FCS frontend electronics and some related items

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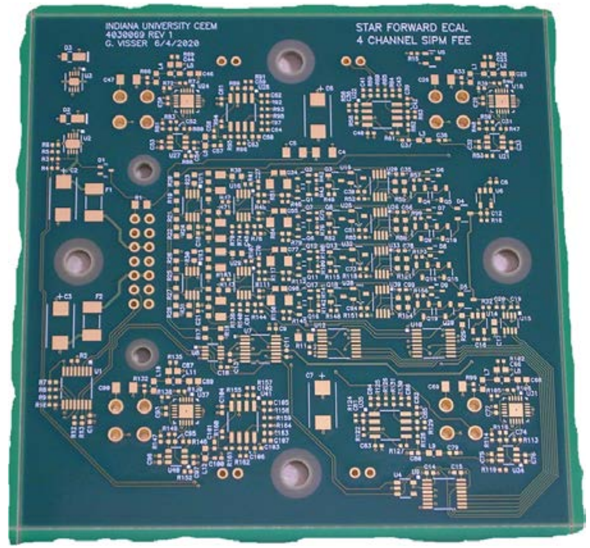
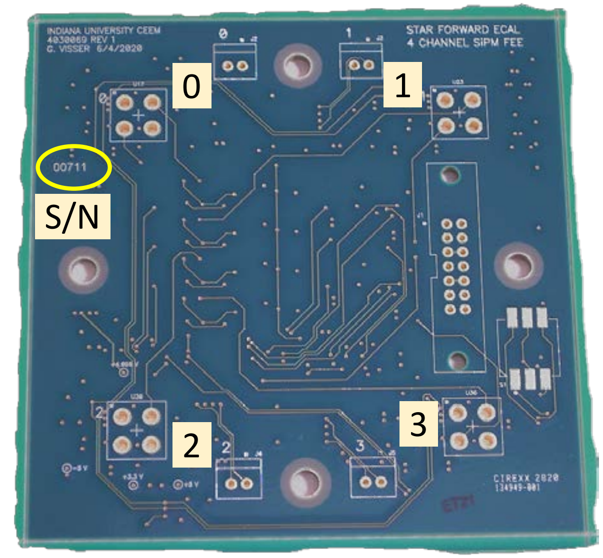
STAR forward upgrade meeting 7/21/2020

new (REV1) ECAL FEE PCB

- All PCB's in hand (420)
- 4 × 2 array for assembly
- finally, all parts in hand (after last minute crisis with one key part)
- quotes (5) in, we will go with SAS Manufacturing, an LA area vendor I have used often, has best price
- Working on the order now, w/ Mike (OSU)
- Some boards in 3 weeks, balance in 4 weeks after order
- HCAL boards & assembly following along asap; basically same revisions correspondingly; same vendors





Change list (executive summary)

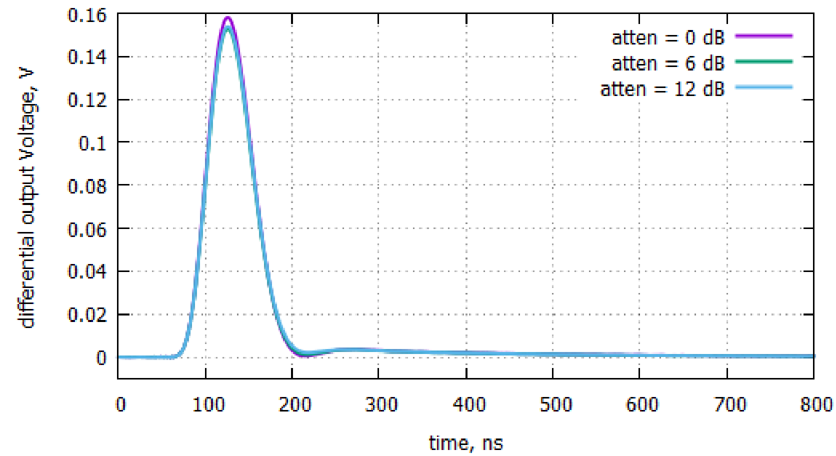
- add resistor patched on 2019 boards (fix the monitoring bug)
- shorter pulse width, slightly improved tail
- about 4x higher gain (in terms of pulse height / charge in)
- improved bias voltage transient response (larger bypass capacitor, short term higher current limit) → more stable SiPM gain
- moved address switch (was in the way of pogo pin soldering)
- reduced fuses to 250 mA (more appropriate value)
- added unique serial number in silkscreen
- + a few layout improvements

No changes to interfaces (mechanical or electrical)

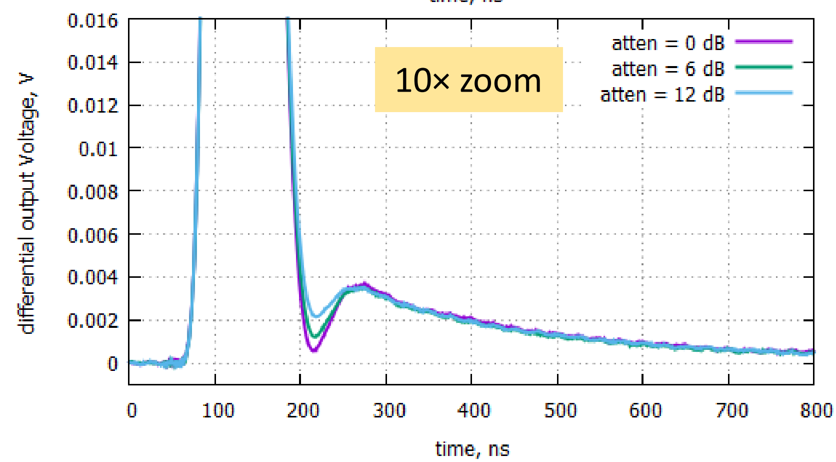
annotated changes on schematic: http://npvm2.ceem.indiana.edu/~gvisser/STAR/FCS/FEE/ECAL/4030068-REV1_STAR_FCS_ECAL_FEE__sch_REV1_changes_annotated.pdf

new (REV1) ECAL FEE PCB

- laser signals, 68.0 V bias →
- laser amplitude adjusted to match output at various attenuator settings
- final component values for REV1 assembly

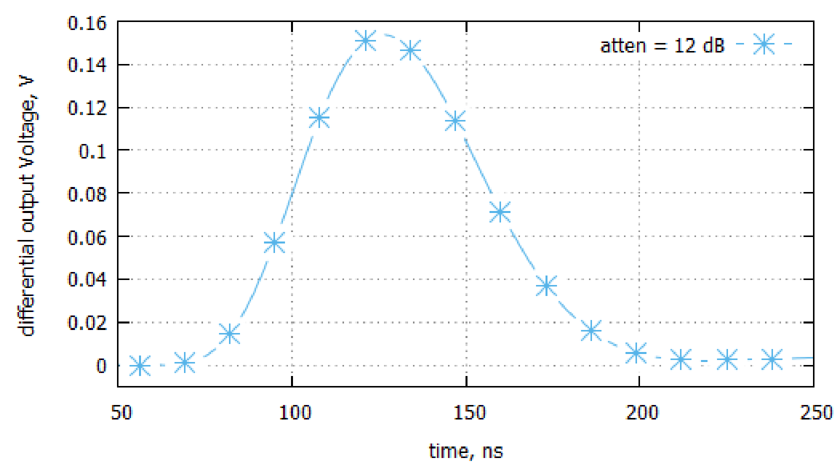


- there is still a long tail ~2% of peak amplitude; unfortunately an unavoidable “feature” of this attenuator IC
- if it *really* matters, we have to cancel it in DEP firmware
- anyway, remember there will be also an O(1%) tail due to cable losses



showing (approximate) 80 MSPS sampling, i.e. DEP-eye view

note sum ≈ 4.5 × peak
(was 7 × peak in 2019)
→ about half the resolution now



ECAL/HCAL FEE production test

We will test the following items in production:

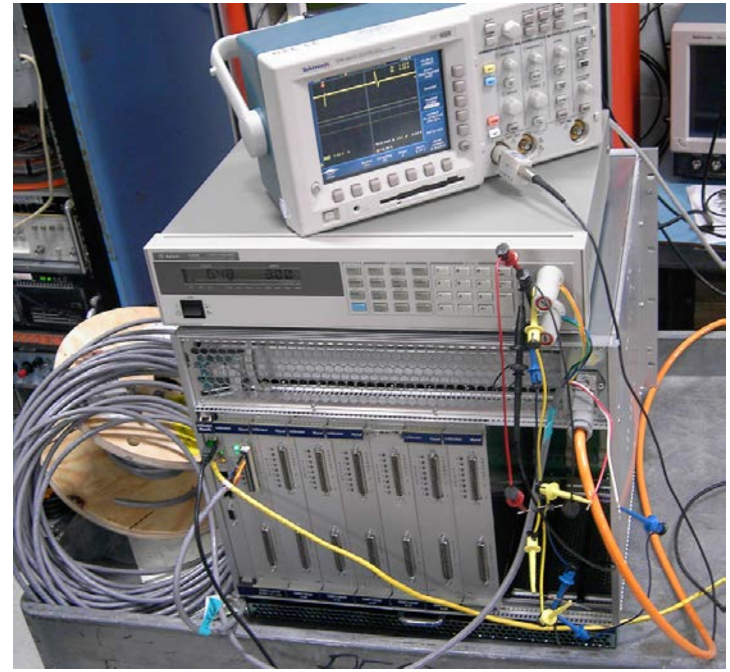
- Pogo pin visual and travel (fingertip) inspection
- Supply currents (abnormal value usually indicates a problem)
- Regulated supply voltage quick DMM check (data not saved)
- Read serial number repeatedly to check communications, record all test data automatically w/ serial number
- For each channel:
    - Check bias voltage vs. DAC (5 – 10 points TBD). This will be fitted for the slow controls bias voltage calibration V=m*DAC+b
    - Check bias voltage at 1 – 2 points with load resistors
    - Check bias slope compensation with fake thermistor
    - Check IMON values for that too
    - Check DC signal output levels (i.e. pedestal) w/ no signal
    - Check signal output waveform with simple test pulse input (in place of SiPM)

The test system to do this will consist of DMM, power supply, scope (not DEP) for signal measurement, and a test board that makes contact w/ pogo pins for ECAL and has “SiPM” cable for HCAL.

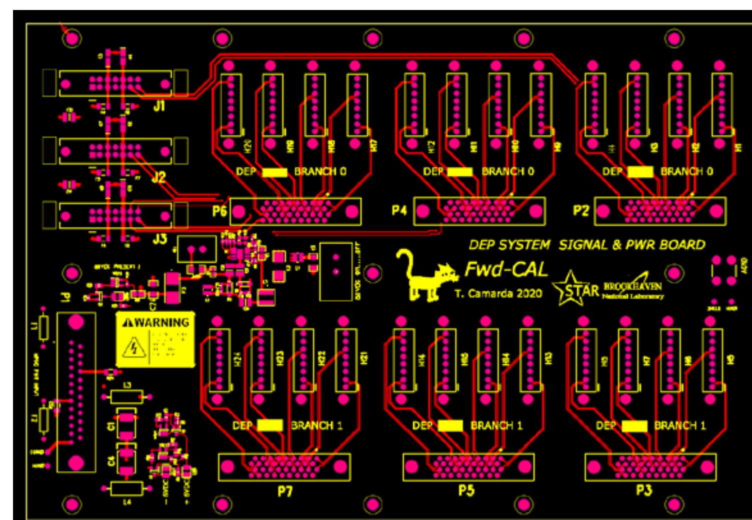
Hannah is writing test software now and will run most of the tests, Gerard is preparing test board and of course will be helping w/ tests at least initially.

ECAL+HCAL LV & slow controls

- power is served to 3 rows of ECAL or HCAL from each patchpanel board; not all PPB are used for power feed, some are for signals only
- this requires 2×6 power PPB for ECAL, 2×4 for HCAL
- each PPB takes +6.5 V and −6.5 V input, and generates +80 V internally
- for LVPS, use Wiener MPV8016 which provides 2 connectors with 4 LV channels each, 5 A up to 16 V
  - one long power cable = four channels = power for two PPB's; Y breakout at the detector end
- typical idle load currents
  - +70, −60 mA per FEE (ECAL)
  - +3.23, −1.98 A per full PPB (ECAL) including 80 V supply with max SiPM load (full radiation damage)
- MAX load w/ signals +4.45 , −2.90 A
- I2C controls happen through same horizontal flat cables on detector as carry the power
  - one row = one control group
  - 2×17 half-DEP for ECAL controls, 2×10 for HCAL



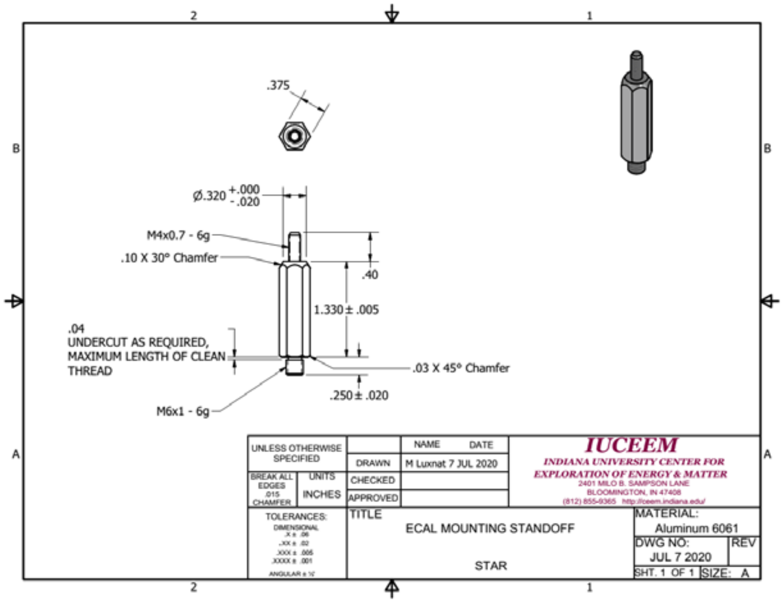
MPV8016 under evaluation w/ 75 ft cable at IU



final PPB layout (Tim), now in fab

Miscellaneous

ECAL FEE mounting standoff



- New length based on measurement of 16 ECAL quads by student A. Edwards
  - It agrees reasonably w/ the impromptu fix we did for 2019
- Ordered, from Griner Eng. (Bloomington), same vendor as 2019
- 1650 (10% spare), $2.908 each
- expected “early September,” should be getting a more formal estimate soon

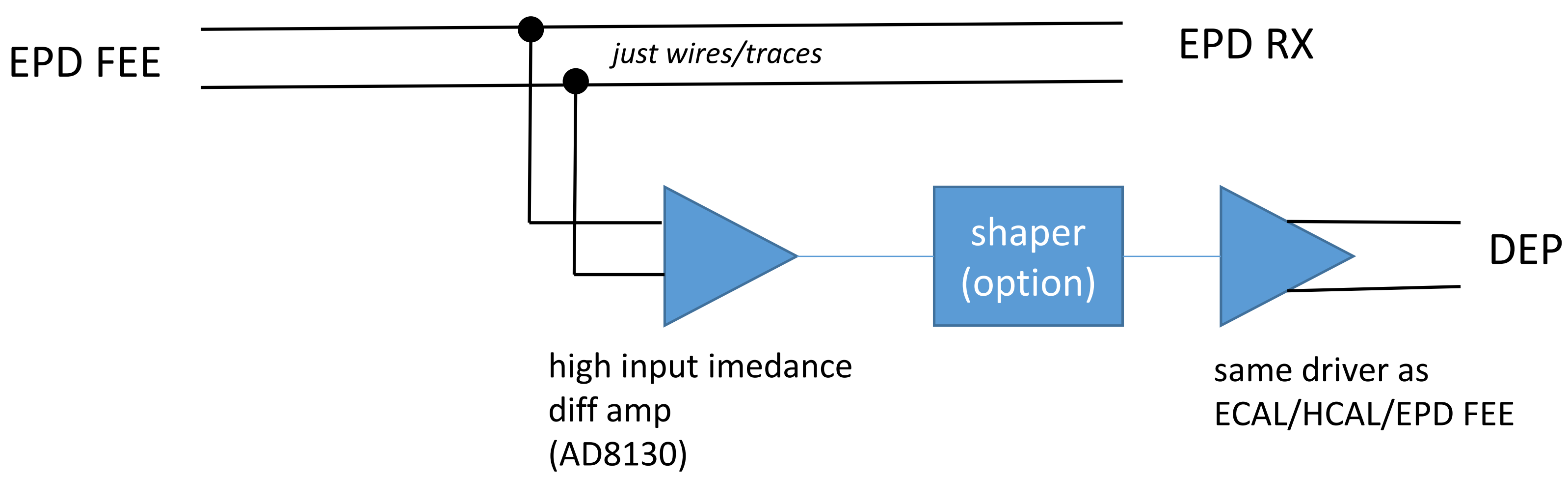
long signal cables (“MDR” cables)

- same type as used in FPOST, EPD, and as will be used for EPD-preshower
- need 132 cables for ECAL+HCAL, 60 ft
  - +8 spare, −12 recovered from FPOST
- 128 cables ordered by UKY from Sub-Sem on 5/11/20
- due to ship by 8/14, should be OK I think from our past experience
- $262 per cable ($14.55 per signal)

EPD splitter

To provide EPD signals to DEP boards for readout as preshower for the forward calorimeter, *with no gain loss and certainly no possibility of unstable gain or other problems for the EPD*.

"Tap amplifier" scheme seems best:



We'll make a 16 or 32 channel board (1 or 2 cables tapped). Will install for at least two cables (one DEP, two EPD "PP") for run 21.

As long as tap board is powered, there is no chance of disturbing EPD signals with this.

backup

Expenses to date →

and remaining:

- ECAL assembly $23k
- HCAL PCB $8k
- HCAL R&C $1.5k
- HCAL assembly $23k
- test setup $3k
- HCAL blocks shipping $5.5k
- maybe premium for special HCAL blocks, $5k ??

… that's about all from me

This includes all and only items ordered "by" Gerard (from IU, UKY, and OSU)				
Item(s)	Amount (excluding S&H)	req. date	from	vendor
HCAL absorber blocks	$425,295.36	12/2/2019	IU	Chapman Lake
design parts	$101.98	1/7/2020	IU	Mouser
attenuators	$6,890.00	1/8/2020	IU	Minicircuits
pogo pins & connectors	$4,068.20	1/10/2020	IU	Bisco
DAC's	$9,404.10	1/13/2020	IU	Rochester
various FEE parts	$21,682.78	1/14/2020	OSU	Mouser
other DAC's	$965.00	1/17/2020	OSU	Mouser
various FEE parts (mostly IC's)	$14,953.70	2/4/2020	OSU	Mouser
various FEE parts	$464.51	2/5/2020	OSU	Digikey
design parts	$57.33	4/7/2020	IU	Mouser
design parts	$37.09	4/14/2020	IU	Mouser
design parts (test LV cable)	$94.49	4/16/2020	IU	Allied
design parts, MDR conn. backshells	$770.79	4/29/2020	IU	Digikey
MDR conn. backshells	$257.07	4/30/2020	IU	Mouser
MDR cable 60 ft x 128	$33,536.00	5/1/2020	UKY	Sub-Sem
pogo soldering fixture parts	$72.57	5/11/2020	IU	Techni-Tool
pogo soldering fixture parts	$185.92	5/12/2020	IU	McMaster
HCAL block inspection fixtures	$400.00	5/12/2020	IU	Chapman Lake
various FEE parts	$974.72	6/5/2020	OSU	Mouser
ECAL FEE PCB's	$9,238.96	6/8/2020	IU	Cirexx
inductors for shaper	$1,219.00	7/2/2020	IU	Coilcraft
various FEE parts	$1,544.76	7/6/2020	IU	Digikey
various FEE parts	$4,060.45	7/6/2020	OSU	Mouser
design parts	$7.80	7/7/2020	IU	Digikey
ECAL mounting standoffs	$4,798.20	7/8/2020	IU	Griner
HCAL blocks lot 1 shipping	$1,104.81	7/8/2020	IU	UPS freight
inductors, resistors	$903.77	7/10/2020	OSU	Digikey
	Totals			
	$39,148.25	IU FEE		
	$44,004.93	OSU FEE		
	$33,536.00	UKY		
	$426,400.17	IU HCAL blocks		
	$543,089.36	total		

Quotes for EPD FEE assembly

vendor	cost, k$	notes
CEM	24.5	BNL used for several jobs, good results. *Water soluble flux process not available, would be some cleaned "no-clean" process.*
Creative Hi-Tech	15.5 – 16.7	We do not know this vendor; located nearby (Chicago) and may be good, but a risk.
RCE	30.0	BNL used for DEP boards, good results, good communications. *Water soluble flux process not available, would be some cleaned "no-clean" process.*
SAS	22.6	IU used for several productions with good results, usually good price. Communications excellent, resolves all issues effectively.
Sierra Circuits	40.4 – 44.6	IU used frequently for complex boards, good experience, usually not lowest quote