SoLID DAQ Update

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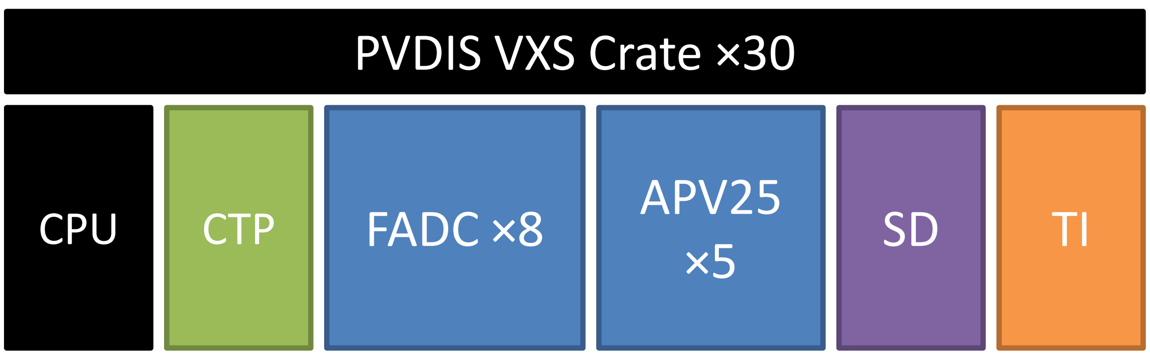
Overview

- DAQ Setup
- Event Sizes and Data Rates
- APV25 Test Stand
- Future Plan

PVDIS DAQ Setup

Detector	Module	# of Channels	# of Modules
Calorimeter (CAL)	FADC	114 × 30	8 x 30
Gas Cherenkov (GC)	FADC	9 × 30	
GEM	APV25-VME	4800 × 30	5 x 30



Crate **T**rigger **P**rocessor (**CTP**)
Trigger **I**nterface (**TI**)
Signal **D**istribution (**SD**)

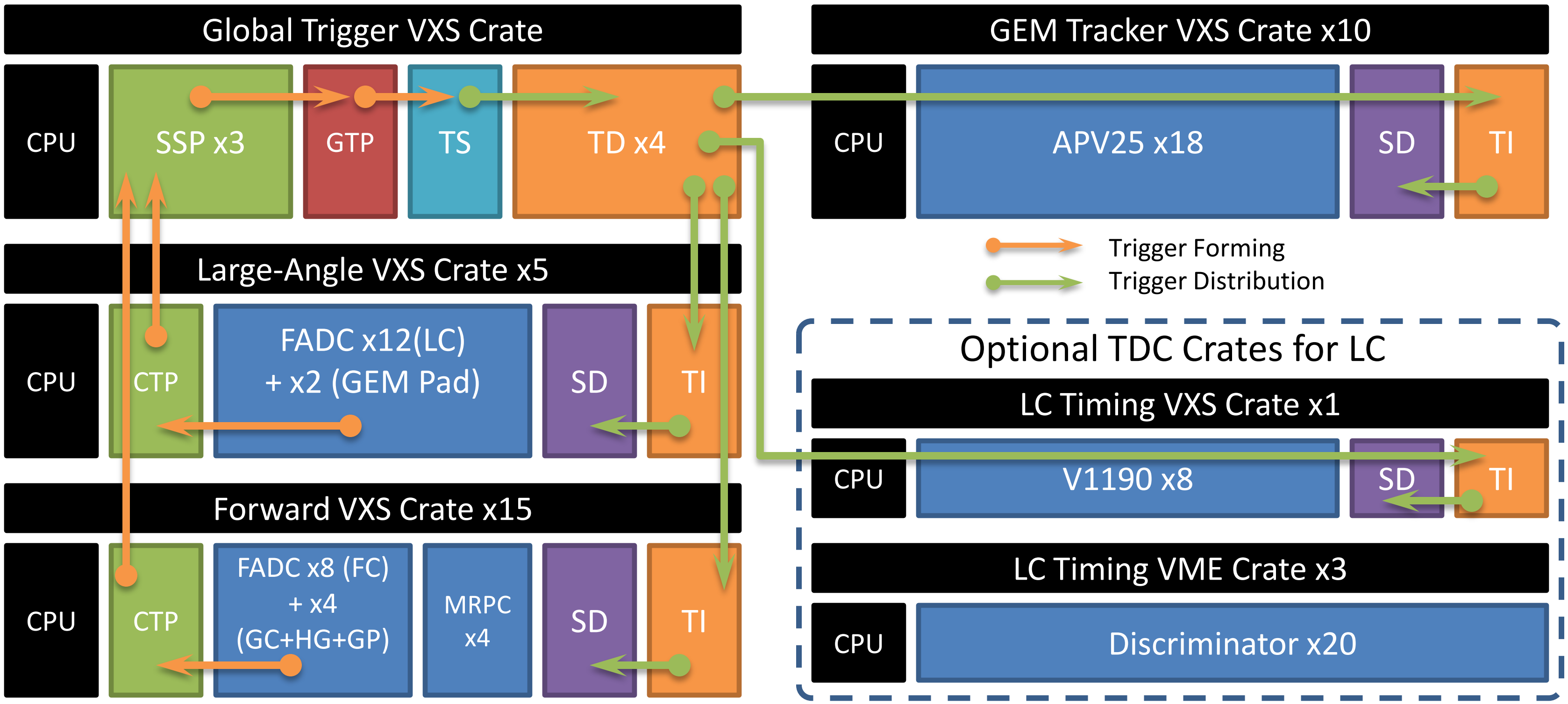
- Trigger rate for each crate: 20 kHz

SIDIS DAQ Channel/Module Counts

Detector	Module	# of Channels	# of Modules
Forward Calorimeter (FC)	FADC	1920	120
Large-angle Calorimeter (LC)	FADC	960	60
Light Gas Cherenkov (GC)	FADC	270	20
Heavy Gas Cherenkov (HG)	FADC	270	20
GEM Pad Readout (GP)*	FADC	150(L)/270(F)	10/20
GEM	AVP25-VME	180k	180
MRPC	VME	7500	60

* Original scintillator bars in forward will be replaced by GEM pad readout if possible

SIDIS DAQ/Trigger Setup



- e^-@Large: LC & GP — 13 kHz
- e^-@Forward: FC(high) & GC — 65 kHz
- π@Forward: FC(low) & MRPC & GP — 15 MHz
- Coincidence: e^- & π — 60 kHz@50 ns

* Coincidence rate scales with the **square** of luminosity

Crate **T**rigger **P**rocessor (**CTP**)
Sub-**S**ystem **P**rocessor (**SSP**)
Global **T**rigger **P**rocessor (**GTP**)
Trigger **S**upervisor (**TS**)
Trigger **I**nterface/**D**istribution(**TI/D**)
Signal **D**istribution (**SD**)

J/ϕ DAQ Setup

- Same hardware as SIDIS
- Different Trigger Logic:
  - e^-(scattered): FC(medium) & GC
  - Lepton@Large-angle: LC & GP
  - Lepton@Forward: FC(high) & GC
  - Triple Coincidence: e^- & l^+ & l^-
- Trigger Rate:
  - 15 kHz for triple coincidence with 100 ns window

Total DAQ Hardware

Module	PVDIS	SIDIS	Total	Unit Cost	Cost
VXS Crate	30	31	31	$11,500	$356,500
VME CPU	30	31	31	$3,400	$105,400
CTP	30	20	30	$5,000	$150,000
SD	30	30	30	$2,500	$75,000
FADC	240	250	250	$4,500	$1,125,000
AVP25-VME	150	180	180	UVa/China	
TI	30	30	30	$3,000	$90,000
GTP		1	1	$5,000	$5,000
TS		1	1	$3,500	$3,500
TD		4	4	$3,000	$12,000
MRPC-VME		60	60	China	
Total	$1,842,000	$1,872,400			$1,922,400

* Optional SIDIS Large-angle Timing: $292,980

PVDIS Event Size and Data Rate

- GEM Rates per Sector (25 ns window, LH_2, 11 GeV)

	Raw	w/ Threshold	Deconvolution
Hits	1182	555	53
Occupancy	25%	12%	1.1%

- Event Size per Sector (50 ns window, 11 GeV)

Detector	Rate	Hits	Type	Data Size per hit
GEM (25 ns)	47 GHz	555 (threshold)	3xSamples, Time, Position	12 Bytes
Calorimetry	5 MHz	1	Energy, Time, Position	8 Bytes x 2 (PS/SH)
Gas Cher	10 kHz	1	Energy, Time, Position	8 Bytes x 9 (Split)
Total				7 kB

- Data Rate per Sector:
  - 20 kHz x 7 kB = 140 MB/s

Comments on PVDIS

- Rates per sector are manageable.
- High occupancy in GEM: 3 samples are absolutely needed. Deconvolution helps, but might be safer to send non de-convoluted signal for offline treatment as long as bandwidth allows.
- Need two Ethernet links for each crate: ~ 200 MB/s.
- Test convolution behavior at very high rate.
- Strategy for online data reduction before recording:
  - Trace back from shower to define region of interest
  - PID cut
  - Online coarse tracking

SIDIS Event Size

➢ GEM Rates (25 ns window, 11 GeV)

	Raw	w/ Threshold	Deconvolution	Proposal
Hits	5826	1358	122	110
Occupancy	3.2%	0.8%	0.1%	0.1%

➢ Event Size (50 ns window, 11 GeV)

Detector	Rate	Hits	Type	Data Size per hit
GEM (25 ns)	4.9 GHz	122 (deconv.)	Integral, Time, Position	8 Bytes
LC	120 kHz	1	Energy, Time, Position	8 Bytes x 2 (PS/SH)
FC	200 MHz	10	Energy, Time, Position	8 Bytes x 2 (PS/SH)
GC	40 MHz	3	Energy, Time, Position	8 Bytes x 9 (split)
HG	60 MHz	4	Energy, Time, Position	8 Bytes x 9 (split)
MRPC	850 MHz	45	Time, Position	6 Bytes
GEM Pad	300 MHz	15	Energy, Time, Position	8 Bytes
Total				2.1 kB*

* 17 kB if use only apply threshold on GEM Readout with 3 sample mode

SIDIS Data Rates

- 60 kHz Trigger Rate:

Crate Name	# of Crate	Detectors	Total Data Rate	Data Rate per Crate
GEM	10	GEM	59 MB/s	5.9 MB/s*
Large-angle	5	LC GEM Pad	1.2 MB/s	0.24 MB/s
Forward	15	FC GC HG GEM Pad MRPC	63 MB/s	4.2 MB/s

* 98 MB/s is only apply threshold w/ 3 sample mode

Comments on SIDIS

- Deconvoluted GEM rate consistent with proposal.
- GEM occupancy is low, 1 sample may be OK for less noisy environment, but cannot be used if deconvolution method used.
- Data rates well under control.
- Still need to test GEM pad readout.

APV25 GEM Readout

- Switch Capacitor Array ASICs
  - 128 channels
  - Sample rate: 40 MHz
  - Buffer length: 192 samples, 4.8 us
  - Look back: 160 samples, 4 us
- Readout Time/Max Readout Rate:
  - T_APV = 141 x N_{sample} / 40 MHz
  - 1 sample mode: 3.5 us, 280 kHz
  - 3 sample mode: 10.6 us, 90 kHz
- PVDIS: 20 kHz
  - 3 sample mode is feasible and needed
- SIDIS: 60 kHz
  - 1 sample mode if using a global GEM trigger, deconvolution cannot be applied
  - 3 sample mode if using crate dependent trigger, taking advantage of low occupancy

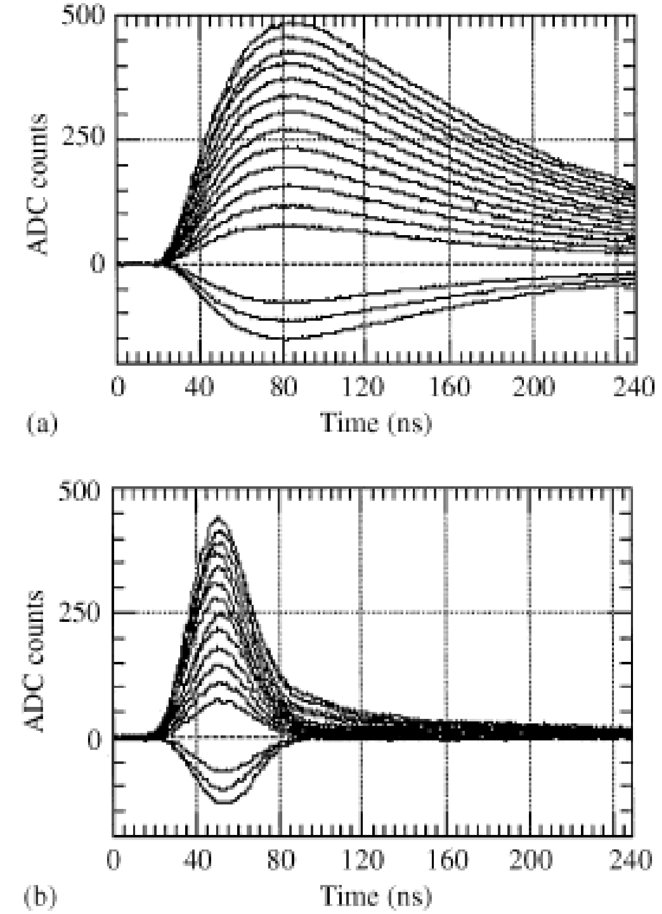


Fig. 5. Response curve of the APV25 as a function of the input signal. (a) Peak mode, (b) deconvolution mode.

APV25 Test Stand at UVa/JLab

- University of Virginia:
  - Running VME system using multi-purpose degitizer (MPD) modules with CAEN controller.
  - SRS DAQ system.
  - Some work ongoing on electronic noise
  - Plan to move to JLab
- Jefferson Lab
  - Test setup deployed
  - Development of readout with Intel VME CPU and CODA
  - Should be able to start testing in 2013
- Evaluation of electronics performance by 2013

Future Plan

- Continue work on GEM readout:
  - Study threshold and deconvolution efficiency
  - Data reduction
- Trigger Simulation (Software):
  - On top of existing physics simulation
  - Find optimal trigger logic
    - Information needed: Energy sum? Hit pattern?
    - Formula to process information
    - Bandwidth usage: within limit?
    - Minimize background rate
    - Maximum efficiency for real events, less bias
  - Get more reliable trigger rates

Future Plan (continued.)

- Bench Top Tests of Trigger Electronics:
  - Setup a small scale DAQ system
  - No detector really needed as FADC can replay "predefined" waveforms
  - Test the capability of the processing power of various modules: CTP, SSP, GTP
- Possible Resources:
  - Jlab: Pipeline electronics
  - UVa: GEM related
  - UMass: Testing hardware
  - Duke: Min Huang

BACKUP

Comments on GEM Readout

- No show stopper
- Realistic effect of background
- Need to define threshold from MIP signal
- Study hit/tracking efficiency as function of threshold
- Start work on data reduction