

Fermilab

Fermi National Laboratory: The national laboratory for particle physics in the US

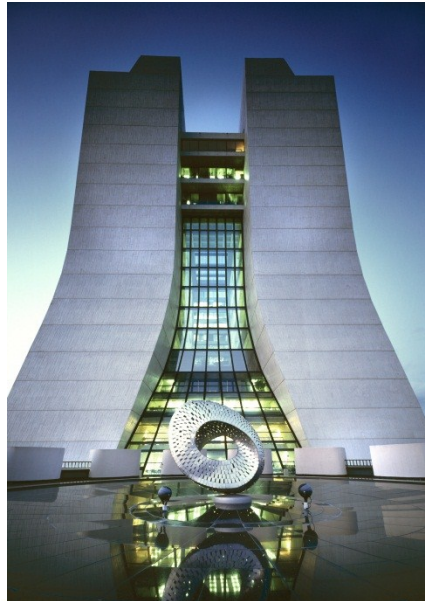
FNAL is an external partner in the portfolio

This presentation is based on material received from Young-Kee Kim and Erik Ramberg

It represents my interpretation and is not officially blessed.



Young-Kee Kim
deputy director, FNAL
Prof. U. Chicago



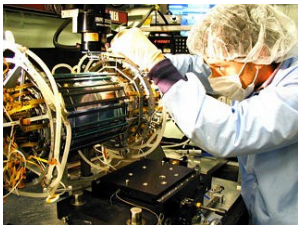
FNAL



Erik Ramberg
Head of detector group
FNAL



The European CALICE hadron calorimeter being installed at the Test Beam Facility



Building a silicon vertex detector at the Silicon Detector Facility



Liquid Argon Test stands at Proton Assembly Building



MINOS Underground Facility, with MINERVA detector in background

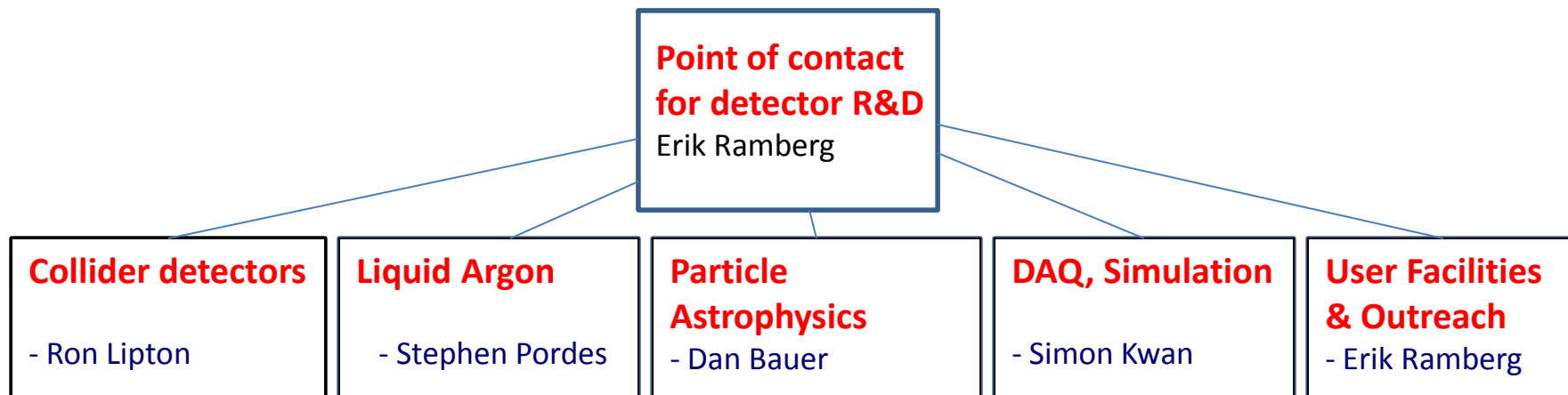


D0 Experiment. One of two Tevatron collider detectors



CDF Experiment. One of two Tevatron collider detectors

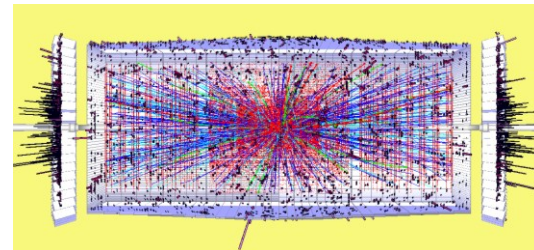
Fermilab Detector R&D Organization



- The Detector Advisory Group:
 - consists of scientists active in detector R&D
 - has PPD and CD representatives
 - meets twice a month
 - monitors and reports on progress in each thrust
 - facilitates reviews of projects in each thrust
 - gives advice on the future of the program

Frontier Detectors: an example

At the energy frontier, LHC upgrades will need to withstand a daunting luminosity of $10^{35}/\text{cm}^2/\text{s}$. Fermilab is using a comprehensive approach to this detector problem.



Sensor

Radiation hardness in new sensors
(3D columnar + Diamond)

Front End

New 3D ASIC developments to give
integrated track segment
information

L1 Trigger

Track trigger using 3D techniques

Data Transmission

Multi-wavelength
optical DAQ

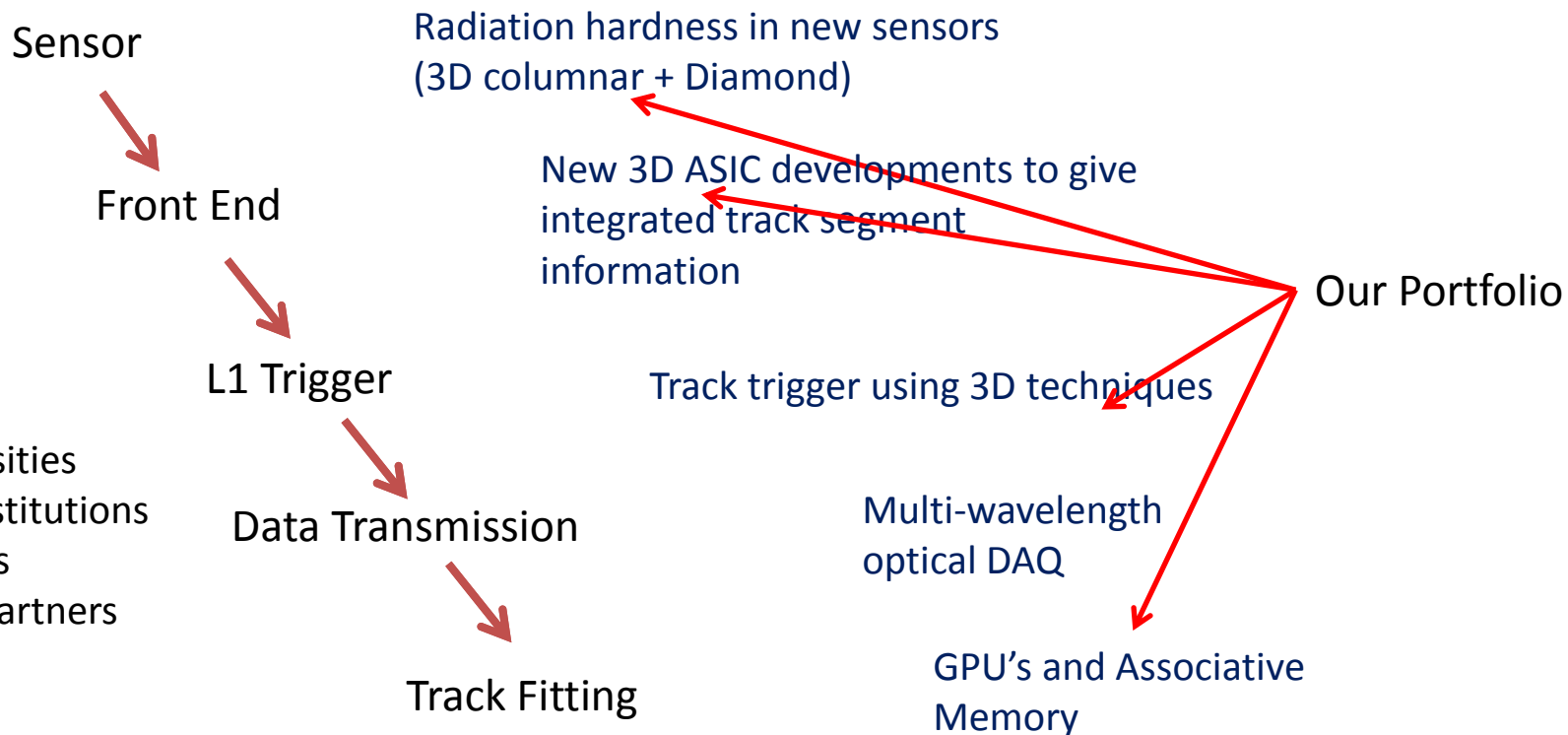
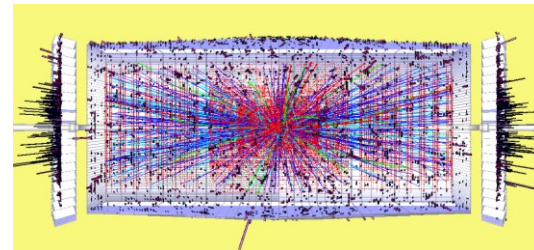
Track Fitting

GPU's and Associative
Memory

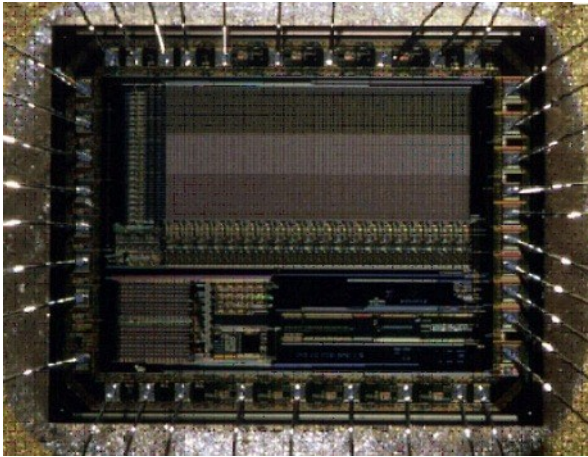
15 US universities
19 foreign institutions
5 laboratories
8 industrial partners

Frontier Detectors: an example

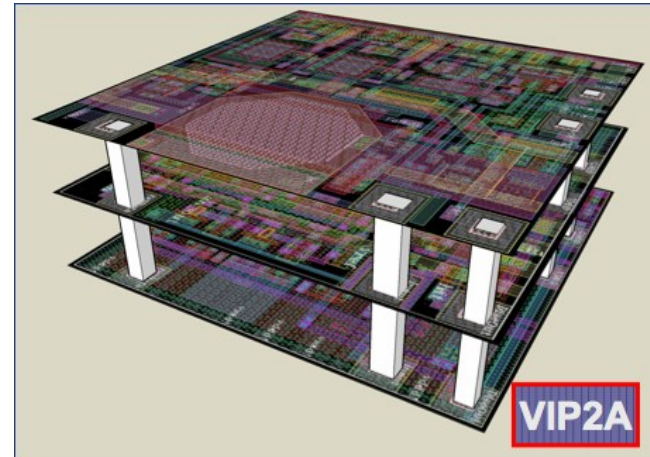
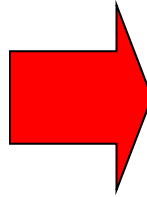
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3-dim ASICS Program



Conventional Monolithic
Active Pixel Sensor



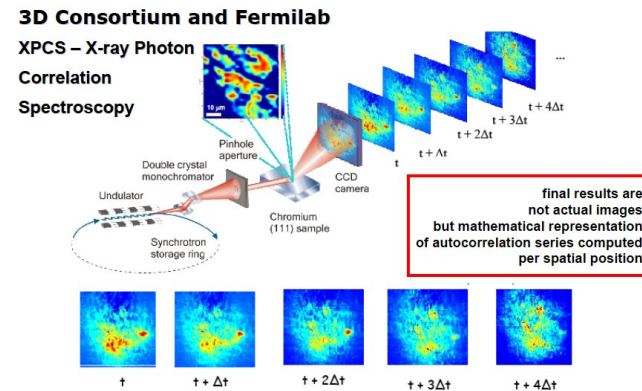
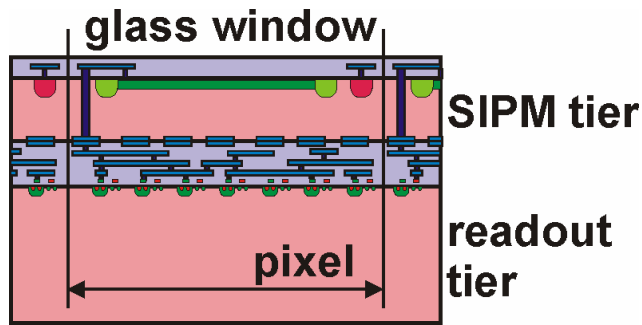
3 tier 3D stack for FNAL ILC vertex chip,
fabricated by MIT-LL

Fermilab has led the formation of a large international consortium (<http://3dic.fnal.gov>) addressing this new technology. This group of 17 members from 6 countries shared a multi-project run in 2009 and are still testing structures coming from that run.

A very important development has occurred in that the tools and techniques learned from this process have been adopted by the major silicon fabrication brokers: MOSIS, CMP and CMC.

Future 3D ASICS Activities

- 3D SiPM with active quenching and addressable subpixels (many possible collaborators)
- Collaboration with NSF/Northwestern University Imaging Center proposal
- Thinned sensors and readout for g-2
- X-ray imaging
- SBIR Collaborations with American Semiconductor, Vega Wave, Voxel

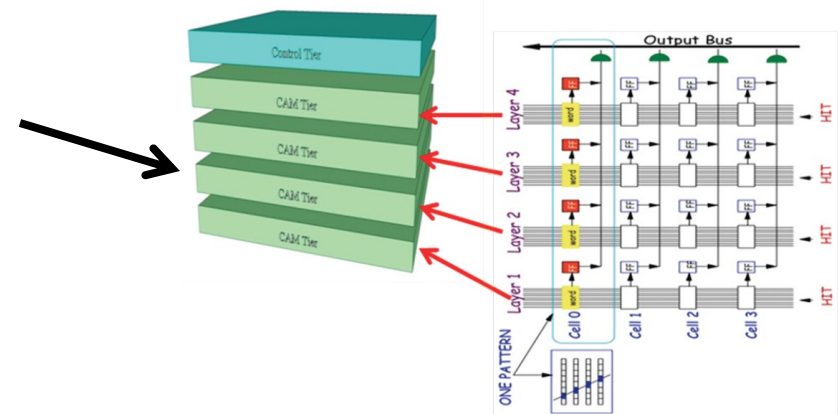


New Standards: xTCA

- ATCA = Advanced Telecommunications Computing Architecture.
- Large experiments (CMS, ATLAS, LHCb, PANDA, XFEL) are considering xTCA over VME.
- Task force at Fermilab formed including engineers from CD, PPD, and AD. Collaboration with SLAC
- L1.5 with embedded Associative Memory
- L2 with Graphical Processing Units



12U 14-slot ATCA



Challenges

- Use our comprehensive tracking detector R&D collaboration to engineer collider detector upgrades
- Prove Liquid Argon TPC as a cost-effective, high-efficiency detector for neutrino and dark matter detection
- Develop high-rate, ultra-low-mass tracking, and high rate, high efficiency photon detection for the Intensity Frontier rare decay program
- Fully streaming DAQ technologies: GHz front-ends to Peta-Byte data stores.
- Continue to explore extreme low-noise environment in CCD readout
- Continue outreach efforts. Detector R&D Summer Study immediately following Fermilab Users Meeting, focused on Intensity Frontier future detector challenges.

Conclusion and outlook – from a European Perspective

Close connections exist between FNAL and Germany (DESY in particular)

German groups for many years have collaborated on Tevatron experiments (e.g. KIT)

Intense cooperation on detector development for future facilities:

- Calorimeter development
- Silicon developments
- Test beam support and development

Cooperation already on 3D ASICS

Large overlap between interests and goals of both partners.

The Detector Portfolio can profit in many ways from a close cooperation with FNAL.
My impression is that FNAL is very interested in this, we should utilize this.