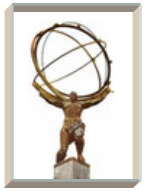
LHC Schedule



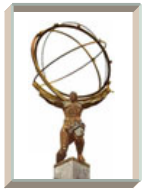
year	*energy*	*luminosity*	*physics beam time*
2007	**450+450 GeV**	**$5x10^{30}$**	**protons - 26 days at 30% overall efficiency ➔ $0.7*10^6$ seconds**
2008	**7+7 TeV**	**$0.5x10^{33}$**	**protons - starting beginning July ➔ $4*10^6$ seconds ions - end of run - 5 days at 50% overall efficiency ➔ $0.2*10^6$ seconds**
2009	**7+7 TeV**	**$1x10^{33}$**	**protons:50% better than 2008 ➔ $6*10^6$ seconds ions: 20 days of beam at 50% efficiency ➔10^6 seconds**
2010	**7+7 TeV**	**$1x10^{34}$**	**TDR targets: protons: ➔ 10^7 seconds ions: ➔ $2*10^6$ seconds**

Funding

U.S. ATLAS Research Program Target Chart (AYk$s)

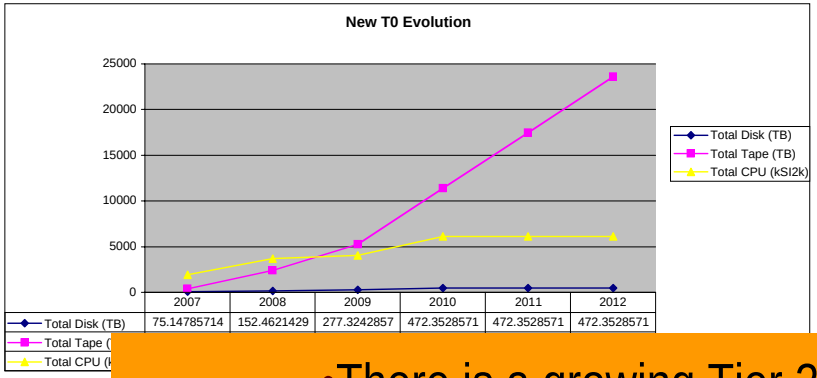
Category	WBS	Description	FY07	FY08	FY09	FY10	FY11
Computing	2.2	Software	5,268	5,199	5,439	5,535	5,790
	2.3	Facilities	9,965	11,928	12,611	14,504	12,587
	2.0	**Total Computing**	**15,233**	**17,127**	**18,050**	**20,039**	**18,377**
M&O	3.1	Silicon	2,095	1,642	1,642	1,642	1,638
	3.2	TRT	547	445	440	465	440
	3.3	Liquid Argon	2,716	2,093	2,161	2,162	2,227
	3.4	Tile	1,531	768	785	804	825
	3.5	Endcap Muon	2,714	1,032	880	895	919
	3.6	Trigger/DAQ	1,814	765	556	571	586
		**Common Funds Cat. B (included in subsystems above)	1,066	1,515	1,609	1,659	1,589
	3.7	Common Funds Cat. A	1,630	1,700	1,877	2,141	2,198
	3.7.2	C&I	1,256	-	-	-	-
	3.8	Outreach	50	53	54	55	57
	3.9	Program Management	600	837	866	895	924
	3.10	Technical Coordination	1,137	463	488	514	540
	3.0	**Total M&O**	**16,090**	**9,799**	**9,749**	**10,145**	**10,354**
Upgrade R&D	4.1	Silicon Upgrade R&D	2,015	2,095	1,878	1,885	1,859
	4.2	Liquid Argon Upgrade R&D	1,053	1,142	1,360	1,353	1,378
	4.5	Muon Upgrade R&D	10	-	-	-	-
	4.0	**Total Upgrades**	**3,078**	**3,237**	**3,238**	**3,238**	**3,237**
Subtotal (Comput.+ M&O + Upgrades)		**Subtotal U.S. ATLAS Research Program**	**34,401**	**30,163**	**31,036**	**33,422**	**31,968**
Management Reserve		Management Reserve (%)	9%	10%	10%	8%	15%
		Management Reserve	**3,589**	**3,437**	**3,464**	**3,078**	**5,532**
Total U.S. ATLAS Research Program		**Total U.S. ATLAS Research Program**	**37,991**	**33,600**	**34,500**	**36,500**	**37,500**

ATLAS Requirements start 2008, 2010

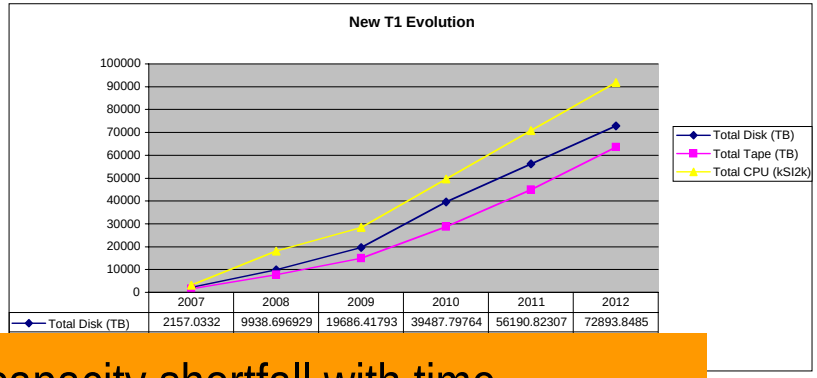


	CPU (MSi2k)		Disk (PB)		Tape (PB)	
	2008	2010	2008	2010	2008	2010
Tier-0	3.7	6.1	0.15	0.5	2.4	11.4
CERN Analysis Facility	2.1	4.6	1.0	2.8	0.4	1.0
Sum of Tier-1s	18.1	50	10	40	7.7	28.7
Sum of Tier-2s	17.5	51.5	7.7	22.1		
Total	41.4	112.2	18.9	65.4	10.5	41.1

Evolution

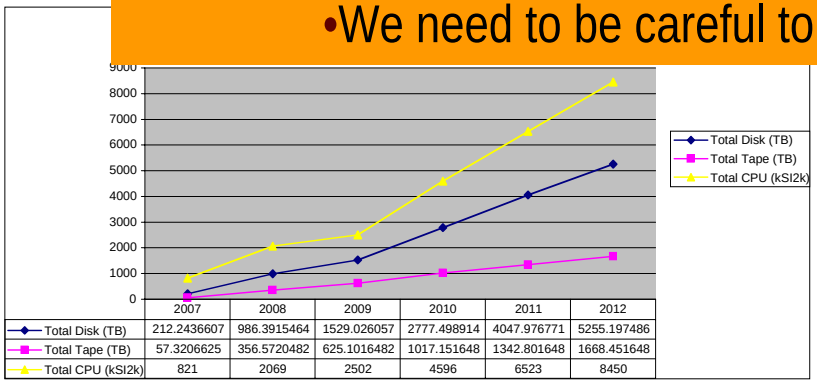


	2007	2008	2009	2010	2011	2012
Total Disk (TB)	75.14785714	152.4621429	277.3242857	472.3528571	472.3528571	472.3528571
Total Tape (						
Total CPU (						

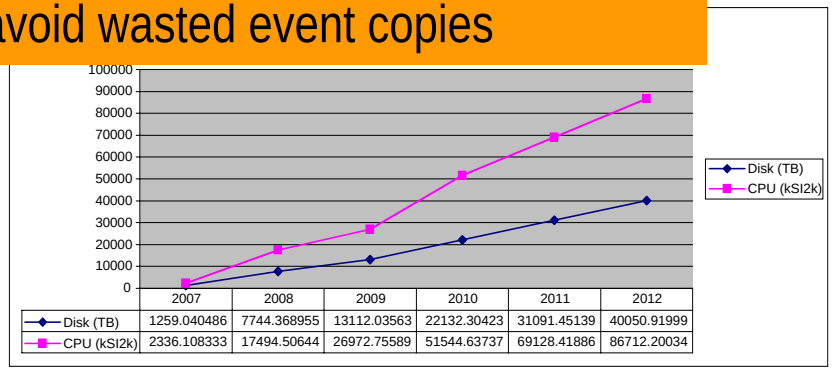


	2007	2008	2009	2010	2011	2012
Total Disk (TB)	2157.0332	9938.696929	19686.41793	39487.79764	56190.82307	72893.8485

- There is a growing Tier 2 capacity shortfall with time
- We need to be careful to avoid wasted event copies

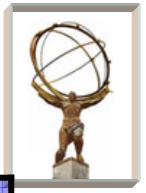


	2007	2008	2009	2010	2011	2012
Total Disk (TB)	212.2436607	986.3915464	1529.026057	2777.498914	4047.976771	5255.197486
Total Tape (TB)	57.3206625	356.5720482	625.1016482	1017.151648	1342.801648	1668.451648
Total CPU (kSI2k)	821	2069	2502	4596	6523	8450



	2007	2008	2009	2010	2011	2012
Disk (TB)	1259.040486	7744.368955	13112.03563	22132.30423	31091.45139	40050.91999
CPU (kSI2k)	2336.108333	17494.50644	26972.75589	51544.63737	69128.41886	86712.20034

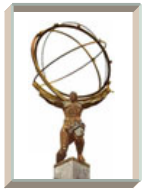
Projected T2 Hardware Growth (dedicated to ATLAS)



Tier 2 Center	2005	2006	2007	2008	2009
Boston/Harvard					
CPU (kSi2k)	210	350	730	1,090	1,600
Disk (TB)	40	170	370	480	630
Southwest					
CPU (kSi2k)	500	900	1,500	1,700	2,100
Disk (TB)	60	200	380	540	700
Midwest					
CPU (kSi2k)	360	510	900	1,100	1,300
Disk (TB)	50	130	260	465	790

- Assumes Moore's law doubling of CPU (3 yrs) and disk capacity (1.5 yrs) at constant cost
- Assumes replacement of hardware every 3 years

Required Capacities in 2008



- Centrally Managed Capacities

Aggregate ATLAS Capacities for 2008
(Revised LHC Schedule, etc.)

Oct '06

	CPU (MSI2K)	Disk (PB)	Tape (PB)
CERN Tier 0	3.7	0.2	2.4
CERN AF	2.1	1.0	0.4
Sum of Tier 1's	18.1	9.9	7.7
Sum of Tier 2's	17.7	7.7	-
TOTAL	41.6	18.8	10.4

- ATLAS Computing Model specifically anticipates additional locally controlled regional or national resources beyond those described above
- The US must have such additional resources
  - … at the scales discussed in the ATLAS Computing Model

    (plan is for additional capacity at 50% of the per physicist capacity of that managed centrally)
  - … in order to … maintain reasonable autonomy in analyses

    … play a leadership role in getting ATLAS physics results out

US ATLAS Capacities

- US ATLAS capacity requirements (ATLAS plus US ATLAS)

US ATLAS Capacity in 2008

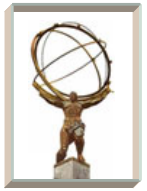
	CPU (MSI2K)	Disk (PB)	Tape (PB)
Tier 1	7.1	4.6	3.3
Sum of Tier 2's	5.9	2.6	0.0

- Capacity profile
  - Tier 1 Disk is dominated by dCache managed Linux farm distributed disk

Total US ATLAS Target Install Capacities

	2006	2007	2008	2009	2010	2011	2012
Tier 1							
CPU (kSI2k)	1,125	2,834	7,140	11,598	18,838	26,875	34,912
Disk (TB)	525	1,556	4,610	8,921	17,262	24,427	31,511
Tape (TB)	300	993	3,284	6,276	11,996	18,781	26,604
Tier 2							
CPU (kSI2k)	-	794	5,948	9,171	17,525	23,504	29,482
Disk (TB)	-	428	2,633	4,458	7,525	10,571	13,617

Tier 1 Facility Cost Estimate



- Revised Tier 1 Facility Cost Profile

Projected Tier 1 Cost Profile (@ Year k$)

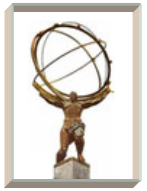
($ Items below include overheads)	2006	2007	2008	2009	2010	2011	2012
On Project Staff Level (FTE's)	***15***	***20***	***20.0***	***20***	***20***	***20***	***20***
Labor (Fully loaded salaries)	1,960	2,892	3,855	4,048	4,250	4,463	4,686
MST (travel, maint, licen, etc)	588	923	1,221	1,409	1,826	1,542	1,529
Facility Space & Power	205	373	524	669	840	840	840
Capital Equipment	1,314	2,228	3,762	3,902	4,989	3,124	2,378
Total	**4,067**	**6,416**	**9,362**	**10,028**	**11,904**	**9,969**	**9,432**

- Power has become a much more significant term

US ATLAS Tier 1 Projected Power Cost

	FY ' 06	FY ' 07	FY ' 08	FY ' 09	FY ' 10	FY ' 11	FY '12
Tier 1 Power (kW-Hr)	2,236,954	4,034,506	6,033,888	7,332,120	8,167,824	8,664,516	8,915,490
Unit Cost ($/kW-Hr)	0.085	0.085	0.085	0.085	0.085	0.085	0.085
Power Cost (k$)	190	343	513	623	694	736	758

Capacity Projections for US Tier 2's

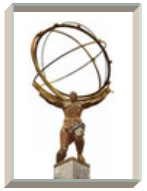


- Totals include capacity committed to international ATLAS and capacity retained under US control for US physicists

	2005	2006	2007	2008	2009	2010
Boston/Harvard						
CPU (kSI2k)	210	350	730	1,090	1,600	2,314
Disk (TB)	40	170	370	480	630	840
Great Lakes						
CPU (kSI2k)	-	509	837	1,250	1,948	2,743
Disk (TB)	-	156	304	471	770	1,055
Midwest						
CPU (kSI2k)	360	510	900	1,100	1,300	1,580
Disk (TB)	50	130	260	465	790	1,245
SLAC						
CPU (kSI2k)	-	111	427	872	1,503	2,505
Disk (TB)	-	64	244	498	858	1,430
Southwest						
CPU (kSI2k)	500	900	1,500	1,700	2,100	2,660
Disk (TB)	60	200	380	540	700	924
TOTAL						
CPU (kSI2k)	1,070	2,380	4,394	6,012	8,451	11,802
Disk (TB)	150	720	1,558	2,454	3,748	5,494
Target Capacities						
CPU (kSI2k)	-	-	794	5,948	9,171	17,525
Disk (TB)	-	-	428	2,633	4,458	7,525

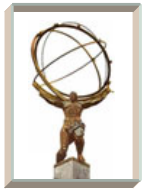
Note: constant funding Moorse Law Extrapolation =>

ATLAS Network Model



- Primarily Hierarchical Data Flow
  - Well defined relationship between Tier 2's and Tier 1
    - US Tier 2's served by US Tier 1
  - Data services by Tier 1 include:
    - Archiving then serving simulation data from Tier 2's
    - Serving to Tier 2 current official collaboration produced derived data
      - ESD, AOD, TAG, … (US will have complete ESD at Tier 1)
    - Individual and Tier 3 data access will be via regional Tier 2's and Tier 1
      - US Tier 2's on average will have 0.5 PBytes of disk in '08 so …
        - **should rarely need to reread data from Tier 1**
        - **should share with Tier 1 the AOD, TAG serving to local Tier 3's**
- Access to Tier 0 and other Tier 2's or Tier 1's not excluded but not encouraged nor designed for
  - Chaotic assess patterns stress networks, servers and storage at sites in unpredictable ways requiring major over provisioning

Network Requirements



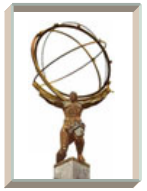
- Based on ATLAS computing model, ATLAS / WLCG estimated requirements
  - Peak in general means factor of twice average

Estimated Network Bandwidth Requirements (MB/sec Peak)

	Tier 0		Tier 1		Tier 2	
	In	Out	In	Out	In	Out
BNL (Tier 1)	420		295	260	190	460
Boston/Harvard			95	40		
Great Lakes			65	15		
Midwest			95	40		
SLAC			100	20		
Southwest			110	80		

- Most Tier 2's have at least 1 Gb already, some 10 Gb, and all expect to have 10 Gb by 2008 so Tier 2 bandwidth for initial year running and beyond seems adequate
- Tier 1 currently has 20 Gb, adequate bandwidth for initial year running, but increases in 2009/2010 time frame will probably be necessary

The Infamous Mega-Table

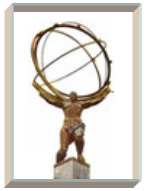


- Recent Megatable meeting before the GDB:
  - http://indico.cern.ch/conferenceDisplay.py?confId=a058492

- For BNL:

TOTALS			T0=>T1	T2=>T1	T1=>T1	T1=>T2	T1<=T1	Storage for T2 TByte			Storage for T1 TByte			
	Total Tape Tbyte	Eff. Disk Tbyte	MByte/s	MByte/s aver.	MByte/s in	MByte/s aver.	MByte/s out	Tape1-Disk0	Tape1-Disk1	Tape0-Disk1	Tape1-Disk0	Tape1-Disk1	Tape0-Disk1	Cache-Disk
ALICE	0.0	0.0		0.0		0.0		0.0	0.0	0.0				
ATLAS	1444.4	3873.2	355.0	92.4	293.1	225.7	258.4	427.5	162.9	320.0	571.2	282.9	1945.4	
CMS	0.0	0.0		0.0		0.0		0.0	0.0	0.0				
LHCb	0.0	0.0		0.0		0.0		0.0	0.0	0.0				
SUM	1444.4	3873.2	355.0	92.4	293.1	225.7	258.4	427.5	162.9	320.0	571.2	282.9	1945.4	0.0
					With 70% Disk Efficiency				232.7	457.2		404.1	2779.2	0.0
					Total Storage Requ. Tape			590			854			
					Total Storage Requ. Disk					690				3183
					Tape and Disk Pledges					Tape	2023		Disk	3093
					Balance						579			-780

Next US ATLAS T2 meeting



- In conjunction with the OSG Consortium meeting
  - In particular, concurrent with the US CMS T2 meeting
- At UCSD 5-8, March, 2007
  - https://indico.fnal.gov/conferenceDisplay.py?confId=468
  - The US ATLAS T2 part will be Wed morning and Thursday all day (7-8 March)