The challenge of online triggering

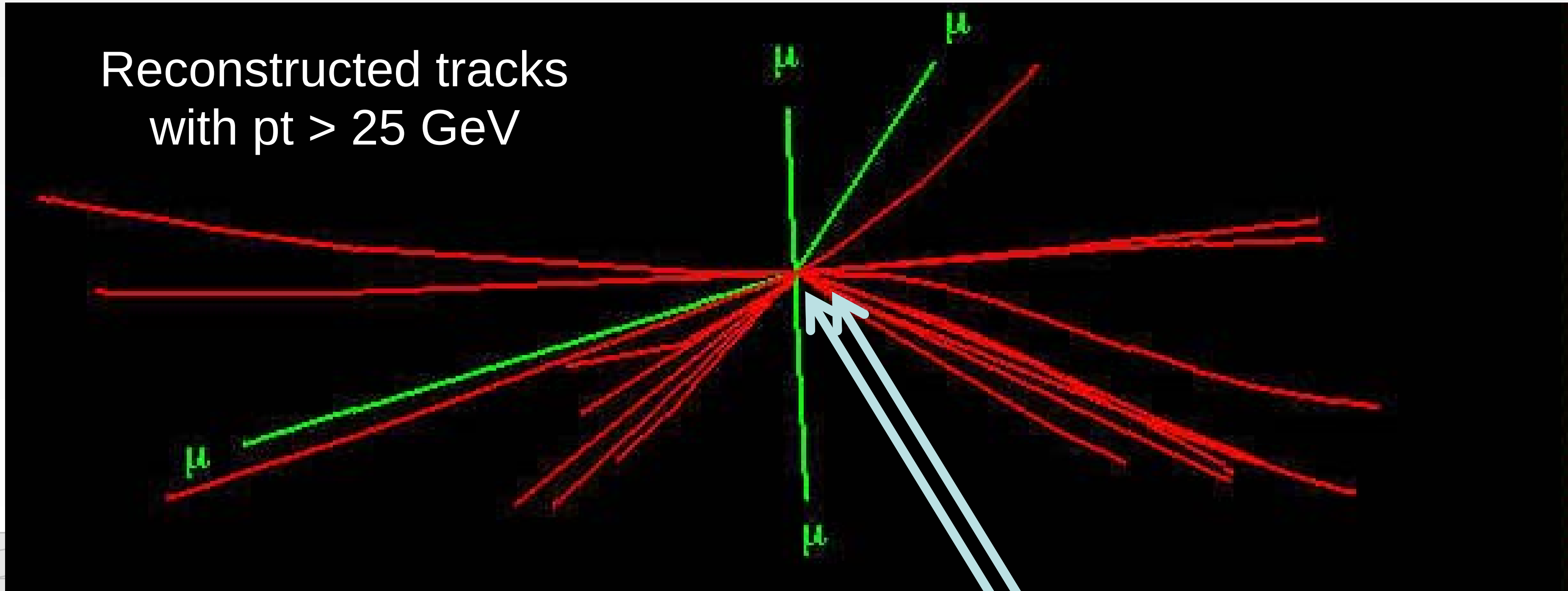
LHC Grid Fest

Niko Neufeld, CERN-PH

Oct 3rd 2008

The needle in the hay-stack

Simulation from CMS



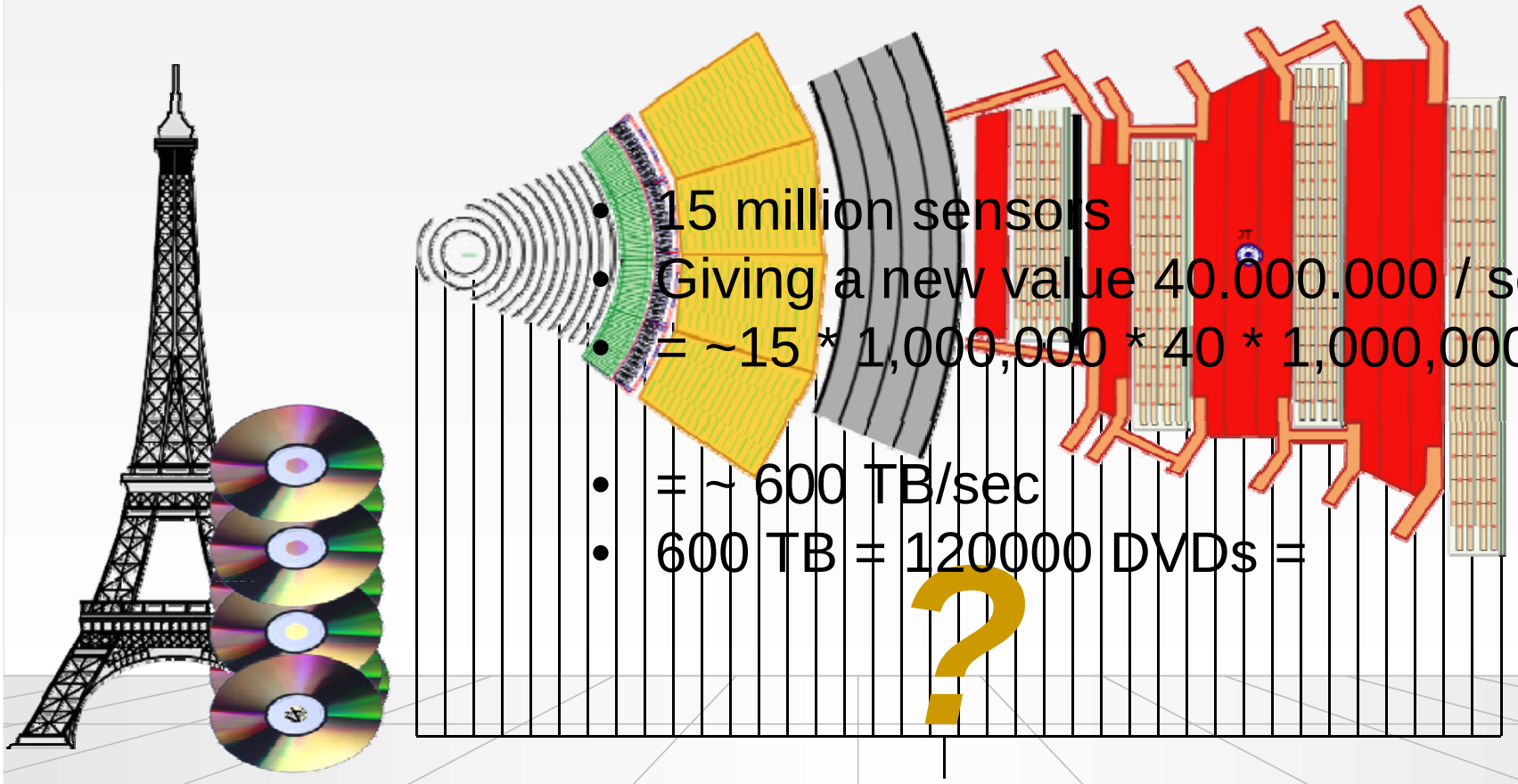
This is what we are looking for: a Higgs [illegible]

This is what we find: more than 1000 particles

We hope to get this once per **day**

We get this 40.000.000 times per second!

The hay: 15 million sensors

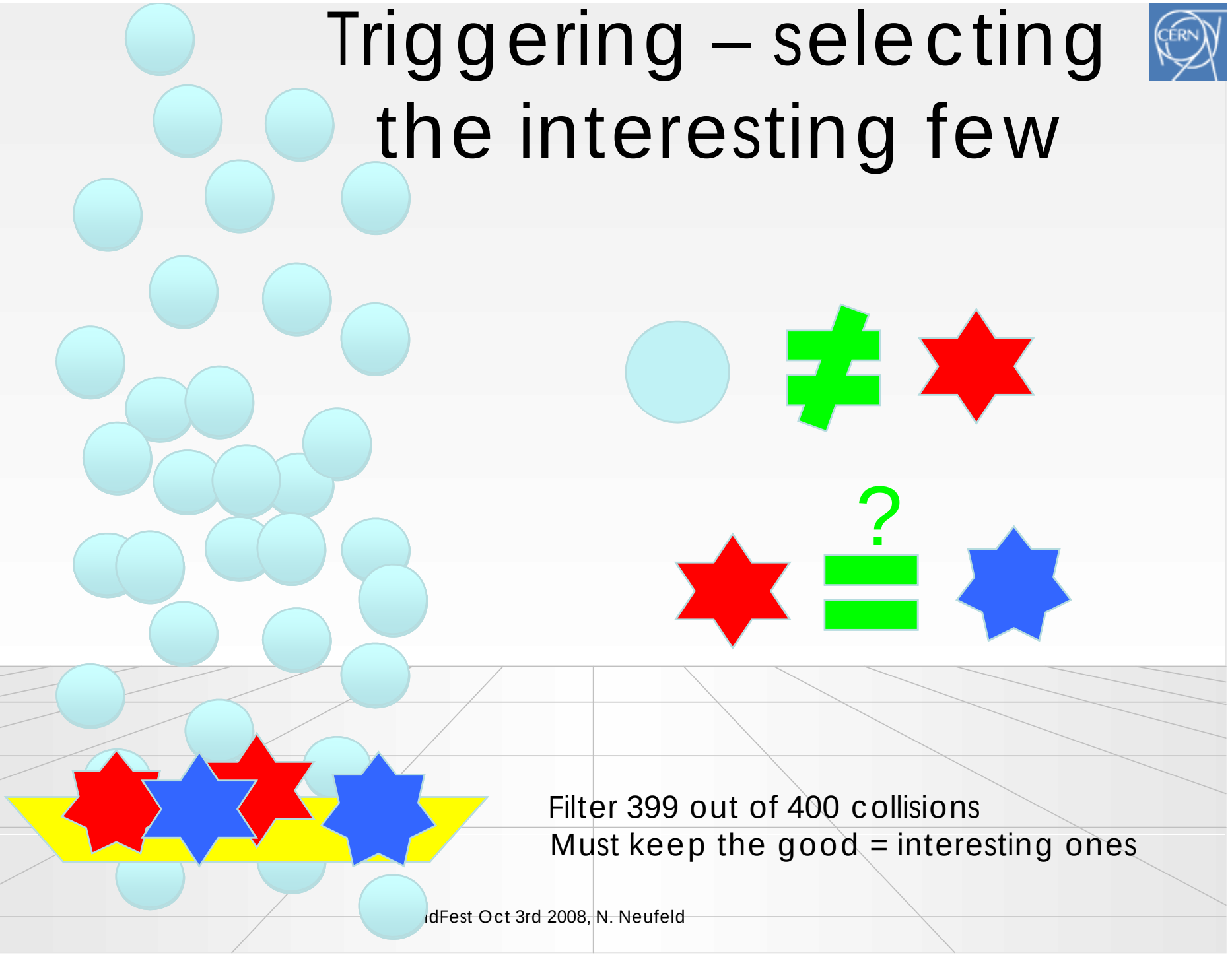


- 15 million sensors
- Giving a new value 40.000.000 / second
- = ~15 * 1,000,000 * 40 * 1,000,000 bytes
- = ~ 600 TB/sec
- 600 TB = 120000 DVDs =

?

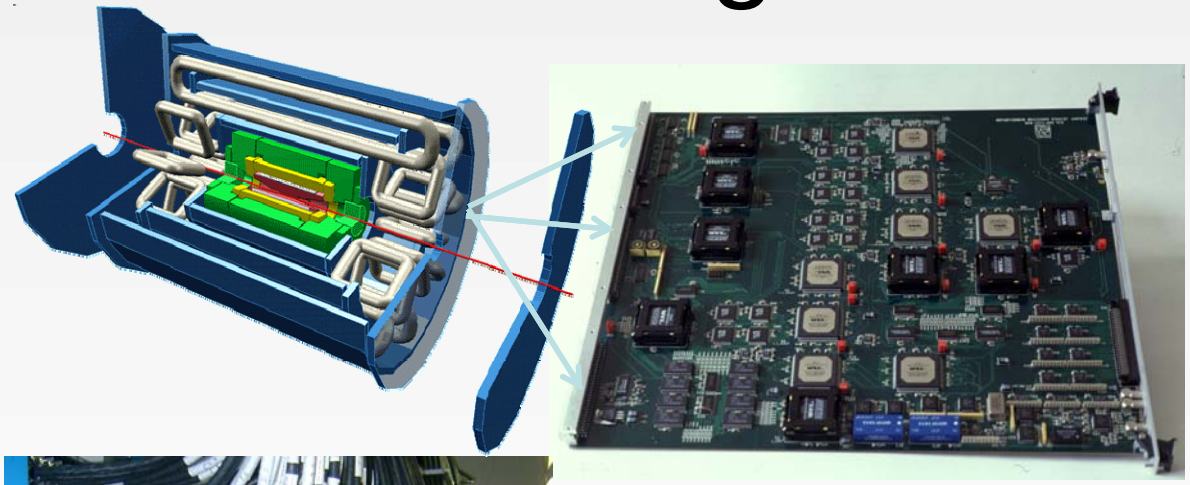
How do you sift through 600 Terabytes / s?
This means going through a 100 m high stack of DVDs

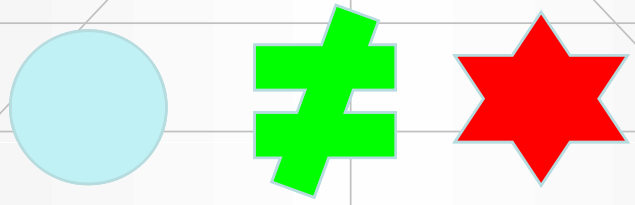
Triggering – selecting the interesting few



Filter 399 out of 400 collisions
Must keep the good = interesting ones

Filtering in hardware





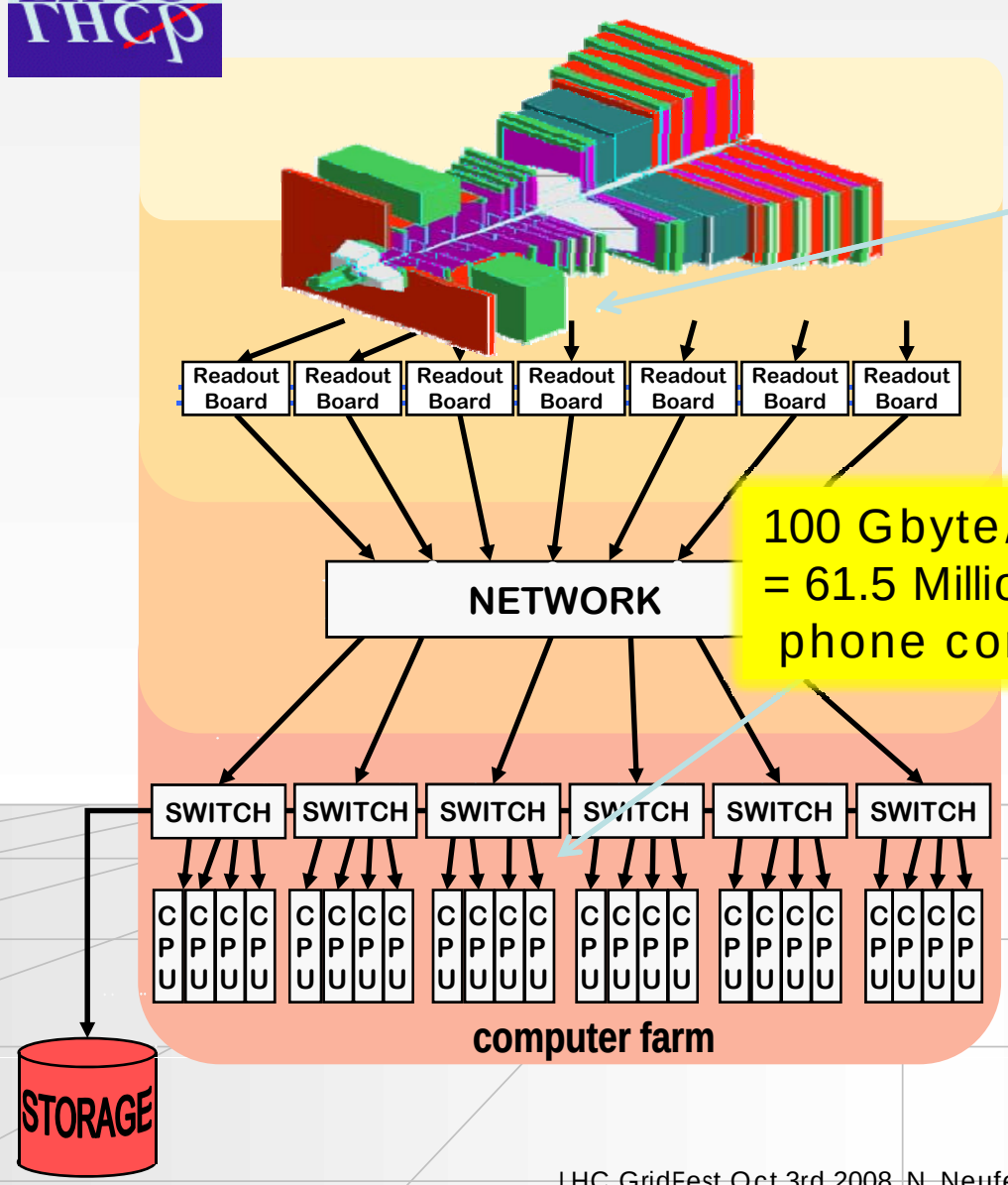
- Sophisticated electronics
- Hundreds of custom-built boards – process a small piece of the collision at enormous speeds (40 million times / second)
- They give a crude, but effective decision, based on simple criteria

High Level Trigger

"And this, in simple terms, is how we find the Higgs Boson"

- Pack the knowledge of tens of thousands of physicists and decades of research into a huge sophisticated algorithm
- Several 100.000 lines of code
- Takes (only!) a few 100 milliseconds ***per collision***

Data Acquisition

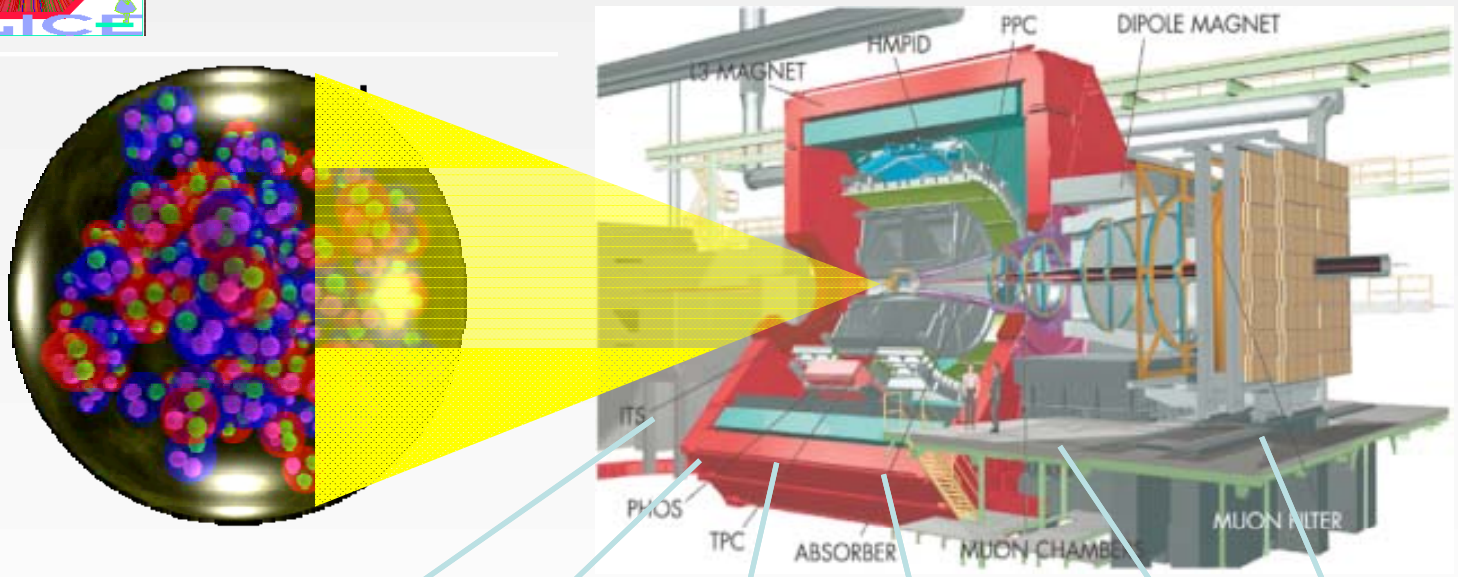


- Data from each collision spread out over hundreds of places on the detector
- Thousands of computers needed to select interesting events

100 Gbyte/s network
= 61.5 Million simultaneous phone conversations

- Each computer needs data from the entire detector
- Huge networks between computers and detector elements

Storing large amounts of data



Each mini-big-bang in Alice creates 25 MB/s of data
2.5 Gigabyte need to be stored every second

On to tape...and the GRID