Electronics, Trigger, and DAQ

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Detector	Elements/ Channels	Notes
IFP SciFi	256 / 512	σ≈1 ns, rate≈0.1 MHz/channel
Target SciFi	85 / 170	σ≈1 ns, max channel rate≈2 MHz
GEMs	-	Separate DAQ system
Wire Chambers	2950 / 760	Multiplexing: wire rate≈1.5 kHz
Scintillators	88 / 176	σ≈50 ps, rate≈10 kHz/channel
Beam scintillator	6 / 12	σ≈50 ps, max channel rate≈2 MHz

Scintillating Fiber Arrays Readout

IFP SciFi fibers

128 plane 1

128 plane 2

Target SciFi fibers

25 X

25 Y

35 U

Amplifiers

splitters

ADCs

Discriminators

scalers

TDCs

FPGA beam PID

Total SciFi:
682 ADC Channels
682 TDC Channels
682 Discriminators
682 Splitters

Numbers of Channels

IFP SciFi's

512 phototube channels, amplifiers, splitters, ADCs, discriminators, scalers, TDCs

Target SciFi

170 phototube channels, amplifiers, splitters, ADCs, discriminators, scalers, TDCs

Total SciFi:
682 ADC Channels
682 TDC Channels
682 Discriminators
682 Splitters

PMTs:
4 MultiAnode PMTs (64 channels) / IFP Plane
2 MultiAnode PMTs (64 channels) / Target Plane
Total: 8+6 = 14 MultiAnode PMTs

High Precision Scintillator Readout

LEFT Scintillators

17 plane 1

27 plane 2

RIGHT Scintillators

17 plane 1

27 plane 2

Beam Monitor

6 paddles

splitters

ADCs

Discriminators

scalers

TDCs

trigger

Numbers of Channels

Scintillator Detectors

176 phototube channels, splitters, ADCs, discriminators, scalers, TDCs

Beam Scintillators

12 phototube channels, splitters, ADCs, discriminators, scalers, TDCs

Total SciFi:
188 ADC Channels
188 High Precision TDC Channels
188 Discriminators
188 Splitters
188 PMTs

WC Numbers of Channels

LEFT & RIGHT Wire chambers:

WC1:
64 Wires / U Plane
64 Wires / V Plane
45 Wires / X plane
Total 346 Wires

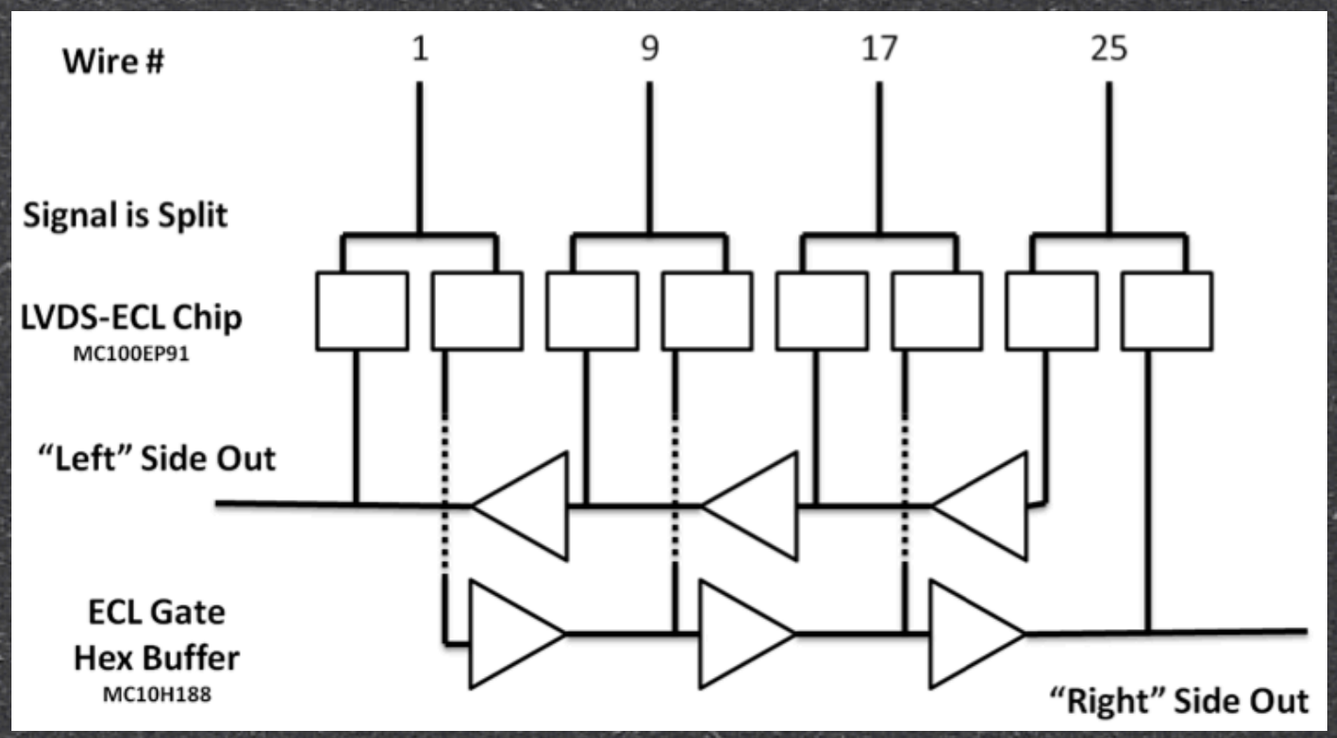
WC 2:
92 Wires / U Plane
92 Wires / V Plane
68 Wires / X plane
Total 504 Wires

WC 3:
114 Wires / U Plane
114 Wires / V Plane
80 Wires / X plane
Total 616 Wires

Total for both Wire Chambers: (346+504+616)*2=2932 Channels

WC Multiplexing

Drift time ≈100 ns.
Wire chamber rates range from 66 kHz - 324 kHz.
Expected rate of wire chambers ≈1.5 - 7 kHz/wire, corresponding to at most a hit every 140 μs, or a probability of 0.7% of a second hit within 1 μs.
Taking this into account we plan to multiplex wires, probably copying the Qweak system, shown below, which combines 16 input channels into 2 TDC channels.



Total channels after multiplexing ≈760. The forward most channels will not be multiplexed, since they have the highest rates.

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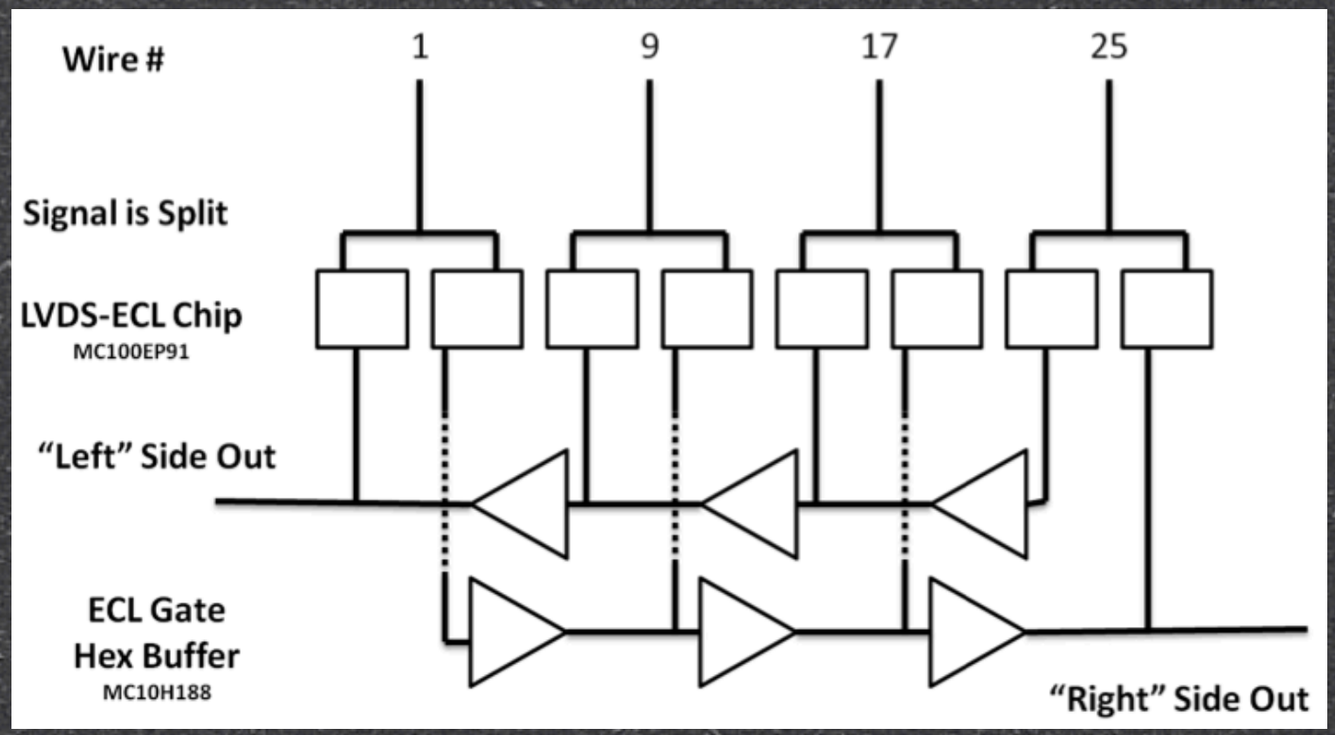
Can potentially reuse readout from QWeak subject to availability.



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Electronics Summary

	Channels	Ch/Module	Modules
ADCs	870	32	28
Splitters	870	Passive?	Homebuilt
High Precision TDCs	188	32	6
TDCs	~1450	32	46
Discriminators	870	16	55
Scalars	872 (and change)	32	28
Crates	20 Modules/Crate		9 Crates
Controllers	9	1	9

HV and Signal

~900 Signal cables (IFP/Target SciFi, Target/Beam Scints)
WCs use LVDS cables, GEMs use separate readout

HV

Detector	HV Channels	Notes
IFP SciFi	8	MultiAnode PMTs
Target SciFi	6	MultiAnode PMTs
GEMs	6	Separate (existing) system
Wire Chambers	24	Assuming 2 Channels/Plane
Scintillators	176	2 PMTs/Bar
Beam scintillator	12	2 PMTs/Bar

Assuming CAEN A3535 (32ch) for PMTs & WCs:
9 * A3535 (7+ 2 spare)
2 HV Crates
~240 HV Cables

Cost Estimate:
~45K$ HV+Signal cables+connectors
~65K$ HV crates + modules
Total cables+HV: ~110K$
Does not include splitters
Does not include HV for GEMs

DAQ Rates

Highest DAQ Rate ~5.5kHz (assume 6 for some prescaling flexibility)
Individual DAQ system per detector -> Max DAQ Rate ~3kHz/DAQ

DAQ Event size (GEMs readout independently): ~256byte, assuming 18 wires firing , and 2 detectors firing in each of the scintillator planes (including SciFi) and adding (lots of) overhead

Total maximum data rate/DAQ: 3kHz*256b - 768kB/sec (PCI bus at 100-133MB/sec, not a problem).

Disk space needs: 100GB/day*2DAQ = 200GB/day
Total 6Months of beam = ~36TB

The small size of the events and the simple analysis assures we can perform essentially online replay of the data.

Existing Equipment @ PSI

- 100 HV Channels
- 1600 TDC Channels (0.5ns resolution) - Dual ECL Output.
- 1600 Amplifier Channels.

Summary

Electronics requirements are quite significant, but do not require any new development beyond some simple board layouts.

Same for HV (even easier).

Plan to beg/borrow/steal as much electronics as possible concurrently with submission of grants.

~1/2 of needed electronics exists @ PSI and can potentially be borrowed.

DAQ rates/Disk space/Replay rates a non-issue.