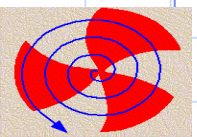
The Kolkata Tier-2@ALICE past, present and future

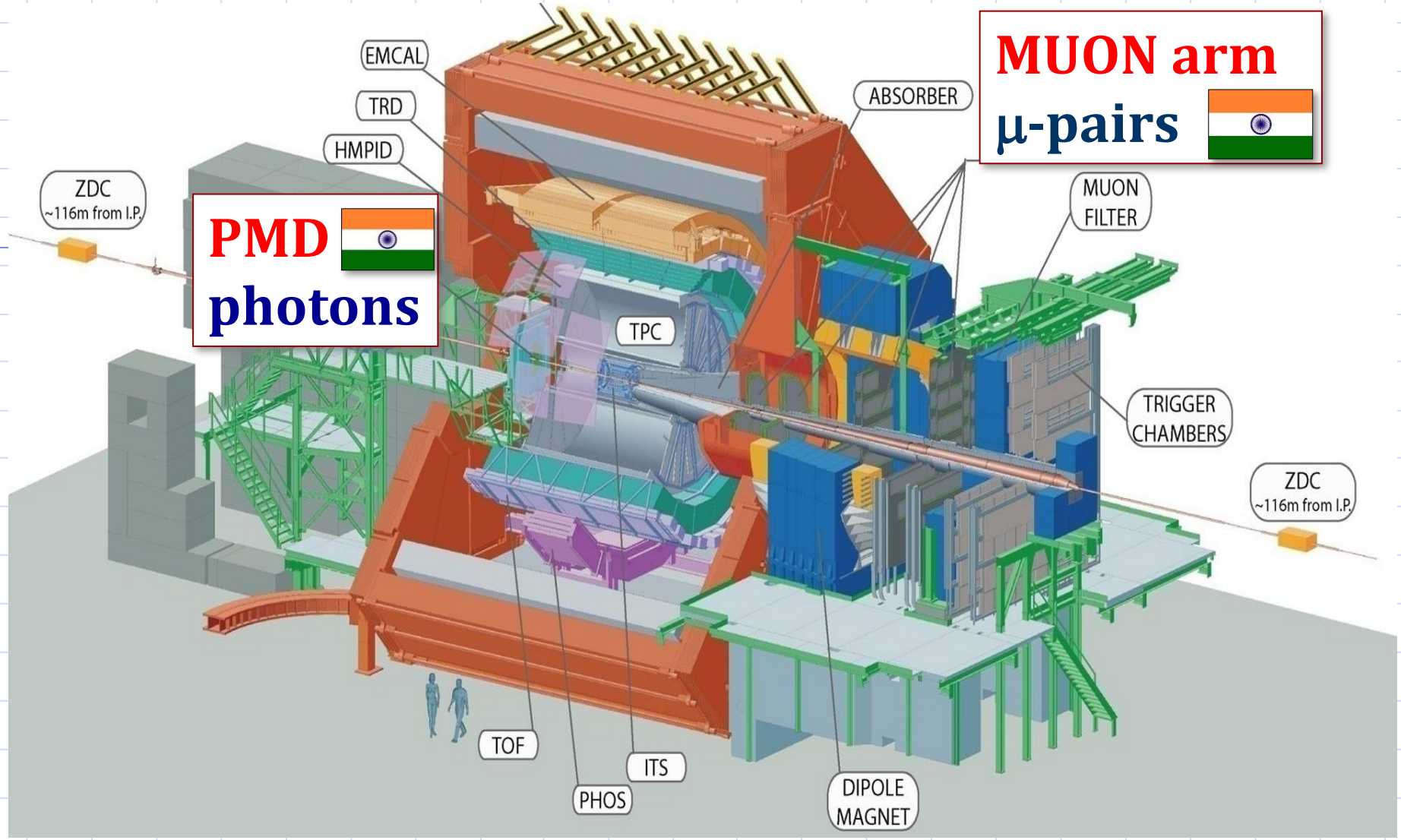
Outline

- Why Tier-2
- From where we started at VECC Kolkata
- Implementation of Efficient Cooling Solution
- Evolution of Grid Computing Facility at VECC (for Computing, Storage, Network etc)
- Present Status
- What we achieved
- How we achieved
- Future Road Map and Vision
- GRID India Project and Monthly Meeting
- Heterogeneous Computing Aspects



India in ALICE (in detector front)

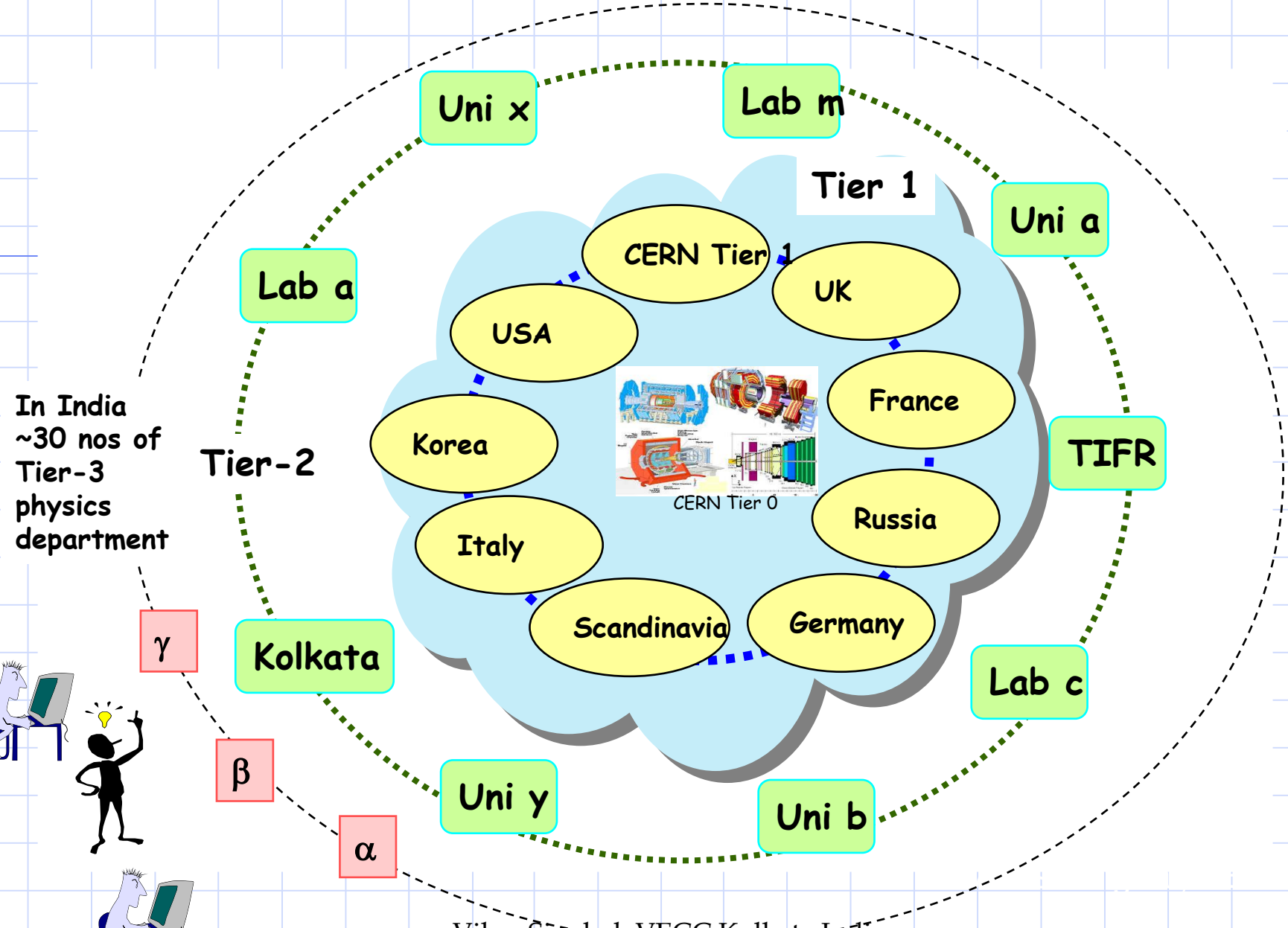
During late 1990s, India started participating in LHC, CERN



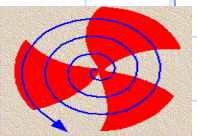
ALICE setup during RUN-2

Slide from Tapan Nayak

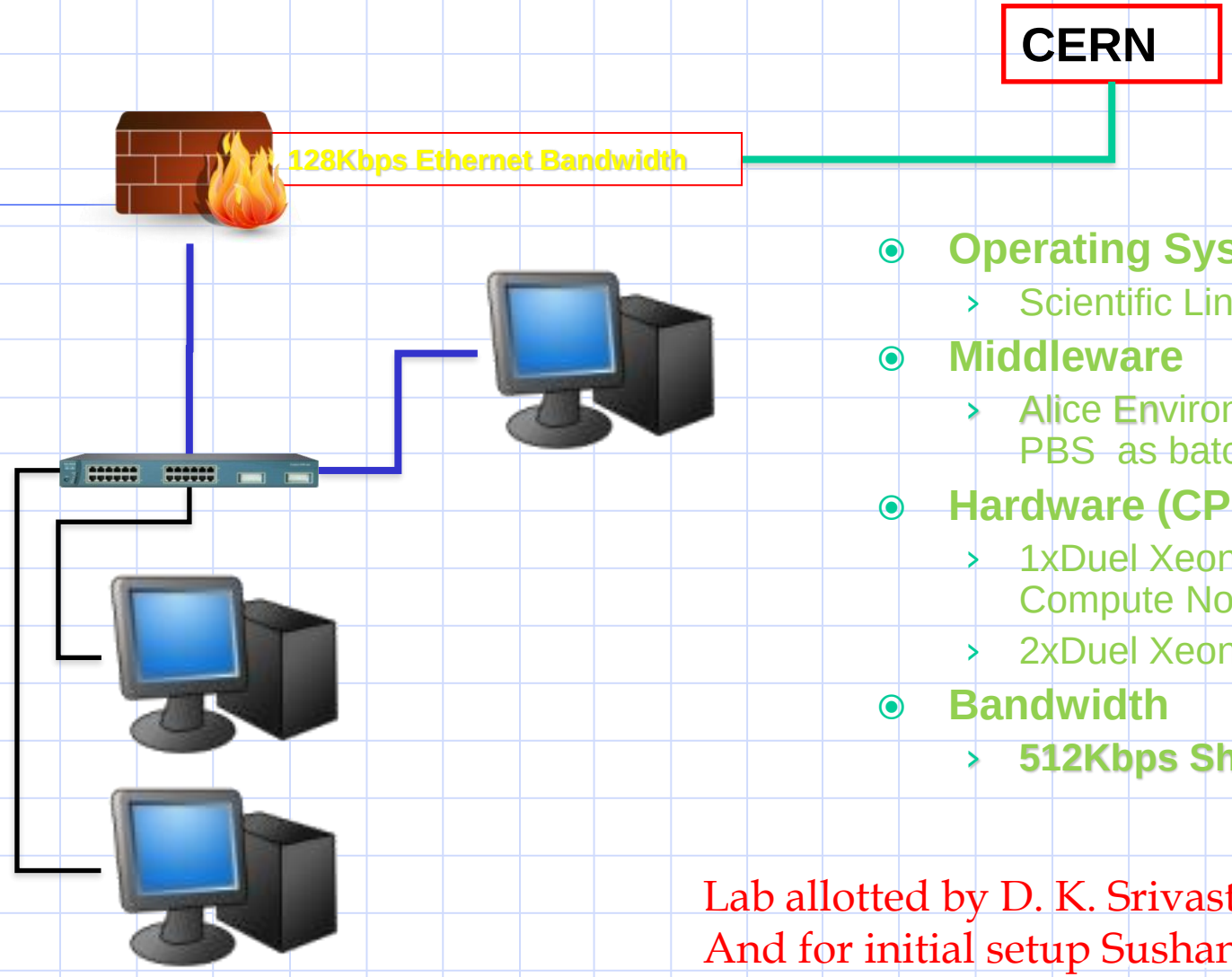
The Grid Computing Model at WLCG



From where we started



Started in 2002



- **Operating System**
  - Scientific Linux 3.05
- **Middleware**
  - Alice Environment with PBS as batch system
- **Hardware (CPU, Disk)**
  - 1xDuel Xeon,4GB Compute Node
  - 2xDuel Xeon,2GB WNs
- **Bandwidth**
  - **512Kbps Shared**

Lab allotted by D. K. Srivastav Sir,
And for initial setup Sushant Sir and Tapas Sir helped.

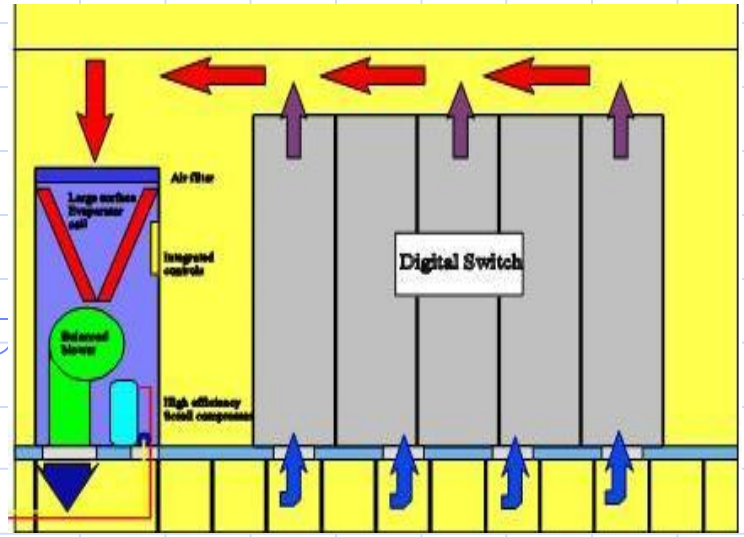
GRID Computing Facility Lab during initial years (2004 – 2010)

2008-09 Jean Cleymans visited.

An article in TOI on 12/09/08 on
Grid Computing used for LHC project.

LHC Started in 2008

Implementation of Efficient Cooling Solution



- Hot and Cool Air is separated using Cold Air Containment which is least accessible Area.
- All the management and monitoring of the server, storage is from outside Cold Aisle Containment.
- Temperature gradient between Cold and Hot zone is 5°C.

- Power usage effectiveness (PUE)
  =Total Facility Power/
  IT Equipment Power
  = 1200Units / 816Unit per Day
  = 1.47
- New Cooling solution reduced cooling power consumption by half.
- Earlier PUE factor was ~ 2.

In TopSuperComputers India List and Procurement

Listed in TopSuperComputers India list

http://topsc.cdacb.in/

48 Nodes Cluster
Commissioned Q4-2017

Theoretical Peak Performance
Rpeak = 1.0752 Tflops /Server
Rpeak = 51.6 Tflops Cluster
Linpack Benchmark performance
Rmax = 43.0471 Tflops.

Top Super Computers in India is list of the most powerful supercomputers in India and it is maintained by C-DAC Bangalore. Earlier it was maintained by IISc Banglore since its inception in 2009.

Since 2017 Kolkata Tier-2 HPC Installation is still on the list.

From 2 Core to 4000 Cores

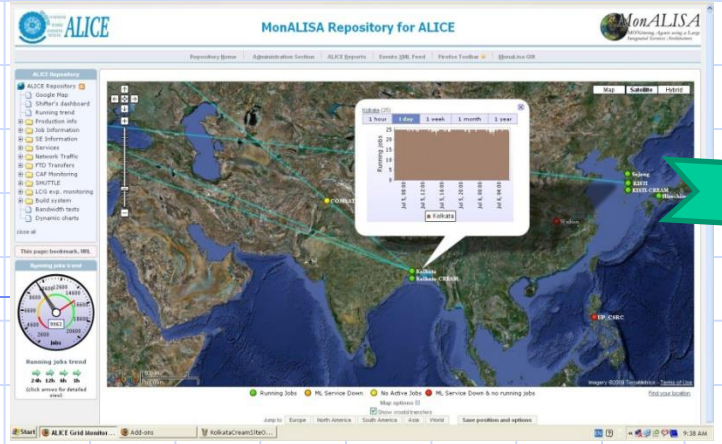
Started with

----2 Desktop Machine	2002
----2 Tower Like Servers	2003
----9 HP 1U Servers	2004
----17 Wipro 1U Servers Single Core	2006
----40 HP Blades Dual Core	2008
----8 HP Blades Quad Core	2009
----32 Dell Blade Dual Processor Dual Core	2011
----GPU Server with Tesla 2070 with 448Cores	2012
----2* Intel Xeon Phi Co-processor 244 core	2016
----48 Node Cluster 2688 core	2017
----16 DELL Node Cluster	2020

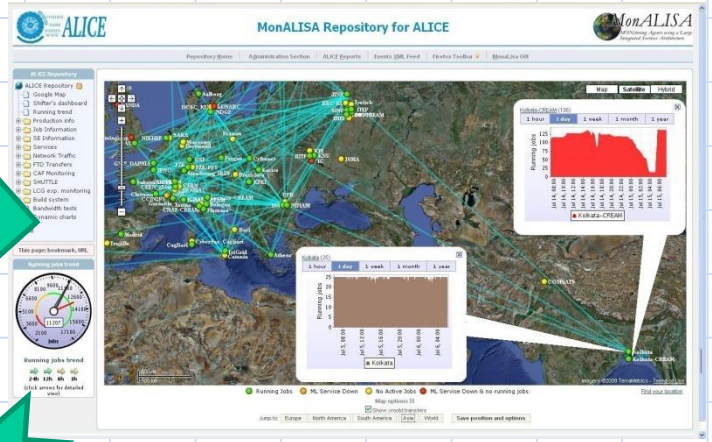
These resources are total for the facility not only for Tier-2.

Kolkata Tier2 on Monalisa

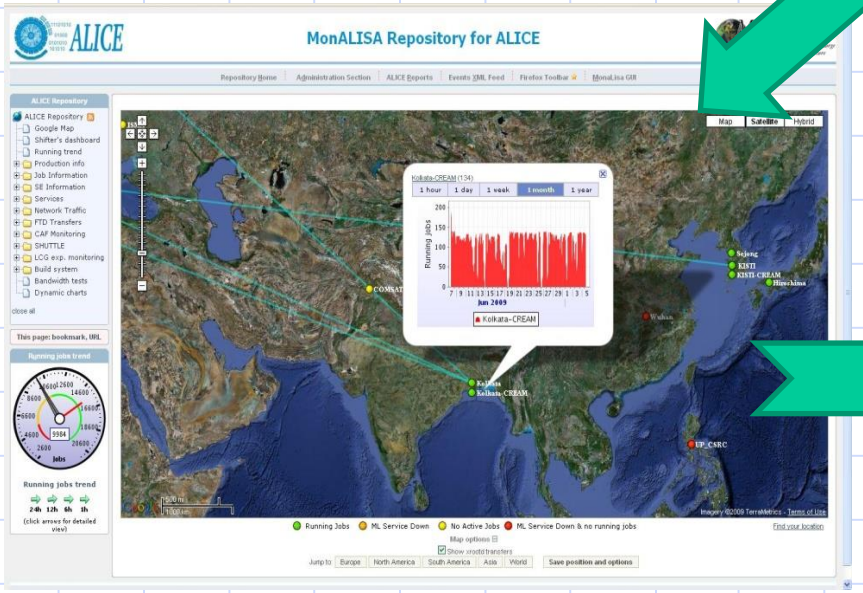
Step by step increase and always on MonaLisa



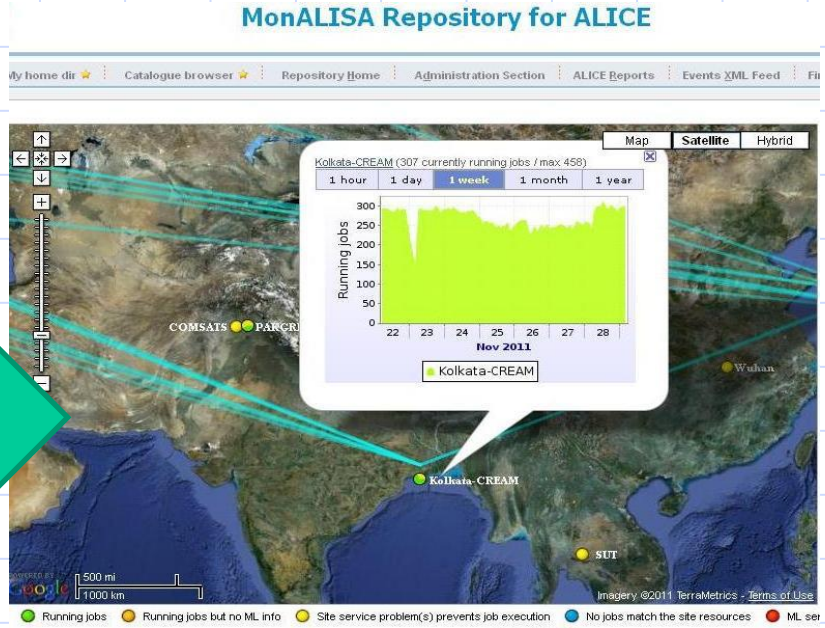
2007



2009



2010

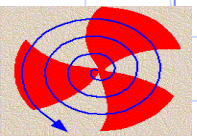


2013

From 512MB Disk to 4000TB Disk

Started with

----512MB in Desktop Machine	2002
----40GB in Tower Like Servers as DAS	2003
----400GB in HP MSA 500	2004
----2TB Wipro NAS	2006
----108TB HP EVA SAN	2008
---- 25 TB i-scsi	2009
----200TB IBM DS 5100	2011
----2TB Hard disk in GPU Server	2012
----3*48 TB (12*4TB) Disk Servers	2015
----7*160 TB (16*10TB) Disk Servers	2018
----8* 192 TB (16*12TB) Disk Servers (EOS RAIN-6)	2020



It shows gathered piece by piece and all kind of infrastructure.

Evolution of Infrastructure

2006

2008

2010

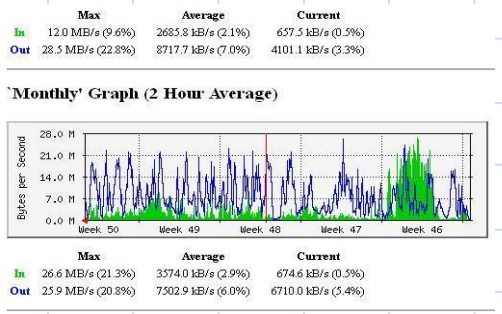
2012

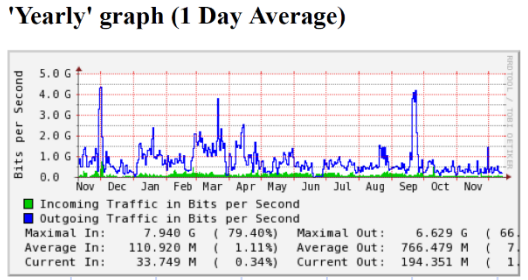
shows lab evolution. Vikas Singhal, VECC Kolkata India

From 128Kbps to 10+ Gbps Network

Started with

----128Kbps shared link	2002
----512Kbps	2003
----2Mbps Dedicated Link	2004
----4Mbps from Bharti	2006
----30Mbps from Reliance	2008
----100Mbps from VSNL (ERNET)	2009
----300 Mbps (NKN Took over)	2011
----Upgraded with 1Gbps	2012
---- 10Gbps	2017
---- Upgrading to 16Gbps	2023



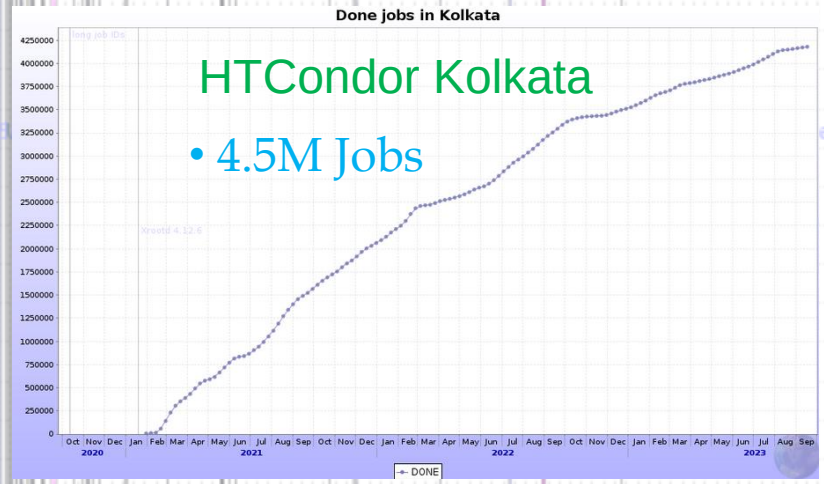


ROI at ALICE Tier-2 @ Kolkata

Only ₹ 2/ job

17.5 M* ALICE jobs completed, at Kolkata Tier-2 during past 15 years.

For last 6 years, every day 7000 jobs successfully completed.
(each job is 12 hrs long).
Last one and half year is not optimal



HTCondor Kolkata

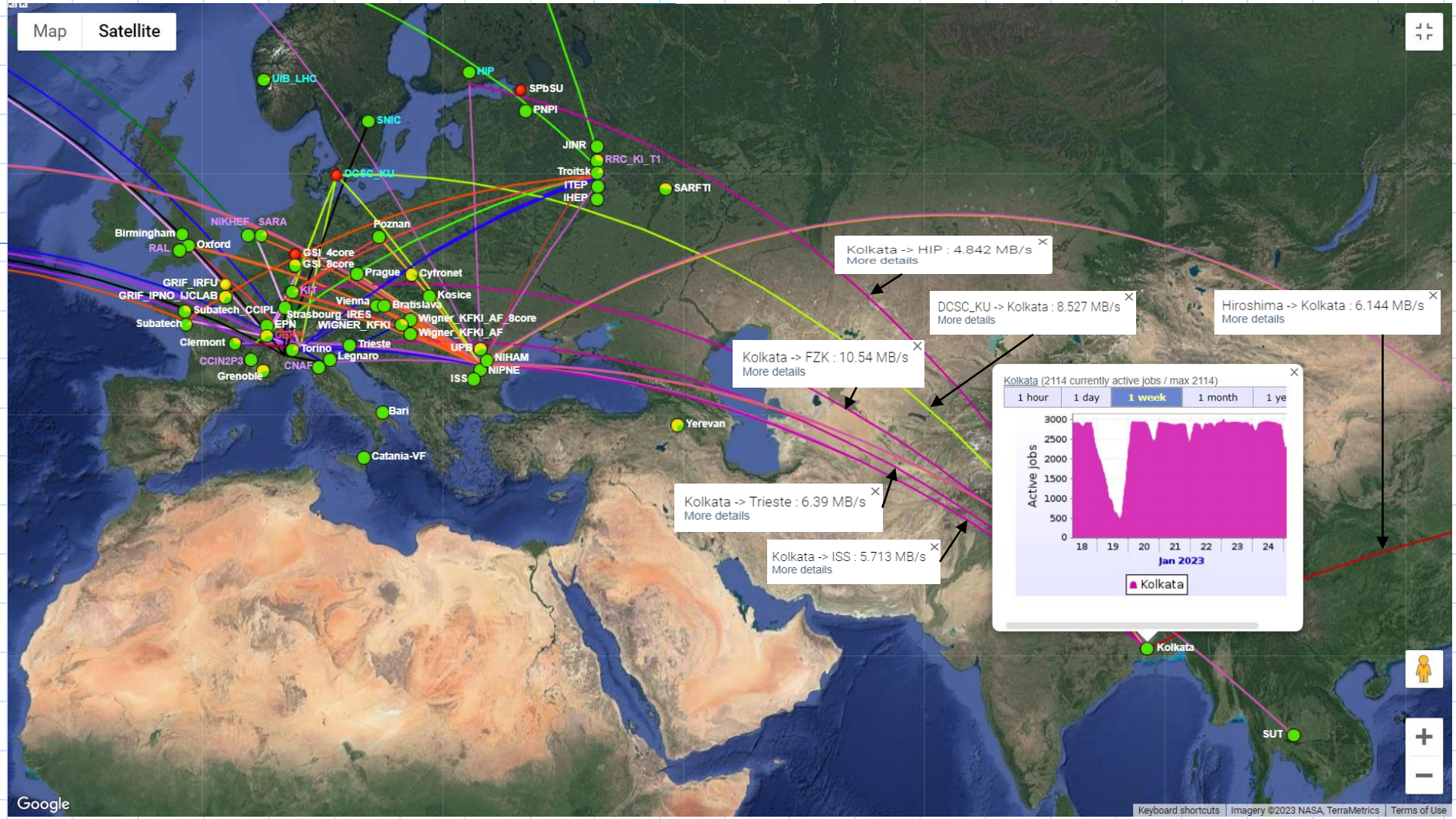
- 4.5M Jobs

24x7 Operation,
>90% availability,
No AMC.

- Since 2008, for only computing ~ ₹ 3.5 Cr.
- For Storage, Cooling and electricity etc. ~ ₹ 3.5 Cr.

ALICE MonaLISA Monitoring Page

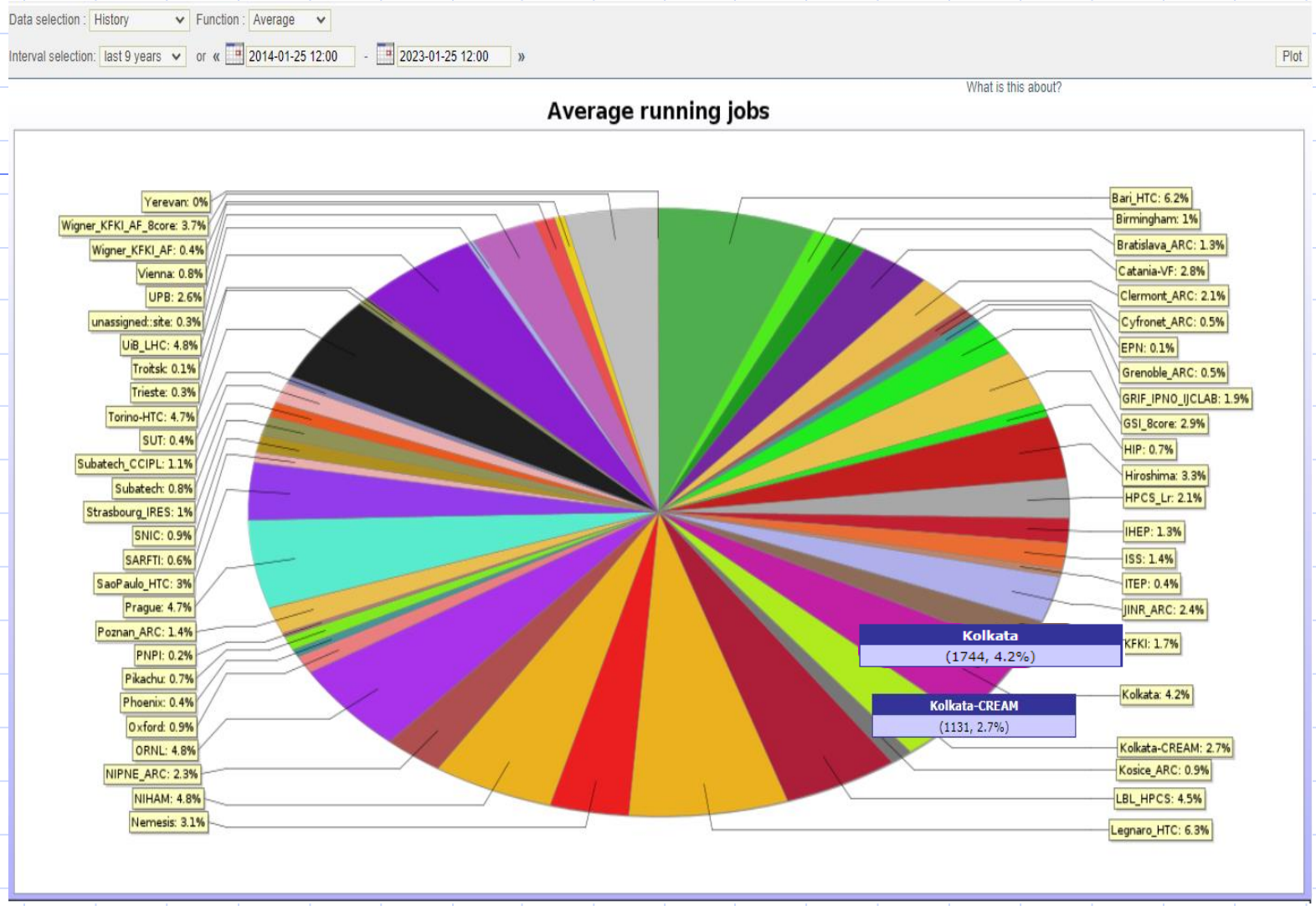
Kolkata on MonaLisa on any usual day

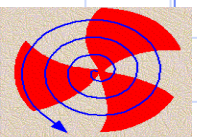


Multiple Data Transfers And Active Jobs At Kolkata Site

Vikas Singhal, VECC Kolkata India

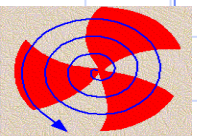
The average number of running jobs during last 9 years among all the ALICE Tier-2s





What we achieved

- **India's Only Tier-2 for ALICE since 2002.**
- **Providing Tier-2 resources to ALICE Community.**
- **Procured and commissioned resources for Kolkata Tier-2 for ALICE Grid as per pledges and M&O-A Fair Share.**
- **Commissioned Green and Efficient cooling solution in the Grid Computing Facility which reduced power requirement by half.**
- Consistently and continuously **running for last 20 years with more than 90% uptime.**
- **Maintaining a reasonable Tier-3 infrastructure for all our Indian collaborators. Good utilization.**



Grid-Peer Tier3 Cluster

Computing: Total 624 Threads.

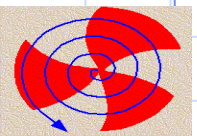
- Extensively used by VECC users ALICE INDIA/CBM INDIA Collaborators. 75+ active users (across India)
- Ldap Authentication Server + HT Condor CM
- Interactive Nodes (Grid-peer) : 4 Nos.
- Non-interactive Nodes(HT-Condor Execute Nodes): 9 Nos. @48 threads & 128GB RAM.
- Network Connected : 10G Fibre.
- OS debian 11.3 (64bit).
- Two factor authentication Login
- gcc version 10.2.1 20210110
- HT Condor version 9.12.0-1.1

Storage: Total space 216TB

- 18Hard disk-- 15 hard disk usable and 3 Global hot spare and Configuring RAID 5
- Glusterfs Storage are installed with Centos Stream 8.
- Users home directory of interactive nodes are mounted by NFS through Glusterfs storages.

What we achieved cont…

- Providing computing support for all the major projects like STAR, ALICE, CBM, Medical Imaging, etc.
- Birth of IGCA:- Indian Grid Certification Authority. (Due to the requirement for ALICE only IGCA established. Thanks to Subrata da and his team.)
- HIGH SPEED Network infrastructure.
- NKN is the greatest achievement.
- Low Cost Disk ServersDisk based storage solution.



Disk based storage solution

Low Cost Disk Servers to make EOS RAIN-6 (RAID-6 across the Servers) Redundant Array of Independent Nodes.

8 nos. of Dell PowerEdge R730XD servers

(Procured in Nov. 2018)

16 * 10TB NLSAS HDD,

2 * 480GB SSD,

8 * 16 (128GB) DDR4 RAM,

4 * 10GB Ethernet (Fibre),

2 * 10 core Processors,

RAID-0 in 16 * 10TB HDD

RAID-1 in 2 * 480 GB SSD.

Storage @ Kolkata for ALICE

Name	Status	Size	Used	Free	Usage	No of files	Type	ADD test
ALICE::Kolkata::EOS	OK	128.9 TB	21.52%	101.2 TB	27.74 TB	408.5 K	FILE	OK
ALICE::Kolkata::EOS2	OK	1.1 PB	9.308%	1021 TB	104.8 TB	2.785 M	FILE	OK
ALICE::Kolkata::SE	OK	76.39 TB	12.85%	66.57 TB	9.817 TB	278.1 K	FILE	OK

How we achieved

- Dedication and hard work is only the KEY.
- Keeping facility neat and clean and also proactively doing Time to time Preventive Maintenance
- It is a LONG Journey, every day a few steps walked.
- Procured the each and every piece of resource to build the CENTRE.
- Efficiently purchasing and managing the resources, bit by bit procured the resources by following all RULEs and regulation.
- Working with Prasun and CASUAL STAFF for last 8 years.

Optimized and Intelligent Procurement:-

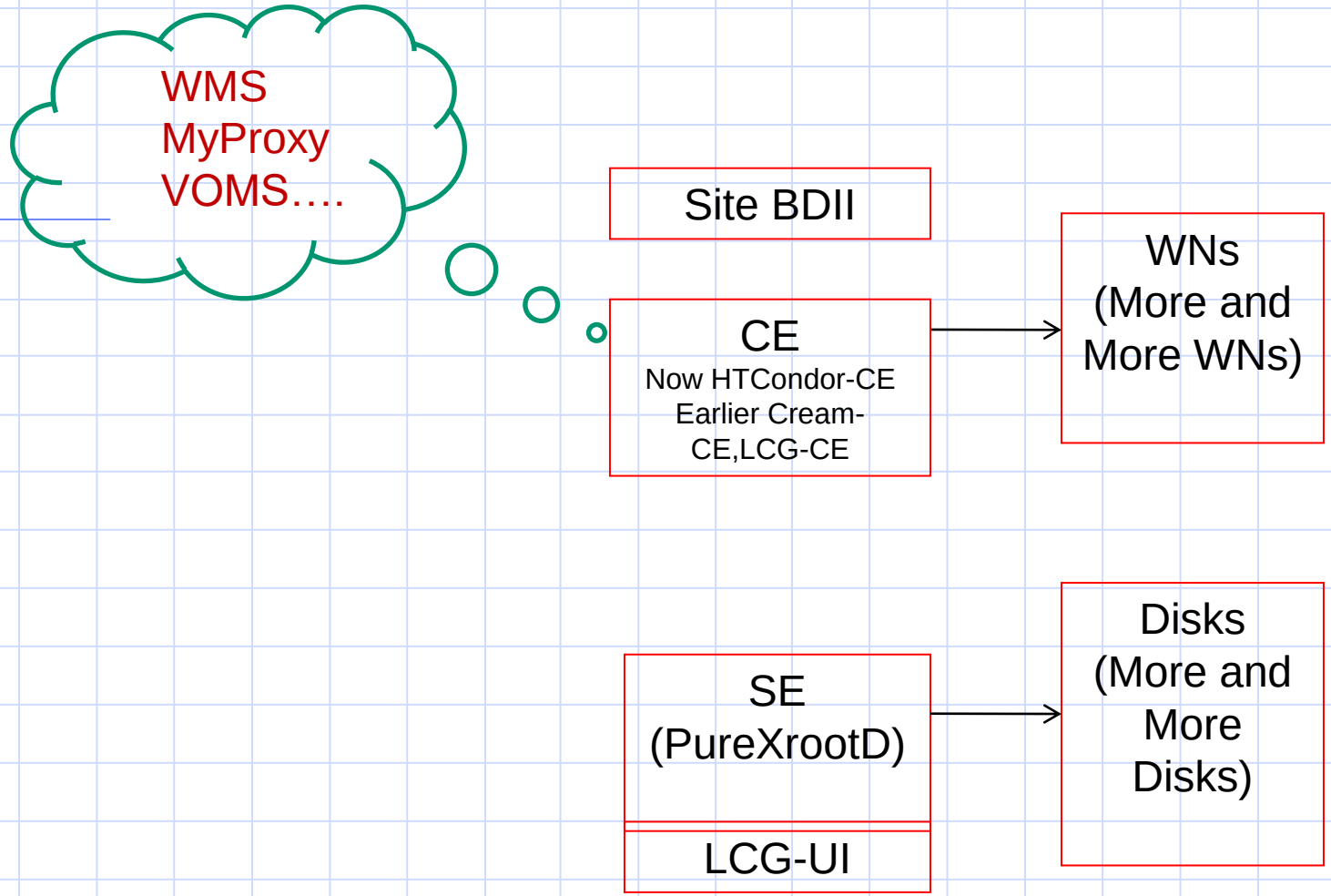
- OEM Independent Specifications
- Optimization between requirement and configuration
- One order lower configuration,

eg. Intel Xeon Silver 4214 processors

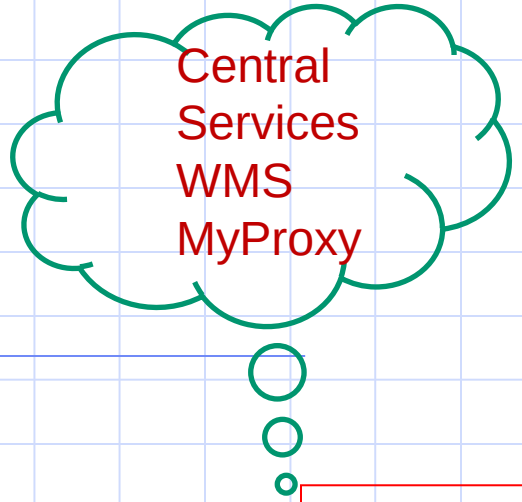
2.20 Ghz

12C (2 x 12C each)

Grid Site As per WLCG & Experiment Requirement



KOLKATA Site Components



VO-BOX

Site BDII

CREAM-CE

EOS

PureXrootD

XrootD Redirector

XrootD Disk Server

Network Infrastructure

NFS SERVER

PBS SERVER

DNS SERVER

UI SERVER

Tier3 Management Server and cluster

HA SERVER

Blade 64 bit Servers With Blade Enclosures

HP
DELL
IBM
Etc…

32or64bit Servers

1U & 2U Servers

New SAN Box

Old NAS

Older NAS

Even Older DAS

Few Tower Servers

Disks Arrays (More and More Arrays)

Monitoring Server

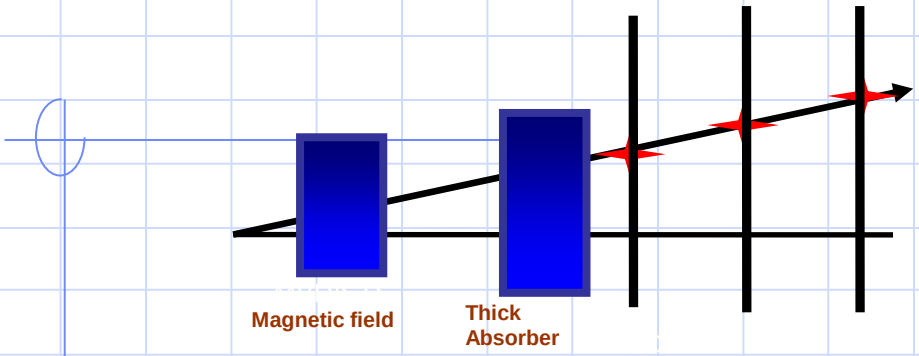
Installation,DHCP Server etc..

GRID India Monthly Meeting and Status

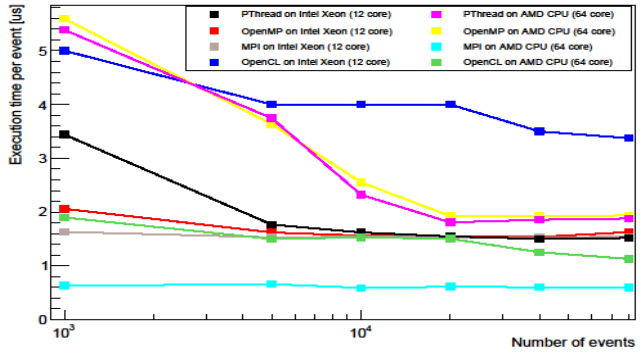
S. No.	Date	Link	Meeting Agenda
1	05/01/2023	https://indico.cern.ch/event/1234841/	Kolkata Tier-2 Details
2	02/03/2023	https://indico.cern.ch/event/1249345/	TIFR Tier-2 Details, Last meeting queries and Answers
3	06/04/2023	https://indico.cern.ch/event/1274050/	Grid India Project Reports Disk Based Storage Discussion
4	11/05/2023	https://indico.cern.ch/event/1285315/	Grid India Project Reports, Disk Based Storage Servers At EOS Kolkata
5	06/07/2023	https://indico.cern.ch/event/1304370/	Grid India Project Status, EOS Kolkata and MonaLisa File Crawler, Future Outlook and Plan
6	03/08/2023	https://indico.cern.ch/event/1313159/	TIFR Tier-2 Storage Migration, HSF Details, Grid India Project Status,
7	06/09/2023	https://indico.cern.ch/event/1322307/	TIFR Tier-2 Storage and migration from DPM to Dcache. Expedite the Grid India Project
8	05/10/2023	https://indico.cern.ch/event/1333606/	The GRID India Project Status. Problem statement and outlook.
9	09/11/2023	https://indico.cern.ch/event/1345690/	7th ATCF Update, Grid India Project Status.

Heterogeneous Computing Aspects

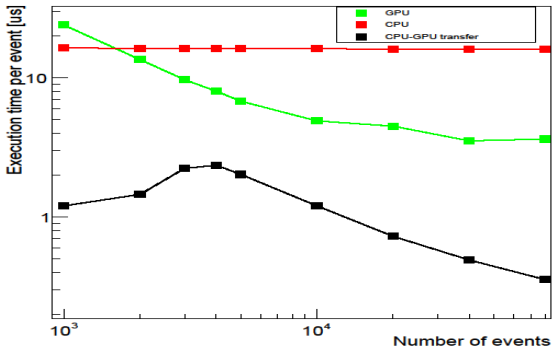
Event Selection via Heterogeneous Computing at MuCh CBM



Trivial Jpsi Event Trigger Algorithm



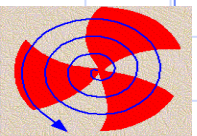
CPC DOI: 10.1016/j.cpc.2020.107190



DOI:10.2139/ssrn.3366339

- GPU Computing for O2 framework,
- Parallelization
  - (using Trivial event approach)
- Using different parallel paradigms.
- Harnessing multicore capabilities.
- Storage optimization of existing container classes.
- Developing of PMD Clustering Algorithm.

Thank You



Job submission

VO-Box
LCG
User Job
ALICE catalogues