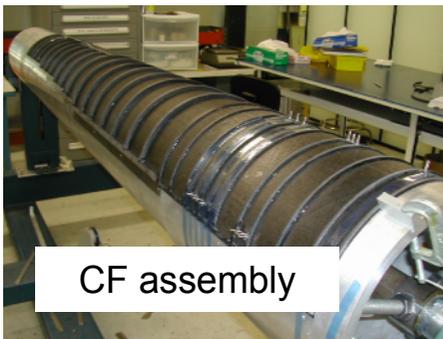
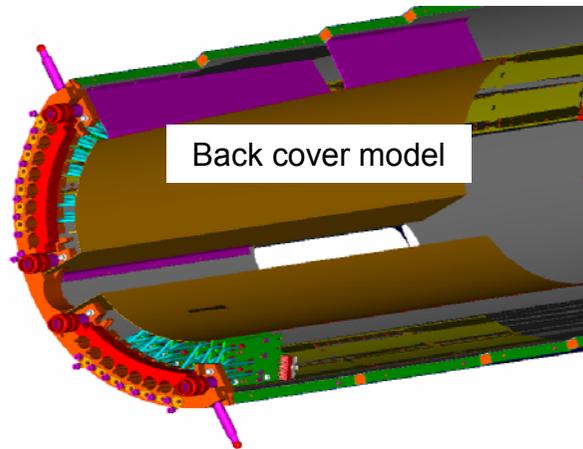
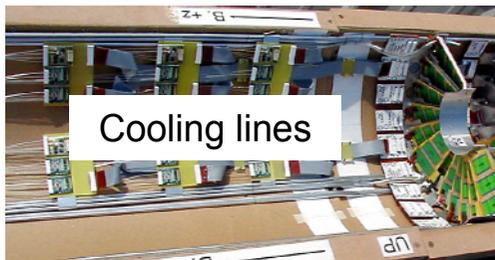
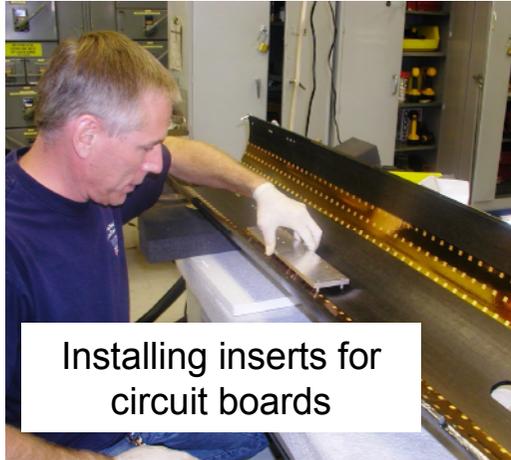


Production Disk parts status

Cooling channels	2/3 of brazed blanks received, 1/3 in final machining process
Inner/Outer rings	Machining complete, need coating
Titanium Screws	Complete
PEEK Screws	Complete
Fiducial balls	Ruby balls complete, mounting posts being machined
Sleeves	Machining complete, need coating
Nipples	Nipples (32 parts) pending design update
Disk Mounts	(24 parts) pending prototyping of kinematic design options



Service 1/2 cylinder components





Service 1/2 cylinder status

Carbon fiber skins	complete
Carbon fiber ribs	95% complete
CF assembly	2 of 5 complete, 1 each 6 weeks
End flange	Machined parts due Oct 2, need coating
Corner inserts*	Parts due Oct 9
Disk mount bushings*	Complete
Support feet	Ceramic balls complete, machined posts due Oct 9
Fiducial balls	Ruby balls due Oct 30, posts pending design
Electronics mounts	Inserts machined, Insert tooling being tested for 07 detector construction
Cooling manifold	Design in process, some elements being fabricated for 07 detector
Back cover	Prototype being fabricated for 07 detector
Fasteners	80% in process and due by Oct 30

*** - required for CF assembly**



Remaining work

- Update nipple design for hose clamp removal clearance and tighter fit on tubing (delayed due to attention on 07 detector)
- Prototype and test kinematic disk mount designs (delayed due to attention on 07 detector)
- Complete design of production cooling manifolds and procure parts
- Fabricate and evaluate back cover prototype and electronics mounts. Update design if required
- Receive and inspect numerous production parts to be received over the next 30 days.
- Procure coating services for several metal parts
- Understand and implement target features for the installed detector survey
- Continue service $\frac{1}{2}$ cylinder assembly
- Continue production oversight and QA of cooling channels
- **Monitor cooling channel yields and if necessary obtain more channels for the final disks**



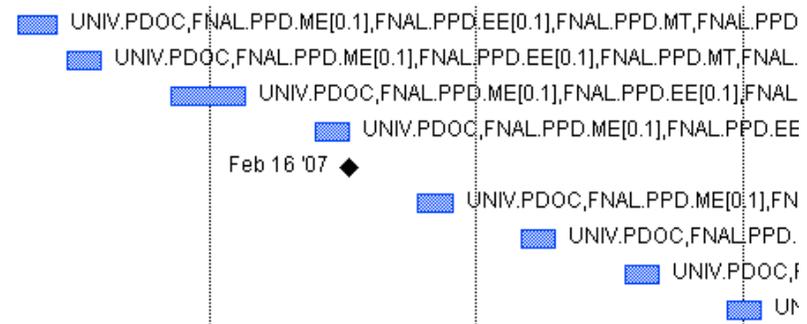
Schedule for remaining work

MSPrj Cost	4th Quarter			1st Quarter			2nd Quarter			3rd Quarter		
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Ju

Components for first 2 disk assemblies ready by October 30th

All mechanical components for remaining disks ready by the end of CY2006

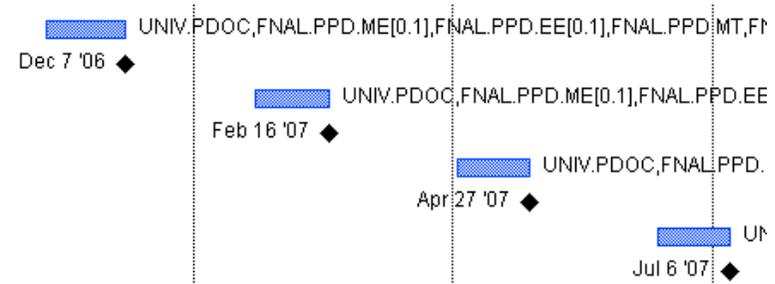
H_D Final Assembly #1	\$8,399.76
H_D Final Assembly #2	\$8,399.76
H_D Final Assembly #3	\$8,399.76
H_D Final Assembly #4	\$8,399.76
4 Half Disks Completed	\$0.00
H_D Final Assembly #5	\$8,399.76
H_D Final Assembly #6	\$8,399.76
H_D Final Assembly #7	\$8,399.76
H_D Final Assembly #8	\$8,399.76



Components for first production 1/2 service cylinder ready by Dec. 1 (critical item: cooling manifold)

Mechanical components for remaining service 1/2 cylinders follow at 6 week intervals

1/2 Service Cylinder #1	\$16,799.52
1/2 Service Cylinder 1 Ready	\$0.00
1/2 Service Cylinder #2	\$9,567.52
1/2 Service Cylinder 2 Ready	\$0.00
1/2 Service Cylinder #3	\$9,567.52
1/2 Service Cylinder 3 Ready	\$0.00
1/2 Service Cylinder #4	\$9,567.52
1/2 Service Cylinder 4 Ready	\$0.00





Risks

- **Cooling channel yield lower than spares can accommodate**
 - **< 80% yield on higher quantity styles (8 failures)**
 - **< 67% yield on lower quantity styles (4 failures)**
- **Only one carbon fiber assembly expert in the laboratory.**



Cost of Remaining Work

WBS#	Item	Base Cost (FY00 K\$)	Remaining Cost (FY00 K\$)
5.23.2.4.3	Service Half-Cylinder Production	75	68
5.23.2.5.3.7	Fabricate production cooling channels	101	102 (66% committed)
5.23.2.5.3.8	Test production cooling channels	14	12
5.23.2.5.4	Nipples	26	6
5.23.2.6.2	Lines Internal to Service Cylinders	30	24
		total	212



Summary

- Procurement of many components are complete or will complete in the next 30 days
- Some design work remains on 4 items
- $\frac{1}{2}$ service cylinder components are on track to meet schedule requirements for $\frac{1}{2}$ service cylinder assembly
- Cooling channel production started about 3 weeks later than projected at the June PMG and first disks will be about 3 weeks later than projected at that time
- Balance of cooling channels should meet schedule requirements for disk assemblies as long as yield is acceptable
- Cooling channel yield needs to be monitored carefully so that schedule of the final disks is not affected