

L2 Triggering

James T. Linnemann

Michigan State University

January 23, 2002


Present L2 Hardware Status

- ✍ MBT all except final monitoring tests
 - Need software for full support of > 1 MBT/crate
- ✍ SLIC need firmware to write out inputs (Jan?)
- ✍ CIC done, all working
- ✍ SFO done; support SLIC shadowing?
- ✍ Alpha 13 working (2 more?)
firmware needed for multiple alphas in crate
- ✍ Arbitration MBT, Alpha: PECL ? TTL
board mods, firmware testing under way
- ✍ Beta prototype testing in Feb; prod Nov
- ✍ STT ~July

Inputs

 Mu All types available, most sources

- Need rest of PDTs on; some A stubs missing


 Cal $|\text{?}| < .8$ now


upgrade priorities: Feb/March?

- Header with event #, seed masks, rest of ?
- Constant pedestals would help L1, L2 resolution
 - And allow simulation to match online
- $\frac{1}{2}$ GeV in ETot(tower) ; Emiss

 CPS March

 CTT April

 FPS May/June?

 STT July

Current Capabilities

Full **Muon** algorithms

- Forward + $\frac{1}{2}$ Central (multiple MBTs needed)
- Shakedown fairly advanced
 - But no L1 track trigger for L1 nor L2

Central **Cal em** algorithm

- No preshower, track so $e = ?$
- Early shakedown stages

Or, could run **Jet** algorithm

- Probably rejection 2-3 or so
- 3x3 makes more sense with restricted ? coverage
- 5x5 vs. 3x3 decision needed
- Currently, need to choose one or other
 - Run **em, jet simultaneously in February**
- Both limited by pedestal adjustment now

Global now turning on

- ✍ Running with simple jet or em filters
 - Input data looks good; glitches in output data
- ✍ **Debugging** with commissioning filters
 - PassOrFail(fraction), TimeDelay(mean, distribution)
- ✍ Scripts downloaded by hand
- ✍ L2Answer ? L2HWFramework: ready for tests
- ✍ Cut on em, jet, mu parameters (works offline)
- ✍ Can simultaneously cut and write to tape
 1. Mark&Pass (adjustable fraction) directly to tape
 - Trickier if want to cut in L3 on these
 2. L2 Pass events sent to L3 for filtering
 - Implement by doubling each L1 bit
 - 128 bits (plenty for now!)

Monitoring

- ✍ Monitoring from inside software Jan/Feb
- ✍ Dataflow monitoring of hardware Jan/Feb
 - Improved diagnosis of missing inputs
 - Improved diagnosis if DSP crashes (rare!)
- ✍ Verification with L2sim Feb?
 - Problems running L1, L2 separately on raw data
- ✍ Examine Feb/Mar
 - How much needed before starting?
 - Porting from trigsim packages...

Releases

 Nearly under full release control

– Presently base release + private areas

 To run rejecting, **must** run from releases

• Minimum needed to find efficiency later end Jan

 Hard to keep Tsim, L2online synched

– Different platforms (Alpha vs. Pentium)

– Different release schedules (online vs. offline)

– Best method still under discussion

Current Developments

 Full script downloading

 Sending of SLIC inputs to L3

- SLIC Firmware and software (early Feb)
 - L1 Framework (or MBT) firmware to set bits
 - Need for [Verification](#)


 Monitoring Data Collection Feb/Mar

- Hardware, Scalers, Event counters
- Pass rates by bit; run summary
- Monitoring Displays

 Test Stand Feb/Mar

- Copy data; test algorithms before running

 Tsim on raw data: Rejection, Eff_2 1-2 wk

 Joint Trigger, Reco ntuple 2 wk?

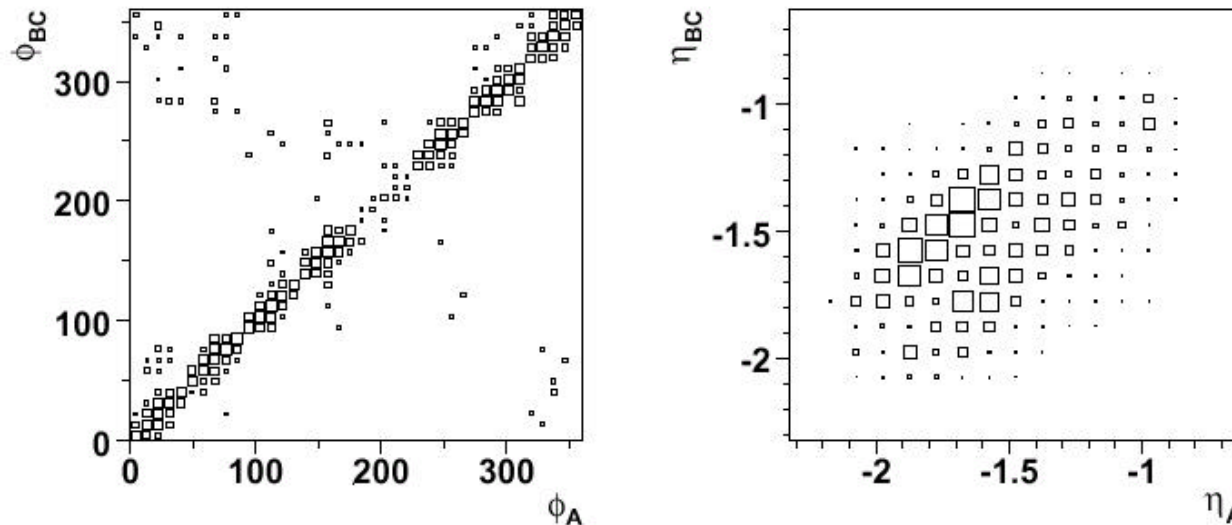
Short Term Schedule

Required before rejection	task	who	date
> 1 MBT/crate	software	Roger	Jan
SLIC inputs to tape	firmware	Nevis/Hal	Jan
L1 Qualifiers, UBS scalars??	firmware	Dan (or MBT/Drew????)	Jan??
SLIC inputs to tape	software	Roger	Jan
L2 answer to framework	software	Roger	Jan
Global inputs verify	software	Adam	Jan
Global scripts rejection verification	software	Adam	Jan
Scripts for UBS + Rejection	software	Levan, Adam?	Feb
Test UBS+Rejection scripts	software	Adam	Feb
measure throughput	hardware	Reinhard	Feb
measure rejection	?	?	Feb
stable base release	software	Roger, Reiner	Jan
Pass Rate measurement	software	Philippe, Hays, ?	Feb
Desirable before rejection			Feb?
em, jet simultaneously	software	Kostas	Feb
cal constant pedestals	firmware	Kehoe+?	Feb
monitoring from DSP software	software	already done??	?
monitoring from DSP software writing	software	Christos	Jan
monitoring counts from Workers	software	?	
monitoring distributions from Workers	software	Reinhard?	
monitoring alpha states	software	Adam?	
monitoring displays	software	Ike, Philippe, Reinhard...	
monitoring missing input diagnosis	software	Christos	Jan
monitoring crashed DSP	software	Christos	
verification of L2 standalone on raw data	software	Dugan, Xiaojiang,....	
Examine	software	Steele	
full automated download	software	Philippe, Roger, Scott	
Test Stand for MBT data	hardware	Reinhard?	
Test Stand for SLIC data	hardware	?	
Test stand control for Global	software	Scott, Roger, Philippe, Reinhard	March?
Object Interface design	software	?	
Root Interface(s)	software	?	
Merge Trigger, Reco Ntuples	software	?	
Object Matching Code	software	?	
MC Event ID	software	?	

Muon certification status

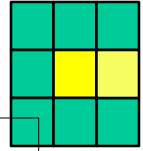
- ✍ ADM December <http://www-clued0.fnal.gov/~tim/l2/all0 tim.pdf>
- ✍ Data makes reasonably good sense
- ✍ Efficiency, Rejection measurement under way
 - Select events by trigger bit; match to L1, L3/offline

A ↔ BC Matching (all combinations)

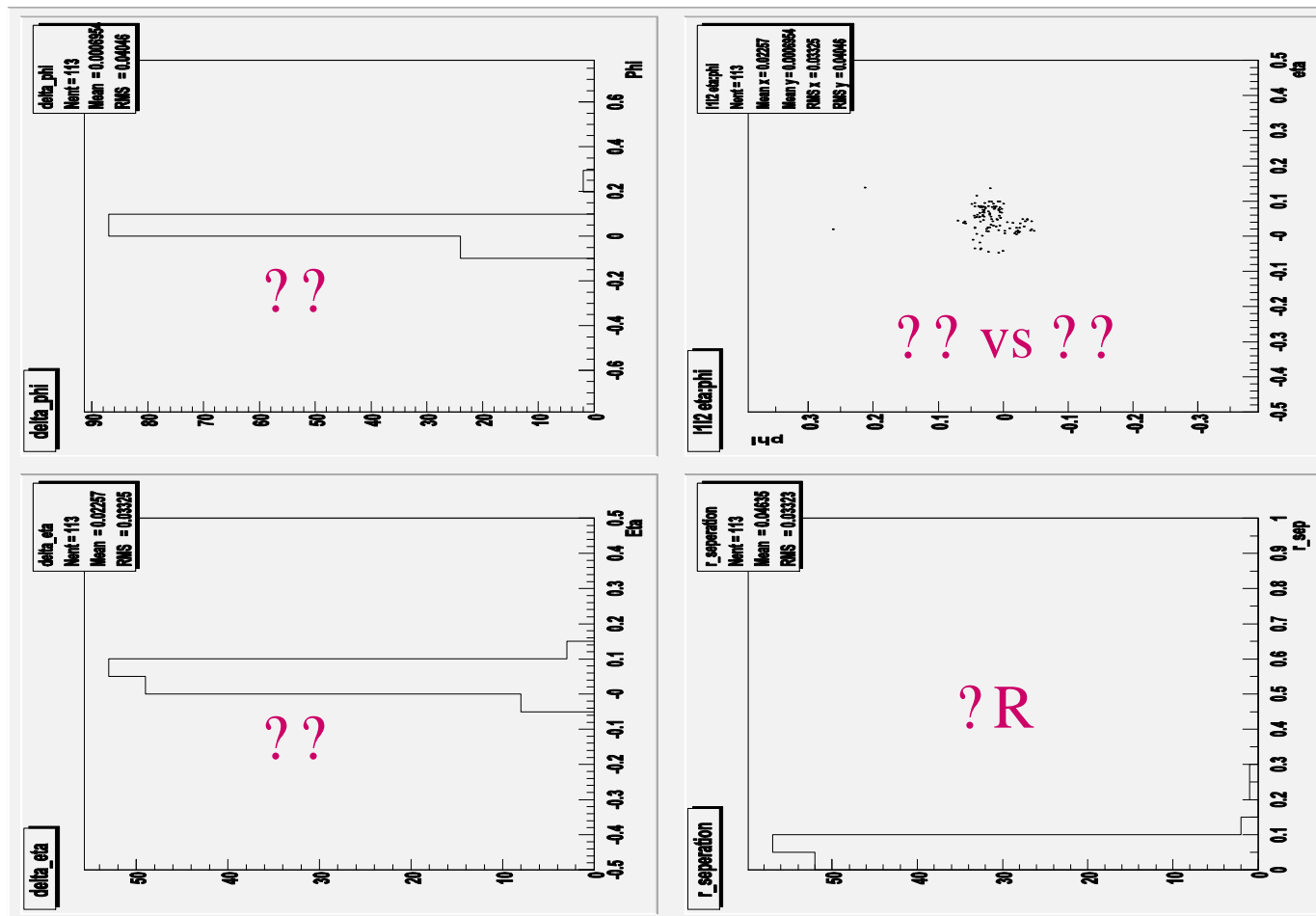


Electron Certification Status

finding L2 at L1 sites

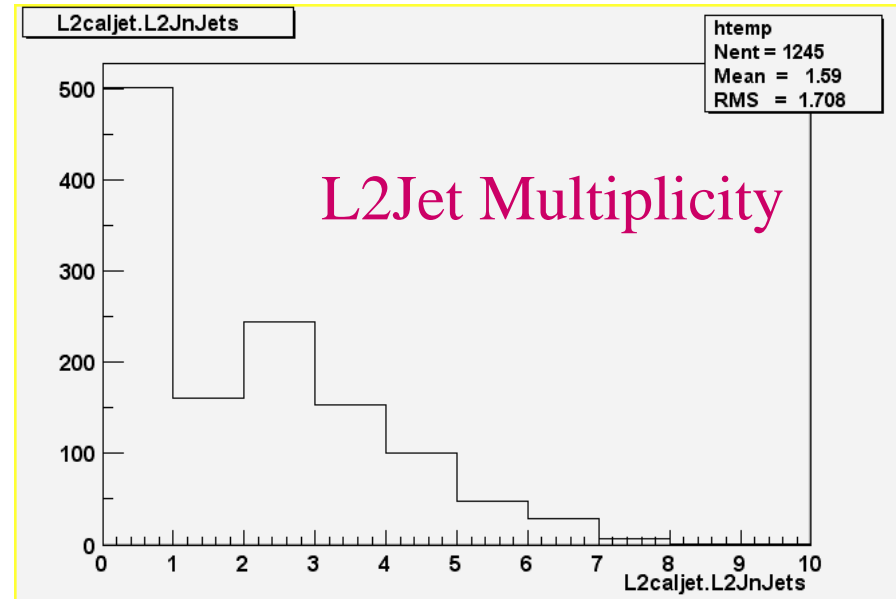
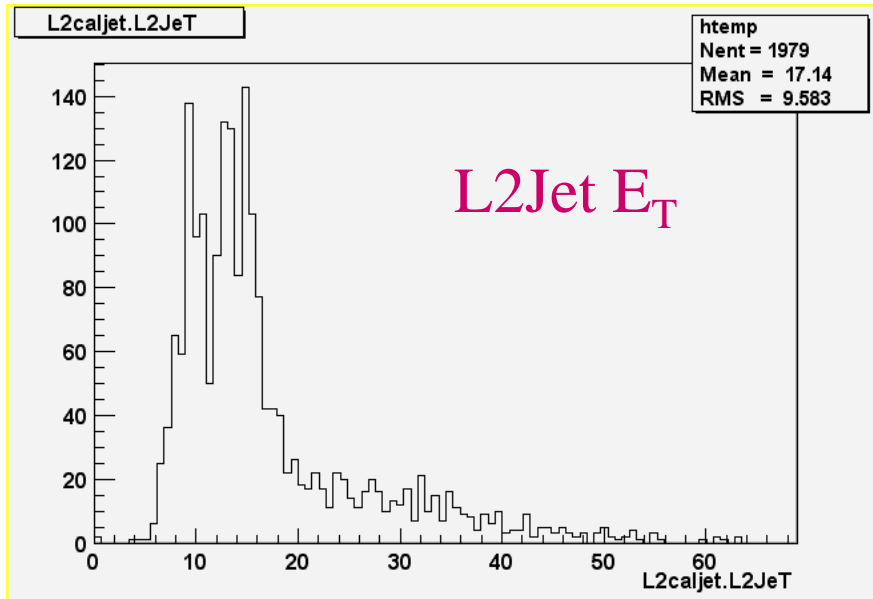
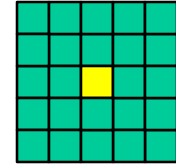


L1 vs L2Em



L2Em Algorithm: NN; 1 GeV seeds

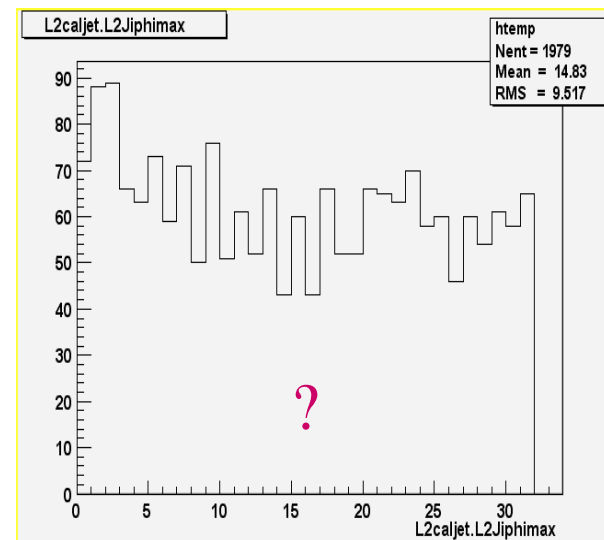
Jet Certification Status



~~L2Jet 5x5 TT~~

2 GeV seeds

~~Next: Match to L1~~



Where might it help?

no rejections measured yet!

More data by:

- Remove or lower *prescales* by L2 cuts
 - tighten *quality cuts* in L2 (**mu** flag; **em** fraction)
 - raising *jet threshold* in L2 with similar efficiency
 - For now, must choose **em, or jet (not both)**
- OR *Lower L1 threshold* for same rate to L3

Single Mu no clue on rejection yet

- Mu1ptx, · CJT prescaled;

Single e? Maybe factor or 2-3?

- CEM(1,15)
- CEM(1,10) · CJT prescaled

Jet? Factor of 2-3?

- Remove prescale on Cem,mu1·CJT's?
- More data for CJT(2,7)
- Or improve e ·j, mu ·j

Prescale
Removal
Candidates

global_CalMuon-3.30 (Luminosity)	Measured Rate				Prescales	
	5.5E+30	1.0E+30	2.0E+30	4.0E+30	6.0E+30	
ALiveBx (1.7 MHz -> 0.5 Hz)		85000	3.40E+06	3.40E+06	3.40E+06	
Afastz (43mb -> 0.5 Hz)		3400000	1.7E+05	3.4E+05	5.2E+05	
CEM(1,5)	225.931	50	2000	2000	2000	
CEM(1,5)CJT(2,5)	19.15	2	40	40	40	
CEM(2,5)	12.573	2	20	20	20	
→ CEM(2,5)CEM(1,10)	4.642	1	1	4	4	
→ CEM(1,10)CJT(2,5)	5.416	1	10	10	10	
→ CEM(1,10)CJT(2,7)	2.321	1	1	1	2	
CEM(1,10)CJT(2,10)		1	1	1	1	
CEM(1,15)CJT(2,7)		1	1	1	1	
CEM(2,10)	0.774	1	1	1	1	
→ CEM(1,15)	2.708	1	1	2	2	
CEM(1,20)	1.161	1	1	1	1	
CJT(2,3)	340.444	100	3500	3500	3500	
CJT(2,3)CJT(1,5)	104.261	29	1000	1000	1000	
CJT(2,3)CJT(1,7)	36.172	10	361	361	361	
CJT(2,3)CJT(1,10)	12.38	31	61	61	61	
CJT(3,5)	3.869	10	20	20	20	
CJT(4,5)	1.161	1	1	1	1	
CJT(2,7)	4.449	50	50	50	50	
CJT(3,7)	0.774	1	1	1	1	
CJT(4,7)	0	1	1	1	1	
→ mu1ptxctxx_fz	49.906	4	17	35	50	
→ mu1ptxbtxx_fz	74.279	7	25	50	76	
mu2ptxbtxx_fz	0.387	1	1	1	1	
mu2ptxctxx_fz	0.387	1	1	1	1	
mu1ptxctxx_CEM(1,5)	0.387	1	1	1	1	
→ mu1ptxctxx_CJT(1,3)	4.449	1	2	4	5	
mu1ptxctxx_CJT(1,5)	0.58	1	1	1	1	
mu1ptxctxx_CJT(1,7)	0.193	1	1	1	1	
→ mu1ptxbtxx_CJT(1,5)		1	1	2	4	
mu1ptxbtxx_CJT(1,7)	0.58	1	1	1	1	
→ mu1ptxwtxx_fz		16	34	65	101	
→ mu1ptxatxx_fz		20	43	85	127	
mu2ptxwtxx_fz		1	1	1	1	
mu2ptxatxx_fz		1	1	1	1	
mu1ptxatxx_CEM(1,5)		1	1	1	1	
→ mu1ptxqtxx_CJT(2,3)		1	1	4	5	
Total post-prescale rate into L3	12-15Hz					

Better performance with time

- ✍ Run L2Global filters only on passed L1 bits
 - For now, **run all**, and framework does L1&&L2
 - Need software, and L1 event tag on mask (Feb/Mar?)
- ✍ Implement multiple alphas in crate
 - Execute algorithms in parallel, not serial
- ✍ Implement hardware seed masks in L2Cal
 - For now, build in software
- ✍ Interleave event processing with I/O
 - For now, just L3 output overlaps with processing
 - Later, DMA data input overlapped
 - Awaits running VRBC in buffering mode
 - Eventually, Interrupt routine may make faster (Betas?)
- ✍ Turn off Linux
 - But loses much of debugging capability

A Comment on L2 Dead Time

✍ Front ends operating un-buffered (VRBC)
– Breaks L2 pipeline

✍ Result: **dead time = L2 latency, not processing time**

- Latency is time for SLIC+Alpha+Global+all L2 I/O

$$DT = R_1 T_2 \quad 50 \text{ Hz} \times 1 \text{ ms} = 5\% \quad \text{dead time}$$

✍ L2 needs to measure achieved throughput

- And check code for hang-ups
- Not just measure rejection

What Needed to Run L2 Trigger?

- ✍ **Technical Readiness**: ability to reject end Jan?
- ✍ “better than prescaling” efficiency ? rejection
- ✍ Acceptable **deadtime** (**primarily L2 group**)
- ✍ Efficiency possible to measure (**releases!**)
- ✍ Un-buffered mode, or headers for L2Cal
 - To show events synched
- ✍ Tools to measure
 - efficiency on MC
 - **Efficiency wrt L1**, L3, offline; **select events by trigger**
 - **Rejection wrt L1** (more work on **Trigsim?**; beam time?)
 - Efficiency really means turn-on curves
 - Standardized initial cut values (will change)
- ✍ Sufficient stability (releases how often?)
- ✍ Working **test stand?**

In the control room

and from Leslie

- ✍ COOR to harmonize **multi-run readout lists**
 - Or enforce by hand
- ✍ Better **communication**
 - If an expected **input** is **removed**, L2 hangs
 - L2 must adjust configuration if a single muon input dies
 - **For now we turn off a whole SLIC**
 - ~10 inputs, 10-15% of detector
 - Thus, **DAQ expert has to hear** about it
 - L2 experts on call 24x7
- ✍ Priority **consultation** on Framework, L1Cal work

Where do we need help?

Root Object Interface (who?)

- And **ability to join** trigger and reco **ntuples**
 - **Coming: D0_analyze—make both at same time**

ID groups:

- Measure efficiency vs. L1, L3, Offline
- Help with 3x3 vs. 5x5 jet choice
- Select standard cut sets for L2Global

Physics groups:

- Measure efficiency for signal MC

L2 + DAQ experts + maybe trigger panel reps

- Measure rejection, latency (deadtime vs. rate)
- Looks like 1-2 wk to rejection measurements

Standard Object Interface

Standard object interface at L1, L2, L3, Reco, MC

- Some thought needed: $E_t(z=0)$, ?, ? ($z=0$)
 - in same units
 - $z=0$ because vertex choice should not confuse ID and matching of objects across levels
 - L1 and L2 use $z=0$
 - Study of impact of $z=0$ a physics group matter

Needs **DESIGN**

Implementations:

- Trigger Root-tuple

SEED (Nikef) a strong start?

<http://www-d0.fnal.gov/nikhef/seed/>

- Reco Root-tuple

- **A big problem: can't look at both at same time yet**

- Raw Data and Analyzed Data (later)

Standard Comparison Tools: Design needed cf. ESUM_COMPARE

Select closest matches

- Between objects of 2 types (L2, Reco, say)
- Algorithm: ??, ??, ? cos?
- Select events by trigger bit **names**

Plots

- Spatial, $E_t(z=0)$ resolution
 - Weight by $E_t(0)$ to reduce artifacts?
 - Threshold mechanism?
- Turn-on (relative efficiency) curves
 - Ratios of spectra
 - What variable on the x axis?

What kind of comparisons without merged ntuples?

 Raw event dumps, hand scans of few events

 ? -? distributions of 10's events

– Weight by $N >$ threshold; $E_t(0)$?

 But no distributions of ??, ??, ? E_T

Summary


Hoping for L2 **technical readiness early Feb**

- More running needed to be confident
 - L2-specific measurements won't be done yet
- Initial environment may be painful for DAQ, L2 experts
- First basic capability, then performance enhancements
 - More/better inputs
 - L2 technical developments drive this

Physics readiness: 1 month? can we??

- Collaboration (Trigger panel) decides along with L2
 - Do we think L2 is doing something reasonable?
 - How good is better than prescaling?—where does L2 help most?
 - Rejection available, quality of certification, dead time
- Need **help from outside L2 group (sets time scale)**
 - Tools
 - running jobs to certify

Better than Prescaling?

 Purity Enhancement = $\text{Eff}_2 ? (R_1/R_2)$
= $\text{Eff}_2 ? \text{Rejection}$
= 1 for prescaling

Impact of No Arbitration, few Alphas

- ✍ One Alpha per crate for now
 - 2kHz probably possible
- ✍ But limited L2 rejection now (few inputs)
 - L2 input bandwidth won't limit
 - until more L3 input bandwidth available
- ✍ Multiple Alphas for some crates later
 - Need arbitration fix, PIO firmware upgrade
 - Balance slowest crates, test stand