U.S. Deliverables
Cost and Schedule Summary

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U.S. ATLAS Review

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Outline

- US institutions and management
- Definition of goals and baseline scope
- Summary of proposed U.S. deliverables by WBS
- Summary costs
- Principal management contingency decision dates
- Critical path
- Schedule contingencies

US Institutions and Management

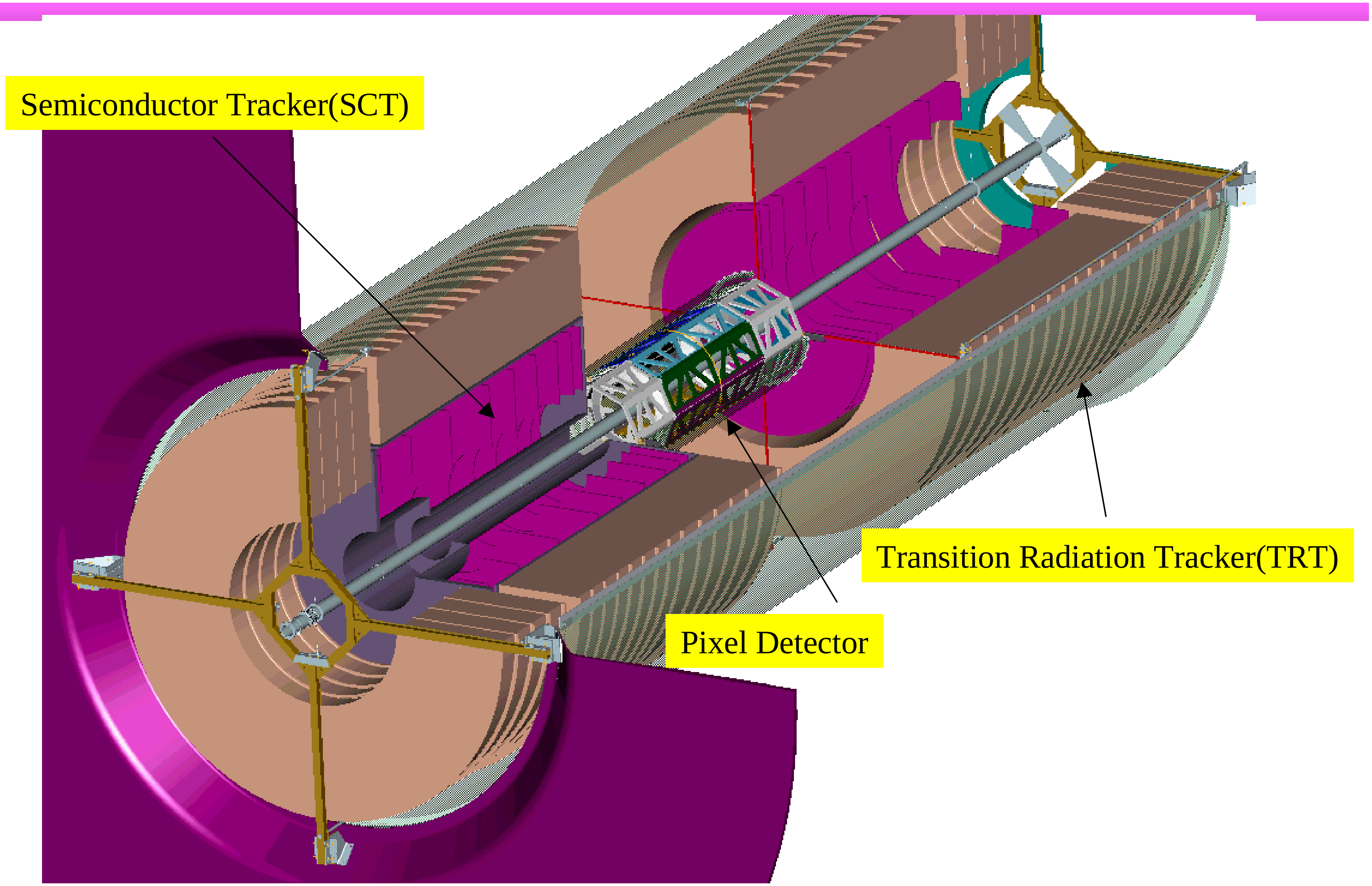
	ALB	LBL	UNM	UOK	OSU
1.1.1 Pixels(Gilchriese)					
1.1.1.1 Mechanics(Gilchriese, Anderssen)		x			
1.1.1.2 Sensors(Seidel, Hoeferkamp)	x		x	x	
1.1.1.3 Electronics(Einsweiler, TBD)		x			x
1.1.1.4 Hybrids(Skubic, Boyd, Gan)	x	x		x	x
1.1.1.5 Modules(Garcia-Sciveres, Goozen)		x	x	x	x
1.1.1.6 Test Support(Gilchriese)		x			

(Physicist, Engineer)

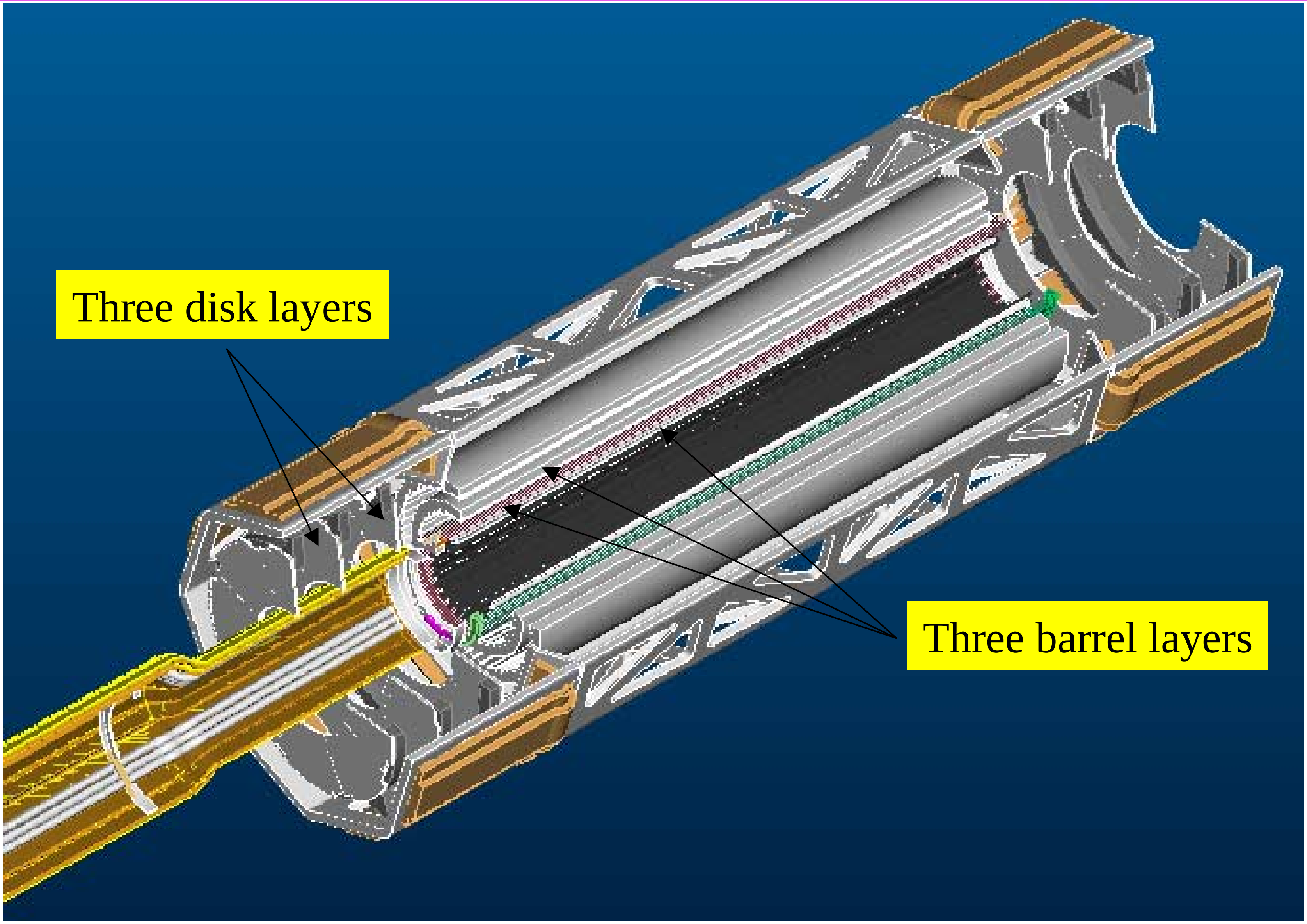
SUNY Albany, LBL, New Mexico, Oklahoma, Ohio State

In addition, off-detector electronics(ReadOut Drivers for both pixels and SCT) are separate project(Wisconsin, Iowa State and LBL) and will not be presented at this review.

Pixel Detector Inserted from Outside Inner Detector



ATLAS Pixel Baseline



Goals vs Baseline Scope

- The current ATLAS baseline is a 3-hit pixel system with three barrel layers and 2x3 disk layers.
- The recent decision to make it possible to insert/remove the full pixel detector from outside the Inner Detector volume requires a considerable structure to support the pixel system and to provide a thermal enclosure for the Semiconductor Tracker (SCT).
- The US <u>goals</u> are identical to the ATLAS baseline - a 3-hit system - <u>and</u> to provide the support structure/thermal enclosure.
- The US <u>baseline scope</u>, however, corresponds to a 2-hit pixel system and to about six months of design effort for the support structure/thermal enclosure.
- US ATLAS management decisions will be required(dates given later) to move items from the <u>management contingency</u> pool into the baseline scope to reach some or all of the goals.

Pixel Layout - US Goals

3-hit system

Barrel						Active	Tilt
	Radius(mm)	Staves	Modules	Chips	Channels	Area(m^2)	Angle(^{o})
B-layer	50.5	22	286	4576	1.76E+07	0.28	-19
Layer 1	88.5	38	494	7904	3.04E+07	0.48	-17.5
Layer 2	122.5	54	702	11232	4.31E+07	0.68	-17.5
Subtotal		114	1482	23712	9.11E+07	1.43	
Disks							
	Inner	Outer				Active	
Z(m)	Radius(mm)	Radius(mm)	Modules	Chips	Channels	Area(m^2)	Sectors
495	99.2	160	54	864	2.49E+06	0.05	9
580	88.1	148.9	48	768	2.21E+06	0.04	8
650	88.1	148.9	48	768	2.21E+06	0.04	8
Subtotal(Both Sides)			300	4800	1.38E+07	0.28	50
GRAND TOTALS			1782	28512	1.0E+08	1.71	

Layout - US Baseline Scope

2-hit system

Barrel						Active	Tilt
	Radius(mm)	Staves	Modules	Chips	Channels	Area(m^2)	Angle(^{o})
B-layer	50.5	22	286	4576	1.76E+07	0.28	-19
Layer 2	122.5	54	702	11232	4.31E+07	0.68	-17.5
Subtotal		76	988	15808	6.07E+07	0.96	
Disks							
	Inner	Outer				Active	
Z(m)	Radius(mm)	Radius(mm)	Modules	Chips	Channels	Area(m^2)	Sectors
495	99.2	160	54	864	2.49E+06	0.05	9
650	88.1	148.9	48	768	2.21E+06	0.04	8
Subtotal(Both Sides)			204	3264	9.40E+06	0.19	34
GRAND TOTALS			1192	19072	7.0E+07	1.15	

Goals vs Baseline Scope - Performance

- The tracking performance of a 3-hit pixel system and a 2-hit pixel system was compared almost three years ago(ATLAS Internal Note INDET-NO-188).
- The b-tagging performance(jet rejection) of ATLAS, for fixed efficiency, was found to be degraded by about 30% going from a 3-hit to 2-hit pixel system.
- This study was done with a more robust disk system(2x5 disks to have best coverage in higher density track region)
- Since then, the material in the tracking system has increased, and the number of disk decreased. New simulation studies will be done with the most recent layout over the next six months. It is likely that the degradation of performance going from 3 to 2 hits will increase, particularly in the forward region.
- Nevertheless it's the US position that the initial performance of ATLAS will be adequate with two pixel hits, given our cost and schedule constraints.
- Fully-insertable system allows upgrade albeit removal and re-installation requires some months.

Deliverables

- Will go through proposed deliverables for each WBS item.
- In some cases, terminology will only be clear after subsequent talks - appreciate your patience.
- Differences between goals and baseline scope are highlighted in red.
- Schedules are in US fiscal years.
- Costs are in FY00 dollars.

1.1.1.1 Mechanics

Goals	Baseline Scope
6 disk structures(sectors, rings, mounts)	6 disk structures(sectors, rings, mounts)
Global support frame	Global support frame
Mounts to SCT	Mounts to SCT
Support/SCT thermal enclosure/rails	6 months design effort
Patch panel 0(PP0) - 360	Patch panel 0(PP0) - 241
Type II cables for 1782 modules	Type II cables for 1192 modules
Services support structure	Services support structure
Level of effort for outer and B-layer installation tooling and equipment	Level of effort for outer and B-layer installation tooling and equipment
Test equipment	Test equipment
Assembly/test/installation of disk system	Assembly/test/installation of disk system

1.1.1.2 Sensors

Goals	Baseline Scope
Preproduction order is launched	Preproduction order is launched
Testing of preproduction	Testing of preproduction
Fund fab of 251 production wafers	Fund fab of 168 production wafers
Testing of 314 wafers	Testing of 210 wafers

1.1.1.3 Electronics

Goals	Baseline Scope
Contribution to FE-D3 prototype	Contribution to FE-D3 prototype
Contribution to 1st and 2nd 0.25 μ prototypes	Contribution to 1st and 2nd 0.25 μ prototypes
Contribution to optical IC prototypes	Contribution to optical IC prototypes
Fund fab of 74 0.25 μ (8”)wafers	Fund fab of 49 0.25 μ (8”) wafers
Probing of 168 8” wafers.	Probing of 112 8” wafers.
Fund fab of 110 DMILL 6” wafers	
Probing of 250 DMILL 6” wafers.	
20 test systems	20 test systems
One-half of minimum DMILL 8 wafer run for optical ICs	One-half of minimum DMILL 8 wafer run for optical ICs
Probing of one-half of optical IC wafers	Probing of one-half of optical IC wafers

1.1.1.4 Flex/Optical Hybrids

Goals	Baseline Scope
1782 flex hybrids in detector	1192 flex hybrids in detector
Components and loading of same	Components and loading of same
Die attach/wire bond of MCC to yield 891 in detector	Die attach/wire bond of MCC to yield 596 in detector
300 disk pigtails in detector	204 disk pigtails in detector
Assembly of disk pigtails to flex.	Assembly of disk pigtails to flex.
50 optical hybrids in detector	34 optical hybrids in detector

1.1.1.5 Modules

Goals	Baseline Scope
Thinning of 335 8” wafers	Thinning of 224 8” wafers
Dicing of 335 8” wafers	Dicing of 224 wafers
Die sort for 335 8” wafers	Die sort for 224 wafers
Thinning of 500 6” wafers	
Dicing of 500 6” wafers	
Die sort of 500 6” wafers	
Probing of bare modules to yield 446 in detector	Probing of bare modules to yield 298 in detector
Assembly/test to yield 446 in detector	Assembly/test to yield 298 in detector
Attachment/test of all disk modules to sectors	Attachment/test of all disk modules to sectors
Test equipment for modules	Test equipment for modules

1.1.1.6 Beam/System Tests

Goals

Level of effort test beam support

Level of effort system test support at CERN

Baseline Scope

Level of effort test beam support

Level of effort system test support at CERN

Base Costs(FY00$K) - Level 5

WBS Profile Estimates

Funding Source: All **Funding Type:** Project 10/25/00 12:31:31 PM

Institutions: All

WBS Number	Description	FY 96 (k$)	FY 97 (k$)	FY 98 (k$)	FY 99 (k$)	FY 00 (k$)	FY 01 (k$)	FY 02 (k$)	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	Total (k$)
1.1.1	Pixels	0	0	0	0	0	2108	1945	2094	500	106	6753
1.1.1.1	Mechanics and Final Assembly	0	0	0	0	0	911	620	708	250	96	2586
1.1.1.1.1	Design	0	0	0	0	0	599	226	144	128	34	1131
1.1.1.1.2	Development and Prototypes	0	0	0	0	0	113	84	0	0	0	197
1.1.1.1.3	Production	0	0	0	0	0	199	310	565	122	62	1258
1.1.1.2	Sensors	0	0	0	0	0	97	167	39	0	0	303
1.1.1.2.1	Design/Engineering	0	0	0	0	0	35	35	0	0	0	70
1.1.1.2.3	Production	0	0	0	0	0	62	132	39	0	0	233
1.1.1.3	Electronics	0	0	0	0	0	756	579	470	26	0	1830
1.1.1.3.1	Design/Engineering	0	0	0	0	0	381	400	161	0	0	942
1.1.1.3.2	Development and Prototypes	0	0	0	0	0	374	137	0	0	0	512
1.1.1.3.3	Production	0	0	0	0	0	0	42	308	26	0	376
1.1.1.4	Flex Hybrids/Optical Hybrids	0	0	0	0	0	110	258	422	0	0	790
1.1.1.4.1	Design/Engineering	0	0	0	0	0	18	50	9	0	0	77
1.1.1.4.2	Development and Prototypes	0	0	0	0	0	92	62	0	0	0	154
1.1.1.4.3	Production	0	0	0	0	0	0	146	413	0	0	559
1.1.1.5	Module Assembly/Test	0	0	0	0	0	194	282	420	206	0	1102
1.1.1.5.1	Design/Engineering	0	0	0	0	0	82	96	14	0	0	191
1.1.1.5.2	Development and Prototypes	0	0	0	0	0	112	122	46	0	0	280
1.1.1.5.3	Production	0	0	0	0	0	0	65	360	206	0	631
1.1.1.6	Beam/System Test Support	0	0	0	0	0	40	40	35	18	10	143
1.1.1.6.1	Test Beam Support	0	0	0	0	0	20	20	15	8	0	63
1.1.1.6.2	System test support	0	0	0	0	0	20	20	20	10	10	80

Management Contingency(FY00$K) - Level 5

WBS Profile Estimates

Funding Source: All **Funding Type:** Management 10/25/00 12:35:48 PM

Institutions: All

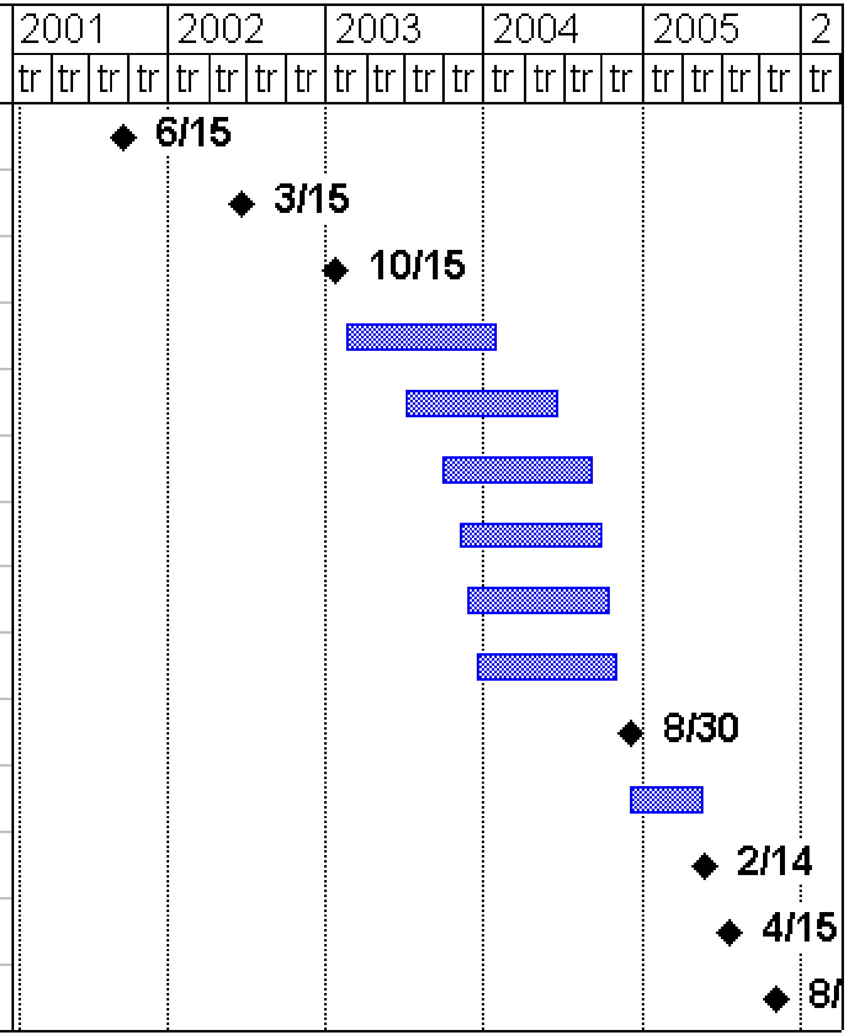
WBS Number	Description	FY 96 (k$)	FY 97 (k$)	FY 98 (k$)	FY 99 (k$)	FY 00 (k$)	FY 01 (k$)	FY 02 (k$)	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	Total (k$)
1.1.1	Pixels	0	0	0	0	0	150	659	987	149	0	1945
1.1.1.1	Mechanics and Final Assembly	0	0	0	0	0	150	197	486	70	0	903
1.1.1.1.1	Design	0	0	0	0	0	114	126	126	70	0	438
1.1.1.1.2	Development and Prototypes	0	0	0	0	0	36	22	0	0	0	58
1.1.1.1.3	Production	0	0	0	0	0	0	48	360	0	0	408
1.1.1.2	Sensors	0	0	0	0	0	0	0	77	0	0	77
1.1.1.2.1	Design/Engineering	0	0	0	0	0	0	0	0	0	0	0
1.1.1.2.3	Production	0	0	0	0	0	0	0	77	0	0	77
1.1.1.3	Electronics	0	0	0	0	0	0	462	82	0	0	544
1.1.1.3.1	Design/Engineering	0	0	0	0	0	0	0	0	0	0	0
1.1.1.3.2	Development and Prototypes	0	0	0	0	0	0	0	0	0	0	0
1.1.1.3.3	Production	0	0	0	0	0	0	462	82	0	0	544
1.1.1.4	Flex Hybrids/Optical Hybrids	0	0	0	0	0	0	0	196	0	0	196
1.1.1.4.1	Design/Engineering	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.2	Development and Prototypes	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.3	Production	0	0	0	0	0	0	0	196	0	0	196
1.1.1.5	Module Assembly/Test	0	0	0	0	0	0	0	145	79	0	224
1.1.1.5.1	Design/Engineering	0	0	0	0	0	0	0	0	0	0	0
1.1.1.5.2	Development and Prototypes	0	0	0	0	0	0	0	0	0	0	0
1.1.1.5.3	Production	0	0	0	0	0	0	0	145	79	0	224
1.1.1.6	Beam/System Test Support	0	0	0	0	0	0	0	0	0	0	0
1.1.1.6.1	Test Beam Support	0	0	0	0	0	0	0	0	0	0	0
1.1.1.6.2	System test support	0	0	0	0	0	0	0	0	0	0	0

Management Contingency - Major Decisions

- Pixel support/SCT thermal enclosure/rails
  - Well matched to US capabilities in composite design and manufacture
  - Have committed to about 6 months (intense) design effort to produce conceptual design and cost/schedule to keep design moving.
  - Management decision required **March 2001** to proceed beyond conceptual design. Very rough cost estimate today is $0.5M + design engineering labor.
- Atmel/DMILL front-end ICs
  - Summary already covered by Rossi and will be discussed in detail by Einsweiler.
  - If next prototype successful, advance overall production schedule at some cost, head towards 3-hit system.
  - Management decision required by **January 2002** to realize schedule advantage.

Critical Path - US Baseline Scope

ID	Task Name
1	1st 0.25 micron prototype submitted
2	2nd 0.25 micron prototype submitted
3	IBM FE PRR
4	Outer FE IBM Production
5	Test outer FE IBM wafers
6	IBM outer bare module production
7	IBM outer module assembly/test
8	Module attach to disk sectors
9	Disk Assembly/Test
10	Disk System at CERN
11	Outer System Assembly/Test at CERN
12	Pixel System Ready for Installation
13	ATLAS need date for pixel system install
14	ATLAS first beam



Schedule Contingencies

- We have some float in the US baseline scope schedule, as you will see in more detail by tomorrow.
- Nevertheless, it is useful to understand possible fall-back positions in case there are problems with the schedule.
- One general approach is to speed up production, assembly and placement of modules - this is under study(but not yet included in our schedule). So far we have assumed about one-half the expected rate for module assembly/attachment/testing steps.
  - Additional bump bonding vendors and/or increase production rate assumptions
  - Additional module assembly/testing sites within global collaboration.
  - Potential savings about 4-5 months
- The other general approach is take advantage of the ability to insert the pixel system with the ID in place
  - The LHC machine schedule is tight and the current estimate is only 1-2 months of two-beam running in 2005 at best.
  - Delaying installation of some or all of the pixel system to be ready for 2006 run would gain about 8 months in the schedule.