RHIC Computing
Long Term Projections

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4 June 2004

RHIC Computing Plan

➢ RHIC Computing Facility (RCF) at BNL
- o Online recording of Raw data
- o Production reconstruction of all Raw data
- o Primary facility for data selection (mining) and analysis
- o Long term archiving and serving of all data
- o … but not sized for Monte Carlo generation
- o $2M/year equipment refresh funding (~25% annual replacement)
  - Addressing obsolescence
  - Results in important collateral capacity growth

RHIC Computing Plan (2)

- ➢ Remote Facilities
  - o Primary source of Monte Carlo data
  - o Significant analysis activity
  - o Such sites are now operational, main ones being:
    - STAR
      - – NERSC/PDSF, LBNL
      - – Wayne State University
    - PHENIX
      - – RIKEN, Wako campus, Japan
      - – Center for High Performance Computing, University of New Mexico
      - – IN2P3, Lyon, France
      - – VAMPIRE cluster, Vanderbilt University

- ➢ Grid Computing
  - o Promising new direction in remote (distributed) computing
  - o STAR and, to a lesser extent, PHENIX are now active in Grid computing

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Experiment Input to RCF

➢Weekly Operations Meeting

  o Review recent performance and problems

  o Plan for near term operations

➢Experiments / RCF Annual Series of Meetings to Develop Capital Spending Plan

  o Estimate scale of need for coming run

  • Whether there is need for extra capital equipment funding

  o Details of distribution of equipment procured

Major RCF Subsystems Today

- ➢ **Mass Storage System**
  - o Hierarchical Storage Management by *HPSS*
  - o 4 StorageTek robotic tape silos ~4.5 PBytes
  - o 40 StorageTek 9940b tape drives ~1.2 GB/sec
- ➢ **CPU**
  - o Intel/Linux dual racked processor systems
  - o ~ 2300 CPU's for ~1350 kSPECint2000
  - o Condor & LSF based resource management
- ➢ **Central Disk**
  - o 160 TBytes of RAID 5 storage
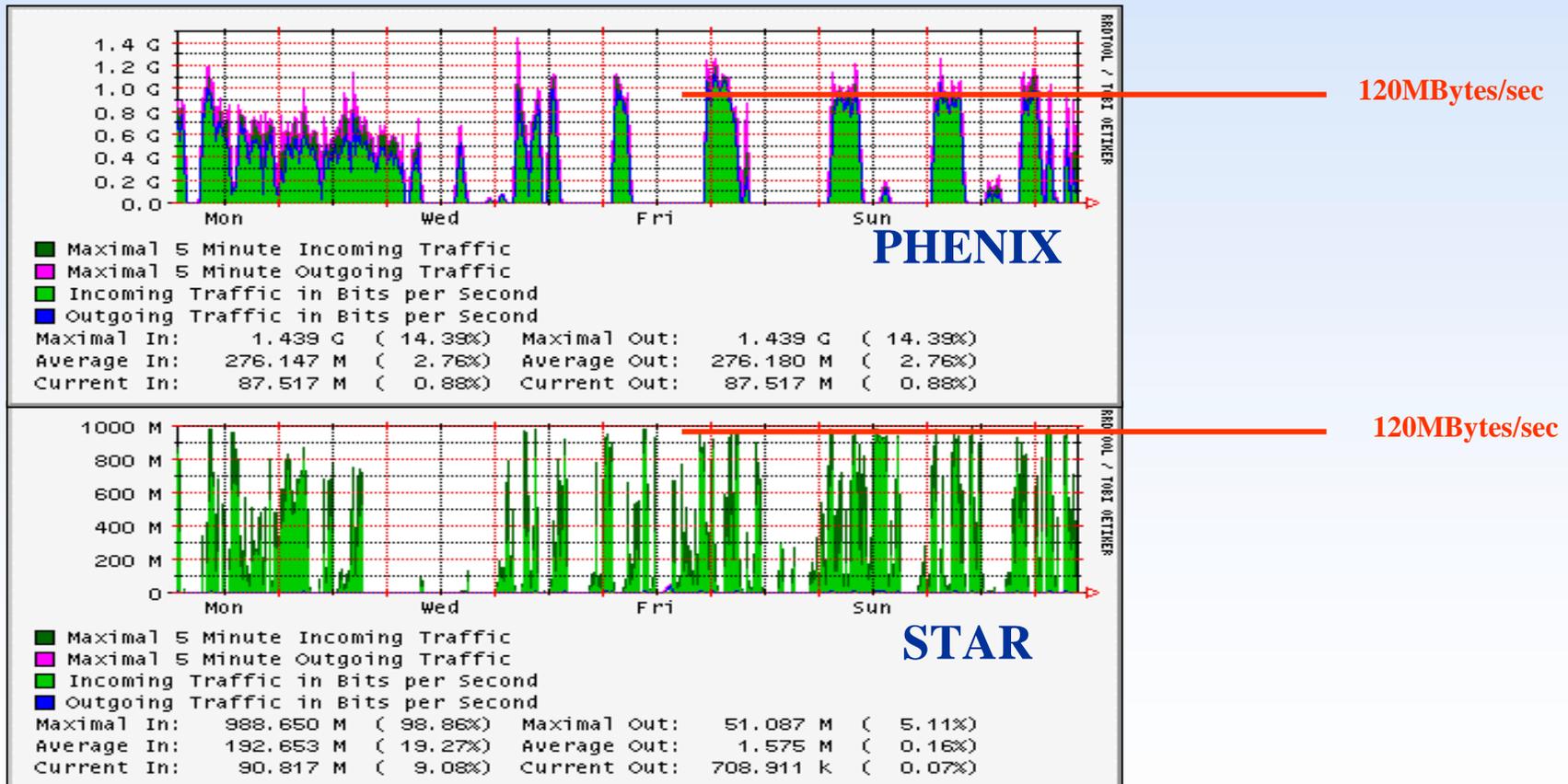 - o 32 Sun/Solaris SMP NFS servers ~1.3 GByte/sec
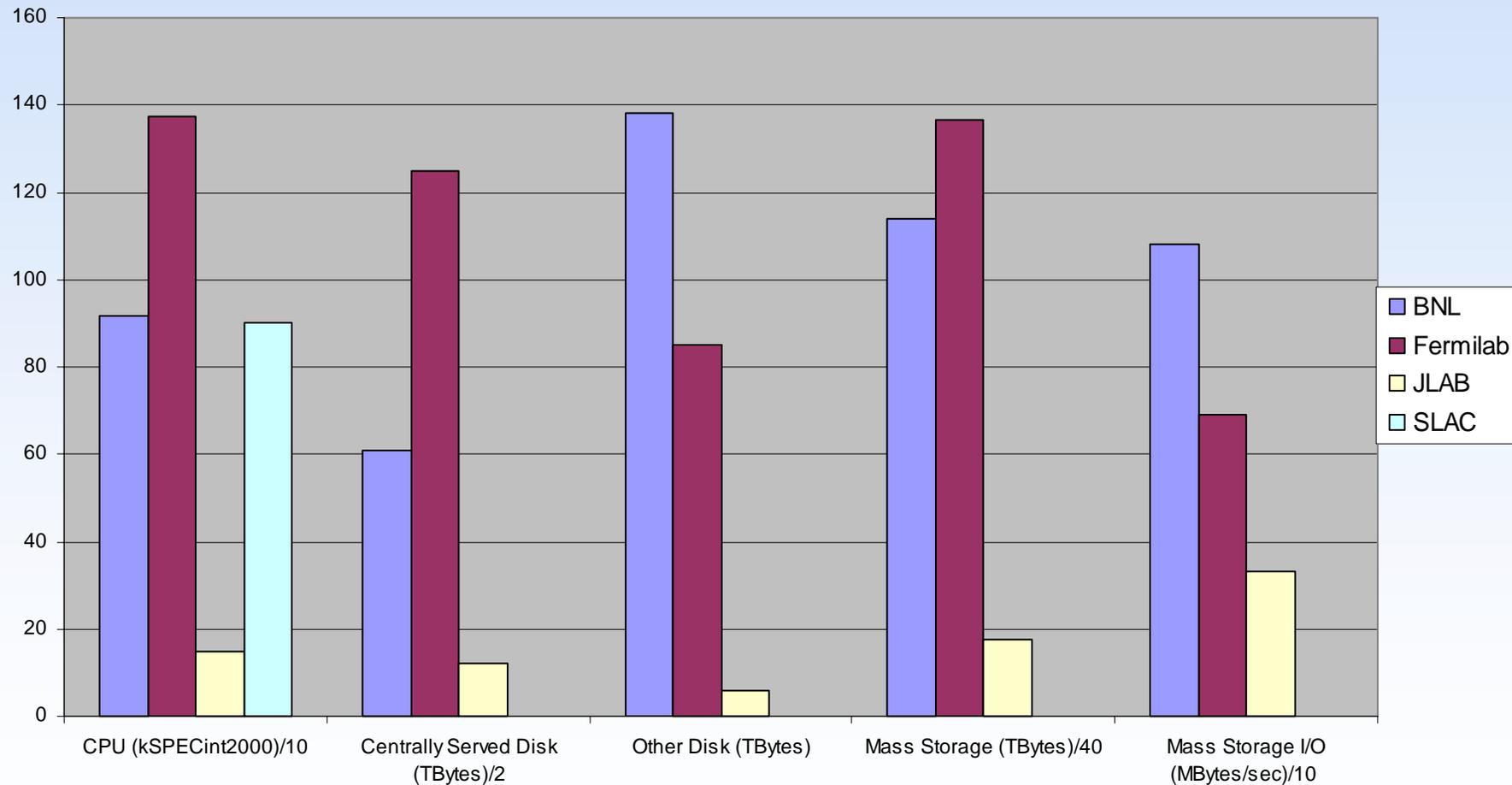
Mass
Storage

CPU

Central
Disk

7

Run 4 Raw Data Recording

➢ Aggregate Raw Data 475 TBytes
➢ Recording Rates to 250 MBytes/sec

120MBytes/sec

120MBytes/sec

Computing Capacity Comparisons
(2003)

Computing Needs
Long Term Projection

➢ Basis of Projection

- o Needs of STAR and PHENIX plus fraction for "other"
- o Raw data volume anticipated by experiment by year
- o A richness factor by experiment for each year

➢ Recent Series of Meetings (May '04)

- o Produced document **"RHIC Computing Facility" (5/19/04)**
- o Conclusion consistent with **"Twenty-Year Planning Study for RHIC Heavy Ion Collider Facility" (BNL -71881-2003)**

Projected Needs

Summary of Projected Requirements

	FY '04	FY '05	FY '06	FY '07	FY '08	FY '09	FY '10
CPU (kSPECint2000)	1,958	3,212	4,413	4,336	5,352	6,366	12,237
Disk (TBytes)	333	677	1,053	903	1,201	1,158	2,018
Disk (GBytes/sec)	3.3	6.8	10.5	9.0	12.0	11.6	20.2
Tape (PBytes)	2.2	4.5	7.8	9.7	13.1	16.1	23.2
Tape (MBytes/sec)	560	854	1,247	813	1,301	1,152	2,602

Projected Disk Requirement

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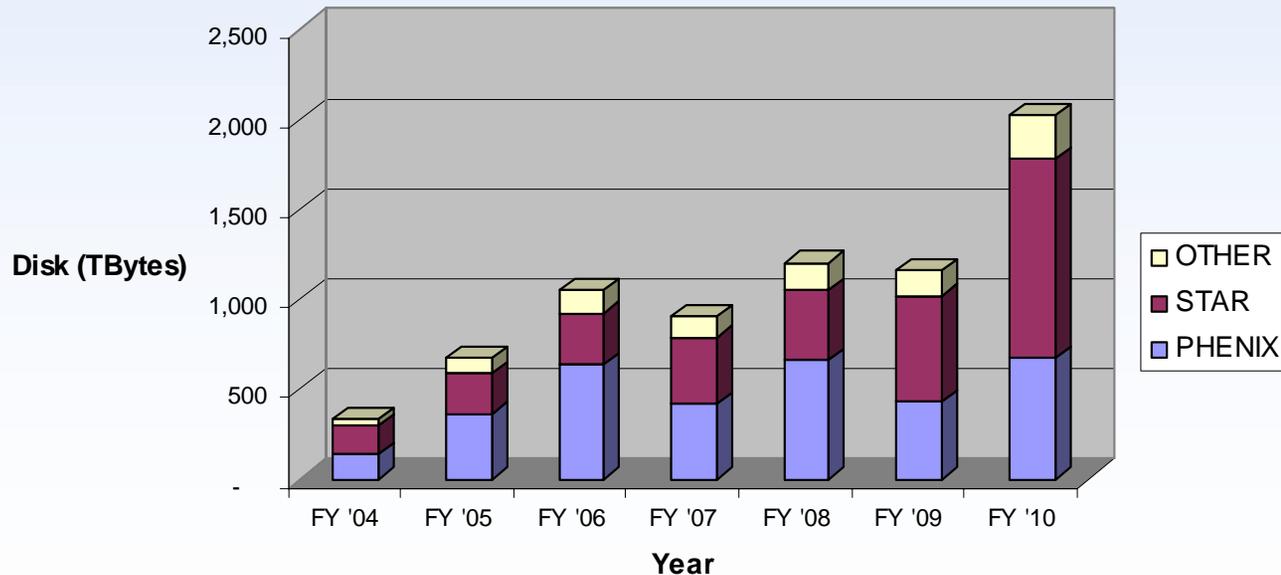

Cost & Capacity Projections

➢ Basis of Costing

- o Recent procurement
- o Historic trends (Moore's Law and similar technology based trends)
- o Assumed migration from reliance on Centralized SAN RAID 5 disk to use of Intel/Linux processor farm distributed disk

➢ Baseline Funding Level of $2M/yr to Replace ~1/4 of the Equipment Each Year

- o Adequate long term but …
- o Short fall near term (region of greater certainty) … **Now !**

Comparison of CPU Delivered to Projected Need
(Basline Funding)
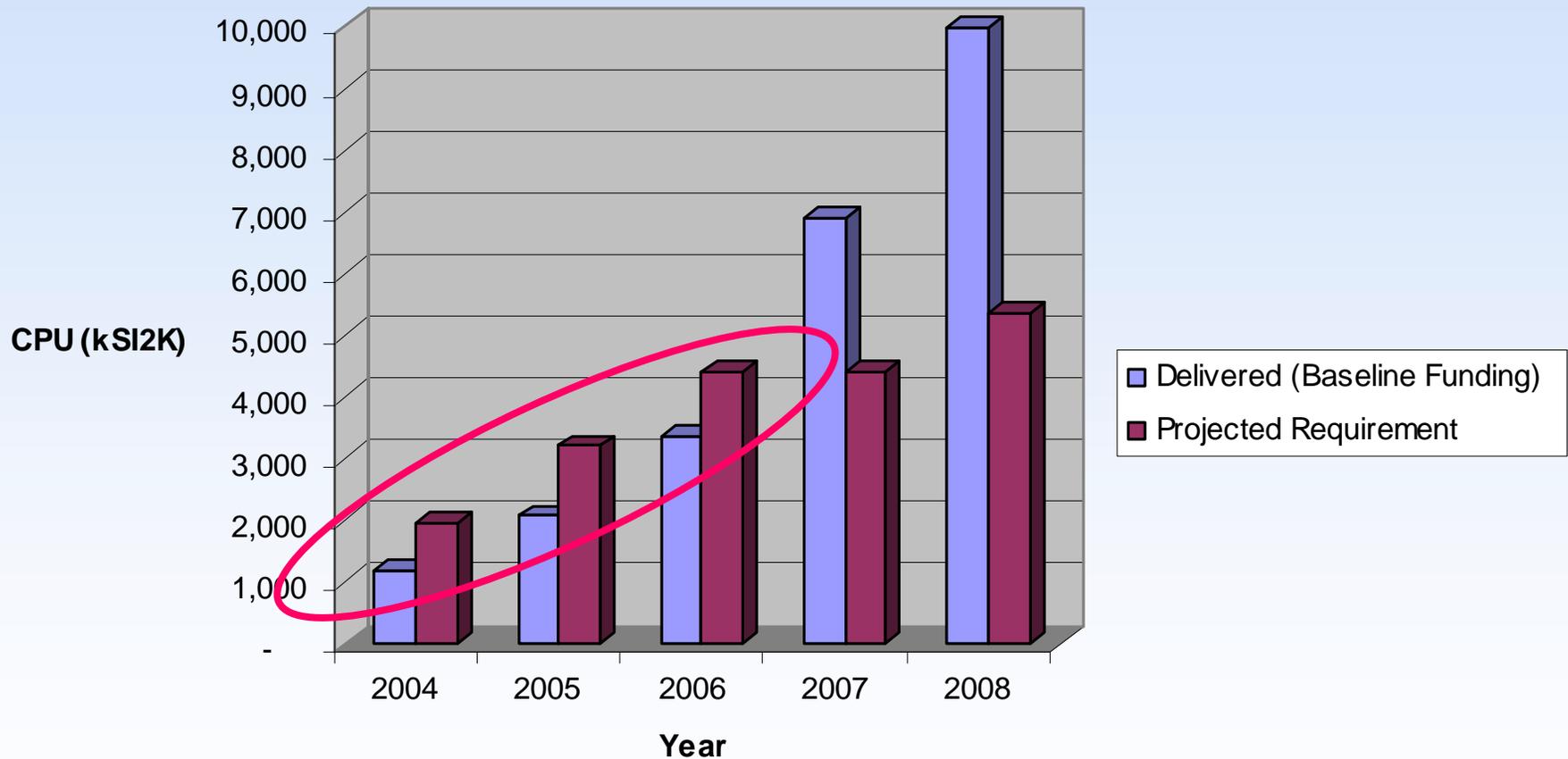
Adaptive Modeling

➢ Excel Based Model Augments $2M where necessary to match requirement

➢ Only required augmentation is in '05

Details of Adequate Funding Profile   (at Yr $k)

	2004	2005	2006	2007	2008	2009	2010
CPU		1904	897	1616	1328	1589	1198
Disk		1026	499	180	226	203	319
Disk Servers		100	50	25	25	25	25
Tape Robotics		120	0	0	0	0	0
Tape Drives		0	420	0	230	0	235
HPSS Servers		0	21	0	3	0	16
LAN		128	62	17	26	21	45
Other Infrastructure		0	0	0	0	0	0
Overhead		288	171	162	162	162	162
Total	**2000**	**3566**	**2120**	**2000**	**2000**	**2000**	**2000**

Discussion of Model

- A funding Supplement of $1.6M in 2005 is require to meet needs in 2005 & 2006
- Uncertainties exist and grow with time in both the estimate of requirements and associated cost
- Cost uncertainty is modeled by varying the rate of price/ performance improvement
  - o Recent concerns in trade journals about heat of current processor technology => evolution retarded in absence of new technology
  - o Price/Performance improvement half-time increased by 50%   20 months => 30 months, used as a relatively arbitrary limit on effect

Comparison of CPU Delivered to Projected Need
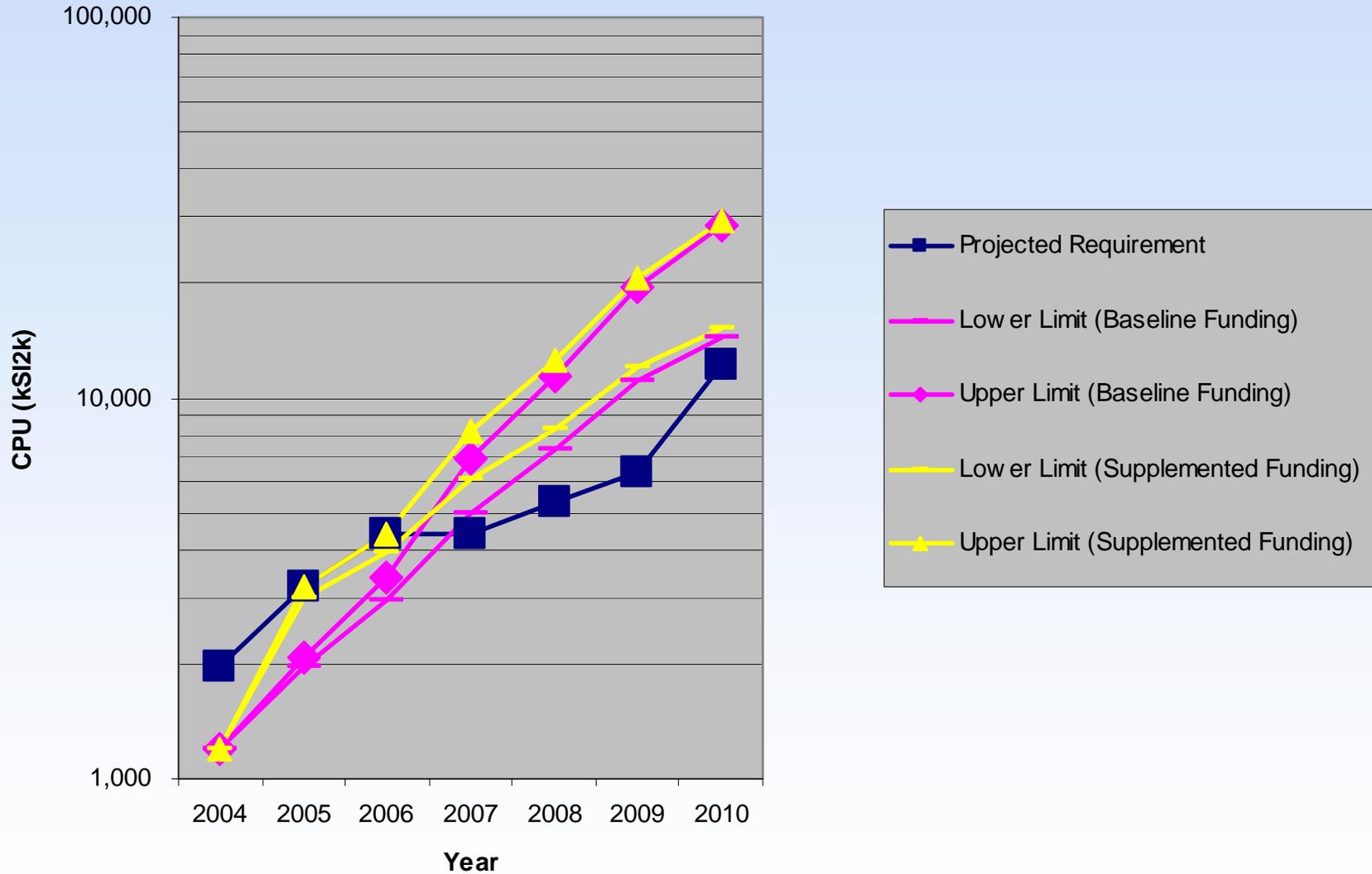
RHIC Computing Conclusions

➢ While uncertainties grow in both ***Requirements*** and in the ***Costs*** to satisfy them with longer term projections

➢ The analysis here indicates that the current RCF, funded to replace equipment with a four year cycle ($2M/yr)
   - While experiencing a near term shortfall (2004 – 2006)
   - Should adequately meet RHIC Computing Requirements in the longer term (2007 – 2010)

➢ A $1.6M equipment funding supplement in 2005 is required to remedy the near term shortfall

➢ By inference remote facilities supporting RHIC, if properly refreshed, should similarly meet long term requirements while experiencing possible near term short falls