

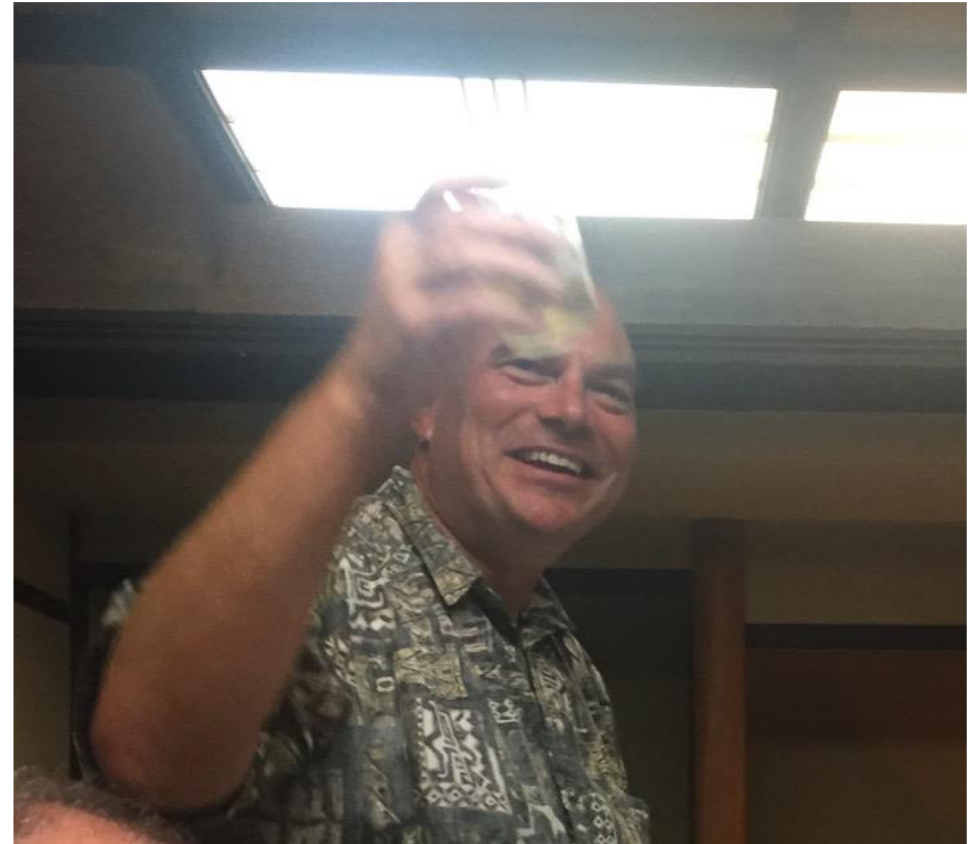
# Gary S. Varner Memorial Symposium

CPAD 2023

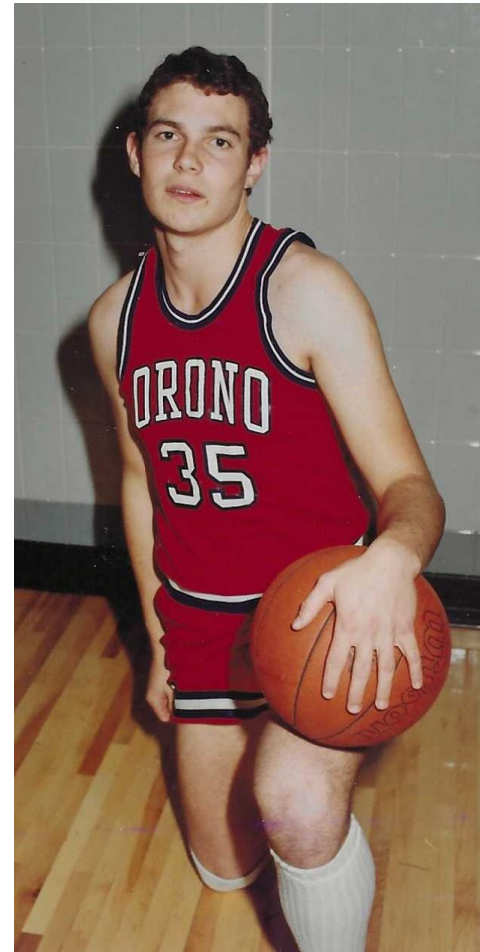
# Gary S. Varner

- Gary passed away on July 14<sup>th</sup> 2023 at only 56 years old
- UH memorial celebration on August 19<sup>th</sup>:
  - <https://www.phys.hawaii.edu/gary-varner/>

(I am liberally stealing from the pictures and memories shared at the UH event)

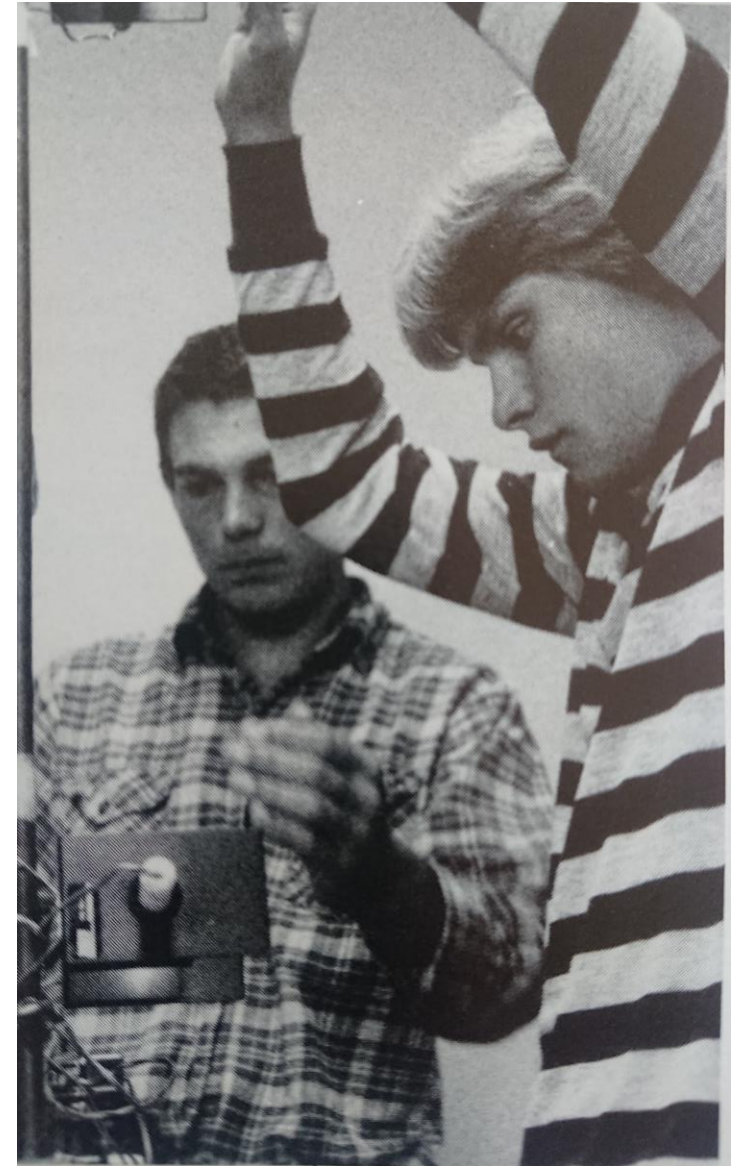


# Gary in Minnesota

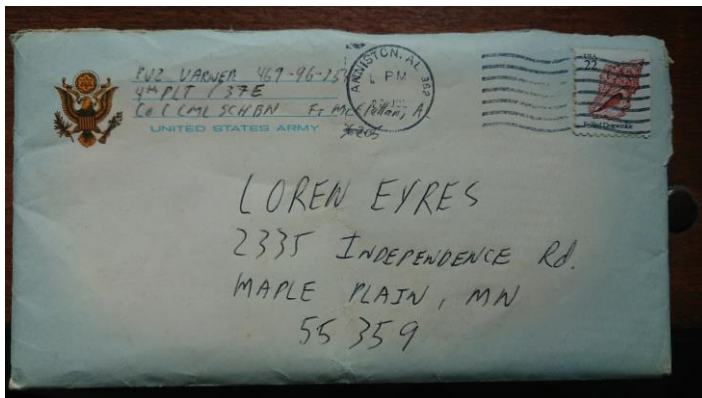


# Gary in High School

- Motivation: Extra credit
- Objective: Measure earth's gravitation
- Method: Time free-fall of metal ball
- Apparatus (at right):
  - Two lamps/photodiodes and digital timer
- Result: Not too accurate (vs.  $9.8 \text{ m/s}^2$ )
- Discussion:
  - Some gaps in experimental technique, statistics, and error analysis



# Gary in the Army



- Gary from Basic Training: Fort Bliss, TX

June 1984

“...if you are going to write, put everything down in one massive letter. I do 20 push-ups for every letter I receive (don't be cruel).”

PS. It's not too bad here, but the first day was horrible and it's going to be a long 8 weeks.”

- Gary from Advanced NBC Engineer Training

June 1985 --

“I'm at Chemical Warfare School, and this course is very bogus.”

# Gary in college and beyond

- 1986-1995: Boston University
  - BSc. in electrical engineering, MSc. in Physics
  - Working on various HEP electronics since the earliest days, effectively senior technical staff since 1992
    - Worked on at least 6 different projects...
    - “Fabrication and testing of a GaAs ASIC for ultra high-speed triggering applications, at the time probably the fastest non-military Bandwidth x Time chip ever made”
  - Short stint as teaching adjunct professor
- 1995-1997: Uni Hawaii
  - Convinced by Stephen Olsen
  - BES drift chamber feedthrough crisis
  - Belle TOF electronics: received R&D100 award for his time-stretcher circuit
  - Belle track trigger
  - Somehow on the side to all of that: BES analysis
- 1997-1998: CERN/L.I.P.
  - CMS trigger studies and rad-hard hardware design
  - Somehow on the side: still doing BES analysis and writing down a PhD thesis in the evenings of two weeks.

# Gary in college and beyond cont'd

- 1998-2001: Back to Hawaii
  - Research staff in Physics Department, setting up the “Silicon Pixel Laboratory” which later turned into IDLab
  - Construction and Commissioning of Belle “BEAST” beam background exploration experiment
- 2001-2002: Bay Area
  - Short stint at a startup for satellite communication, together with Jaimy
- 2002-2023: Back to Hawaii (for good!)
  - First director of IDLab
  - Since 2005: Professor of Physics
  - This is when things really started to ramp up...
  - 2016:

After the official recognition of the “Instrumentation Frontier” at the Snowmass Decadal Survey in 2013, a new award was created: the “The American Physical Society/Division of Particles and Fields” Instrumentation Award.

*Gary was a recipient of the second award in 2016.*

Gary: “I prefer Discovery Frontier rather than Instrumentation Frontier”

## 2016 Awards

**Gary was well-known and recognized in the US and abroad for this and other achievements.**



**STEPHEN HOLLAND**

LAWRENCE BERKELEY NATIONAL LABORATORY



**GARY VARNER**

UNIVERSITY OF HAWAII

*“For the development of technologies for detection of signals in frontier experiments, especially the fully depleted charge coupled device and the ‘oscilloscope on a chip’ integrated circuit.”*



# A world-wide impact

Deep Underground Neutrino Experiment (DUNE)

Electron-Ion Collider

Belle II Construction & Commissioning (pixel, Silicon Upgrades)

Cherenkov Telescope Array (CTA)

APT prototype (ADAPT)

ANITA 1-4 PUEO

Belle II

## Big and Small

How we see different-sized objects:

imaging TOP (iTOP)

Concept: Use best of both TOP (timing) and DIRC (And fits Belle-PID envelope)

Drawings by Marc Rosen (UH)

- Limited volume → limited expansion
- Use simultaneous precision T, Bc (measured products) for maximum K<sub>s</sub> separation

ANITA

AMBER

ARA

Time-Encoded Differential Absorption

Neutrinos

BESIII

LAPPD →

Univ. of HAWAII

SiPIX LAB

We (you) are doing world-class research here

# Year 2010 (party!) in the ID Lab



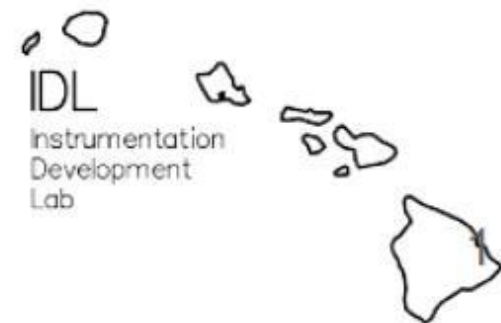
December, 2010

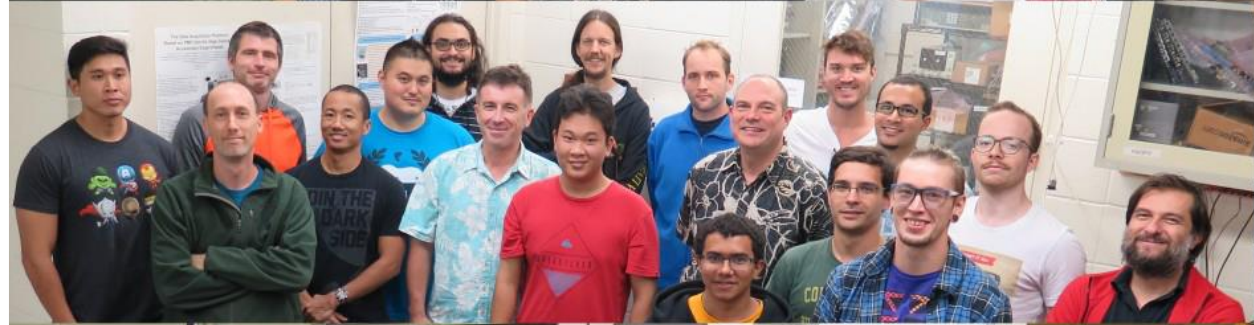
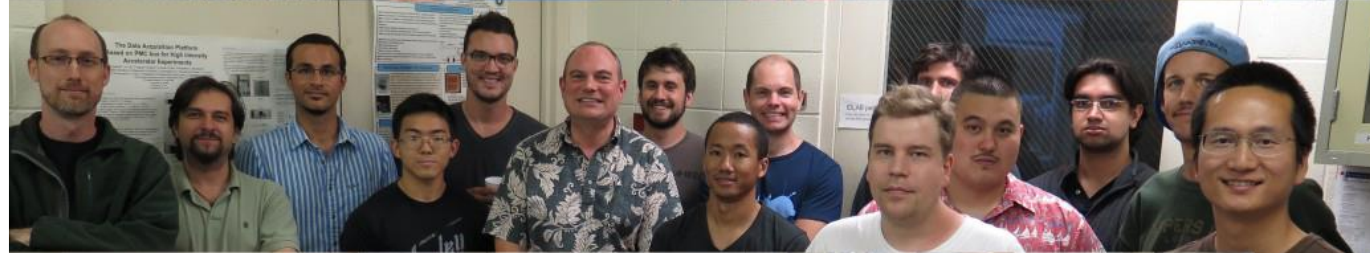


# University of Hawaii Instrumentation Development Laboratory



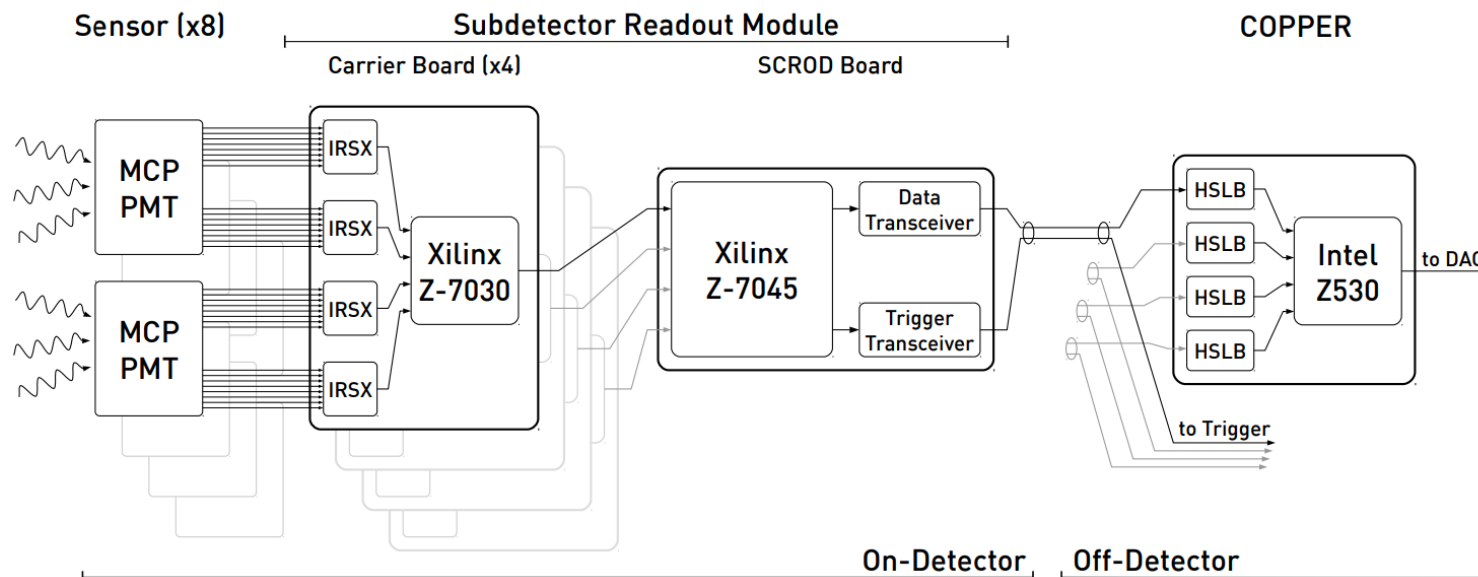
**IDL Overview**  
**(last picture/lab party before the pandemic)**

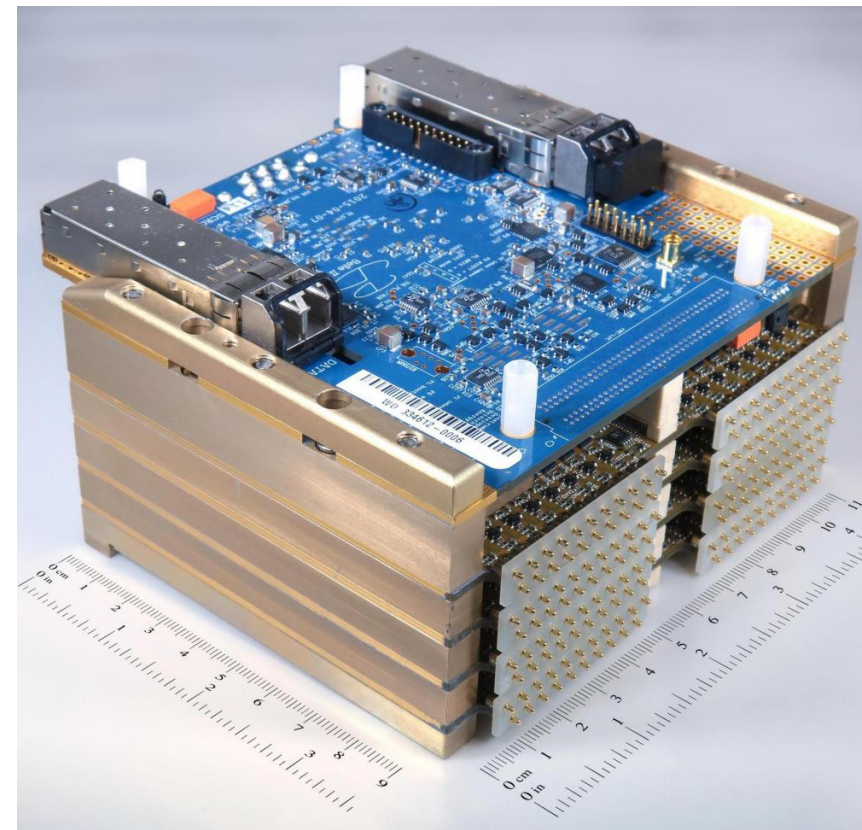
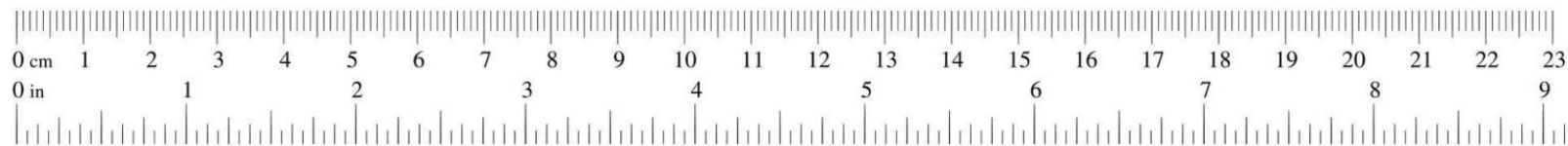
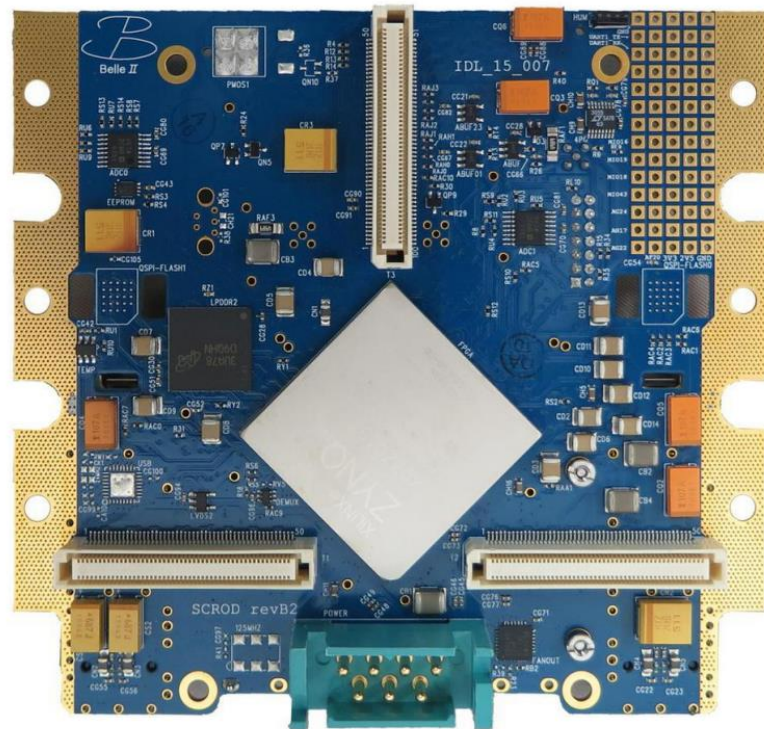
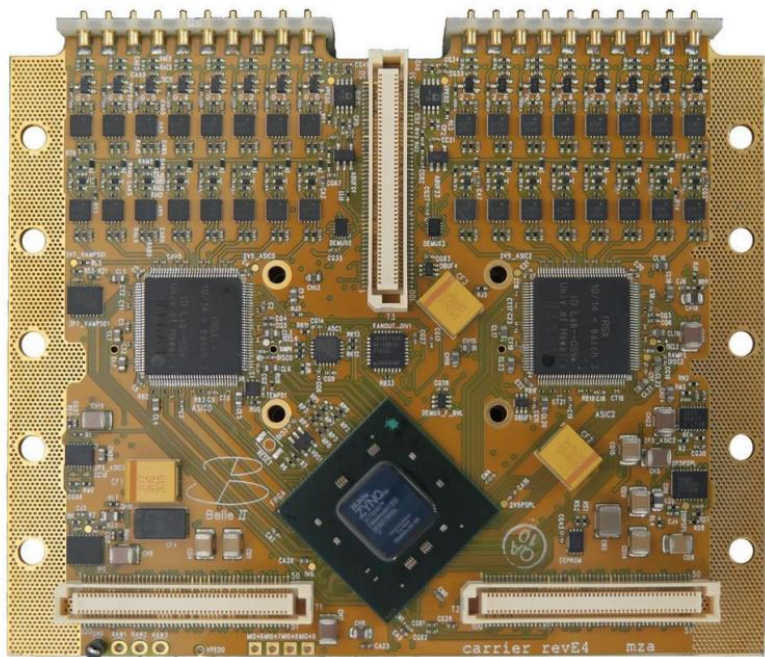


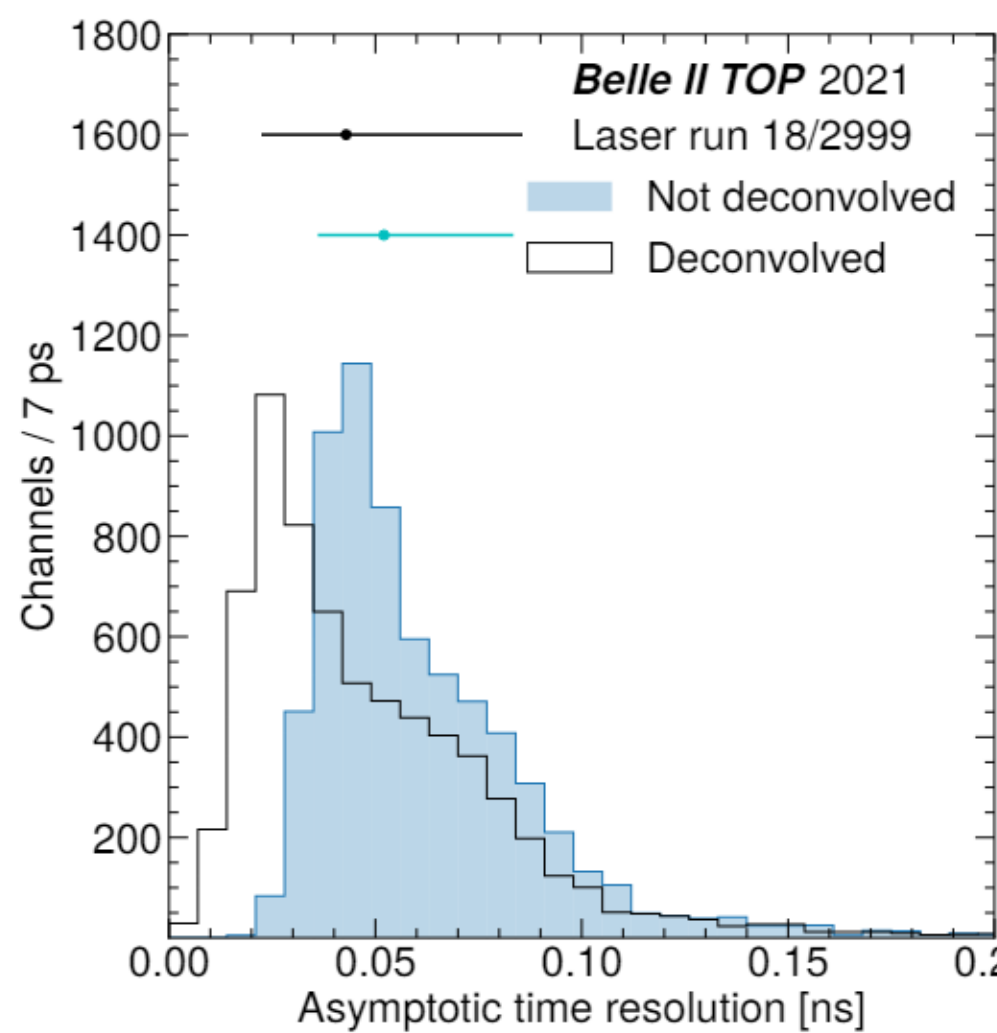
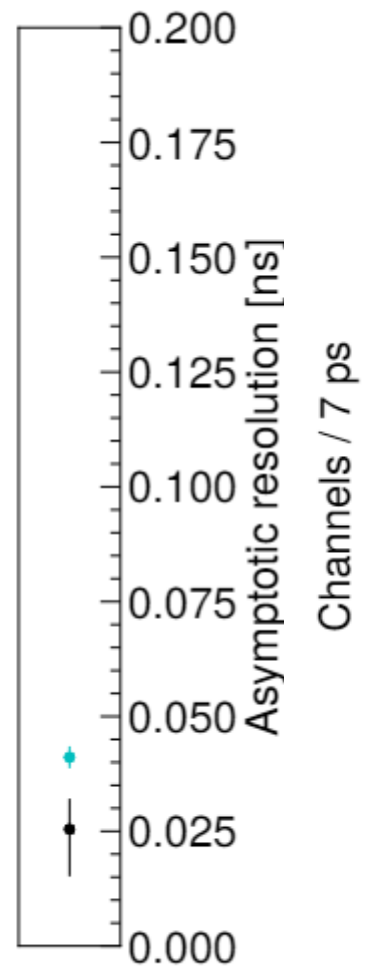
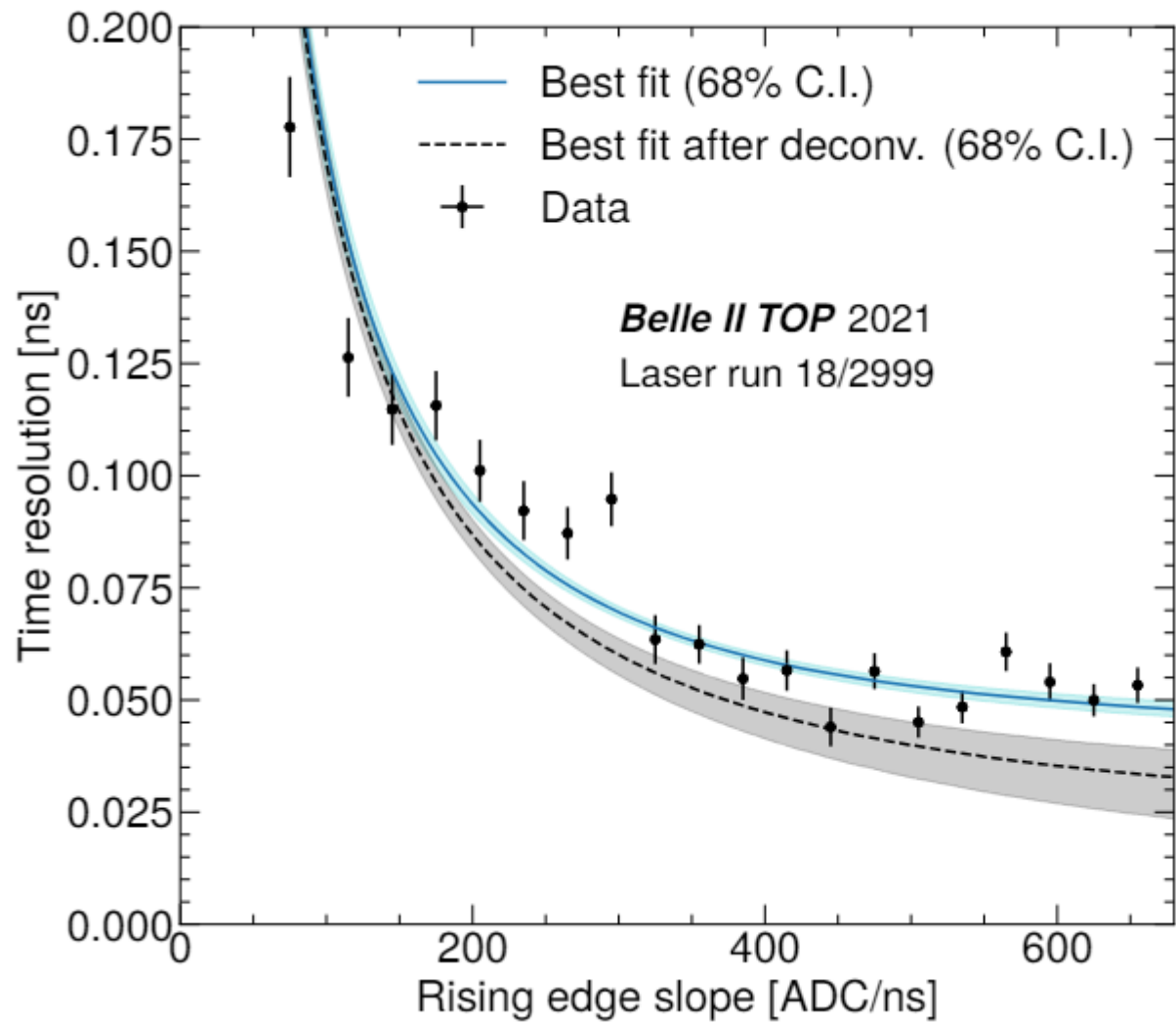


# Belle II TOP Frontend Electronics

- Belle II TOP: DIRC-like barrel PID based on precise photon arrival timing
- 8192 channels of MCP-PMT, < 100ps single photon resolution
- Gary proposed waveform sampling readout based on one of his ASICs
- Full readout chain almost exclusively developed and constructed within IDLab
  - 8192 channels of 2.7GSa/s digitizer, full frontend waveform processing + trigger path output







# A world-wide impact

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Belle II

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BESIII

LAPPD →

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Concept: Use best of both TOP (timing) and DIRC (And fits Belle-PID envelope)

Drawings by Marc Rosen (UH)

Squeeze expansion volume

Limited volume → limited expansion

Use simultaneous precision T, Bc (measured products) for maximum K's separation

Focusing DIRC

Particle Trajectory

Cherenkov Cones

Cherenkov Radiator Bars

Focal Surface

Focusing Block

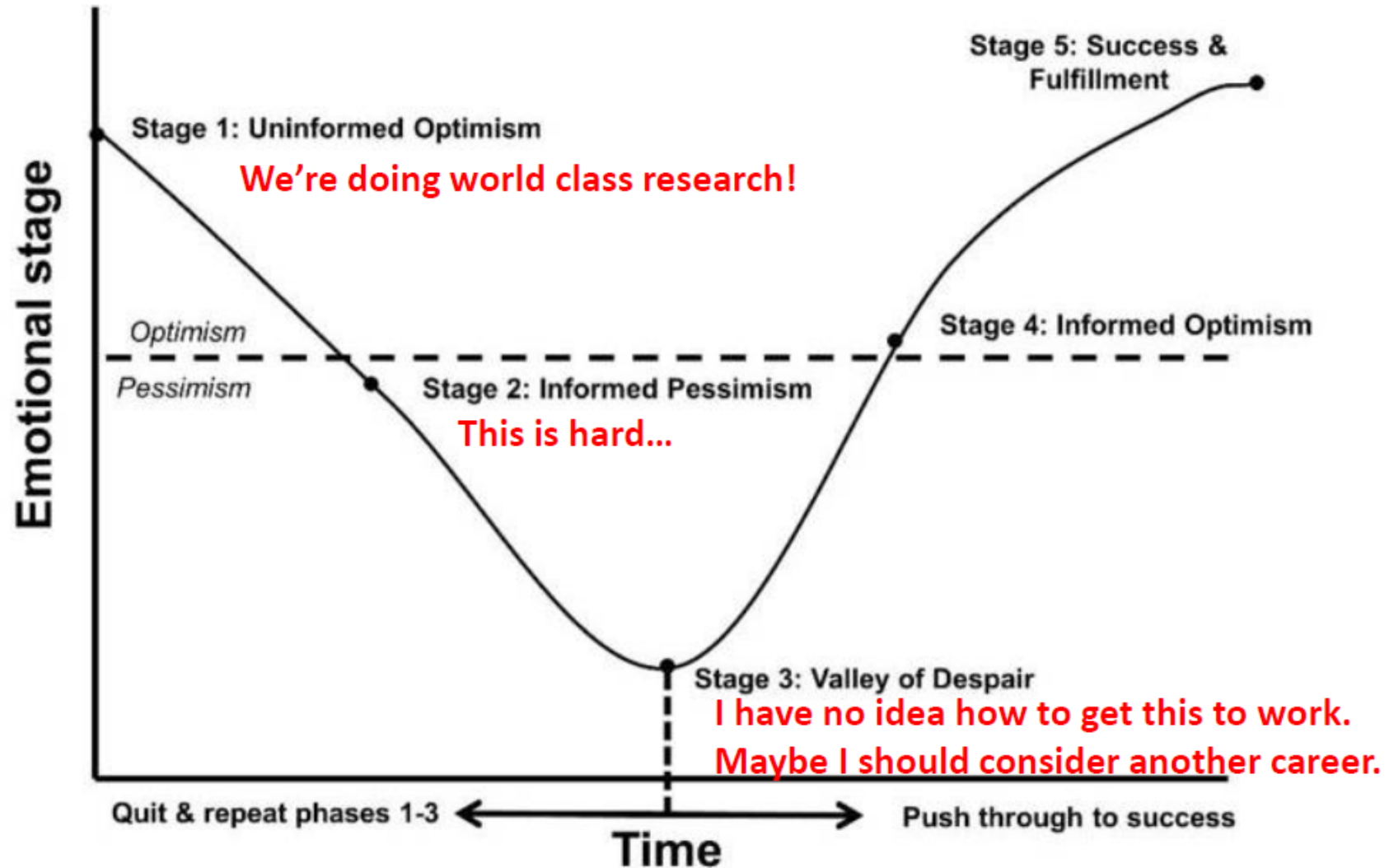
Focal Plane

We (you) are doing world-class research here

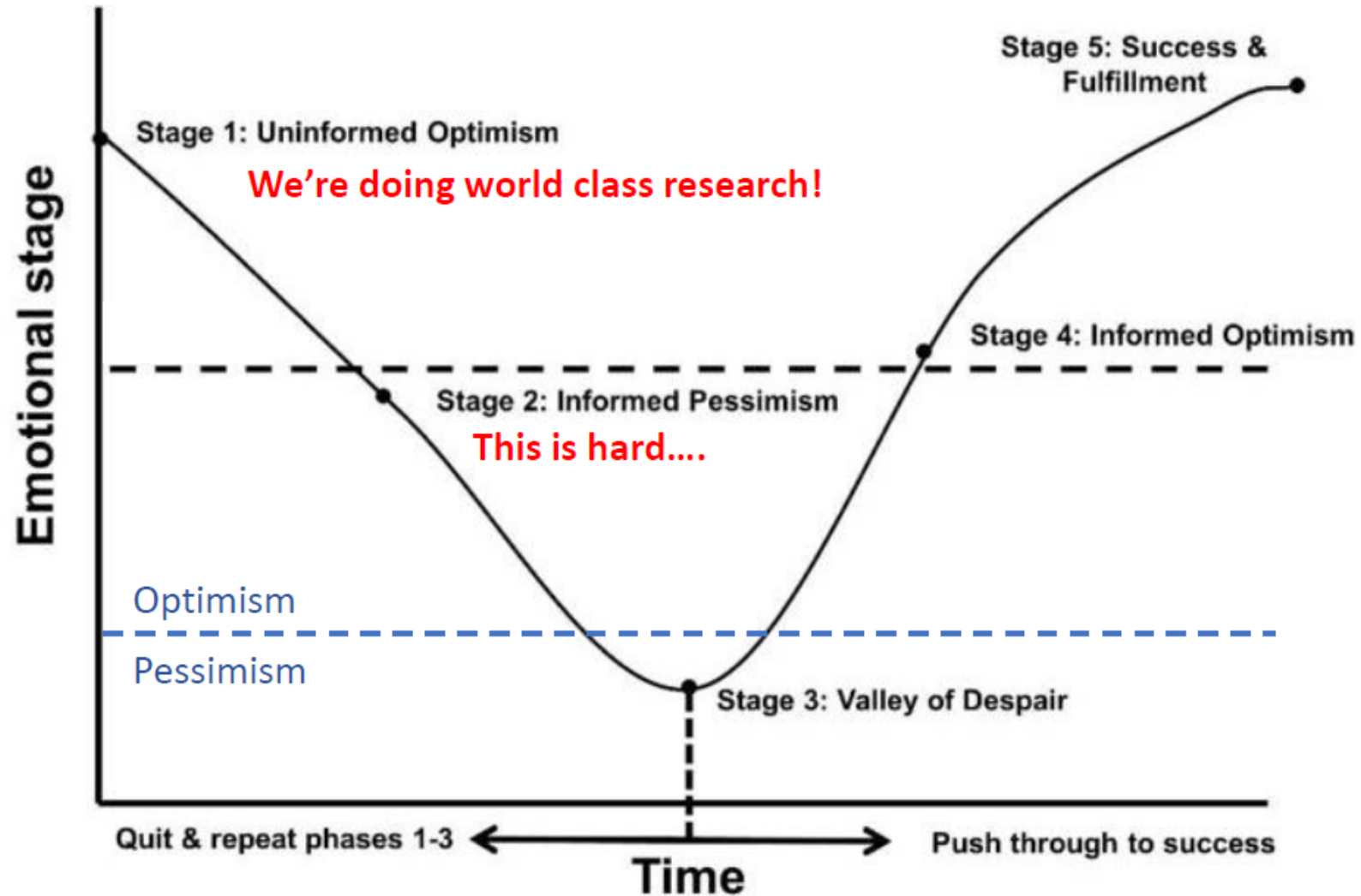
Univ. of HAWAII  
SiPIX LAB



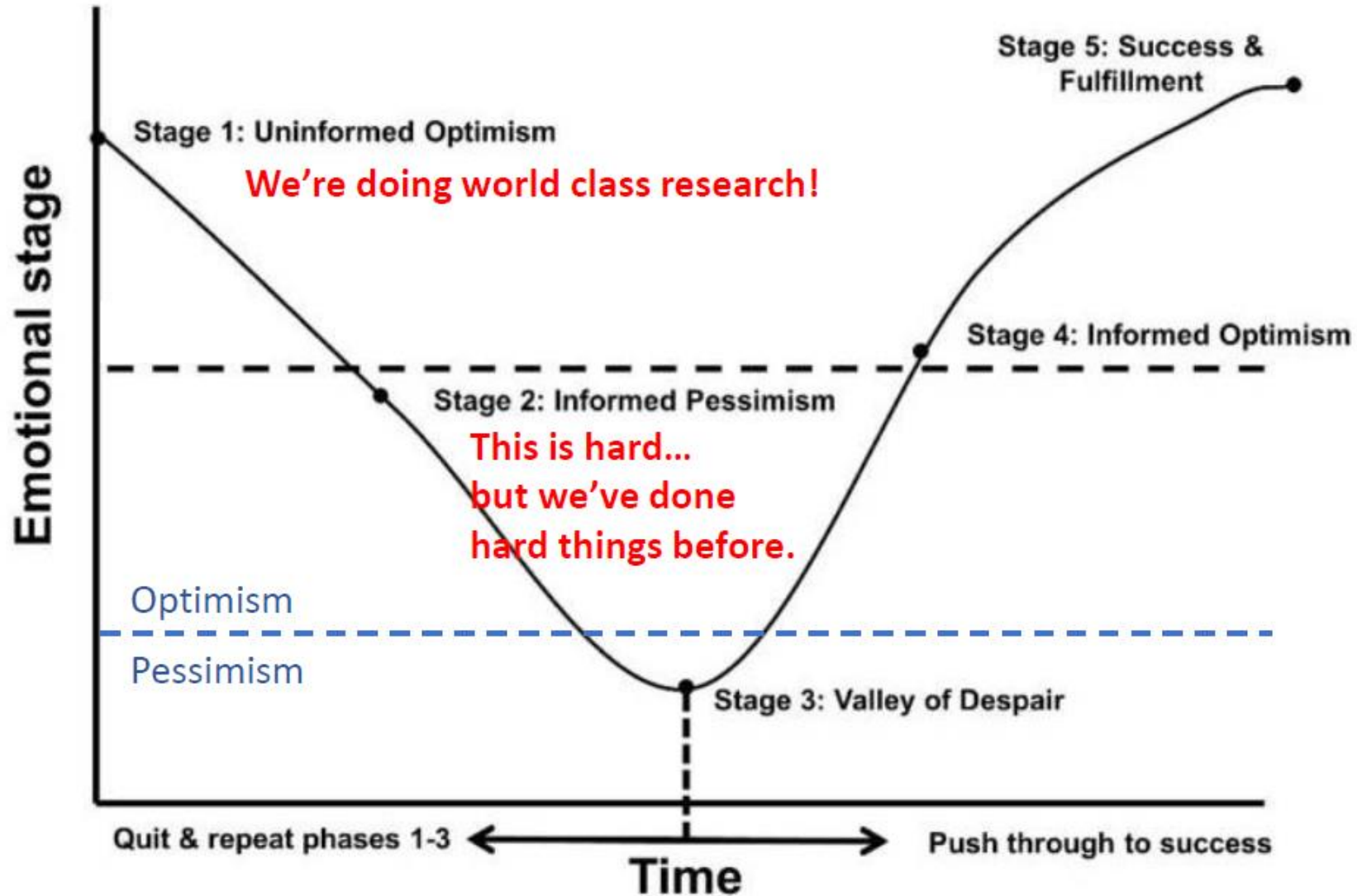
# Stages of a Project



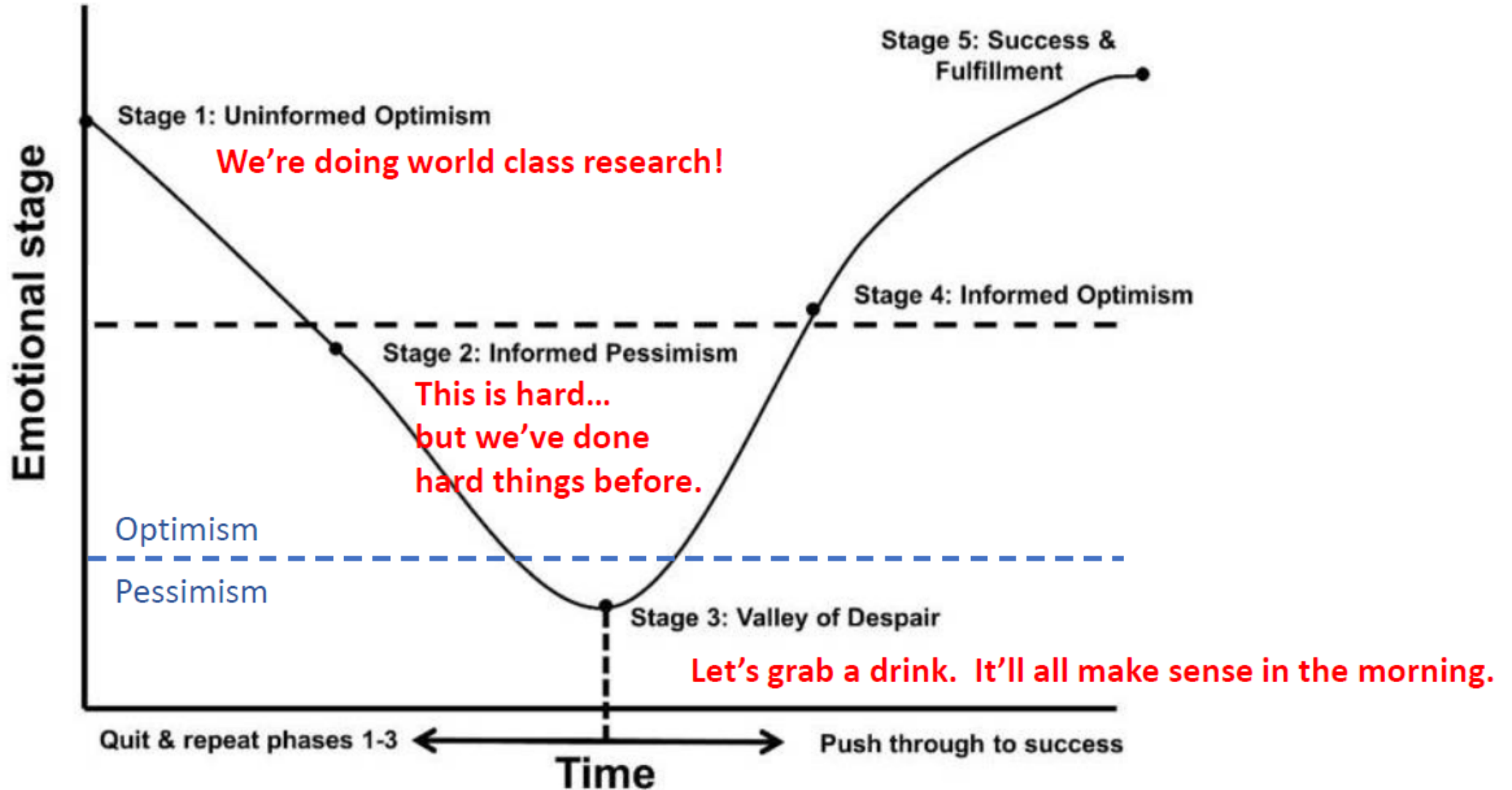
# Stages of a Project (Gary)



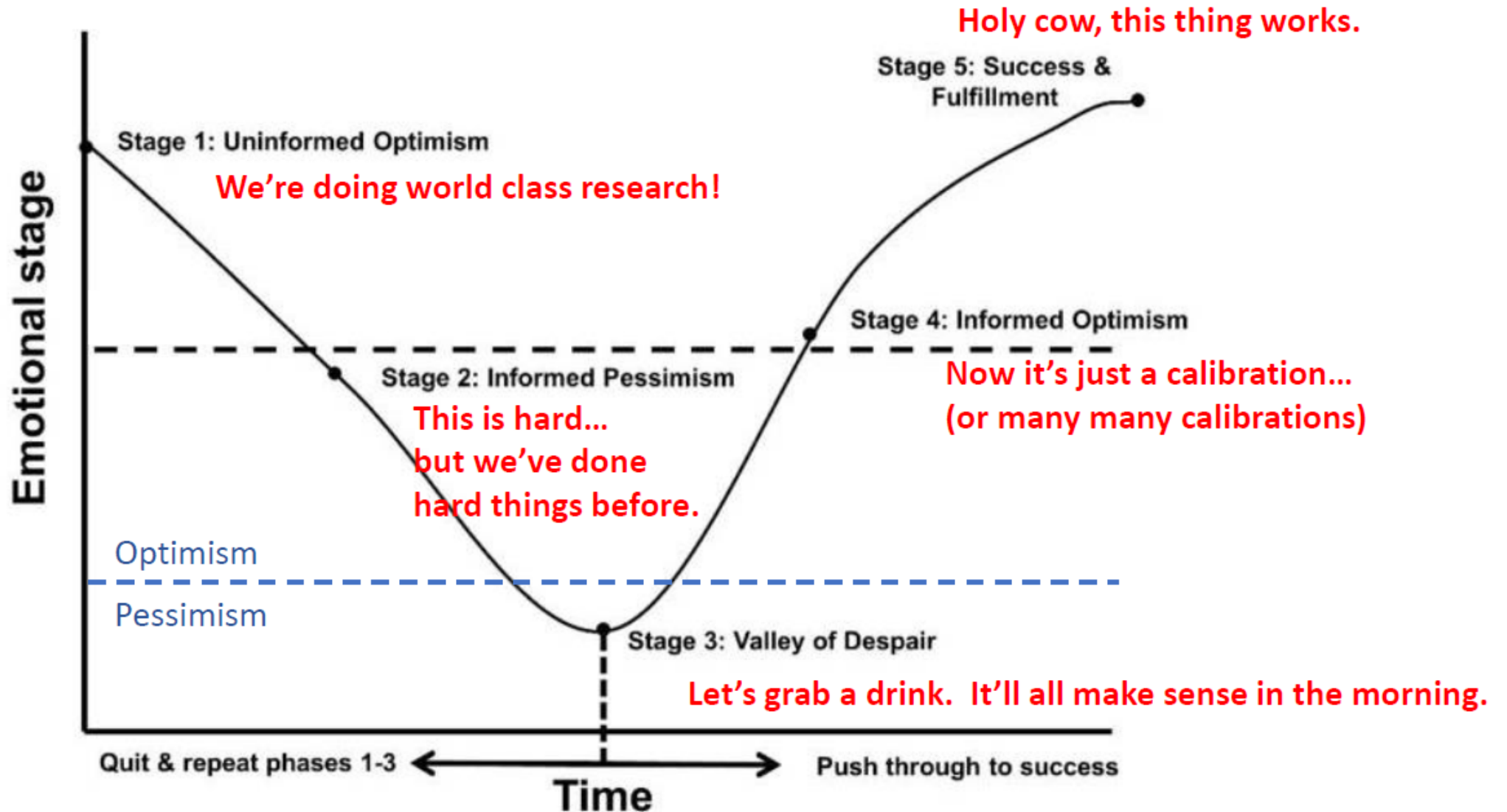
# Stages of a Project (Gary)



# Stages of a Project (Gary)



# Stages of a Project (Gary)



# The Gary Schedule

“making a new instrument requires decades of work and extreme endurance.

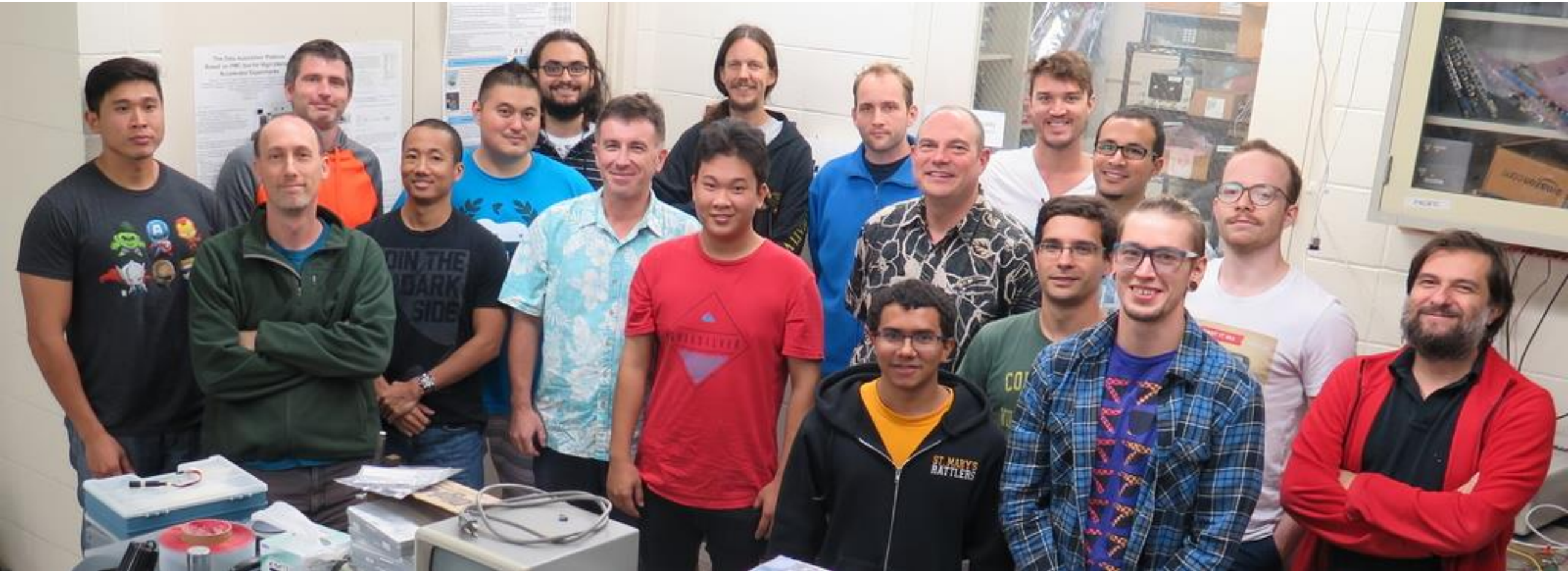
making many at the same time requires to be Gary S. Varner”

(Andrej Seljak)

## Varner Spring 2013

	Monday	Tuesday	Weds	Thurs	Friday
5:00		<b>LAPD</b>			
5:30		<b>general</b>			
6:00		<b>[Argonne]</b>			
6:30		<b>[Nat'l]</b>			
7:00		<b>[Lab]</b>			
7:30					
8:00		lecture		lecture	
8:30	Meetings	prep		prep	
9:00	prep	476 Sect2	<b>LAPD</b>	476 Sect2	US
9:30	Off. Hours	lecture	<b>EE</b>	lecture	Firmware
10:00		prep	ANITA3	prep	<b>xFEL</b>
10:30	<b>ANITA/</b>	476 Sect2	Radio	476 Sect2	
11:00	<b>iTOP</b>	lecture	<b>LAPD</b>	lecture	FEL
11:30	<b>software</b>	Lab	<b>iTOP</b>	Lab	science
12:00	<b>ASIC</b>	prep	<b>work</b>	prep	
12:30	Lunch	Lunch	Lunch	Lunch	Lunch
13:00	ID Lab		<b>iTOP</b>		<b>xFEL</b>
13:30	Facilities	PHYS476	<b>work</b>	PHYS476	mtg
14:00	iTOP	Sect. 2	IDL	Sect. 2	<b>Personnel</b>
14:30	Meeting	Lab	general	Lab	Belle
15:00	ID Lab	HEPG	lab work	<b>STURM</b>	local
15:30	review	seminar	<b>iTOP</b>	Physics	analysis
16:00	Office	radio	<b>[Nagoya]</b>	Dept.	meeting
16:30	Hours	global		Colloq.	<b>ASIC</b>
17:00		<b>STURM</b>		fDIRC	<b>work</b>
17:30		<b>STURM</b>		CRT mtg	<b>TG's</b>
18:00					
18:30					
19:00					
19:30					

# IDLAB 2016









Gary (at 17 years old):  
“... it [some now-forgotten problem] kind of results from the fact that I only have 2 speeds: run and off.”

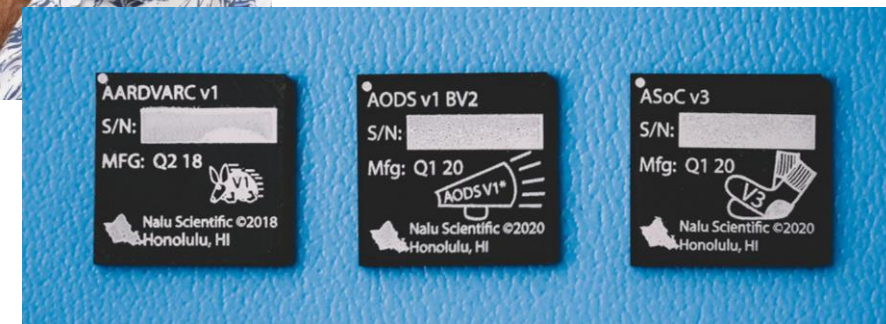
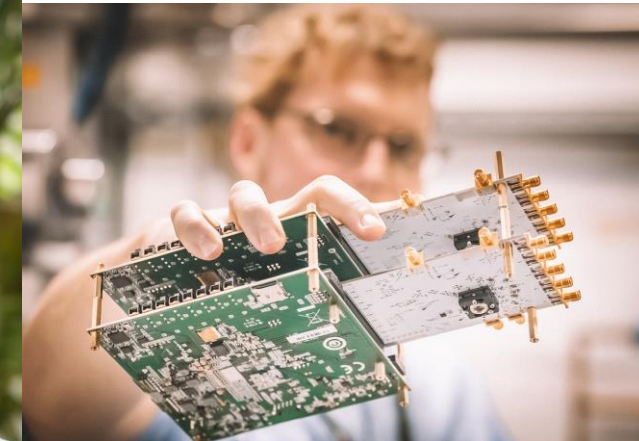
# The ~~IDLab~~ VarnerLab will go forward!

- IDLab has been renamed “VarnerLab” in his honor
- VarnerLab still up and running: Matt Andrew + (incoming) UH Profs.
- No single person can replace Gary. Uni Hawaii is hiring more faculty for HEP frontend R&D:
  - [ML/AI on the front-end in Physics and Astronomy \(P&A\), HEP/NP focused.](#)
  - [ML/AI on the front-end in Electrical/Computer Engineering \(ECE\)](#)
- Uni Hawaii is instituting the  
“Gary Varner graduate fellowship at the instrumentation frontier”



# NALU SCIENTIFIC

- Isar Mostafanezhad founded Nalu Scientific LLC
  - After few years of postdoc in IDLab
- Fast waveform digitizing readout systems
  - Inspired by, and in strong collaboration with, Gary and IDLab
  - Best example of technology transfer of fundamental R&D and workforce development
- Many IDLab graduates worked for Nalu temporarily
  - Many stayed!



# STOPGAP - a Time-of-Flight Extension for the Belle II TOP Barrel PID System

Oskar Hartbrich<sup>a,c</sup>, Umberto Tamponi<sup>b</sup>, Gary S. Varner<sup>\*</sup>

<sup>a</sup>*University of Hawaii at Manoa, 2505 Correa Road, Honolulu 96822, HI, USA*

<sup>b</sup>*INFN - Sezione di Torino, Via Giuria 1, Torino 10125, IT*

<sup>c</sup>*now at ORNL, Physics Division, 1 Bethel Valley Road, Oak Ridge 37830, TN, USA*

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## Abstract

The Belle II barrel region is instrumented with the Time of Propagation (TOP) particle identification system. Due to its mechanical design, the individual TOP modules do not overlap, leaving a gap of around 2 cm between them in the azimuthal direction. This leads to a 6% - 9% drop in acceptance, depending on the track's momentum. We propose a solution to remedy these gaps by instrumenting them with fast silicon detectors to directly measure the time-of-flight of traversing particles. We present here a simulation study discussing the performance requirements and the possible sensor technologies, and we demonstrate that such a project could be realised with novel, fast monolithic CMOS sensors, or alternatively AC-LGAD sensors, both of which are expected to reach MIP timing resolutions of down to 50 ps or better.

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1 Oskar Hartbrich and Umberto Tamponi would like to dedi- 29  
2 cate this paper to the memory of their mentor and colleague, 30  
3 Prof. Gary S. Varner. 31

## 4 1. Introduction

bars. Since the available space around the installed TOP mod-  
ules is quite limited, one or multiple layers of fast-timing sili-  
con detectors would serve this scope. The Supplemental TOP  
Gap Instrumentation (STOPGAP) has become feasible with the  
advent of modern silicon sensor types with very short signal  
collection times and excellent time resolutions in the range of  
32  
33  
34

# Collecting Memories

- Most people have “Gary stories”
- Started a collection, please feel free to still contribute:
  - [Link to submission form](#)
- First edition was presented to Jaimy at the UH celebration
  - Final public edition will be available in a few weeks with print-on-demand

## Gary S. Varner A Book of Stories and Memories

*Collected by M. Andrew, T. Browder, O Hartbrich and A. Seljak*

