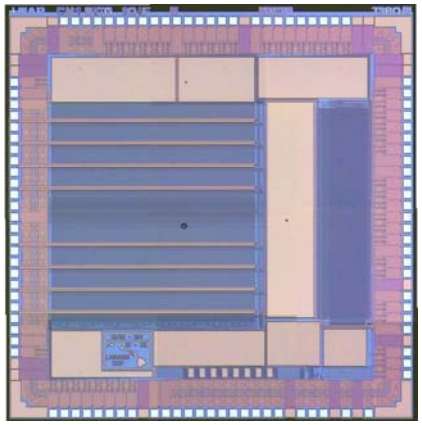
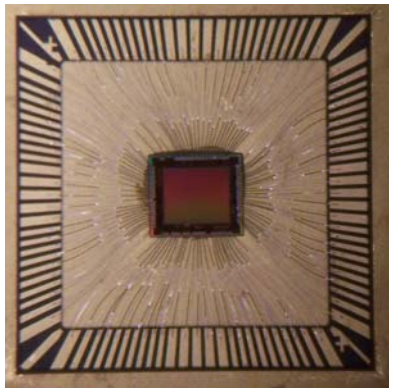
BLAB2 ASIC plans





- BLAB2 ASIC
  - Design specifications, simulation
  - Compact readout system [already covered]
- Upcoming beam test options discussion
  - TOF (2+1 channel) readout module
  - Simple MPPC test bench (March?)
  - SLAC ESA (Sept?)

Larry Ruckman, Gary S. Varner (Univ. of Hawai'i)

Ke Wang (IHEP, Beijing)

SLAC PID Meeting 1-FEB-08

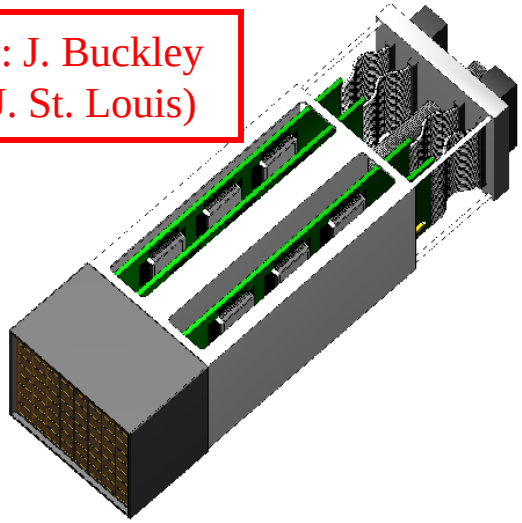
BLAB2

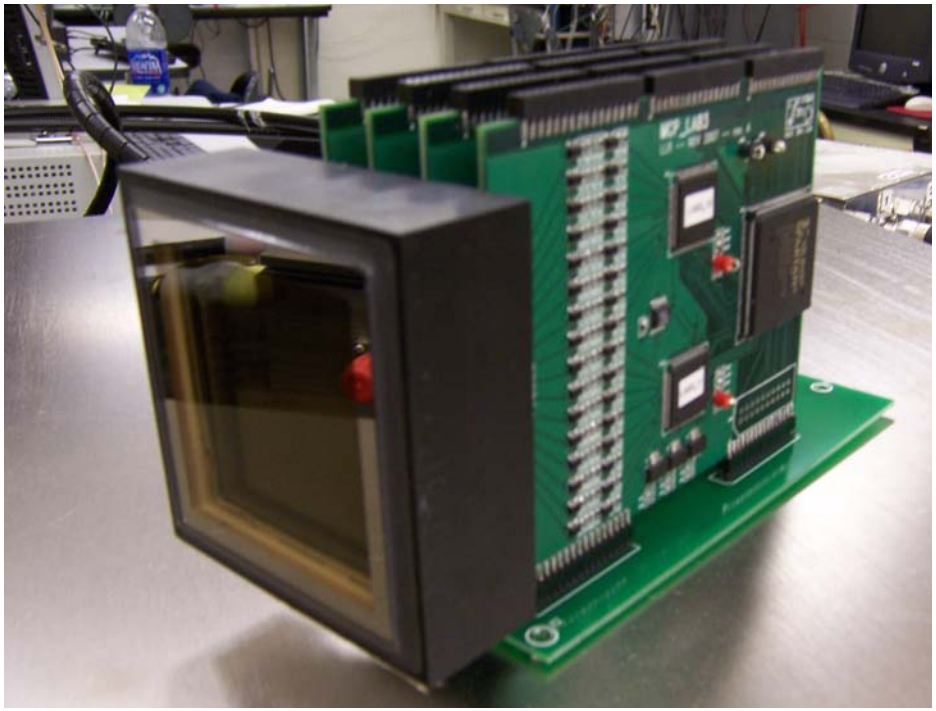
- **Initial Target: New f-DIRC/f-TOP Readout System**

TABLE II: *BLAB2 ASIC Specifications.*

Item	*Value*
Photodetector Input Channels	16
Linear sampling arrays/channel	2
Storage cells/linear array	512
Sampling speed (Giga-samples/s)	2.0 - 10.0
Outputs (Wilkinson)	32

Courtesy: J. Buckley
(Wash U. St. Louis)

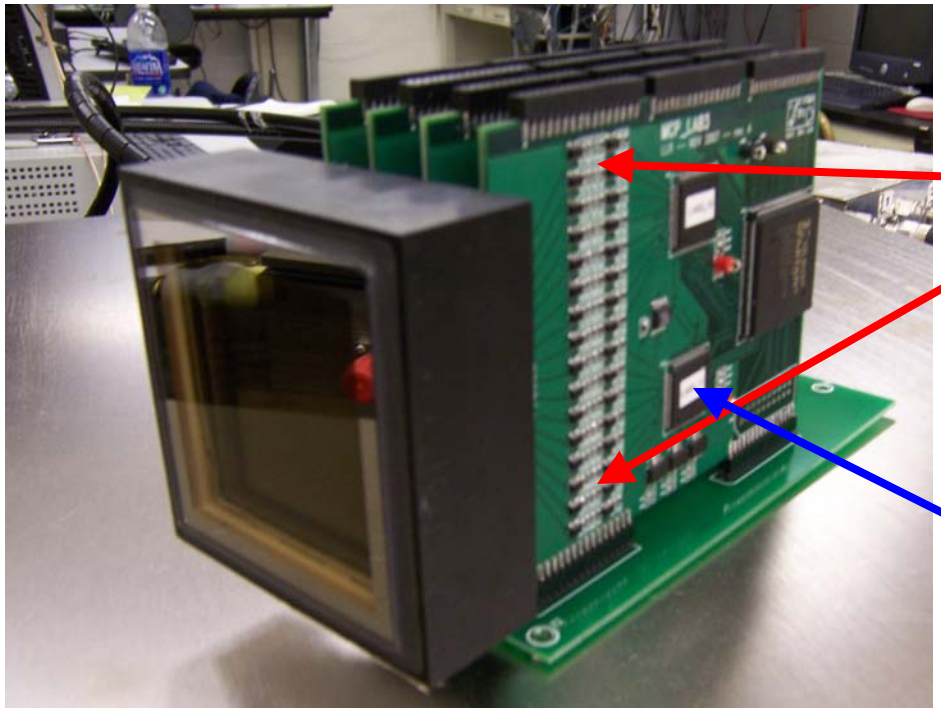




Gen. 0 Prototype (LAB3)

Target Submission: Feb. 11, 2008 → Apr. 4

Gain Needed



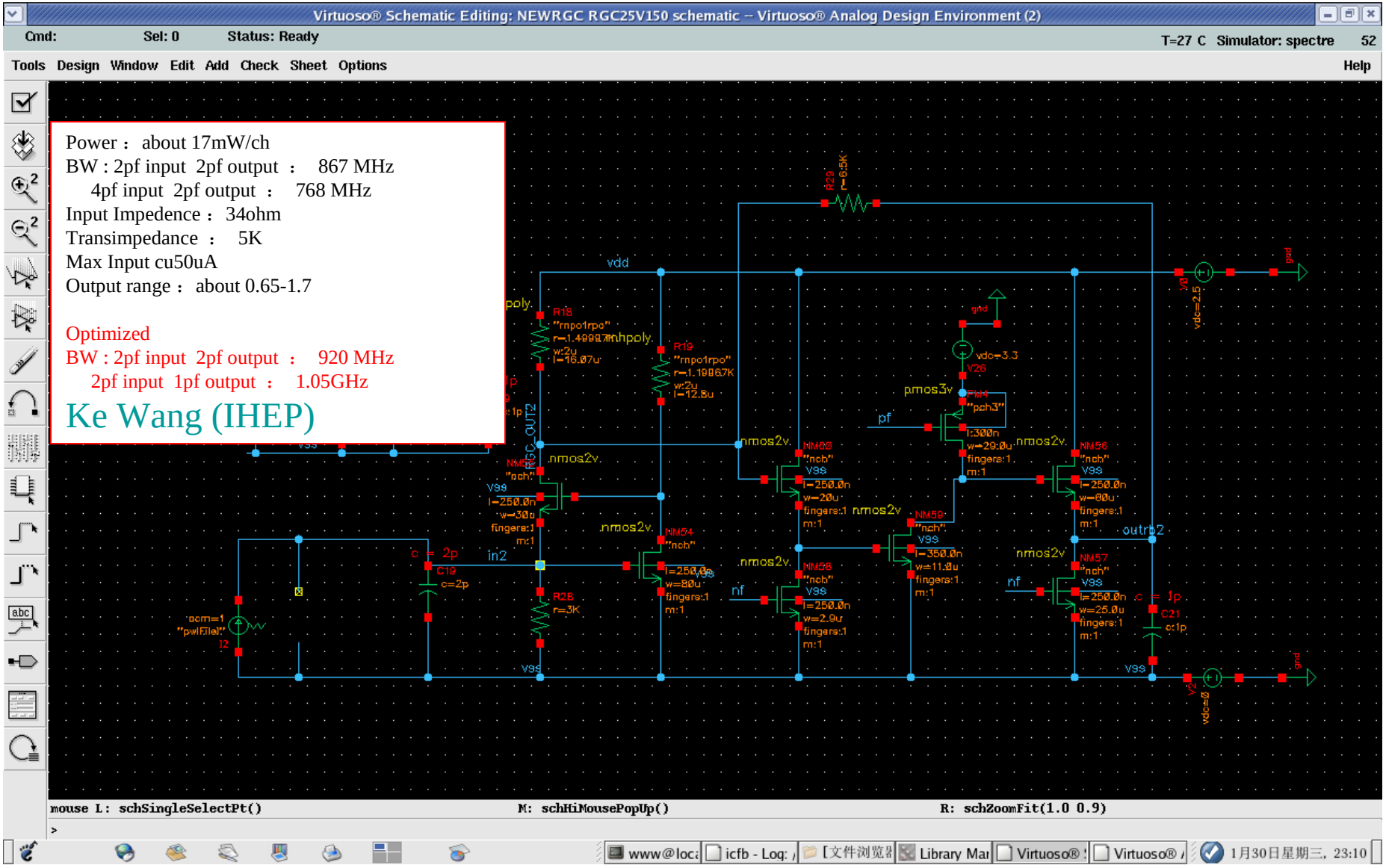
Amplifiers dominate board space

Readout ASIC tiny (14x14mm for 16 channels)

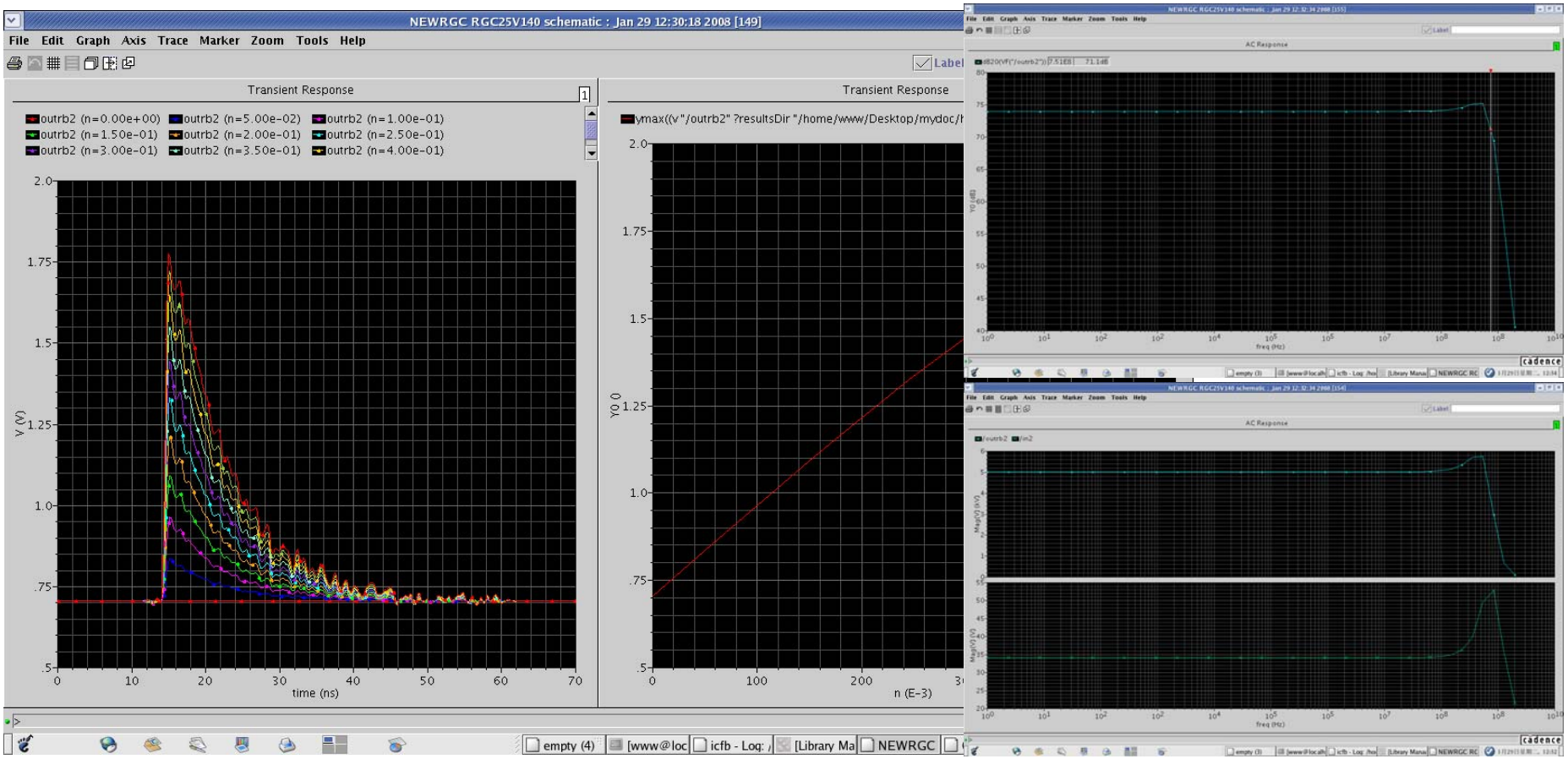
- What gain needed?
  - At 10^6 gain, each p.e. = 160 fC
  - At $2x10^5$ gain (better for aging), each p.e. = 32 fC
  - In typical ~5ns pulse, Vpeak = dQ/dt * R = 32uA * R = 32mV * R [kΩ] (6.4mV)

Gain Estimate	
Rterm	**1 p.e. peak**
50	1mV
1k	20mV
20k	400mV

RGC_TIA Circuit



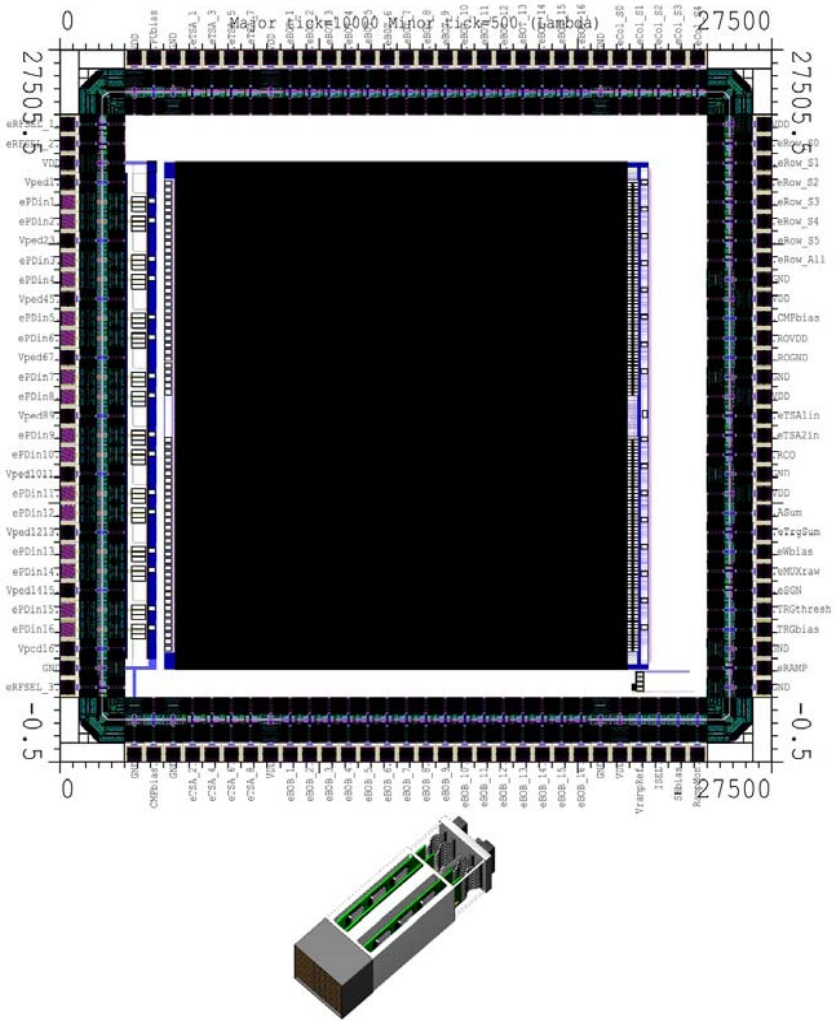
Simulated Performance



- Meets specs on previous slide
- 5k → ~100mV
- Sample noise ~1mV, if match input noise: 6pA/sqrt(Hz)
- SNR is then 100:1

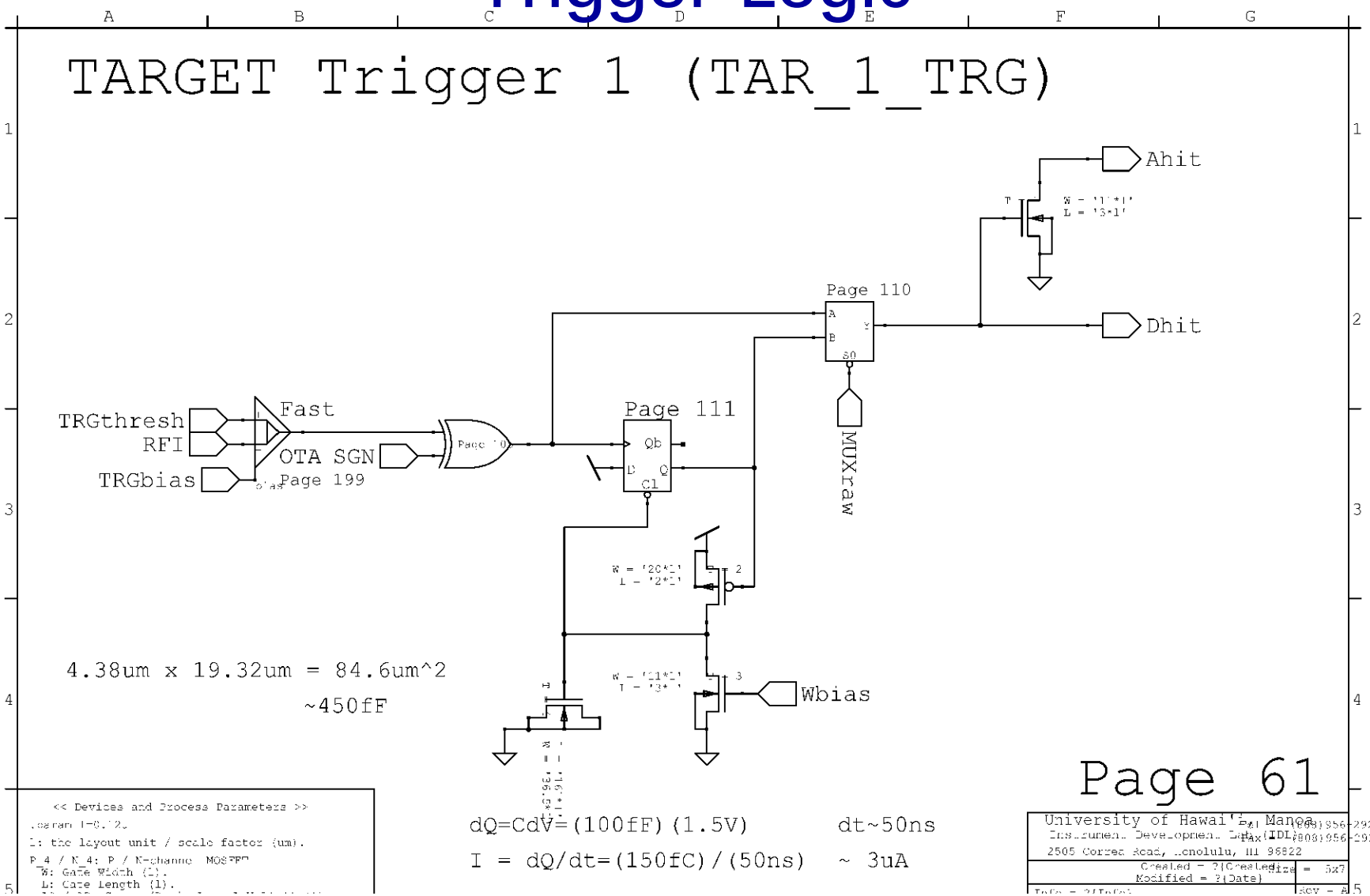
Triggering Capability

Could be incorporated – already doing so for TeV-γ application prototype (TARGET)



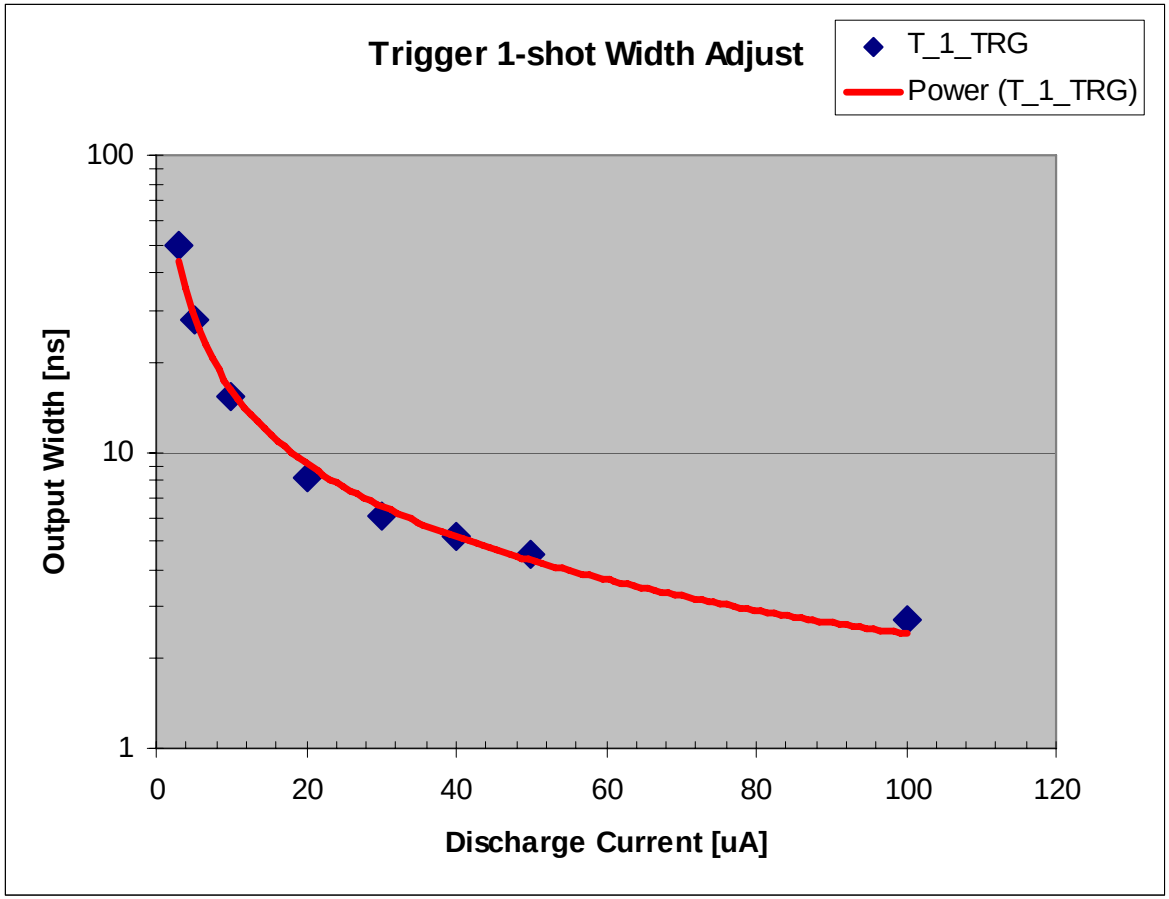
- Need 100 telescopes, each with 10,000 photodetection channels (1M channels)
- Detailed Cost exercise
  - For >10,000 channels, price drops drastically
- Trigger functionality needed
- Very large "dark sky" background, but can still trigger! (use same scheme in Belle2?)

Trigger Logic



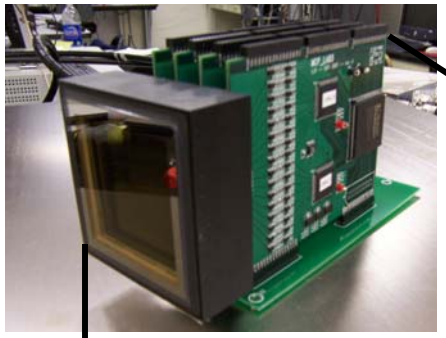
- Analog (Sum of # Ch. ON) & Digital OR output
- 1-Shot or Raw comparator output

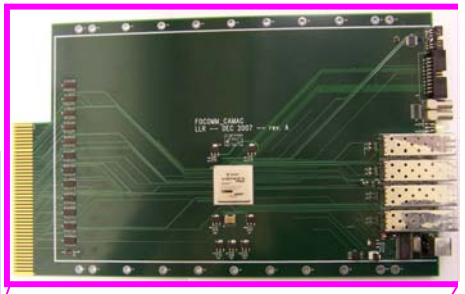
Trigger Simulation



- Good Adjustment Range
  - Reasonable current values
  - Preliminary Design (could also buffer out analog), use FPGA as Discrim. [ANITA] Journ. Instr. Vol 1, P07001 (2006).

Test System Block Diagram





Giga-bit Fiber

MCP

BLAB2

BLAB2

BLAB2

BLAB2

MCP MAIN

x7

cPCI CARD

x1

cPCI Crate (Linux)

CAMAC CARD

CAMAC Backplane

- Up to 7x64 channels per cPCI card
- CAMAC card for SLAC beam test
- Up to 32,256 channels/cPCI crate

Very cost effective, board hardware already exists

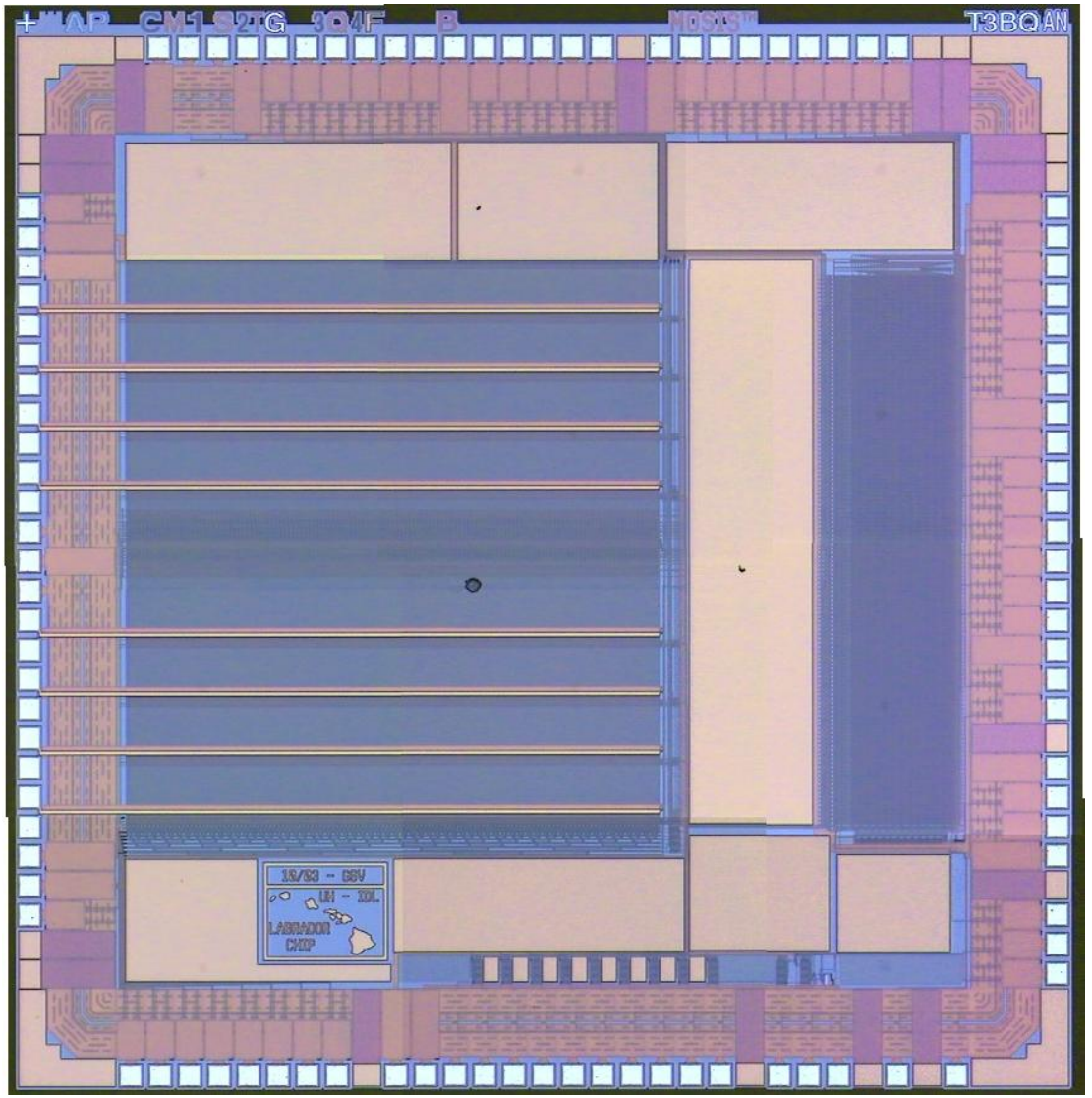
Fast PID Readout Update -- 1-FEB-08

Summary

Building toward a major system (beam) test

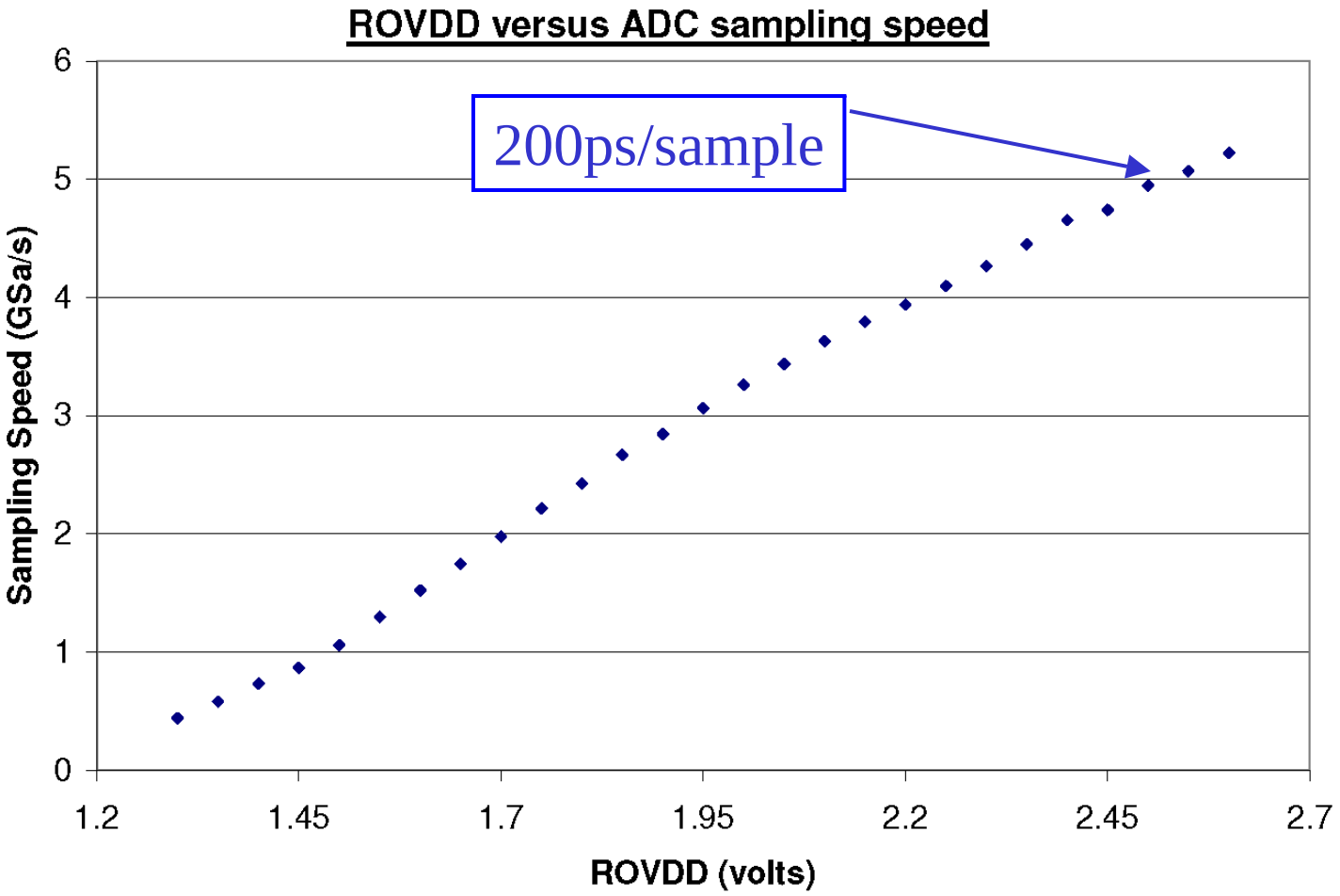
- BLAB2 design almost done (final amplifier, trigger decisions)
- Delay has made design better, also beating the bushes for the ~25k$ needed
- No show-stoppers
- Get serious about a “~1k channel” system test?
- What needed for demonstration in light of upcoming TDR(s)?

Back-up slides



BLAB1 Sampling Speed

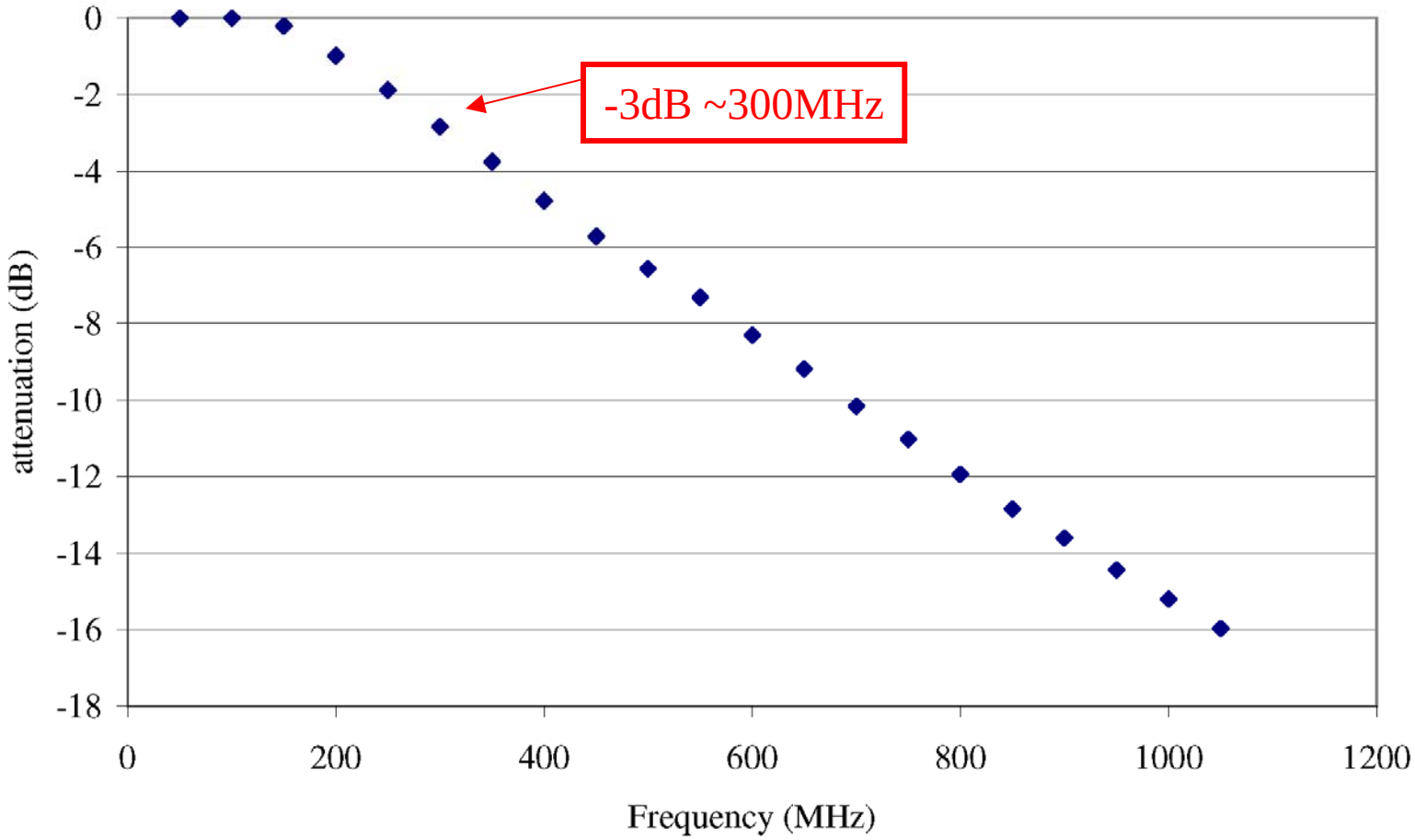
Can store 13us at 5GSa/s (before wrapping around)



Single sample:
200/SQRT(12)
~ 58ps

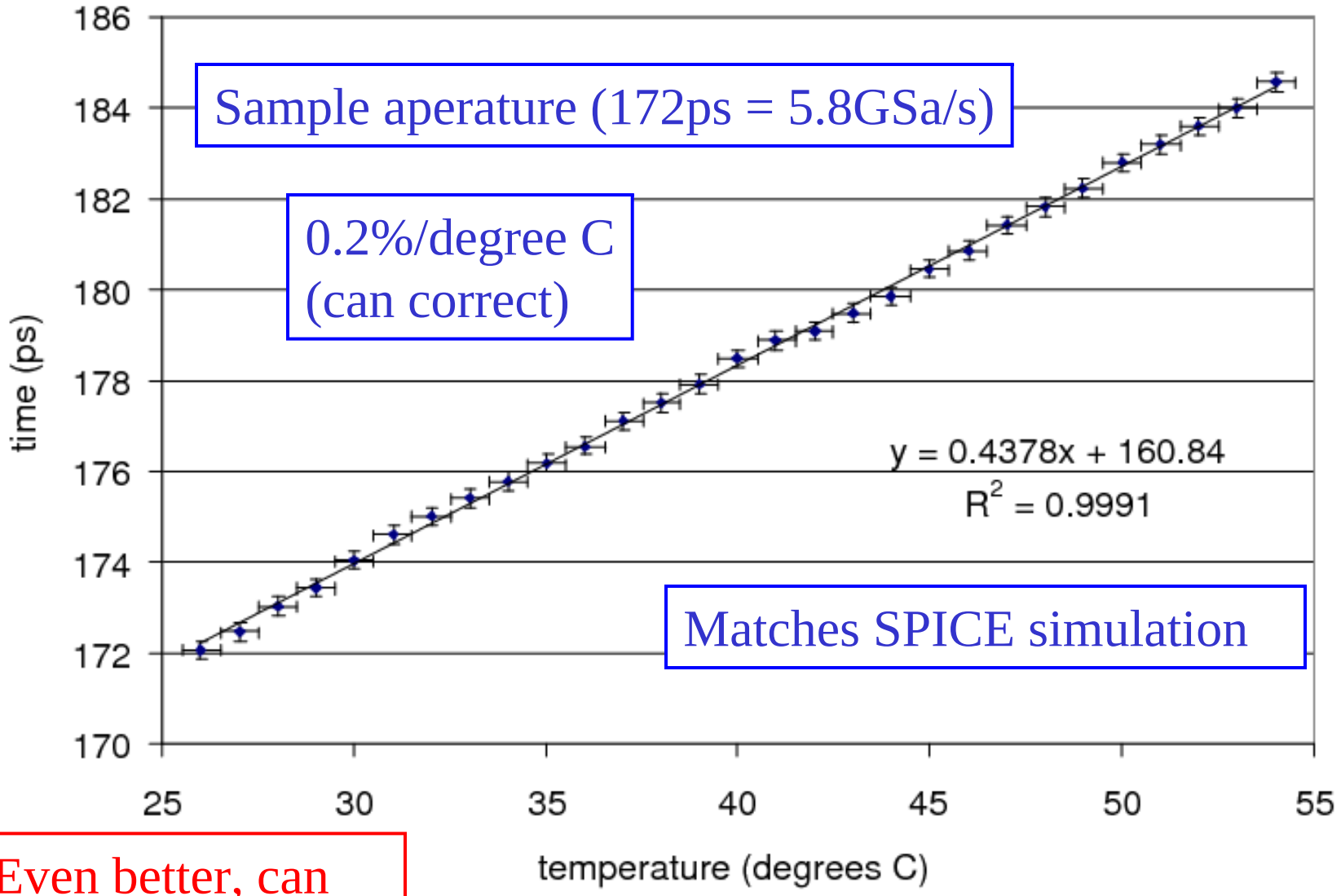
But, have Complete Waveform Information

BLAB1 Analog Bandwidth



- A few fixes (lower power, higher BW)
- Multi-channel: BLAB2 (16), TARGET (16 w/ gain), LARC (32) and PrX

Temperature Dependence



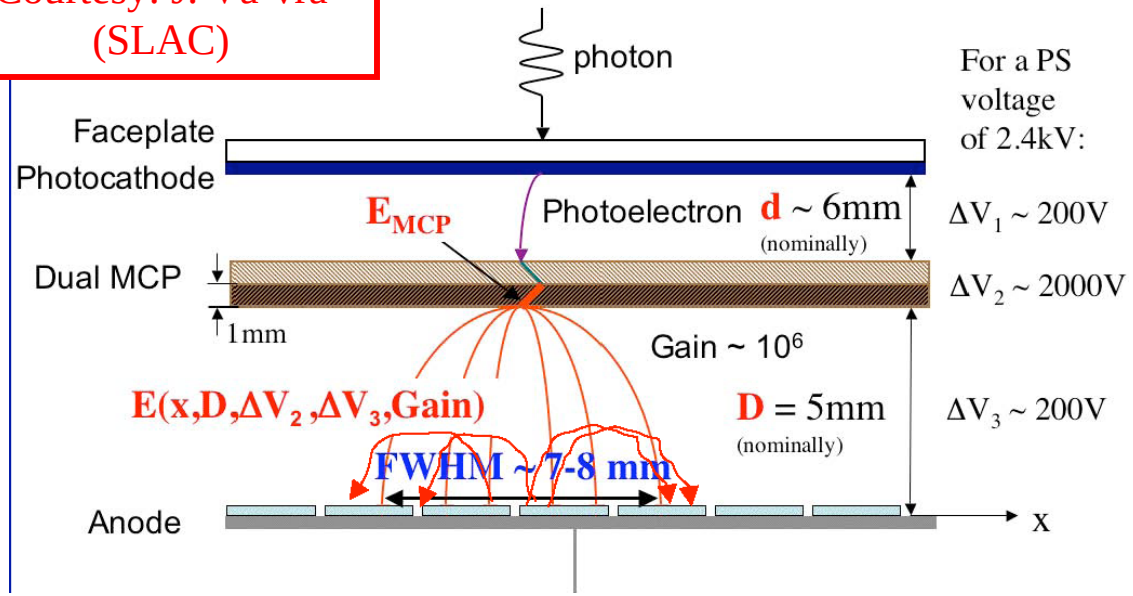
Even better, can delay lock

Limitations 1: Analog Bandwidth

Difficult to couple in Large BW (C is deadly)

At what point stop getting useful information?

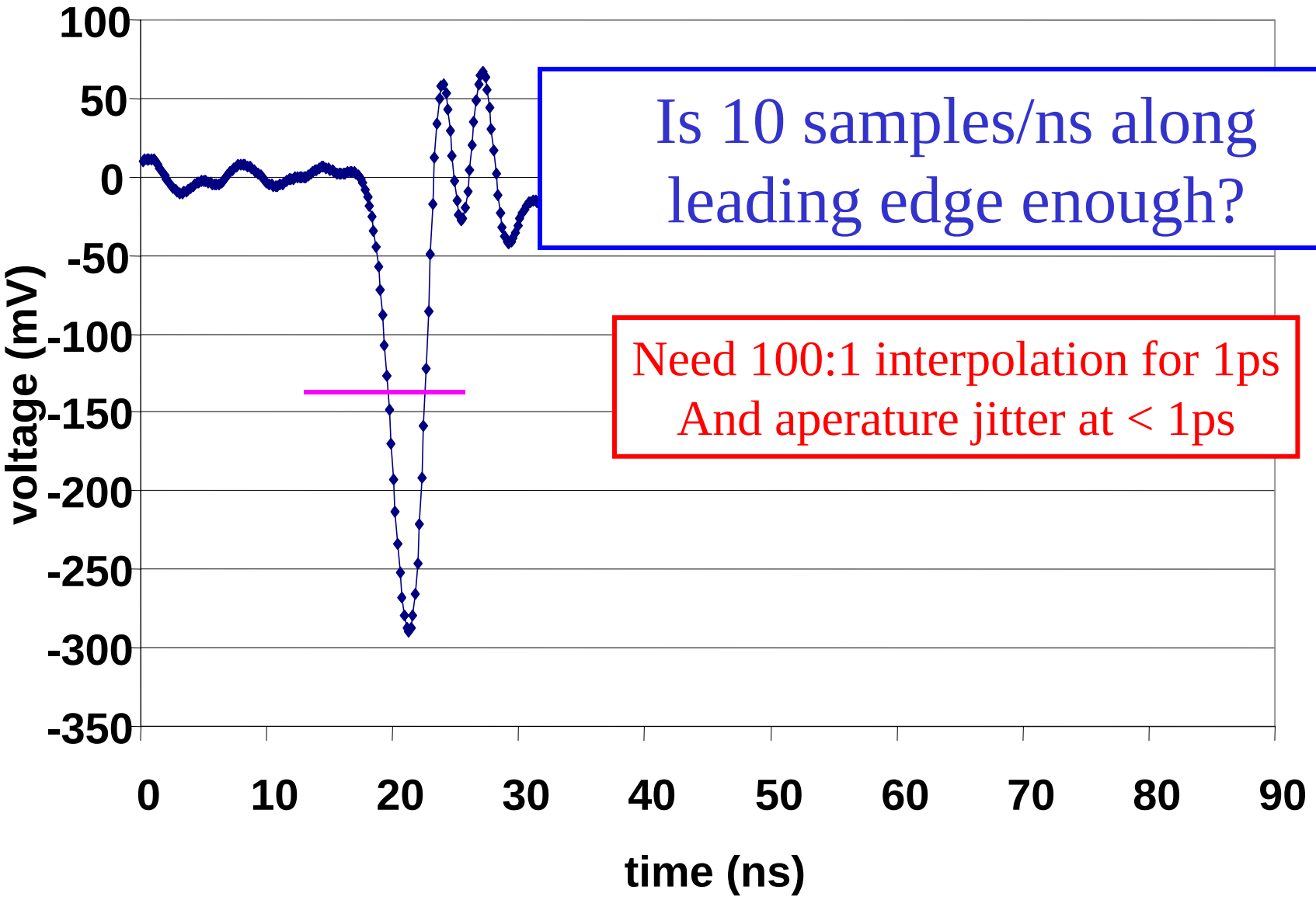
Courtesy: J. Va'vra (SLAC)



$$f_{3dB} = 1/2\pi ZC$$

Limitations 2: Interpolation Error

Tied to Bandwidth Issue



Is 10 samples/ns along leading edge enough?

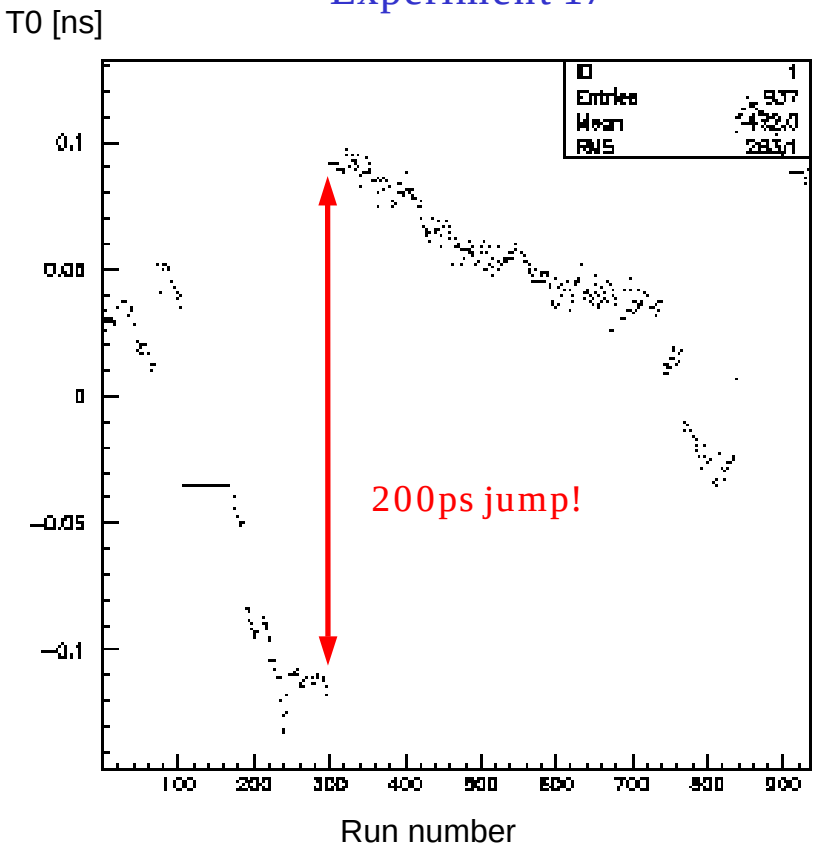
Need 100:1 interpolation for 1ps
And aperature jitter at < 1ps

Limitations 3: Systematic Errors

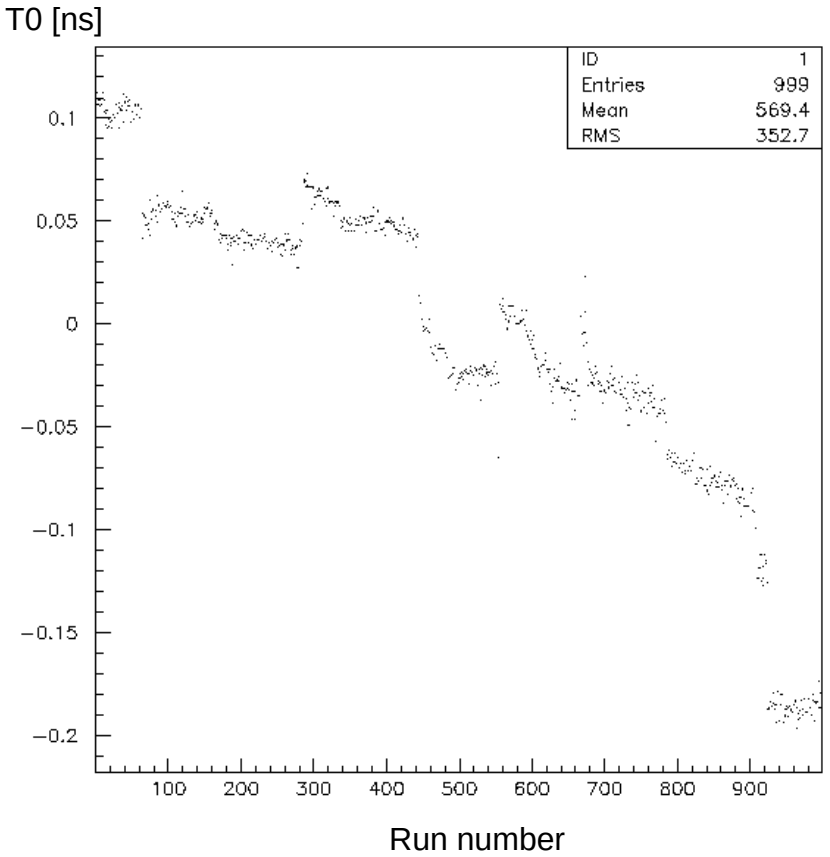
Experience with running Belle TOF System for ~ a decade

Any jitter/shift/jump in reference time is fatal? (differential measurements)

Experiment 17



Experiment 19

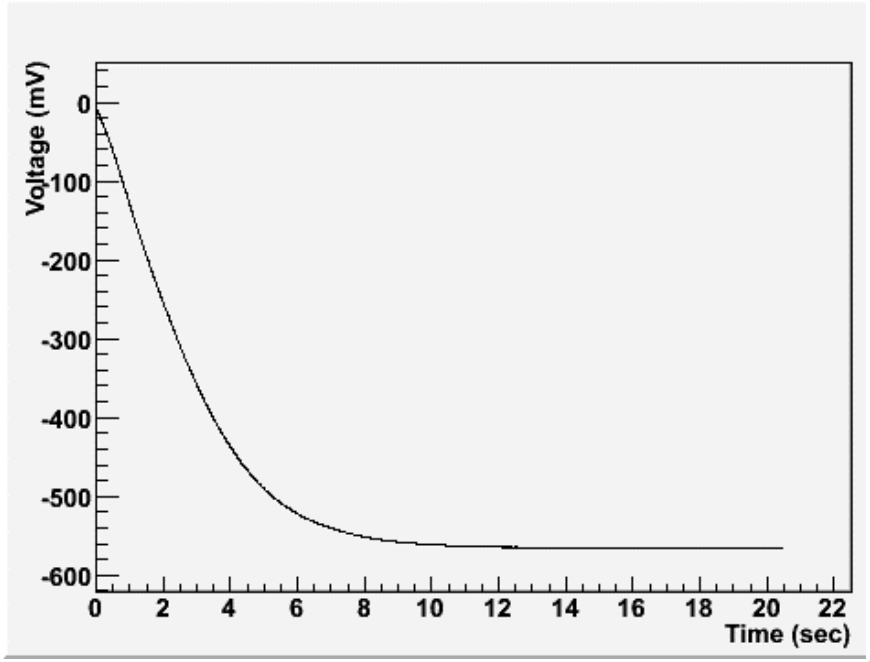


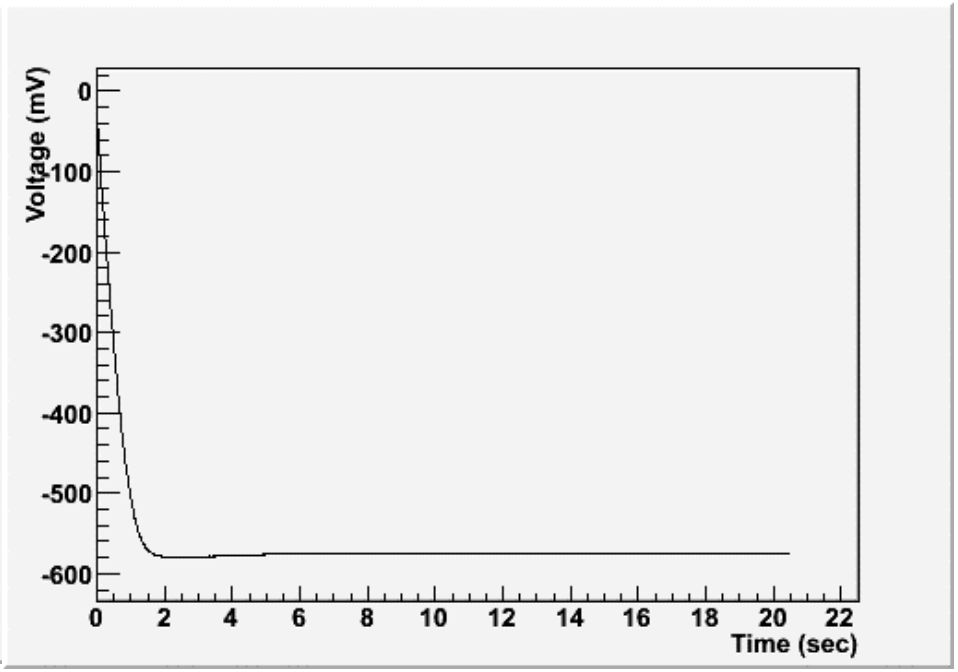
- Run-by-run T_0

Limitations 4: Leakage Current

Need small C for Input Coupling

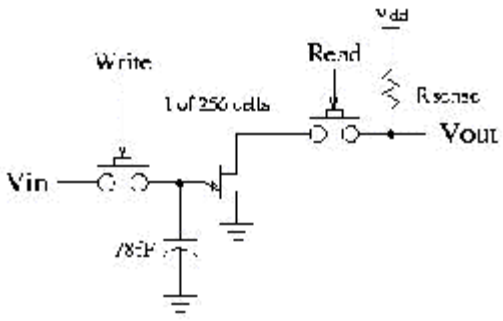
Can Improve? (readout faster)





Limitations 5: kTC Noise

Need small C for Input Coupling



$$v_{rms} = \sqrt{\frac{kT}{C_{store}}} = 0.23mV$$

C_{store} = 78fF