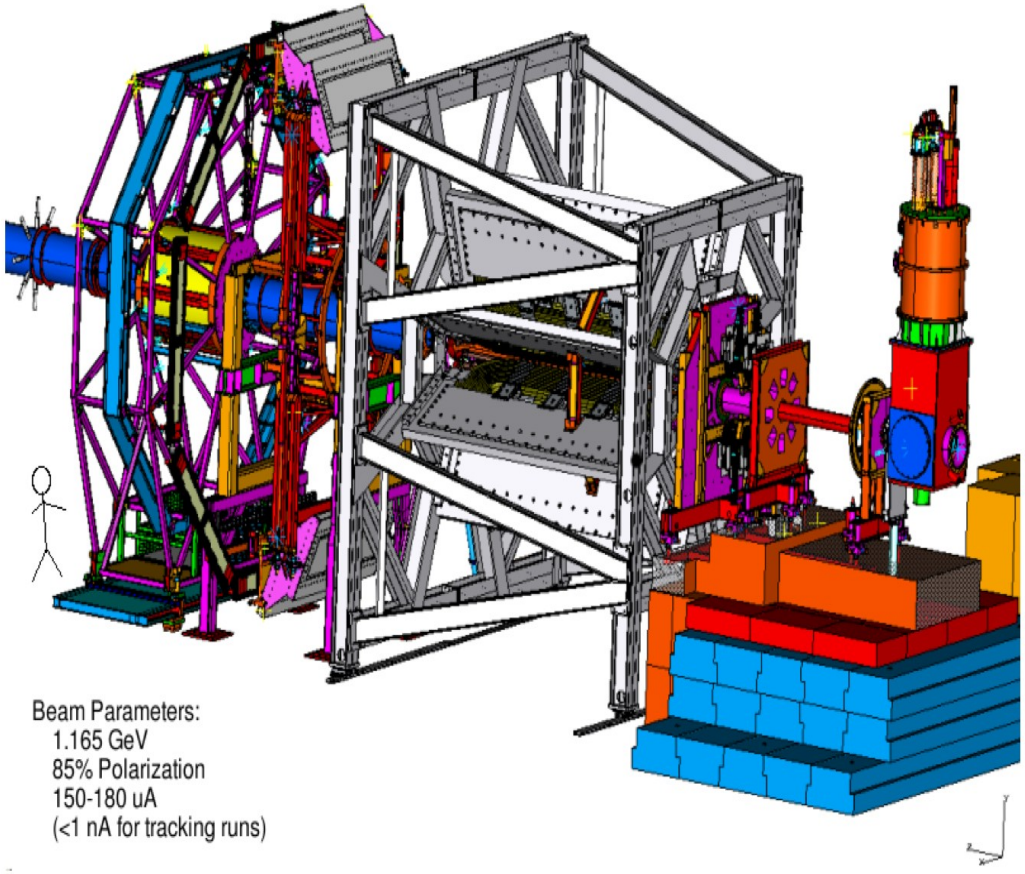
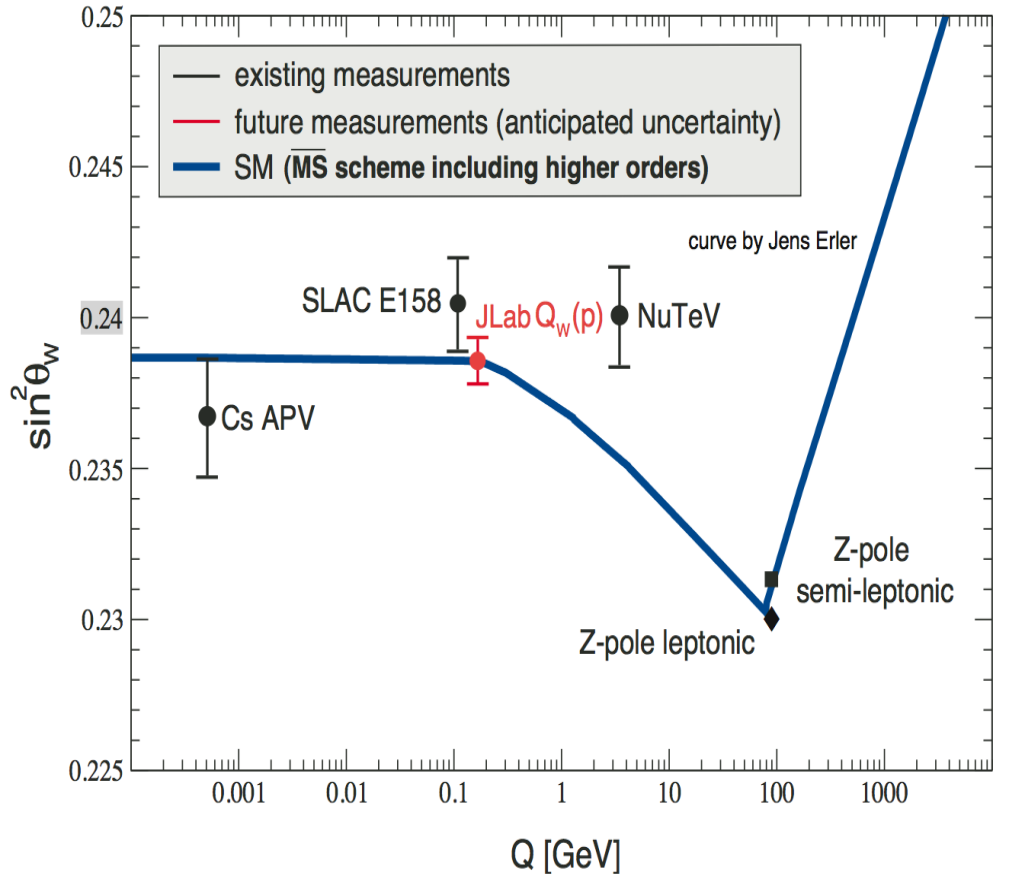
The GEM Tracking Subsystem for Qweak

Outline

- A precision test of The Standard Model
- High radiation flux, small detector footprint and good spatial resolution.
- GEM(Gas Electron Multiplier) ionization chamber
- The VFAT Front End Electronics

The Qweak Experiment

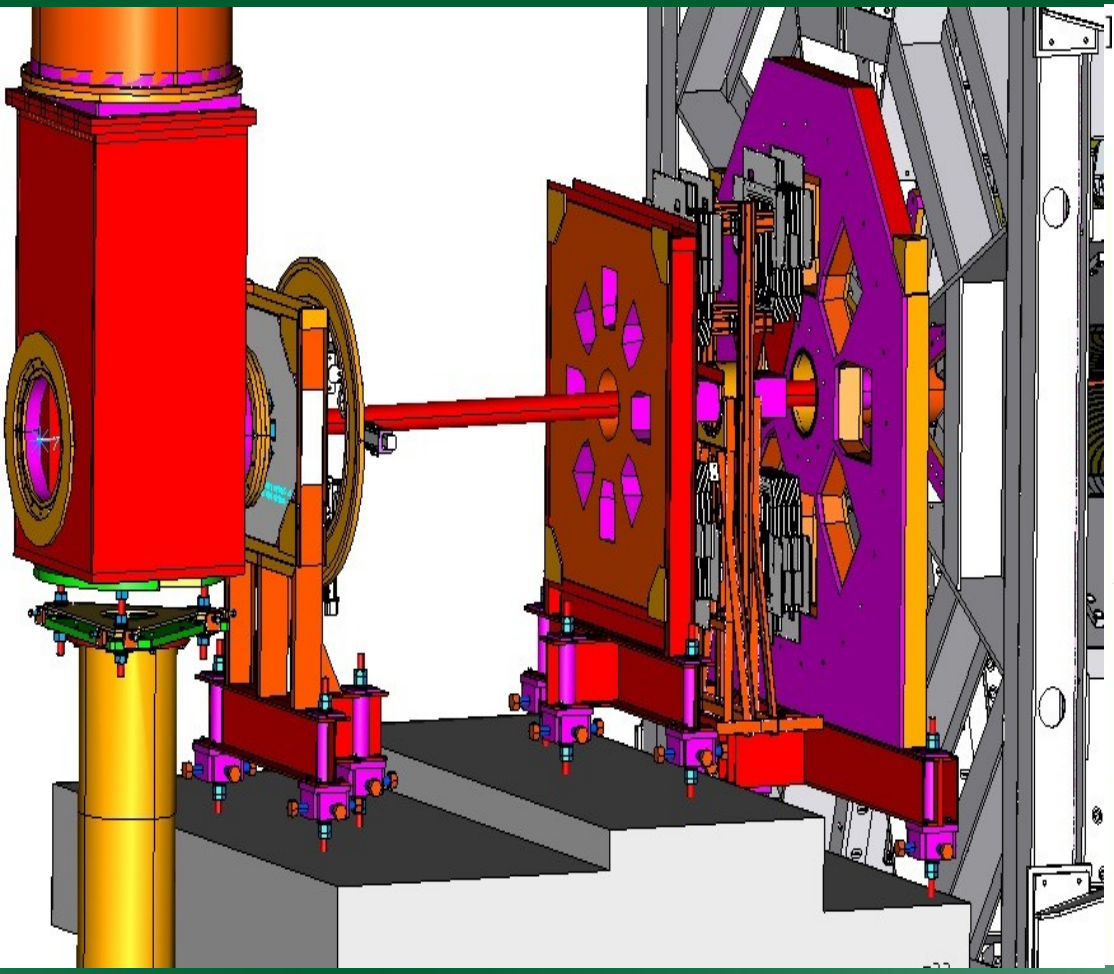


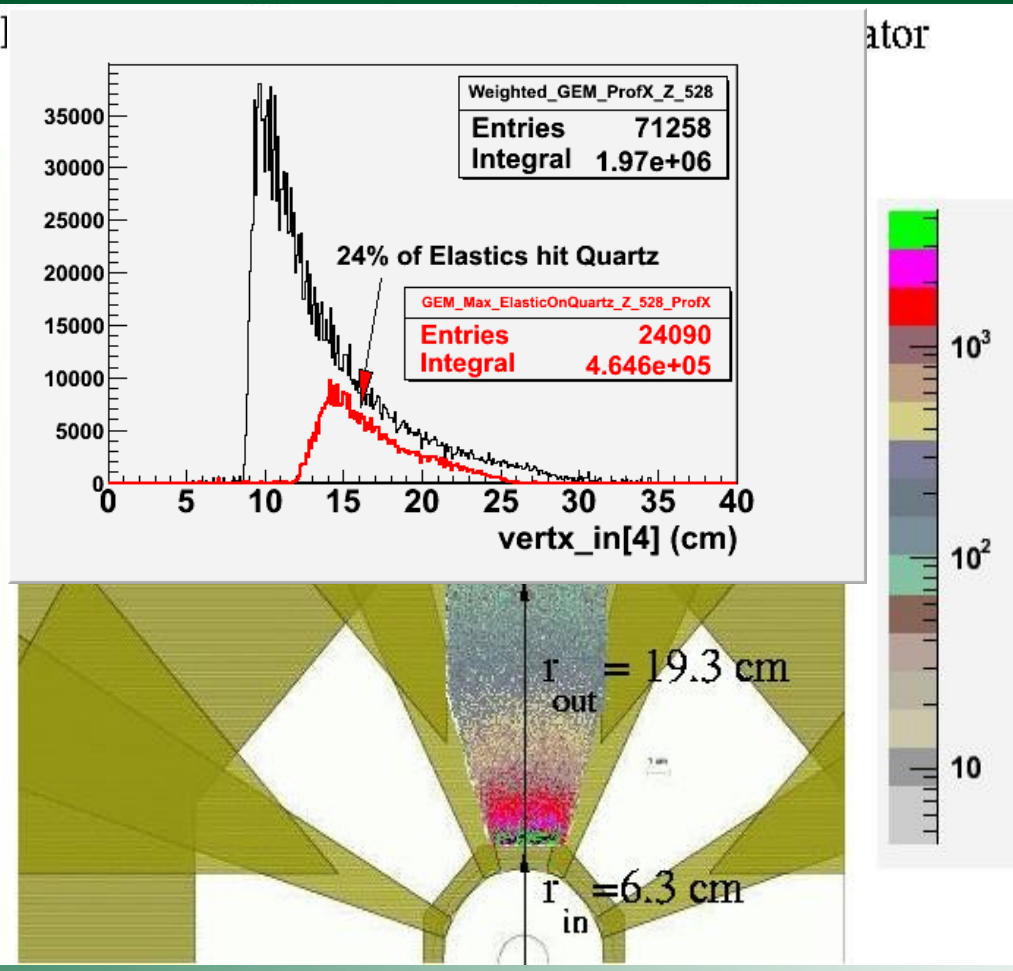


$\sin^2(\theta w)$ at $Q^2 = 0.01 \mathrm{GeV/c^2}$ Measurement with a relative statistical error of 0.3%

Installation begins next month at JLAB in HALL-C(85% polarized beam, 35 cm liquid Hydrogen target, 1.165 GeV beam, 0.3 Mrad radiation)

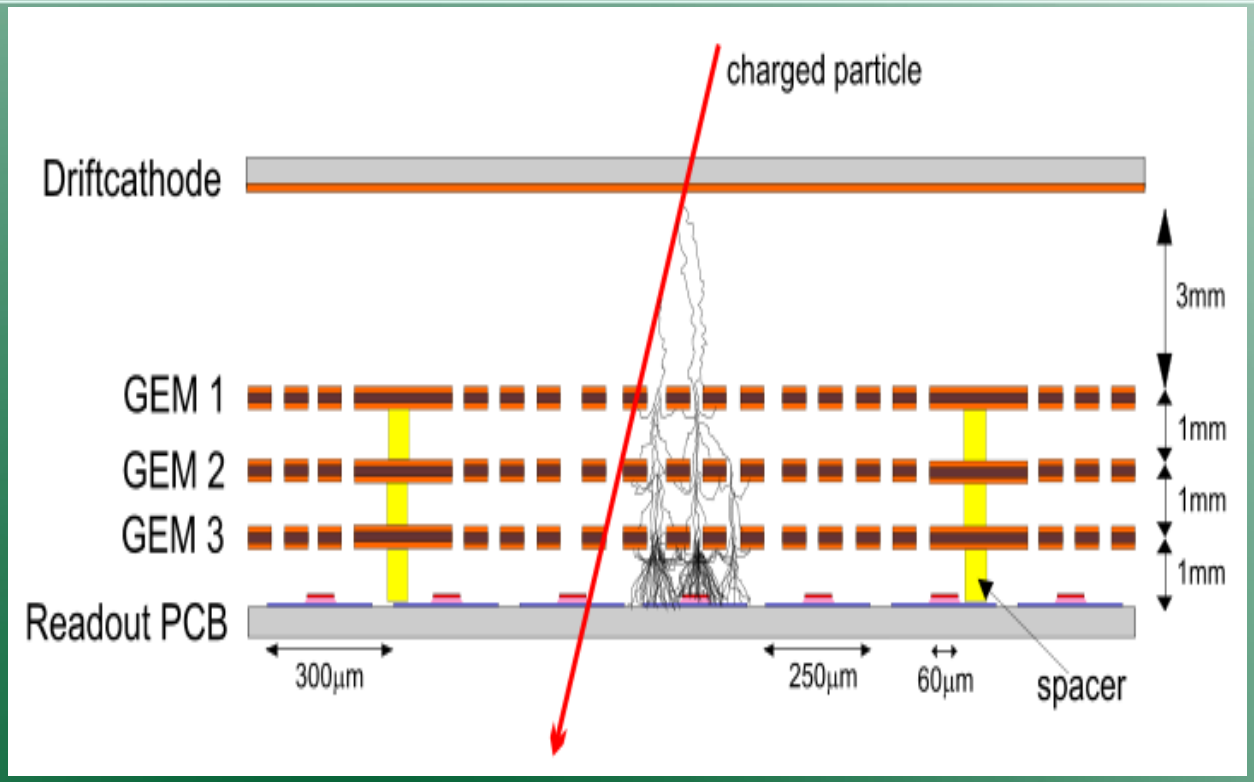
Qweak R1 Location

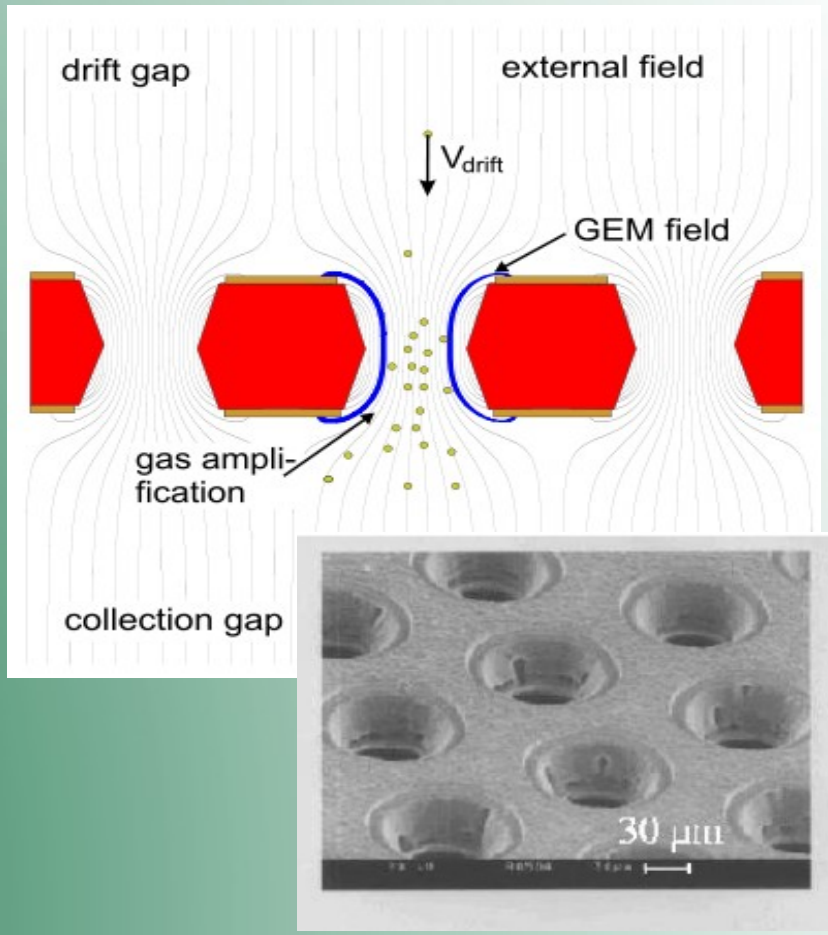




Elastically scattered electron rate ~ 1kHz/nA
and background Moller electron rate ~ 12MHz/nA.

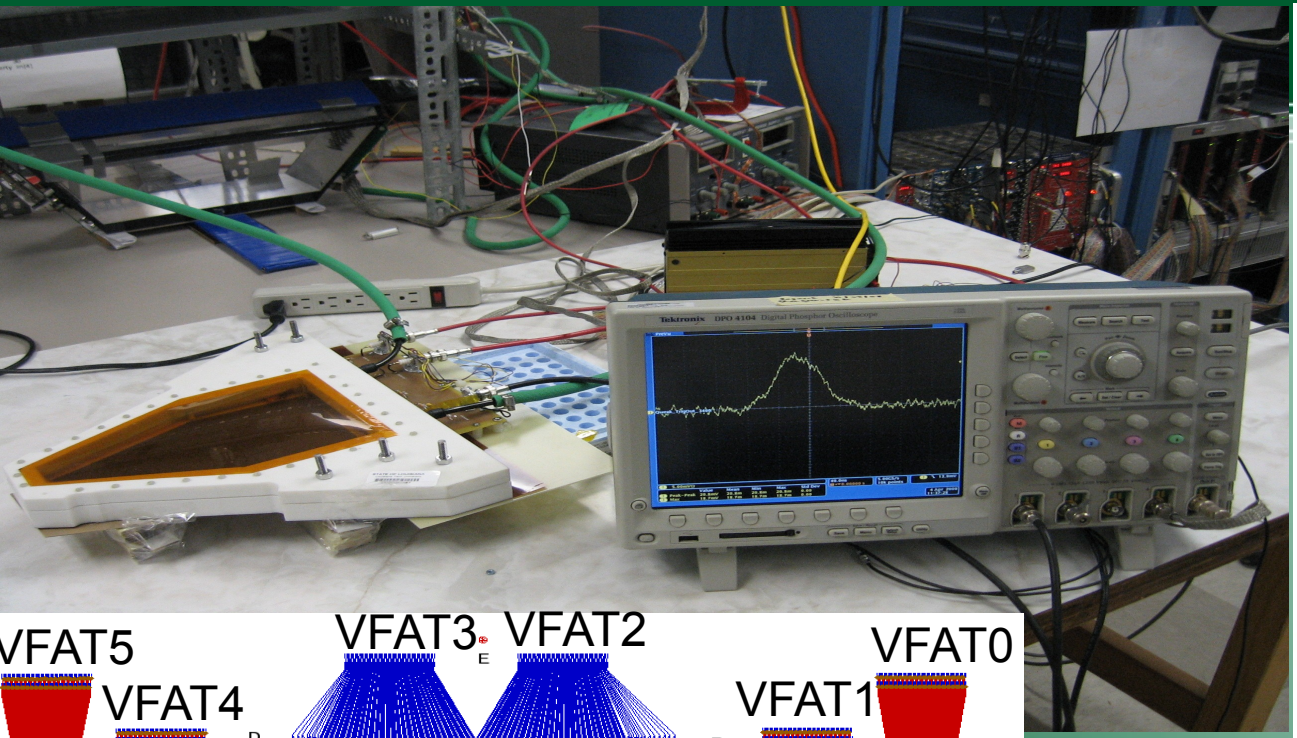
GEM Physics

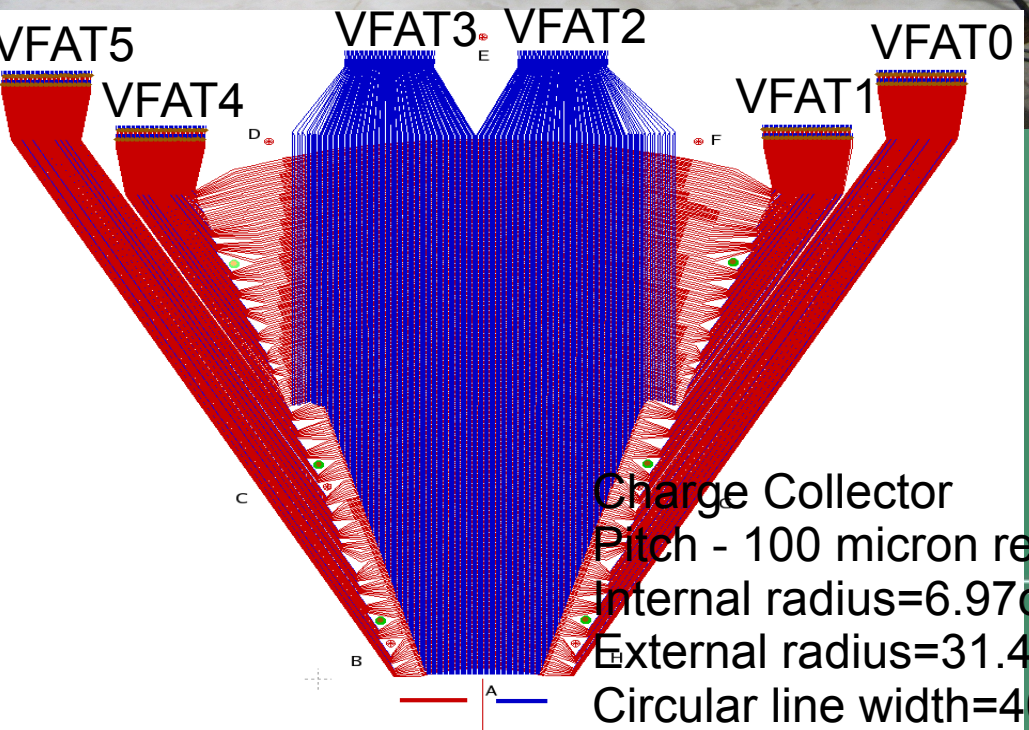


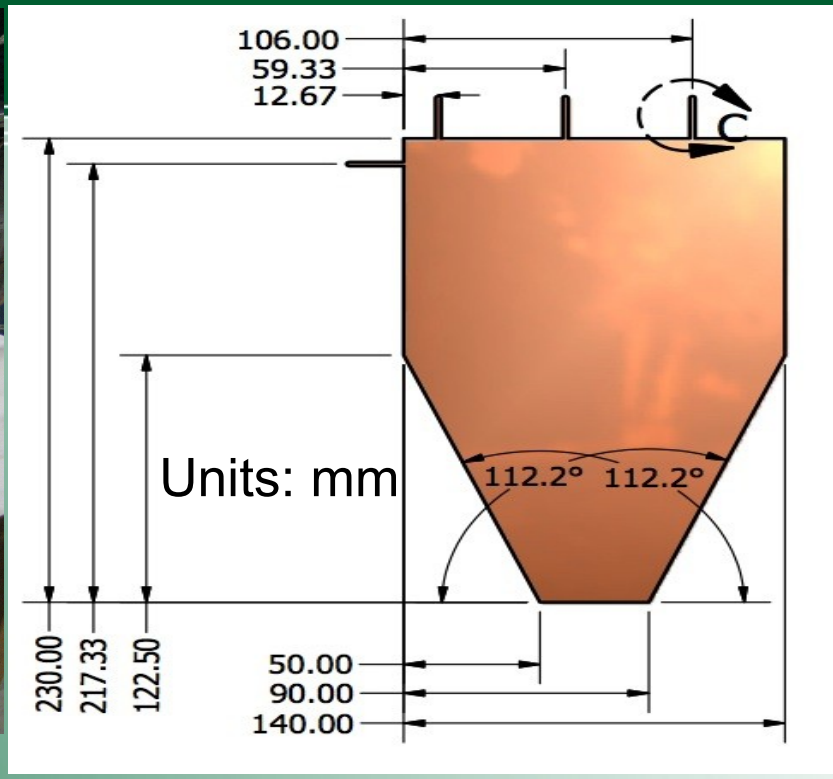


M. Ziegler, Ph.D Thesis, Development of a Triple GEM Detector for the LHCb Experiment(2002)

Qweak GEM Detector



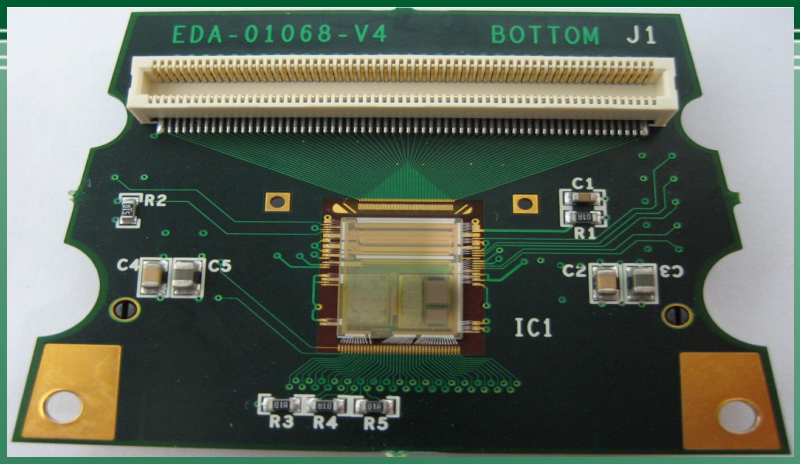




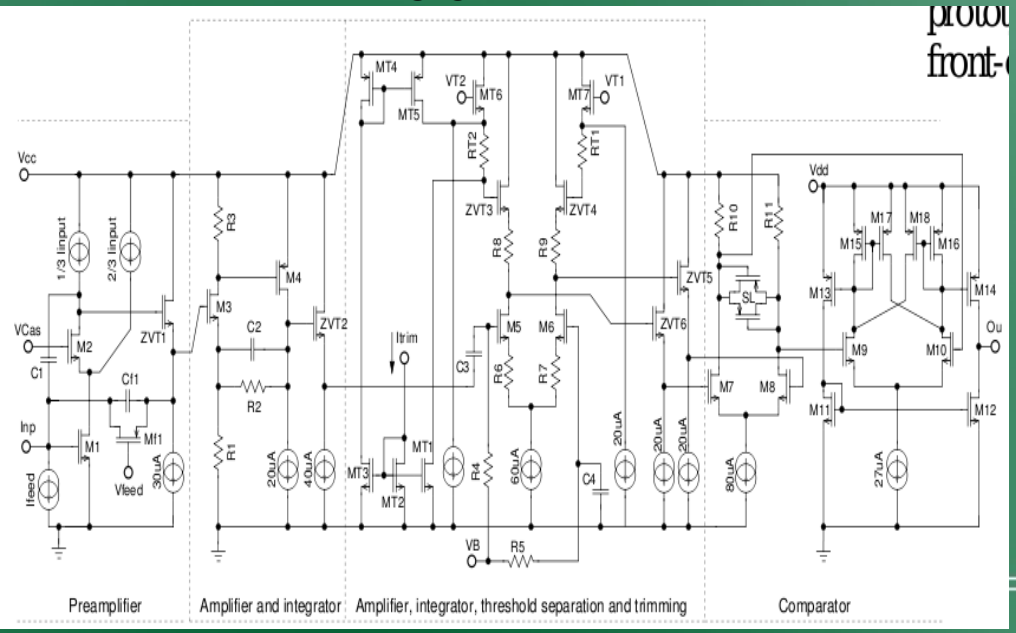
Charge Collector
Pitch - 100 micron resolution
Internal radius=6.97cm
External radius=31.4cm
Circular line width=400um

- The Ionization Chamber
- The Charge Collector
- The Amplifiers(GEM Foils)

VFAT Board Specifications



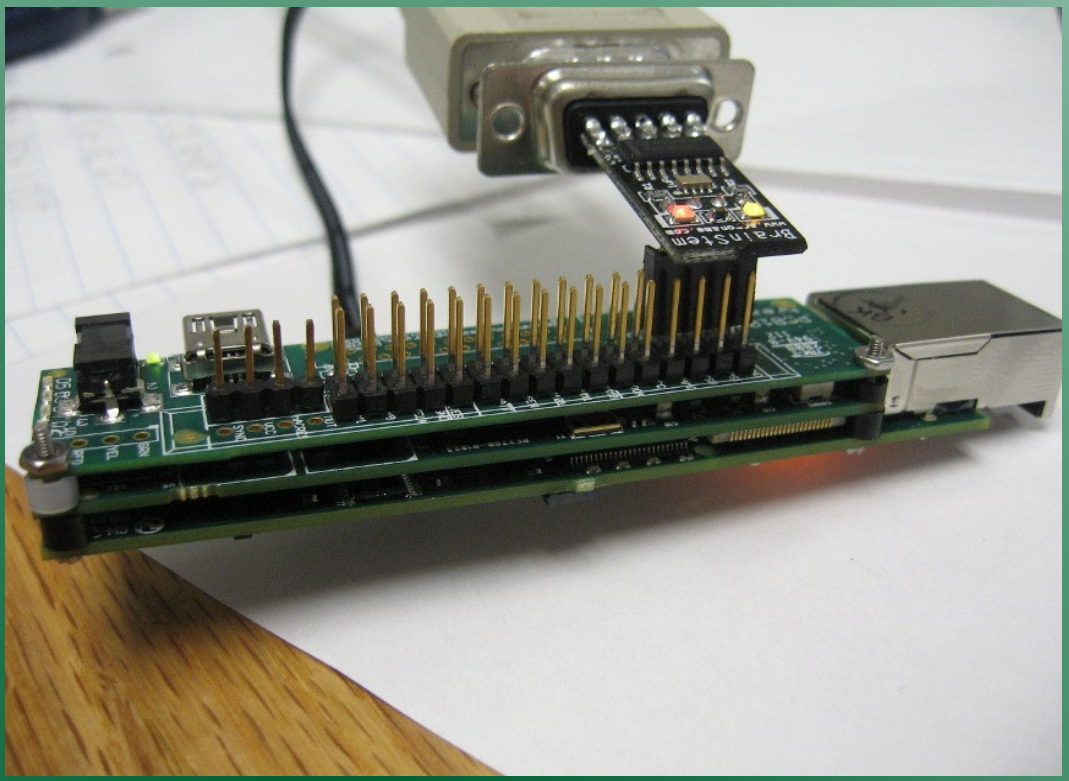
5 cm



- 40 MHz sampling
- 128 low noise analog input channels
- Can store up to 128 triggered events
- 0.25 μm CMOS
- Designed to withstand 100 Mrad
- Single Event Upset protection using triple logic flip flops
- I2C control
- LVDS output
- Programmable latency(<=6.4micro-sec)
- Card outputs data within 6.5 micro-sec

P.Aspell, G.Anelli, P.Chalmet, J.Kaplon, K.Kloukinas, H.Mugnier,W.Snoeys, VFAT2-Operating Manual(2006)
http://totem.web.cern.ch/Totem/

Gumstix



Verdex PXA270 motherboard

600MHz Marvell XScale CPU

128MB of RAM

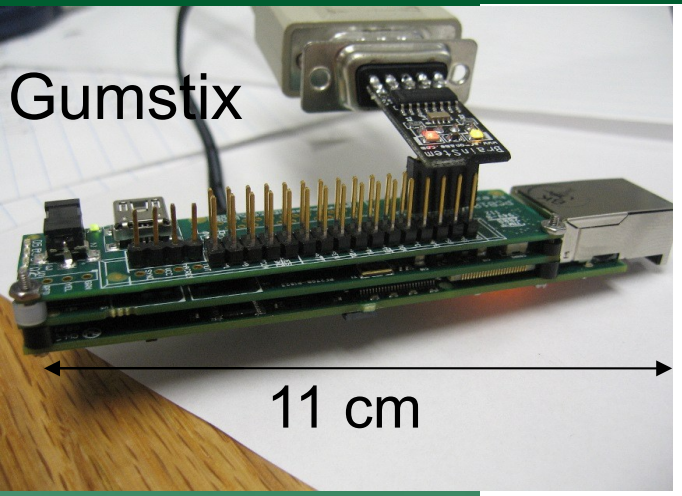
32MB of flash.

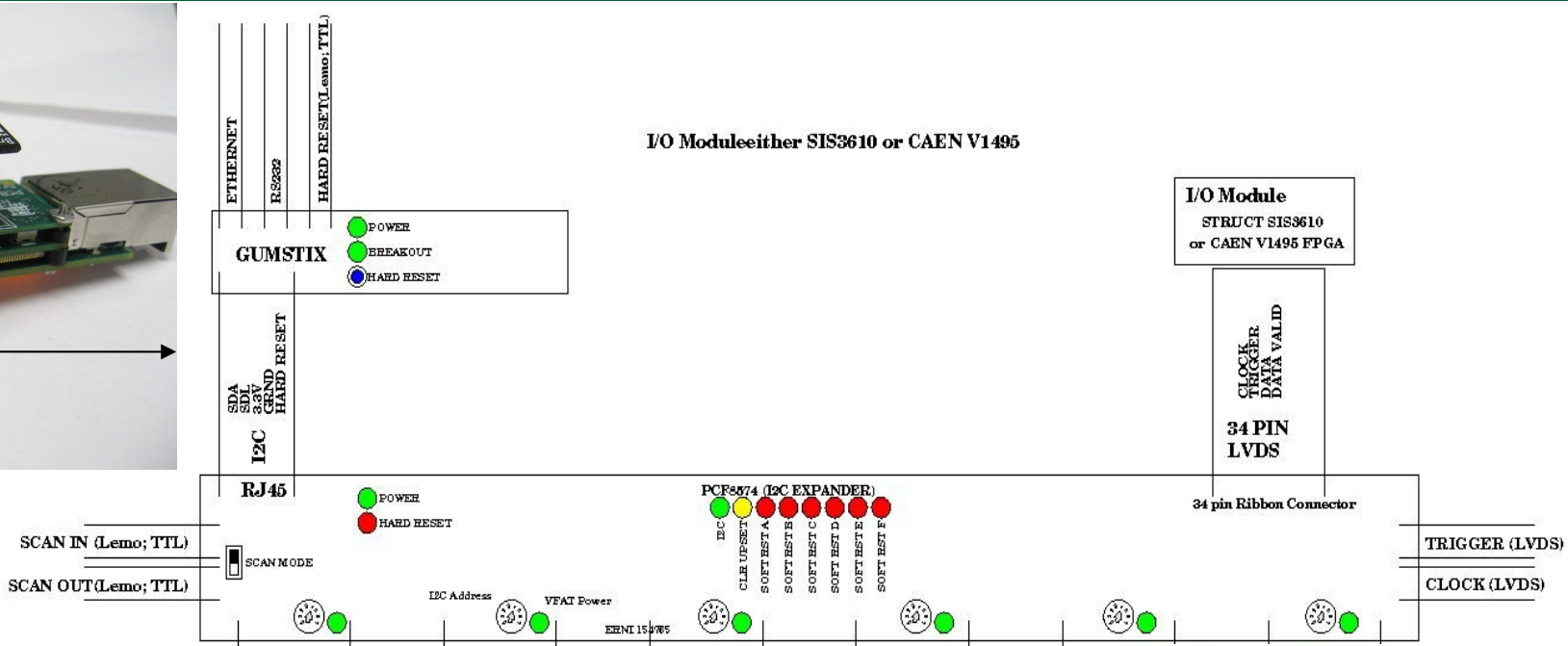
network interface card for TCP/IP

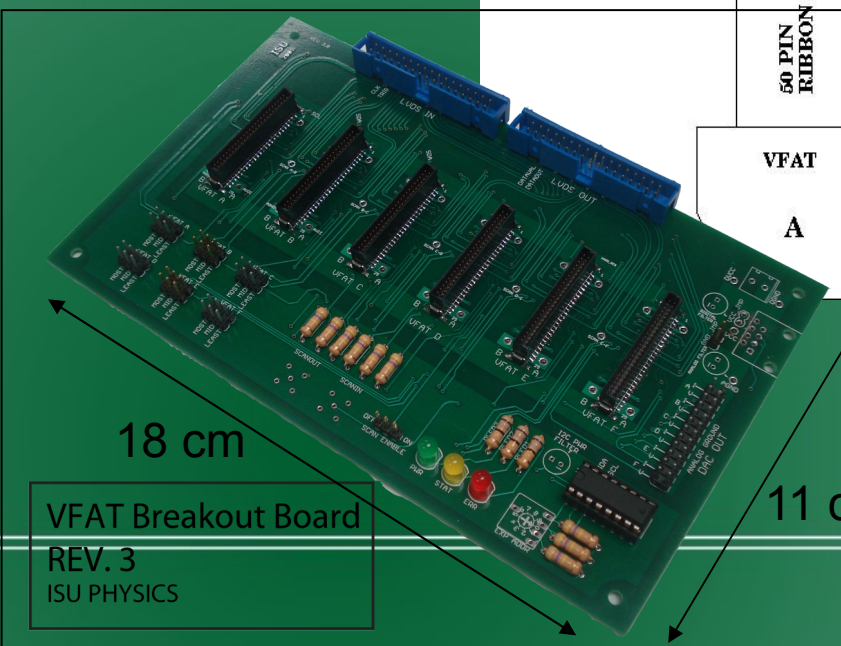
60 pin expansion socket has a breakout-vx card for I2C comm

Unix

VFAT Readout Diagram







FPGA V1495
Transfers 6Mbytes/s

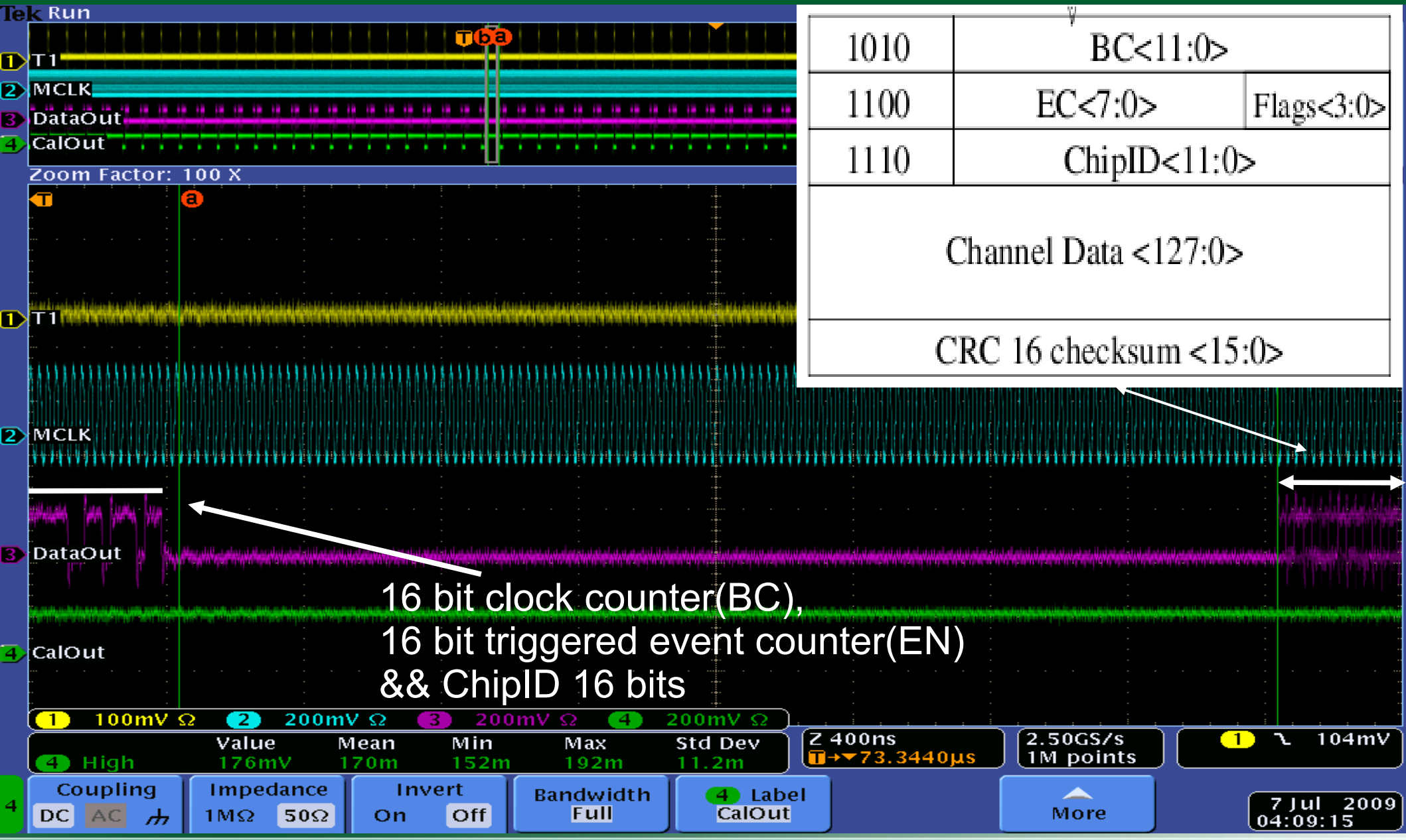
Gumstix I2C Controller

Enter Data

ContReg<0>	16	39	57	CalMode<1>	CalMode<0>	CalPolarity	MSPolarity	Trigmode<2>	Tr
				Off	Off	On	On	On	Of
ContReg<1>	17	0	0	ReHitCT<1>	ReHitCT<0>	LVDSPowerSave	ProbeMode	DACsel<3>	DA
				Off	Off	Off	Off	Off	Of
IPreampIn	18	a8	168						
IPreampFeed	19	50	80						
IPreampOut	20	96	150						
IShaper	21	96	150						
IShaperFeed	22	64	100						
IComp	23	78	120						
ChipID<0>	24	ec	236						
ChipID<1>	25	a6	166						
UpsetReg	26	ff	255						
HitCount0	27	ff	255						
HitCount1	28	0	0						
HitCount2	29	0	0						
ExtRegPointer	30	1	1						
ExtRegData	31	40	64						
VThreshold1	130	1	1						
VThreshold2	131	0	0						
CalPhase	132	0	0						
ContReg<2>	133	0	0	DigInSel	MSPulseLength<2>	MSPulseLength<1>	MSPulseLength<0>	HitCountSel<3>	Hi
				Off	Off	Off	Off	Off	Of
ContReg<3>	134	0	0	-	-	-	DFTestPattern	PbBG	Tr
				Off	Off	Off	Off	Off	Of
Spare<135>	135	0	0						
ChanReg<1>	1	40	64	CalChan0	CalChan1	Mask	TrimDAC<4>	TrimDAC<3>	Tr
				Off	On	Off	Off	Off	Of
ChanReg<2>	2	0	0		CalChan1	Mask	TrimDAC<4>	TrimDAC<3>	Tr
				Off	Off	Off	Off	Off	Of
ChanReg<3>	3	0	0		CalChan1	Mask	TrimDAC<4>	TrimDAC<3>	Tr
				Off	Off	Off	Off	Off	Of
ChanReg<4>	4	0	0		CalChan1	Mask	TrimDAC<4>	TrimDAC<3>	Tr
				Off	Off	Off	Off	Off	Of
ChanReg<5>	5	0	0		CalChan1	Mask	TrimDAC<4>	TrimDAC<3>	Tr
				Off	Off	Off	Off	Off	Of
ChanReg<6>	6	0	0		CalChan1	Mask	TrimDAC<4>	TrimDAC<3>	Tr
				Off	Off	Off	Off	Off	Of

- VFAT board is configured via I2C
- Web interface for I2C
- Set parameters
- Individual channel control
- Turn channels ON and OFF
- Set CalMode

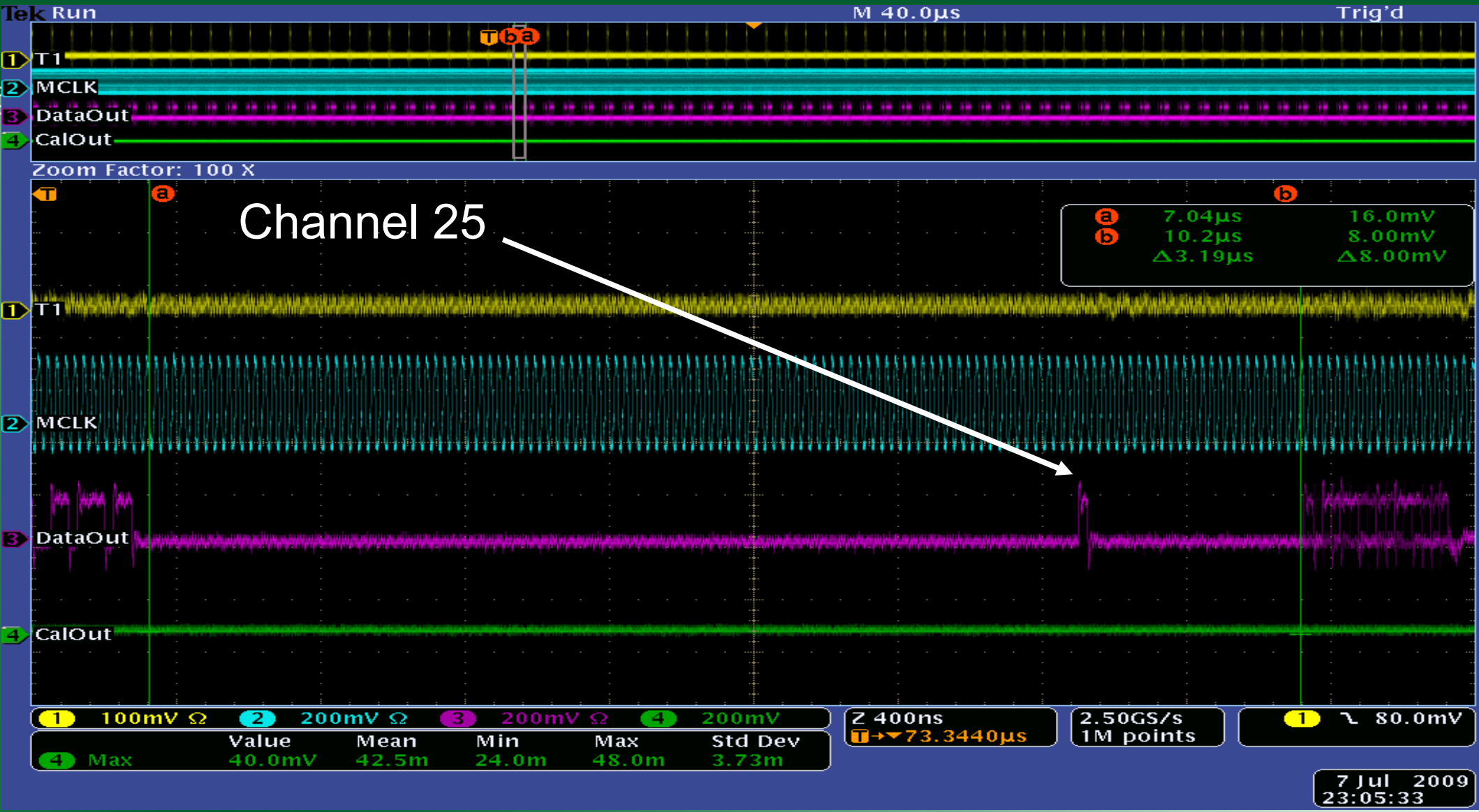
VFAT Output



1010	BC<11:0>	
1100	EC<7:0>	Flags<3:0>
1110	ChipID<11:0>	
Channel Data <127:0>		
CRC 16 checksum <15:0>		

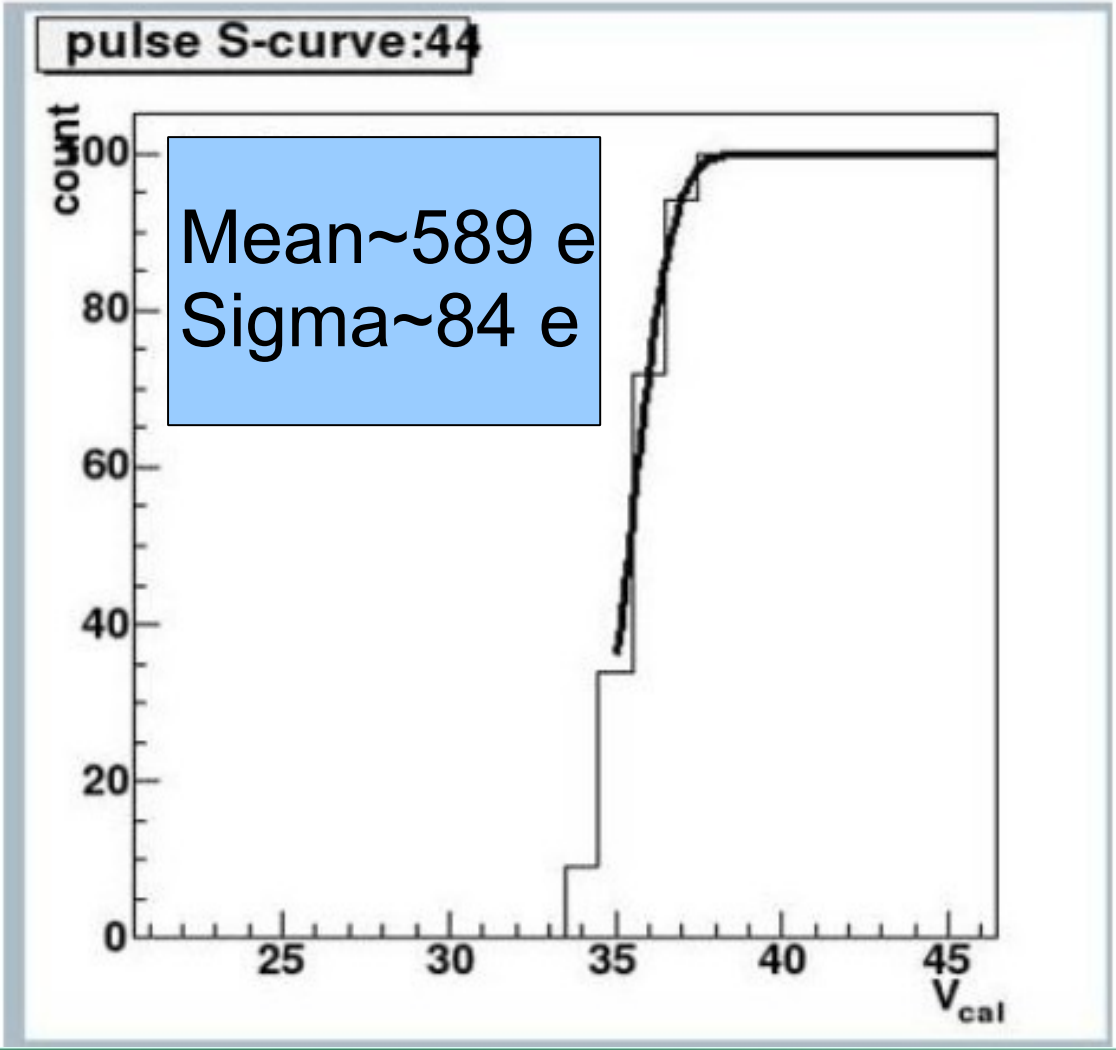
- All Channels are OFF on VFAT card

VFAT Output For Certain Channels



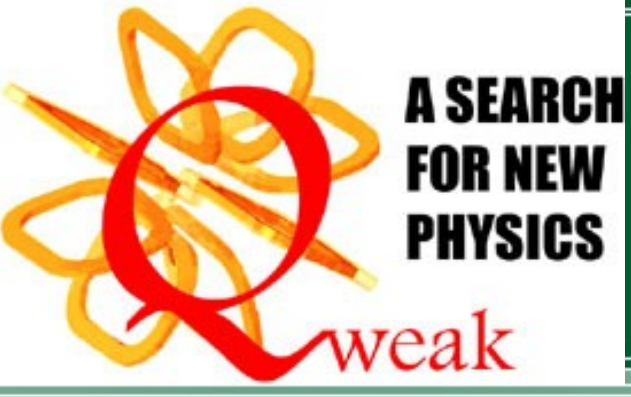
- Channel 25 On Using CalOut Pulse

VFAT Noise Measurements



- Sweeping the input signal amplitude (VCal)
- Constant threshold
- Threshold range 0.7-18.7fC

P.Aspell, G.Anelli, P.Chalmet, J.Kaplon, K.Kloukinas, H.Mugnier,W.Snoeys, VFAT2
http://indico.cern.ch/contributionDisplay.py?contribId=63&sessionId=11&confId=11994



Conclusions

- GEM for high rate experiments(50MHz/cm2)
- VFAT front end(2.5Mbytes/sec)
- FPGA I/O V1495(6Mbytes/sec)

Future Use

TOTEM experiment - http://totem.web.cern.ch/Totem/

Qweak experiment – http://www.jlab.org/qweak/

The End

Questions