Quad module development for the ATLAS Pixel Detector upgrade

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High Luminosity LHC Readout for Pixel Detectors

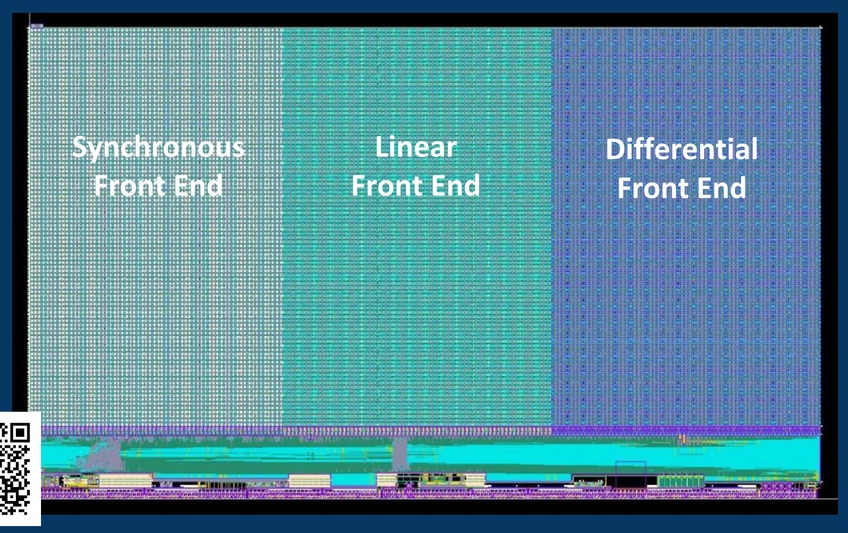
RD53A:
Cross-experiment collaboration of ATLAS and CMS developing pixel readout chips to face HL-LHC requirements

	Current Tracker	HL-LHC Tracker
Pixel Size	50x250 µm^2	50x50 µm^2
Pixel Hit Rate	400 MHz/cm^2	3 GHz/cm^2
Trigger Rate	200 kHz	1 MHz
Trigger Latency	6.4 µs	12.8 µs
Radiation Tolerance	300 Mrad	1 Grad
Current Consumption	20 µA/pixel	<8 µA/pixel

See RD53A talk by Elia Conti

- RD53A implements 3 analog front end designs in chip architecture.
- Differential Front End chosen from prototype results of FE65-P2 chip

See FE65-P2 talk by Timon Heim



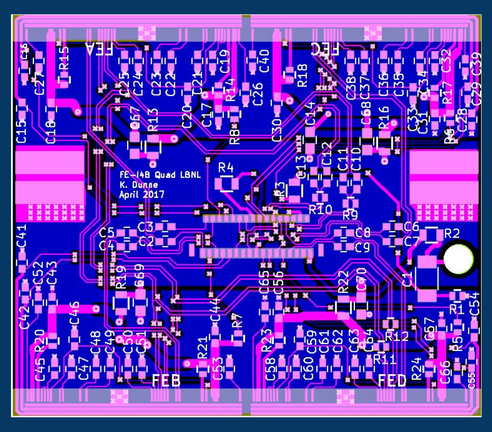
FE-I4B Quad Modules

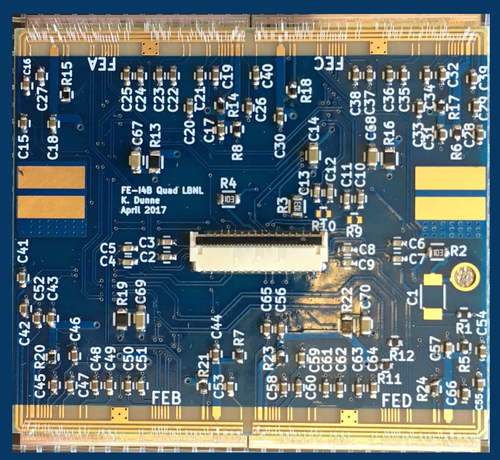
5 FE-I4B quad modules have been assembled and tested at LBNL. Modules provide experience in

- Hybrid circuit board design
- Module handling / flex cable connection near wire bonds
- Service cabling
- Serial power distribution

Hardware Specifications

- 15 mil rigid PCB
- Electroless nickel immersion gold (ENIG) for wire bonding
- Plated hole for high voltage wire bonding directly to sensor surface





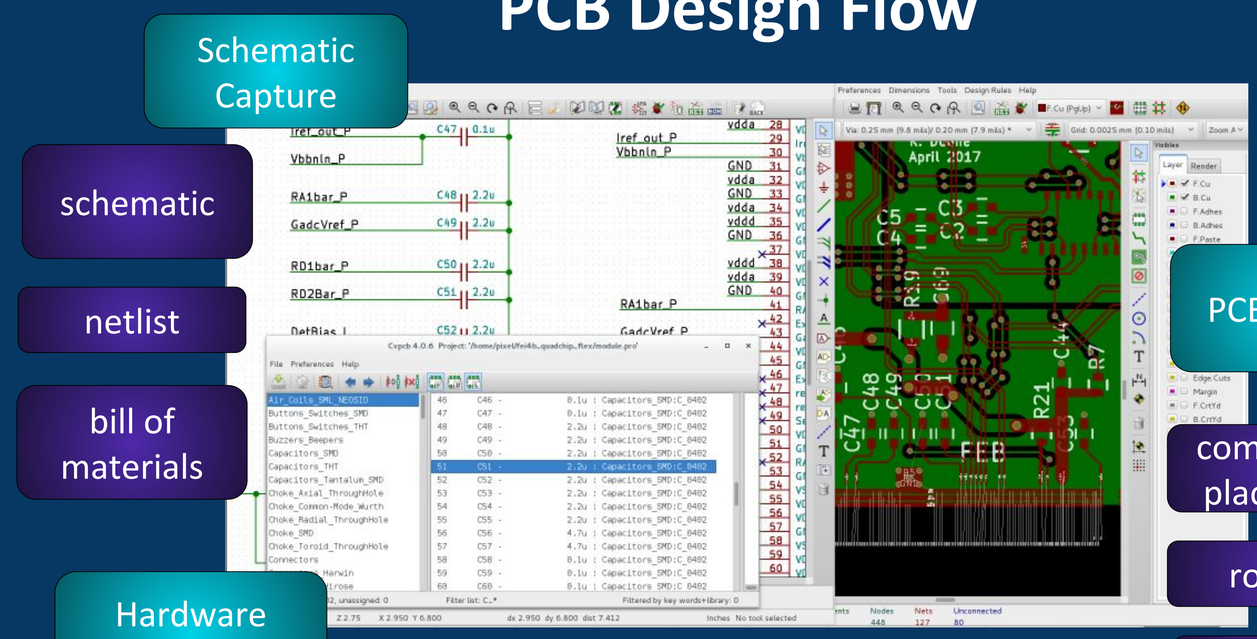
36 mm

Computer aided design layout of hybrid PCB

42 mm

Assembled quad module with four wire bonded FE-I4B chips

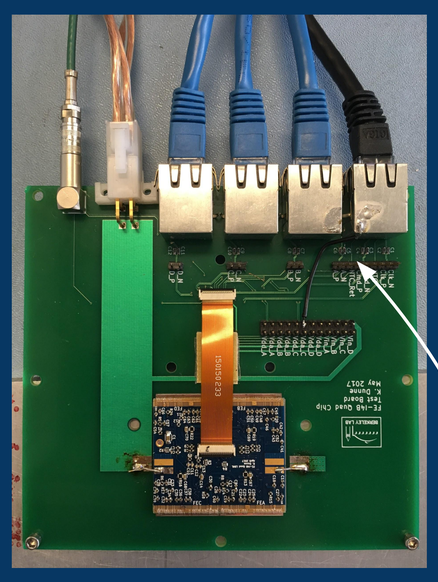
PCB Design Flow

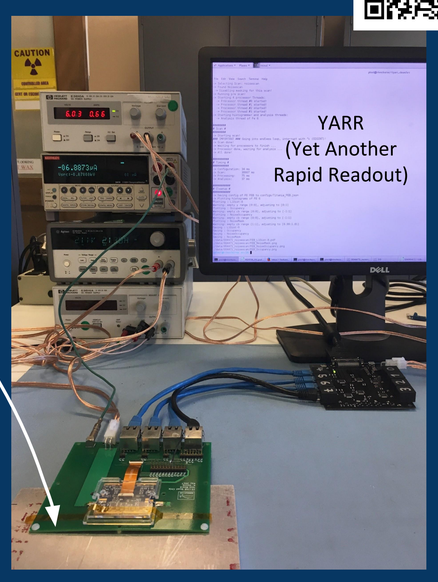


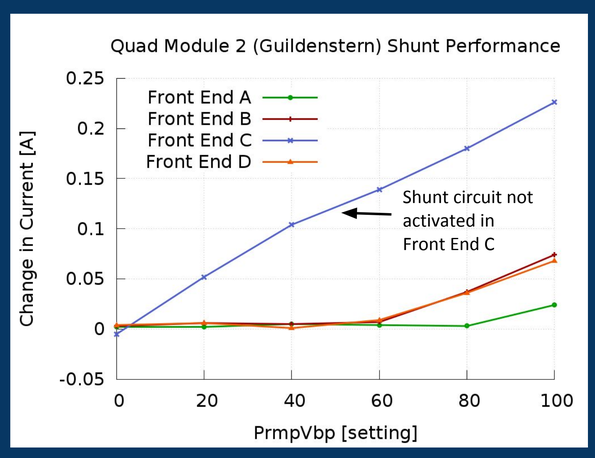
Module Characterization

See YARR poster by Nikola Whallon

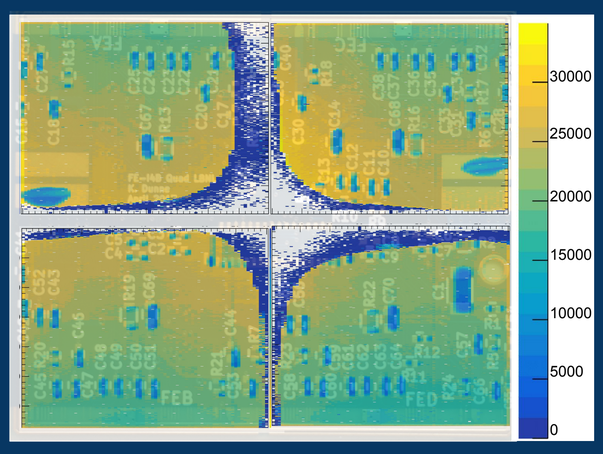
- Solder pads provide power I/O
- Data In/Out is routed through RJ45 connectors.
- Power is supplied with a molex connection
- High voltage sensor biasing with lemo connector





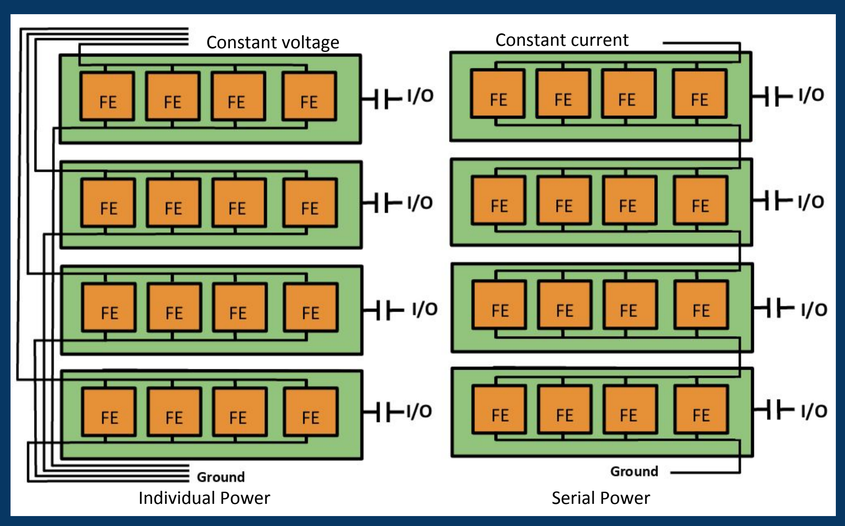


Current fluctuation during chip configuration versus increasing analog current (controlled by register PrmpVbp).

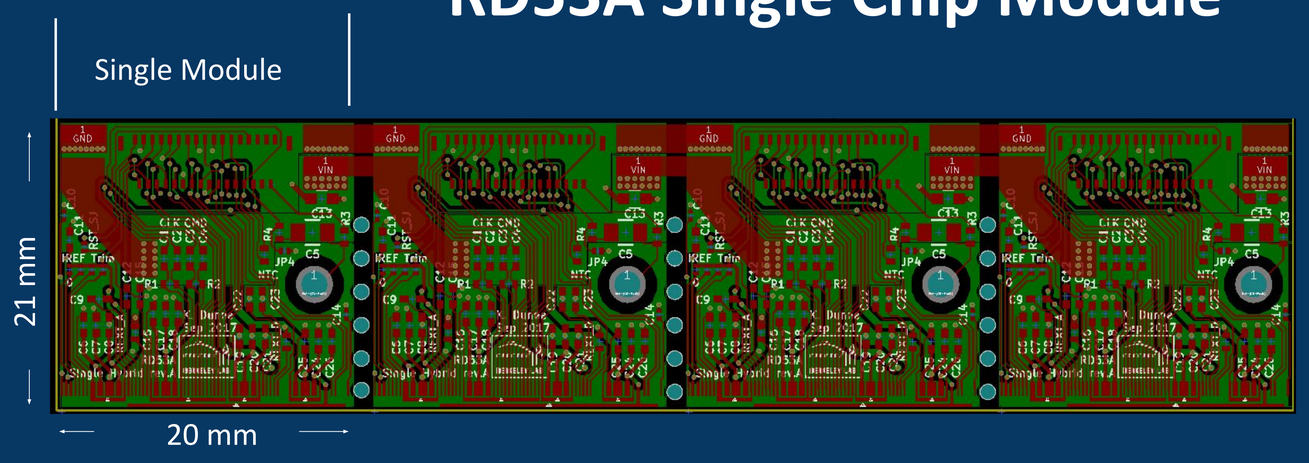


Self-Trigger scan results from 19 hour Am-241 irradiation. Effect on edges from unconnected pixels.
Overlaid onto board geometry to show shadow regions from components

- Serial power baseline distribution for upgraded tracker
- Tests underway with FE-I4B quad modules
- Same Shunt-LDO regulators as in RD53A



RD53A Single Chip Module



- 10 mil rigid PCB
- Manufactured with 4 boards already connected in parallel.
- Single boards can easily be cut apart
- Sets of four can be connected in serial
- Design of quad module (one connecter) underway

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