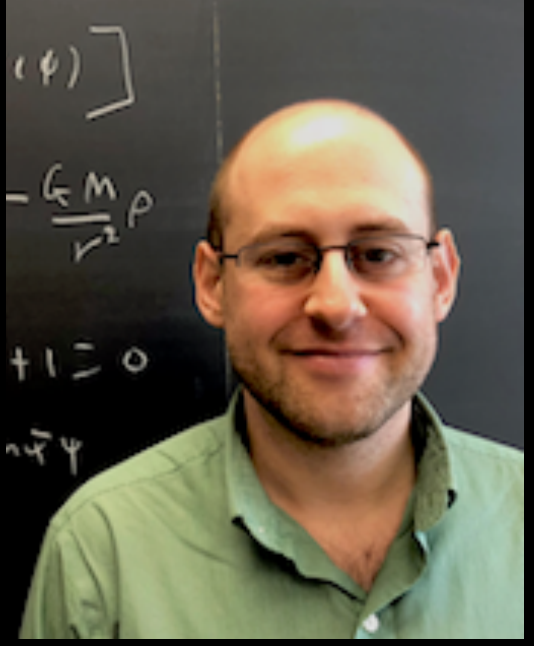
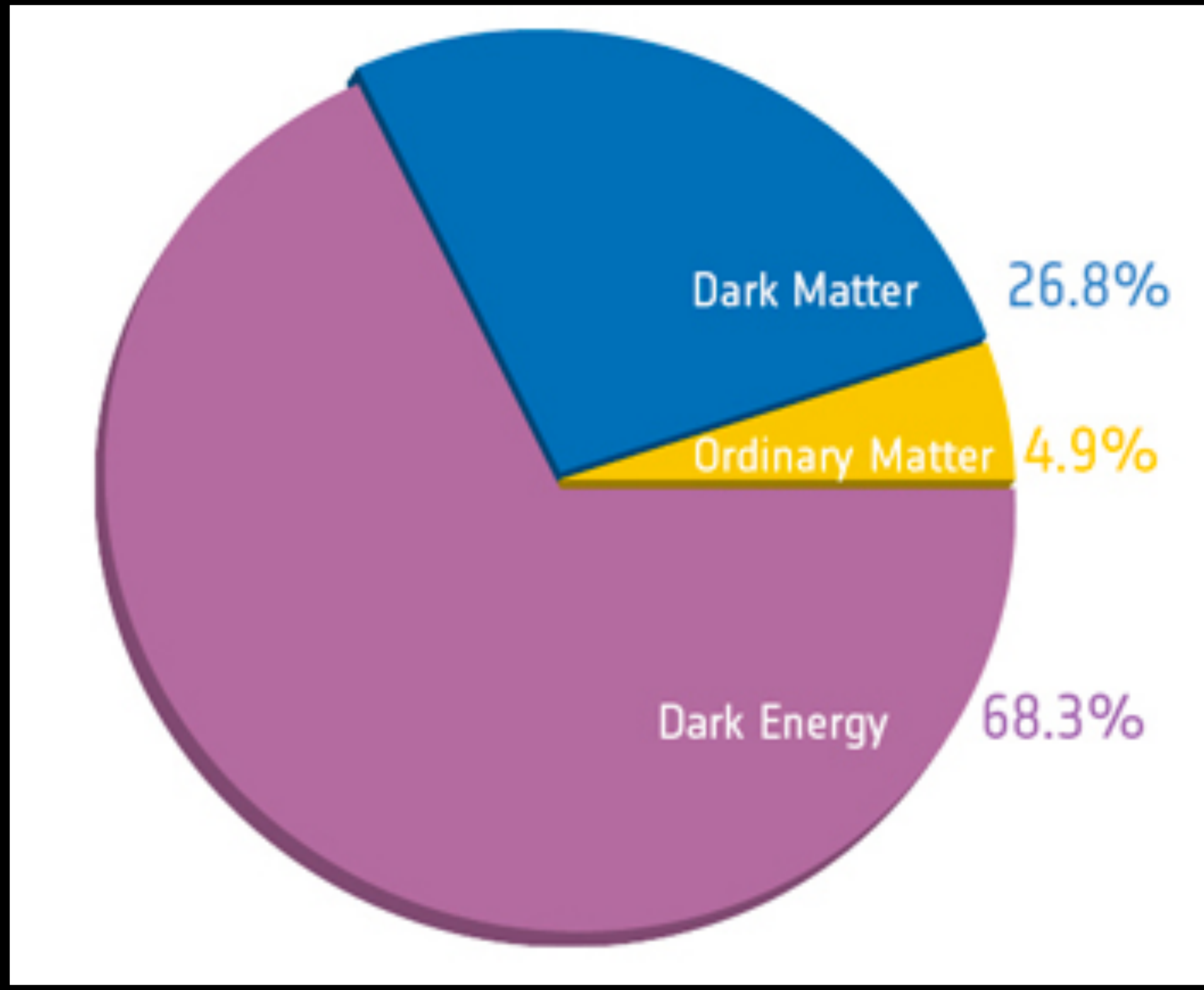
1-minute Colloquium
Sep 19, 2024

University of Hawaii at Manoa
Physics & Astronomy Department

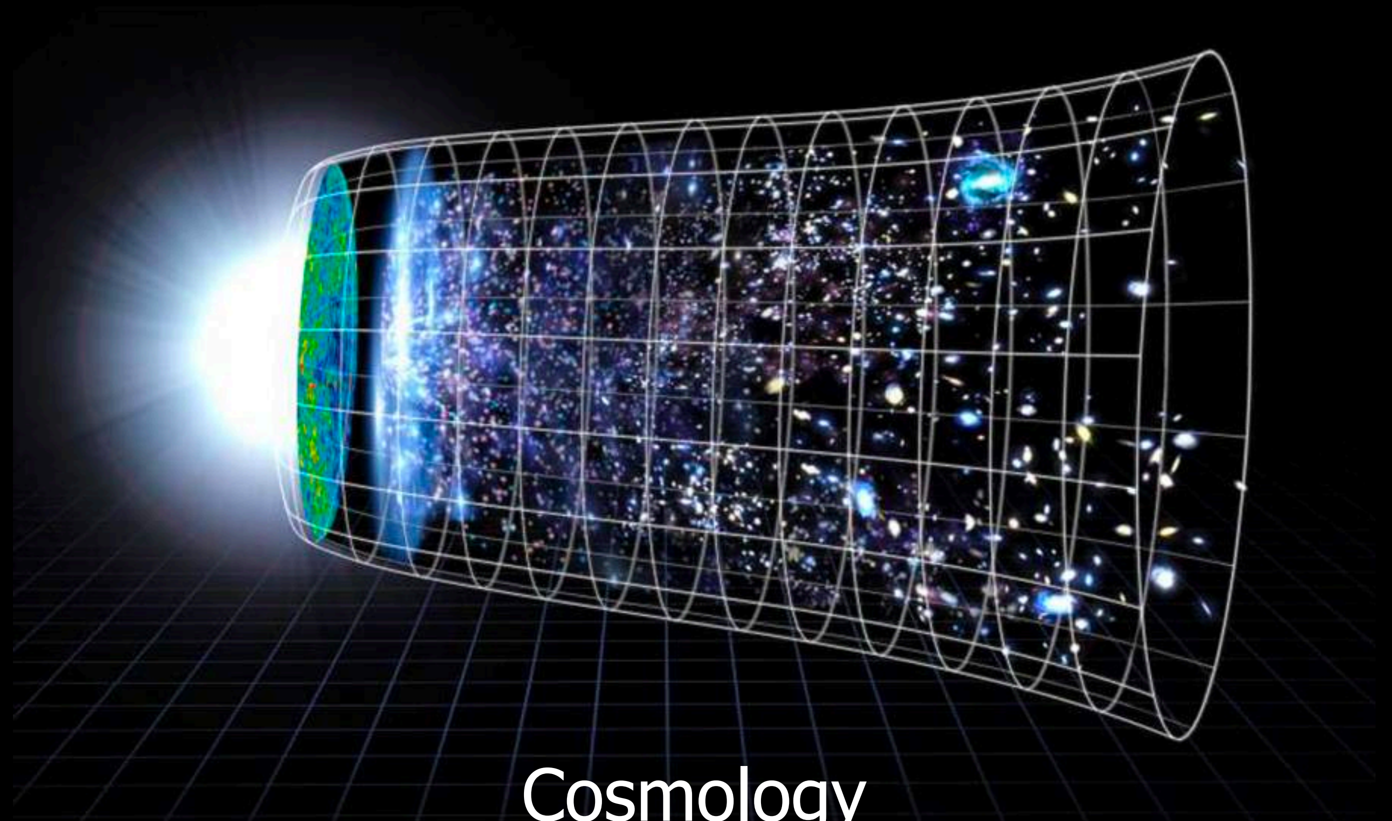


sakstein@hawaii.edu
www.jeremysakstein.com

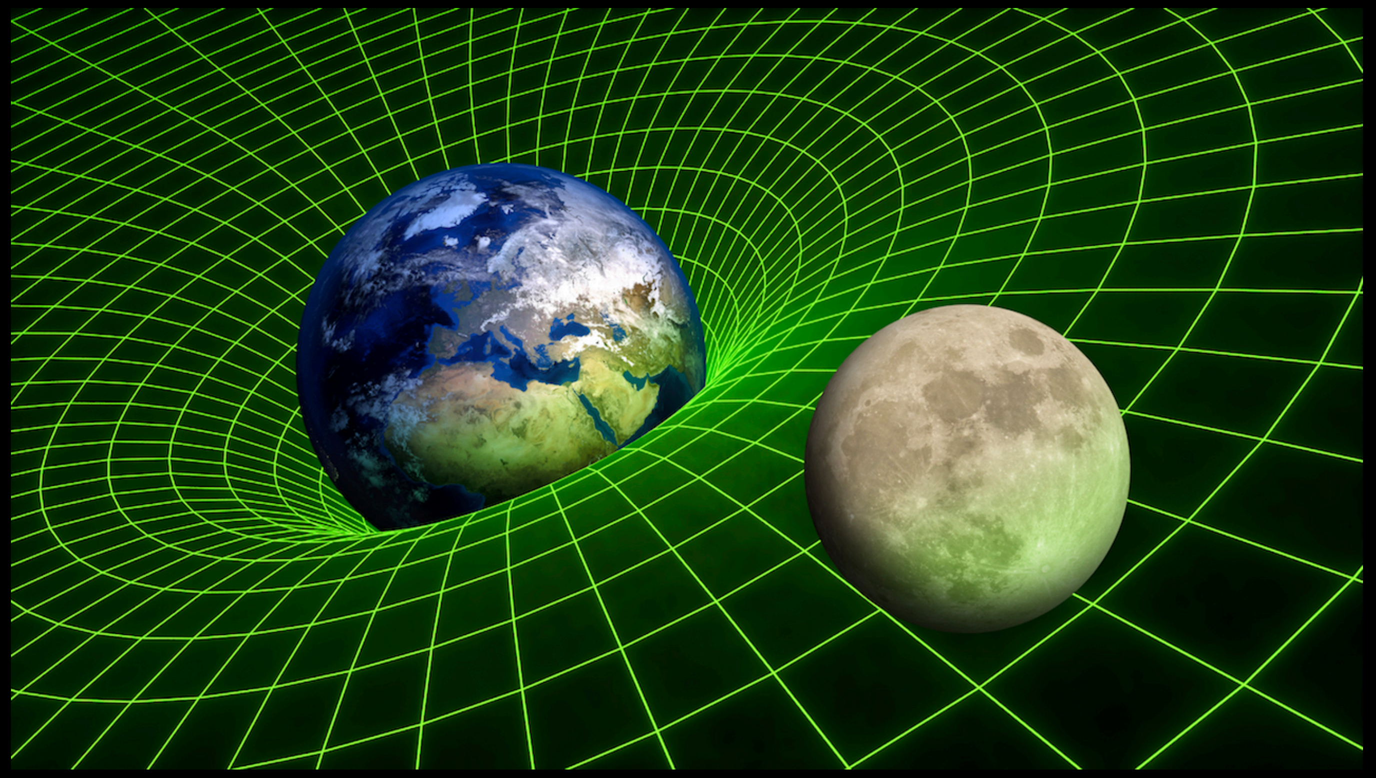
Jeremy Sakstein
Cosmology, Gravitation, Astrophysics



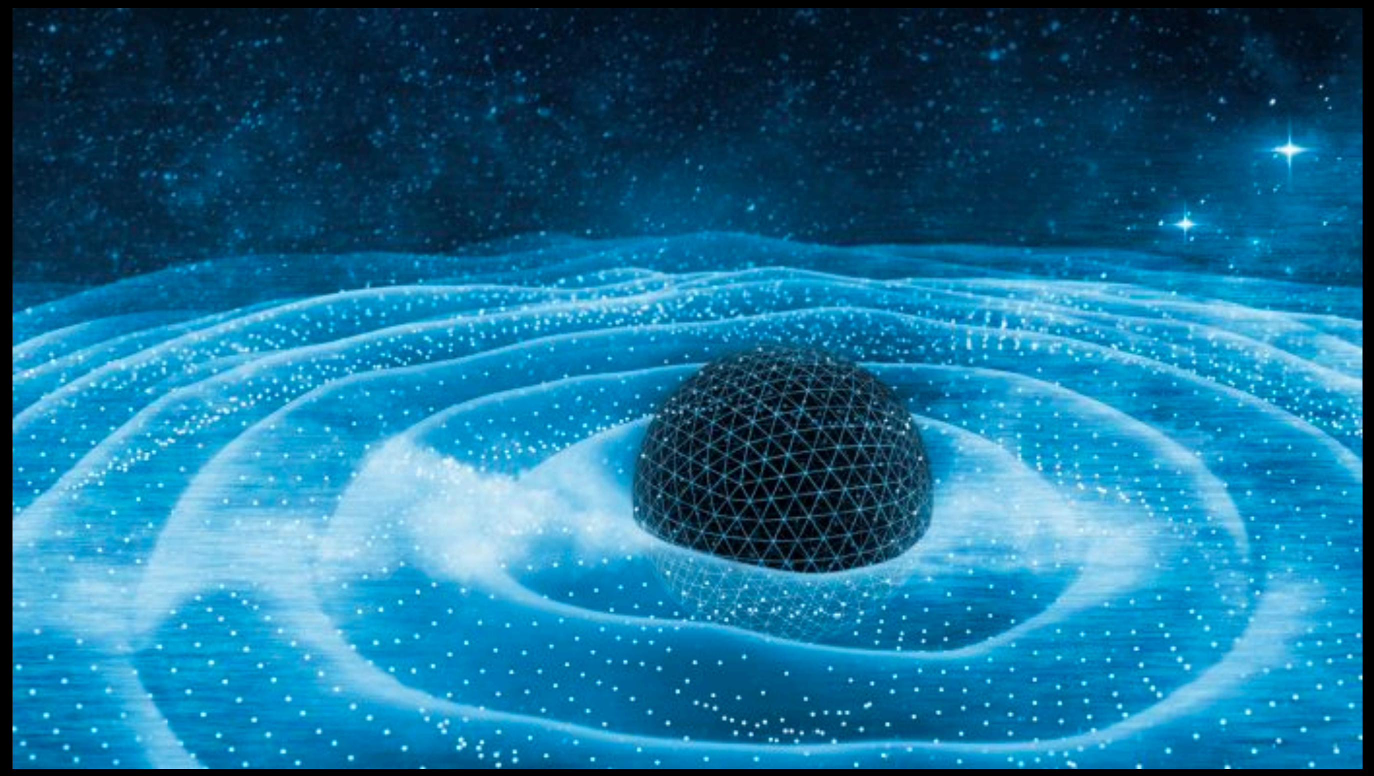
Interests



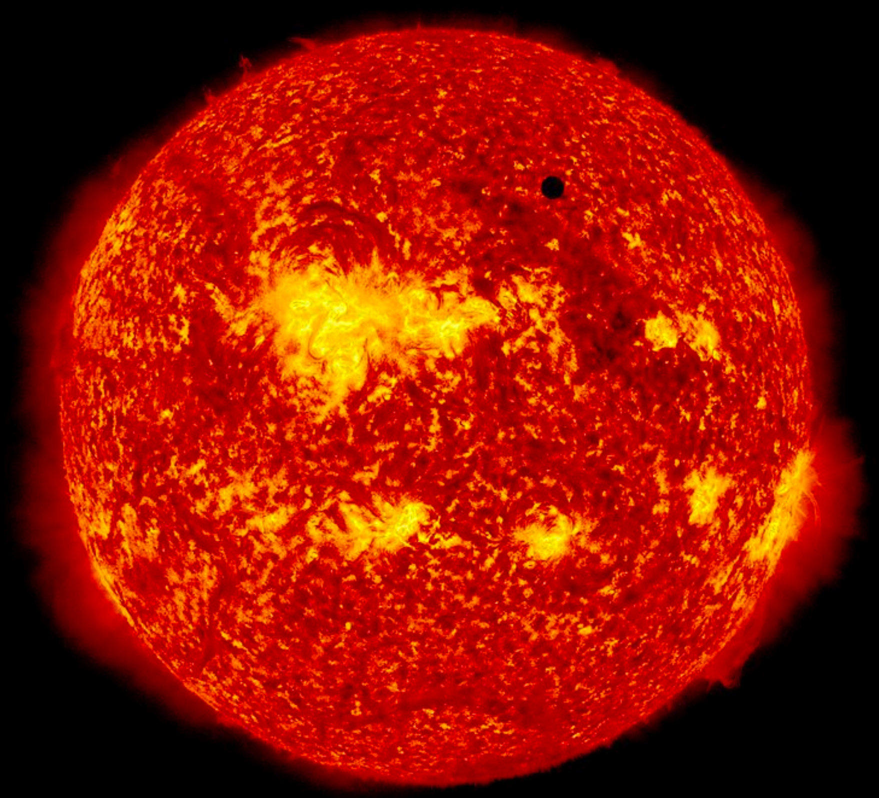
Cosmology
Dark Energy, Dark Matter, Hubble Tension



Gravitation
Modified Gravity, Tests of Gravity in Space



High Energy Astrophysics
Black Holes, Neutron Stars, Gravitational Waves



Stellar Astronomy
Dark Matter Astroparticle Physics

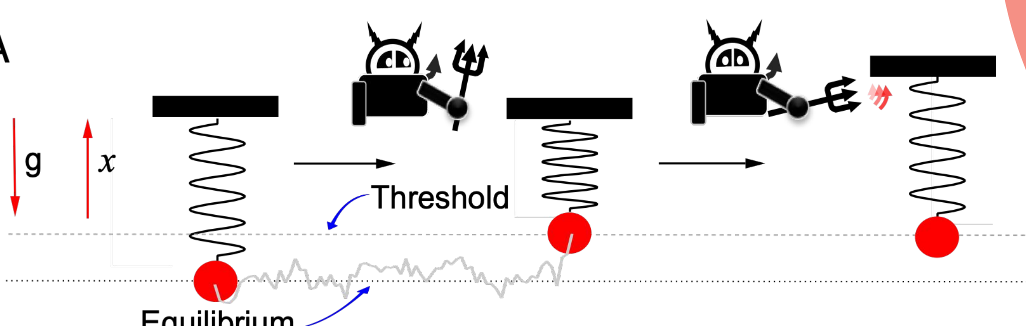
Physics of Information Processing

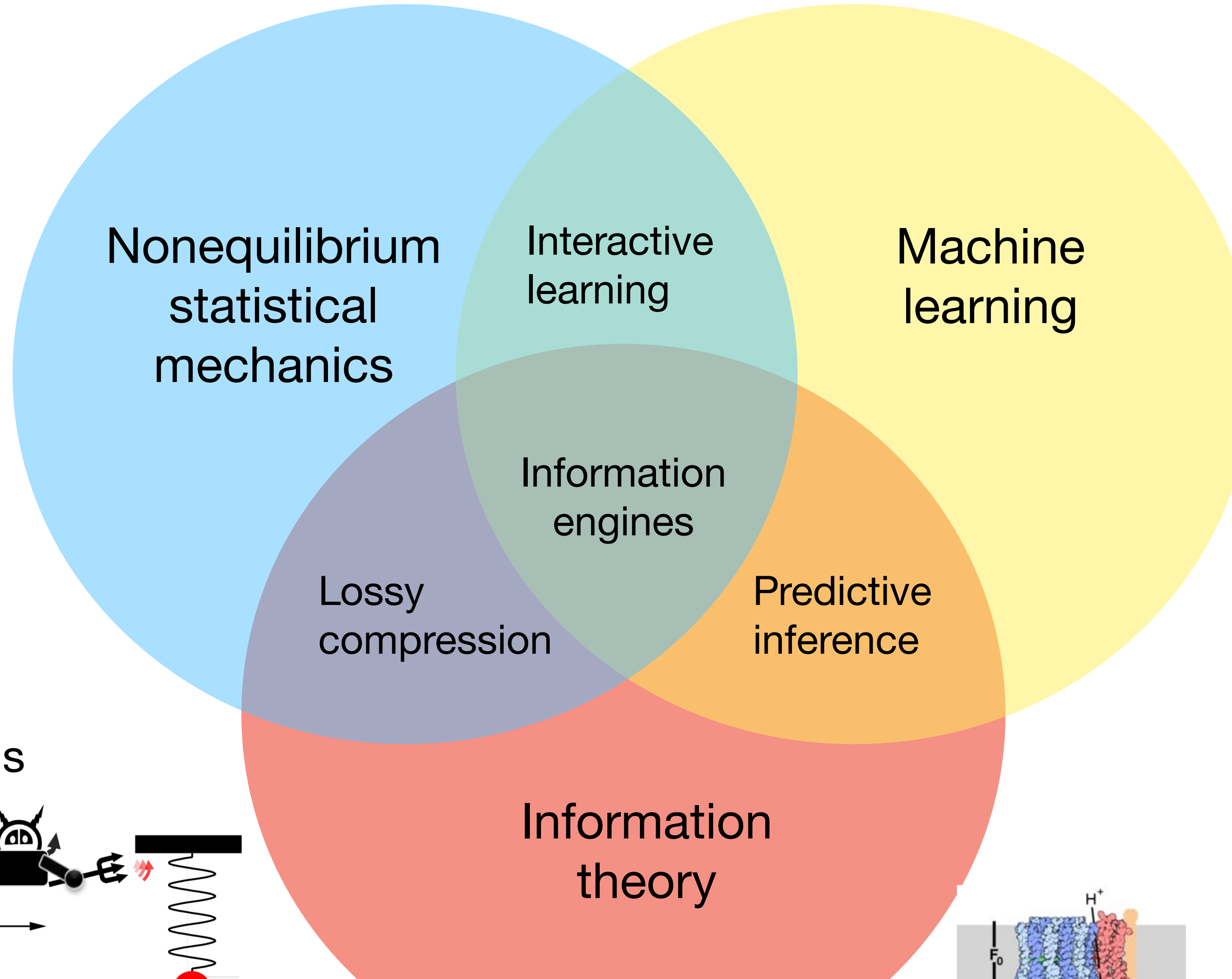
Students:

Tom, Dorian, Chris

Basic physics:

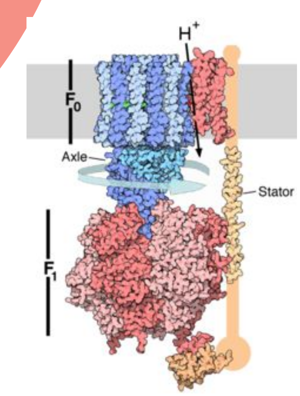
- Far from equilibrium thermodynamics
- Maxwell's demon
- Generalized Partially Observable Information Engines
- Thermodynamics of strongly coupled systems

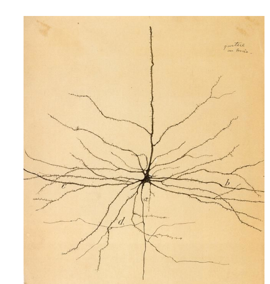


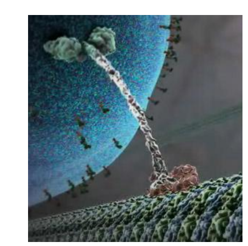


Application areas:

- Machine Learning
- Quantum Machine Learning
- Reinforcement Learning
- Foundations of information theory
- Evolution
- Origin of life
- Econophysics
- Thermodynamic Computing







Funding:

FQXi FOUNDATIONAL QUESTIONS INSTITUTE

Fetzer Franklin Fund Exploring Frontiers. Breakthroughs. Science.

Collaborations:

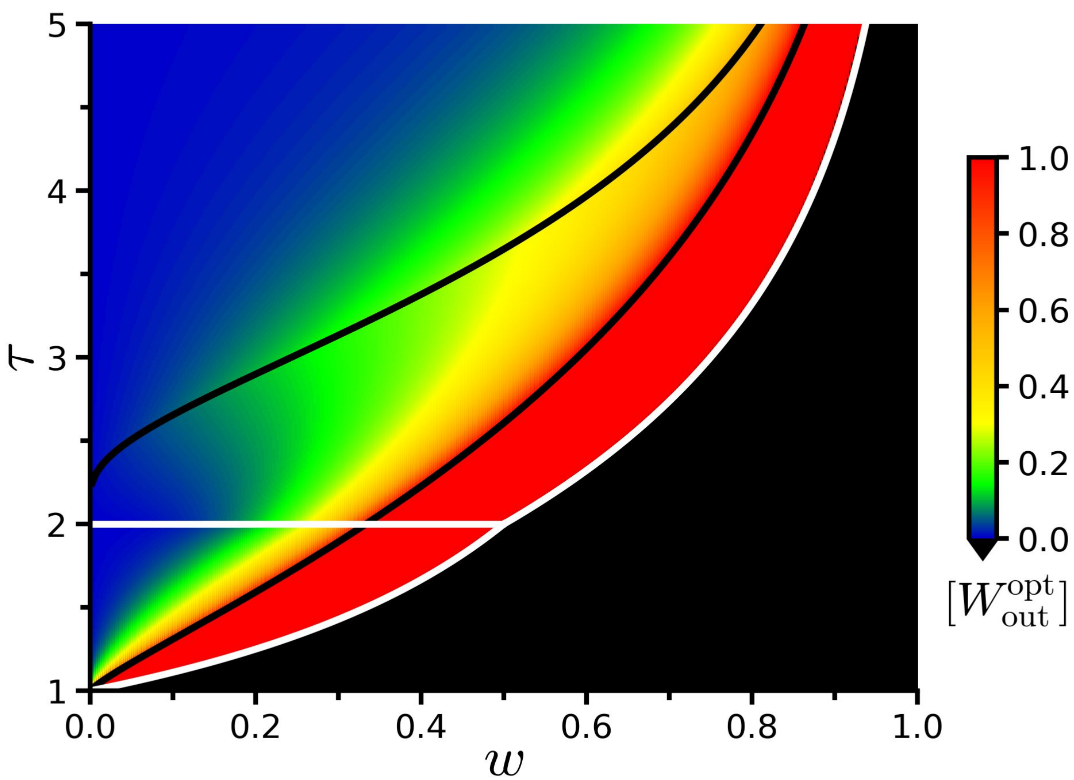
- Theory groups in US, Canada, UK, Italy
- Experimental group at SFU, Vancouver, Canada
- Applied / CS groups in Canada and UK

Thermodynamics of physical observers

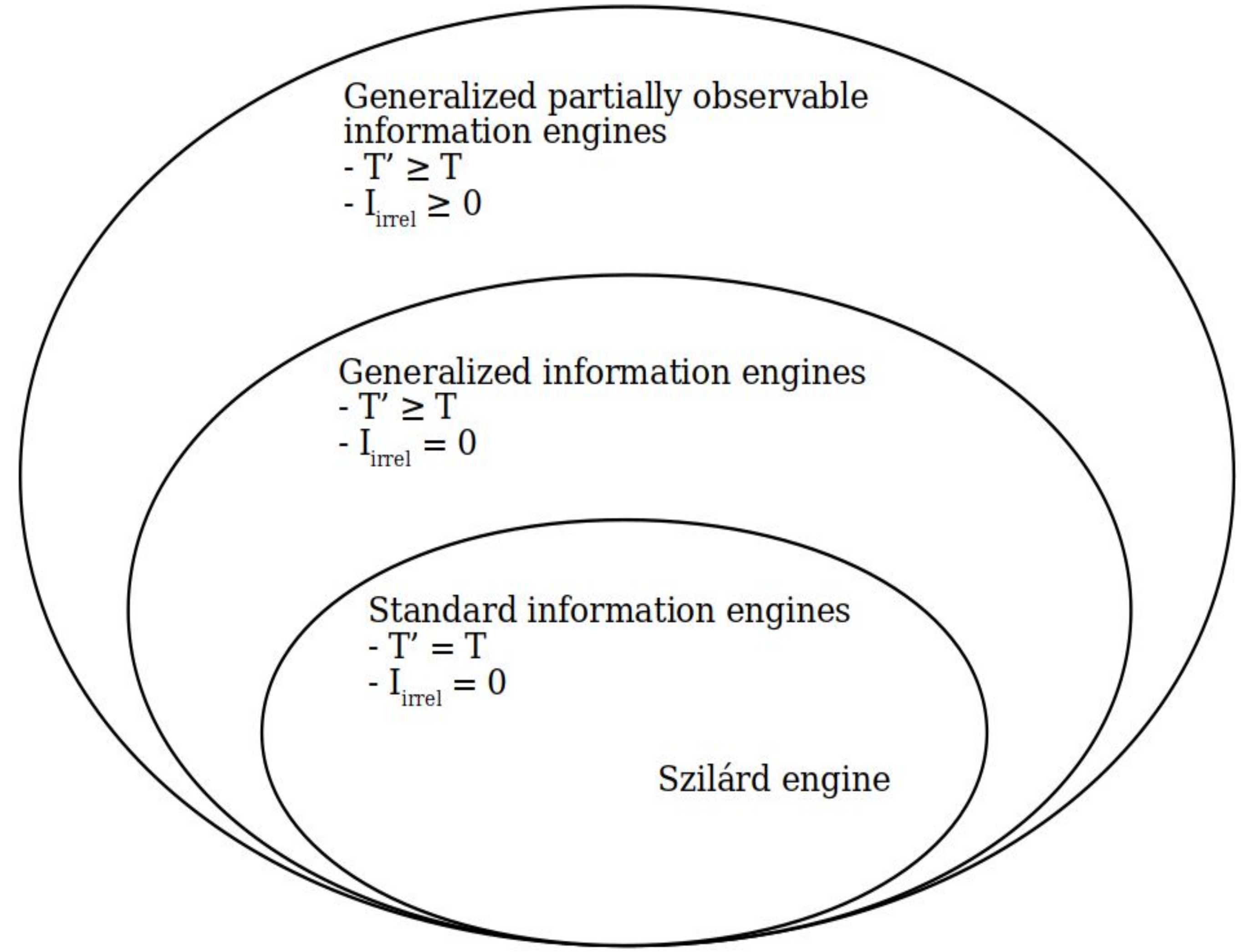
How do different constraints (energy, time, robustness…) affect the observer optimal strategies?

Generalized partially observable Szilárd engines are a physical model for binary decision making under uncertainty.

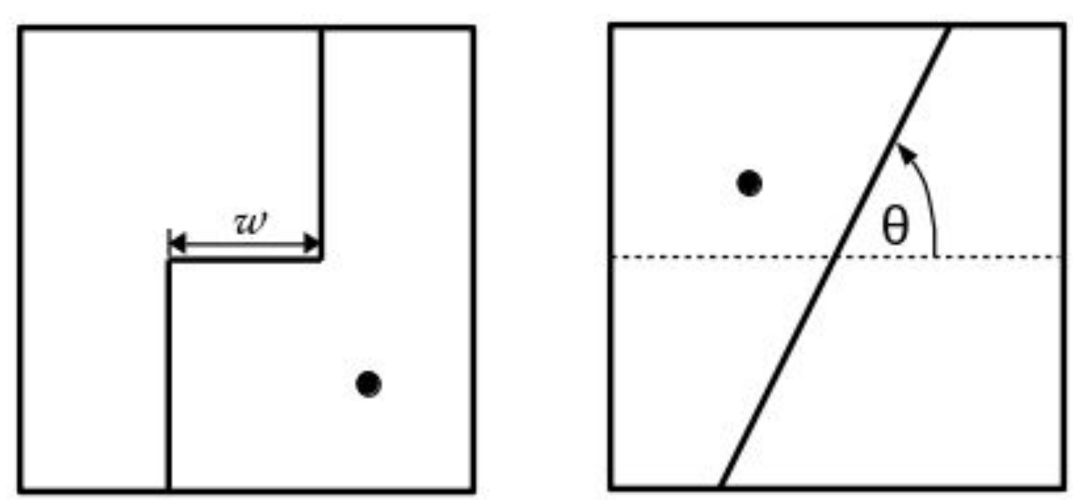
Minimally dissipative observers have complex decision strategies, even for simple model problems.



Phase diagram characterizing and comparing different observer strategies.



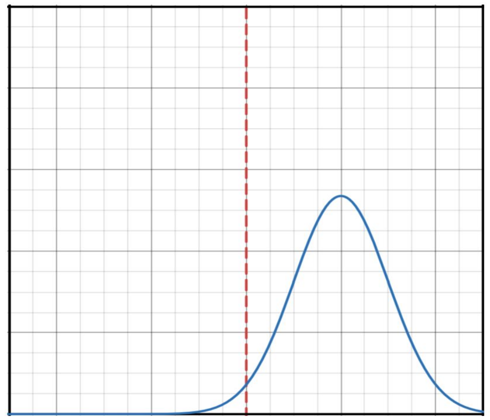
Different classes of information engines. The canonical example is Szilárd's engine.

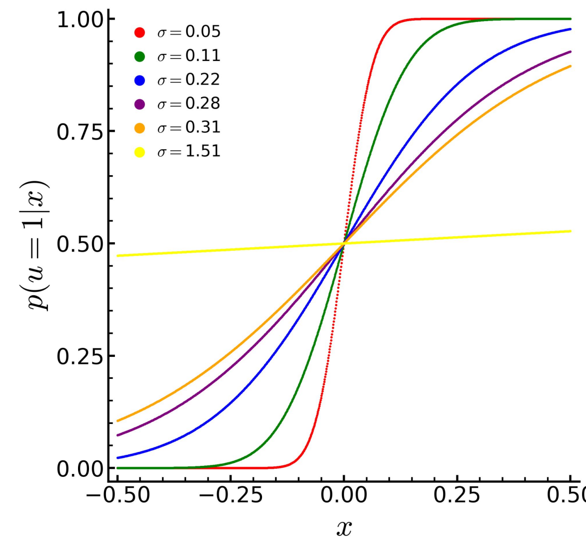


Different types of uncertainties in partially observable Szilárd engines.

Dorian Daimer, ddaimer@hawaii.edu

Two State Memories for Measurement Error across a threshold





IB Algorithm

Iterate through many possible memory assignments for each temperature ratio.

Find optimal memory assignments for a given temperature ratio and divider shape.

<u>Information Engines</u>

1. Do work to make Memory from transient data
2. Determine protocol from memory
3. Extract work using protocol

2 State Closed Form Solution

If Symmetric Error function assume symmetric Memory → Calculate Memory assignment solutions parameterized by α → Using α calculate Temperature ratio

What is the strategy for energy efficient memory making?

<u>Implementations</u>

- Spin in a magnetic field
- Transistors

<u>Applications</u>

- Machine Learning
- Repeated Threshold Measurements
- Energy Efficient Computing

Thomas Redford, tredford@hawaii.edu

Tom Browder, Professor of Physics

Former spokesperson of Belle II, 2013-2019. Currently, chair of the Publications Committee (2021-2025), Member upgrade advisory committee (UAC) and executive committee of US Belle II.

Lately, investigating ML/AI techniques to extract BSM physics in B→K* l+ l- with Shawn Dubey (now a postdoc at Brown) and Ethan Lee (grad student, physics→computer science). Investigating semileptonic B decays with grad student Boyang Zhang and Dr Harsh Purwar.

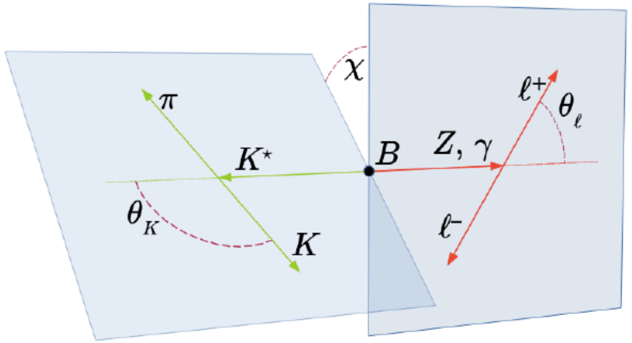


Figure 1: The $B \to K^* \ell^+ \ell^-$ decay topology showing the observables [15]. For this study we only consider the di-muon channel.

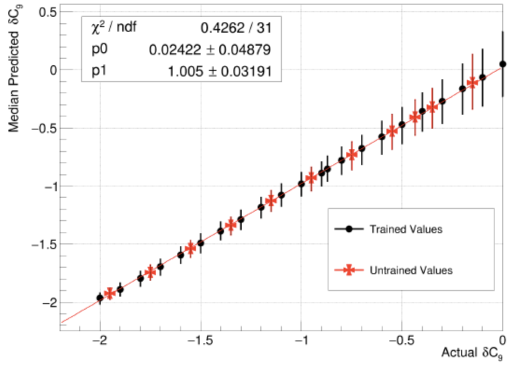
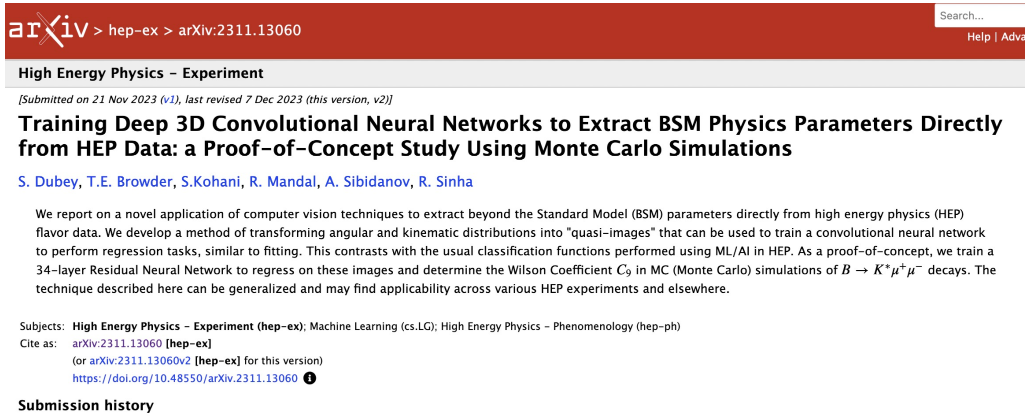


Figure 7: Results from the MC ensemble experiments. Black circles are from MC ensemble experiments in which images are generated using δC_9 values that the model had seen in training. Red crosses are from MC ensemble experiments where images are generated using δC_9 values that the model had not seen in training. The lower error bar is σ_L and the upper error bar is σ_R, which are determined from the test set prediction distributions.


arXiv > hep-ex > arXiv:2311.13060

Search...

Help | Adva

High Energy Physics – Experiment

[Submitted on 21 Nov 2023 (v1), last revised 7 Dec 2023 (this version, v2)]

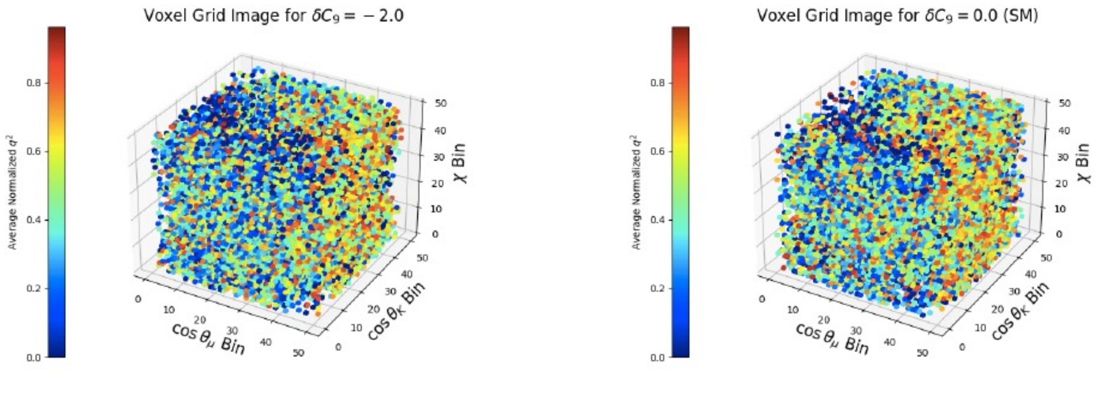
Training Deep 3D Convolutional Neural Networks to Extract BSM Physics Parameters Directly from HEP Data: a Proof-of-Concept Study Using Monte Carlo Simulations

S. Dubey, T.E. Browder, S.Kohani, R. Mandal, A. Sibidanov, R. Sinha

We report on a novel application of computer vision techniques to extract beyond the Standard Model (BSM) parameters directly from high energy physics (HEP) flavor data. We develop a method of transforming angular and kinematic distributions into "quasi-images" that can be used to train a convolutional neural network to perform regression tasks, similar to fitting. This contrasts with the usual classification functions performed using ML/AI in HEP. As a proof-of-concept, we train a 34-layer Residual Neural Network to regress on these images and determine the Wilson Coefficient C_9 in MC (Monte Carlo) simulations of $B \to K^* \mu^+ \mu^-$ decays. The technique described here can be generalized and may find applicability across various HEP experiments and elsewhere.

Subjects: **High Energy Physics – Experiment (hep-ex)**; Machine Learning (cs.LG); High Energy Physics – Phenomenology (hep-ph)
Cite as: arXiv:2311.13060 **[hep-ex]**
(or arXiv:2311.13060v2 **[hep-ex]** for this version)
https://doi.org/10.48550/arXiv.2311.13060

Submission history



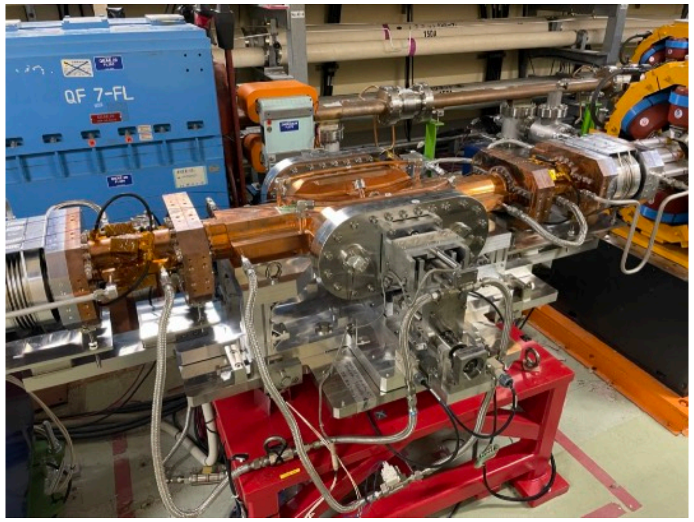
(a) Voxel grid image for $\delta C_9 = -2.0$ (b) Voxel grid image for $\delta C_9 = 0.0$ (SM)

Figure 3: Voxel grid images used for training and evaluation of the ResNet. Each angular variable is binned into 50 equal-width bins. This provides enough resolution and detail in the images while maintaining a reasonable amount of computational resources needed for training. Examples for the cases of $\delta C_9 = 0.0$ (SM) and $\delta C_9 = -2.0$ are shown. The color of the voxels indicates only the average, normalized, q^2 value in a 3D bin.

Keisuke Yoshihara

- **New Intrumentation Frontier Professor**
- SuperKEKB/Belle II Experiment
  - Beam Instrumentation
    - Beam Diagnostics System
    - Abort System Upgrade
    - Beam Collimator Operation
  - TOP Electronics Upgrade
  - $b \to s\ \ell\ \ell$ analysis

- PHYS476 “Electronics for physicists”
  - Digital circuit design
  - FPGA programming
  - ML/AI on Hardware

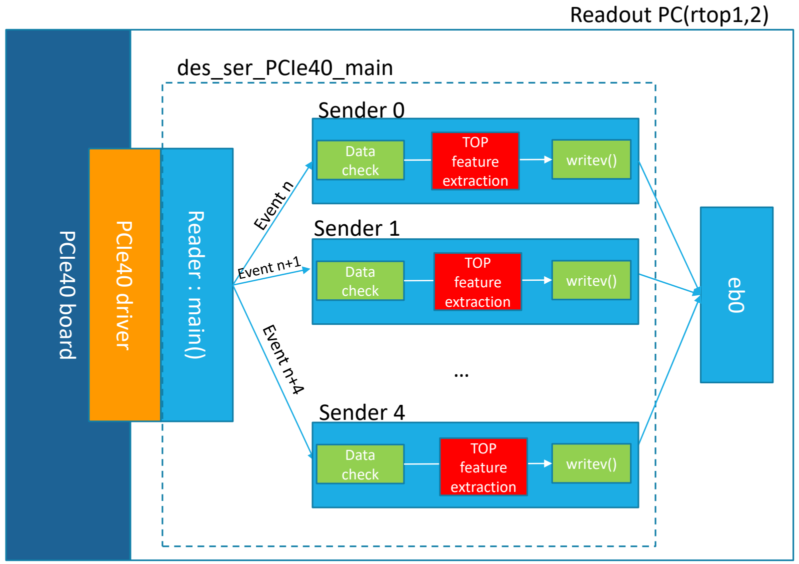


Beam Collimator

IDROGEN Board

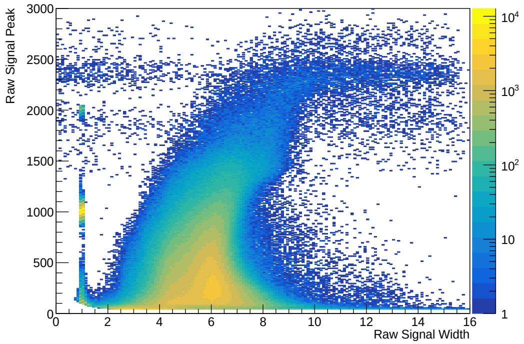
Contact me if you have strong interest in hardware!

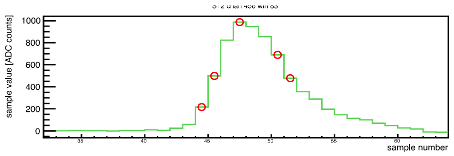
Belle II TOP PCIe40 Feature Extraction



- We plan to phase out as much as computational resource usage on TOP boardstacks' processing system.
- This is to minimize radiation induced lockups.
- To do this we will move the TOP feature extraction to the readout system PCIe computers.
- The PS firmware will also be modified to send raw waveforms and pedestal data to the readout system for use in feature extraction.

- There is also an interest in using a template fitting algorithm or machine learning for the TOP feature extraction.



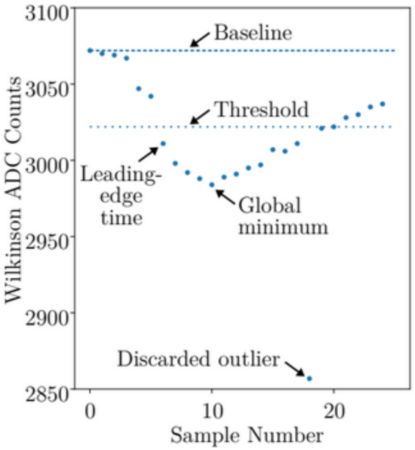


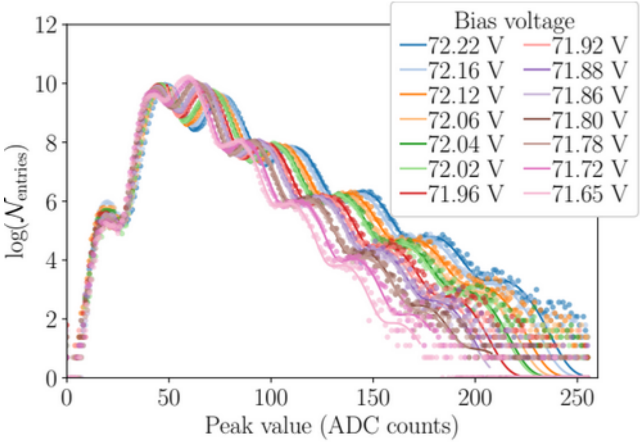
Shahab Kohani (kohani@hawaii.edu) on behalf of the UH TOP group

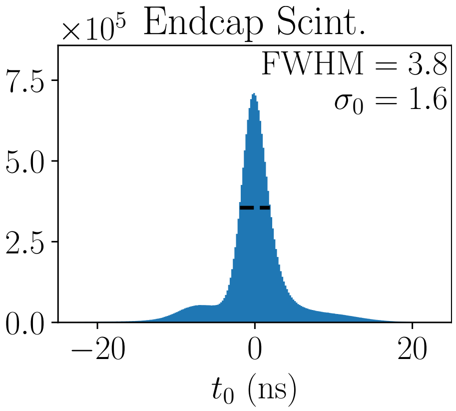
University of Hawai'i at Mānoa
Department of Physics & Astronomy

Chris Ketter
ckketter@hawaii.edu

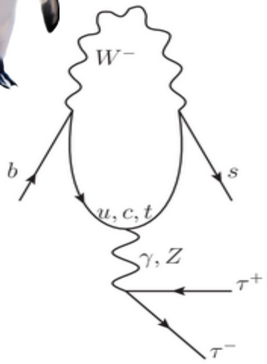
- Service task
  - Waveform readout firmware for TARGETX ASIC and SiPM calibration

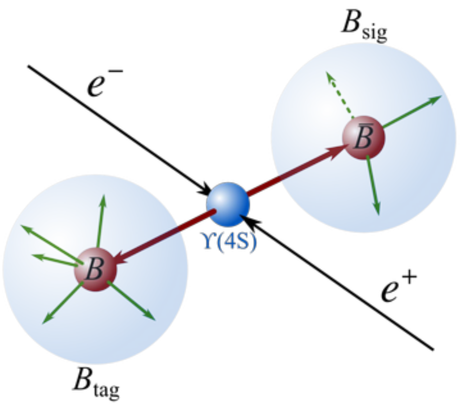


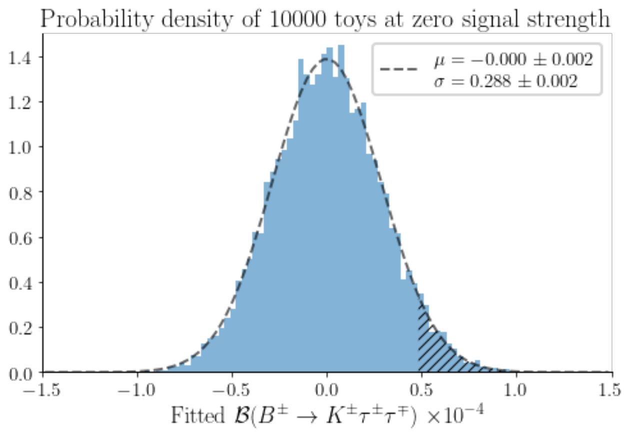




- Analysis
  - Search for $B^+ \to K^+\tau^+\tau^-$
  - Electroweak penguin
  - Inclusive tagging
  - As much as 30× improvement over leading measurement

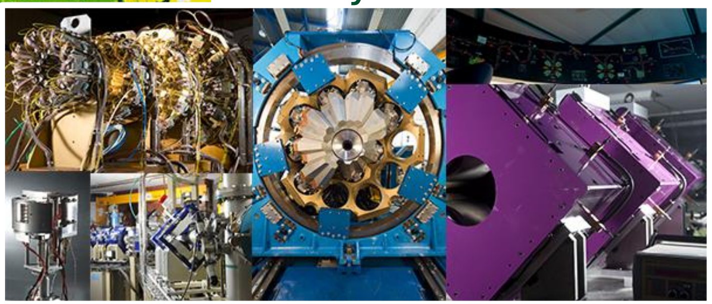






Particle Accelerators

Heavy Ion Accelerator

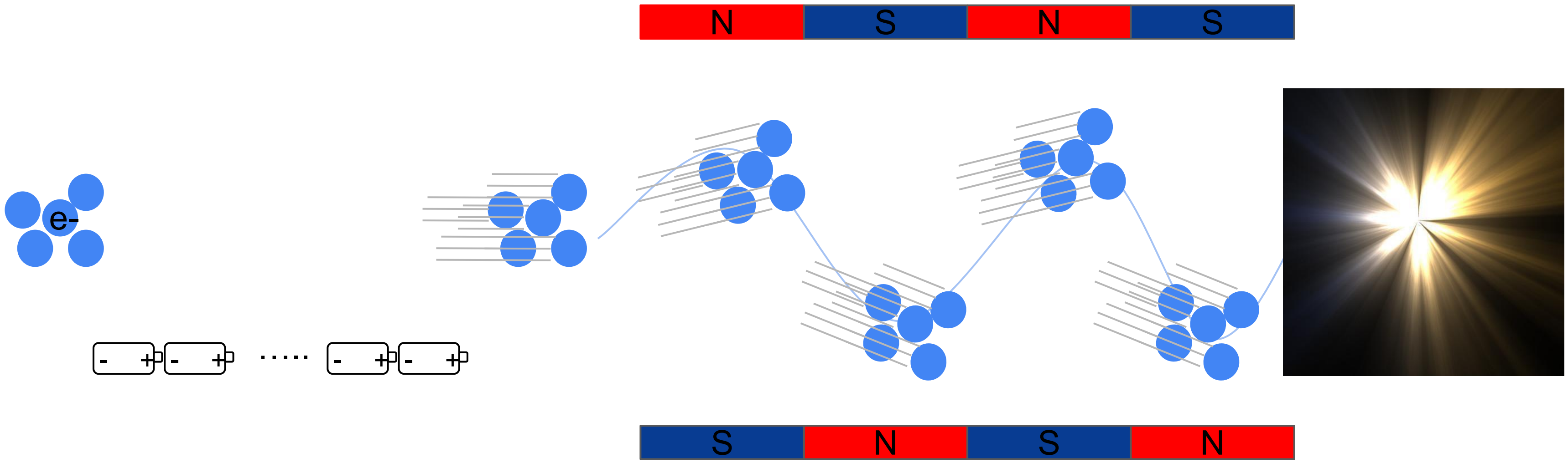


Particle Accelerators cover:
- Academia
- National laboratories
- Public/private organizations
- Industry

Beam and Accelerator Physics:
- Experimental Physics
- Theory and simulations
- Transversal studies

Niels Bidault
Linac/FEL
nbidault@hawaii.edu
WAT 205

Free-electron laser research



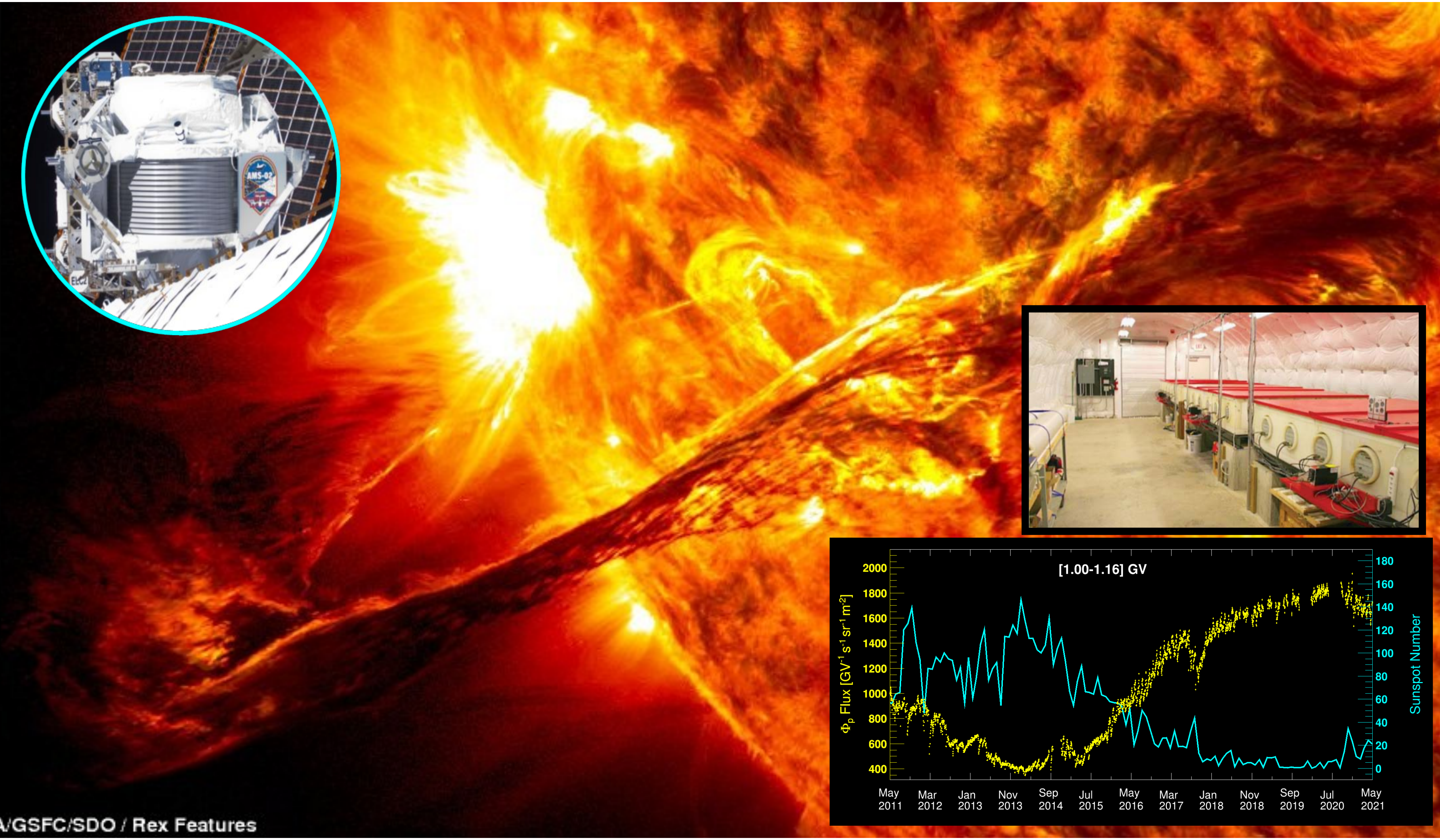
- Tunable in wavelength
  - Infrared/Terahertz
- Coherent
  - Optics
- Powerful
  - Short and intense pulses

Come to next week's colloquium!

Siqi Li
WAT 206
siqili@hawaii.edu

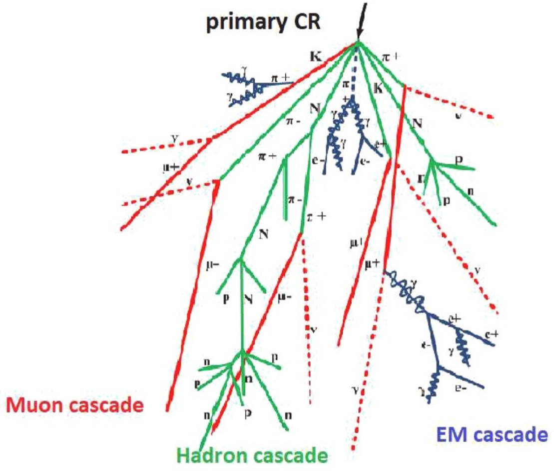
Space Weather Center in Hawaii - V. Bindi

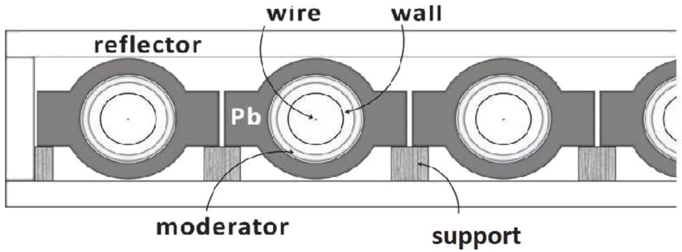
bindi@hawaii.edu



Space Weather Center In Hawaii to use data from space and ground instruments, including AMS, Neutron Monitors, and NASA and NOAA assets.

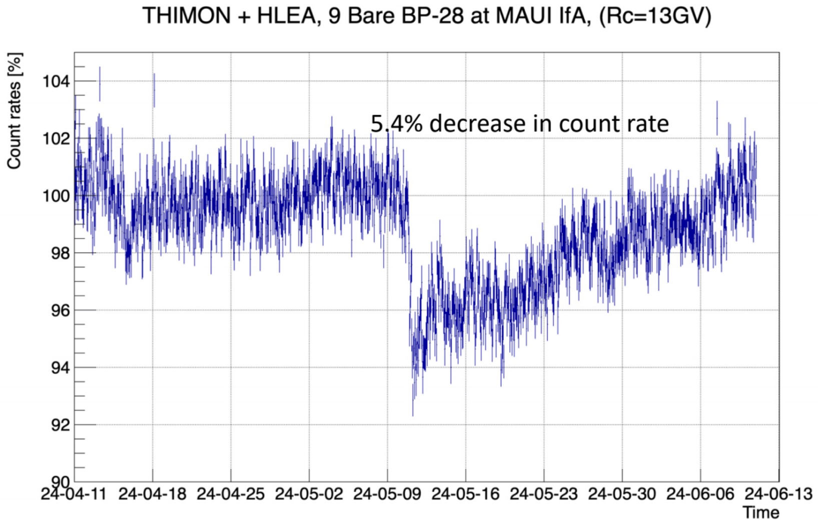
Haleakala Neutron Monitors Redeployment



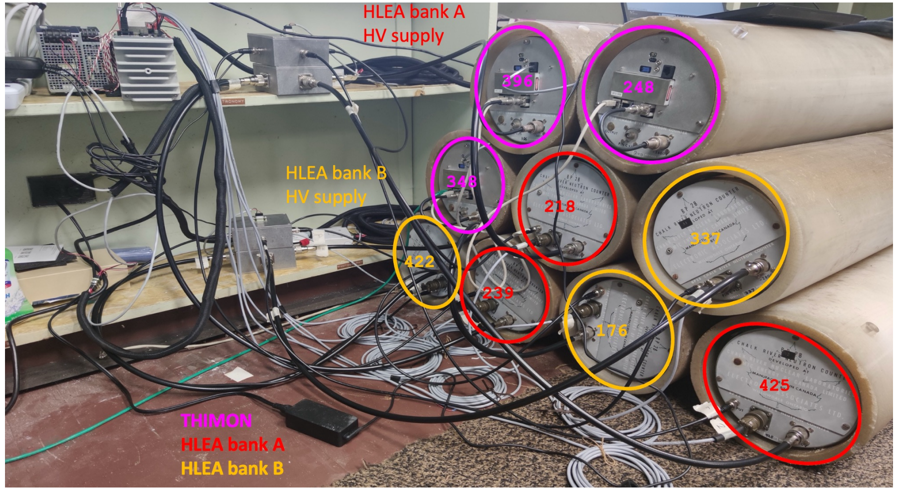


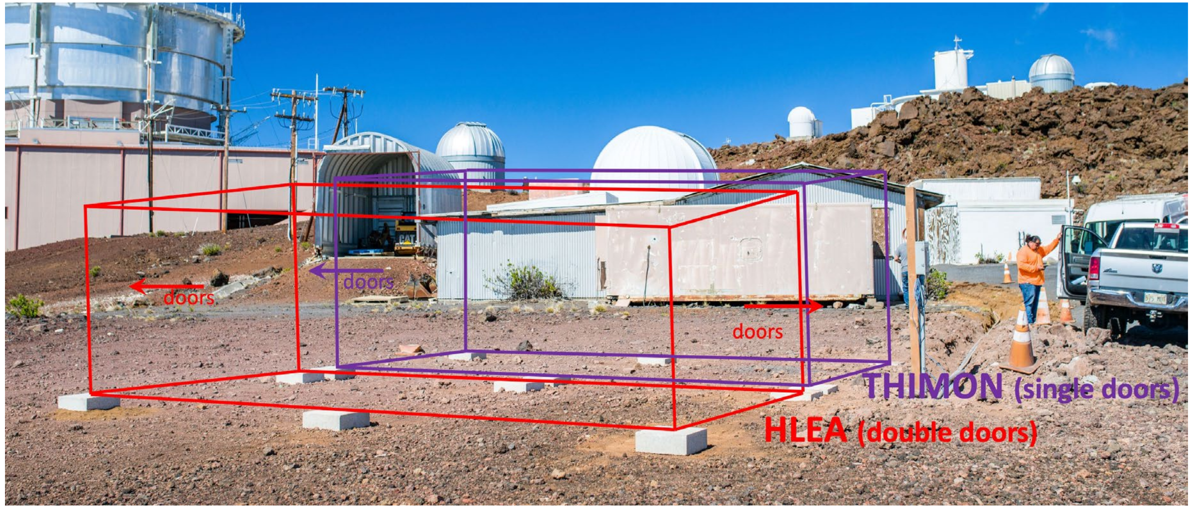
Forbush decrease measured by bare tubes during Solar event on May 11, 2024

Nikolay Nikonov: nikonov@hawaii.edu



Preliminary

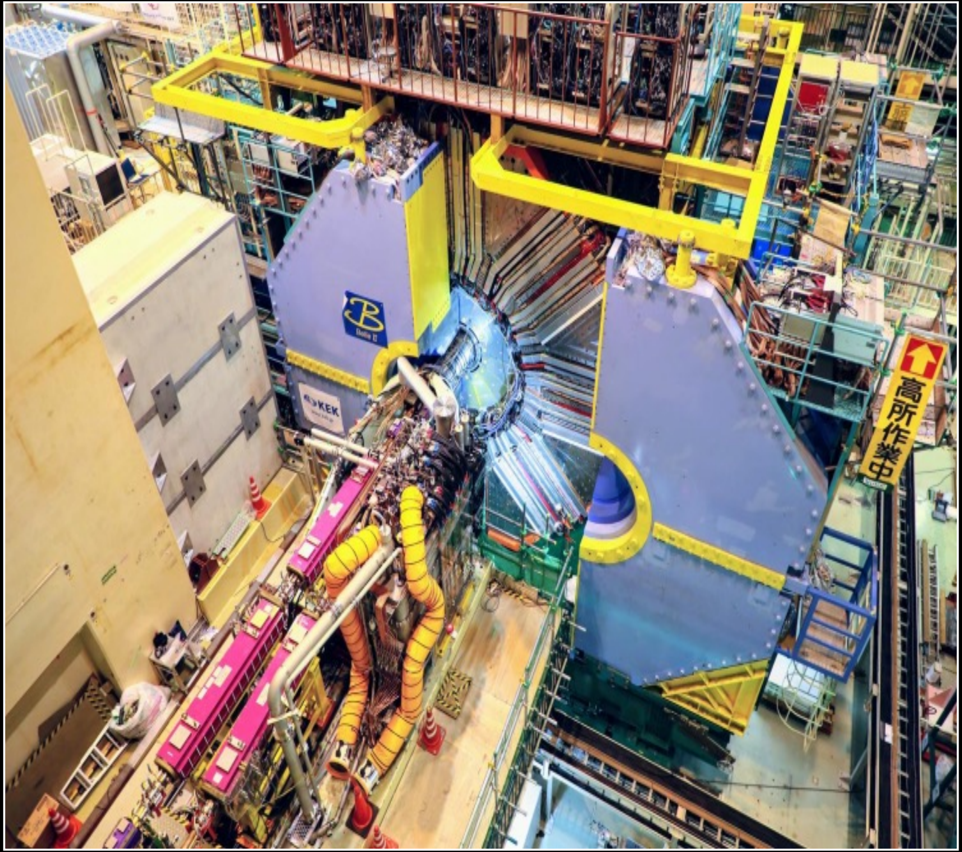




Belle II Experiment

https://www.belle2.org

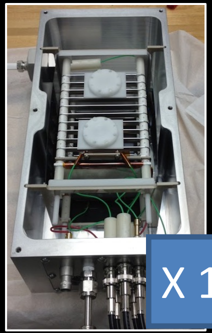
Utilizes the world's brightest particle collider, in Japan
We're studying b-quarks and quantum entanglement



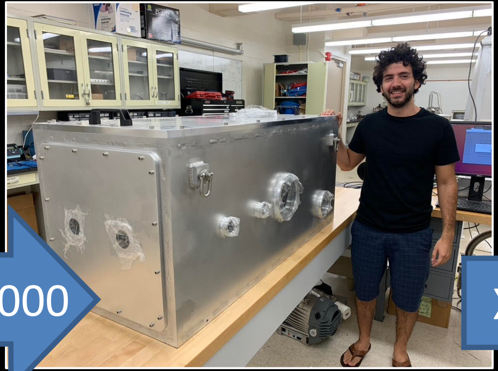
CYGNUS Experiment

https://doi.org/10.1146/annurev-nucl-020821-035016

Proposed experiment that we're designing
Search for dark matter particles and measure solar neutrinos



X 1000

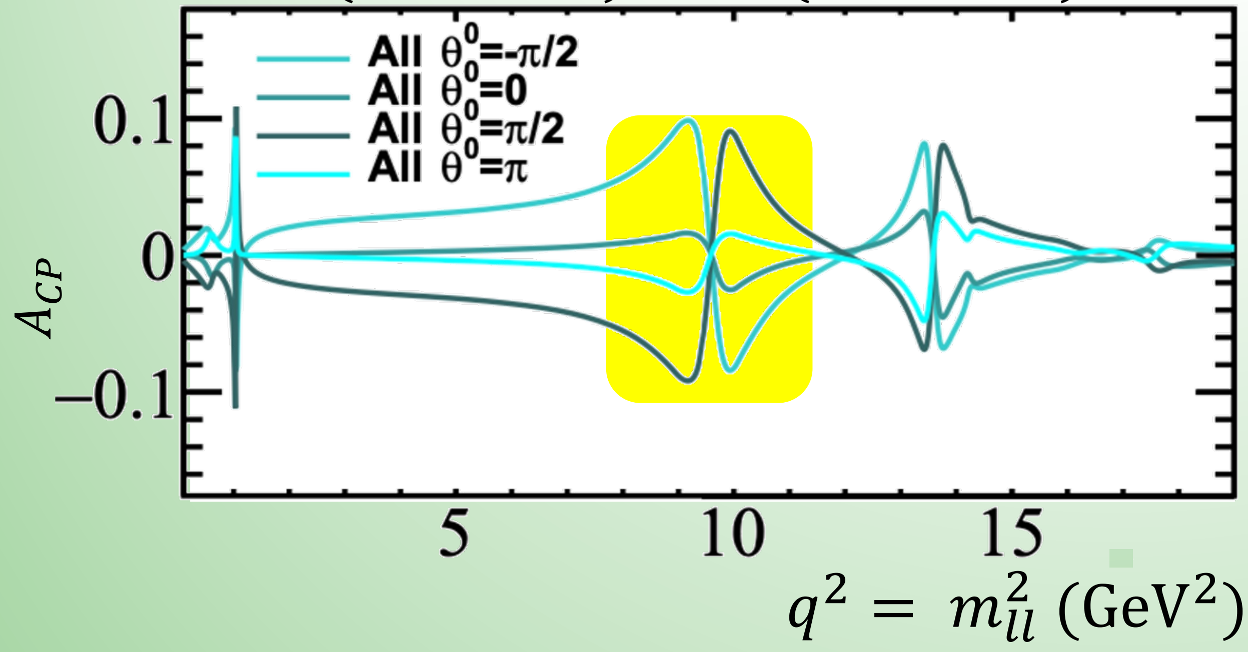


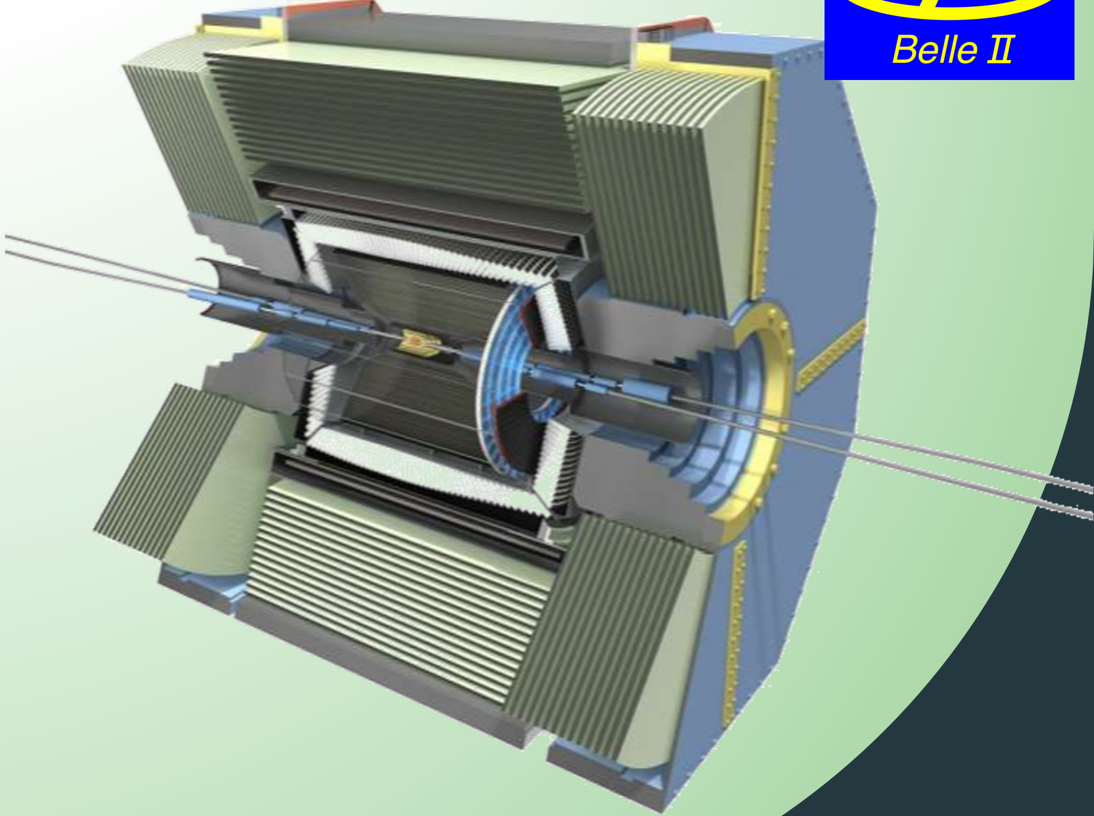
X 25

New prototypes under construction here in Watanabe Hall!
New students always needed. Contact Sven Vahsen, sevahsen@hawaii.edu

Search for New Physics via CP violation in $B \to K^{(*)}ll$ decays

$$\Gamma(B \to K^* ll) \overset{?}{\neq} \Gamma(\bar{B} \to \overline{K^*} ll)$$





IMBALANCE IN THE FORCE?

CP violation explains some of the observed matter-antimatter asymmetry in the universe

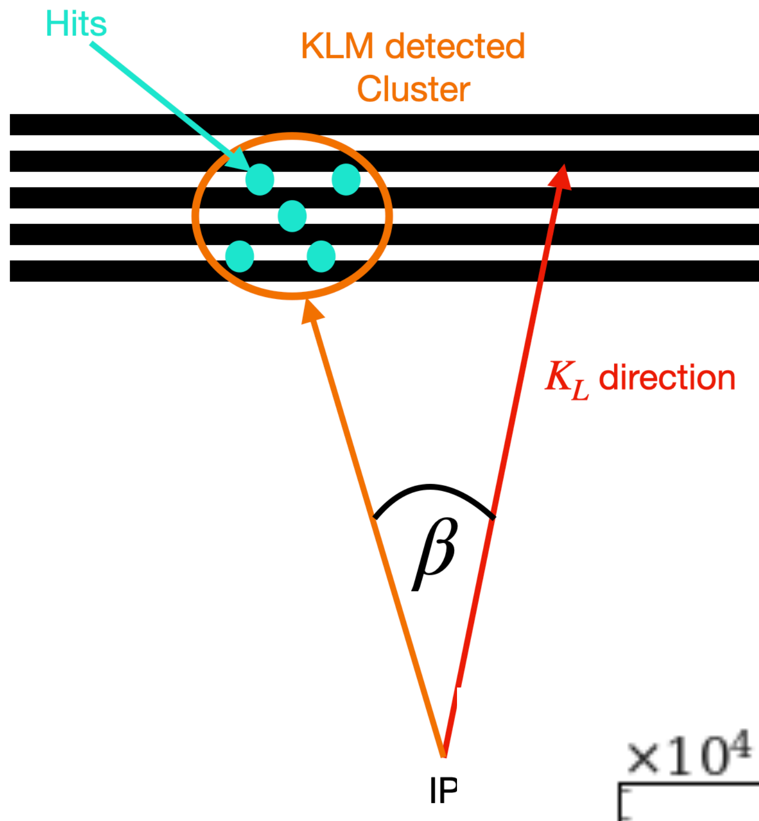
Any asymmetry observed in this decay process will indicate New Physics

HIMA KORANDLA

korandla@hawaii.edu

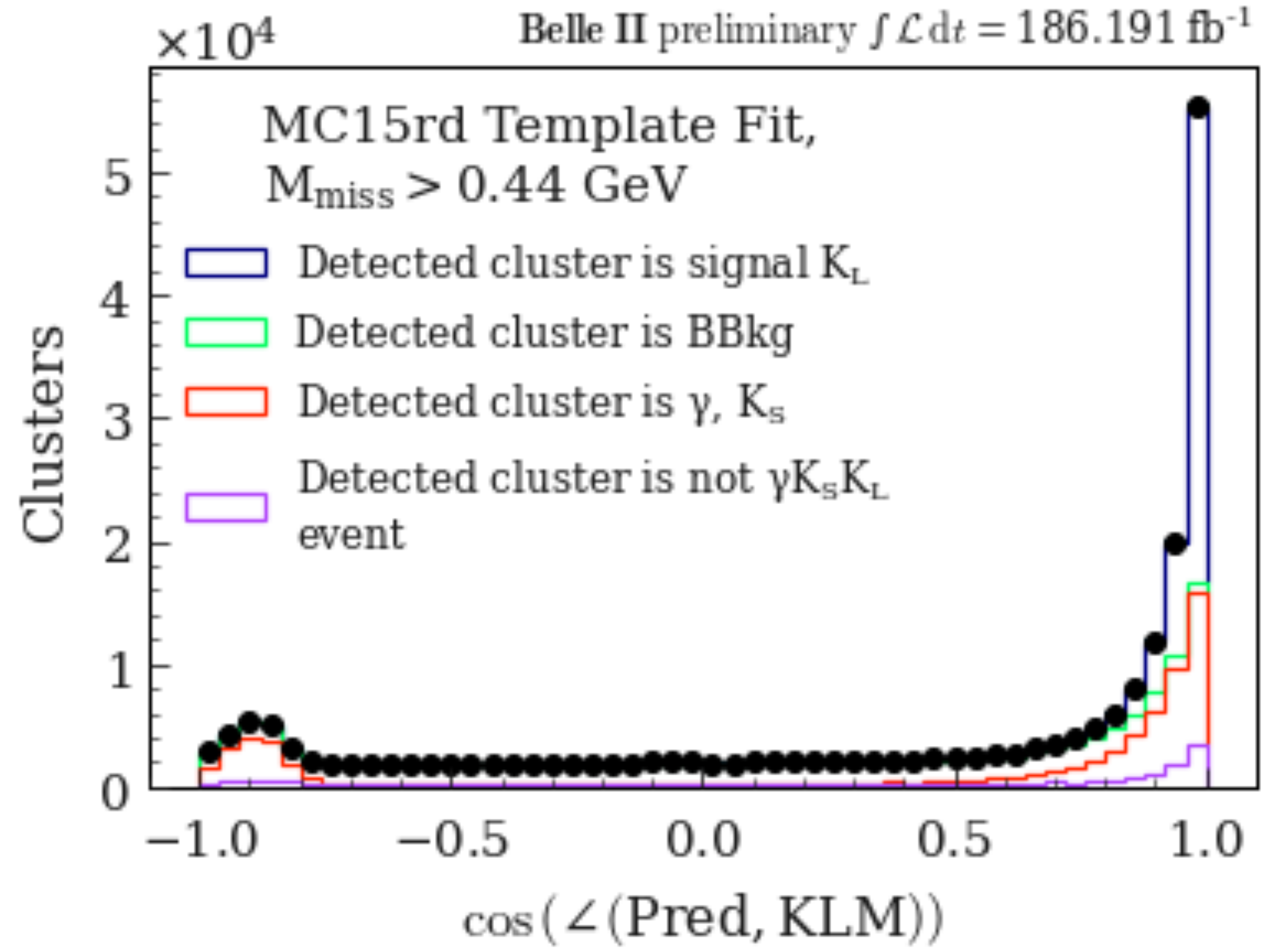
K_L Detection Efficiency & Quantum Decoherence Measurements at Belle II

K_L Detection Efficiency Measurement at Belle II



➡ Use the $e^+e^- \to \gamma_{ISR}\phi(\to K_S K_L)$ decay

➡ In this decay mode we know the direction of the K_L. Thus we can compare it to any detected clusters in the KLM.

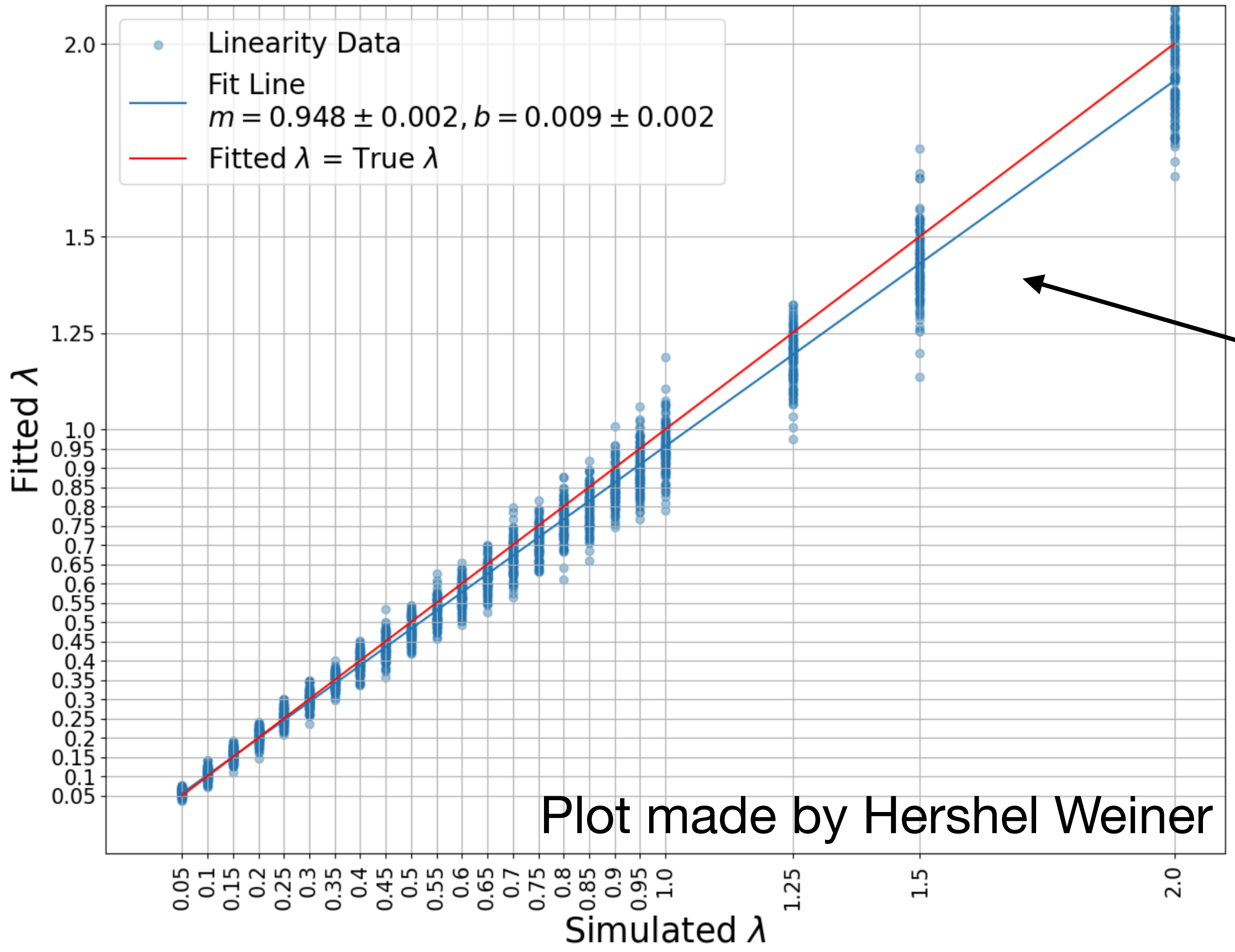


Quantum Decoherence Measurement at Belle II

➡ Thesis topic for my PhD

➡ We want to test and measure different decoherence models

➡ Previous undergrad (Hershel Weiner) did a first generator level MC feasibility check



➡ Crucial: Handling the errors

➡ Started with the work recently

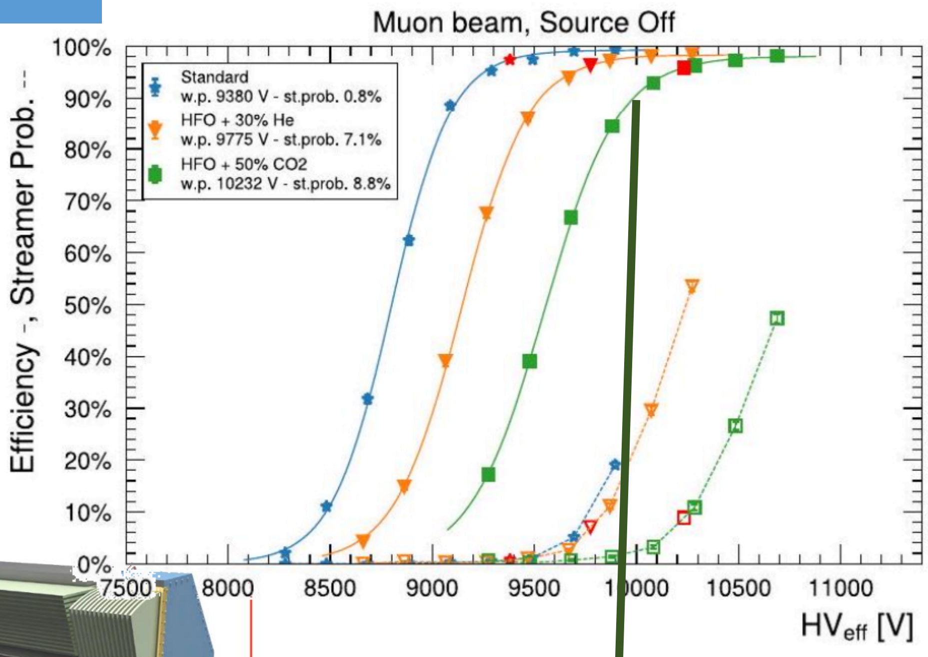
Conceptual Design Report (CDR)
Proposed Upgrades for KLM@BELLE2

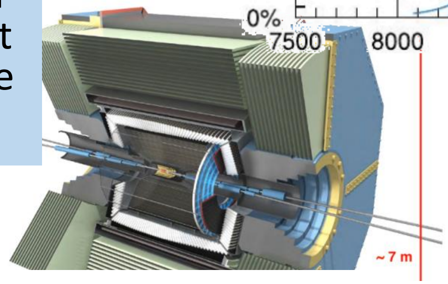
The CDR Contains two proposals for an upgrade to the KLM Resistive Plate Chambers (RPCs)

- Replacing the aging RPCs with a new scintillator-based detector
- Improving the existing Glass RPCs

Motivation:

- The Current Glass RPCs are old and there is some concern that they will not preform adequate at design luminosity





Avalanche Mode

Streamer Mode

RPC Rate Capability: Influenced by factors such as the average charge per incident (<Q>), the resistivity of the plates, and the composition of the gas mixture.

Operation modes of RPCs: Avalanche mode and streamer mode.

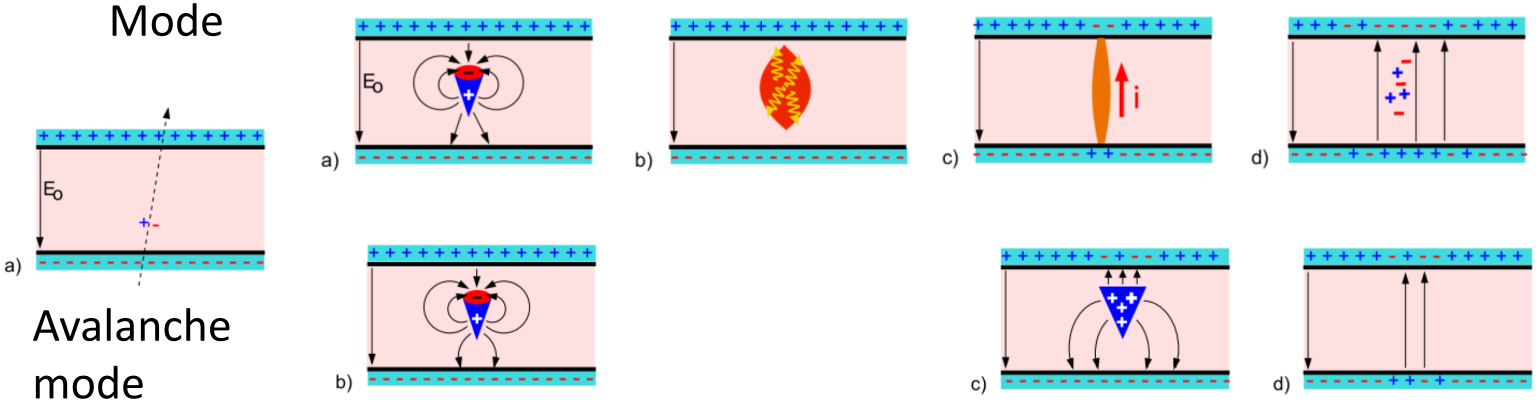
Streamer mode:

- Produces larger signals, enabling simpler readout electronics, but results in reduced rate capabilities.

Avalanche mode:

- Over the last 20 years avalanche mode RPCs have become popular and are used by many groups such as ATLAS@LHC
- The reduced signal height necessitates enhancements to the front-end electronics, including the addition of a preamplifier for each channel.
- A change in the gas mixture may be needed, potentially requiring the addition of an electron-negative gas like SF6.

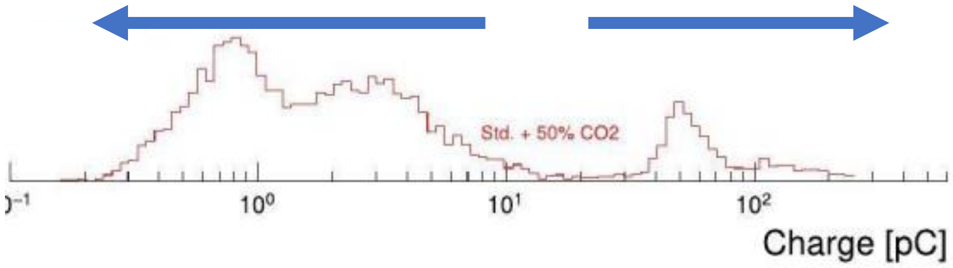
Streamer Mode



Avalanche mode

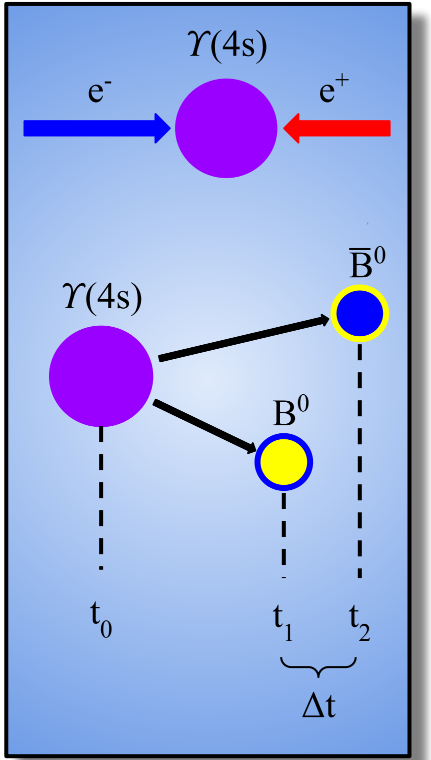
Avalanche

Streamer



Measuring Decoherence at Belle II

Timothy Mahood
mahood@hawaii.edu

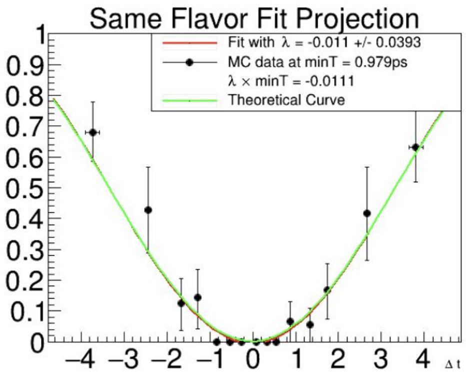


Lindblad Decoherence:

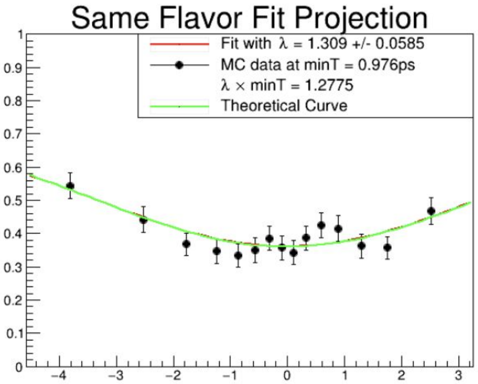
$$\frac{d\rho}{dt} = -iH\rho + i\rho H^\dagger - D[\rho] \qquad D[\rho] = \lambda\left(P_1\rho P_2 + P_2\rho P_1\right)$$

λ parameterizes the strength of decoherence

Measure the amount of Lindblad Decoherence (via λ) at the Belle II experiment by comparing B-meson flavour distribution.



Low Decoherence



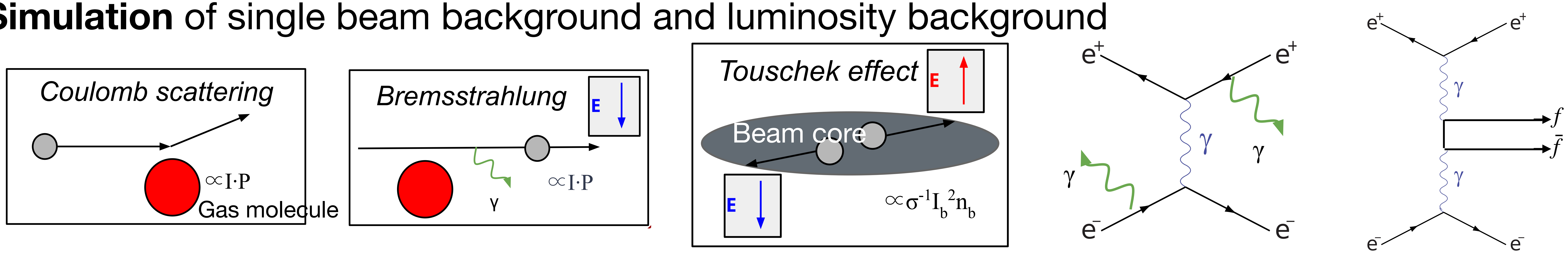
High Decoherence

← plots made by former student Hershel W.

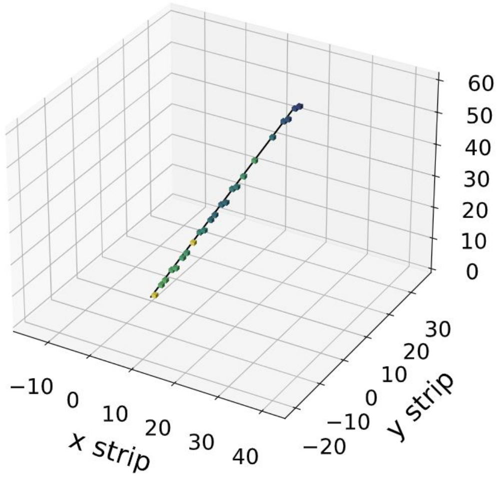
Belle II background study and $e^+e^- \to \pi^+\pi^-(\gamma)$

Qingyuan Liu, qingyuan.liu@hawaii.edu

- Belle II background
  - **Simulation** of single beam background and luminosity background



  - Data-MC **analysis** and **monitoring** of Belle II background
  - **Optimization** of SuperKEKB collimators
- $e^+e^- \to \pi^+\pi^-(\gamma)$ cross-section measurement
  - Major **input to muon g-2 calculation** using the data-driven approach (dispersive integral)
    - **Largest contribution** among all $\mathrm{e^+e^-} \to \mathrm{hadrons}(\gamma)$ channels
    - Understanding **discrepancies** among KLOE, BaBar and CMD-3



Directional Dark Matter Detection

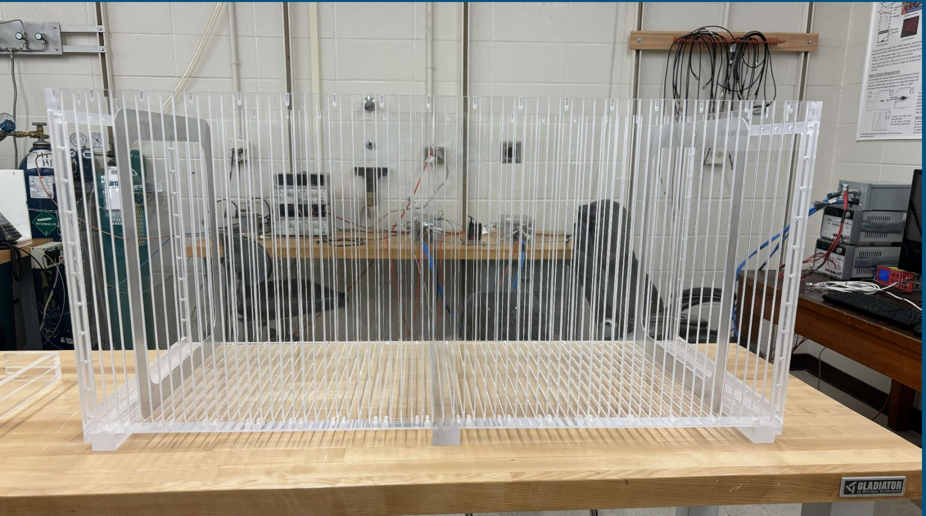
Majd Ghrear
majd@hawaii.edu

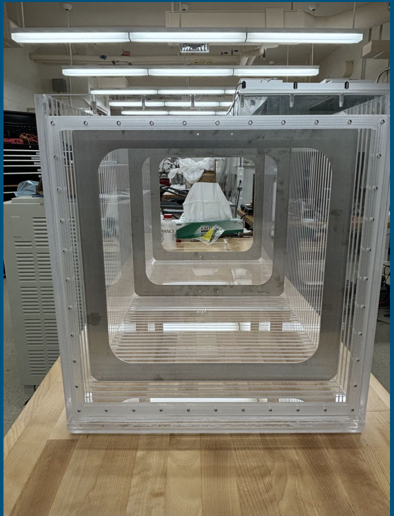
Construction of 40L Time Projection Chamber

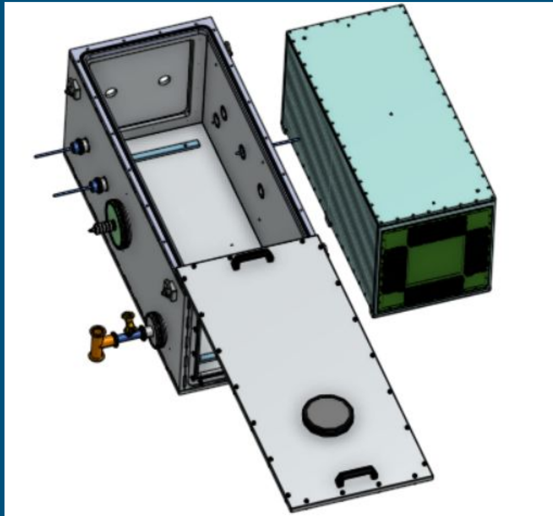
Gage Wettlaufer
Gagewett@hawaii.edu

Currently: Finishing the assembly of the inner chamber

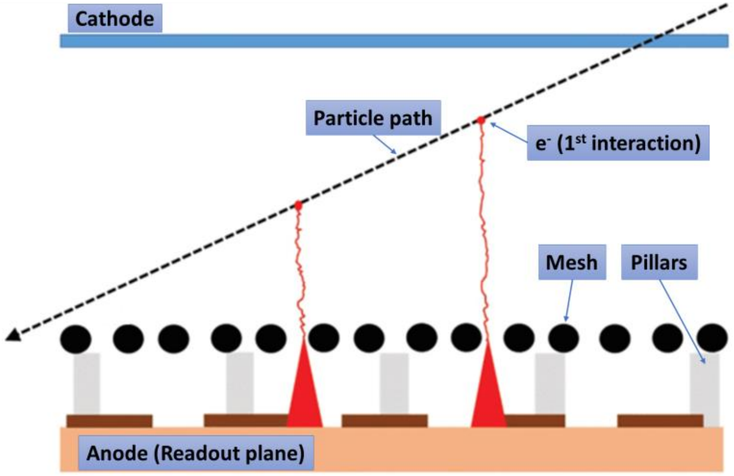
Next Step: Installation of the inner chamber and assembly of the electrical components

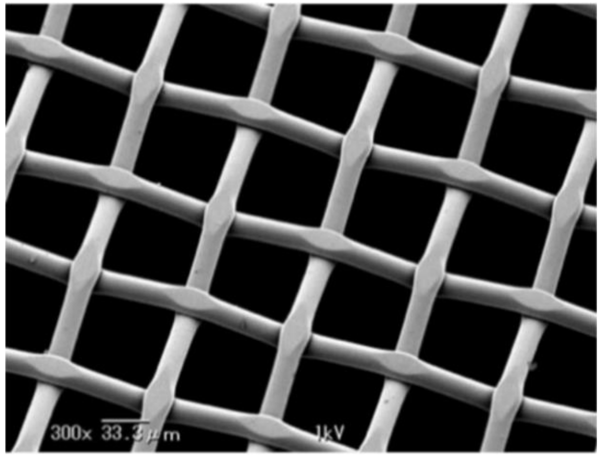






Gas-TPC electron amplification simulations

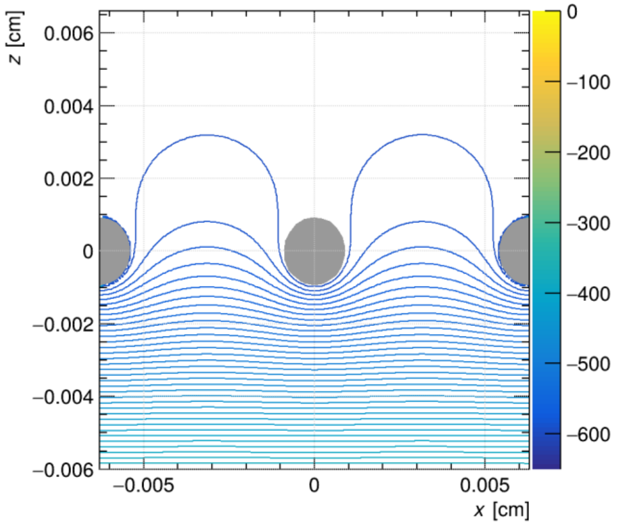


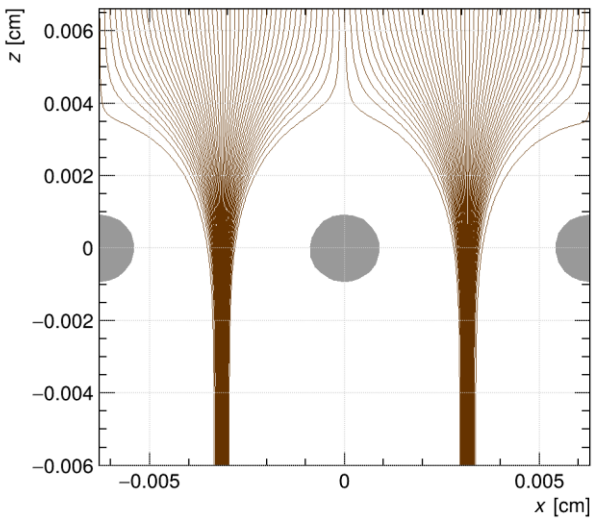


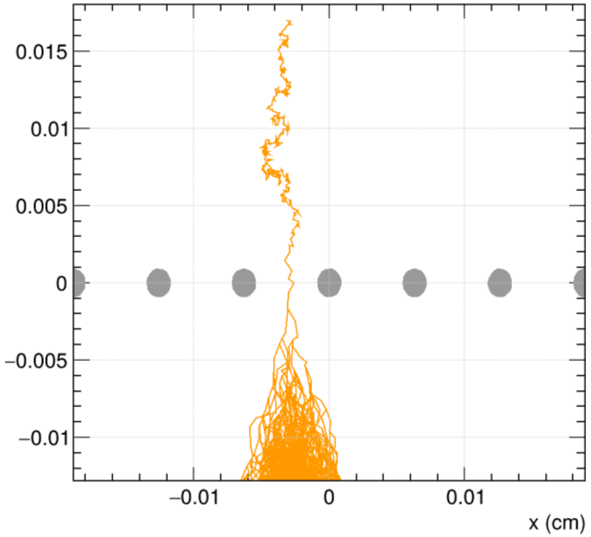
Electron amplification simulation

Guiding detector design and understanding

Fine tuning amplification -> increased detector sensitivity







Michael Litke
mlitke@hawaii.edu

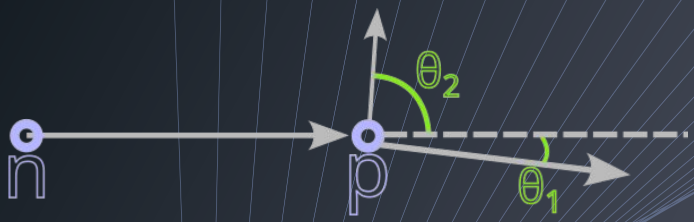
Directional Neutron Reconstruction

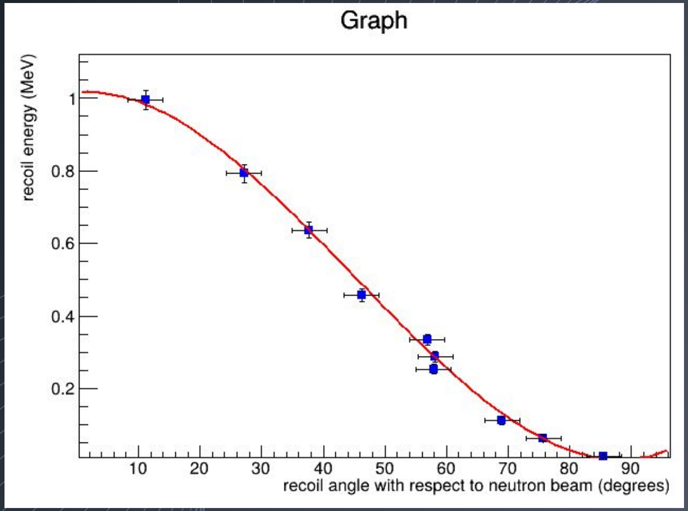
- Incoming neutron direction can be reconstructed with our detectors

- Strong correlation between proton energy and direction

- Let's extend this to 3D with detector effects! Approaches:
    - Theoretical
    - Numerical
    - Machine Learning

- Eventual goal to profile Belle II neutron backgrounds



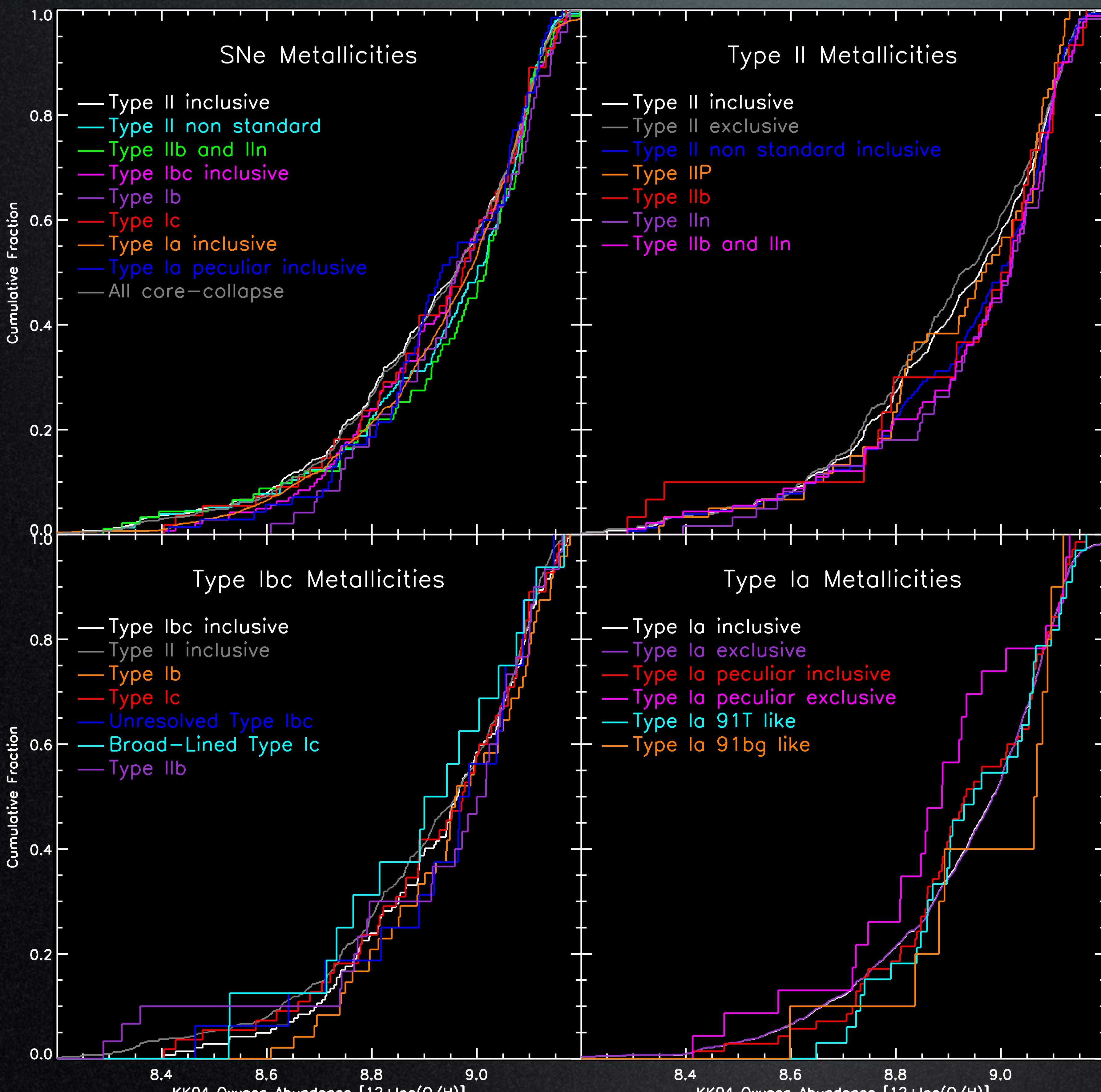


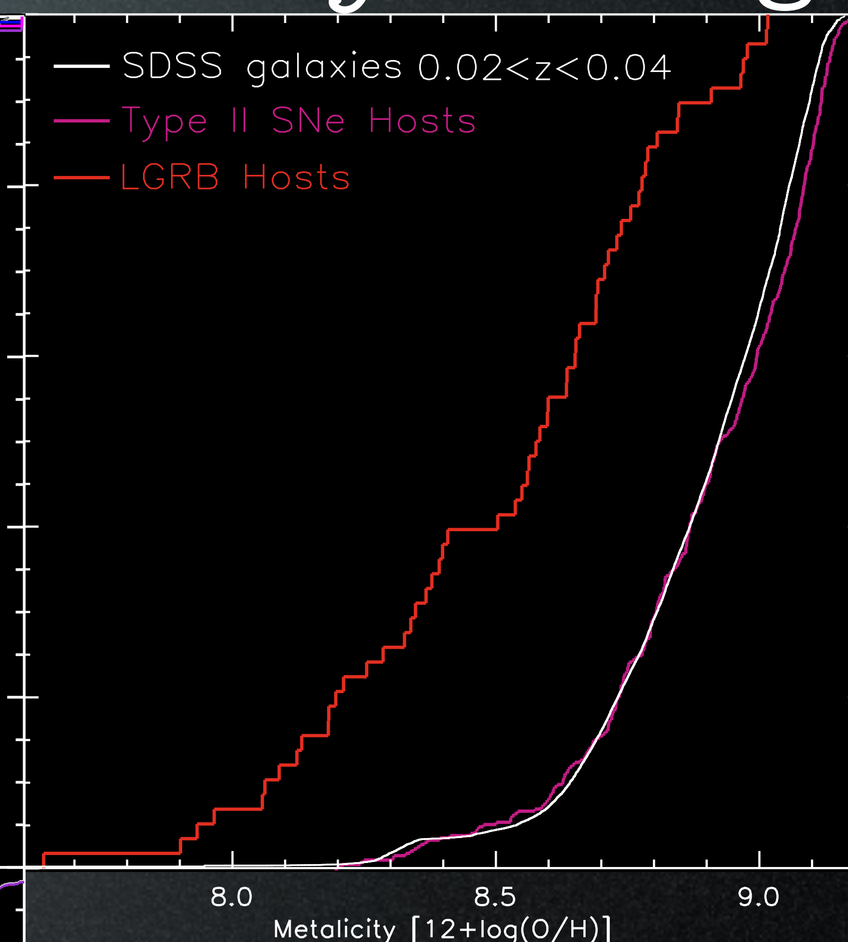
Belle II

Shashank Jayakumar
shashank@hawaii.edu

John Graham

A Supernovae (SNe) SDSS Host Metallicity Catalog





SNe now being discovered at an unprecedented rate.

Small differences in metallicity distributions seen between SNe Types.

Good agreement between metallicity distribution of SNe and SFR weighted galaxies. IFM implications!

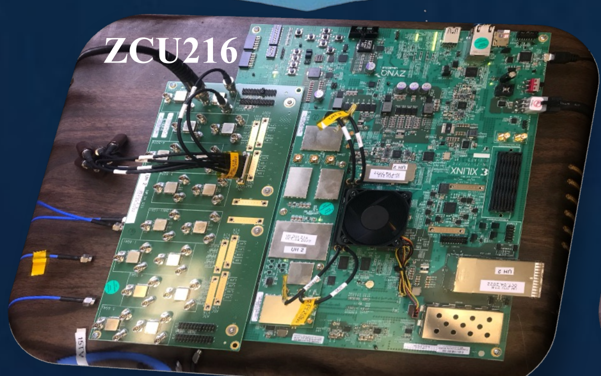
Balloon projects:
PUEO (2025)
ADAPT (2025)

Space project:
CoRaLS

- **P**ayload for **U**ltrahigh **E**nergy **O**bservations (**PUEO**) is a long-duration NASA balloon experiment to measure ultra-energy neutrinos at energies above 1EeV using ZCU111 and ZCU216 boards.

- **A**ntaractic **D**emonstrator for the **A**dvanced **P**article-astrophysics **T**elescope (**ADAPT**) is also a NASA balloon mission to detect gamma-ray and cosmic-ray measurements using HDSoC board.

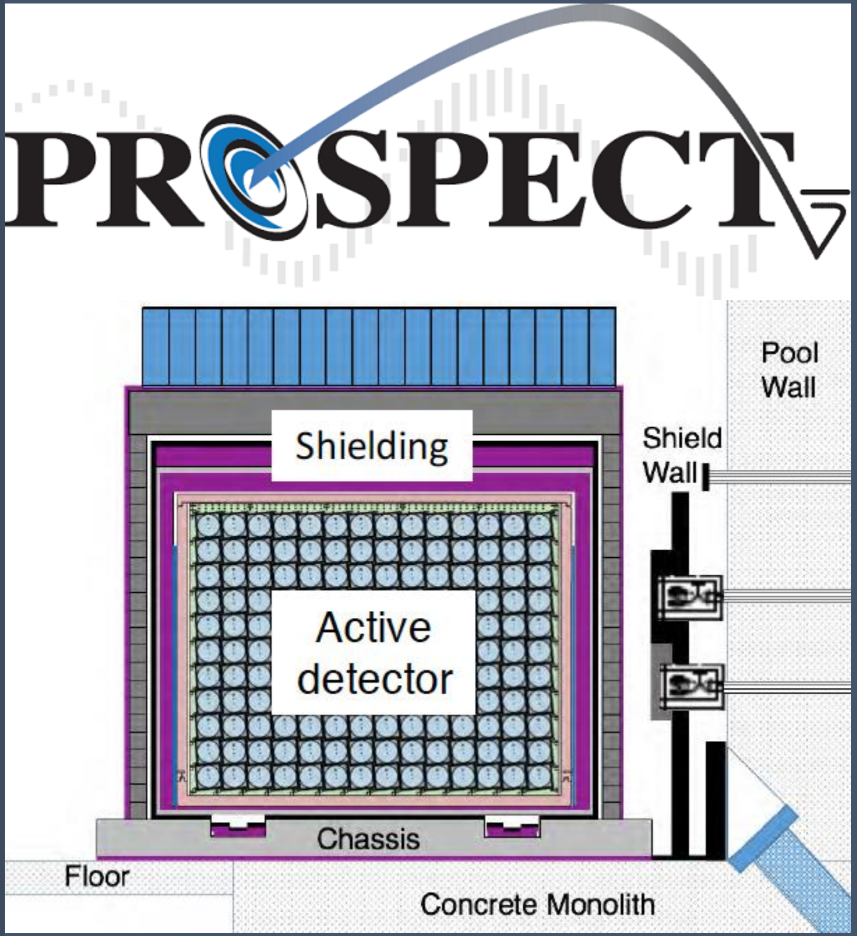
- **Co**smic **Ra**y **L**unar **S**ounder (**CoRaLS**) is a new lunar orbiter mission in development with a targeted goal of detection and characterization of subsurface deposits of water ice within the top 10-20 meters of the lunar regolith using ZCU216 board.

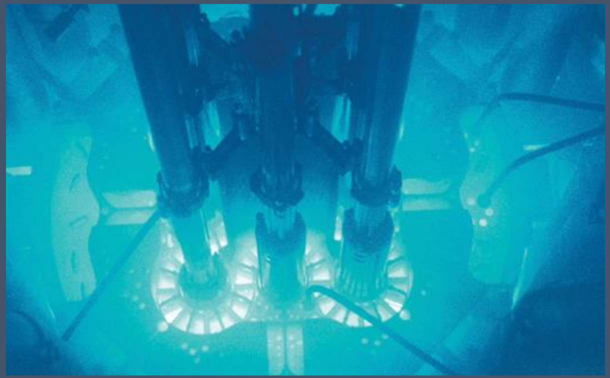


Name: Aera Jung, Position: postdoc, Email: aera@hawaii.edu, Office: WAT 328, Supervisors: Peter Gorham and Boris Murmann

Precision Reactor Oscillation and Spectrum Experiment (PROSPECT)

- PROSPECT is a Neutrino Experiment at Oak Ridge National Laboratory (ORNL)
- Detector is an 11x14 grid of Lithium-loaded Liquid Scintillators
- PROSPECT seeks to explain the anomaly between predicted models of reactor neutrino flux and observations
- Maybe Sterile Neutrinos?
- I'm working on neutron capture ratio and efficiency uncertainties for measurements for absolute reactor flux





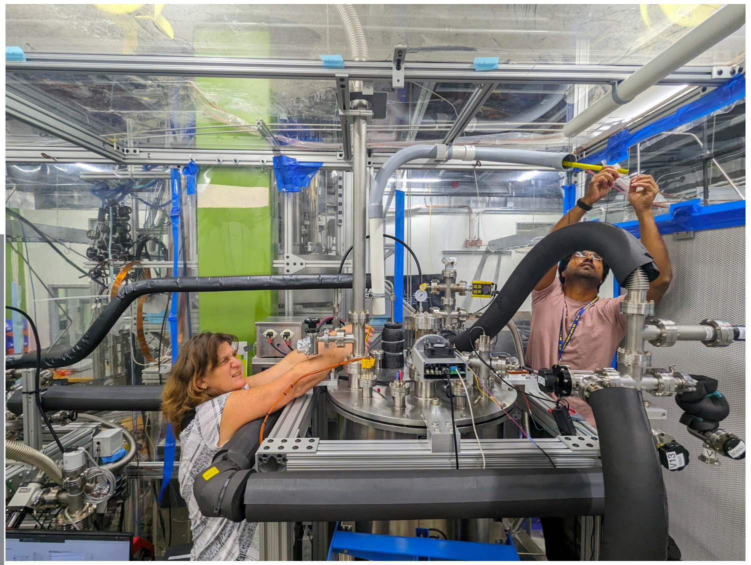
Andrew Meyer andrewm9@hawaii.edu

Ranjan Dharmapalan (Postdoc) ranjand@hawaii.edu

Neutrino group working with Prof. Jelena Maricic

Previously:

- PhD work on MiniBooNE experiment. Neutrino cross sections and searching for sub-GeV dark matter
- Long baseline neutrino oscillations on NOvA experiment and Large Area Picosecond Photodetectors



At SLAC testing a calibration system developed at Hawaii

Current work at Hawai'i:

Deep Underground Neutrino Experiment (DUNE). Answer questions like:

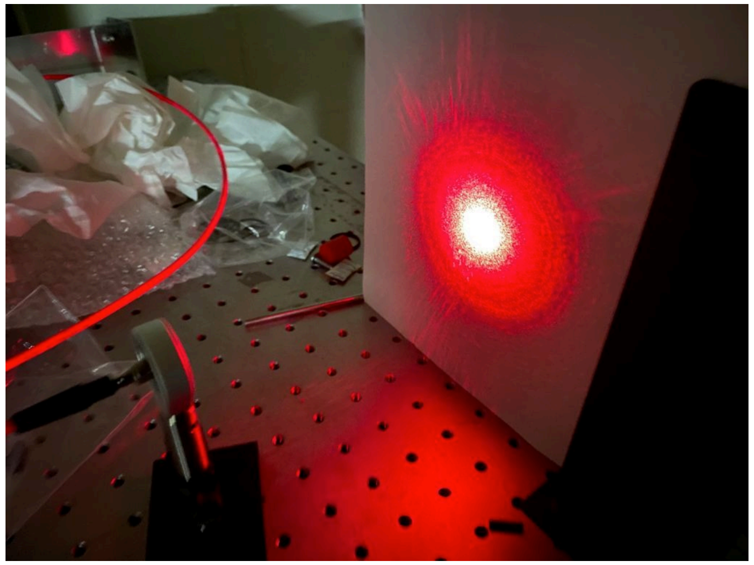
- Why is universe made up of matter rather than antimatter?
- Do protons decay?
- What can we learn from neutrinos produced in SuperNovae?

Electronics setup in the lab

How to make sure the largest Liquid Argon Time Projection Chamber (LArTPC) to be built works and we understand the data?

- New ideas for detector calibration
- Design and test prototypes at our lab in Hawai'i
- Analyze the results from prototype experiments to guide the final design

Testing prototypes in LN2



Testing light output from a fiber

Vacuum pump and test chamber

Cosmic-ray Antinuclei

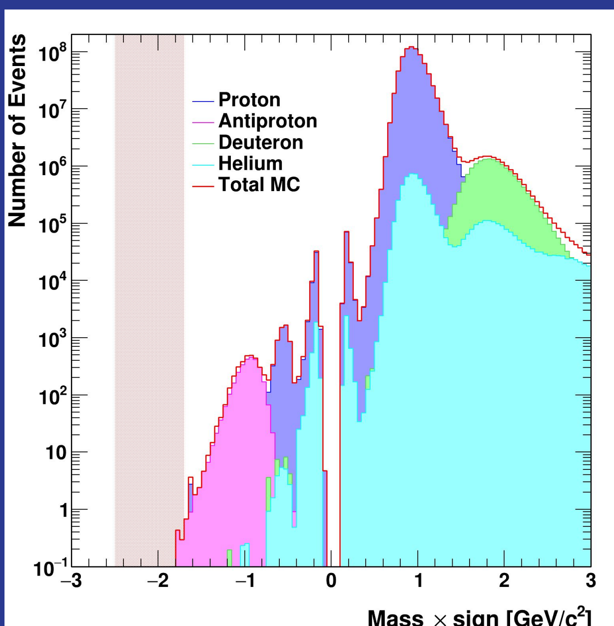
- Measurement of cosmic-ray antinuclei is a promising way to search for “new” physics
- Detection of cosmic-ray antinuclei is experimentally challenging
  → multiple experiments needed
  - AMS-02 on the ISS since 2011 (Anirvan Shukla (PD), Ammar Bayyari (G))
  - GAPS first balloon flight in 2024 (Achim Stoessl (JR), Cory Gerrity (G), Grace Tytus (G))
- Cross section measurements needed to improve understanding of antinuclei production: NA61/SHINE (Anirvan Shkula (PD), Bobby Lyon (G), Moritz Kunze (UG))

Anirvan Shukla

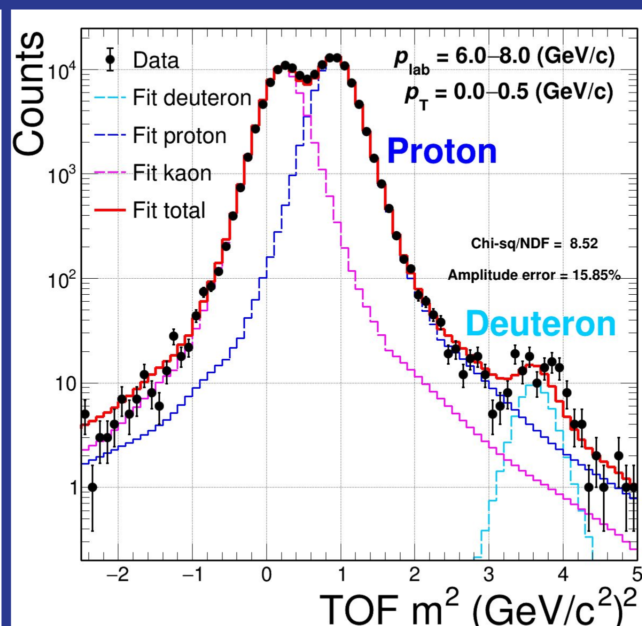
anirvan@hawaii.edu

I am a postdoc working with Philip on:

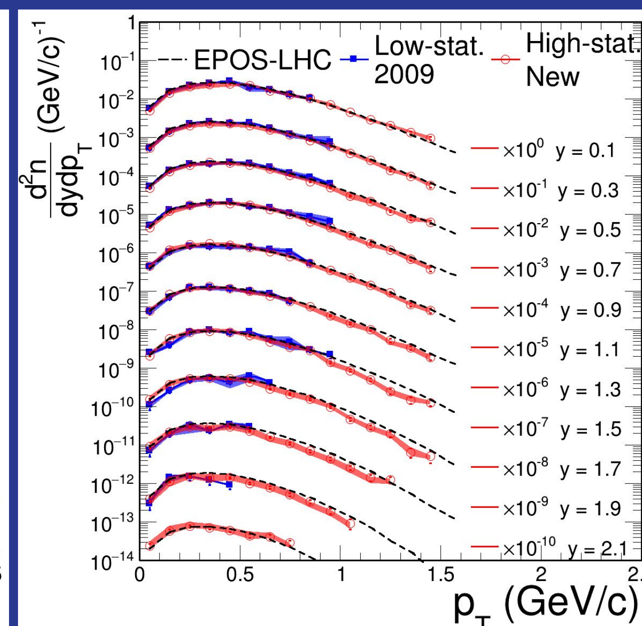
- Searching AMS-02 data for rare cosmic antinuclei like antideuterons and antihelium for hints of dark matter.
- Understanding light (anti)nuclei production in proton-proton collisions at NA61/SHINE, CERN.
- Understanding antinuclei propagation in our Galaxy.



Simulated AMS-02 mass spectra



Deuteron signal in p+p collisions in NA61/SHINE



Antiproton production in p+p collisions in NA61/SHINE

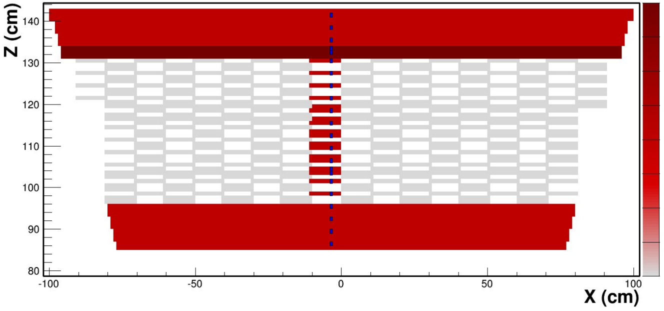
One Minute Colloquium 2024

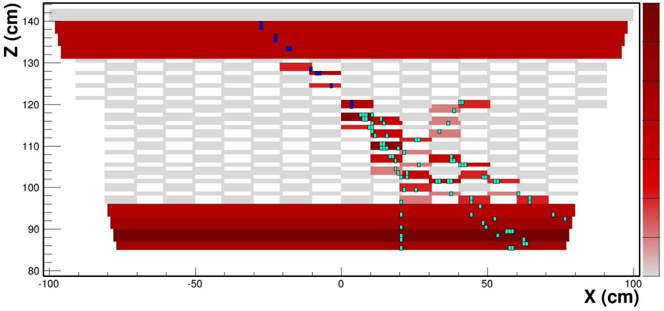
Grad Student: Ammar Bayyari

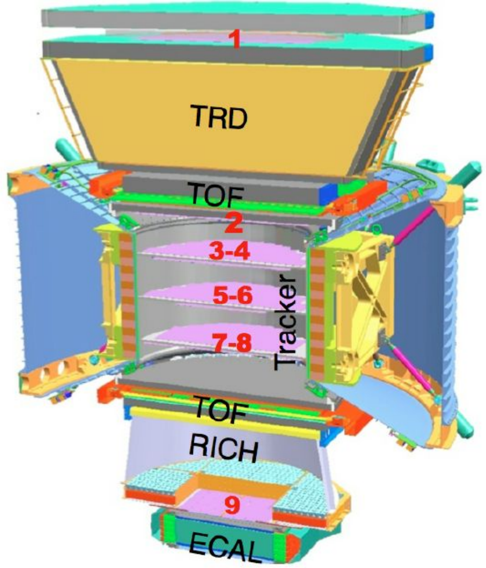
Email: abayyari@hawaii.edu

Advisor: Philip von Doetinchem

Research: AMS-02



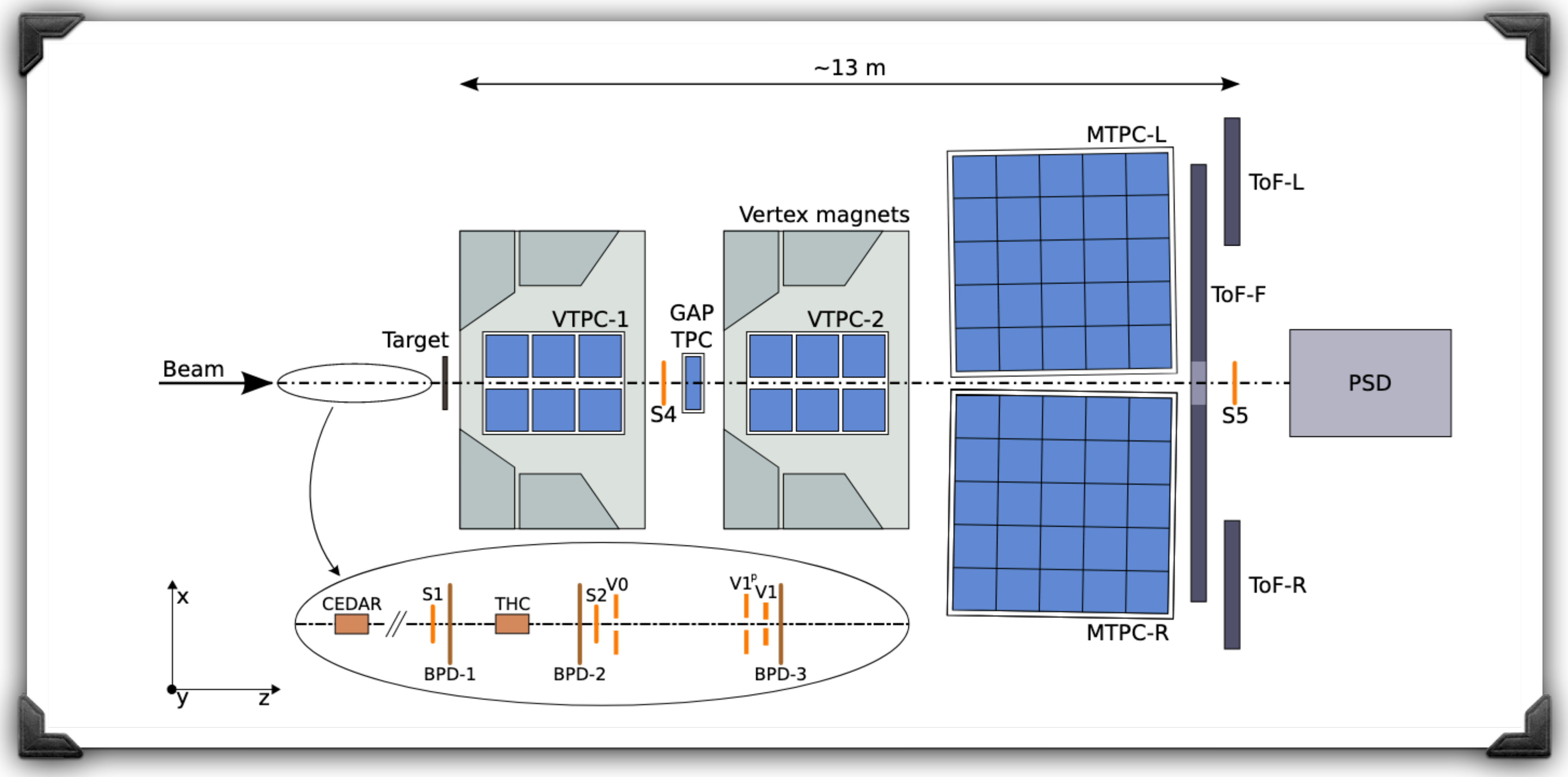




Separating events with clean tracks (signal) from events with incoherent multiple tracks / interactions (background) that potentially impacts charge sign or momentum resolution in the Transition Radiation Detector (TRD) using Convolutional Neural Networks

NA61/SHINE

- **S**PS **H**eavy **I**on and **N**eutrino **E**xperiment
- Fixed target collider capable of studying many types of collisions, e.g. p+p, k+C, Ar+Sc, Pb+Pb.
- Cosmic rays mostly consist of protons, in our goal of understanding dark matter decays we want to learn about the cosmic ray interaction background



- Femtoscopy: $p + p \to X + 2p$ may inform (anti)deuteron coalescence models by observing patterns in produced proton pairs
- Responsible for the gas system for Time Projection Chambers during data taking runs

BOBBY LYON - LYON42@HAWAII.EDU

Moritz Kunze, 21, from Hamburg, Germany

- DAAD Undergraduate Summer Research Intern
- Geant4 simulations of (anti-)deuterons at the NA61 LHT

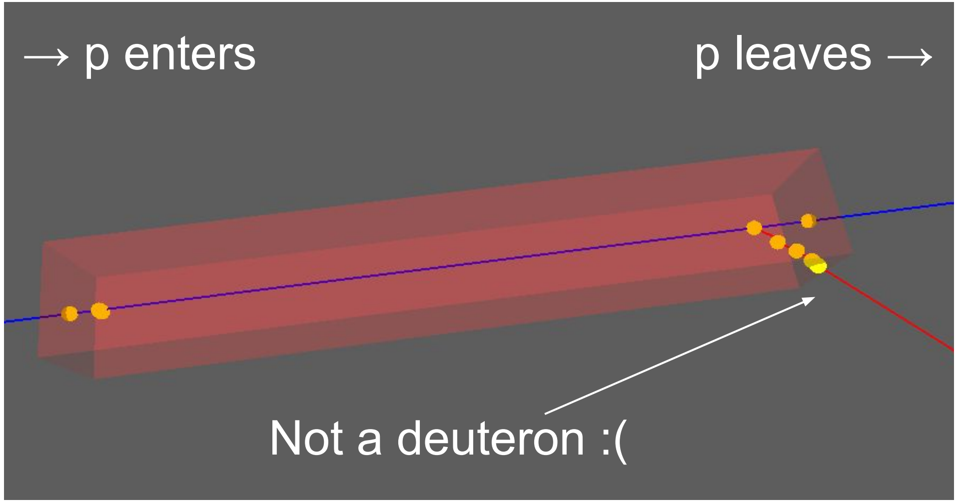
Geant4 = CERN simulation toolkit

NA61 = Fixed target protons at CERN

LHT = Liquid hydrogen target

pp-collision can produce $p, \bar{p}, n, \bar{n}$

Coalescence can produce d, $\bar{d}$

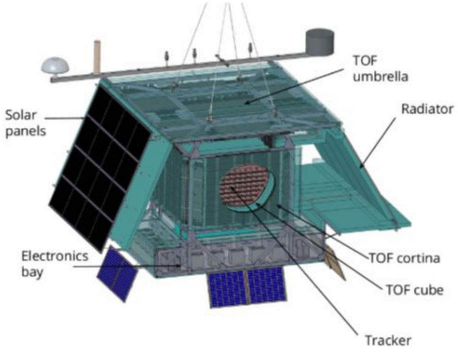


mkunze@hawaii.edu

Achim Stoessl

GAPS Junior researcher - Philip von Doettinchem

stoessl@hawaii.edu



GAPS - *General AntiParticle Spectrometer* Balloon experiment to study antinuclei in cosmic rays, smoking gun signal for dark matter.

2 Independent detector Systems

→ 160 TOF (*time of flight*) Scintillator paddles provides trigger
→ ~1k Si(Li) detectors for inner tracker

<u>Work at UH:</u>

→ UH has characterized ~40% of the Si(Li) detectors in the lab

→ Flight software for TOF written at UH

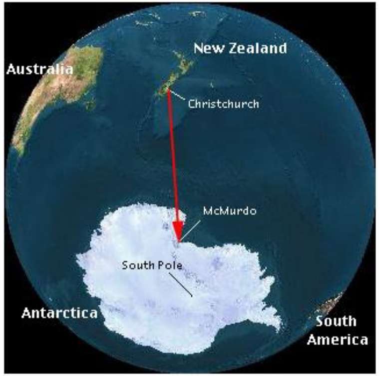
→ Taking part in operations efforts

→ Online data quality assessment

→ Simulation studies & analysis support

Grace Tytus: GAPS

UH Cosmic Ray Antiparticle Group
PI : Philip von Doetinchem
gtytus@hawaii.edu

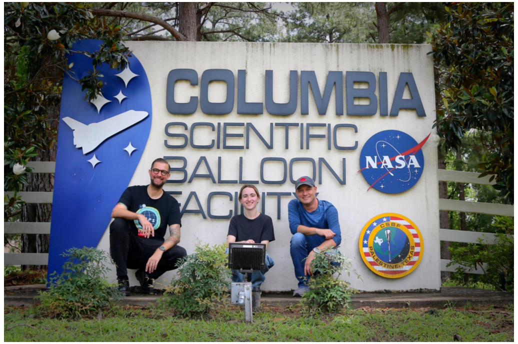


In the past year I have:

- learned to operate the GAPS Tof system
- written online software in rust which will be used to operate GAPS while it is in flight
- built electronic components which will be used in flight
- helped assemble, disassemble, and pack GAPS twice

I will be going to McMurdo Station, Antarctica from November 2024 - January 2025 to operate the GAPS Tof system during GAPS flight 1

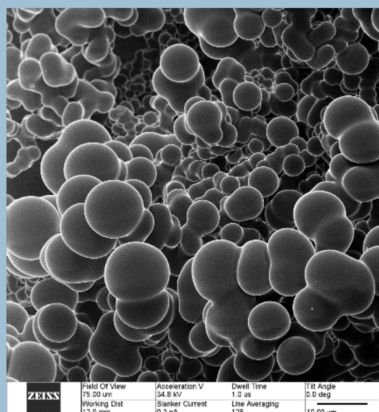
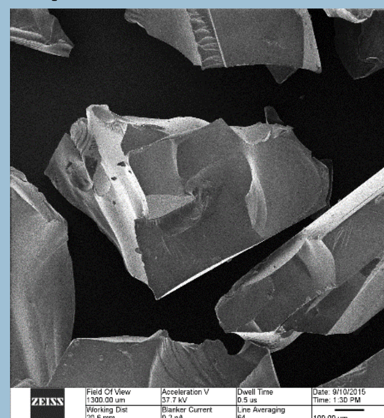
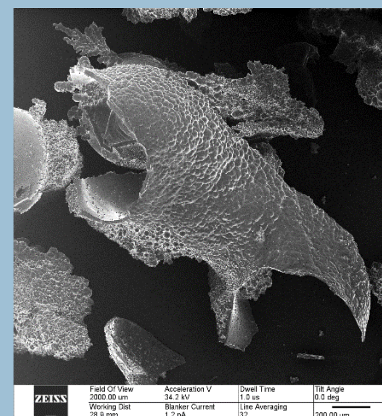
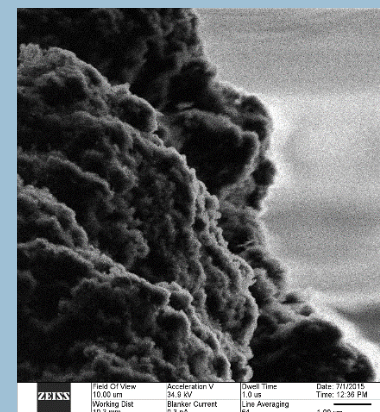
Upcoming analysis work on atmospheric deuteron backgrounds and searching for anti-deuterons in GAPS data post flight



Nanophysics Klaus Sattler sattler@hawaii.edu

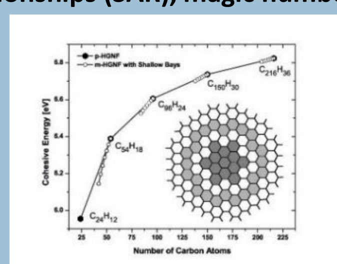
- **Production of New Exotic Carbon Nanomaterials**
- **Analytic methods used: SEM, TEM, HIM, XPS, Raman, FTIR, DLS**

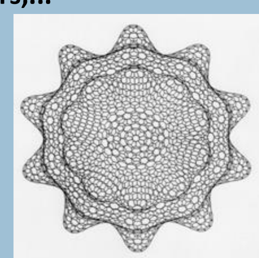
Microparticles, diamond-like particles, ‘weird’ tubular structures, nanofoam

Graphene Quantum Dots (Materials Design with the Computer)

- **Nanoflakes: Search for new types of 5-,6-,7- networks**
- **Determine structure-activity relationships (SAR), magic numbers,…**





Name: Jackson Seligman
Email: jdseligm@hawaii.edu

Interests:
-Neutrino Physics and BSM Physics
-Quantum Information
-Algebraic Topology

Goals:
-Experience as fulfilling PhD as possible with emphasis in both experimental and theoretical backgrounds

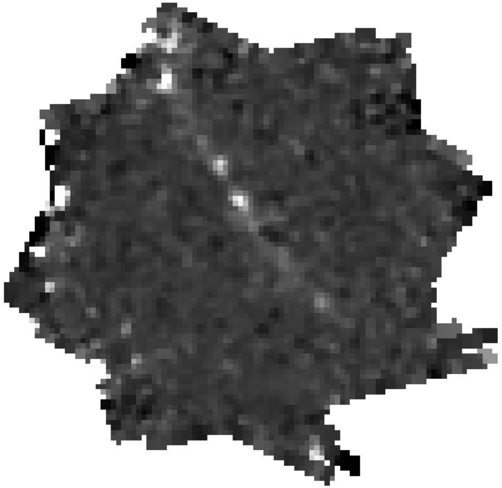
Group Projects:
FROST detector with Dr. Learned

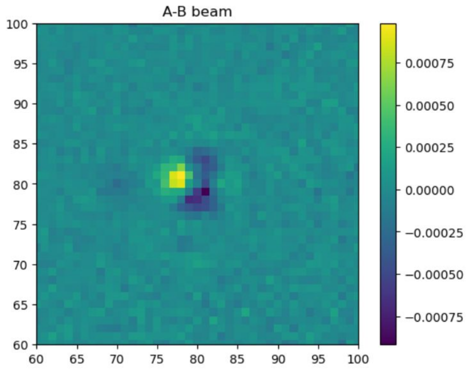
Looking for additional support in theory experience

Eli Meisel He/They

emeisel@hawaii.edu

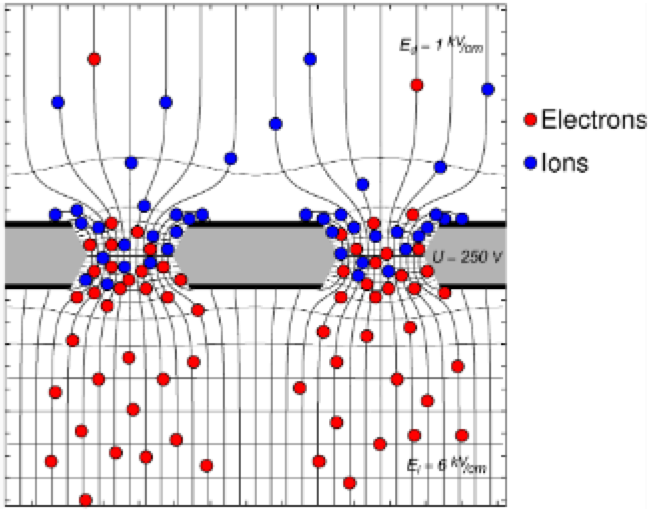
- Research interests:
  - Large scale observational astronomy
  - Galaxies/galaxy evolution
- Past projects:
  - Systematics on BICEP3 with projections to CMB-S4
    - using simulations
  - Modeling of a strongly lensed galaxy (SGAS 1723)
    - using JWST NIRSpec

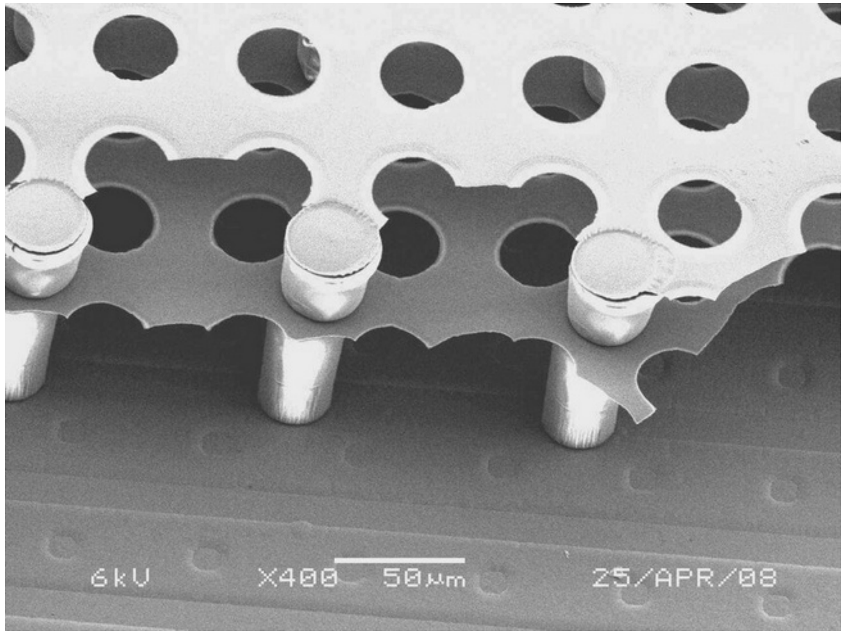




Reducing Ion Backflow in Gaseous Detectors

- When a signal is amplified, it creates an avalanche of electrons. For each new electron, there is also an Ion. These Ions travel backwards along the field lines into the gas of the detector (ion backflow)
- By creating a multi-layered mesh, we hope to reduce the ion backflow to less than one ion per an initial electron (Twingrid)





James E. Harrison IV
(jameseh4@hawaii.edu

Peter Lewis

S.T.E.A.M on the Bookshelf

First Year Results

Chad Junkermeier (Physics & Astronomy), Heather Greenwood (CTAHR Extension)

What: literacy-based family-engagement curriculum disseminated through preschool classrooms, includes art, experimentation, reading, writing

Purpose: teach students and parents introductory science concepts and vocabulary

2023-2024 Participants:

Classrooms = 15

Families = 213

Figure 1. Activities families participated in:

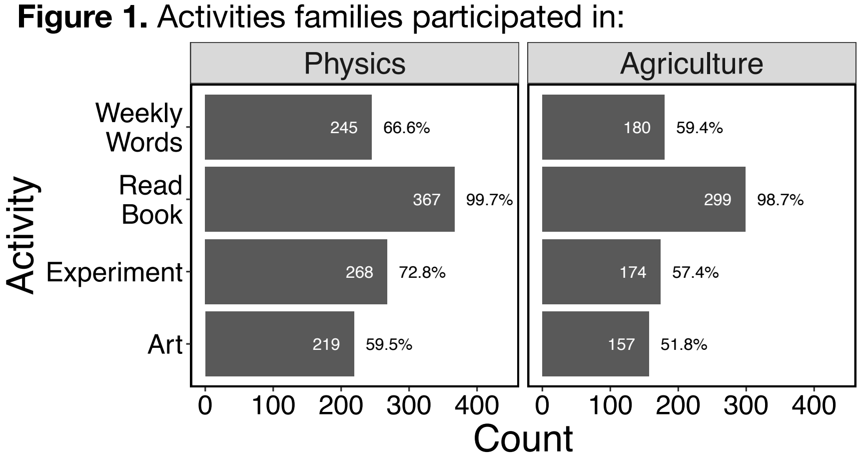


Figure 2. Vocabulary words parents heard children use:

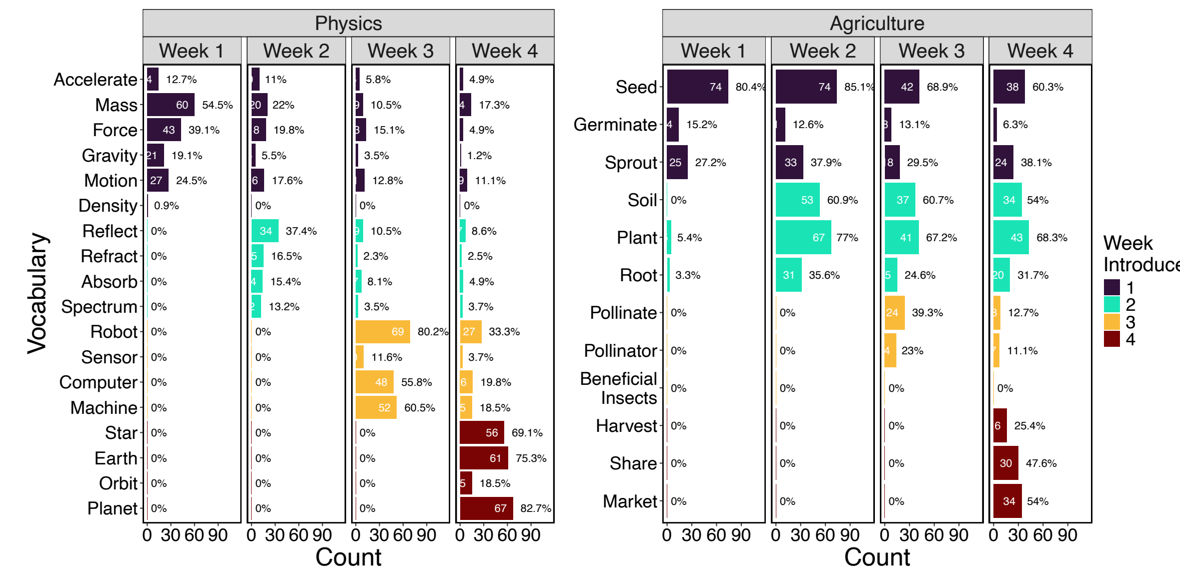
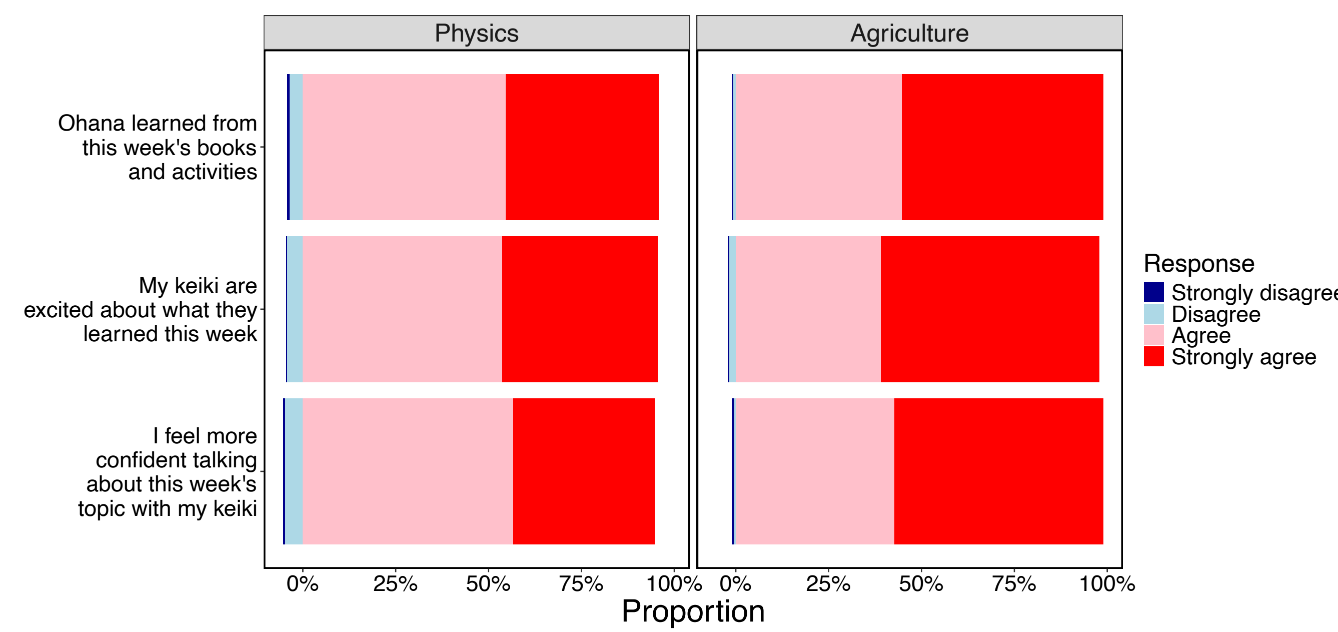


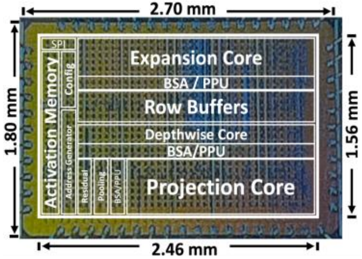
Figure 3. Parent's feelings about the curriculum:



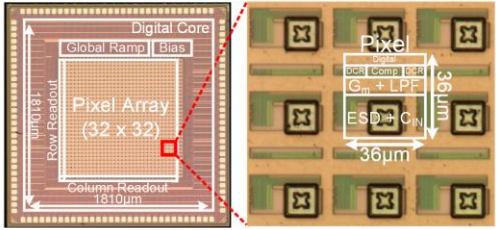
Parent comment: "They are learning advanced concepts in an easy to [understand] format."

junkerme@hawaii.edu

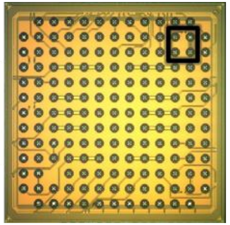
Boris Murmann: Research & Teaching in Mixed-Signal IC Design



Machine learning accelerators

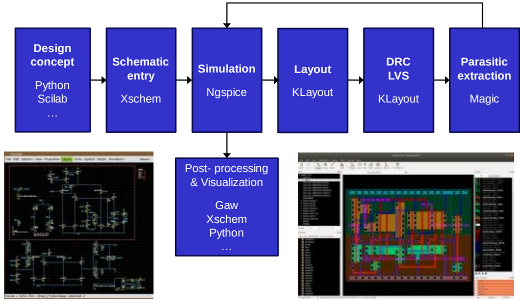


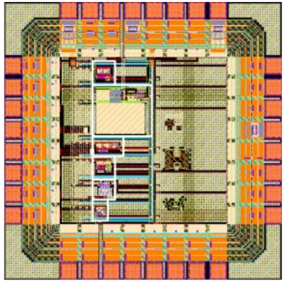
Biomedical interface circuits



High-speed data conversion

ECE 628: Design & Tape Out Your Own Chip!





bmurmann@hawaii.edu

https://github.com/bmurmann/EE628

IHP 130nm + SiGe

Jason Kumar

HEP theory group, jkumar@hawaii.edu

- I mostly work on *dark matter* theory
  - with students Taylor Herbert, Katharena Christy
- since the 1930's, astronomical evidence has suggested that most of the mass in the universe (~85%) is of a type different than found here
  - dark matter ... doesn't interact (much) with light
  - the idea I focus on → it is a *new particle*

Sculptor, believed to be a dark matter-dominated dwarf galaxy

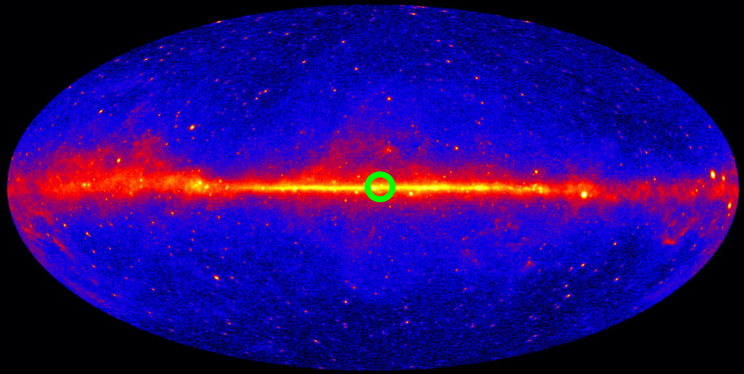
- my work mostly focused on two prongs
  - developing new models for what dark matter could be, and
  - developing new ways of testing with experiments
- this field has great overlap between theory, experiment and observation, and between cosmology, particle physics and astrophysics

Kat Christy

(chri3448@hawaii.edu)

- Indirect dark matter detection
- Dark matter may annihilate or decay into standard model particles, creating a gamma-ray flux
- Signal could be significant where DM is dense: dwarf galaxies, galactic centers, subhalos, etc
- Developing likelihood free inference (LFI), and simulation tools to study:

Galactic center gamma-ray excess



Dark Matter?
Unresolved MSPs?

Fermi (LAT)

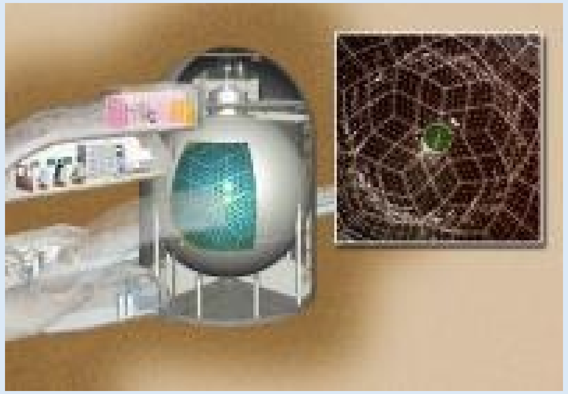
One Minute Colloquia UHPhysics 9/19/2024: **Professor John Gregory Learned**

personal academic highlight of year:

April 2024 @UCI 3 day celebration of Yodh Prize award for

starting neutrino astronomy

(DUMAND Project at UH)



KamLAND

1 kt scintillator

Continuing active membership in **KamLAND** and **SuperKamiokande** major neutrino projects in Japan (collaborator Prof. Jelena Maricic)

Awaiting the next galactic supernova (few / century : last was 2/23/1987):
SN1987A first recorded in Kamioka and Ohio in our detectors

Present Local neutrino projects NuLat and FROST: More talks here from **Brian Crow, Max Dornfest, Gabe Yepez, and Jackson Seligman**

SuperKAMIOKANDE

10 kt water

Nobel in 2015

FROST: Forest of Scintillating Glass Tubes

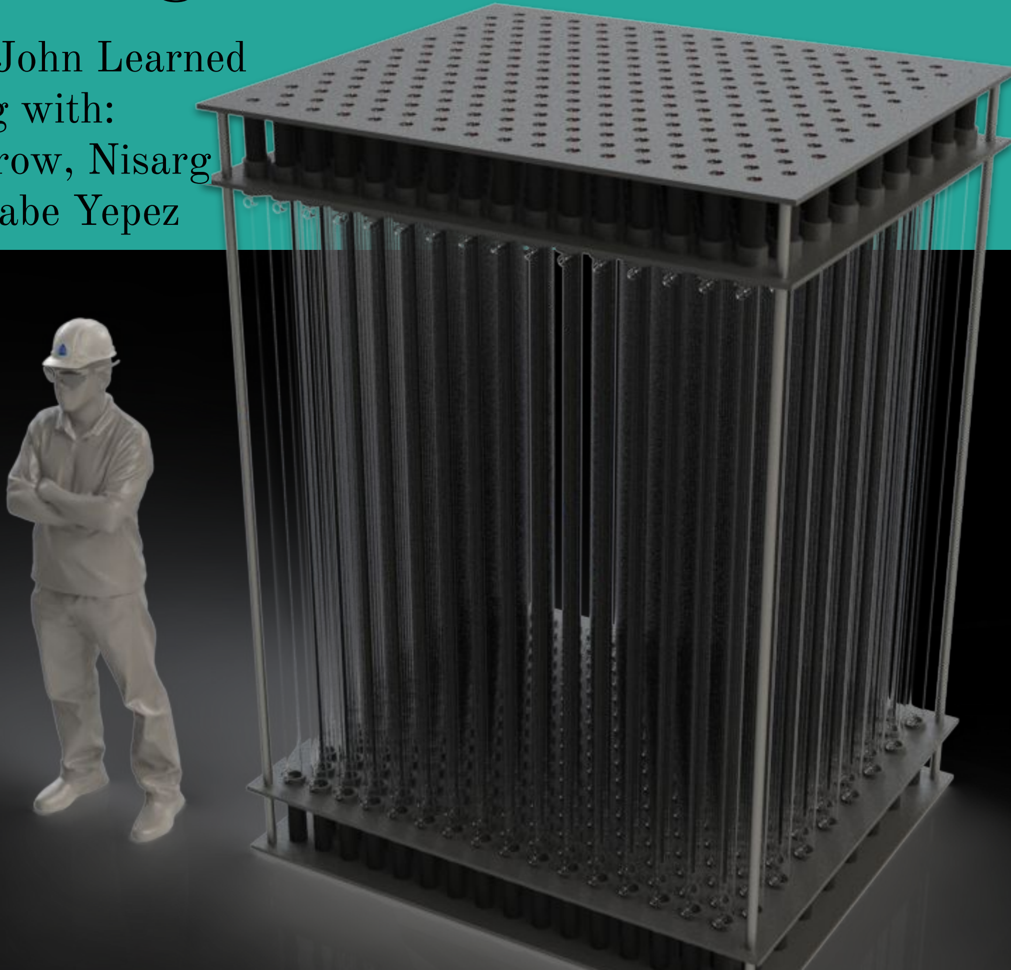
Max Asa Albert Dornfest
Fourth year Physics Ph.D. student
Email: Dornfest@Hawaii.edu

PI: Dr. John Learned
Working with:
Brian Crow, Nisarg Patel, Gabe Yepez

Purpose: Observing nuclear reactors from afar for **nuclear non-proliferation**

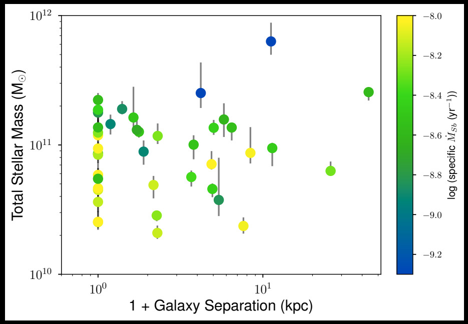
Principle of operation: Observe anti neutrino interaction in one tube and outgoing neutron direction and energy from another tube in the forest.

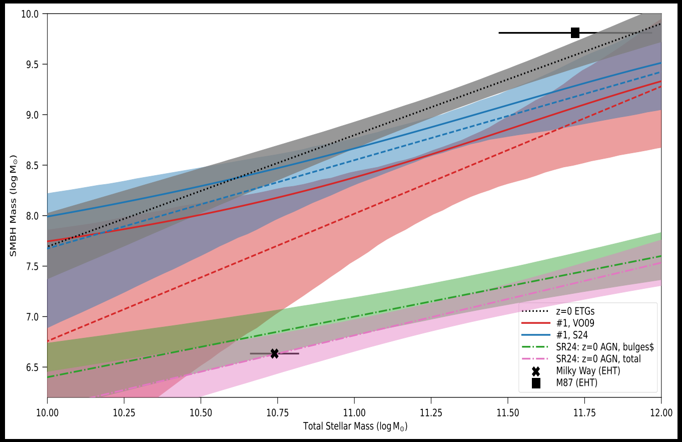
FROST-TEA: Thousands of modular vertical quartz tubes ~3cm diameter filled with organic scintillator and PMTs at the ends.



Duncan Farrah (dfarrah@hawaii.edu)

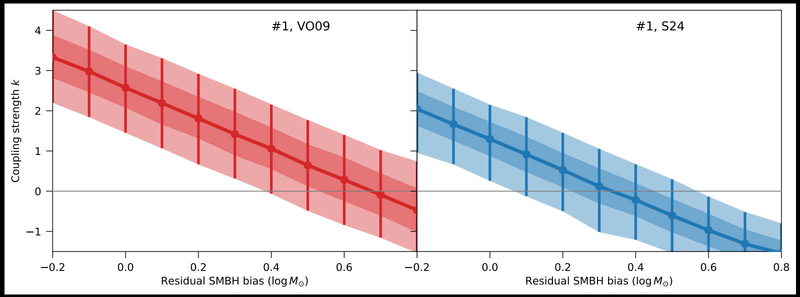
What powers active galaxies at low and high redshift?





Galaxy assembly from scaling relations

Cosmologically coupled black holes and Dark Energy



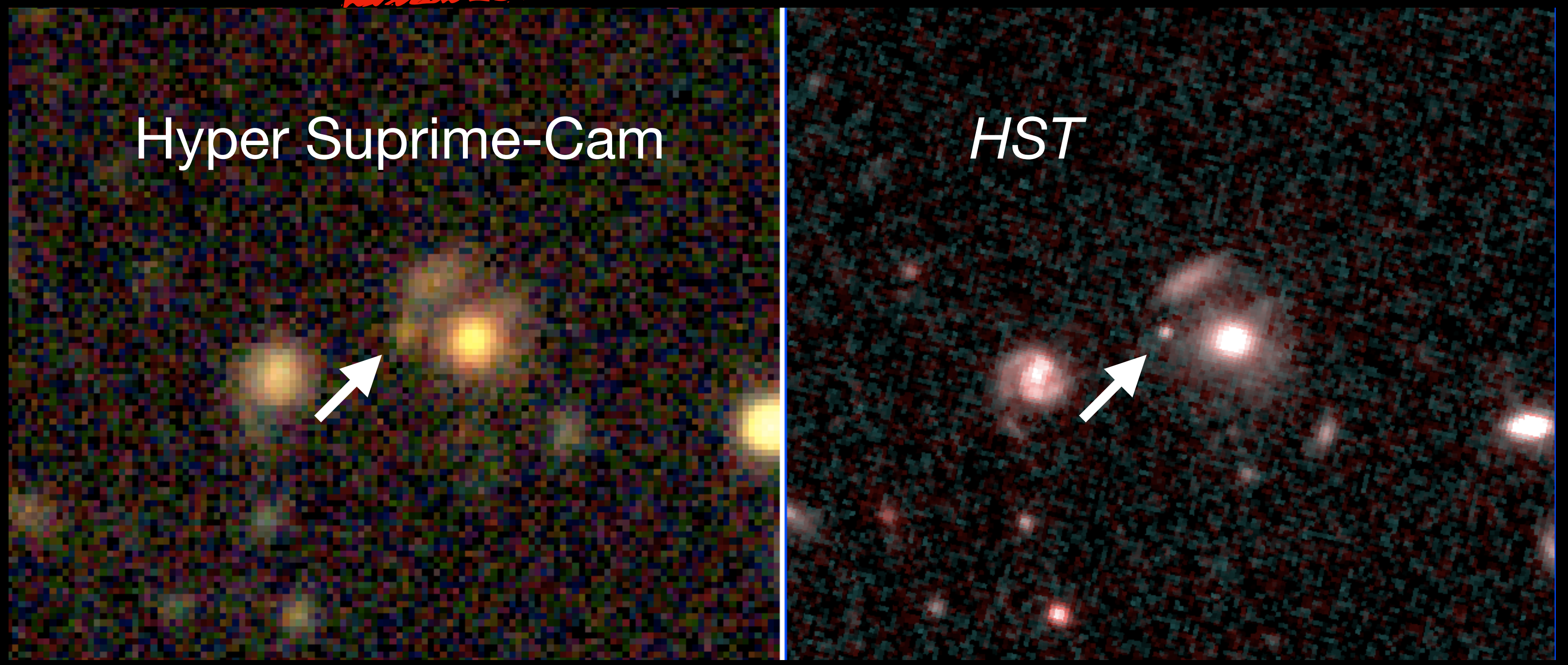
David Rubin: Observational Cosmology

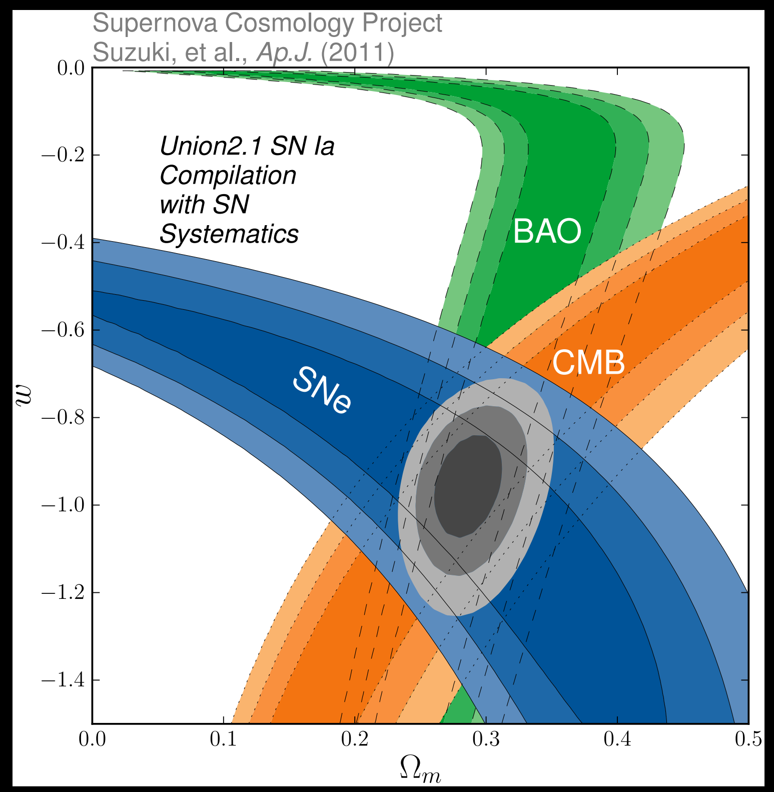
drubin@hawaii.edu

Now Hiring!

Cosmology Surveys

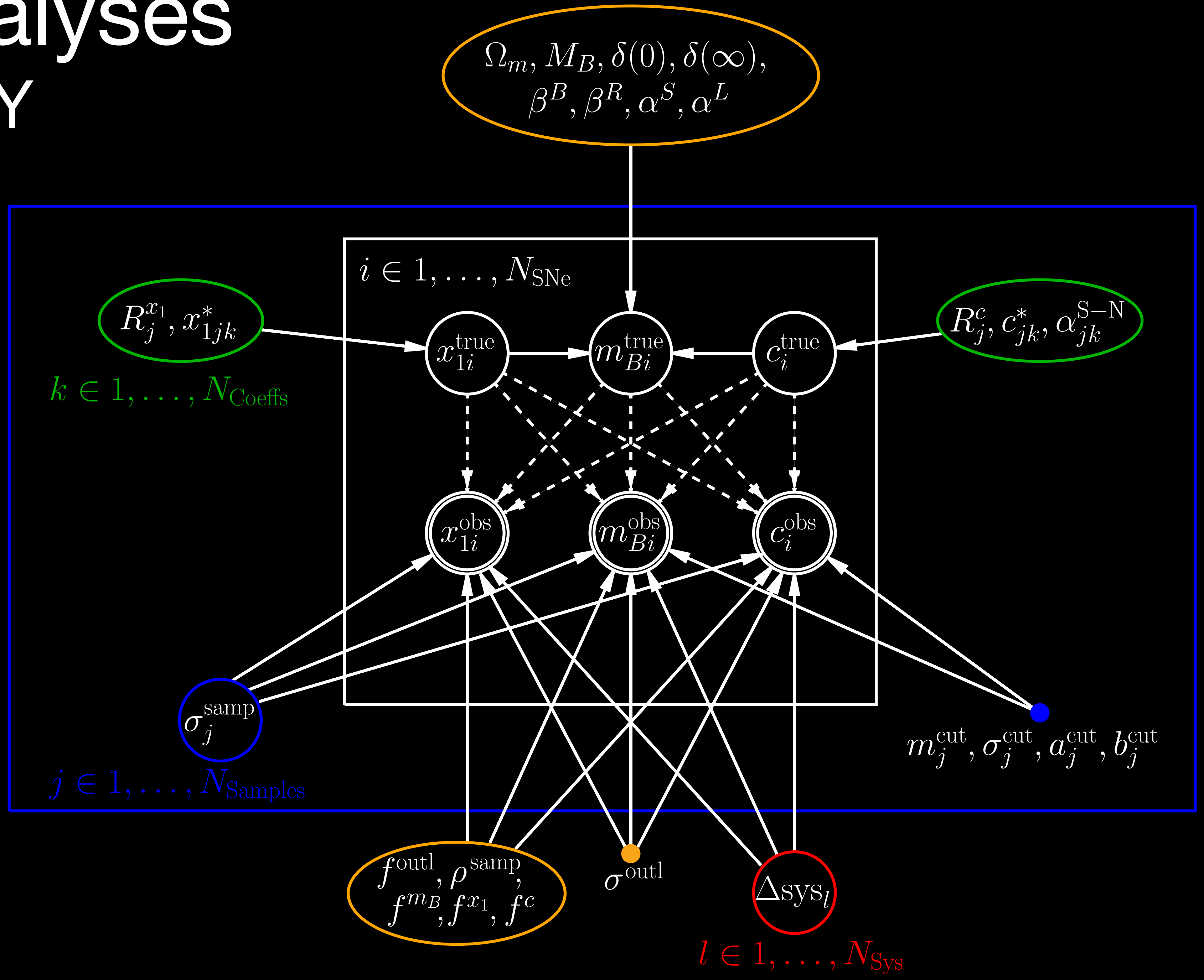
- Measuring gravity and dark energy
- Cosmology with the *Nancy Grace Roman Space Telescope*
- SUbaru Supernovae with *Hubble* Infrared, (SUSHI)
- Nearby SN surveys with the 2.2m, UKIRT, VYSOS, IRTF, and others





SN Standardization and Cosmology Analyses

- Unified Nonlinear Inference for Type Ia cosmologY
- Twin SN Statistics
- Machine Learning
- Union Cosmology Analyses
- Hubble constant measurements
- Blinded analyses



Calibration

- Photometry methods
- Calibration methods
- White-dwarf observations
- Flux scale