Fermilab

CAPTAN

COMPACT AND PROGRAMMABLE DATA ACQUISITION NODE

A GENERIC READOUT ENVIRONMENT FOR PROTOTYPE PIXEL DETECTORS

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LCTW09

Outline

- The CAPTAN platform
  - Objectives of the platform
  - System architecture
  - CAPTAN software
- Applications
  - Pixel applications
  - Telescope applications
  - Other applications
- Conclusion

What is the CAPTAN system?

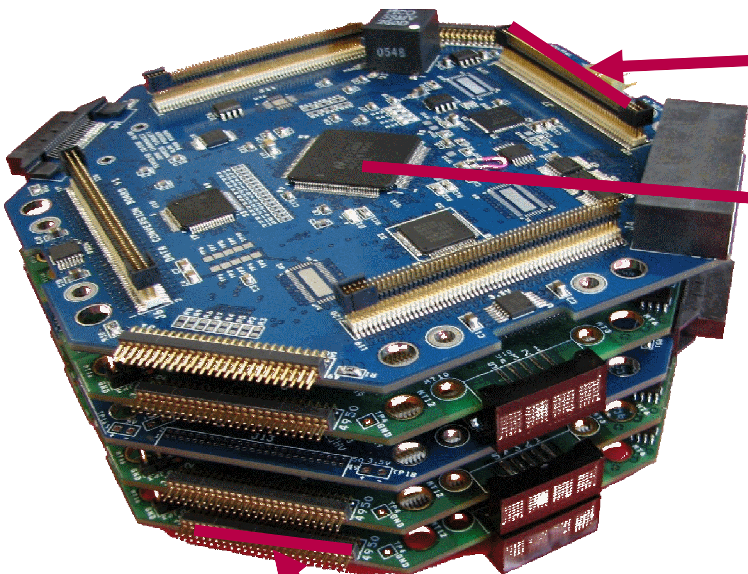
- It is a distributed system that uses a vertical bus based hardware and a series of specially designed core boards in order to implement a very flexible and expandable data acquisition, processing, control or communication platform.
- The CAPTAN platform is network based, systems based on the CAPTAN architecture can vary from a single board to a farm containing hundreds of boards.
- The CAPTAN architecture is intended to be open with a few core boards, allowing users to make their own custom system.

What are the CAPTAN system applications?

- The target application of the CAPTAN system is as a high energy physics data acquisition system. Examples of such applications are tracker readout systems, R&D test stands, and imaging DAQ.
- Another possible application of the CAPTAN system is data processing.
- As the CAPTAN system is a modular system it can be used for a wide range of applications, from very small to very large.

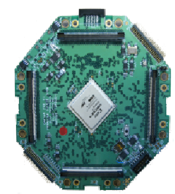
How the CAPTAN system works?

- There are three basic concepts behind the system;

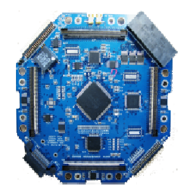


1)Vertical standard bus

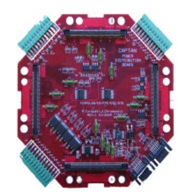
2)The core boards:



NPCB – Node Processing and Control Board



DCB – Data Conversion Board

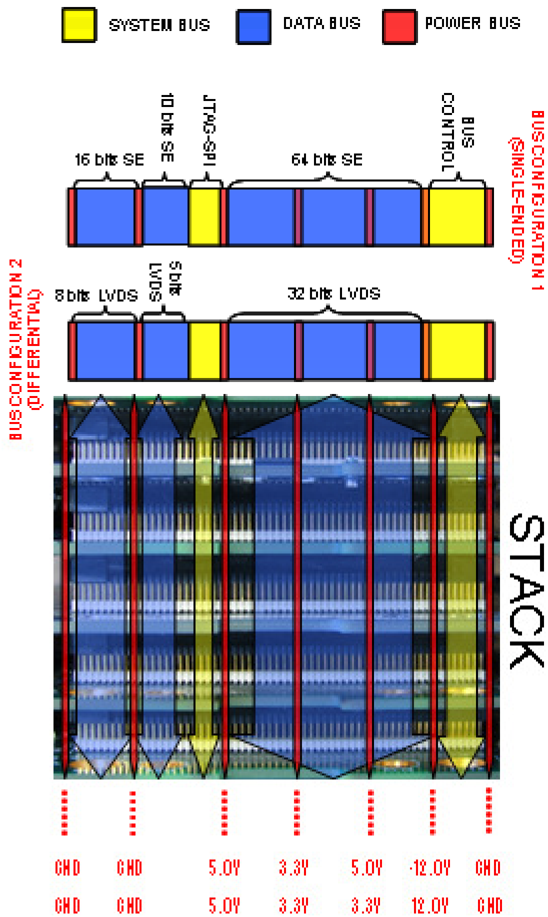


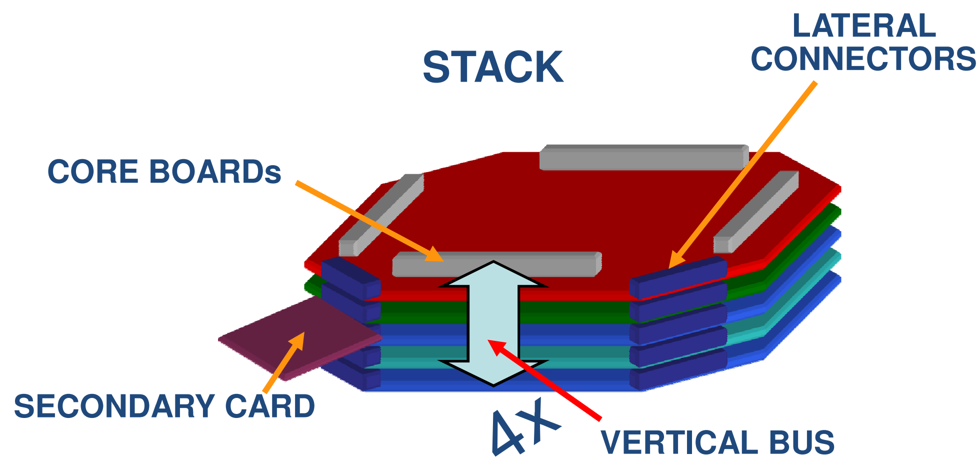
PDB – Power Distribution Board

3)Horizontal connectivity

- **Interface Boards**
- **Gigabit Ethernet Link**
- **Level Translator**
- **USB**

The Vertical Bus





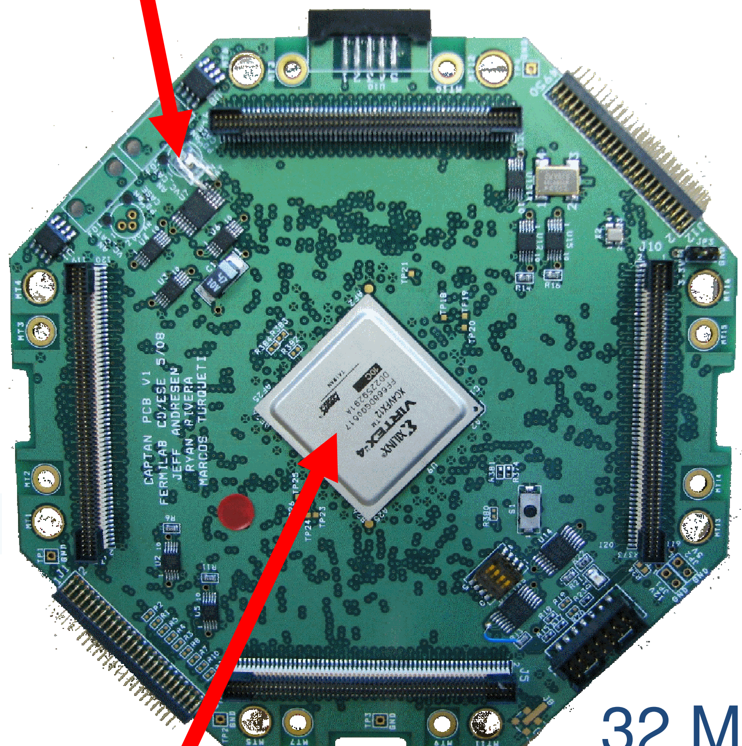
BUS Limitations

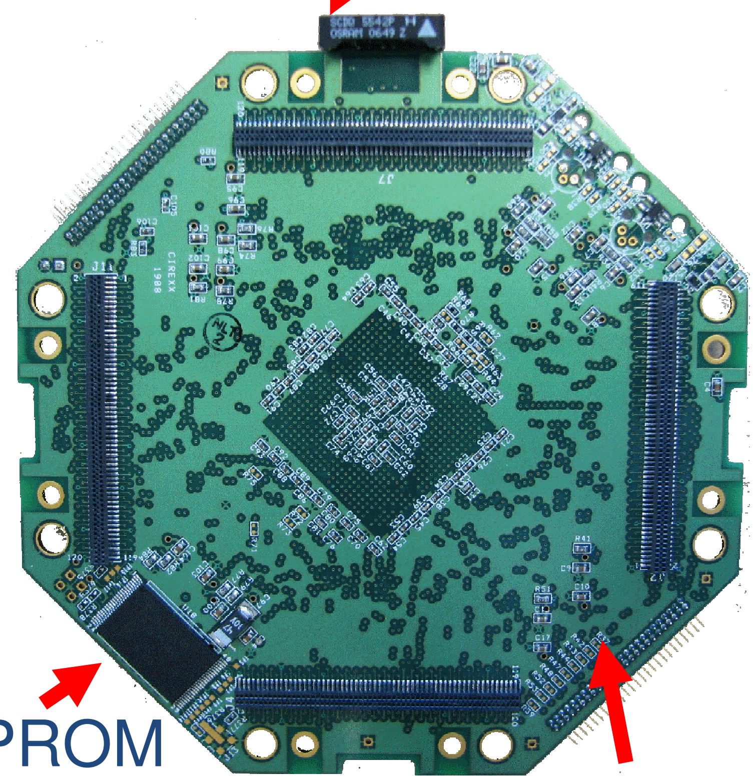
# of boards on the stack	1	2	3	4	5	6	7	8	9
max bus speed MHz (LVDS)	500	450	400	320	240	200	160	125	100
max bus speed MHz (LVCMOS)	400	300	260	125	100	80	66	N/A	N/A

NPCB – Node Processing and Control

Intra stack opto-link

4-digit display



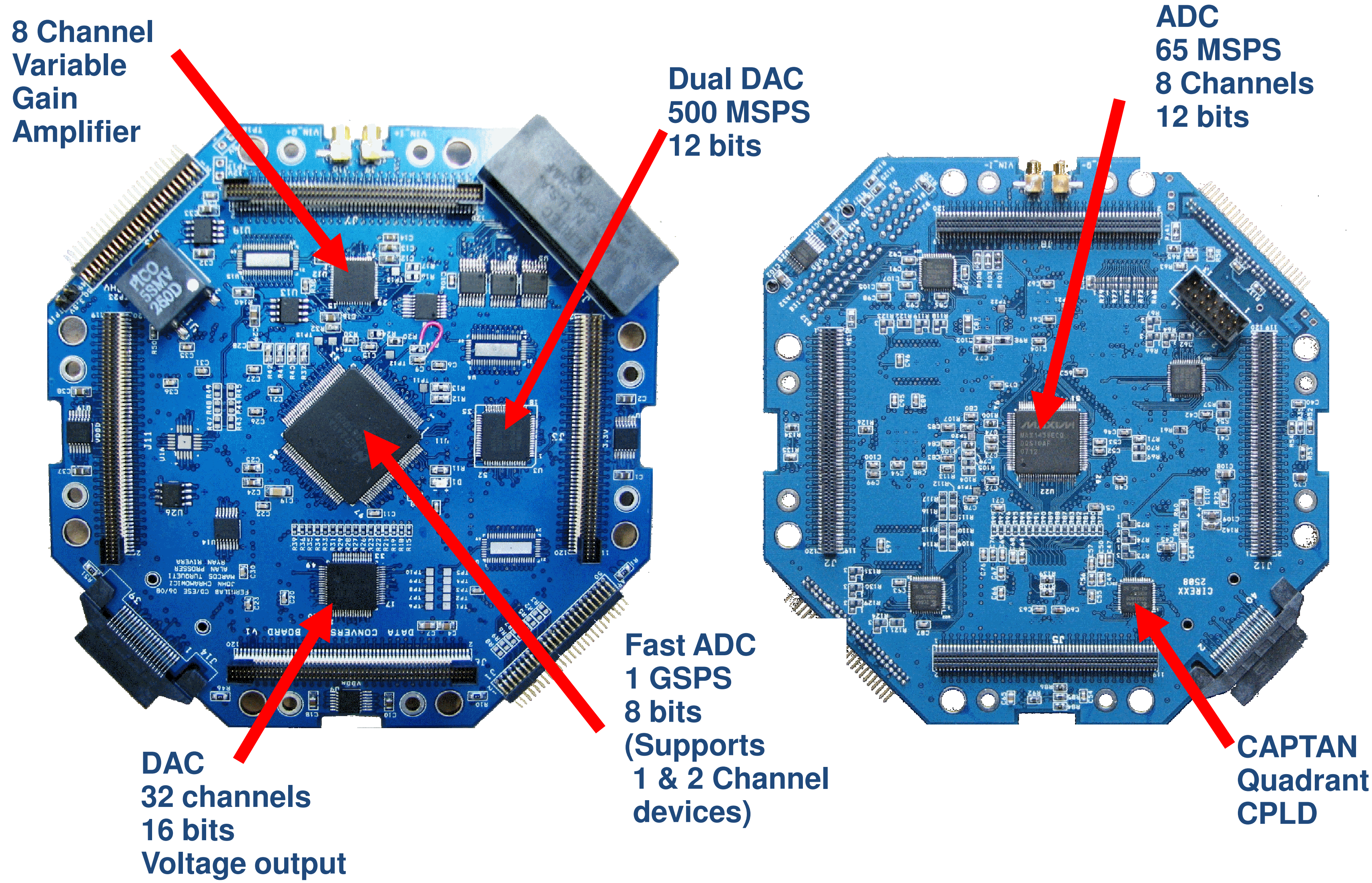


32 MB EPROM

GIGABIT LINK

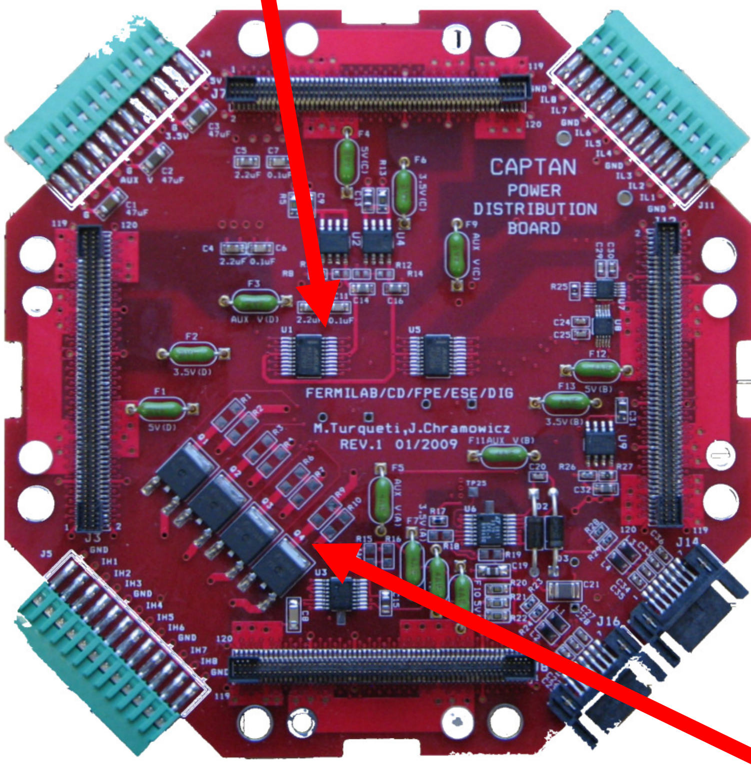
Supports 7 types of FPGAs

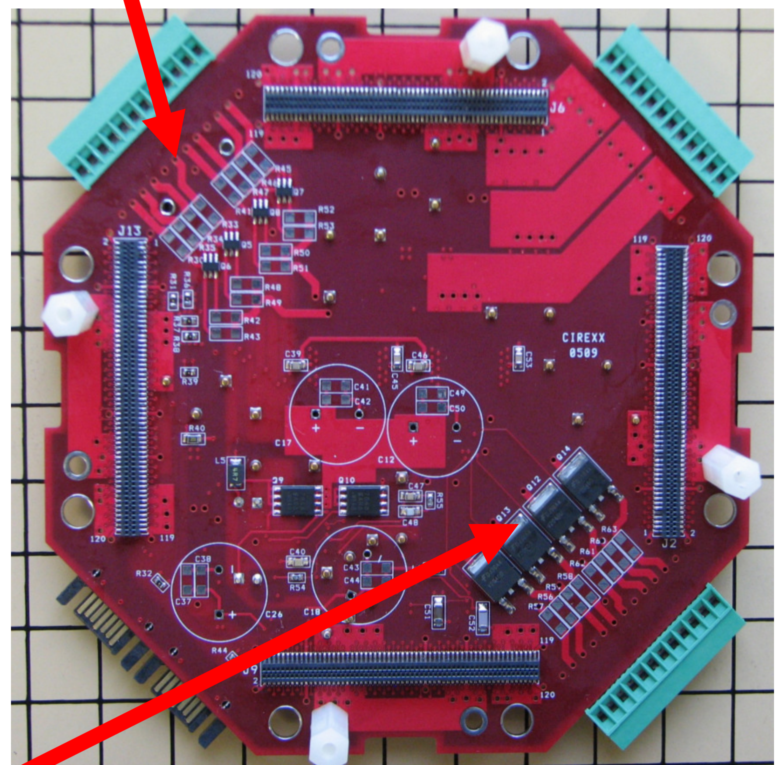
DCB – Data Conversion



PDB – Power Distribution Board

VOLTAGE REGULATORS **HIGH FREQUENCY FETs**

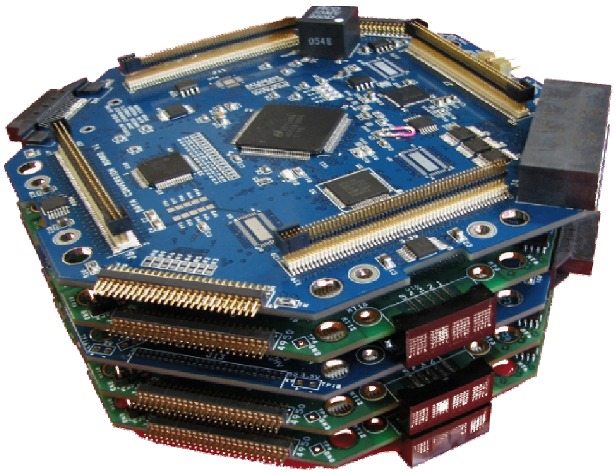




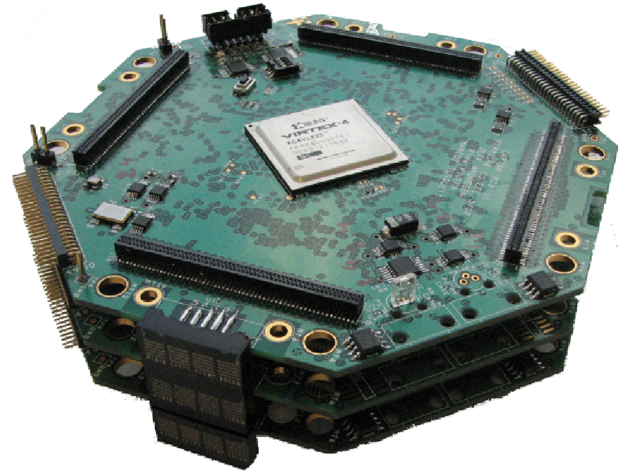
HIGH POWER FETs

The Node

MIX STACK DCB+NPCB



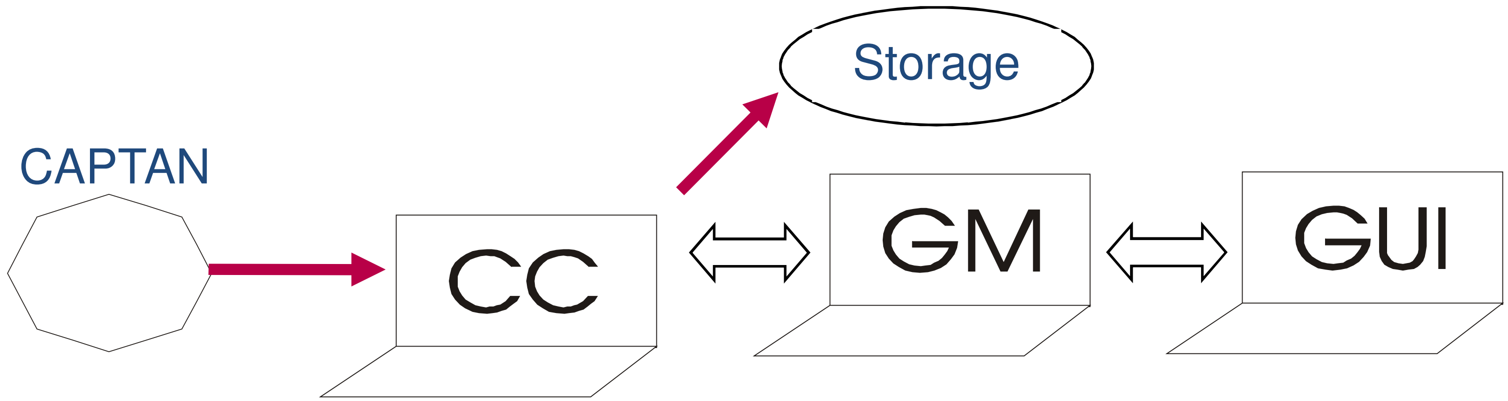
NPCB ONLY STACK



Nodes are core board stacks that can serve any of the following purposes:

- DATA ACQUISITION
- DATA PROCESSING
- COMMUNICATIONS
- POWER DISTRIBUTION/ DRIVER

Software Architecture

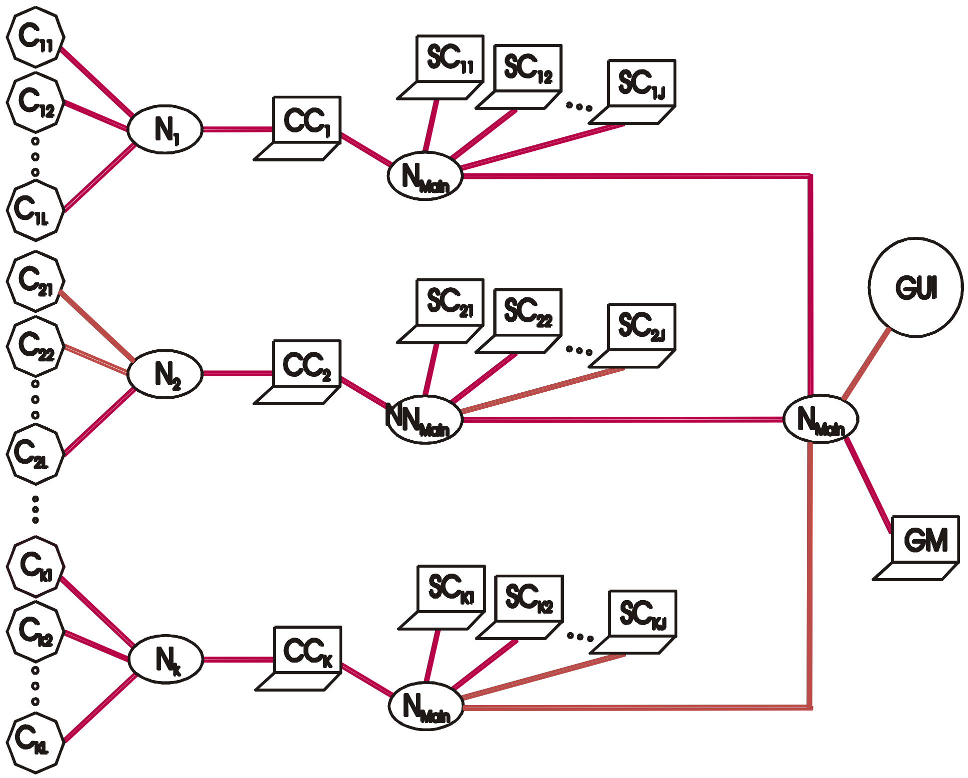


- The CAPTAN system is meant to be used in a network environment and therefore a great deal of planning was dedicated to the software architecture.

- Above the CAPTAN and User sides are better defined. The CAPTAN Controller (CC) is shown as the go-between for the Global Master (GM) and a CAPTAN. The CAPTAN Controller also has access to permanent storage which may be local or remote.

- The GUI is the access point for users to the control and acquisition features of the system. The GUI can either be a stand-alone application using TCP/IP or a web based application using HTTP to communicate with the GM.

Network Based Software



This figure represents the wide range of CAPTAN network topologies supported by the software solution. C stands for CAPTAN, N for Network, CC for CAPTAN Controller, SC for Storage Controller, GUI for Graphical User Interface, and GM for Global Master. There can be only one GM, but the rest of the processing blocks may be replicated.

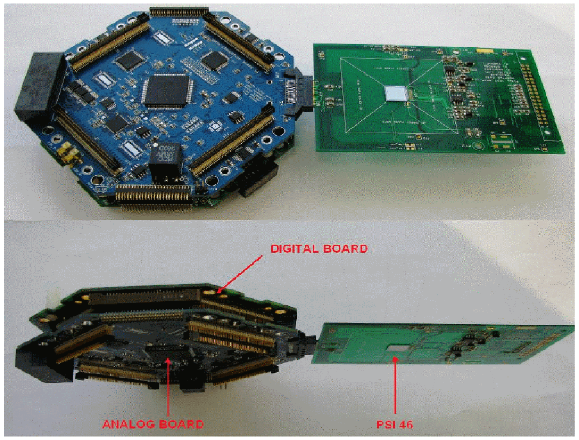
The simplest test stand system would have $K = 1$, $L_1 = 1$, and $J_1 = 0$ within the topology. And the CC, GM, and GUI would all run on the same computer with a CAPTAN connected through the computer's Ethernet interface.

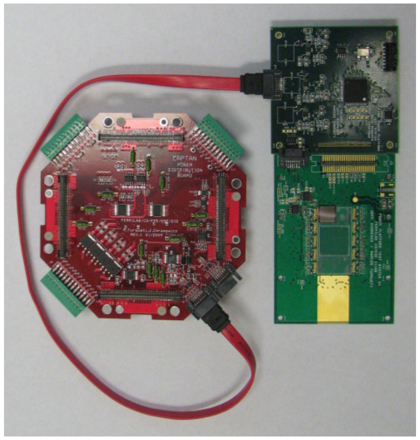
Isolated networks are shown to demonstrate that CAPTANs need not be on the main network that may be shared by an entire facility. This helps allay potential network security concerns.

CAPTAN for General Pixel Applications

• The CAPTAN system's main goal was to provide full support for readout and data processing for pixel devices. The system was designed such that the same hardware could be used for test stands, test beams, and experiments - composing in this way a complete solution for pixel based detectors.

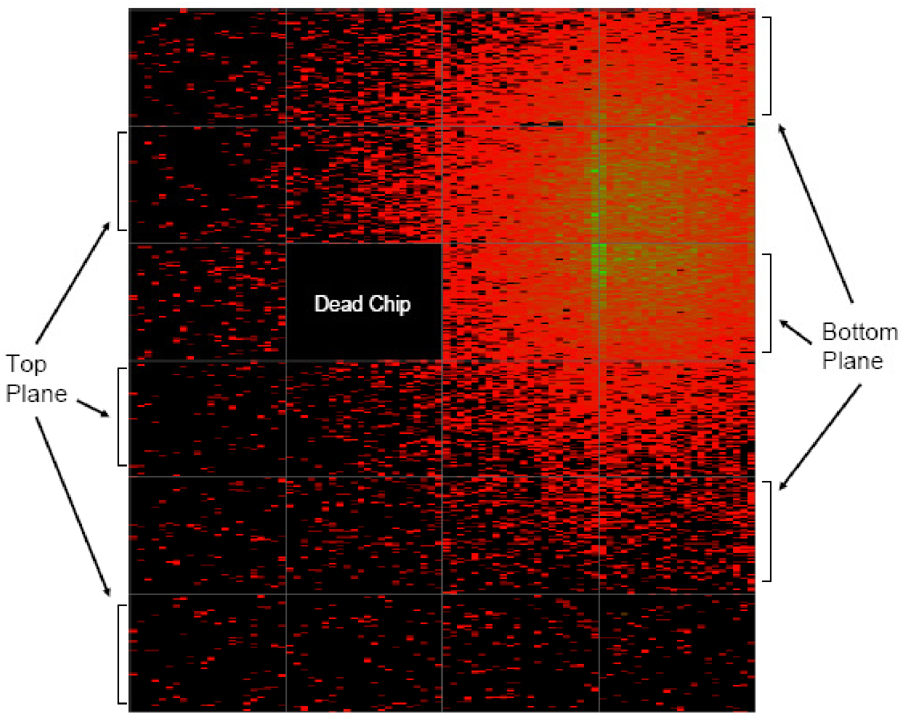
• So far the CAPTAN system is being used in several different test stands for pixel R&D as well as for test beam trackers.

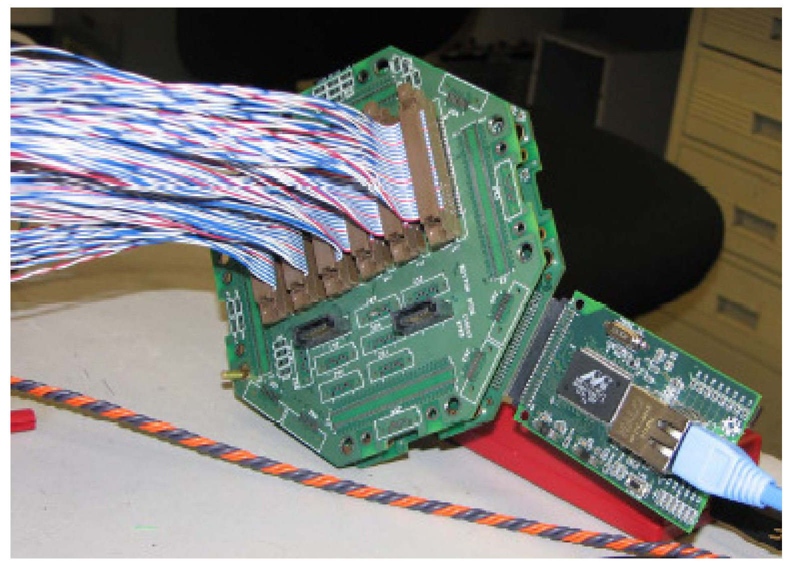




Above are two different test stands for pixel R&D for CMS.

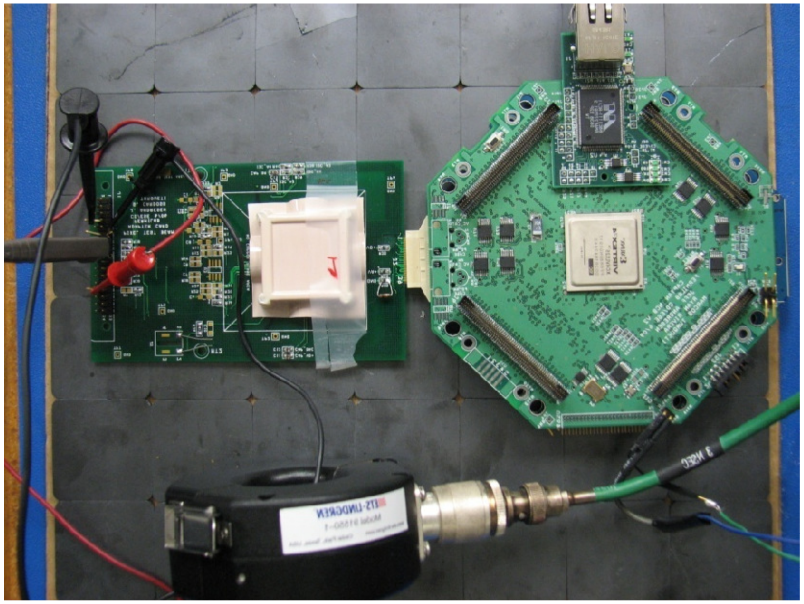
CAPTAN for General Pixel Applications Cont.





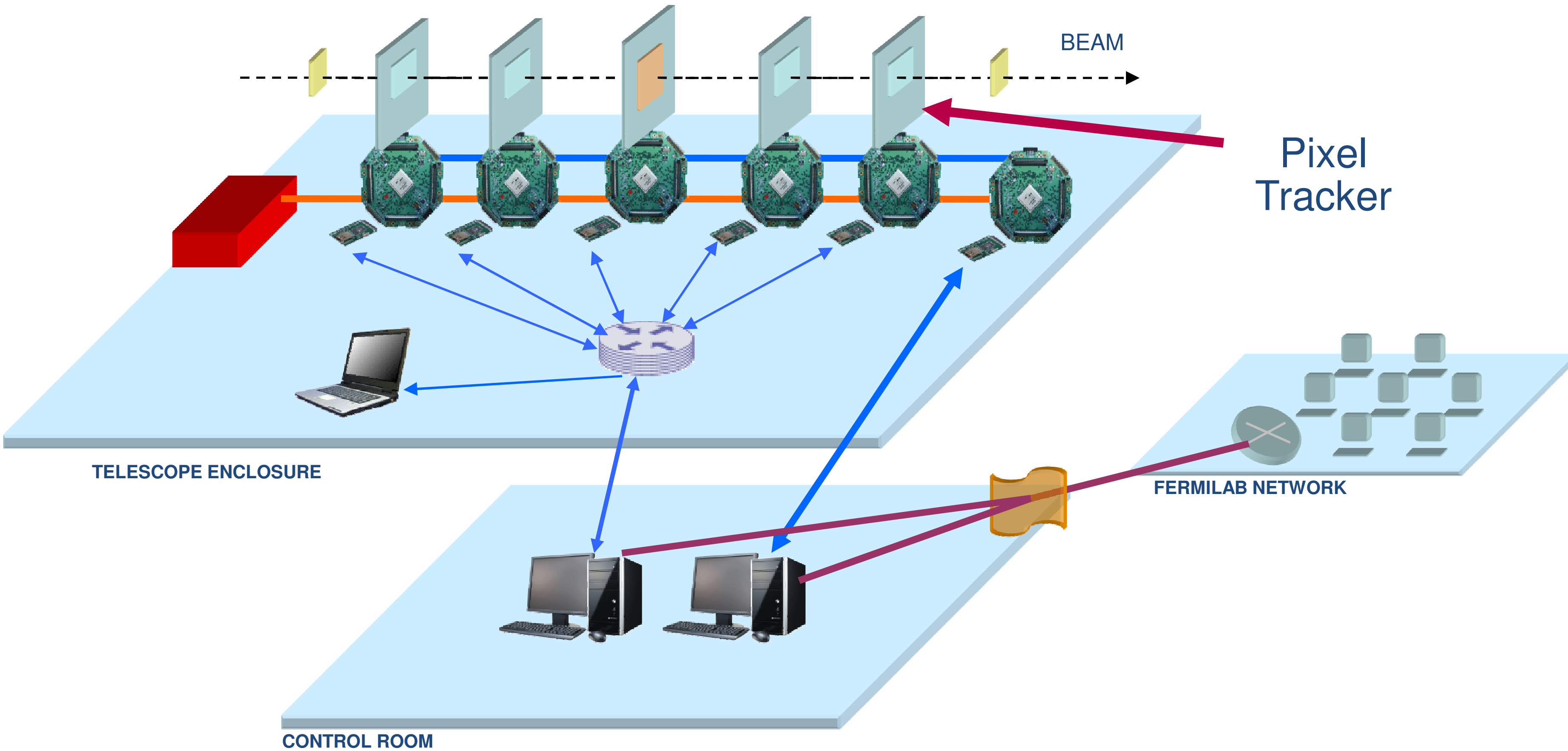
Shown here is a single CAPTAN reading 360,448 channels from 6, 4x1 FPix2.1 modules.

CAPTAN for General Pixel Applications Cont.

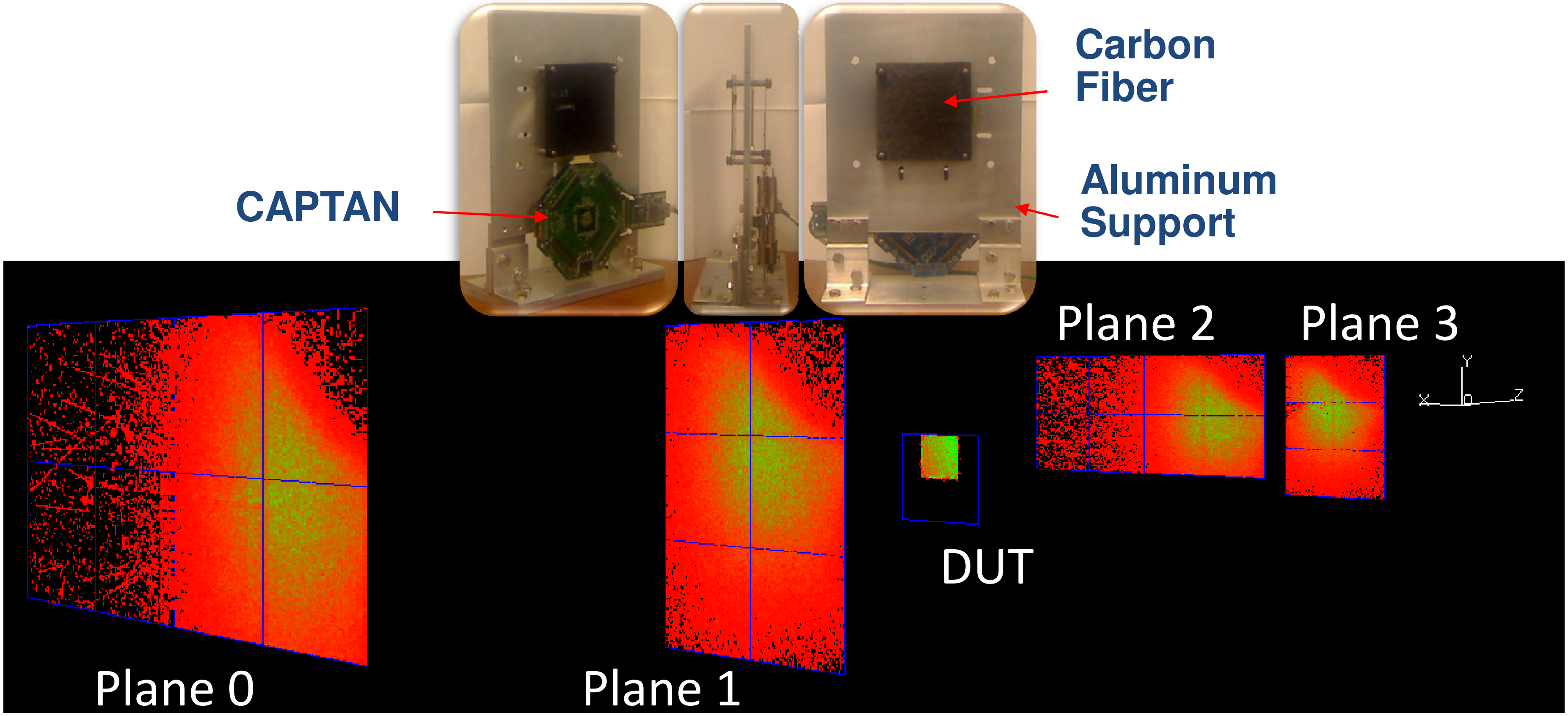


The CAPTAN is being used here for CMS pixel power studies.

CAPTAN for Tracking Telescope Applications

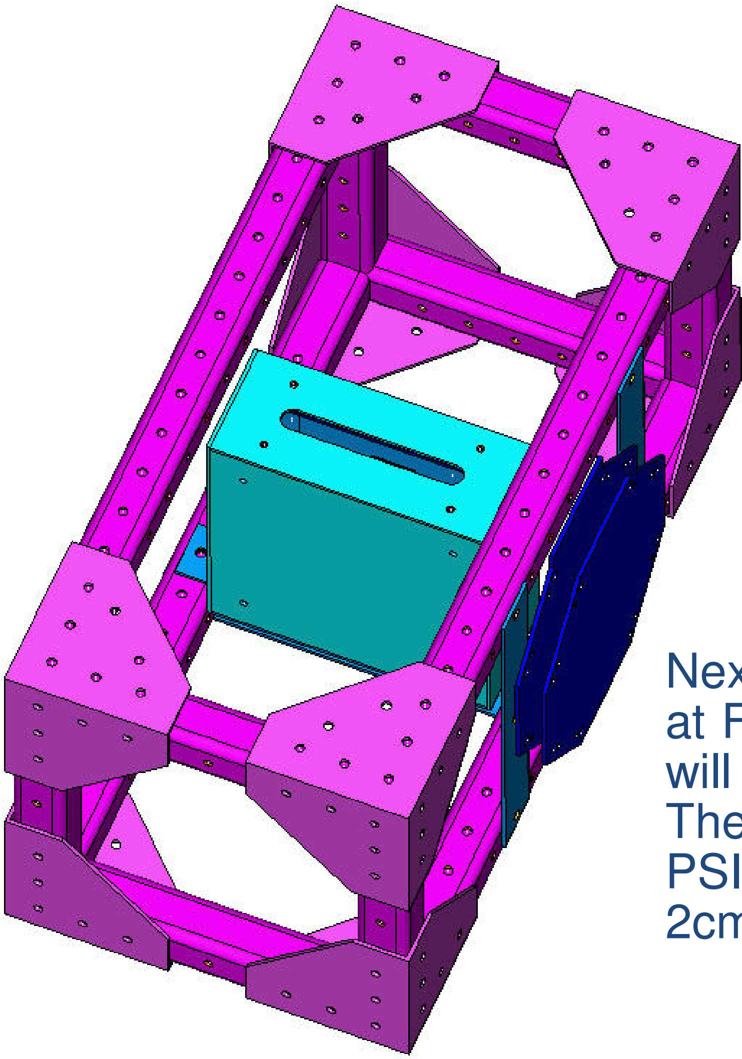


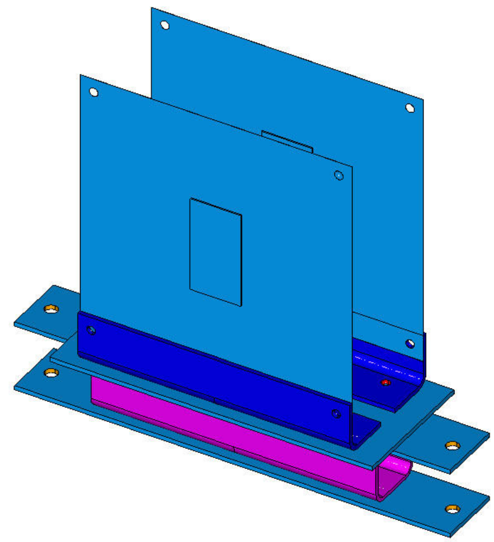
CAPTAN for Tracking Telescope Applications Cont.



Beam spot from a test beam run completed in May 2009 at Fermilab's Meson Test Facility. Alignment and analysis software for test beam run done by ESE at Fermilab.

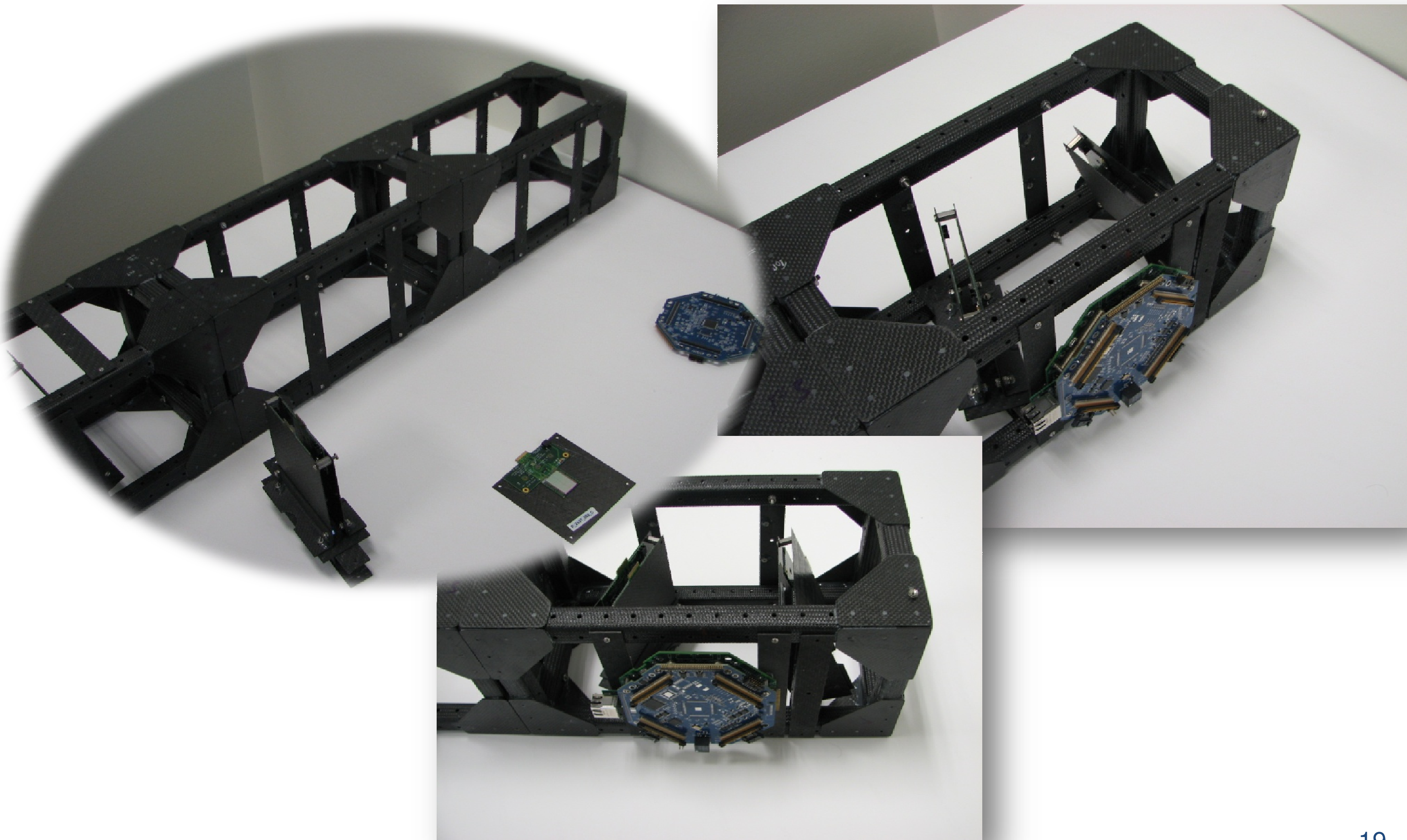
CAPTAN for Tracking Telescope Applications Cont.



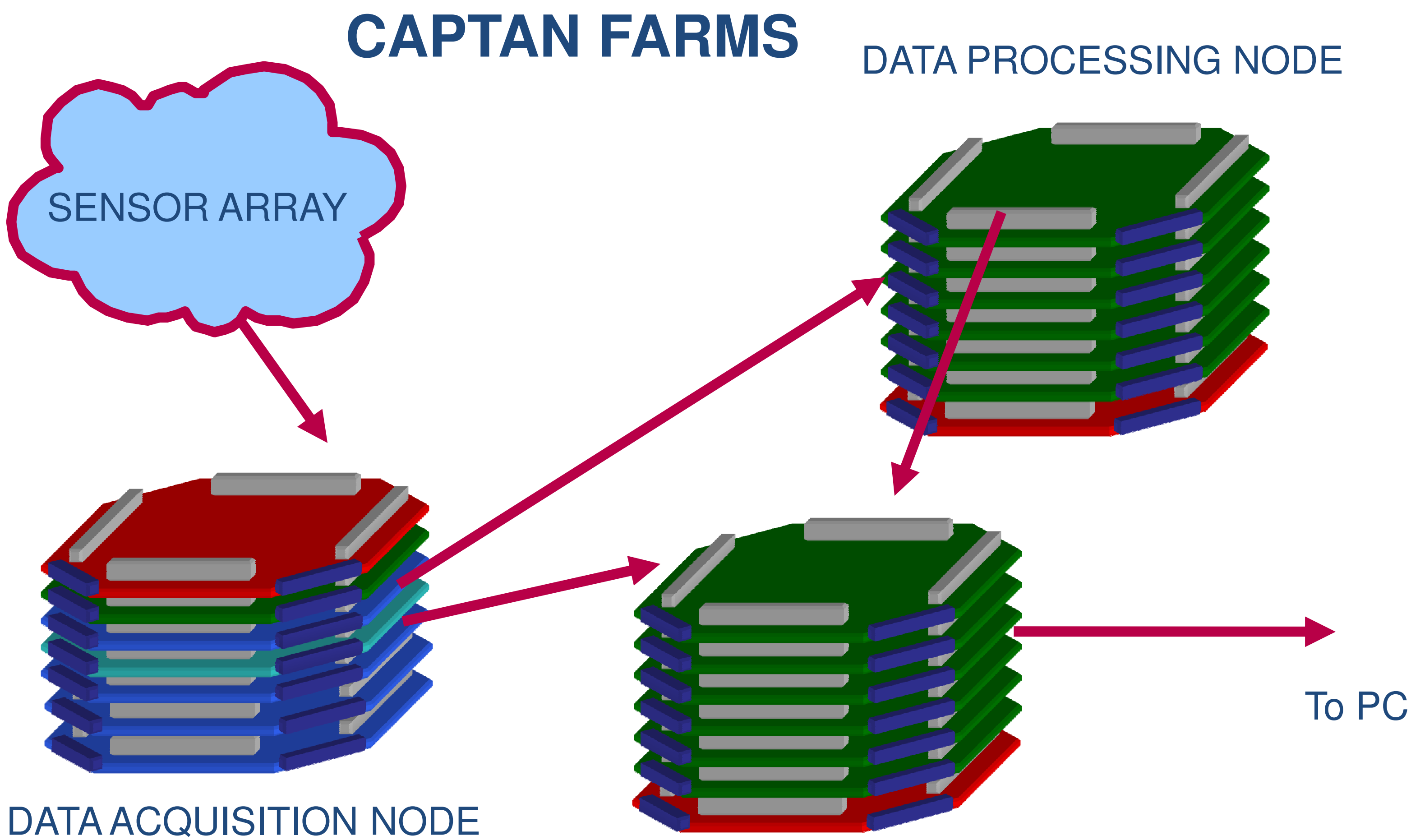


Next test beam run planned for December, 2009 at Fermilab. A new low-mass carbon fiber frame will be used to house the telescope hardware. The telescope will consist of 8 planes of CMS PSI46 pixel chips with a sensitive area of about 2cm x 2cm. Pixel size is 100 x 150 microns.

CAPTAN for Tracking Telescope Applications Cont.



CAPTAN for Other Applications



Conclusion

- The CAPTAN system is a distributed data acquisition and processing system.
- Network based DAQ.
- Very flexible, can deal with small applications as well as large ones.
- Users can customize their own system by using the core boards along with user boards.
- Current users are Fermilab, INFN, Brown Univ., IHEP at Beijing, and IIT.
- The system is operational and continually evolving.

For more information on the CAPTAN system please visit our website at:
http://www-ese.fnal.gov/DIG_Test_Stand/index.html

or

Email: rrivera@fnal.gov

Acknowledgements

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