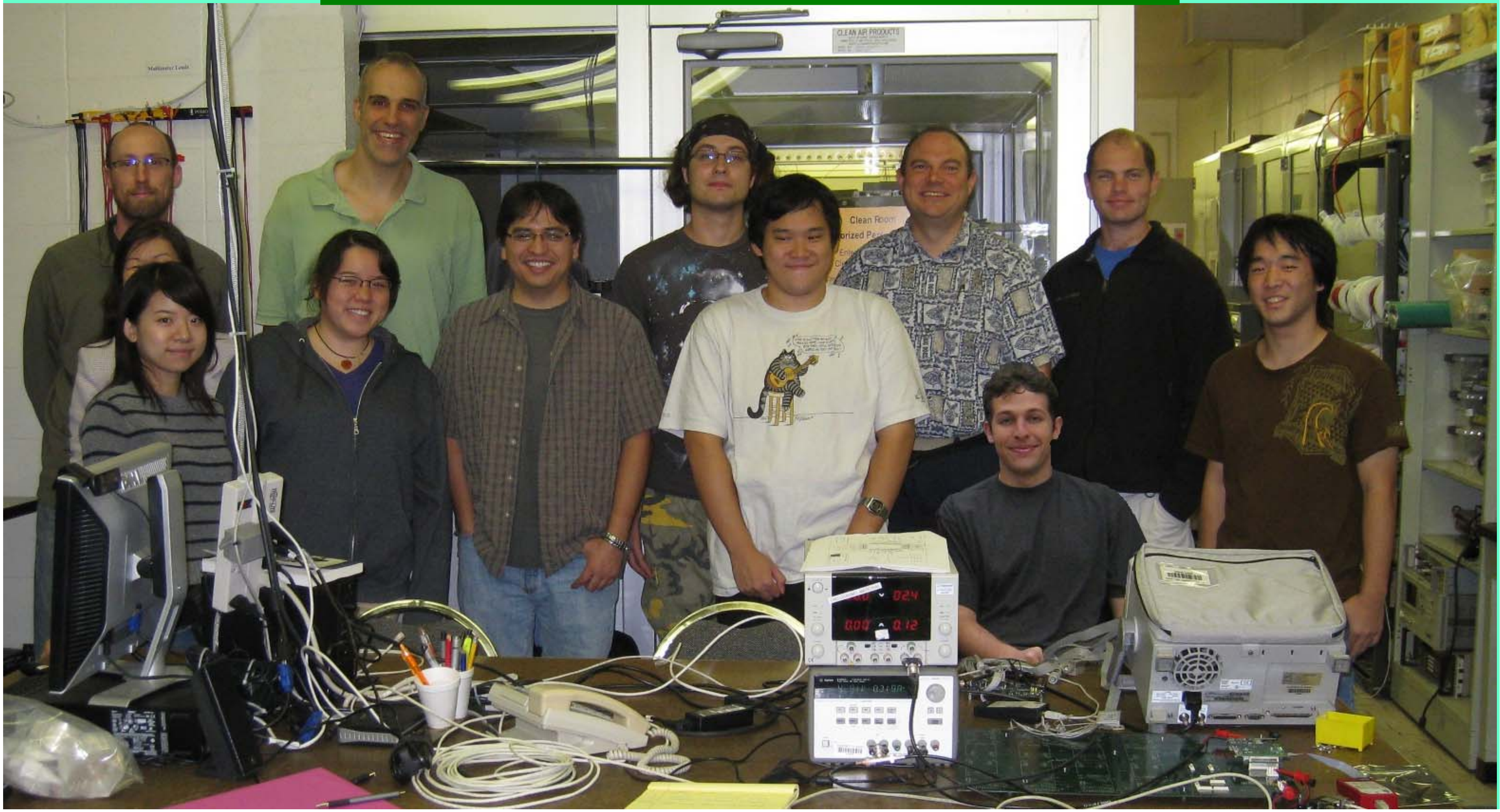
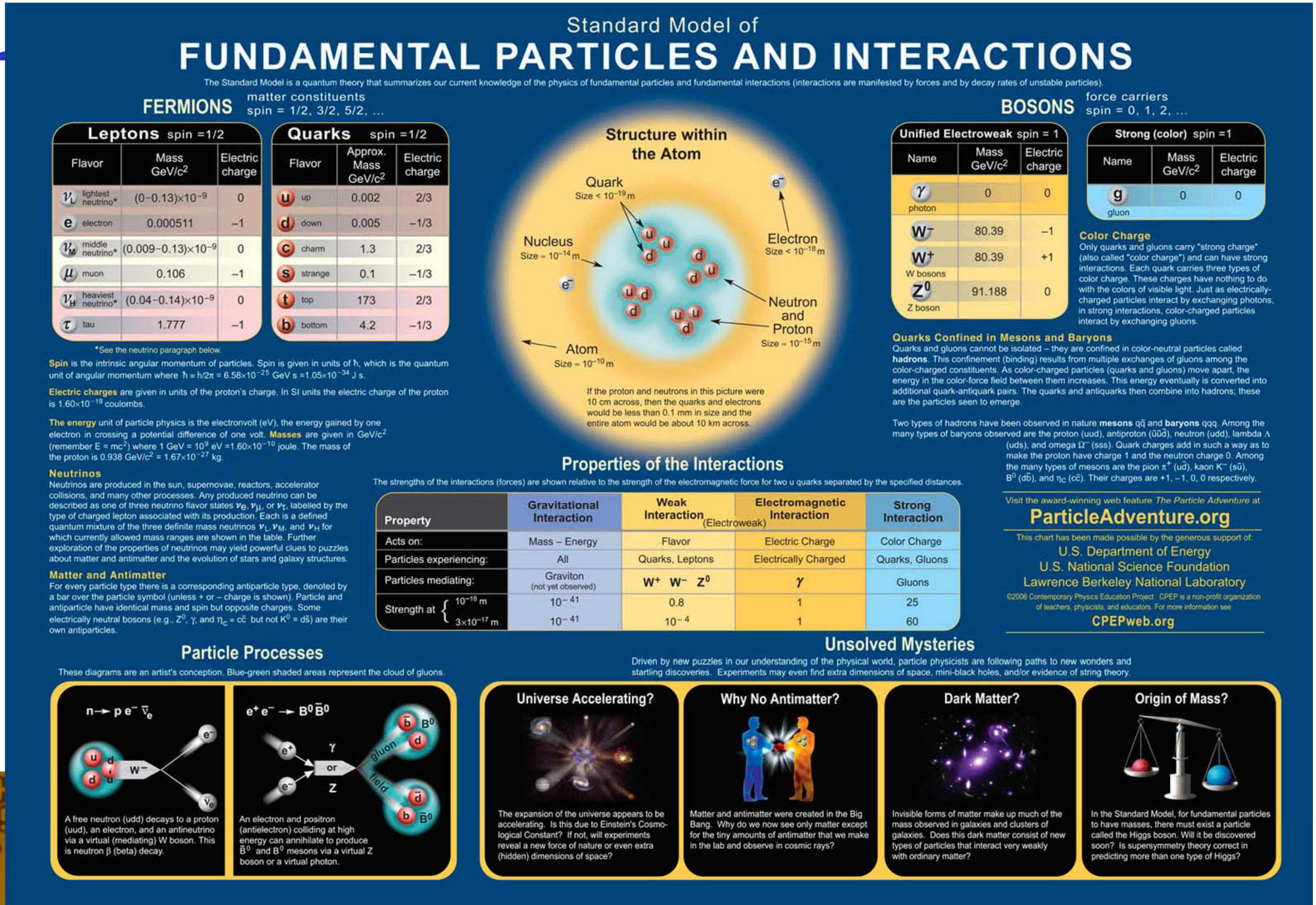
Spring 2011
State of the
ID Lab and Party

May, 2011

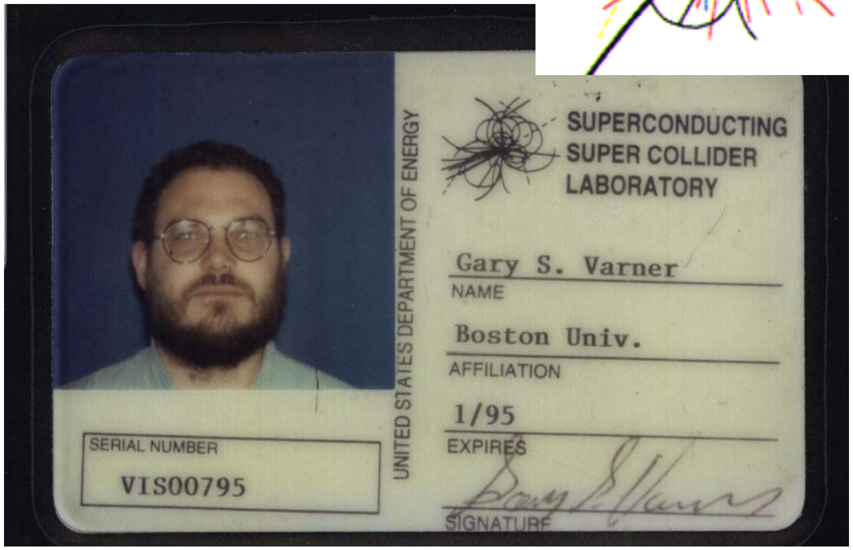


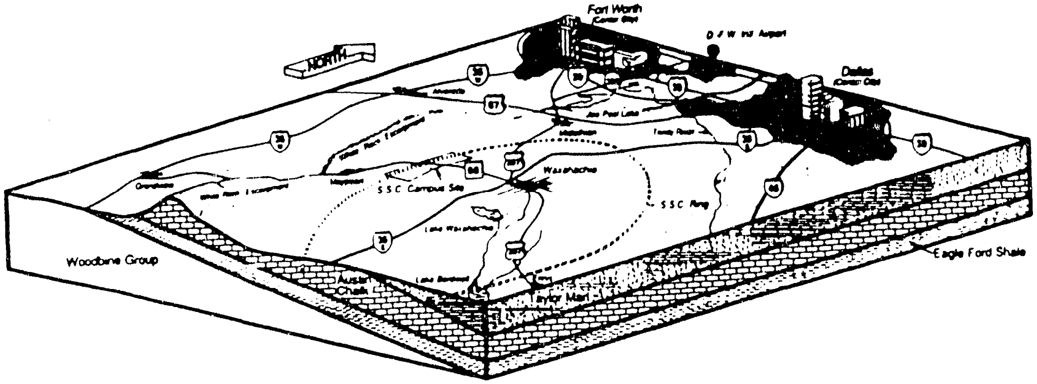
Why are we here??



~ 20 years ago today…

- Very ambitious…



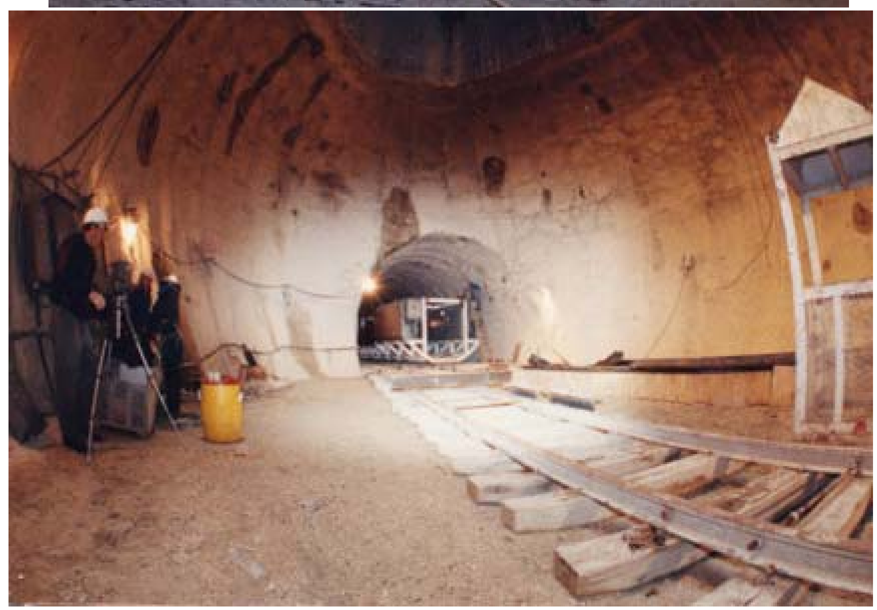


- 40TeV vs 14 TeV (LHC)

Crash and Burn

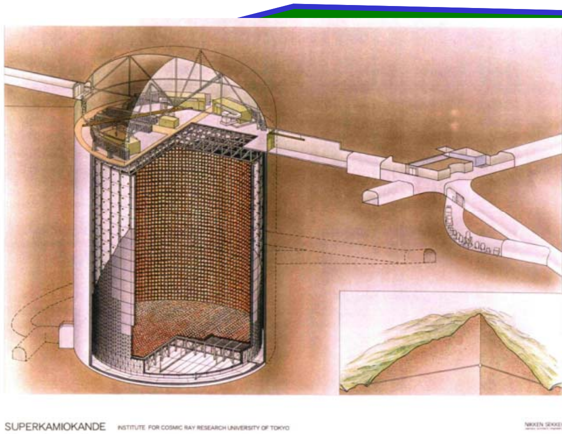
- $2B, 14.6 mi tunnel, Space Station instead

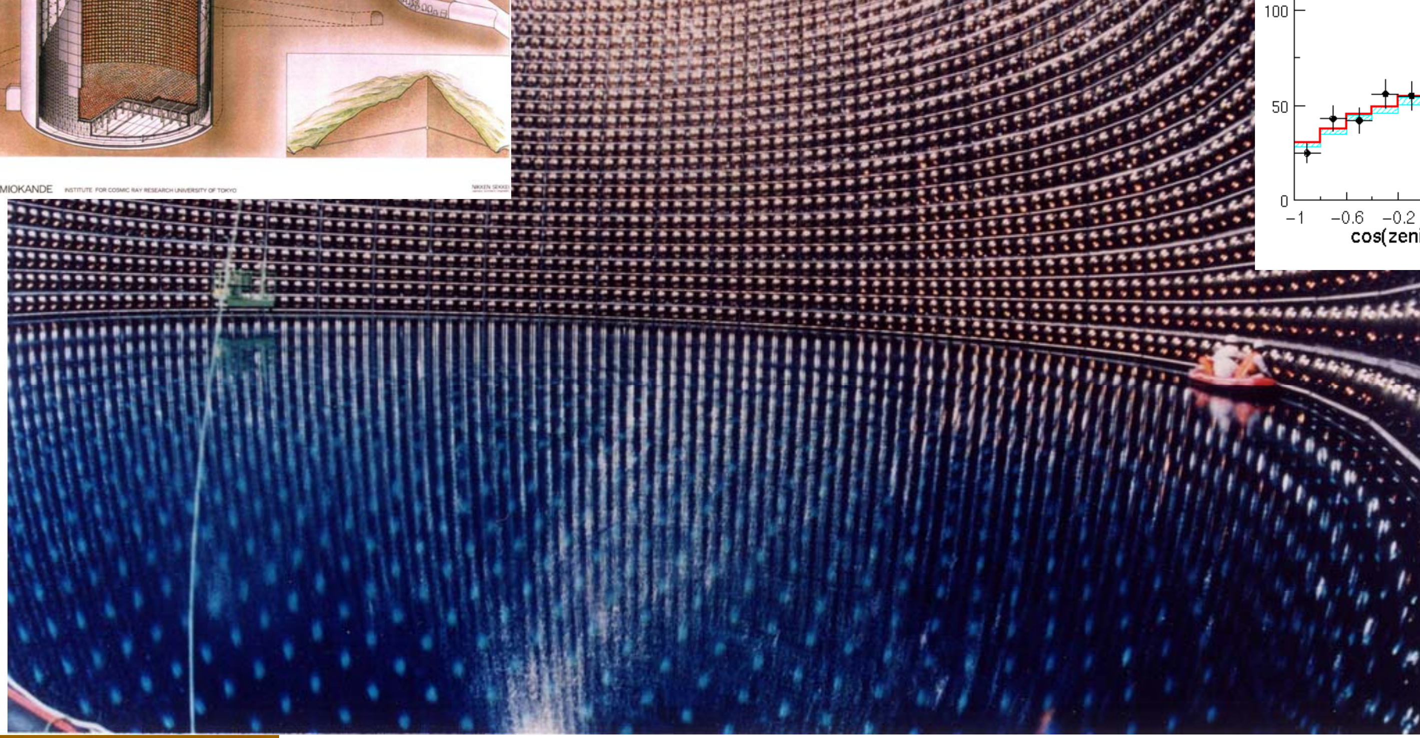
Central Facility

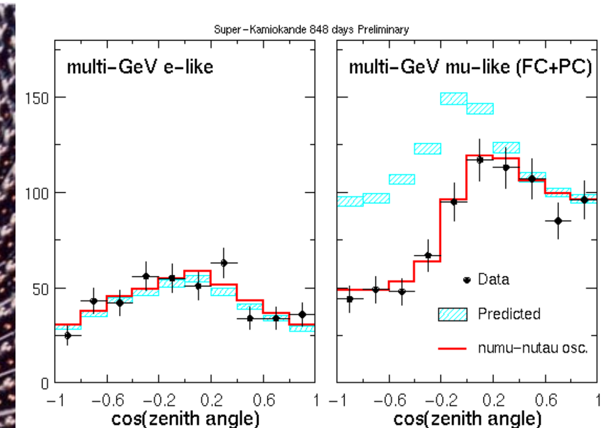


- Perhaps AMS will do science …

Sadly, in last 2 decades…







Neutrinos have mass!!

The field has stagnated… if had stayed on ATLAS…

→ Need "disruptive" new measurements

We need you! (for new measurements)

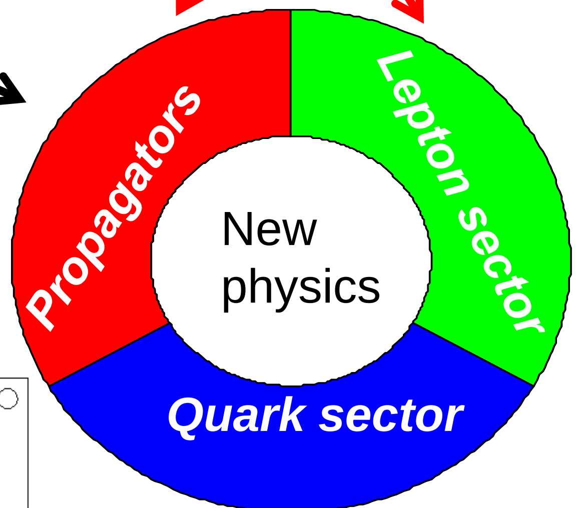
LHC, ILC

Higgs boson mass and couplings. New particle searches

UHE neutrinos

ν expts accel, reactor, g_μ-2, $\mu \rightarrow e\gamma$, etc.

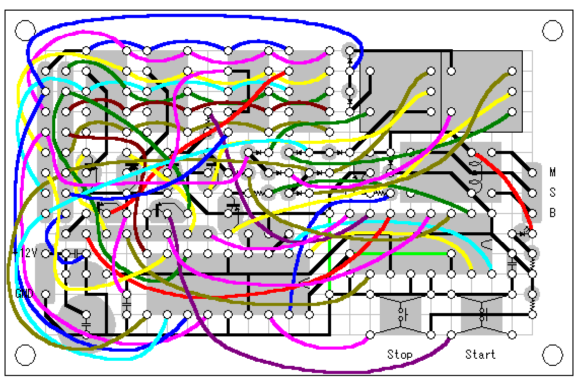
ν mass and mixing, CPV, and LFV



τ LFV,
τ CPV

Flavor mixing, CPV phases

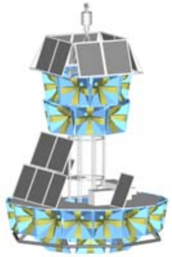
Super B Factory, LHCb, BESIII, Rare *K* expts



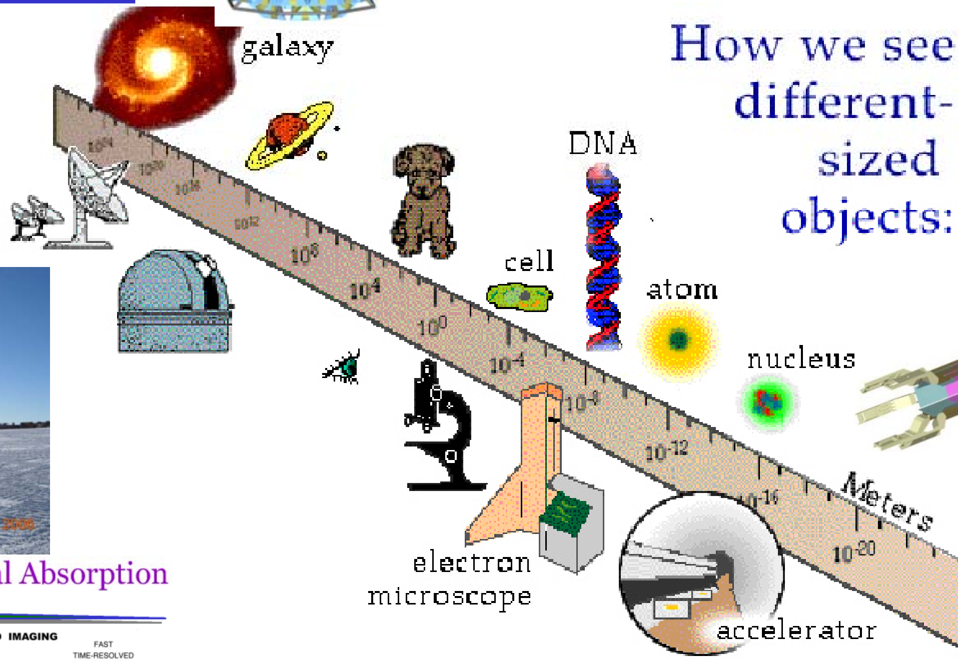
Big and Small

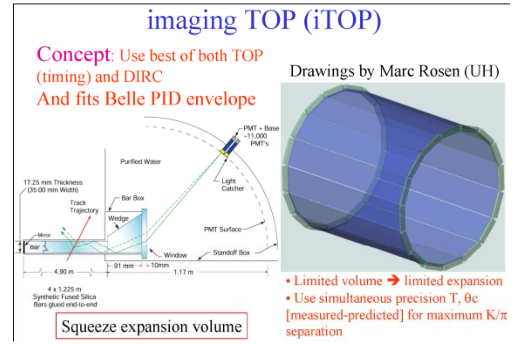
ANITA

AMBER



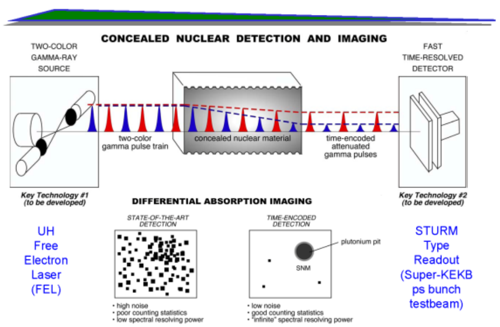
How we see different-sized objects:



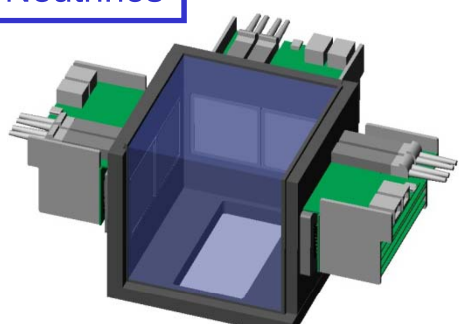


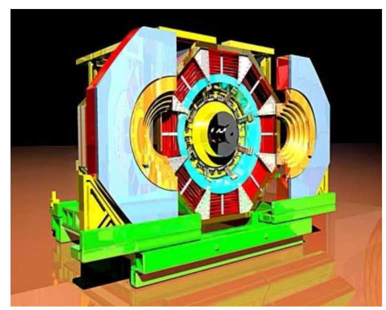
BELLE

Time-Encoded Differential Absorption

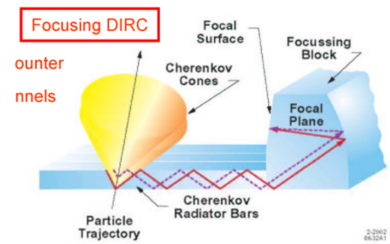


Neutrinos

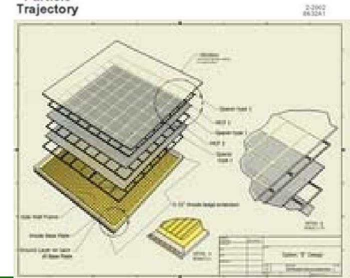




BESIII

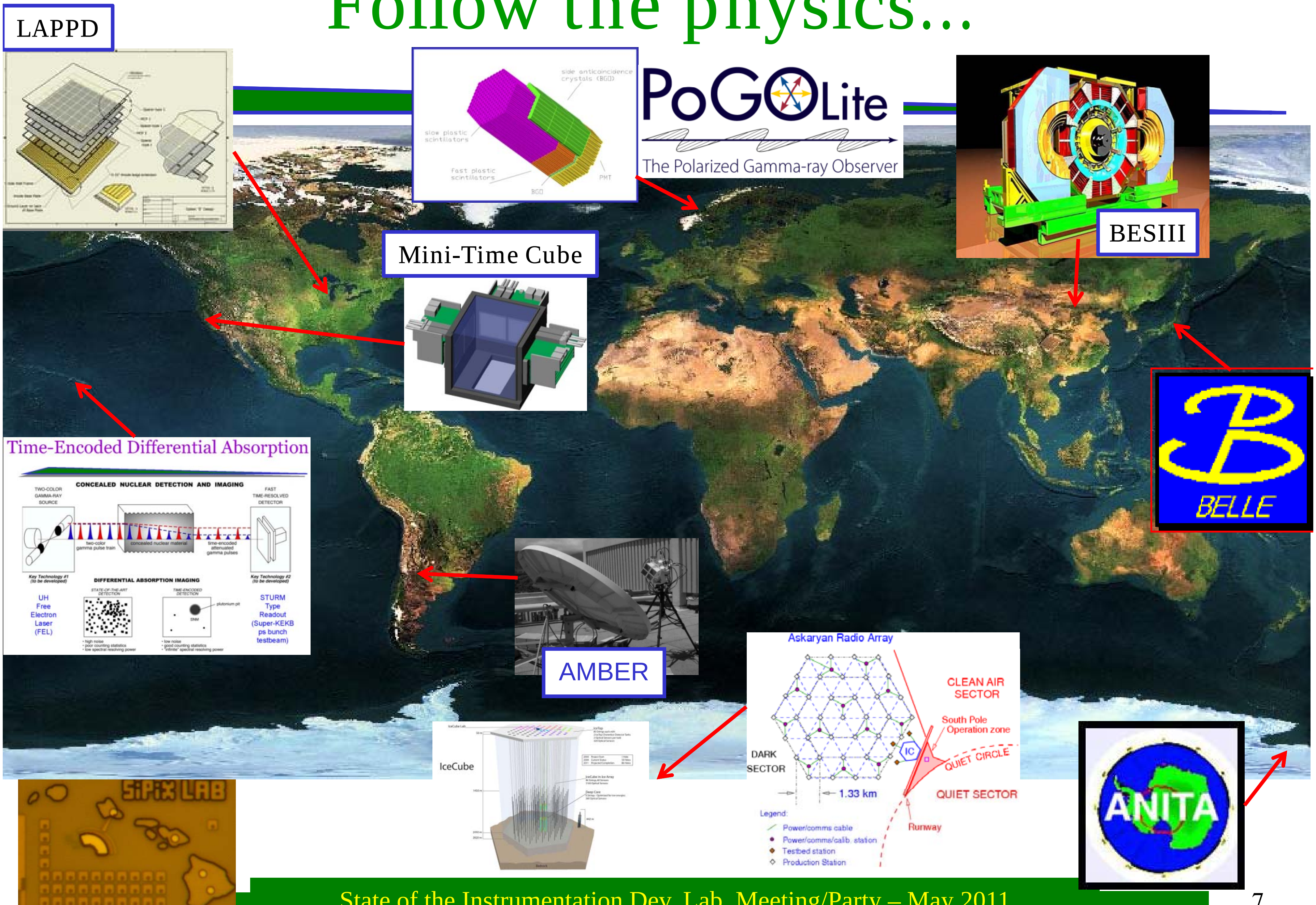


LAPPD→



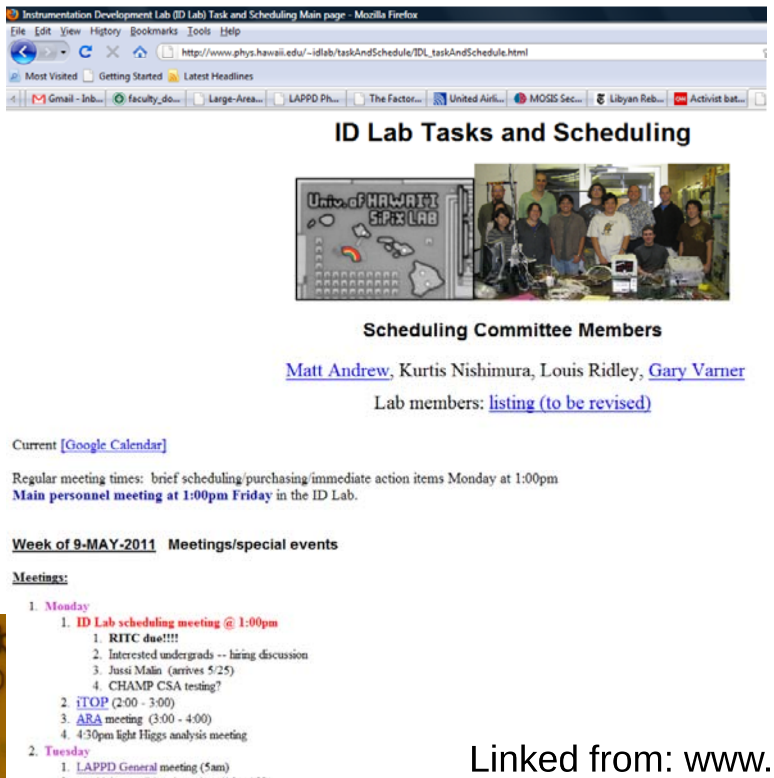
We (you) are doing world-class research here

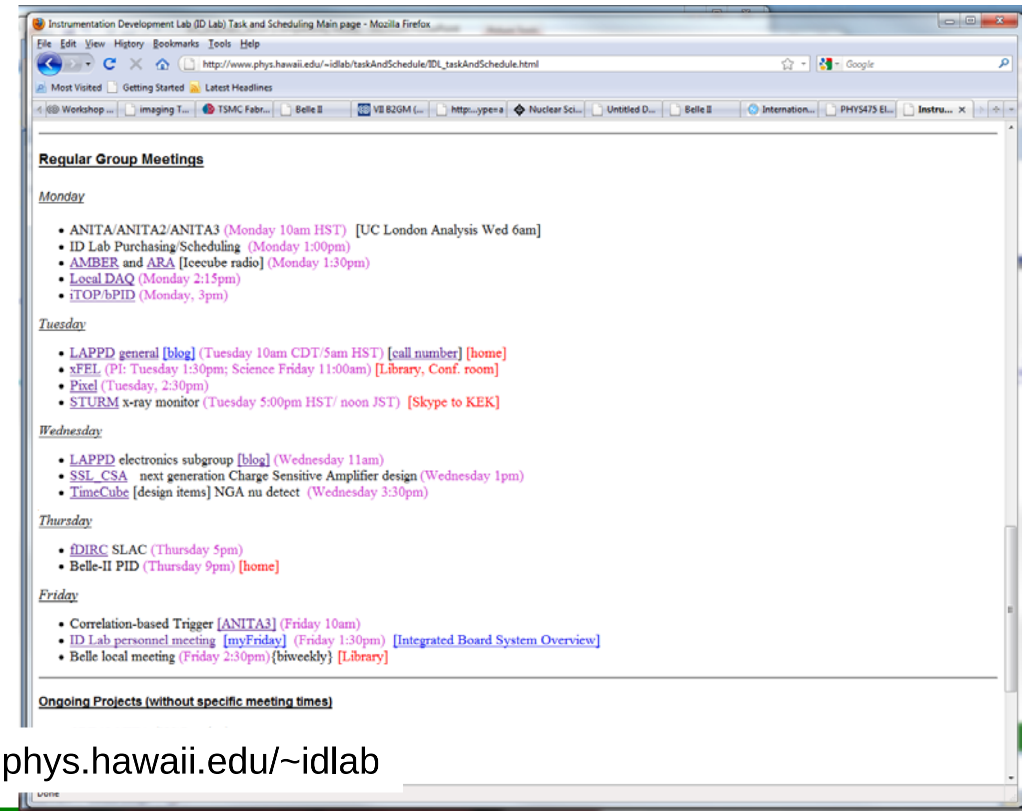
Follow the physics…



From South to north -- a very big year

- Hopeless to cover everything
- Just a brief overview of each project
- For further detailed information, 2 new websites:





Linked from: www.phys.hawaii.edu/~idlab

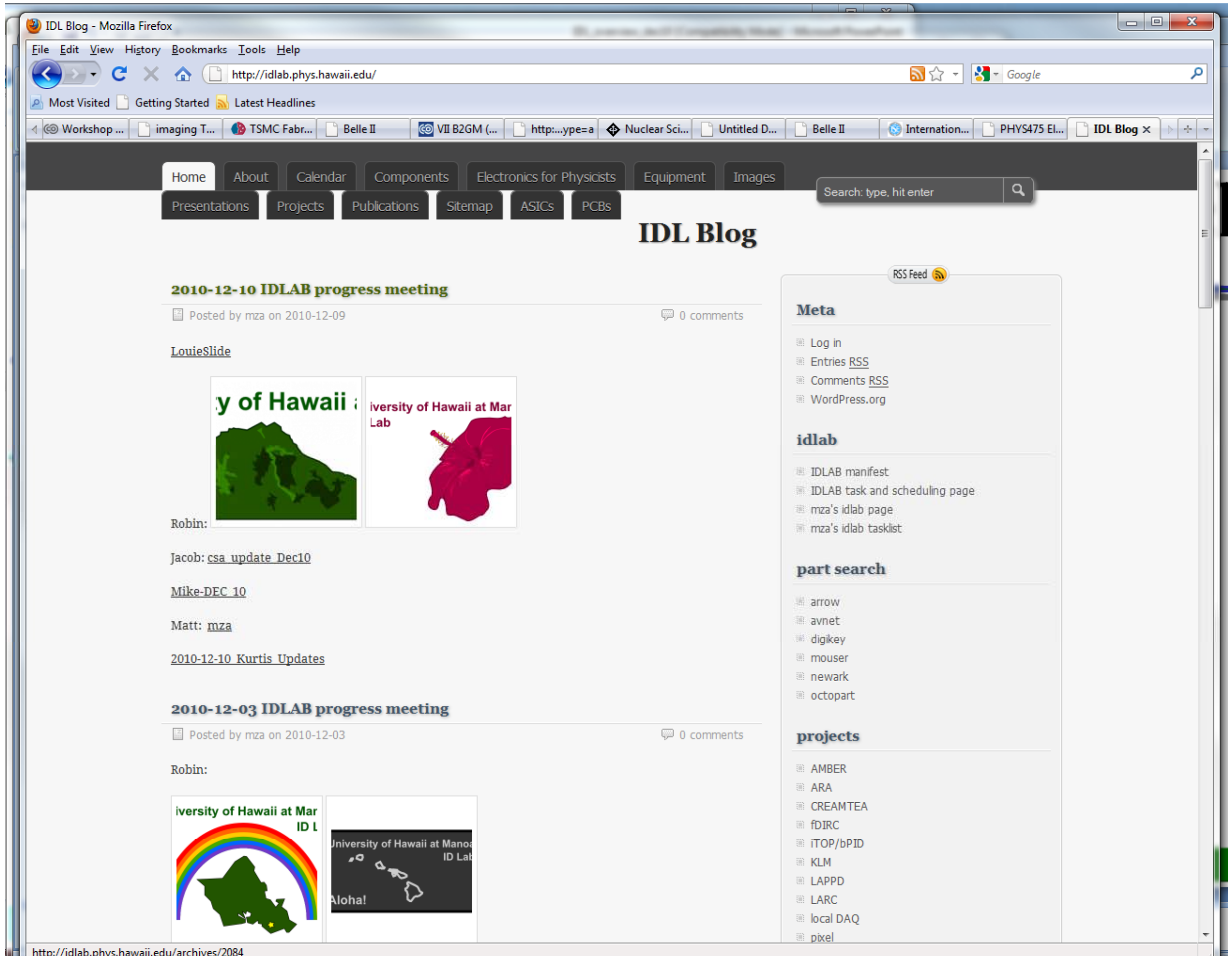
Trying to keep track…

- idlab.phys.hawaii.edu

>>50 active circuit board designs

~15 active ASICs (chips)

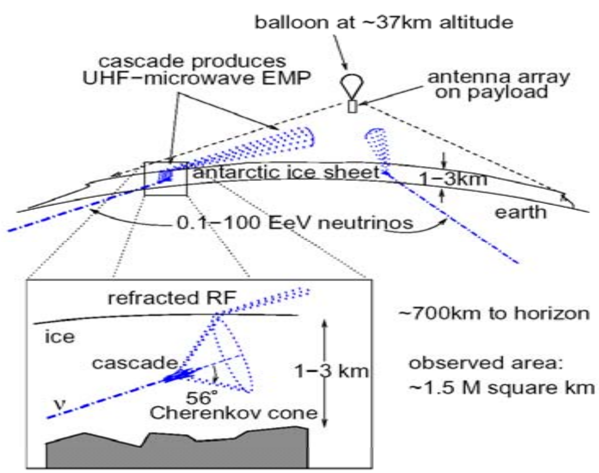
Huge number of design details, components, firmware, software

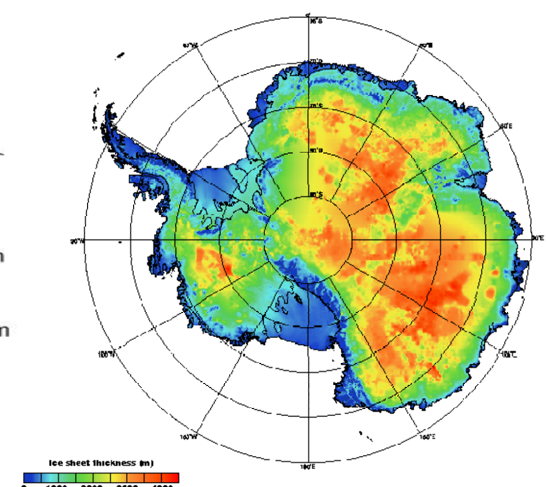


ANITA3

Physics Goals

- Discovery experiment for "BZ" neutrinos, created by the so-called GZK process
- Uses the entire Antarctic continent as a detector!
- Best near-term chance to observe neutrinos from earliest universe
- 3rd (final) flight in December 2013

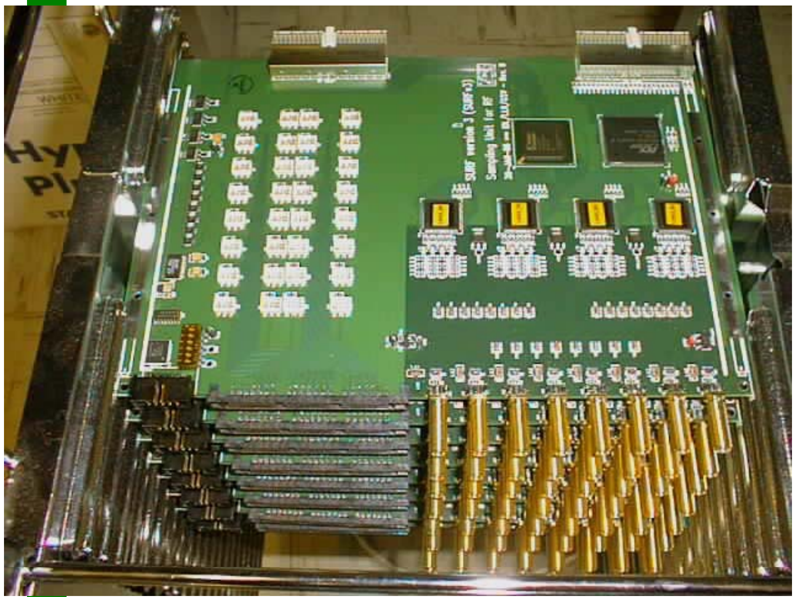




Univ. of HAWAI'I SiPix LAB

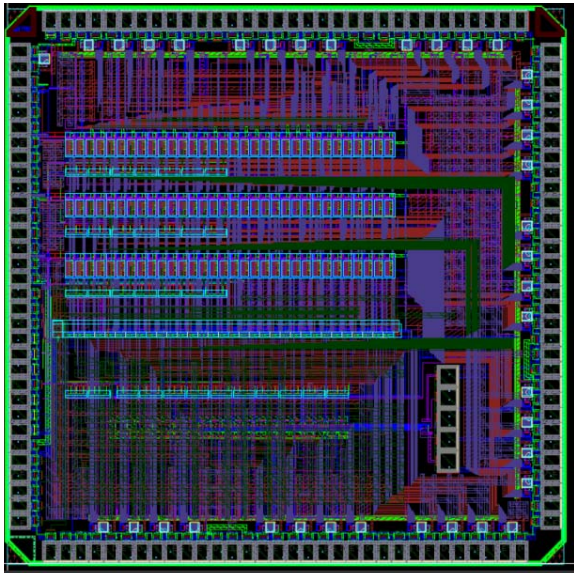
ANITA3 – ID Lab

New SURF & TURF

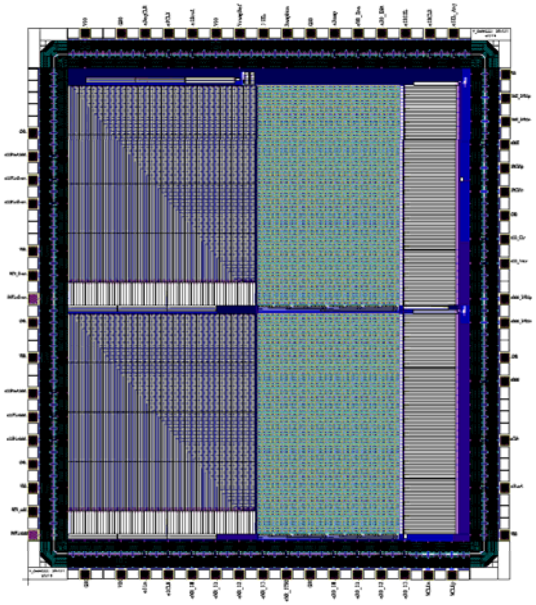


Our Developments

- Rebuild "space flight" readout instrumentation (half a decade old technology)
- Threshold limited – new trigger ASIC (RITC)
- New digitizer (LAB4) to go to longer waveforms
- "going for broke" – ARA is successor

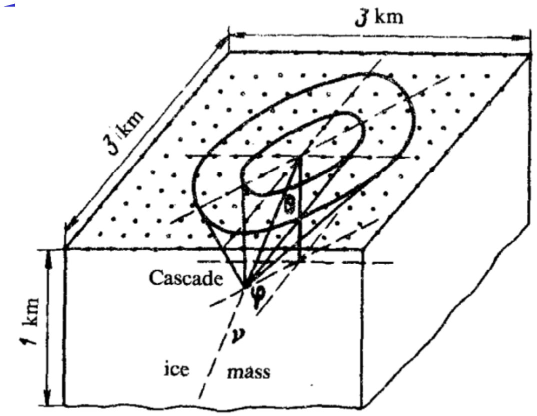


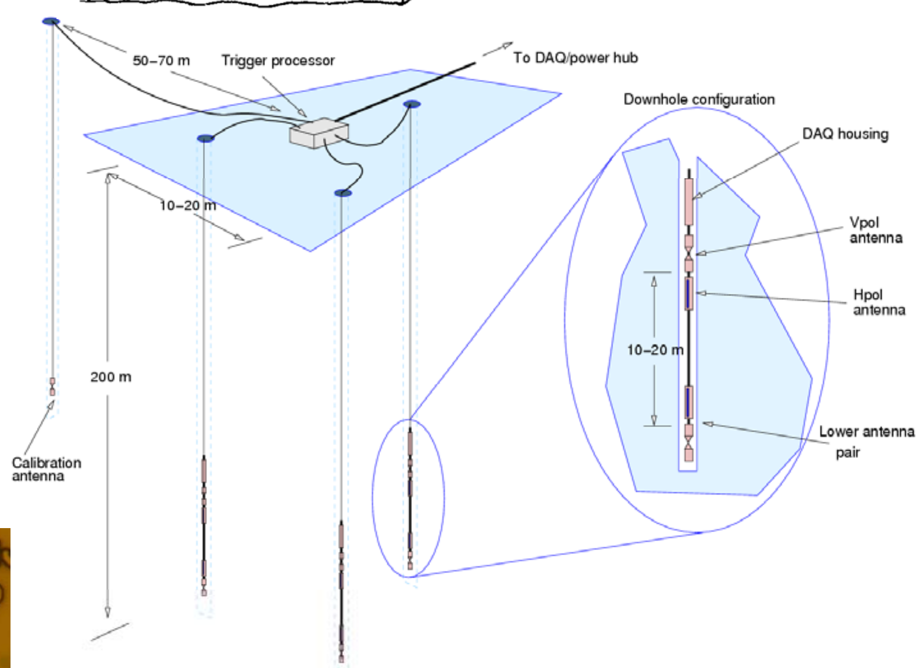
RITC



LAB4

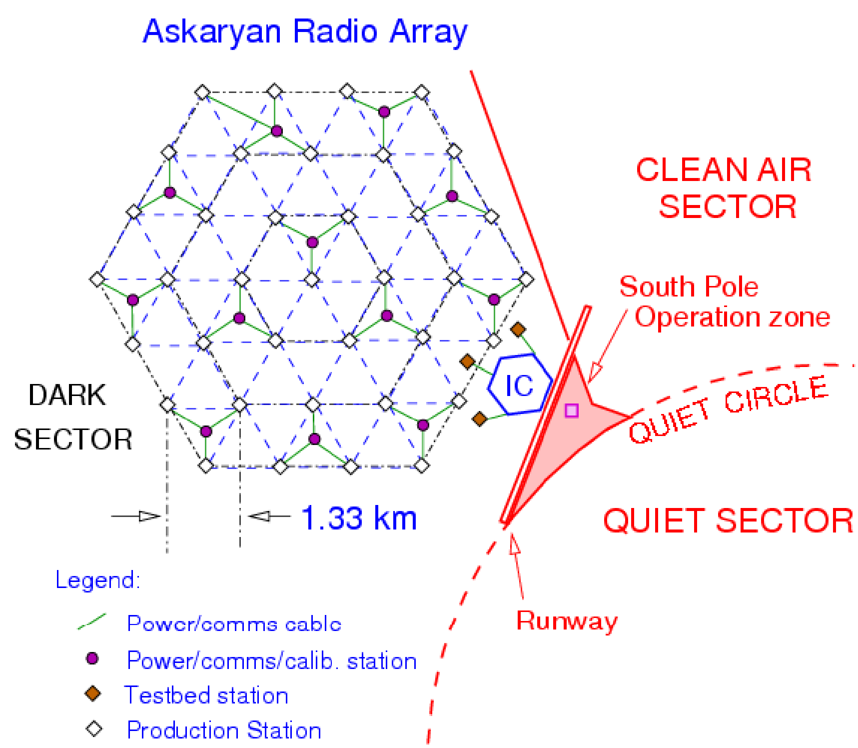
Askaryan Radio Array (ARA)





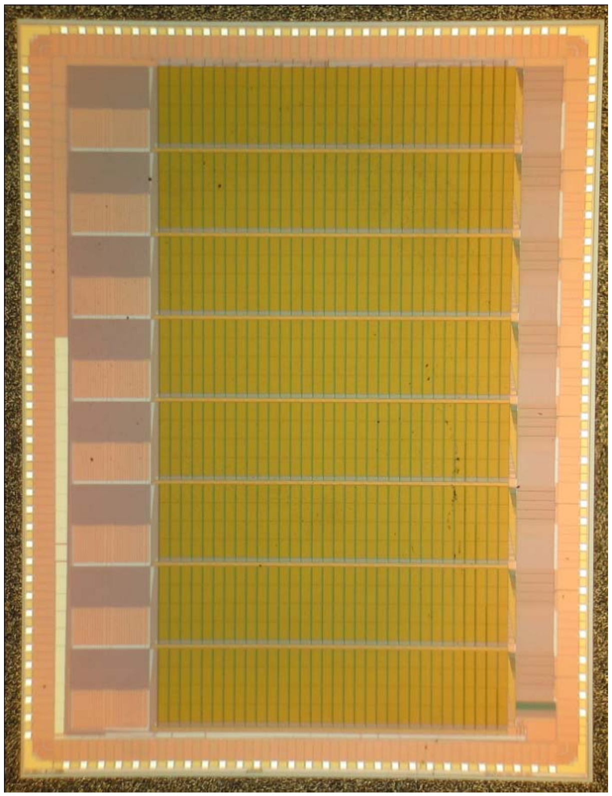
Physics Goals

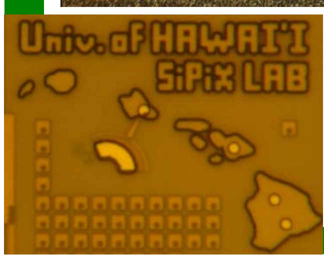
- Gusev and Zheleznykh proposed in 1983!
- 100’s of km3 volume at GZK nu range
- Inexpense extention to IceCube



ARA – ID Lab

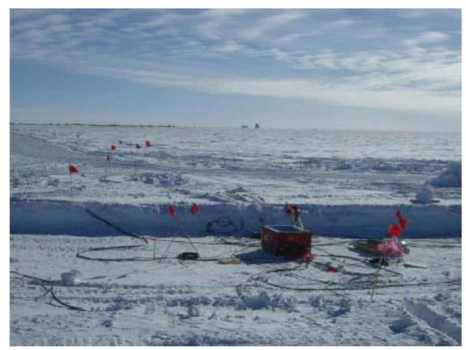
IRS ASIC

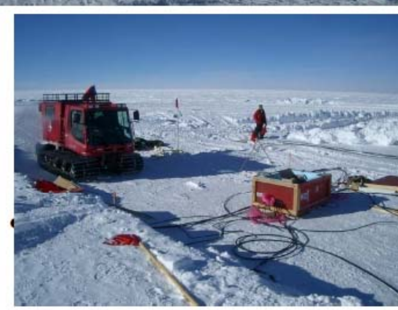




Our Developments

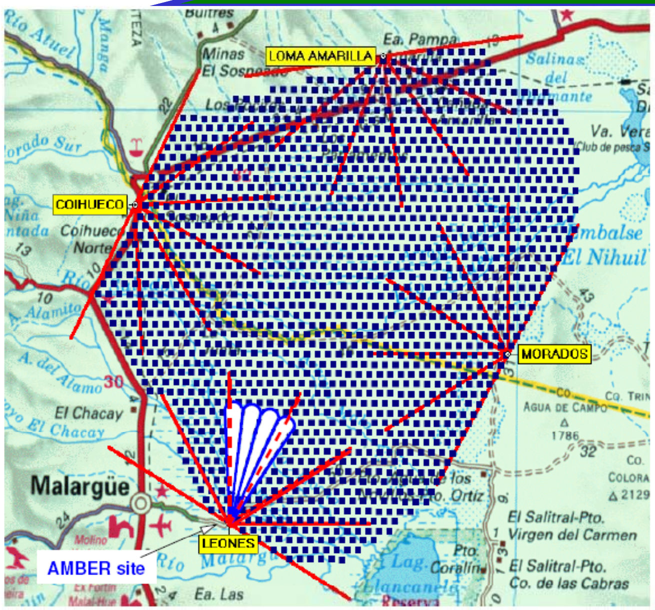
- Translate ANITA trigger/digitizer electronics and experience to ARA
- "array crossing" waveform sampler (IRS)
- Built "testbed" almost 4 years ago….
- Finally deployed in January, taking data





ARA Test Bed

Atmospheric Bremsstrahlung (AMBER)

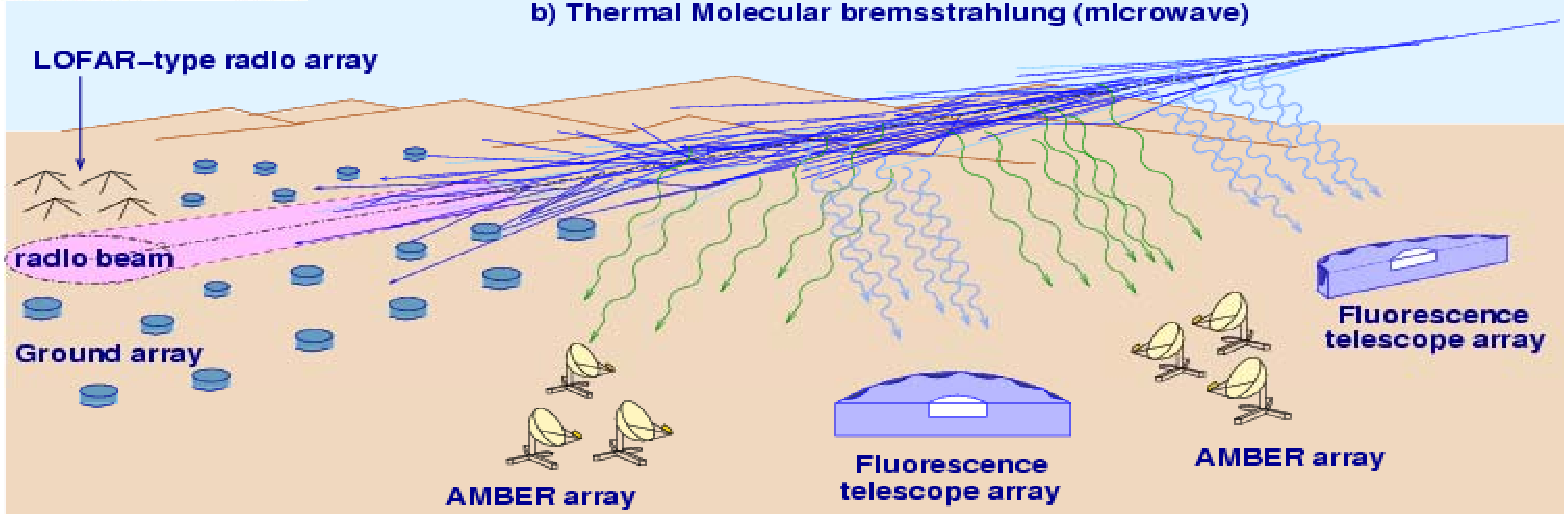


Physics Goals

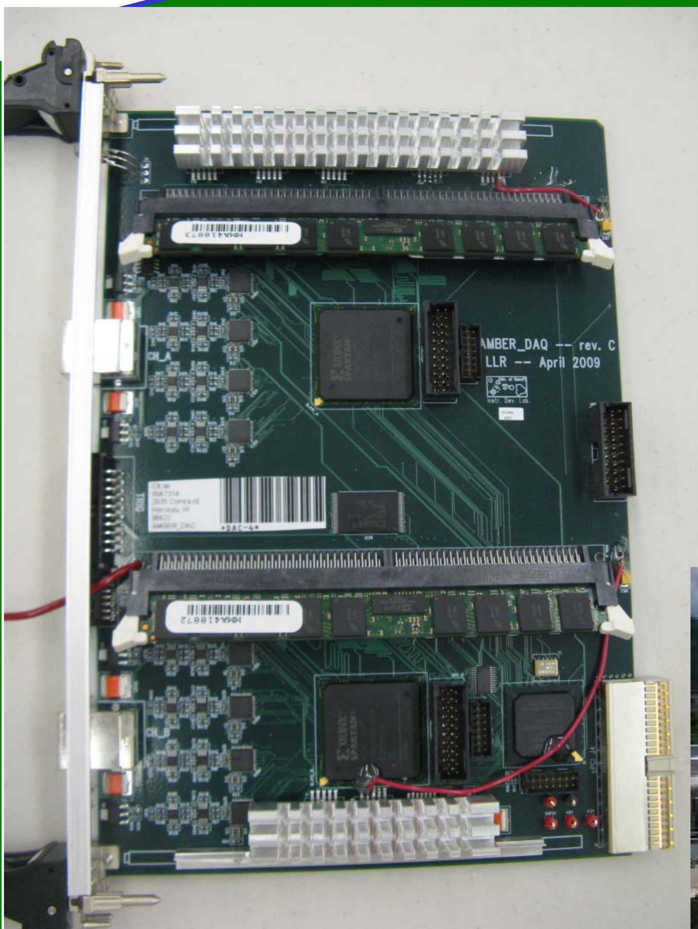
- Use Pierre Auger observatory in Argentina
- Extend “aerial observation” component
- 100% duty cycle, but uncertainty from beam test
- Measure!

Particle shower impact with ground:
- Direct Detection of shower ’slice’ by ground array
- Indirect detection of integrated profile via beamed radio synchrotron

Developing air shower:
- Indirect detection of profile of ionization density by:
  - a) Nitrogen fluorescence (optical)
  - b) Thermal Molecular bremsstrahlung (microwave)

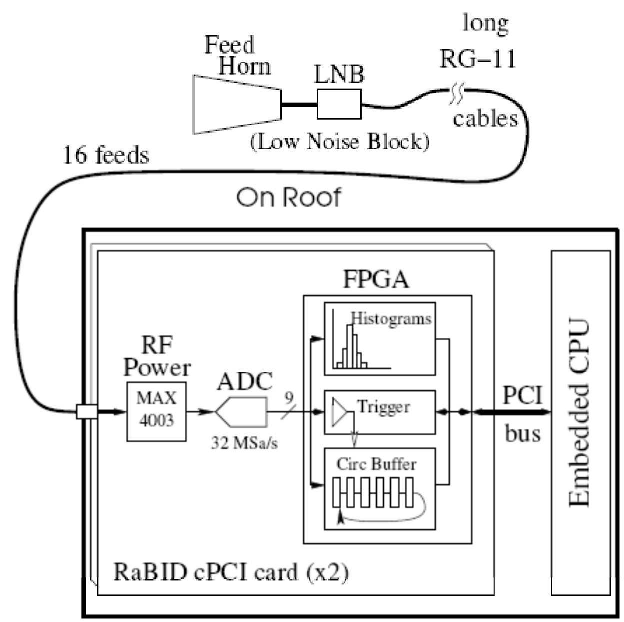


AMBER – ID Lab



Our Developments

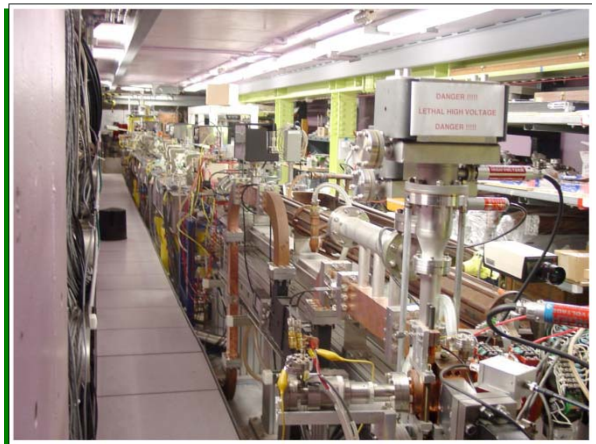
- Entire readout system Hawaii development
- 5 seconds deep storage!!
- RF power monitors
- Trigger algorithms developed by EE colleagues

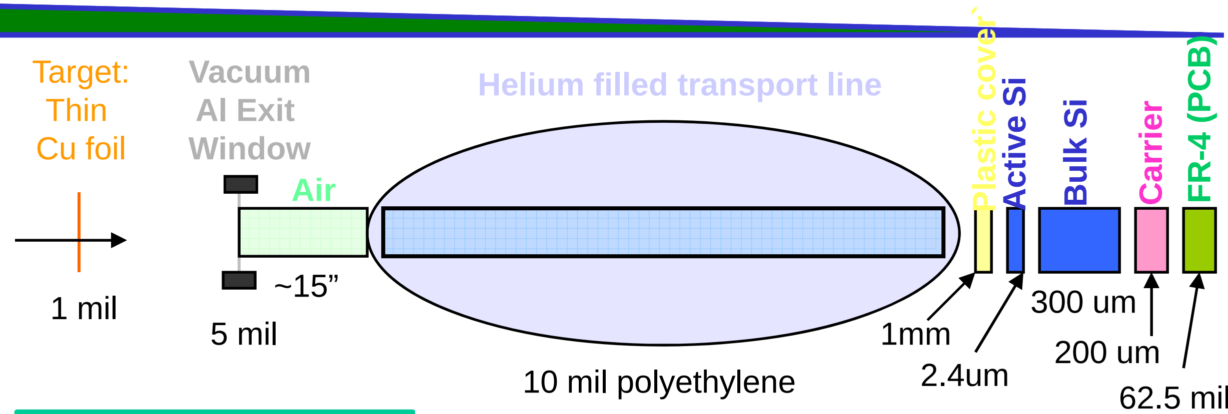


Bremsstrahlung x-rays: UH FEL

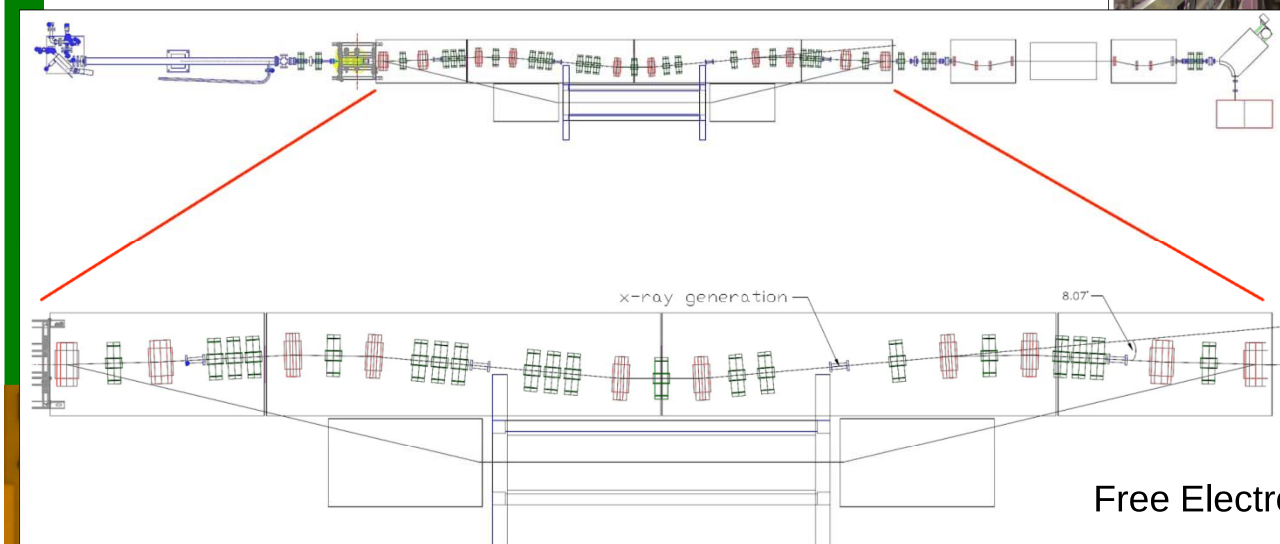
First x-rays: September 2010

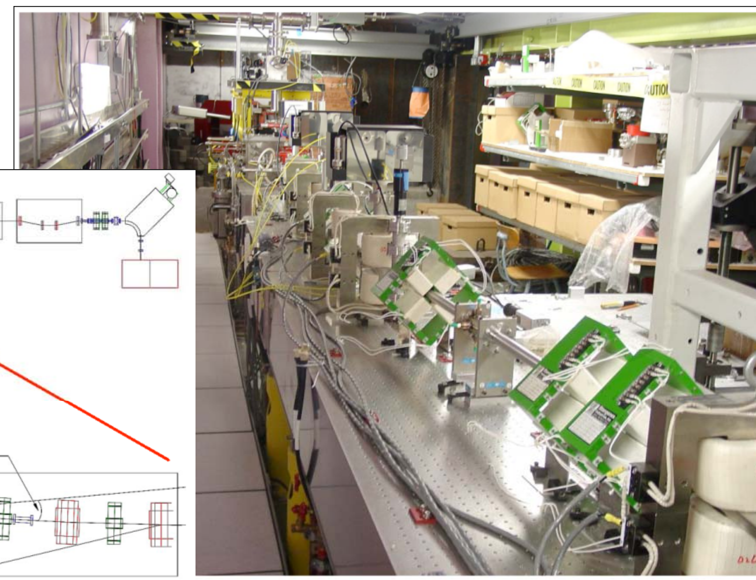
50MeV max. (40MeV typ.)





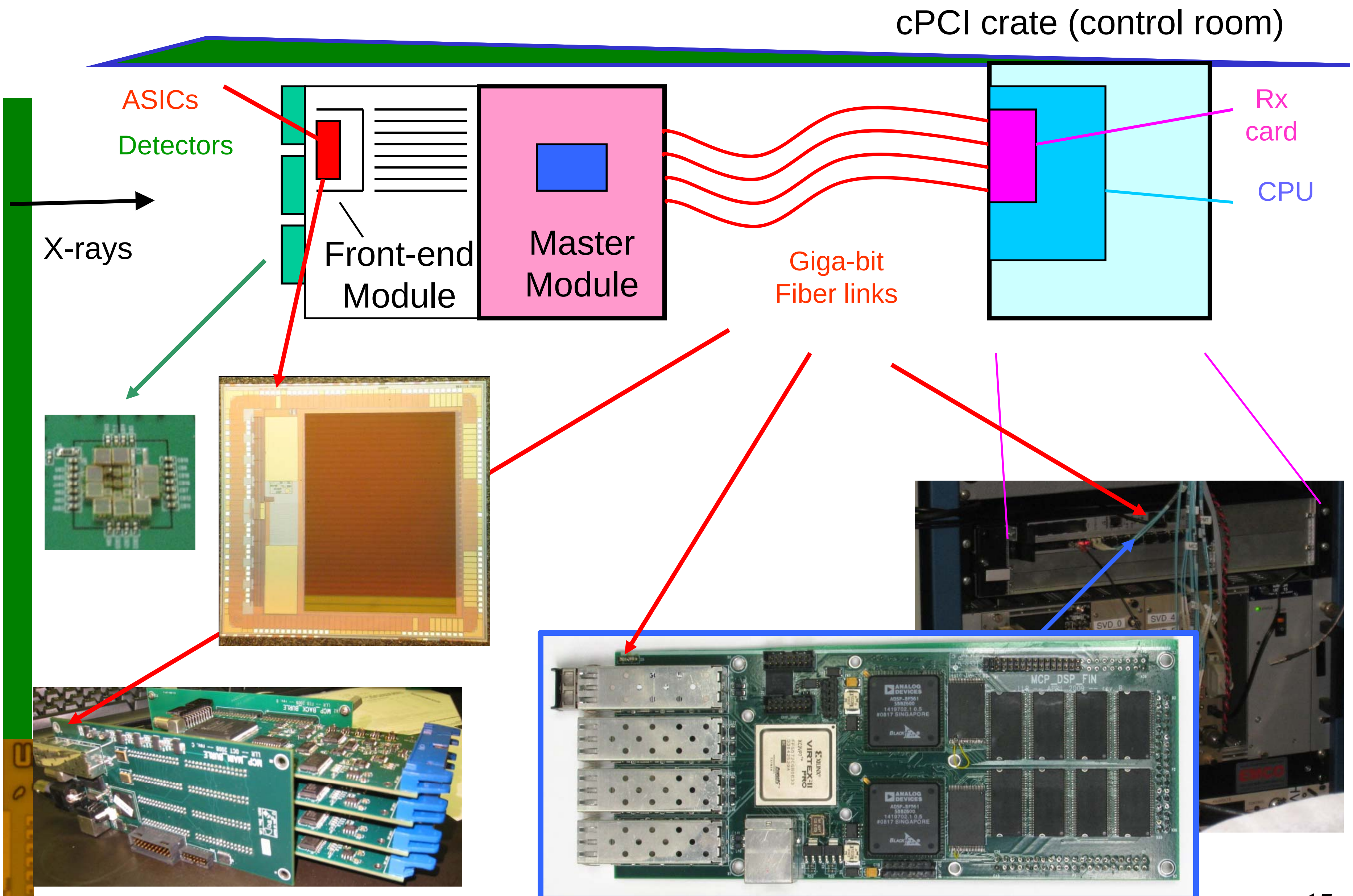
Nobel comment





Free Electron Laser → in old machine shop

TEDA –ID Lab

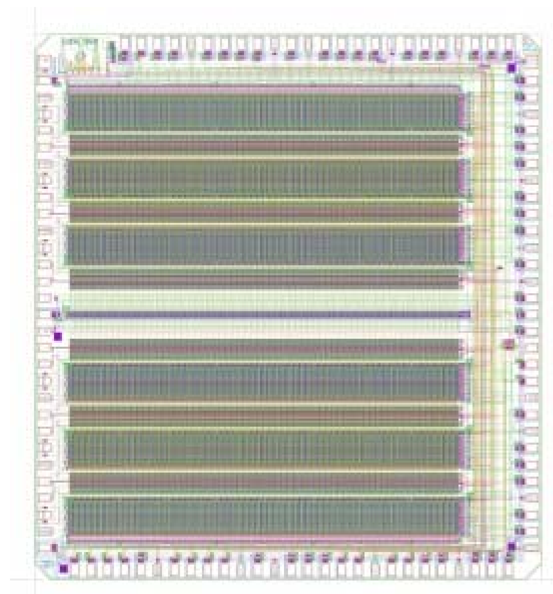


Master module

Large Area Photodetector

Project goals

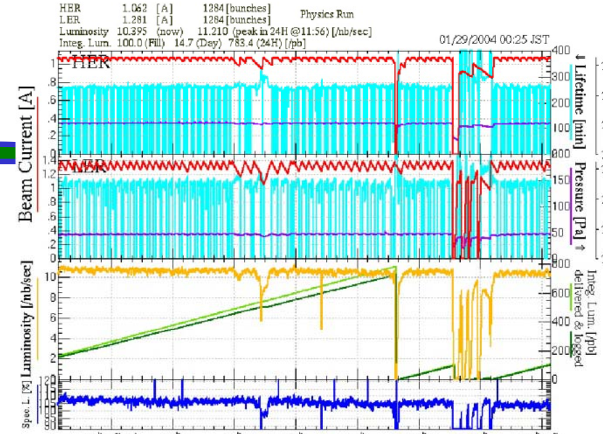
- Photomultipliers still built on vacuum tube technology
- CRT → flat panel screen transition
- Integrated readout electronics
- Necessary for next generation (large) detectors

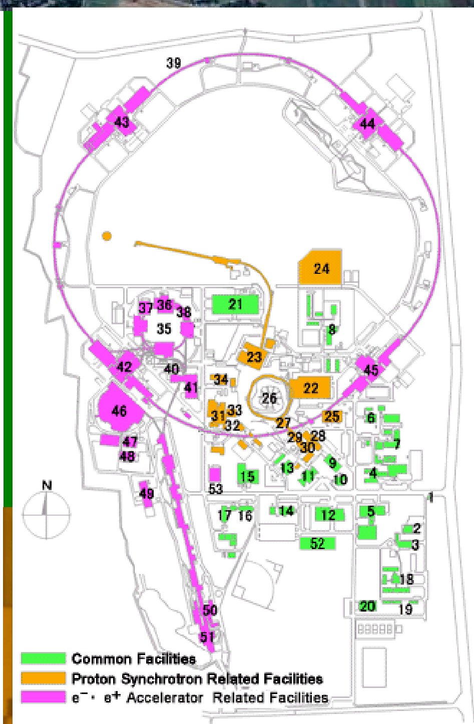


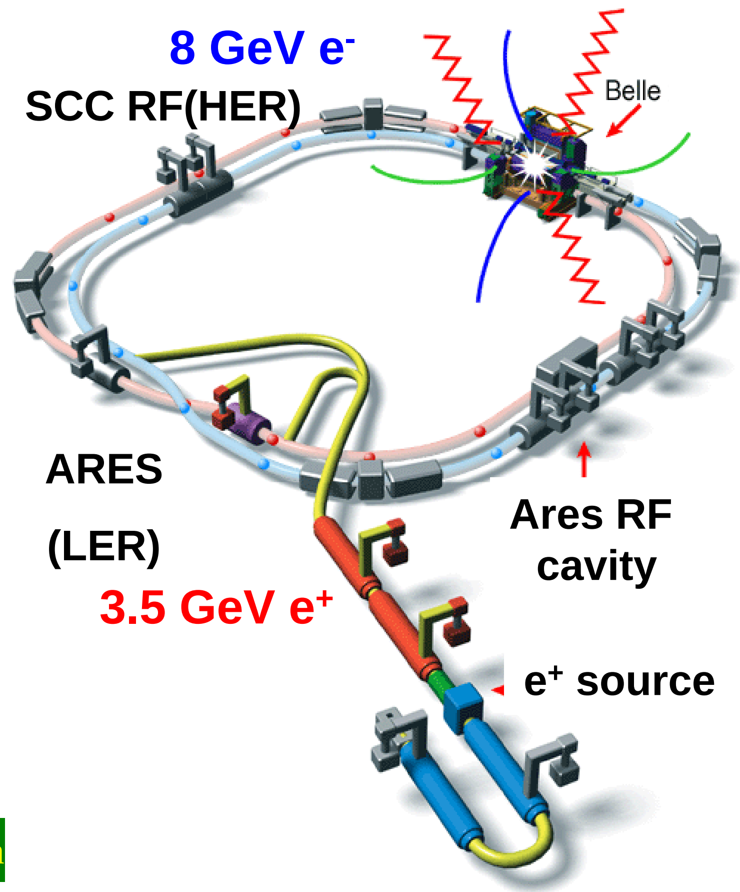
PSEC4

CHAMP

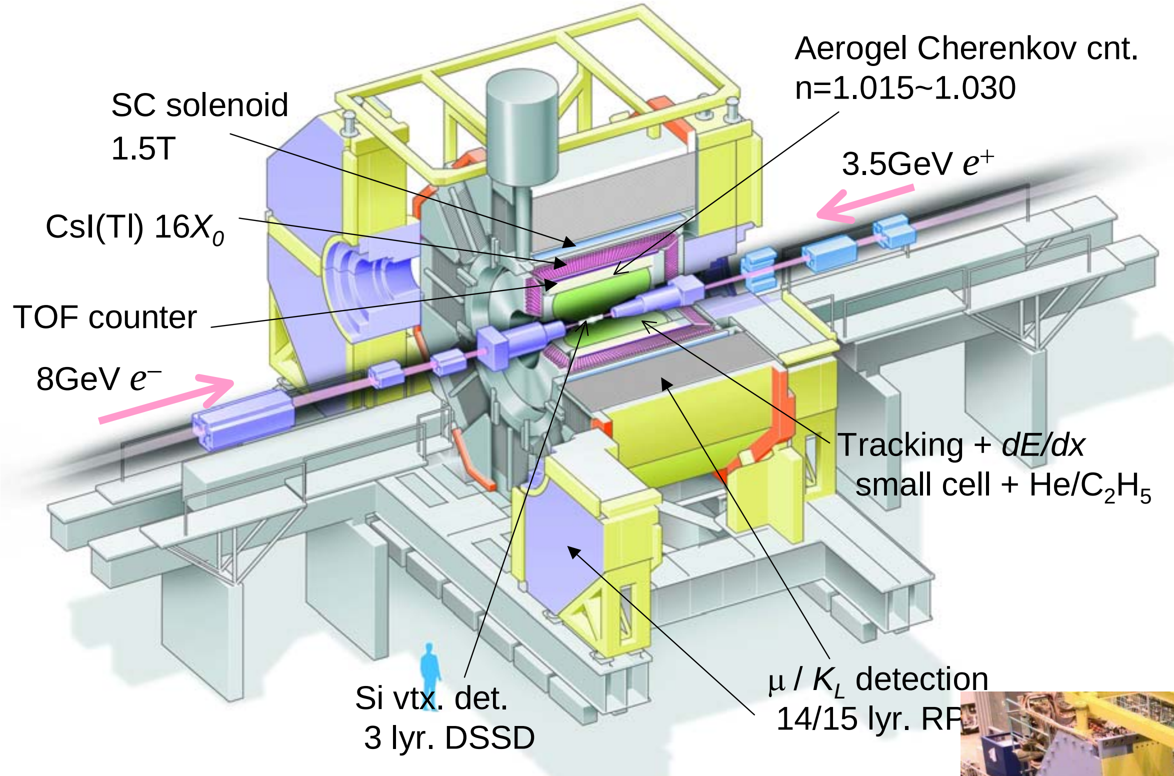
World’s highest Luminosity collider







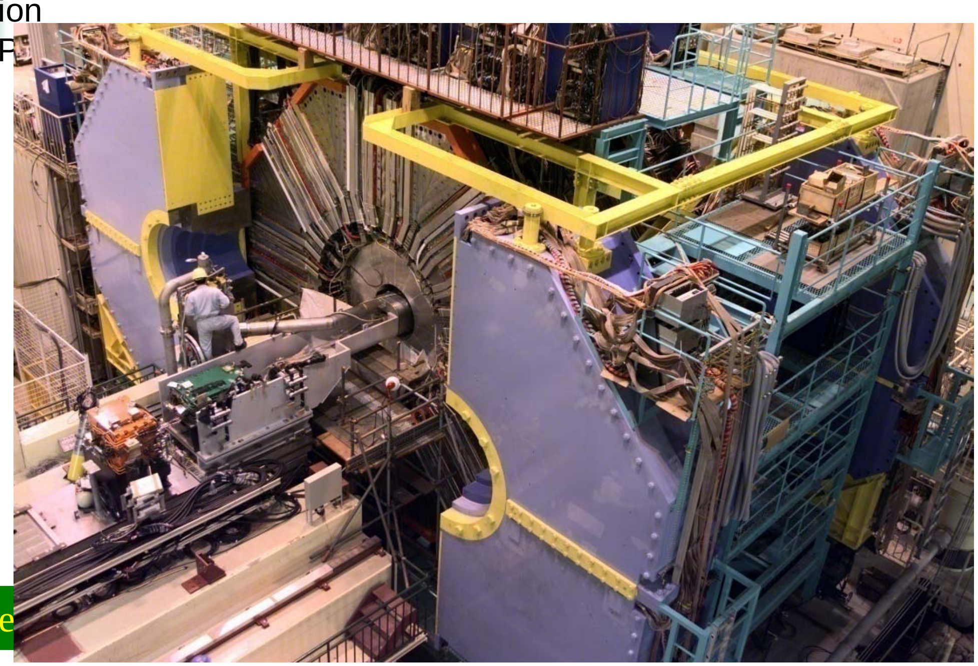
Belle Detector



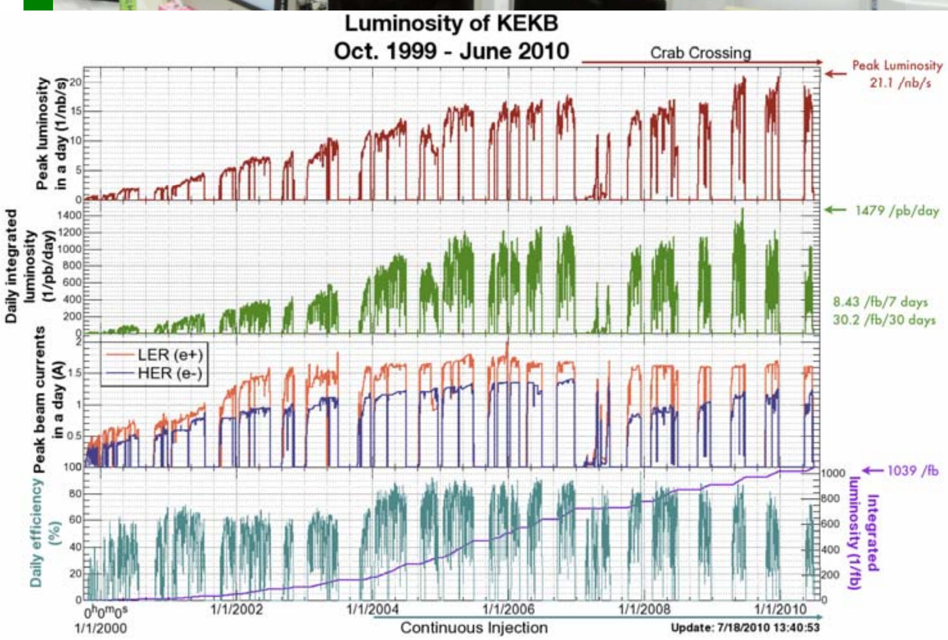
Year 2010 marked a huge milestone:
1000fb^-1 (1ab^-1)

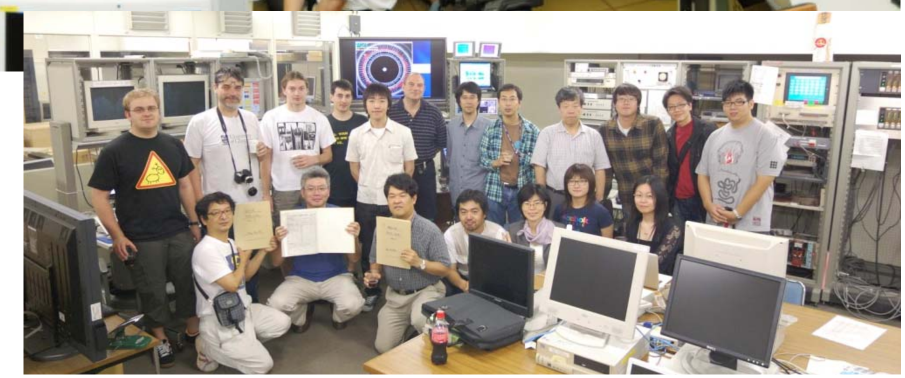
Upgrade project approved!

Side note: I first came to Hawaii (KEK) to work on building Belle in 1995



Final beam abort of KEKB on June 30, 2010 marked the start of SuperKEKB/BelleII





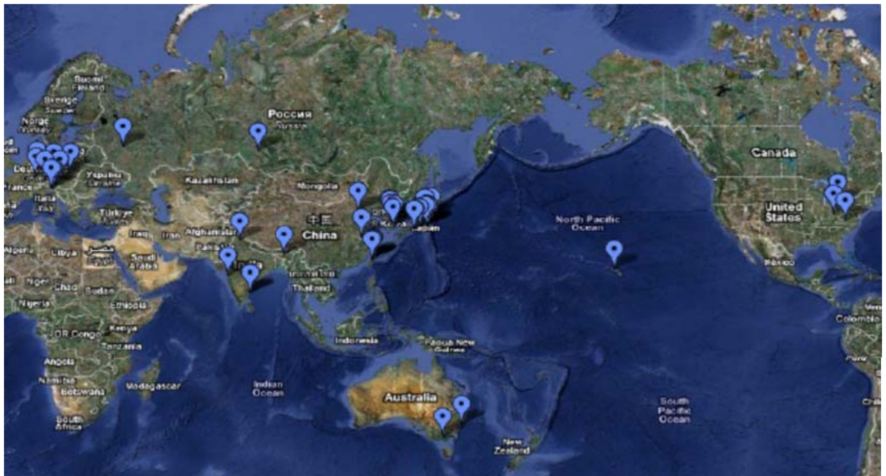
First physics run on June 2, 1999
Last physics run on June 30, 2010
$L_{peak} = 2.1\times10^{34}/cm^2/s$
$L > 1ab^{-1}$

Earthquake

M22 bolts!!

As is now well known, Japan suffered a terrible earthquake and tsunami on March 11, which has caused tremendous damage, especially in the Tohoku area. Fortunately, all KEK personnel and users are safe and accounted for. The injection linac did suffer significant but manageable damage, and repairs are underway. The damage to the KEKB main rings appears to be less serious, though non-negligible. No serious damage has been reported so far at Belle. Further investigation is necessary. We would like to convey our deep appreciation to everyone for your generous expressions of concern and encouragement.

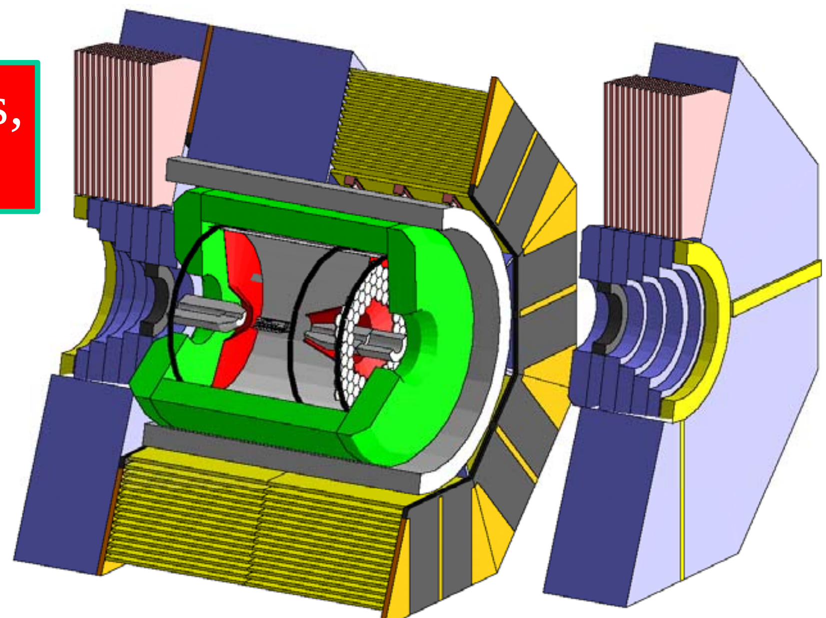
Belle II



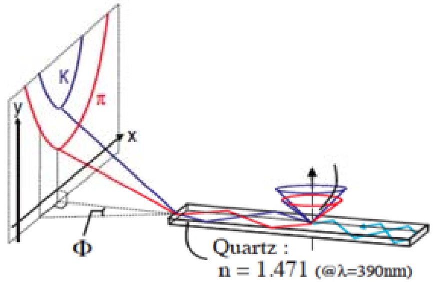
Physics Goals

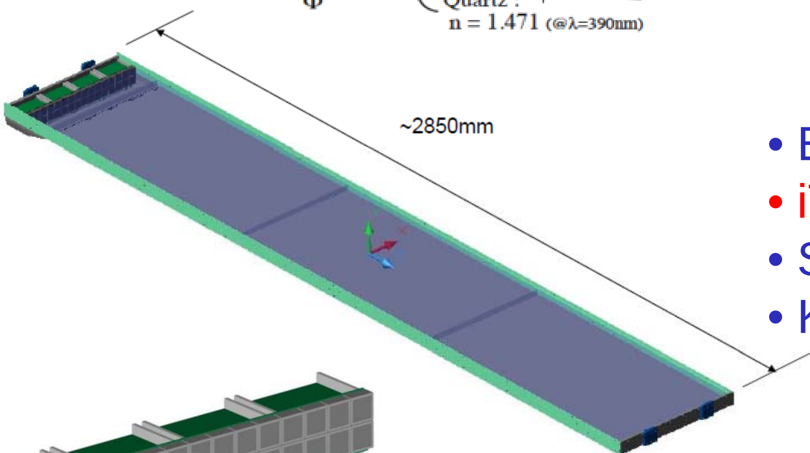
- Belle extremely successful at confirming the Kobayashi-Maskawa mechanism of CP violation in the quark sector
- Data ~ 50x = beyond Standard Model
- Very broad program in beauty, charm and tau physics

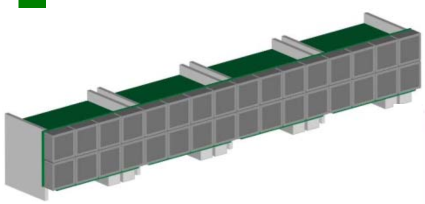
329 individuals, ~13 nations, ~53 institutes



Belle II – ID Lab

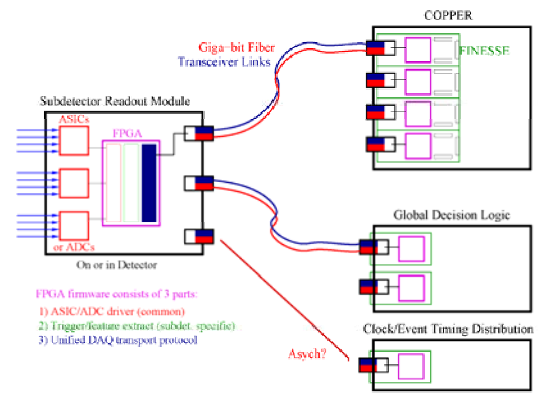


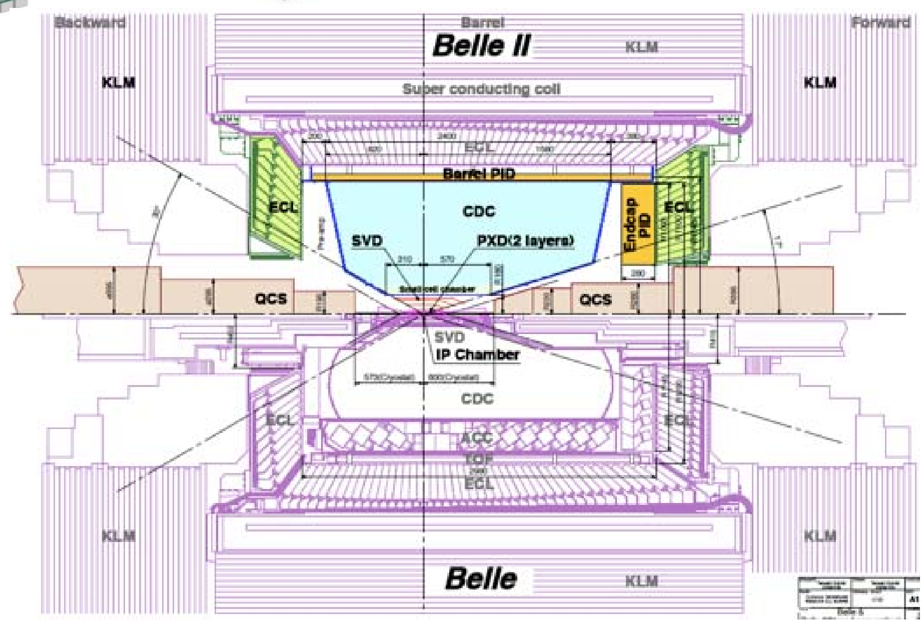


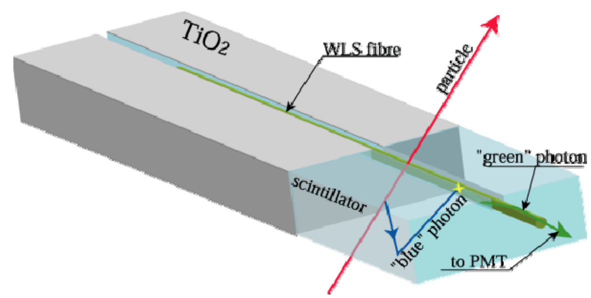


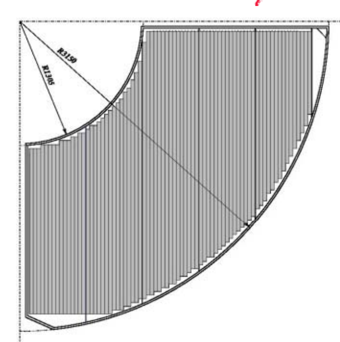
Our activities

- Electronics architecture
- iTOP readout
- Scin strip KLM readout
- KEKB nanometer beam

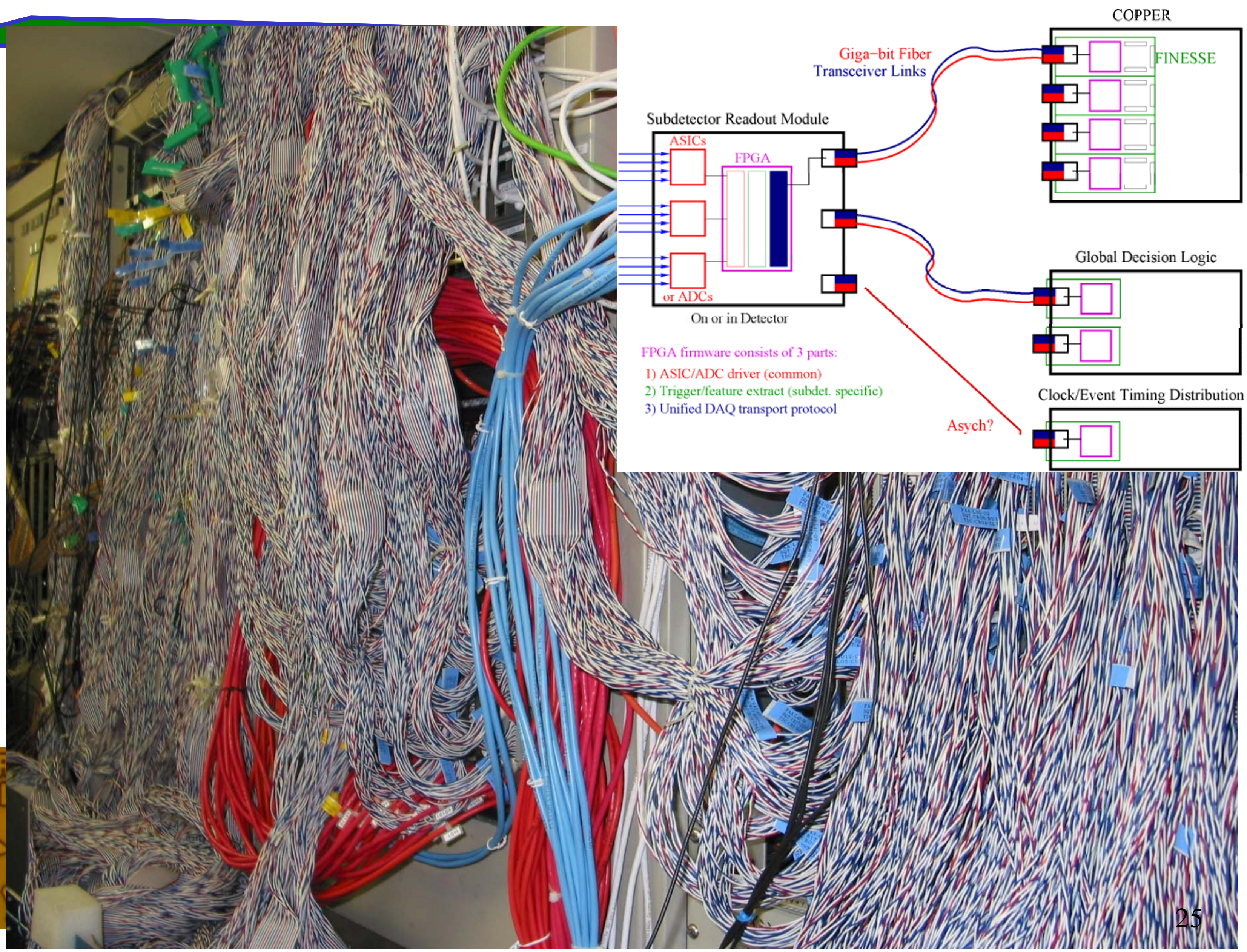






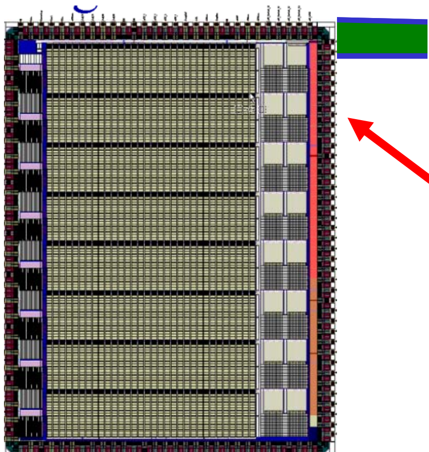


Got fiber?

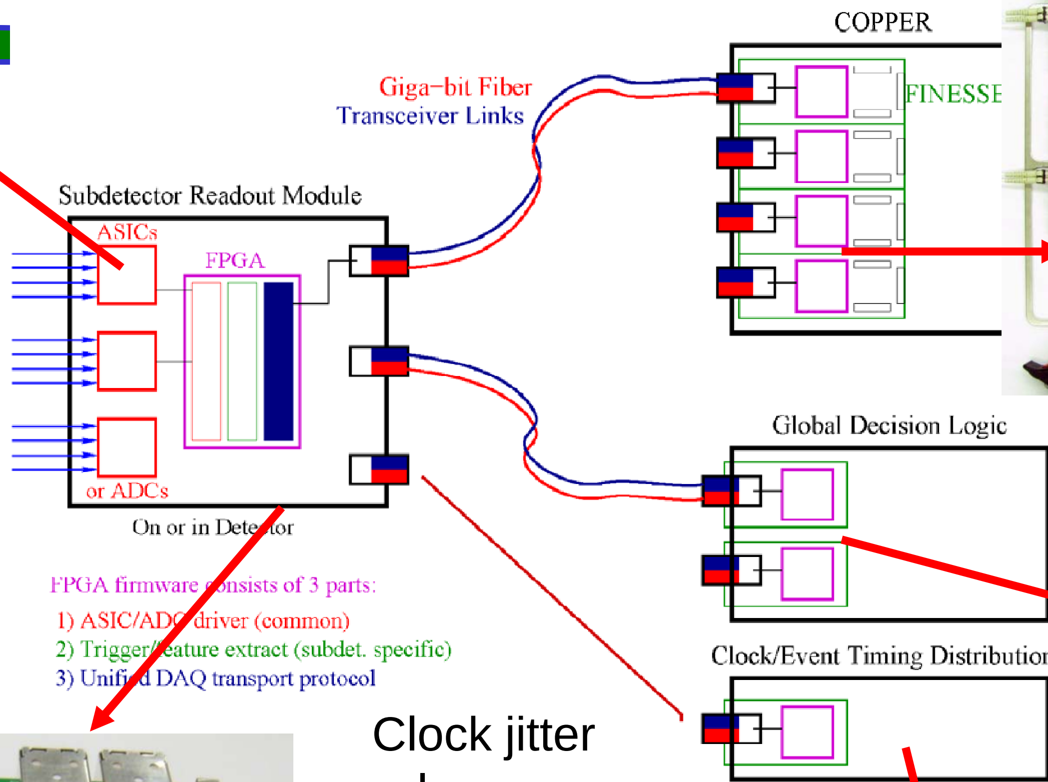

COPPER
Giga–bit Fiber
Transceiver Links
FINESSE
Subdetector Readout Module
ASICs
FPGA
or ADCs
On or in Detector
Global Decision Logic
Clock/Event Timing Distribution
FPGA firmware consists of 3 parts:
1) ASIC/ADC driver (common)
2) Trigger/feature extract (subdet. specific)
3) Unified DAQ transport protocol
Asych?

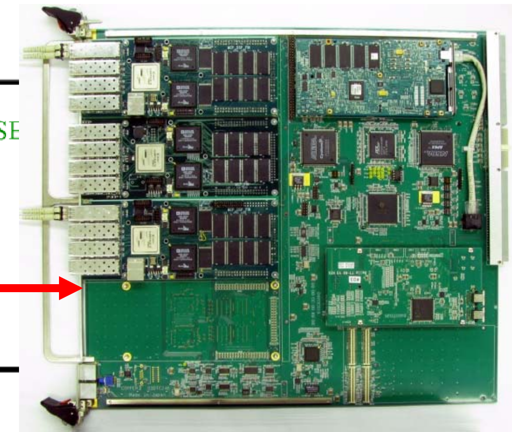
iTOP – ID Lab

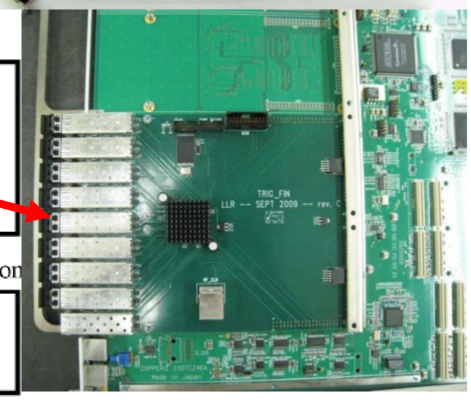
Our activities



BLAB3
ASIC





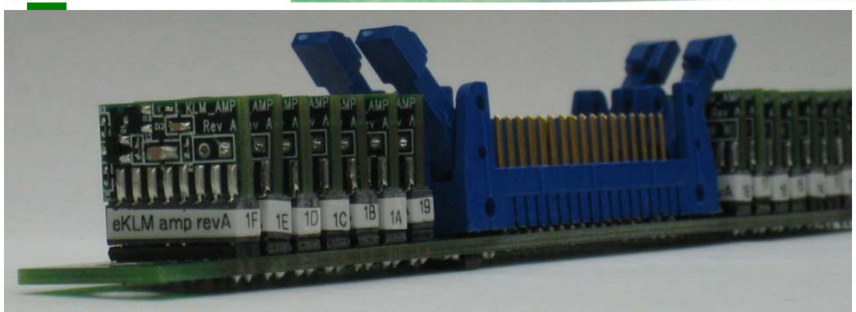


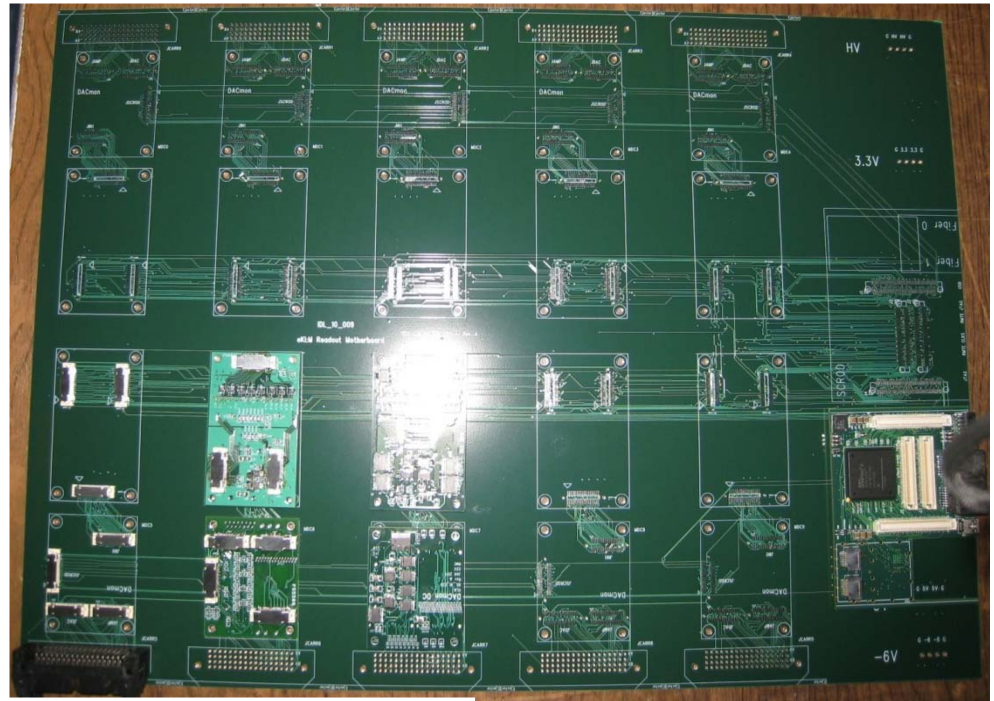
SCROD

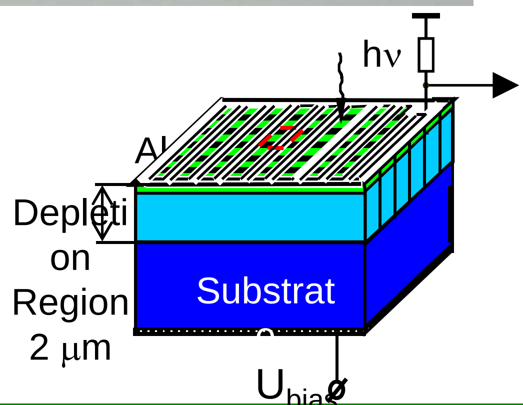
Clock jitter
cleaners

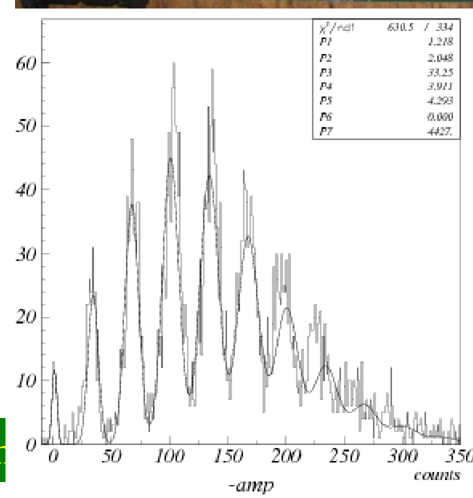
Our activities

KLM – ID Lab





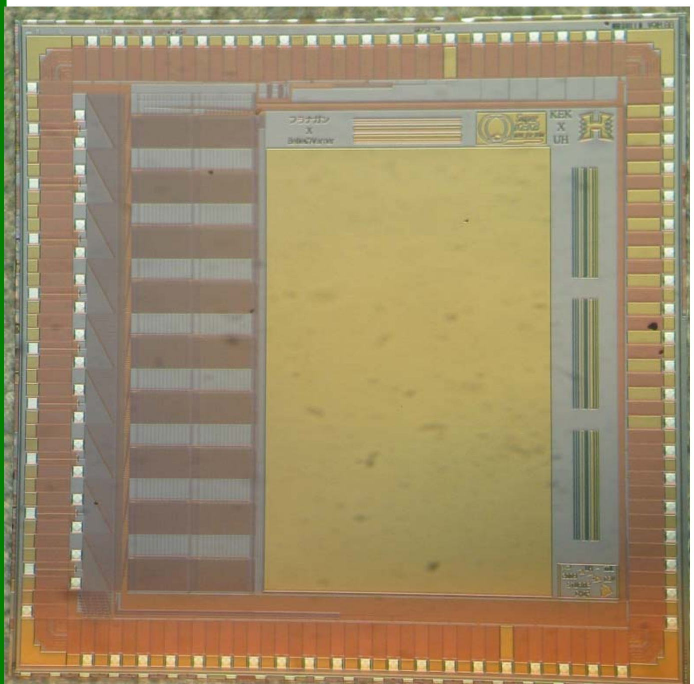




Results with prototype ASIC (TARGET)

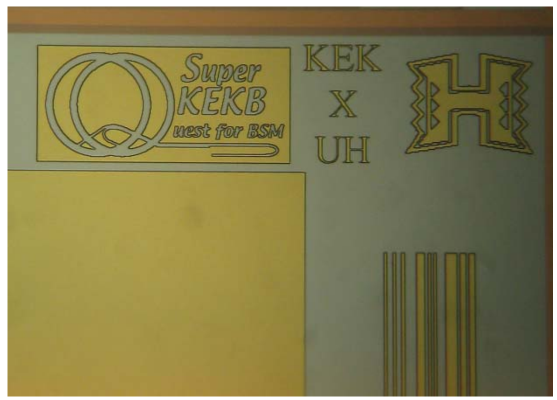
SuperKEKB – ID Lab

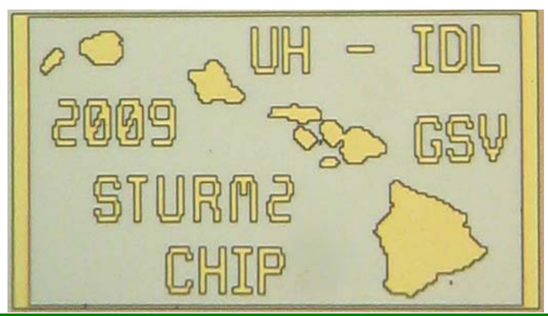
STURM2 ASIC



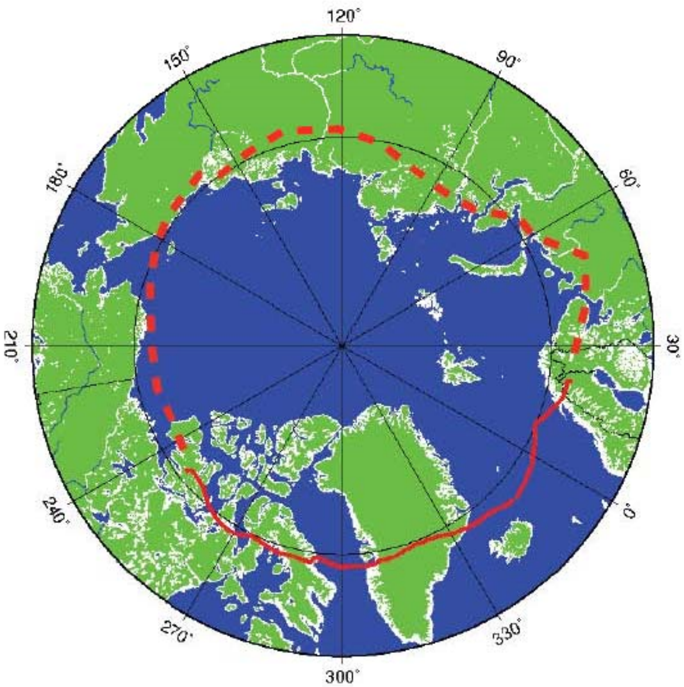
Our Developments

- x-ray monitoring
- High speed sampler, compact RF amplifiers
- Test at the ATF2 facility
- Survived shaking



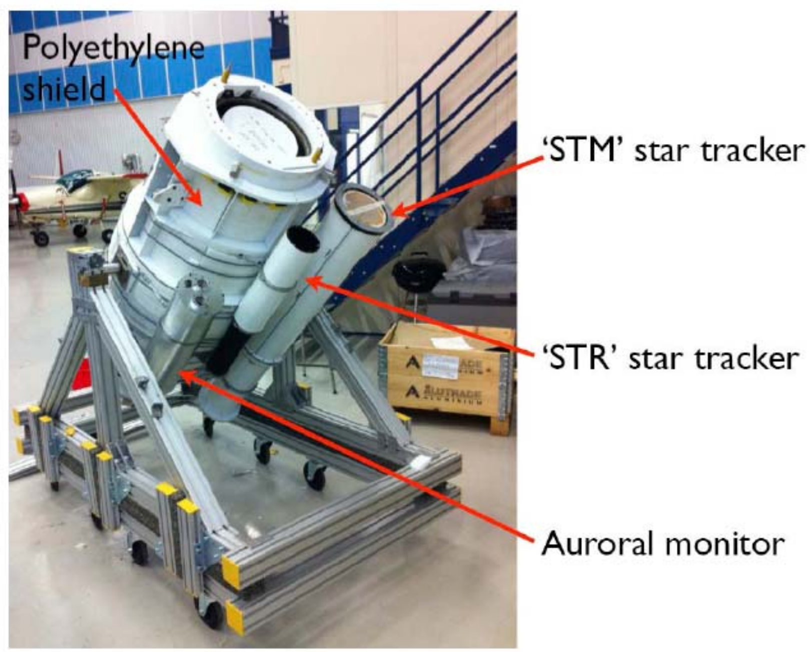


PoGO-lite



Physics Goals

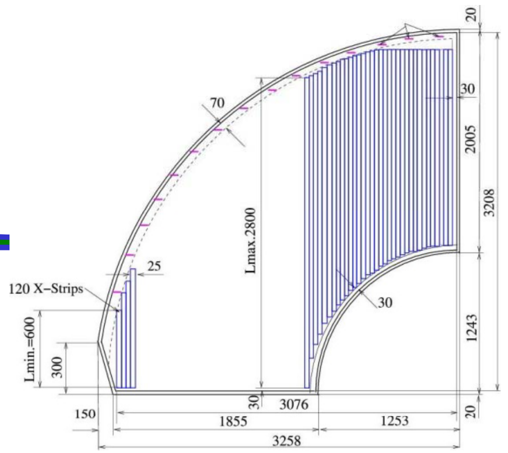
- Direct observation of polarized gammas from back-scatter at pulsar/black-hole energetic region
- Unique ability to measure polarization of photons
- Pioneering flight in a couple weeks
- If neutron backgrounds OK – much larger payload



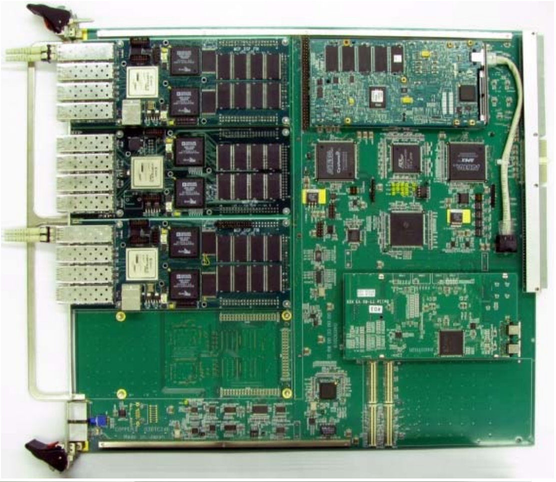
Personnel changes…

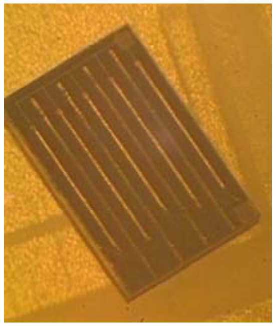
- Continuing – in new role: Dr. Kurtis Nishimura
- From this summer
  - New graduate student: Eric Anderson
  - New undergraduates
    - Xiaowen Shi
    - Grace Jung, Casey, Honniball, Christina Yee
  - Next Finnish (Savonia) visitors
    - Jussi Malin from May 25th
    - 4x(!) more in January
  - Yet more:
    - Prof. Roberto Mussa (INFN Torino)
    - Zhe Cao (USTC postdoc)
    - Joachim Cohen (Paris)
    - …

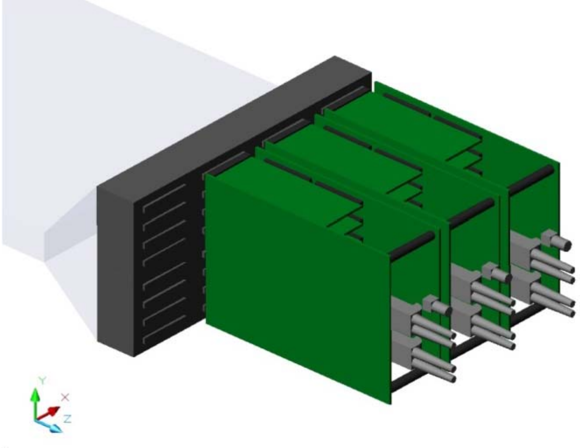
They are all needed...

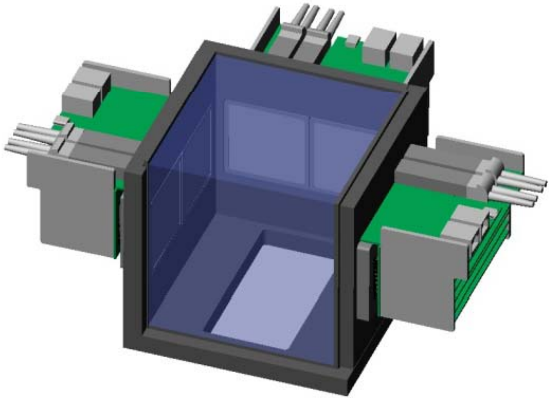


1. Endcap KLM 150 channel system (full quadrant test of muon system) →
2. iTOP beam test --> boards and board test plan
   [512 channel system = 4x 128ch]
3. ATF2 (Fermionics-based) DAQ [128 channels]
4. xFEL Fermionics readout [128 channels]
5. mini-Time Cube [12x 64-channel tube readout minimum?]
6. fDIRC2 readout [14x 64-channel tubes]









What is the Future?

- Belle II – iTOP/KLM by 2014, pixel upgrade thereafter
- Disruptive technology: LAPPD (Detector dev center – ANL)
- ANITA 3rd Flight approved → active R&D (ASICs, trigger…)
- Deploy AMBER station this next <u>week</u> → large array?
- New initiatives: ARA Test bed installed, year 2 & 3
- Great opportunities – life cycle of a university
  - Jr./Sr. research projects (EE 399/499, PHYS 499)
  - Directed study/NASA Space Grant/REU/PUF (Japan/Antarctica/Paris)
  - Publications (NIM/IEEE/JINST …)
  - Board/firmware/chip design (PHYS476)
  - Many designs in queue; LAB4, BLAB3B, STURM3, GRAPH…
    - Design, layout, simulation and test opportunities