

KLOE Computing Update

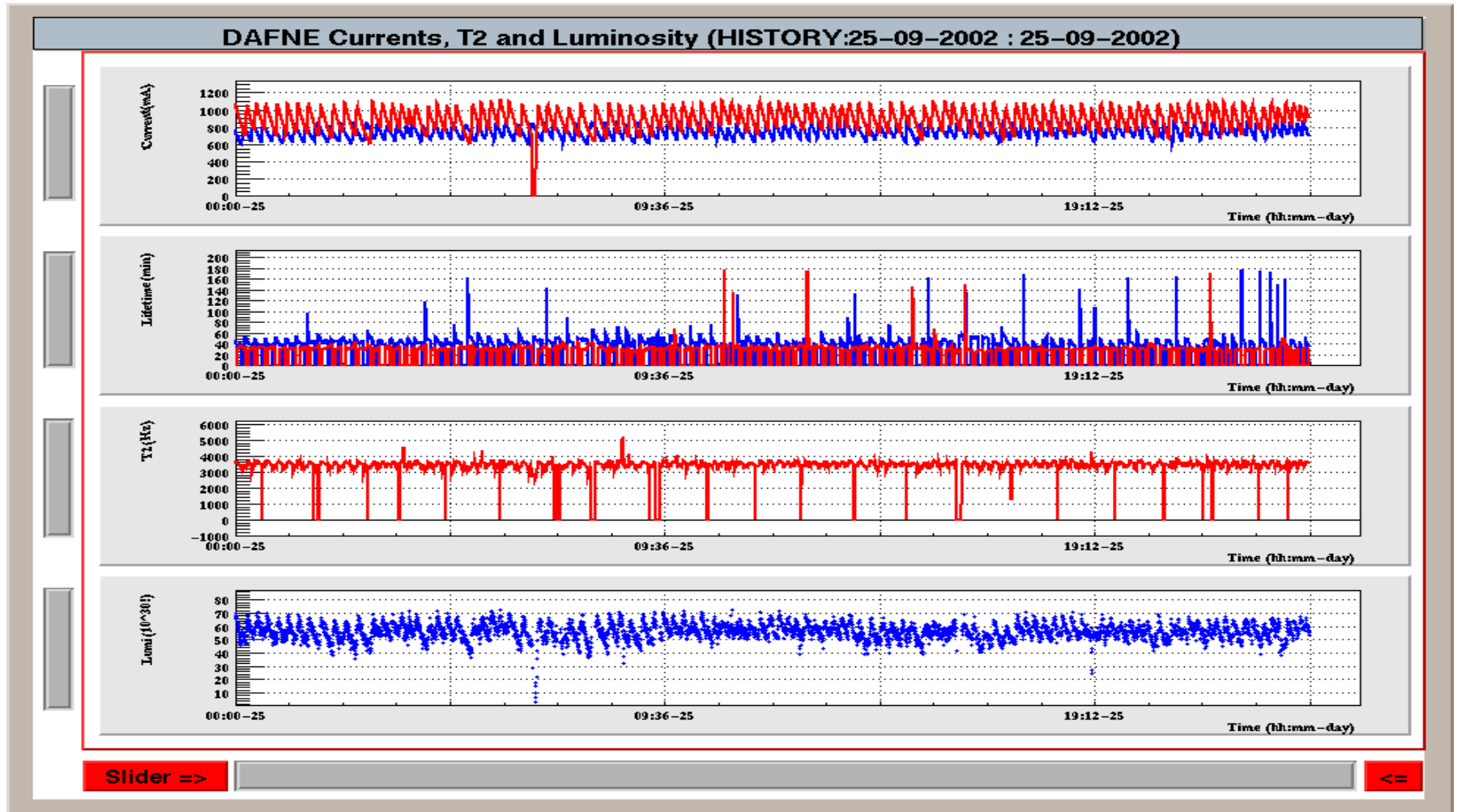
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LNf Scientific Committee
Frascati, 2002, November 24-25

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- 1) DAQ operations
- 2) automated tape space (2003)
- 3) useful data for sizing computing hw
- 4) disk space for DST (2002)
- 5) processing power (2003)

2002 – 3.6 kHz DAQ – 1.6 kHz T3



$$L_{\text{peak}} \sim 7 \cdot 10^{31} \text{ cm}^{-2} \text{ s}^{-1}$$

$$\langle L \rangle \sim 5.4 \cdot 10^{31} \text{ cm}^{-2} \text{ s}^{-1}$$

$$L_{\text{int max}} = 4.8 \text{ pb}^{-1} / \text{day}$$

on-line farm

- Unix *fixed priorities* for *DAQ processes*
guarantee a smooth DAQ acquisition
- measured rates with 3 (4 way SMP) machines
up to 5 kHz of DAQ input
2002 run conditions:
L3 filter cuts 3.6 kHz DAQ input to 1.6 kHz output
- DAQ processes not limited by processor speed

on-line farm computers

1 run control

3 data acquisition

2 idle:

previously data servers
to be be reassigned soon

1 online calibration

1 data quality control

1 database server (DB2)

500 SpecInt95

caption: IBM F50 (4 way 166 MHz PowerPC)

IBM H50 (4 way 332 MHz PowerPC)

KLOE archived Data - October 2002

1999		raw	6 TB	GONE
2000	~20 pb ⁻¹	raw	22 TB	X
		reconstructed	12 TB	X
2001	~180 pb ⁻¹	raw	48 TB	S
		reconstructed	37 TB	S
2002	~288 pb ⁻¹	raw	35 TB	
		reconstructed	29 TB	
total			183 TB	

tape library capacity is 200 TB + compression

upgrade of drives will increase capacity to 300 TB (ordered)

tape storage – 2003 technology

- KLOE has used a full generation of drive/media
from 10 → 60 GB per cartridge
- what will be available next ?
a new generation of drives and media (3Q 2003)
higher track density (300 GB to 1 TB per cartridge)
- expected costs for the new generation ?
cheaper tape drives
more expensive cartridges
total cost similar (in numbers of automated cartridges)

tape storage – 2003 upgrades

- capacity upgrade of present KLOE tape library
 - year 2002: 200 TB (full)
 - year 2003: 300 TB (not sufficient for 2003 data taking)
- more tape space is needed for 2003
 - next generation drives compatible with present library
 - no room for next generation cartridges in present library
 - upgrade of present library impractical
- conclusion
 - KLOE needs an additional tape library (2Q/3Q 2003)

KLOE data taking conditions and CPUs for data processing

year	trigger rate, Hz	ϕ + Bhabha Rate, Hz	data taking DAQ hours/pb ⁻¹	data recon. hours*CPU/pb ⁻¹	total Gb/pb ⁻¹
2000	2100	77	33	970	1500
2001	2000	220	11	520	470
2002	1600	375	6.8	230	210
2003	2150	920	2.7	190	145

200x	5800	4600	0.6	167	115
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extrapolated assuming 2002 background and trigger conditions

nominal processing power for concurrent reconstruction (in units of B80 CPUs) is 34, 70 and 300 CPU units for years 2002, 2003 and 200x respectively

these numbers do not include the sources of inefficiencies, MC production and concurrent reprocessing

data volume for data and MC samples

1 fb ⁻¹	raw data	reconstructed	DSTs	MC files	MC DSTs
	115 TB	90 TB	10 TB	83 TB	20 TB

CPU power for data processing and MC generation

1 fb ⁻¹	reprocessing from raw data	reprocessing from streamed data	MC ϕ decay	
day CPU	9600	kpm 1440	simulation	6650
		ksl 1142	reconstruction	5100
		rad 198		
		bha 1440		
		4220		11750

these numbers do not include the sources of inefficiencies

- using 2002 background and trigger conditions
- all numbers refer to a sample of 1 fb⁻¹
- day CPU number are in units of B80 CPUs

disk space usage – 2002 hw

- DAQ (1.5 TB)
5 strings - 300 GB each - RAID 1
can buffer 8 hours of DAQ data at 50 MB/s
- 2 disk and tape servers (3.5 TB)
12 strings - 300 TB each - RAID 1
1+1 - reconstruction output
5+5 - data staging for reprocessings or analyses
- AFS (2.0 TB)
several RAID 5 strings
user volumes and analysis group volumes
- total: 7.0 TB

disk space - technology

- all KLOE disks are Directly Attached Storage (DAS)
IBM SSA 160 MB/s technology
flexible and yet simple architecture
- upgrades using DAS seem expensive
check “*INFN Gruppo I*” price list (everything is cheap)
other technologies must be selected (NAS, SAN, ...)
- Network Attached Storage (NAS)
cheap but usually too distributed

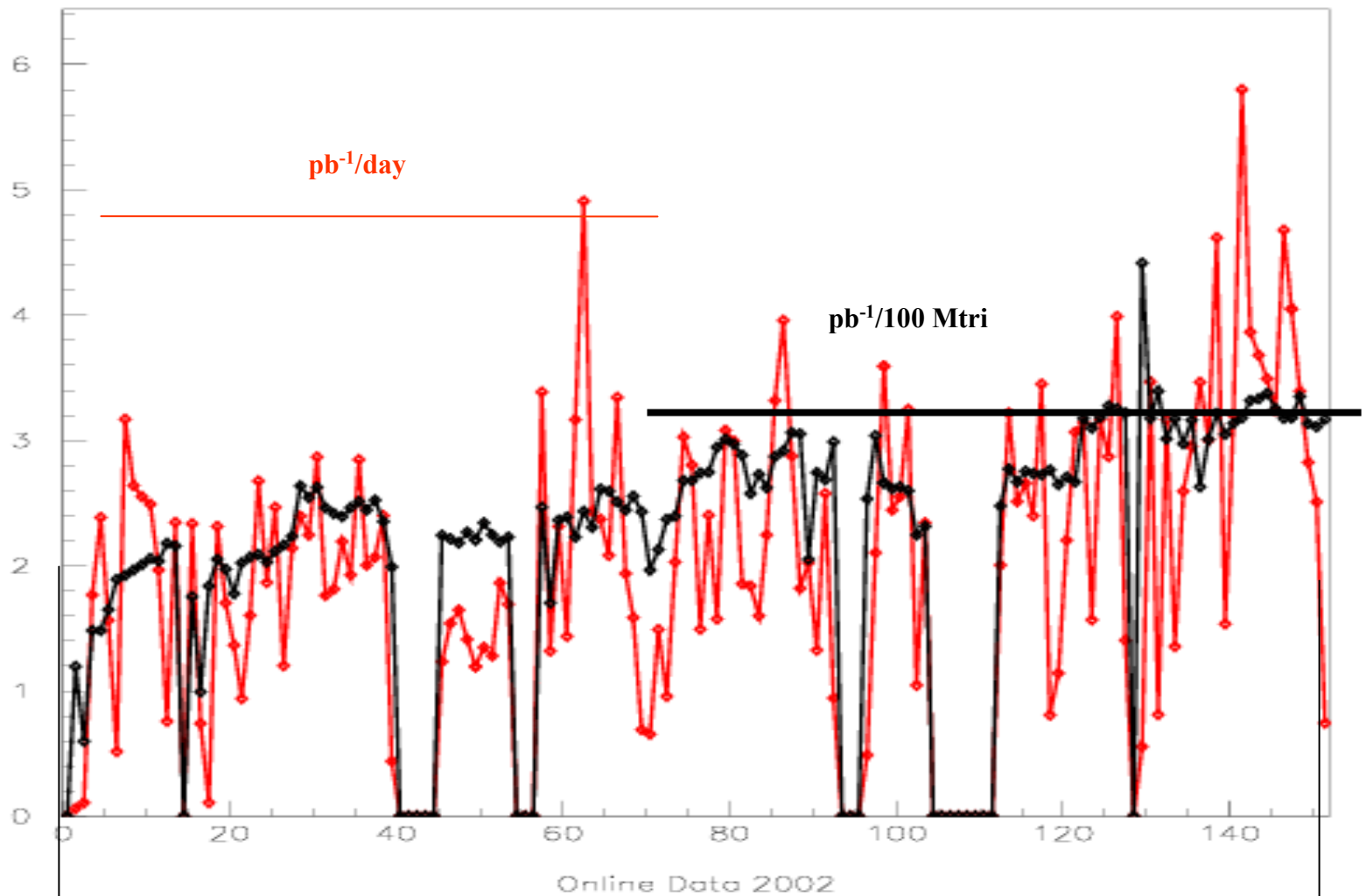
disk space - technology

- Storage Area Network (SAN)
cost is intermediate between NAS and DAS
storage partitioned to servers according to requirements
- present SAN technology is Fiber Channel (FC)
FC technology is 10 years old and available only today
- future tape drives will be FC attached
expected number of FC attachments is about 40
this will require redundant SAN switches
(overall balance increases however ...)

disk space – 2002 / 2003 upgrades

- DST model requires fast access to data
disk space sized according to DST sample
automatic archival in case of disk failures
- estimated KLOE disk space for DSTs
 $0.5 \text{ fb}^{-1} \rightarrow 5 \text{ TB}$
 $1.0 \text{ fb}^{-1} \rightarrow 10 \text{ TB}$
- SAN Fiber Channel technology
2002 / 2003 disk acquisitions
at 10-15 keuro/TB
initial investment
later returns (?)

data reconstruction for 2002 data taking



May, 3rd

Sep, 30th

trigger composition and reconstruction timings

ϕ + Bha	background		
	filtered	tracked	total

triggers	4%	74%	26%	96%
reconstruction time	63 ms	1 ms	51 ms	14 ms
	16%	4%	80%	84%

year 2000

physics is a tiny fraction
computing used mainly for
tracking background events

triggers	11%	67%	33%	89%
reconstruction time	63 ms	1 ms	50 ms	17 ms
	31%	3%	66%	69%

year 2001

DAΦNE gives more physics

triggers	23%	78%	22%	77%
reconstruction time	63 ms	1 ms	33 ms	8 ms
	70%	3%	27%	30%

year 2002

physics is now 23 %
also computing is now used
for useful physics

data processing – 2002 hw

2 AFS clients (analysis)
8 montecarlo

700 SpecInt95
40 processors
0.8 kHz nominal reconstruction rate

4 AFS clients (analysis)
28 data processing

4900 SpecFp95
96 processors
4.5 kHz nominal reconstruction rate

caption: Sun Enterprise 450 (4 way 400 MHz Ultra Sparc 2)
IBM B80 (4 way 375 MHz Power3 II)

data processing – 2003 upgrades

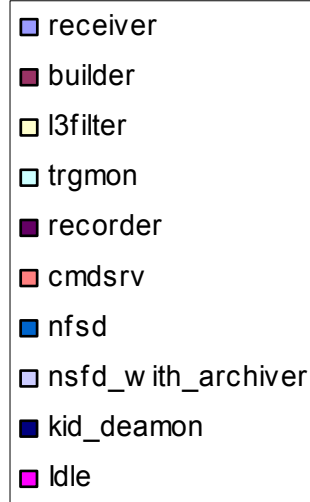
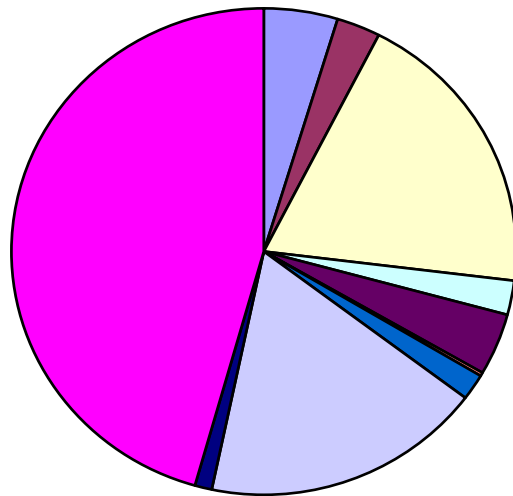
- 2003 data taking
luminosity $10^{32} \text{ cm}^{-2} \text{ s}^{-1}$
with 2002 background and trigger conditions
- doubles required CPUs for online production
in units of present KLOE B80 CPUs
- processor performance
evaluated on the basis KLOE specific benchmarks
SPEC metrics, almost meaningless

conclusions

- KLOE computing ok for 2002 data taking
- uptime only constrained by external events
- 2003 data taking will require upgrades
 - + 1 tape library (+1.5 PB)
 - + 10 TB disk space
 - + 80 CPUs (in units of B80 CPUs)

Backup Slides

0.8 kHz / machine



low rate

2.4 kHz DAQ input

3 computers

each computer

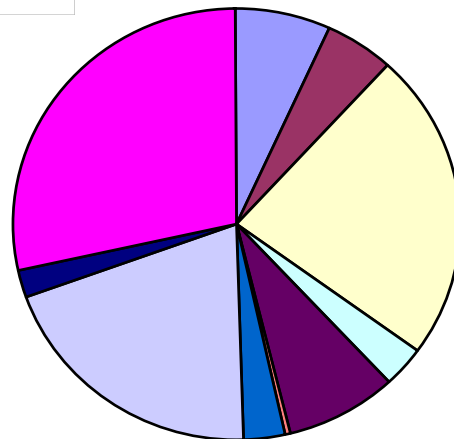
4 way SMP

data moving

simultaneous

with smooth DAQ

1.6 kHz / machine



processes are

compatible

with processors

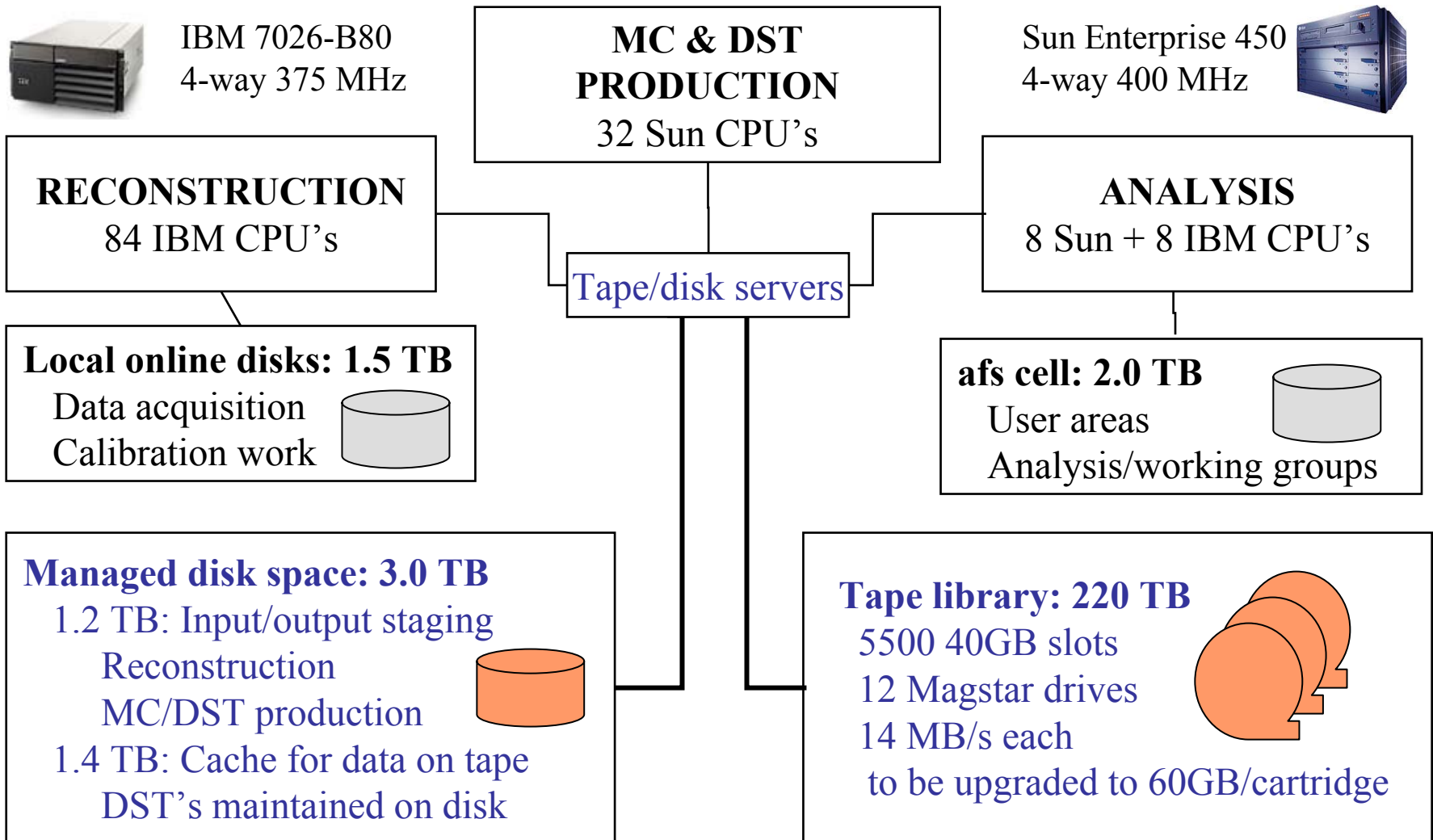
high rate

4.8 kHz DAQ input

3 computers

event size 2.5 KBytes

offline computing resources



tape storage – 2002 hw

- tape library

15 (+2) box long IBM 3494 tape library

5,500 cartridge slots (5,100 cartridges)

high-availability:

dual active accessors

dual library control (standby takeover)

- 12 tape drives

14 MB/s IBM Magstar (linear, high reliability)

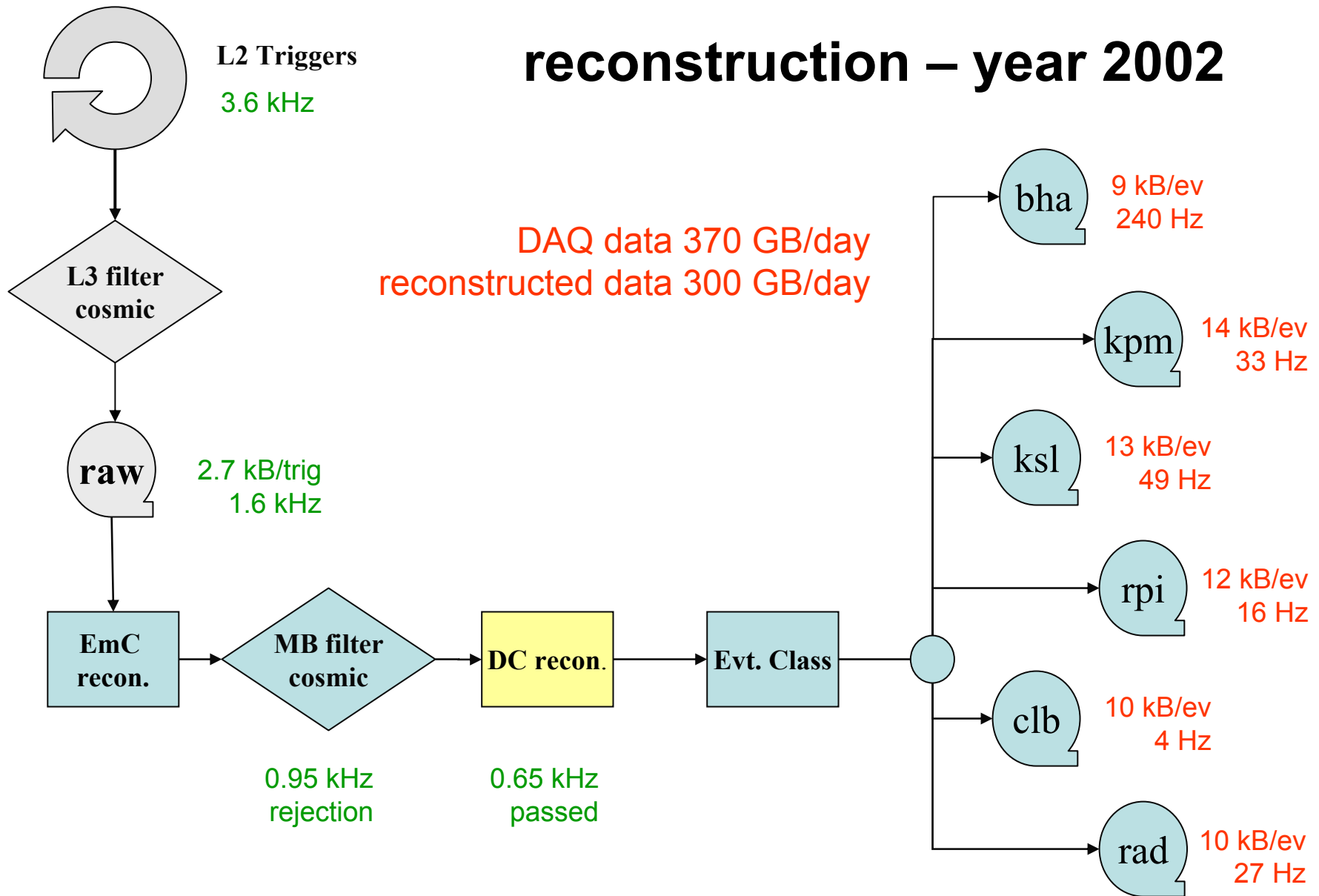
presently 40 GB per cartridge (uncompressed)

drive upgrade to 60 GB per cartridge (ordered)

- safe operations

some cartridges mounted up to 10,000 times

reconstruction – year 2002



Processor Comparison for KLOE Tasks

	IBM Power 3 375 MHz	IBM Power 4 1 GHz	Sun ES 450 450 MHz	PentiumIII 1 GHz	Athlon XP2000+
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ms/trigger					
data, full reconstruction	17	8	40	29	18

ms/event					
data, tracking only	24	12	66	53	32
MC-1 ϕ production	210	110	420	270	150
MC-2 $K_S \rightarrow \pi^+ \pi^-$	120	60	240	160	90
MC-1 reconstruction	70	35	170	130	76
MC-2 reconstruction	120	60	280	210	123