LBNL Physics Program

Jim Siegrist

HEPAP

March 26, 2001

LBNL HEP program

Physics Division
AFRD
Largest four efforts

Energy Frontier:
CDF LHC
D0 NLC
ATLAS

CP Violation:
E871 PEP II Low Energy Ring
BaBar
CDF b physics

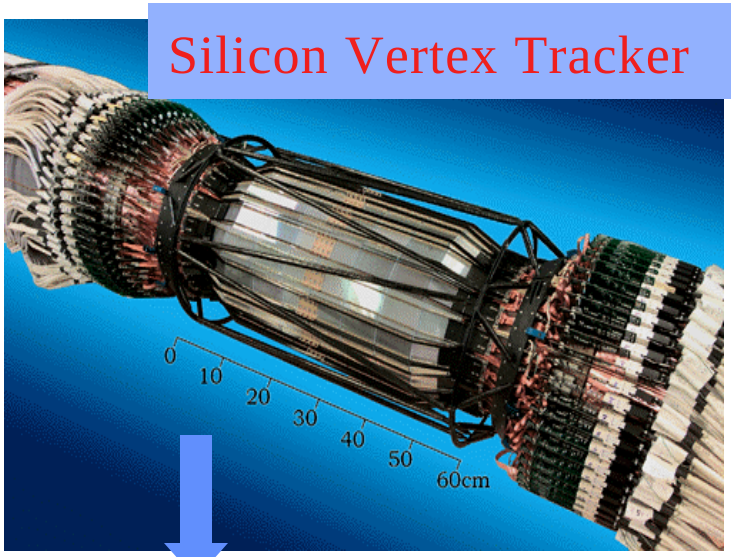
Neutrino sector:
KamLAND
Ice-cubed/Amanda
n Source Studies

Astrophysics:
Supernova Cosmology
CMB
[CDMS]

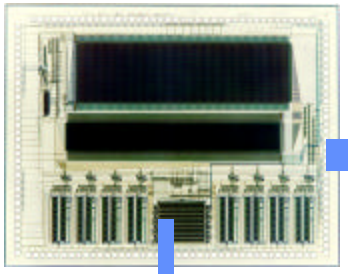
Also:
Theory
PDG
Instrumentation
Supercon
Optical Particle Acceleration

Major Berkeley collaborative efforts- contributions to BaBar

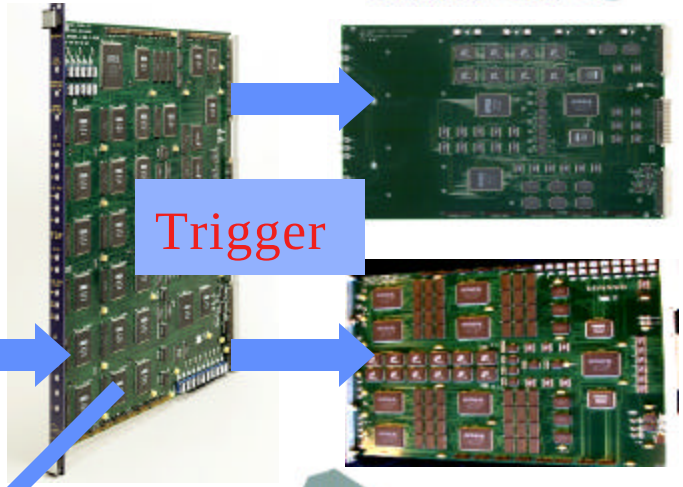
Silicon Vertex Tracker

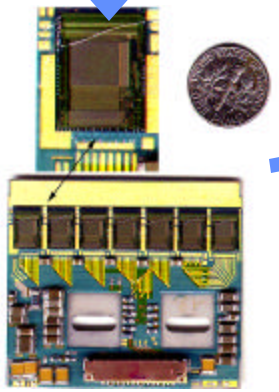


Drift Chamber Readout IC



Trigger

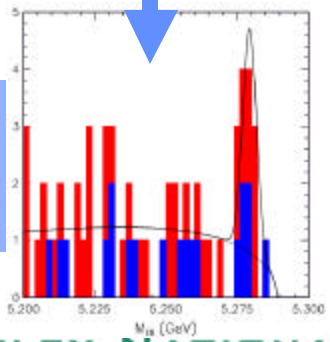


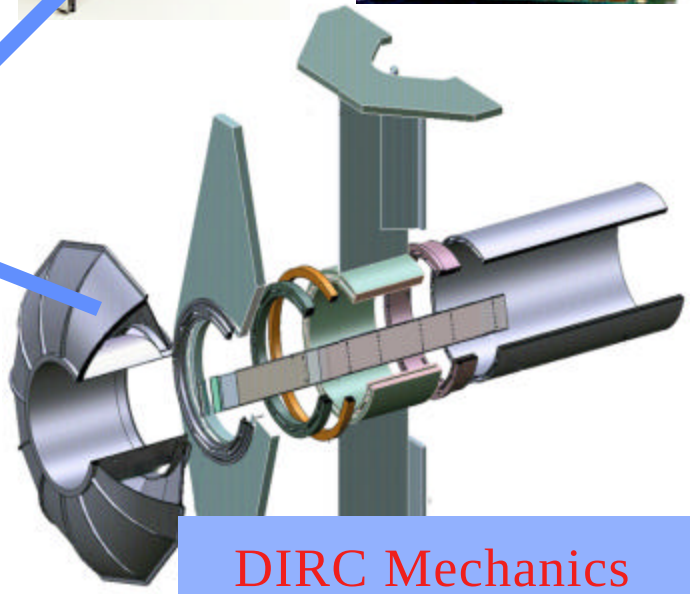


SVT Readout IC

Computing

Physics Analysis

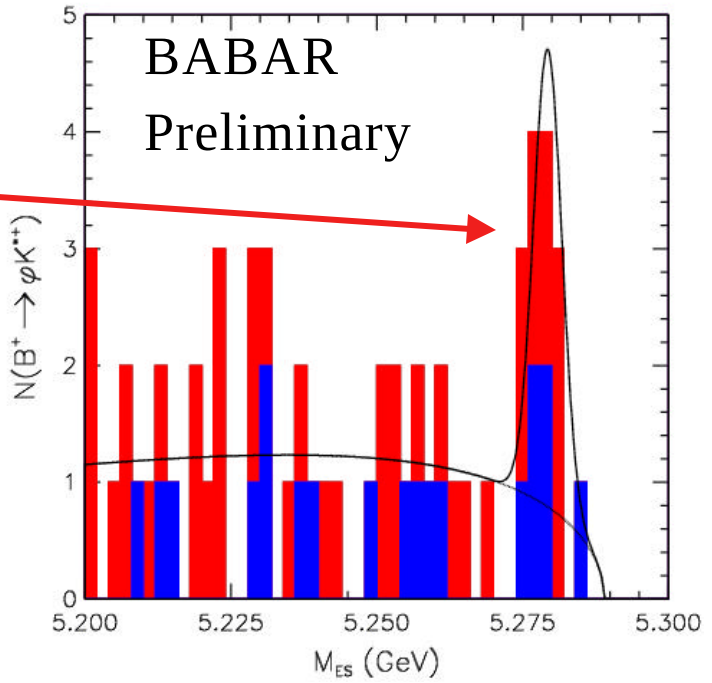


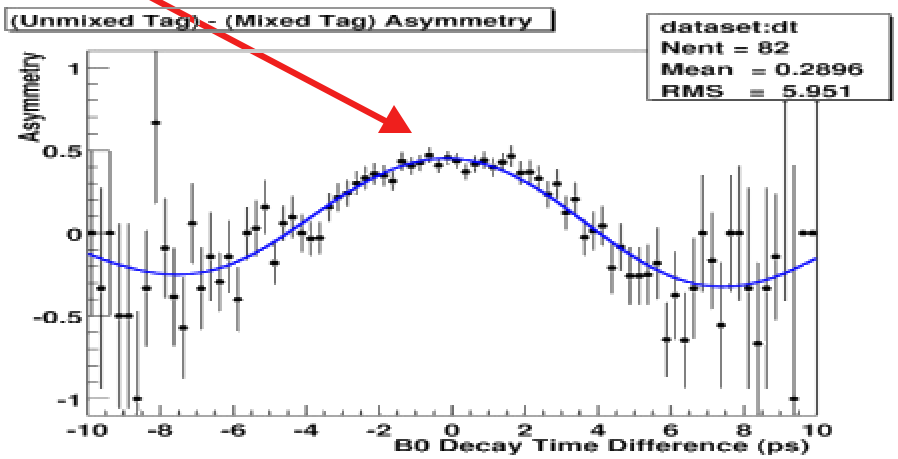


DIRC Mechanics and Online

Berkeley physics analysis

- $B \rightarrow V\ V$ (Gritsan)
  - $B^+ \rightarrow \Phi K^{*+}$ (first observation!)
- $B^0 \rightarrow D^*\ l\ \nu$ (Roe + students)
  - Mixing (Δm) (LeClerc, w/Stanford)
  - Form factors (Gill)
- $\tau \rightarrow \eta\ K(\pi)\ \nu$ (Shelkov)
- $B \rightarrow \rho\pi$, $a_0\pi$ (angle α) (Shelkov w/French)
- BR ($B \rightarrow l\nu$) (f_b) (Abrams)
- sin2β (Cahn)
  - $|\lambda|$ (direct CP term)
- Analysis support (All)
  - Tracking algorithm
  - Alignment





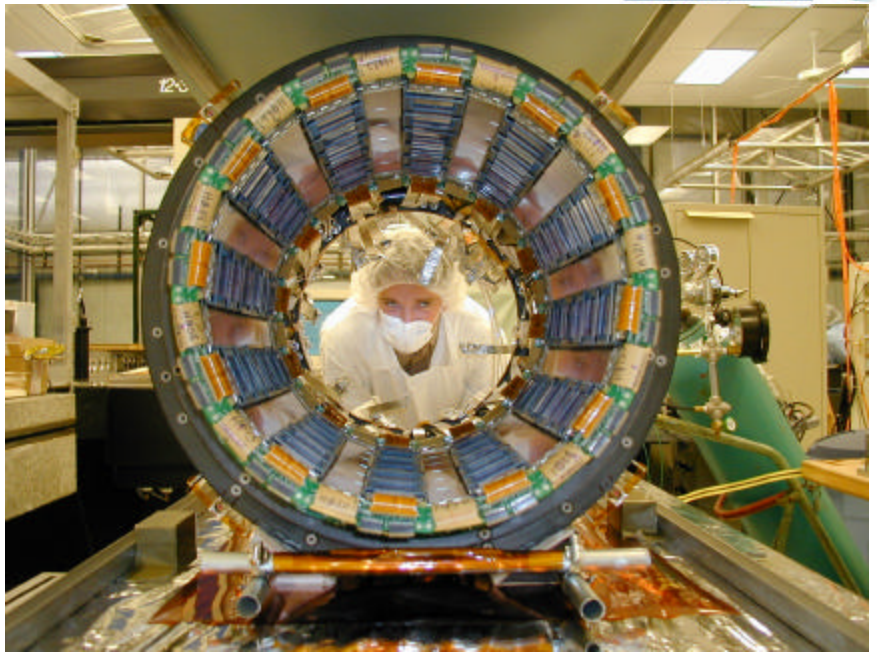
Upgrade plans

- Replace radiation damaged SVT modules (in 2002?)
  - LBNL procuring and testing new ATOM ICs
  - Responsible for assembly procedure, re-installation of SVT
- Longer term SVT upgrades still under discussion
  - Depends on accelerator upgrade program
  - LBNL will contribute as plans become more definite
- Physics Data Model Upgrade (computing)
  - Improve physicist access to data
  - Reduce CPU time and disk space overheads (< $)
  - 3 Staff/Faculty, 2-3 FTE Computing professionals

Major Berkeley collaborative efforts - contributions to CDF

CDF Run I:

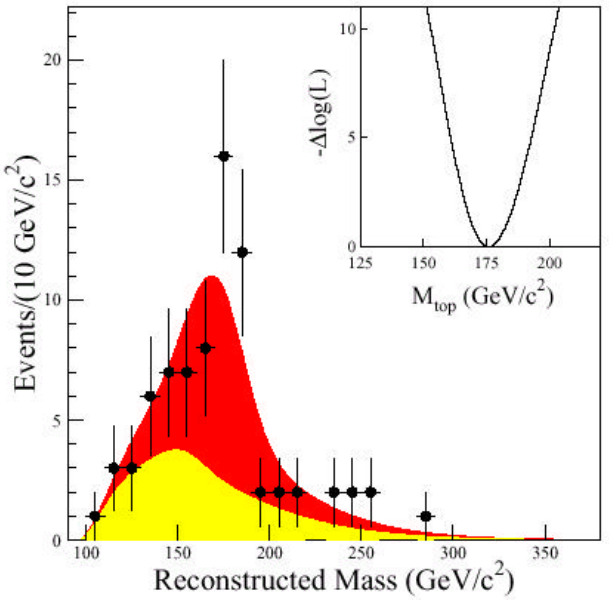
- Hardware
  - Silicon: an LBNL tradition
  - COT



- Leadership
  - Commissioning Coordinator
    Young Kee Kim
  - Offline Computing Head
    Marjorie Shapiro

Berkeley physics analysis

- Run I Physics
  - Top mass
  - Electroweak physics , W mass
  - B physics: Bs lifetime, B_d mixing
- Run II: just around the corner
  - Bottom: B_s mixing, $B \rightarrow \pi\pi$, $\sin 2\beta$
  - Top: improved mass measurement
  - New: Extra dimensions, SUSY
  - Higgs: $WH \hookrightarrow b\bar{b}$

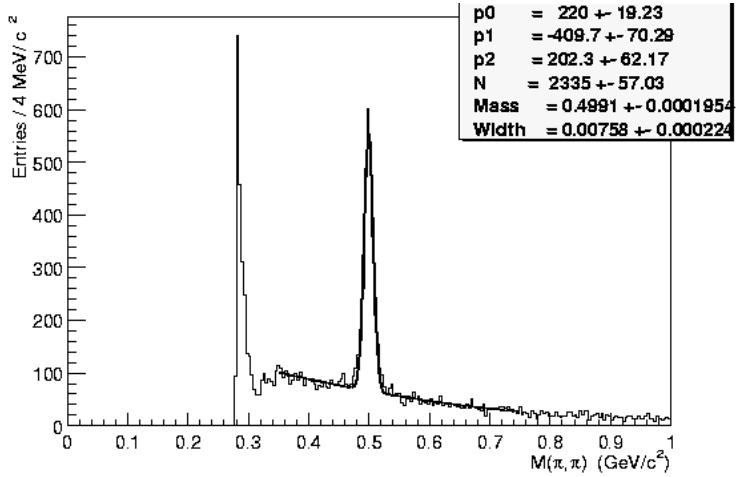


COT Detector + Reconstruction

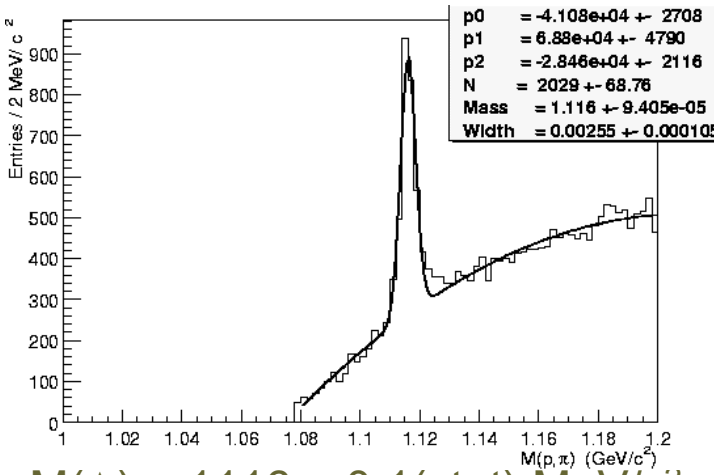
Commissioning run data

$K_s \rightarrow \pi^+\pi^-$

$\Lambda \rightarrow \pi^-p$

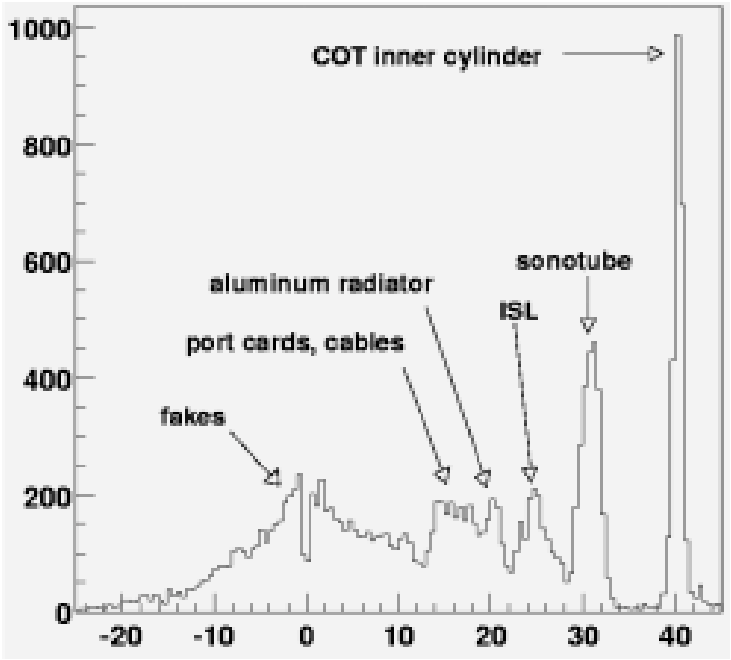


$M(K_s) = 499 \pm 0.2(stat)$ MeV/c^2

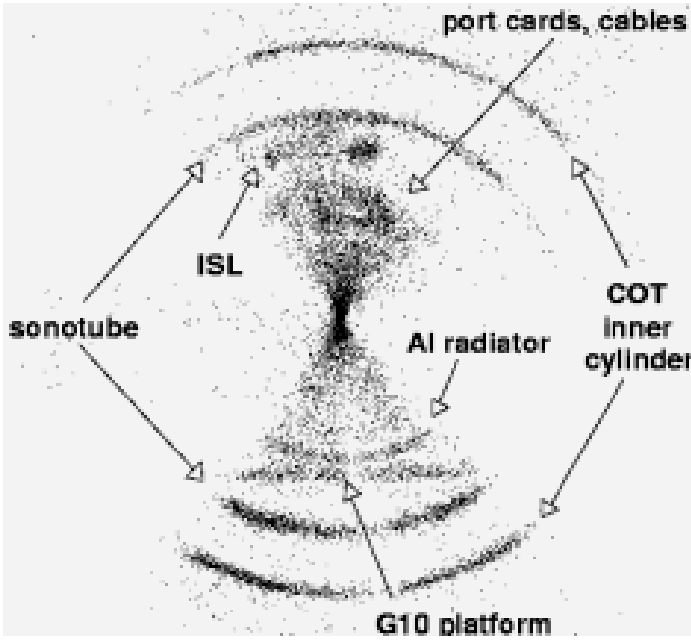


$M(\Lambda) = 1116 \pm 0.1(stat)$ MeV/c^2

Photon conversion in material



radius



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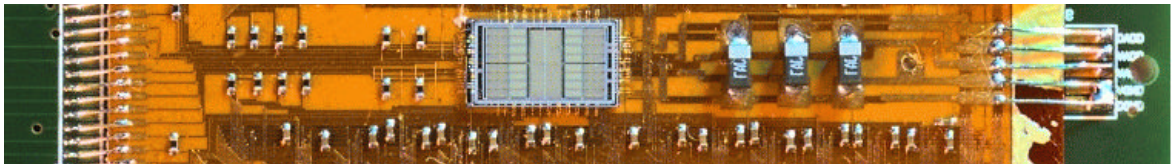
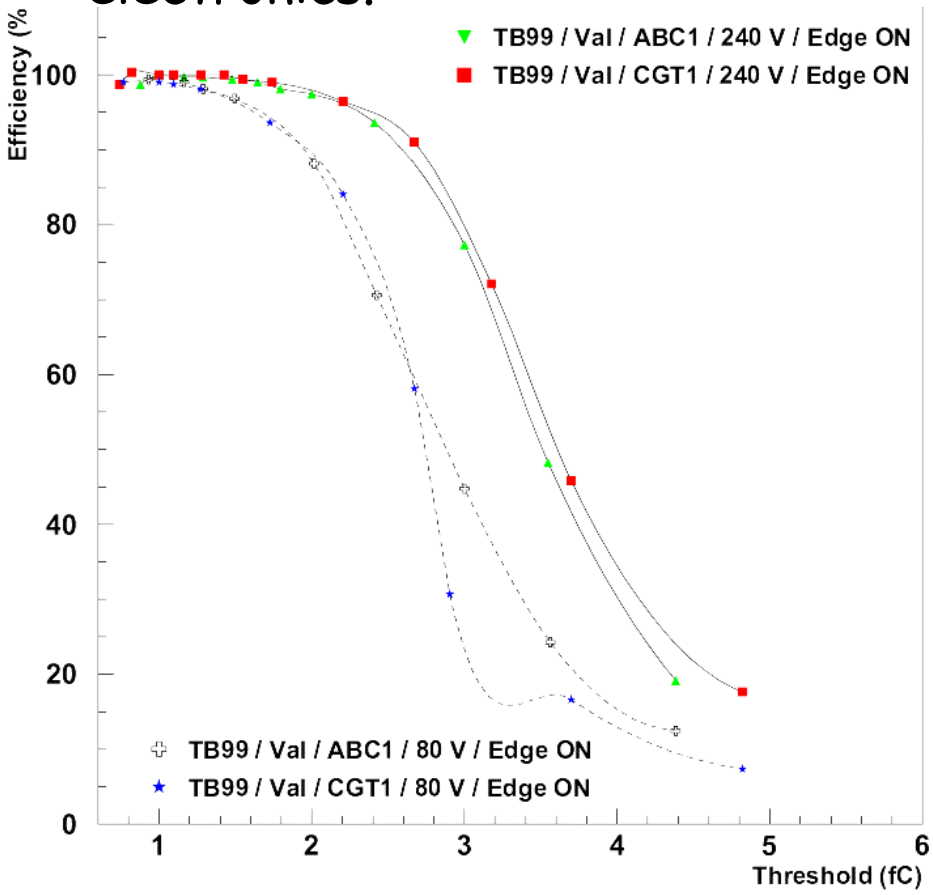
Major Berkeley collaborative efforts - contributions to ATLAS/LHC

- Pixel detector system - a new technology
- Silicon strip detector system - meeting the LHC challenge
- Software and computing - core software and framework
- Physics simulation and studies
- LHC cabling and instrumentation

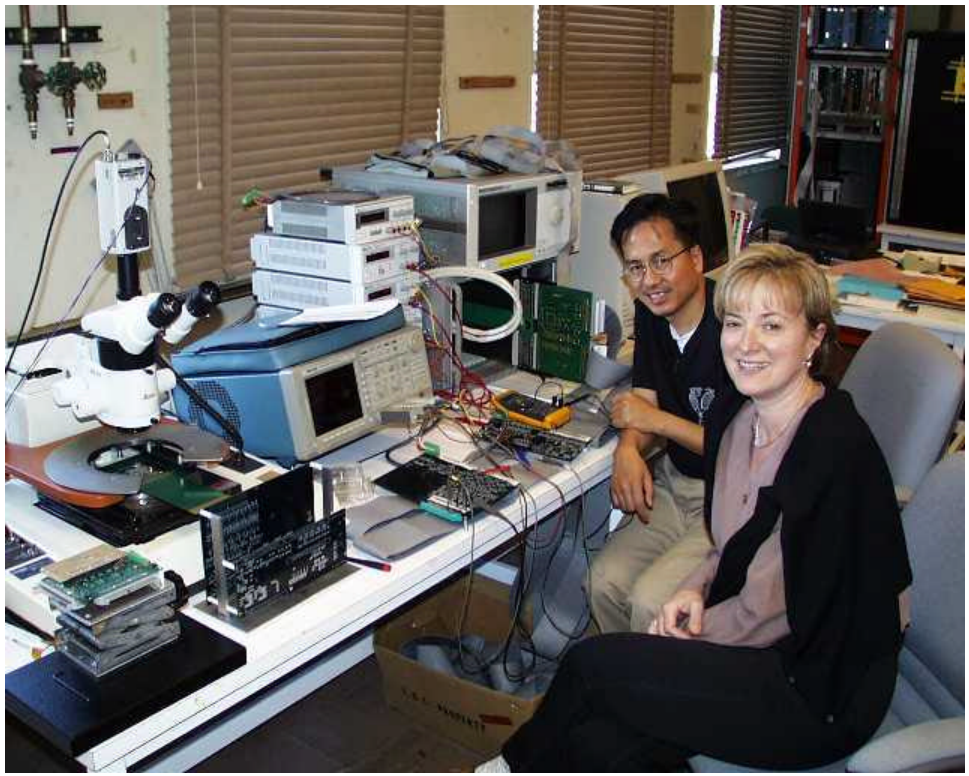


Strips IC testing

- Example of beam test last summer of silicon detectors at two bias voltages with prototype electronics.

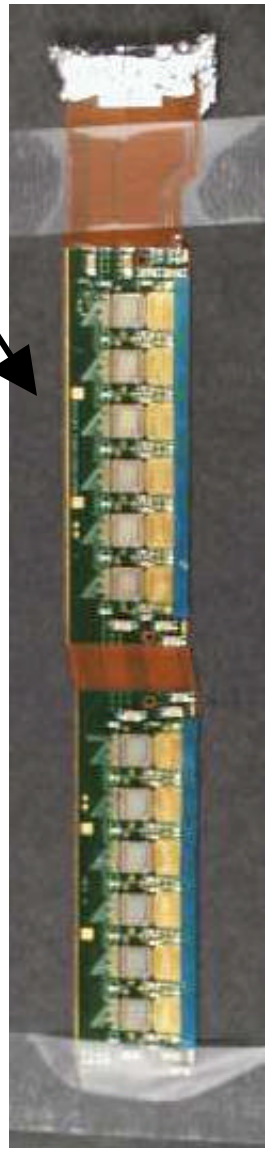


- Up to about 1,000 wafers are to be tested in production.
- High speed test system under intense development at LBNL with expectation of use at Santa Cruz, RAL and CERN.



Hybrid and module assembly

- Hybrid assembly in local firms and at LBNL.
- Testing to be shared between Santa Cruz and LBNL.
- All module mechanical assembly to be done at LBNL.
- Module testing again shared between Santa Cruz and LBNL

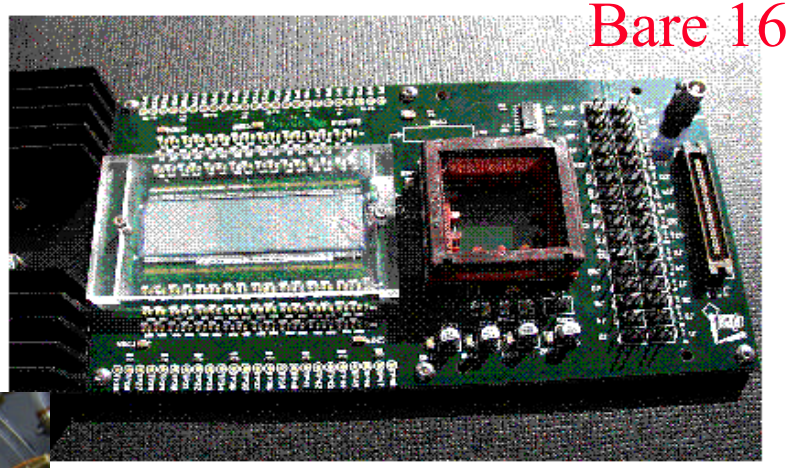


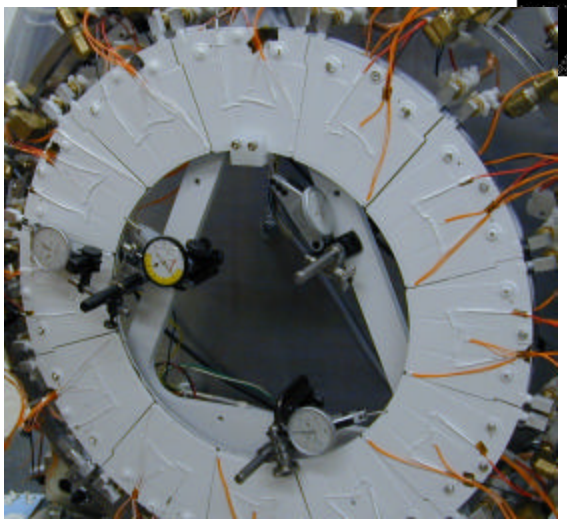
- Module tooling now in recently renovated clean area at LBNL in preparation for production assembly.
- Facility shared with pixels.

Pixel electronics and modules

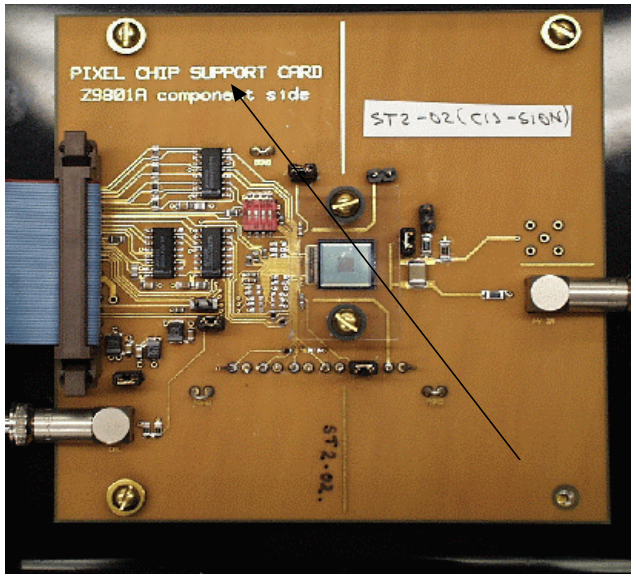
- Full-scale rad-soft electronics prototypes fabricated in rad-soft technologies in 1998 and tested extensively, including with irradiated detectors, since then.

Bare 16-chip modules



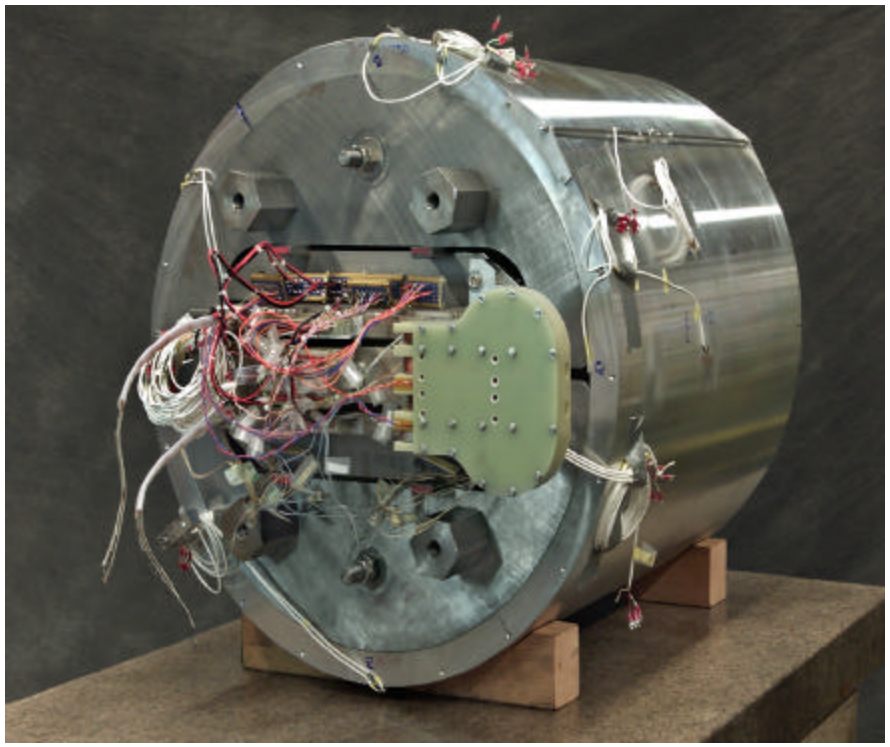


Thermal/mechanical prototype disk fabricated and tested successfully for stability



Dozens of single chip/ sensor assemblies of different types

Major Berkeley collaborative efforts-AFRD Superconducting magnet program(Supercon)



"The jewel in the crown of the national high field magnet program"

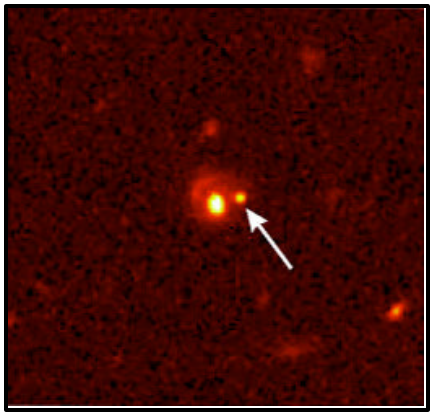
November 2000 DOE Review

RD-3: A 14 Tesla, Nb_3Sn, Common Coil dipole, featuring a simple racetrack coil geometry and a novel support structure design.

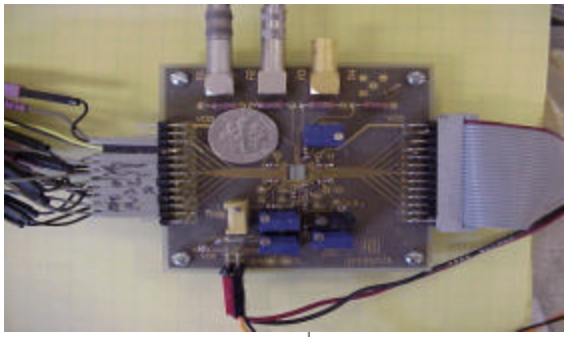
Testing is scheduled for mid-April

Berkeley-led efforts

- Supernova Cosmology Project/SNAP
  - 1998 Discovery of the year-the expanding universe
  - Measure Ω_M, Ω_Λ, explore dark energy properties
  - Development of CCD's for astrophysical use
  - Future SNAP satellite under study



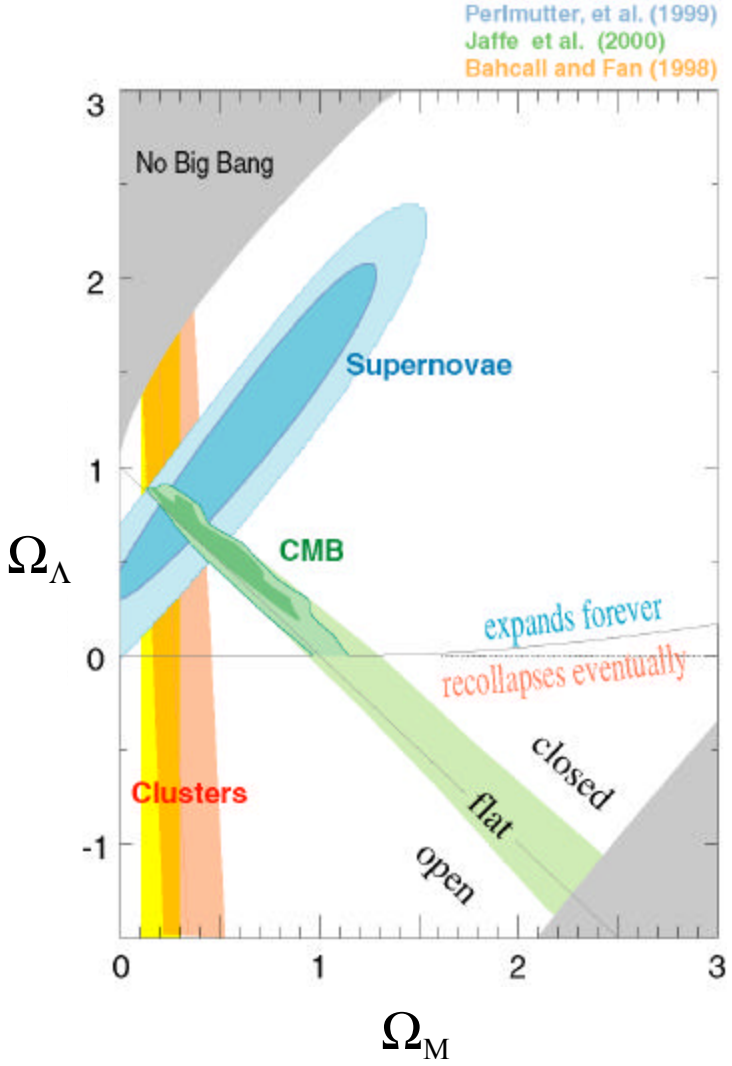
- Optical Particle Acceleration
  - Immediate aim to accelerate bunched electron beams to 40 MeV
  - World's highest current optical accelerator
  - NanoCoulomb, 200 fsec bunches



- KamLAND (joint with NSD)
  - LBNL leads US University contingent
  - Calibration sources and deployment
  - Electronics

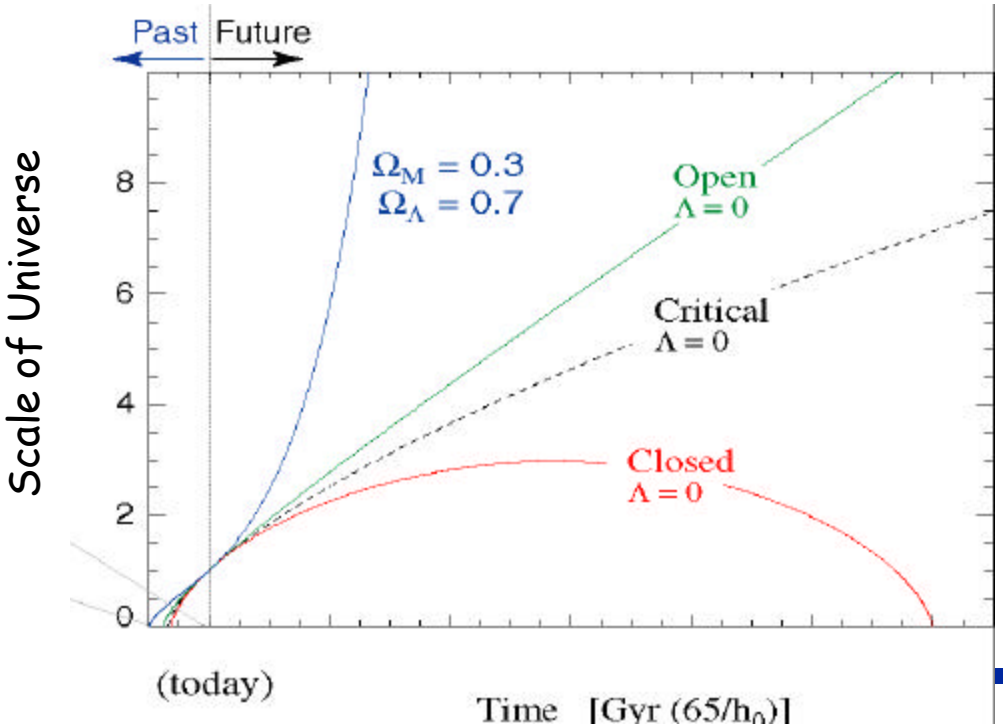
SNAP science background

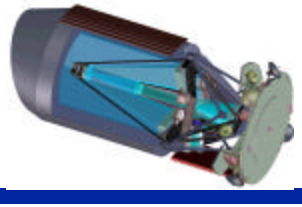
Use Type Ia supernovae to measure the expansion rate. Remarkable agreement between Supernova & CMB.



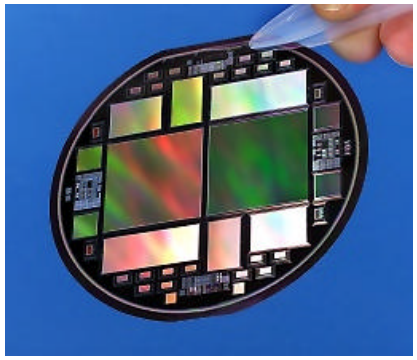
Contrary to expectation, the expansion of the Universe appears to be increasing with time!

What new "dark energy" is responsible?



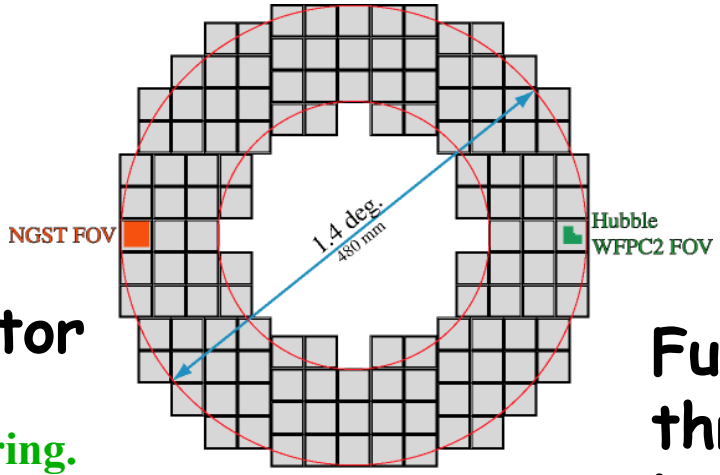


LBNL leads the SNAP collaboration

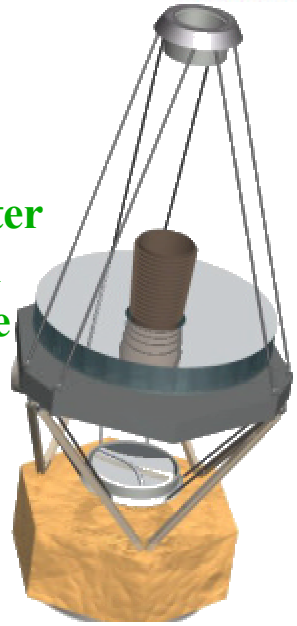


Design & Development of instrumentation packages:

Populate 1° x 1° focal plane with one billion pixels.



2-meter optical telescope



R&D: Novel CCD Detector

Industrialize manufacturing.

High quantum efficiency out to 1 um in the near-IR.

Stable performance in presence of radiation.

Image of moon at same scale

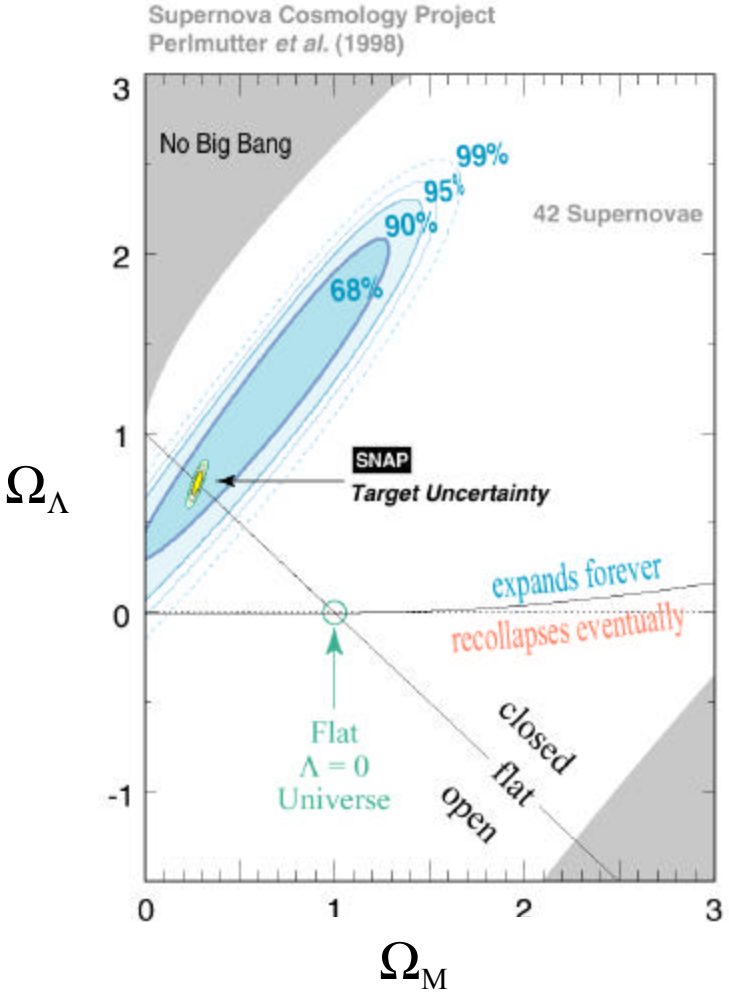
Full System Reviews: through construction & launch

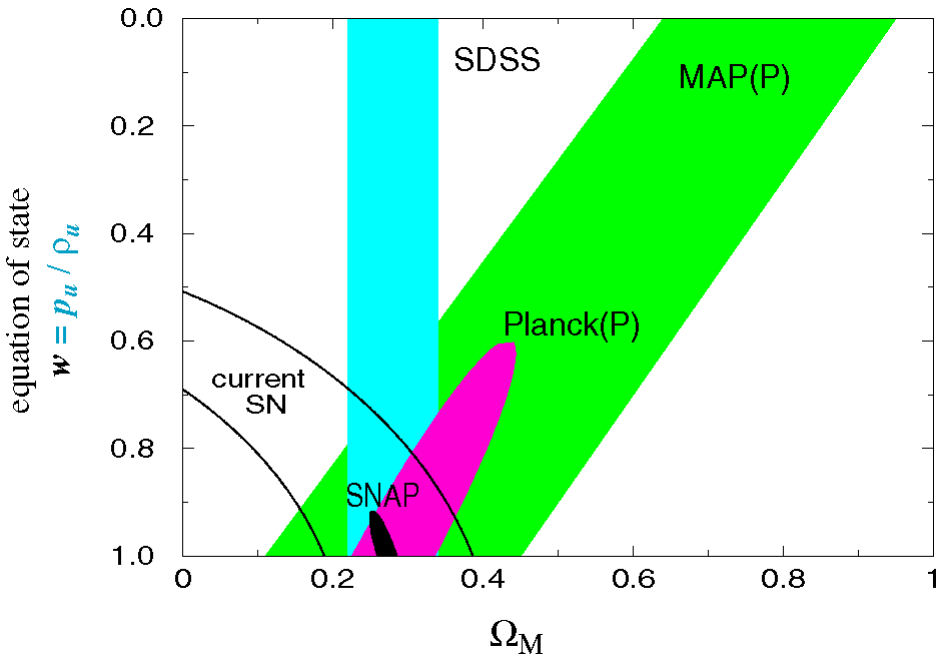
SAGENAP Reviews (3/2000)
R&D Review (1/2001)

"*SNAP is a science-driven project with compelling scientific goals*"

SNAP: a satellite for fundamental physics

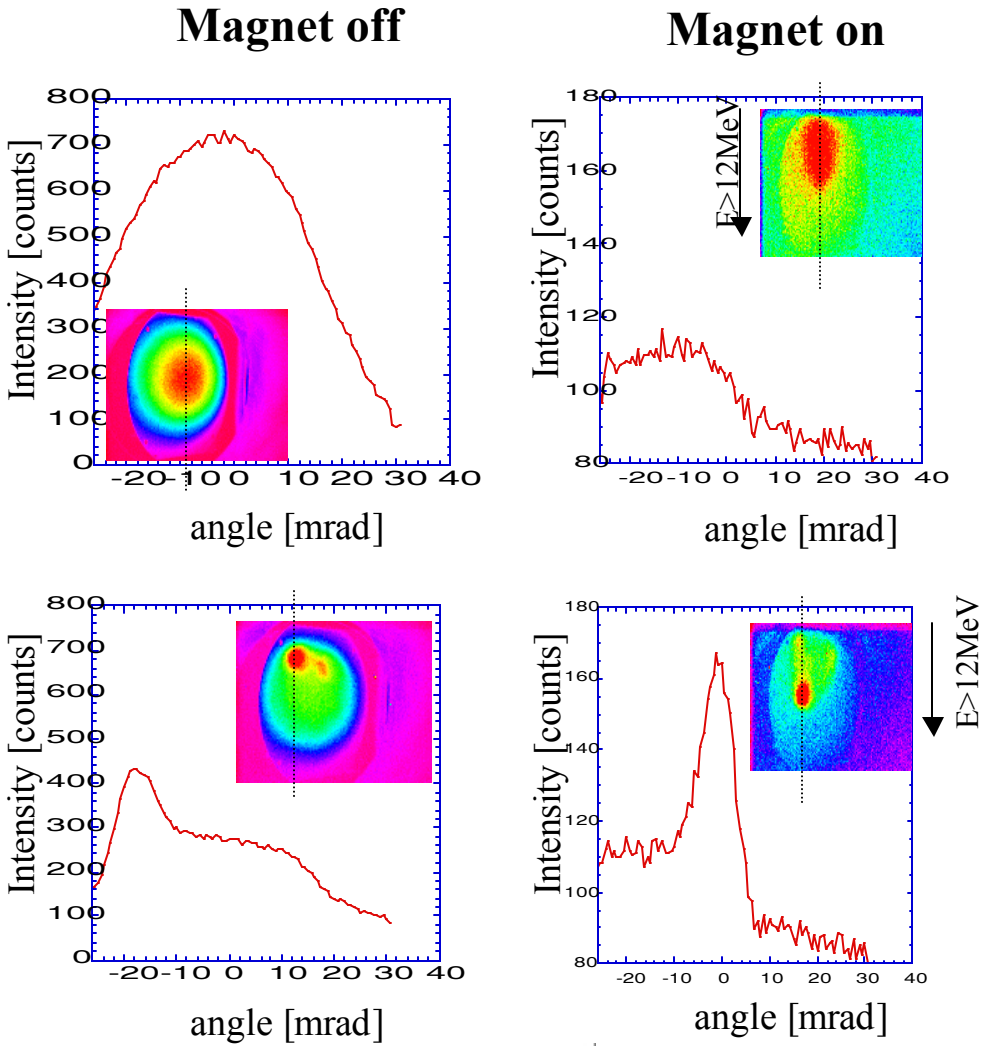
SNAP is designed to study the "dark energy" that dominates the universe, measuring its density and its equation of state to understand its origin, and to differentiate theoretical models (vacuum energy, rolling scaler fields,…)



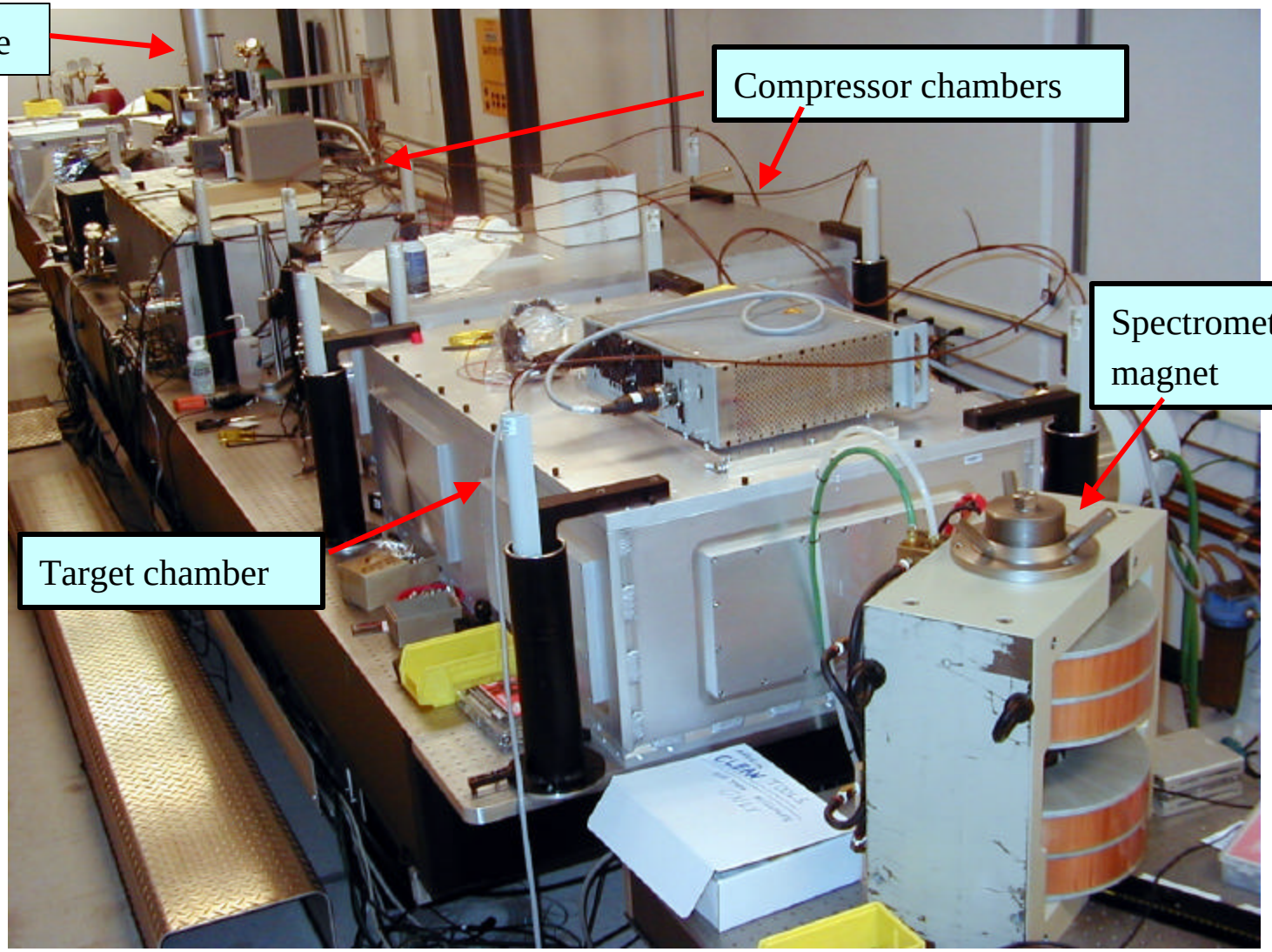


AFRD - Laser plasma acceleration program

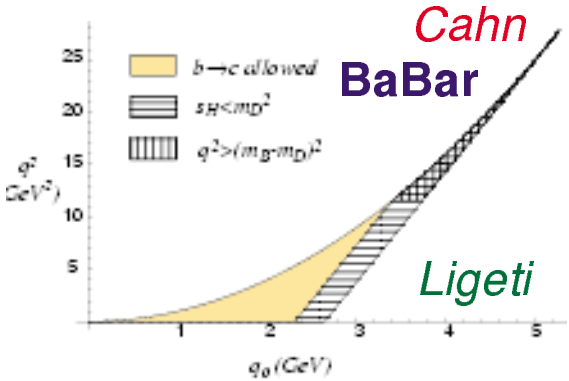
- Self-modulated laser wakefield acceleration
- Observe two different modes of acceleration
- Mode 1:
  - High density plasma
  - High charge: > 5 nC/pulse
  - ~1-2 MeV – tail to 10 MeV
  - Low energy beam (low n and forward γ-rad)
  - Divergence 40 mrad
  - Stable beam output
- Mode 2:
  - Lower density plasma
  - Relativistic channel well defined
  - < 1.5 nC/bunch
  - ~3.5 MeV – tail to 40-50 MeV
  - Low γ_{near}-dose, high n and γ_{far} dose
  - Divergence < 10 mrad
  - Unstable beam output
- Utility as compact injector



Experimental set-up for colliding pulse nearing completion



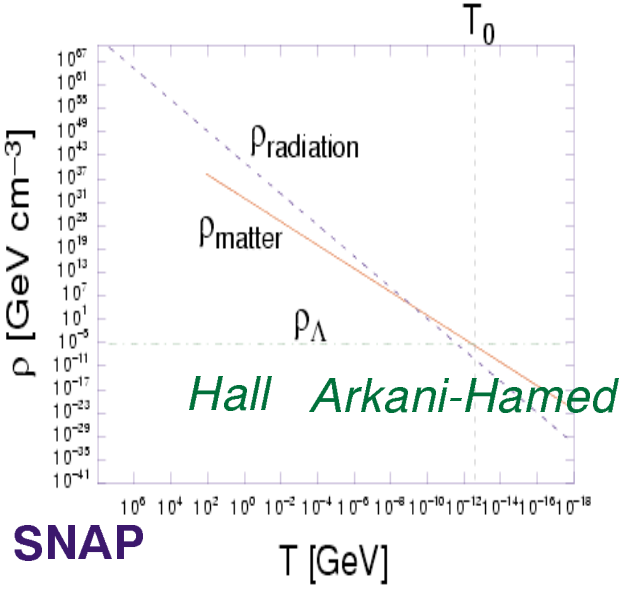
Theory Meets Experiment at Berkeley



Cahn

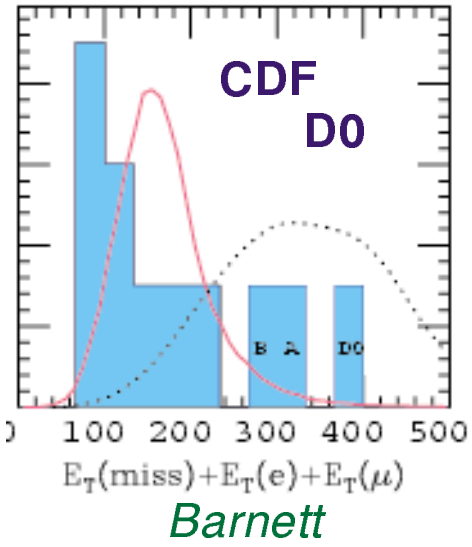
BaBar

Ligeti

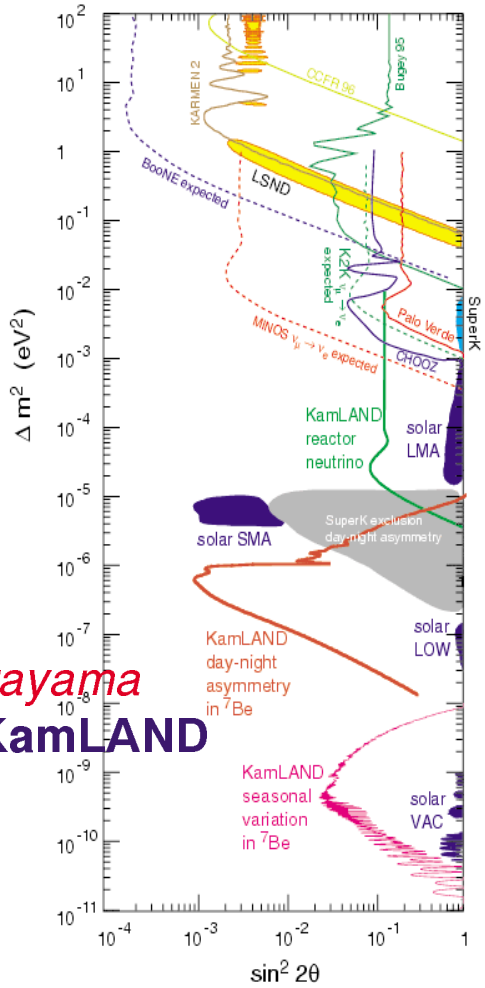


Hall Arkani-Hamed

SNAP

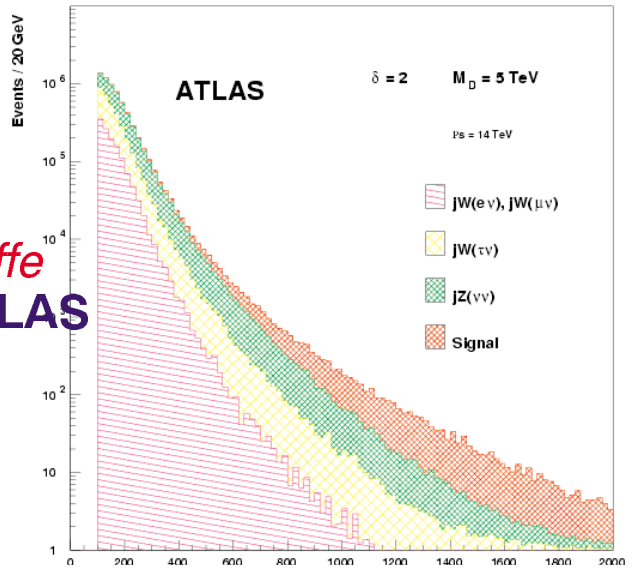


Barnett



Murayama

KamLAND



Hinchliffe

ATLAS

村山 斉

Summary

Berkeley plays an essential role in the National Program
ATLAS – BaBar – CDF - SNAP

- University collaboration enables us to carry a broad program.
- We are starting to reap physics benefits from our major hardware and management contributions over the last few years.
- Major support from LBNL's Directorate for SNAP development.