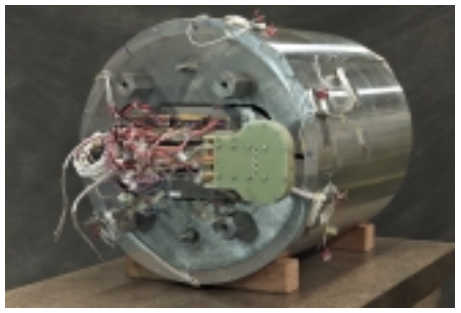
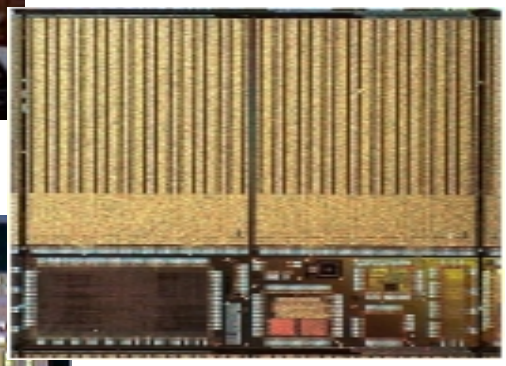
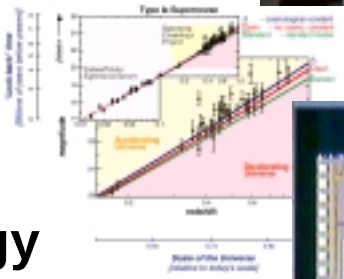
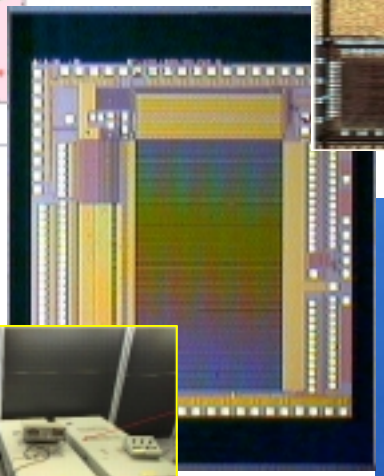
High Energy Physics at LBNL

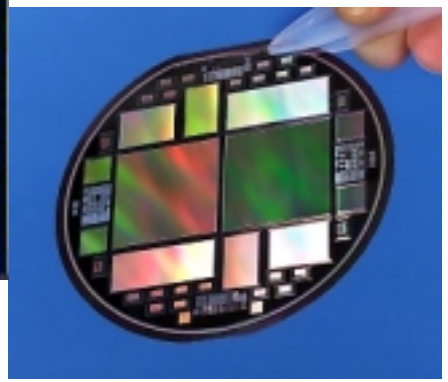
William Barletta

November 7, 2002

LBNL: Creativity and Innovation

- Time Projection Chamber
- SVX chip and first Si vertex detector in hadron collider environment
- Asymmetric B Factory concept
- Smart pixels for ATLAS
- CCDs for astronomy & astrophysics
- SNe cosmology – dark energy
- New paradigm for HEP analysis software
- Leaders in laser acceleration
- Leaders in high field magnets



Combined with Highly Leveraged Infrastructure

- Outstanding faculty supported by UCB
- Small but dedicated full-time scientific staff
- Accelerator infrastructure supported by multiple SC offices
- Excellent technical resources
  - Engineering Division (e.g. IC design)
  - Computing Division (NERSC)
  - Large machine shops, clean room facilities

Synergy leads to creativity and innovation

To Address the Fundamental Questions

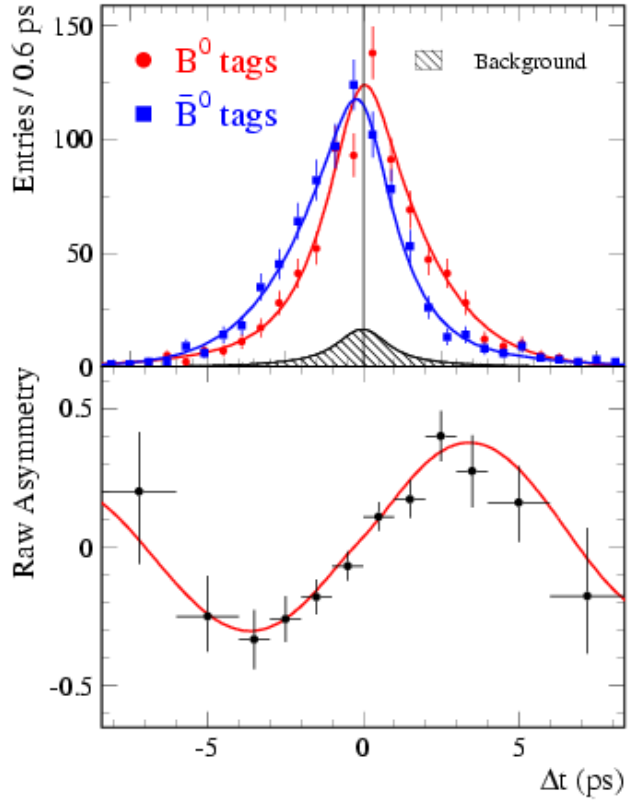
- **Mass [Higgs, SUSY, ν oscillations]**
  - ***—ATLAS, CDF, D0, KamLAND, antarctic ν***
- **Matter [CP Violation]**
  - ***—BaBar, CDF, D0, E871***
- **Origin and Fate of the Universe**
  - ***—CMB, SCP, SNAP***

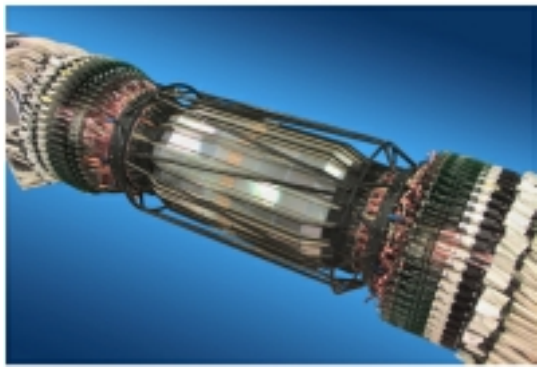
Addressing Limits to Accelerator-based HEP

- **Ultimate practical fields on Superconductors**
- **Ultimate accelerating gradients**
  - ***—All optical accelerators***
- **Ultra-high quality beams**
  - ***—LC damping ring, bright ion sources***

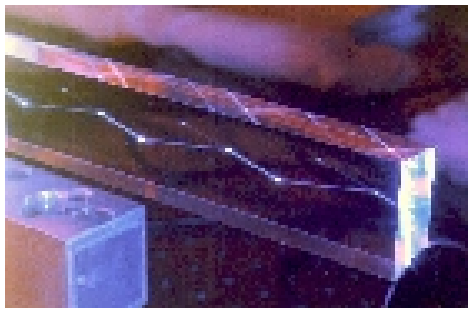
LBNL Contributions Key to BaBAR Major Result

$\sin 2\beta = 0.741 \pm 0.067(\text{stat}) \pm 0.033(\text{syst})$





SVT



DIRC

Trigger

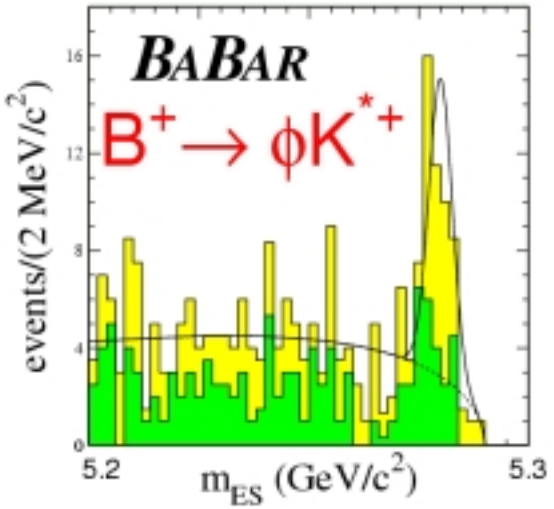
Computing:

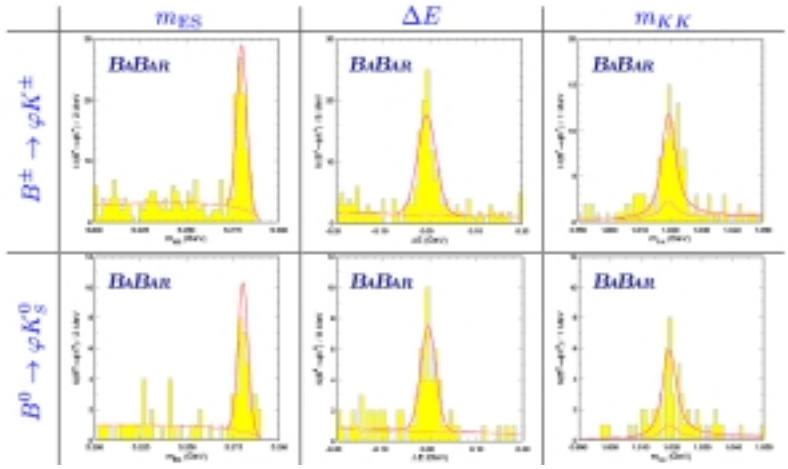
Reconstruction

Online

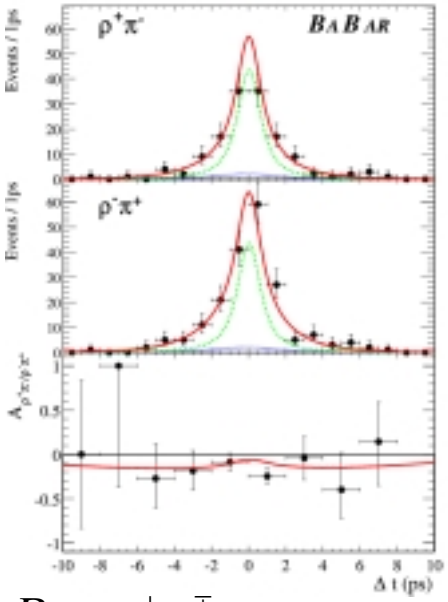
LBNL-led Physics Results

$B \to \phi K^*$

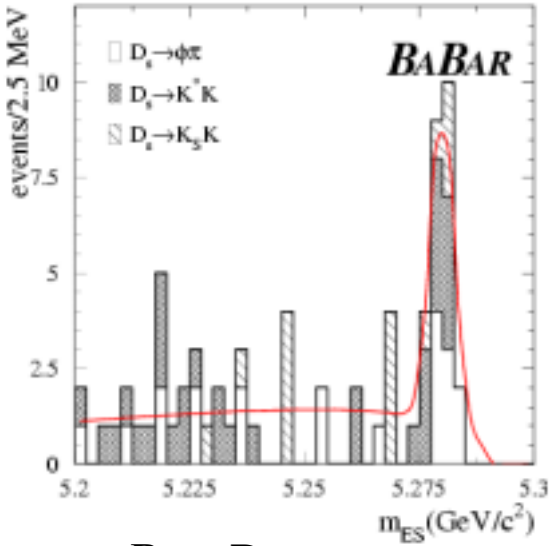




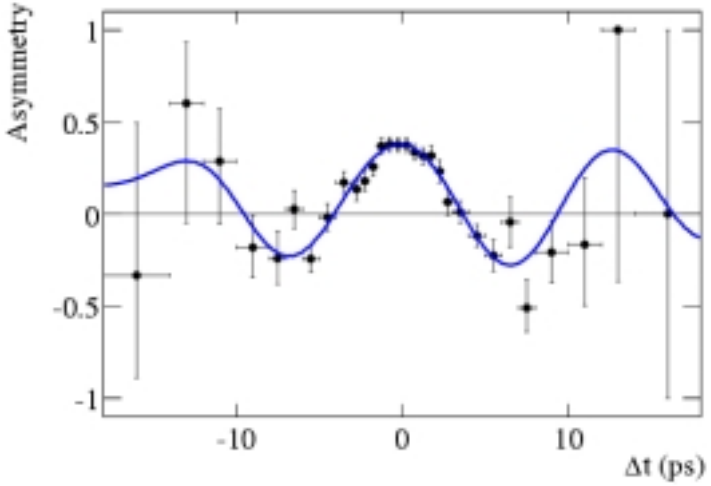
$B \to \phi K$



$B \to \rho^{\pm} \pi^{\mp}$



$B \to D_s \pi$



Mixing in $B \to D^* l \nu$

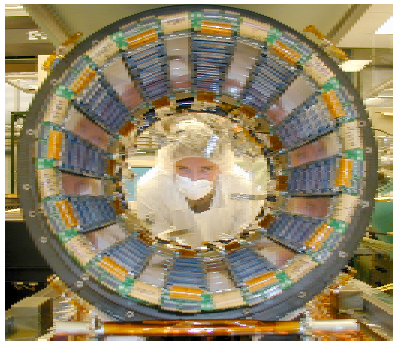
LBNL in CDF Run II Upgrade

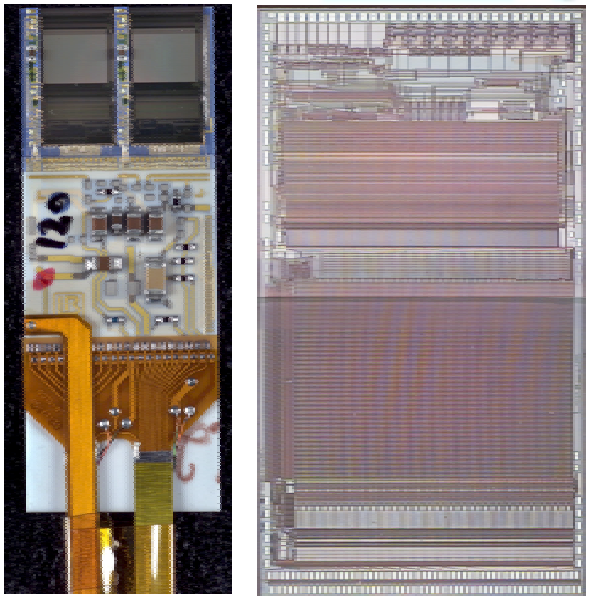
Hardware

- **Silicon: LBNL tradition**
- **COT**

Software

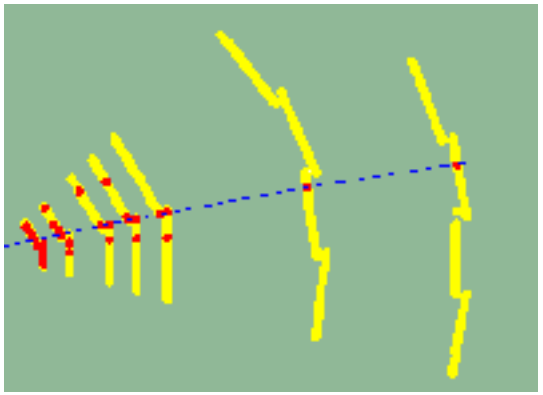
- **Silicon Tracking**
- **Simulation**





Leadership

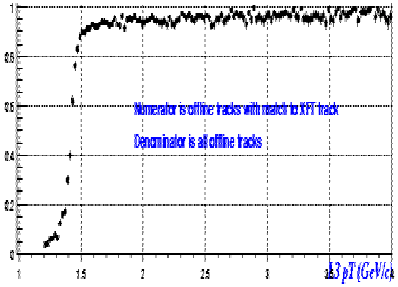
- **One of operations Managers since Jan. 02 (6 months) : Bill Orejudos**
- **Commissioning Czar until Jan. 02 : Young-Kee Kim**
- **Offline Computing Head until Jul. 01, B Physics co-convenor since Jan. 02 : Marjorie Shapiro**
- **Higgs Working group co-convenor since 1998 : Weiming Yao**
- **Jet Correction group co-convenor since May 01 : Lina Galtieri**
- **B-tagging group co-convenor since Apr. 02 : Aaron Dominguez**



Current LBNL / CDF Focus : Performance Studies

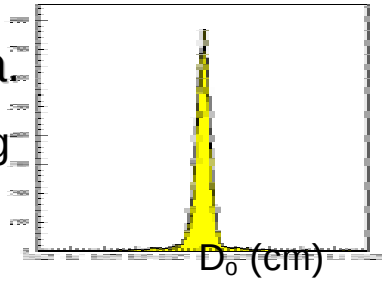
Triggers

XFT : COT Track Triggers



SVT : impact para.

σ = 48 μm including beam spot

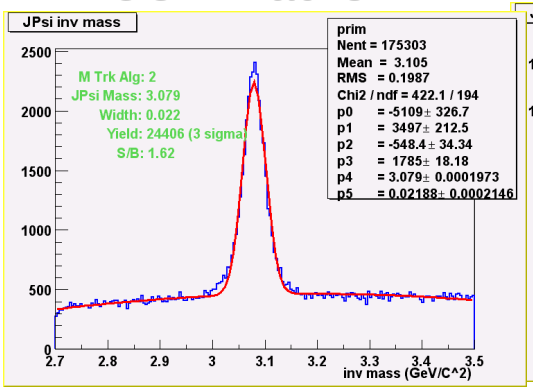


D_0 (cm)

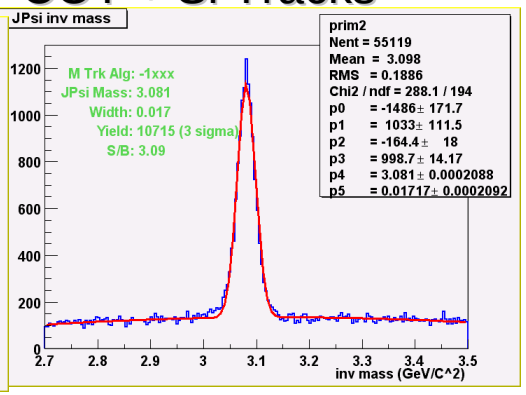
Tracking Performance

$J/\psi \rightarrow \mu^+\mu^-$:

COT Tracks



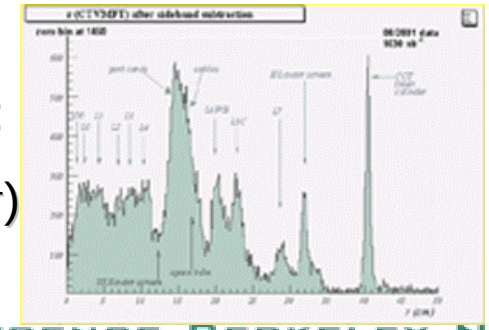
COT + Si Tracks

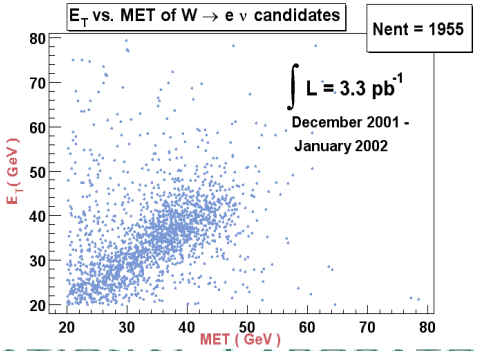


Lepton ID

Low Pt electrons :

γ conversions (e^+e^-)



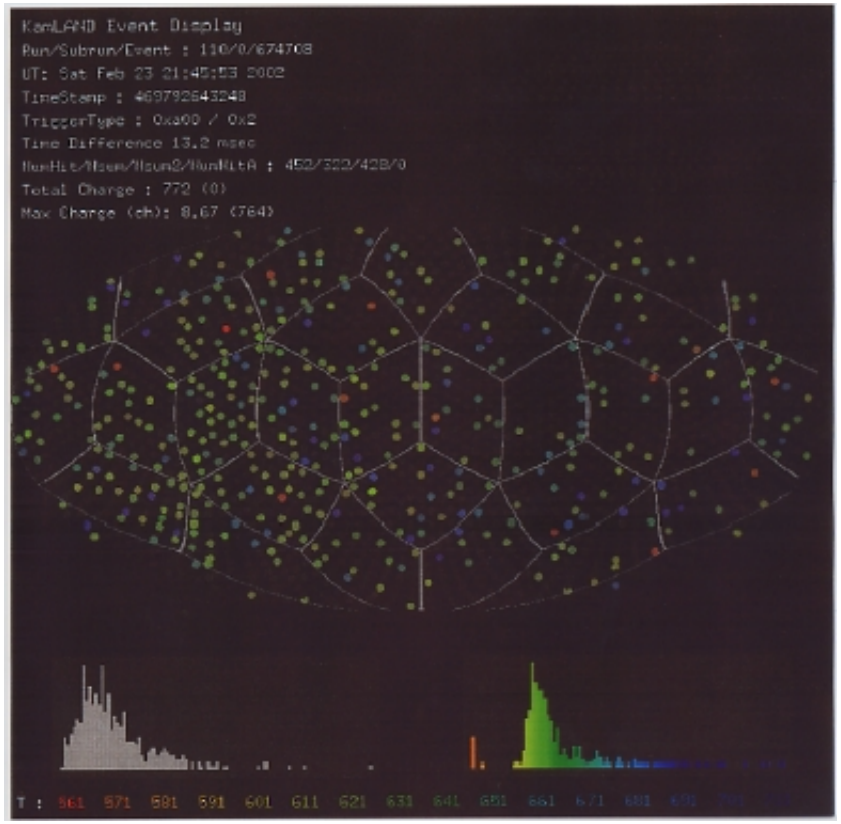


High Pt electrons :

Z $\rightarrow$ e^+e^-, W $\rightarrow$ eν

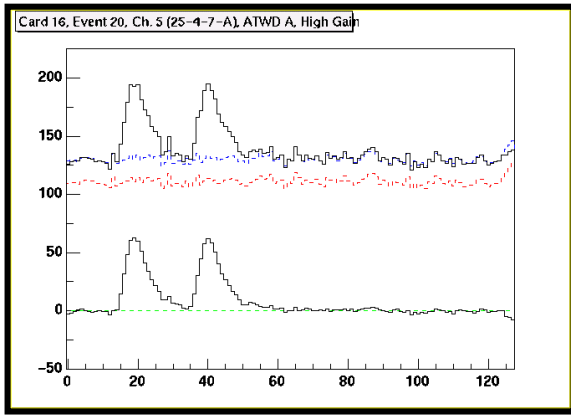
LBNL in KamLAND

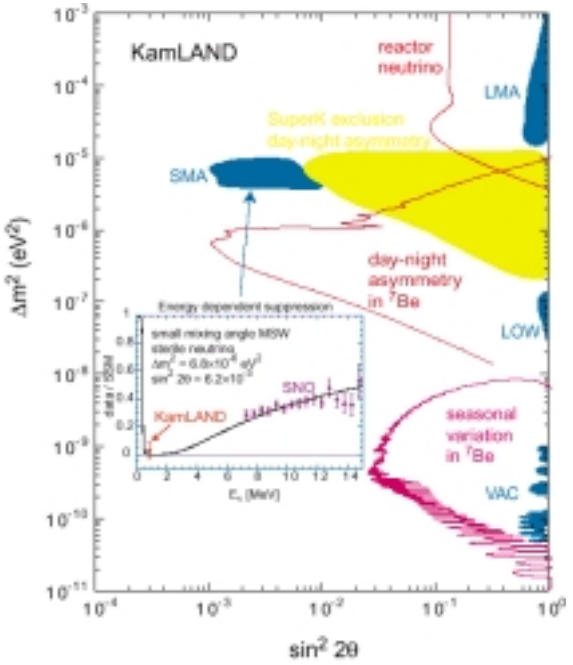
First event



KamLAND 12-channel Front End Electronics Board

Captured Waveforms



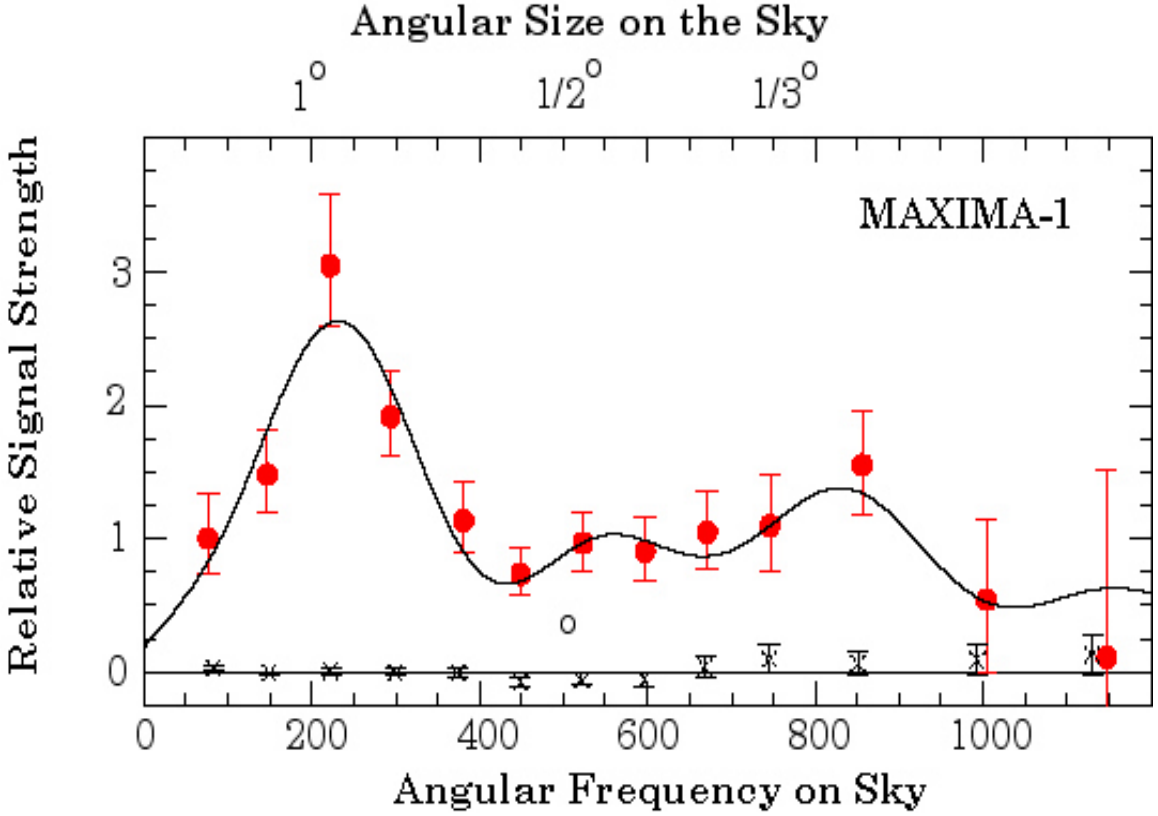


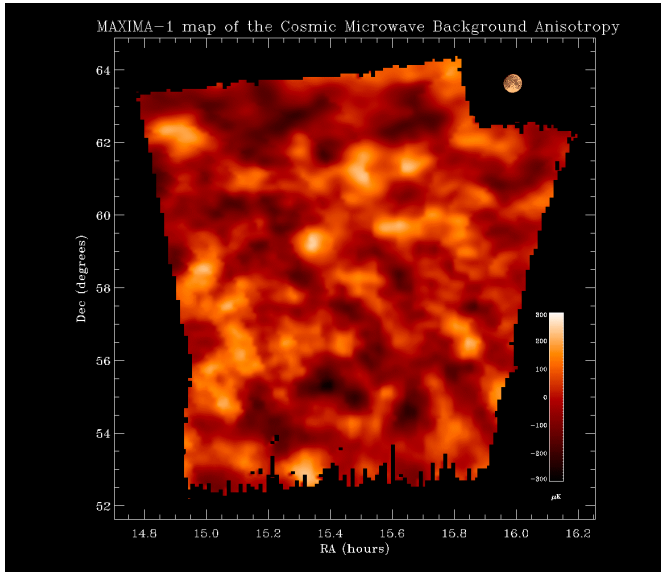
US Co-spokesperson - S. Freedman

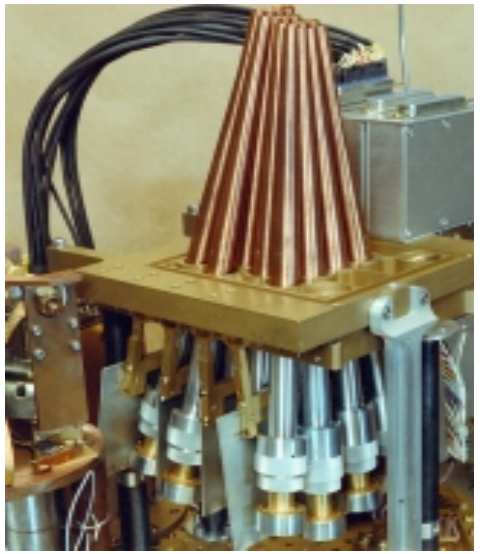
KamLAND will test the LMA solution to the solar neutrino problem with a reactor experiment.

Fast wave form capture developed by Nygren allows KamLAND to separate multiple photon hits.

LBNL Cosmic Microwave Background







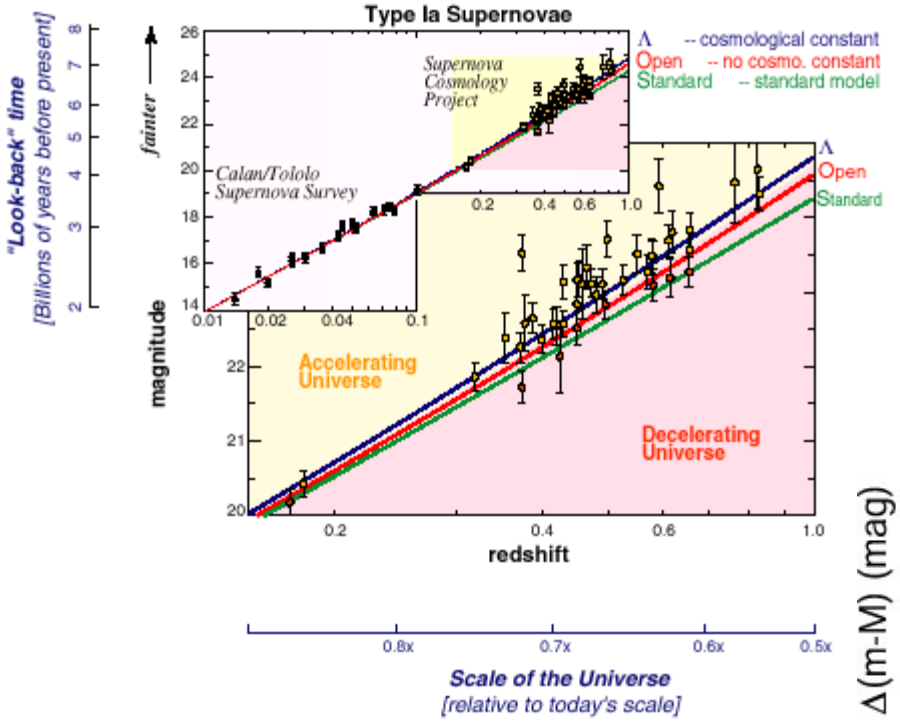
Location of first peak implies flat universe. Location and width support inflation. All three peaks consistent with this interpretation.

Next step: Polarization

Pioneers in Supernova Cosmology

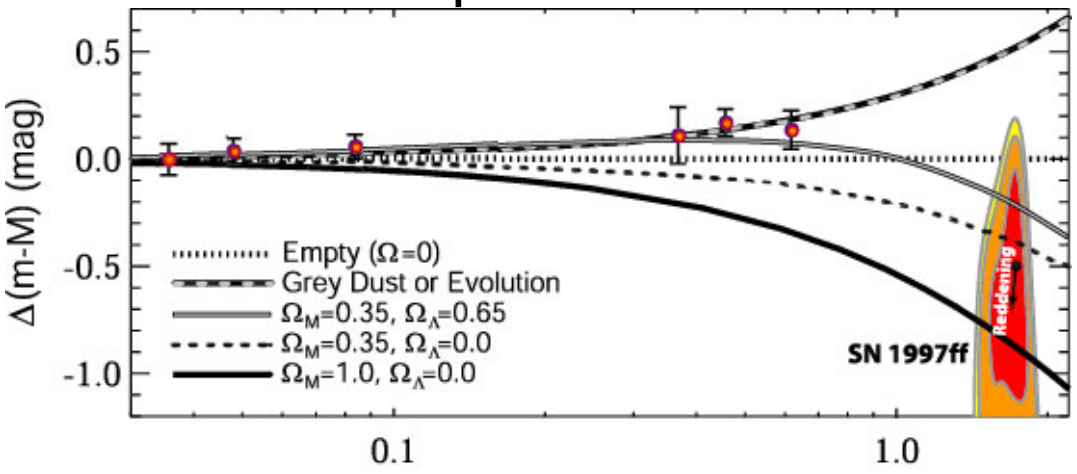
Supernova Cosmology Project

(Perlmutter, et al)



LBNL established the new field of distant supernova cosmology, discovered acceleration of universe.

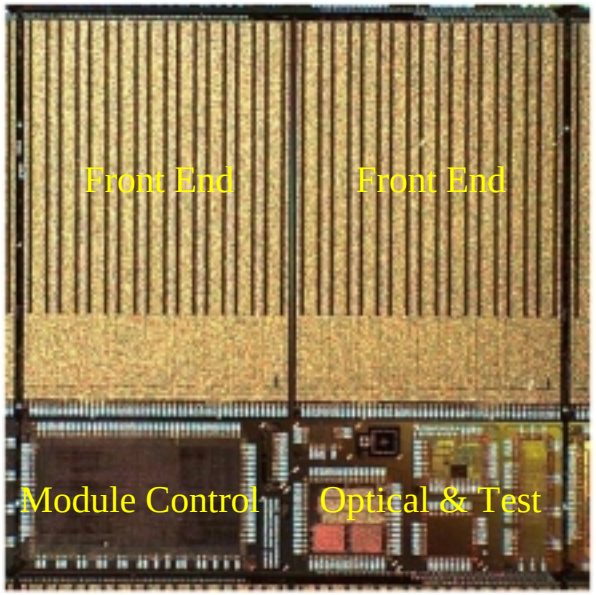
New very distant supernova supports dark energy/cosmological constant interpretation.



Next Step: SN Factory – a nearby SN search

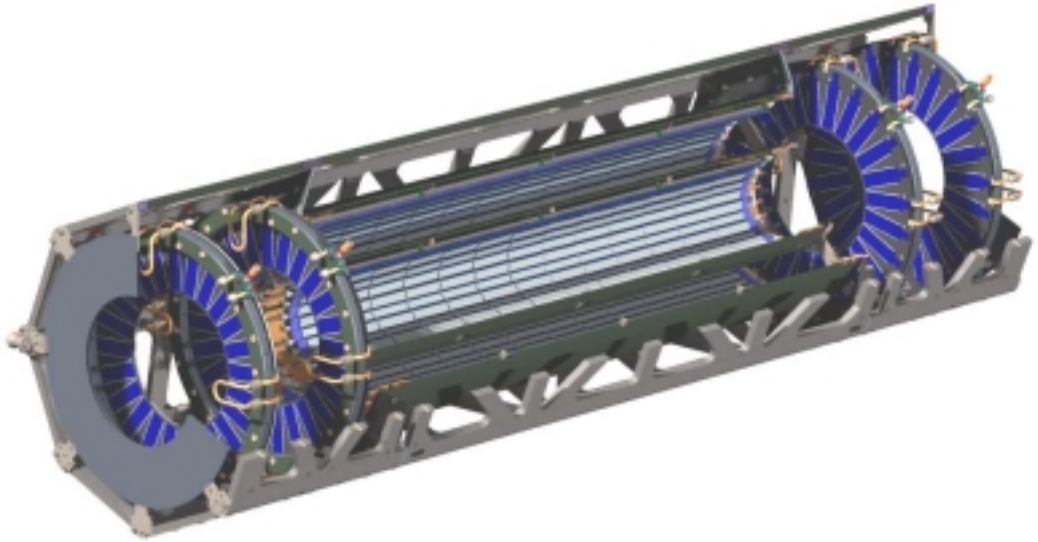
Breakthrough in Pixel Electronics for ATLAS

Pixel Integrated Circuits



Rad-hard deep submicron circuits available since January. THEY WORK!
LBNL has led lab and test beam studies for 1st demonstration that LHC requirements can be met.
(K. Einswiller : Electronics coordinator)

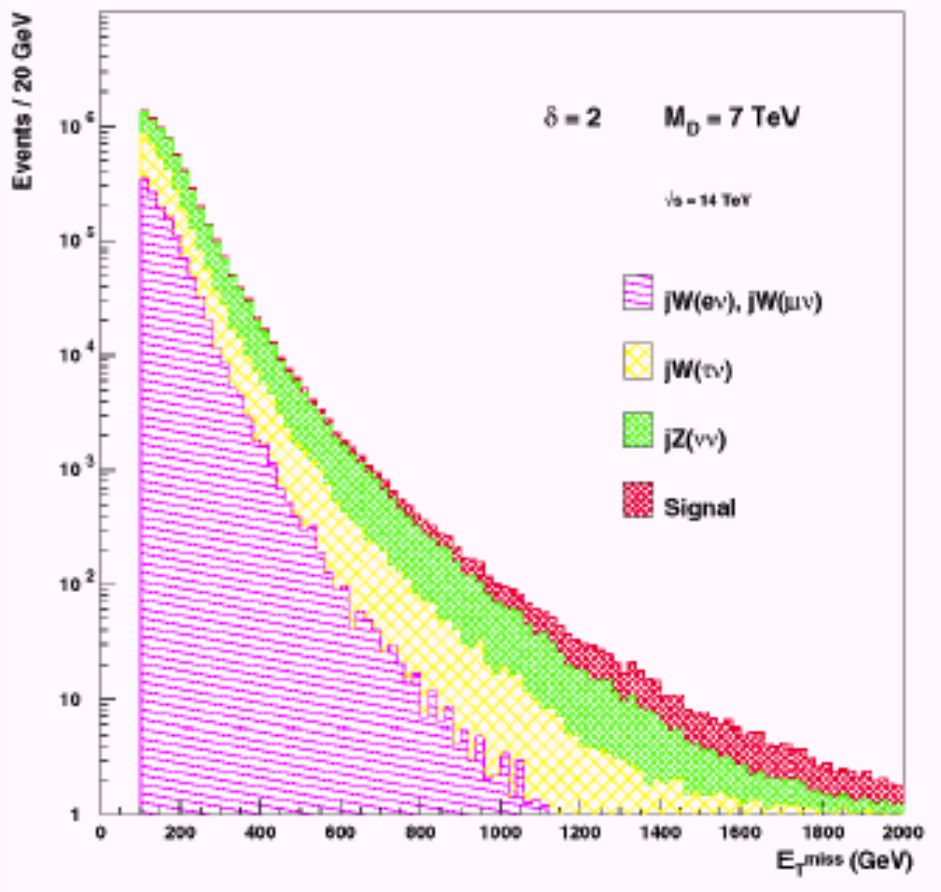
Mechanical structure fabrication underway.



We must meet our commitments in ATLAS

ATLAS Physics and Computing

Missing Energy Signal for Extra Dimensions



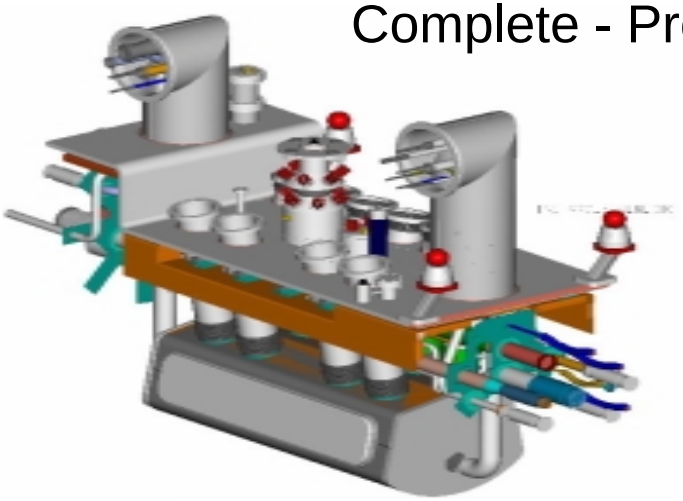
Hinchliffe is US ATLAS physics coordinator, ATLAS deputy physics coordinator.

Quarrie is ATLAS Chief Software Architect. LBNL-designed ATHENA software framework adopted as ATLAS standard and used in first major data challenge.

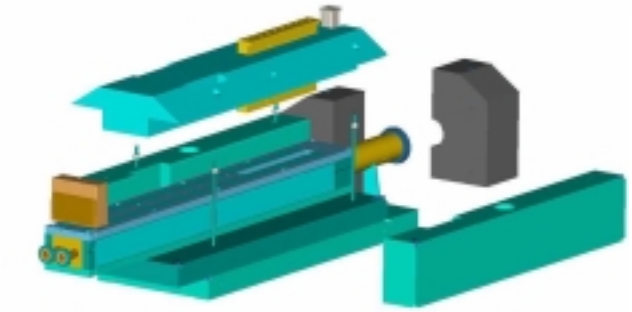
US LHC Accelerator Project : LBNL TASKS 70% COMPLETE

All cabling tasks completed

IR Cryo-feedbox design Complete - Procurement in Progress



HTS leads in production

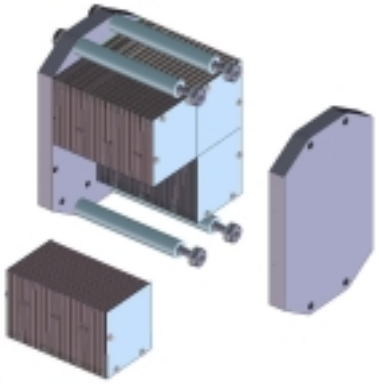


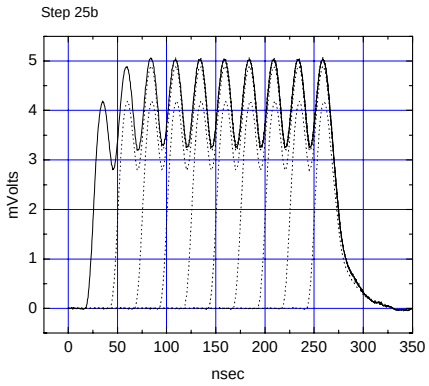
TAS & TAN absorbers in assembly

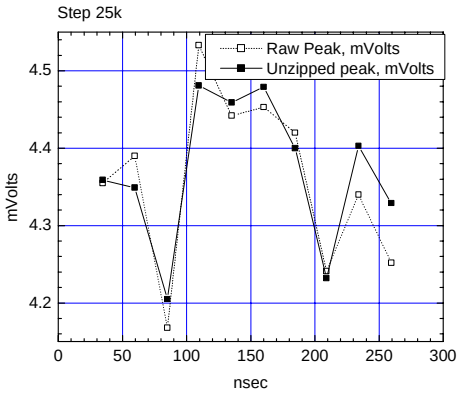
LBNL, FNAL & BNL Planning New US LHC Accelerator Research Program

Instrumentation :

- IR Absorbers supplied by LBNL as part of the US LHC Project can be instrumented for 40MHz luminosity optimization
- Tests on SPS 450 GeV proton beam demonstrated 40MHz capability
- Concept for longitudinal density measurements being tested at ALS



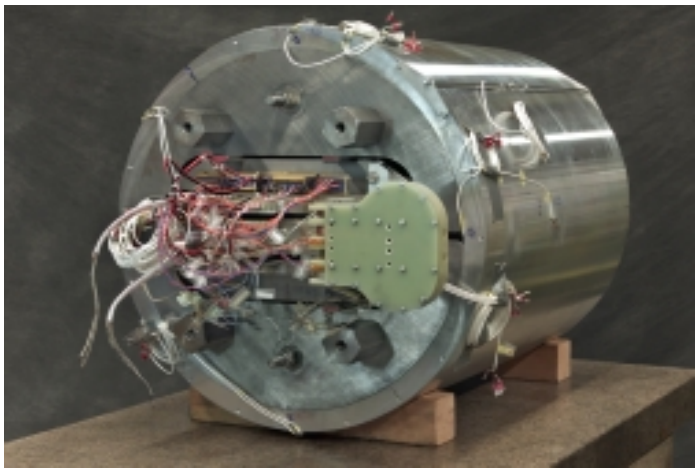


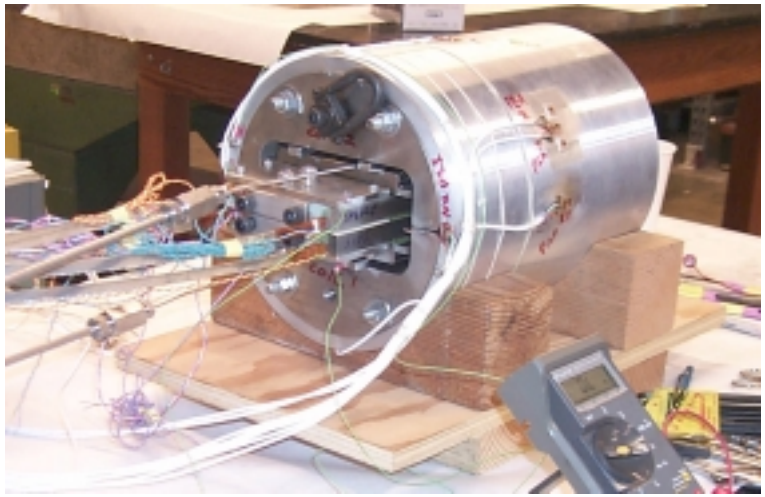


LBNL Superconducting Magnet Program

- **High Field Magnet Program at LBNL has established Nb_3Sn as the enabling technology for the next generation IR quadrupoles and dipoles for the LHC**

World Record Dipole Field
14.7 Tesla
(S. Gourlay)





Sub-scale magnets allow rapid prototyping of new design options

- **National Conductor Program has more than tripled Nb3Sn performance** (R. Scanlan)

Supported by DOE Office of Science, HEP Division, Advanced Technology R&D Program

Linear Collider

- Accelerator Design – Damping Ring Complex (A. Jackson)
- Large Snowmass involvement (Hinchliffe, Murayama, …)
- Active roles in guiding the effort – 2 of 8 members of US LC Executive Committee; US LC Steering; Tracking Working Group Leader (N. Roe)
- Time scale is so long that LC detector design warrants a futuristic R & D effort

Supernova : New Developments

NASA : Structure & Evolution of the Universe
Strategic plan will be officially out this fall

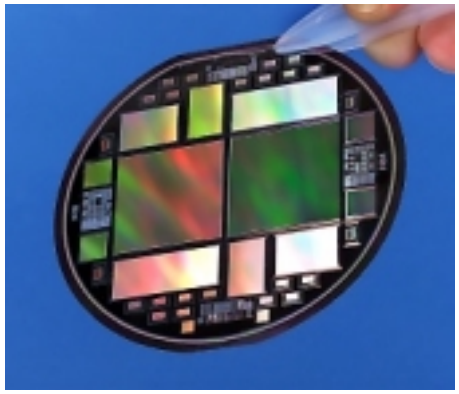
National Academy recommends :

> **"the committee further recommends that NASA and DOE work together to construct a wide-field telescope in space to determine the expansion history of the Universe and fully probe the nature of Dark Energy"**

Lehman Review : "SNAP is ready to go to DC-0, when deemed appropriate by DOE"

Under LBNL Leadership

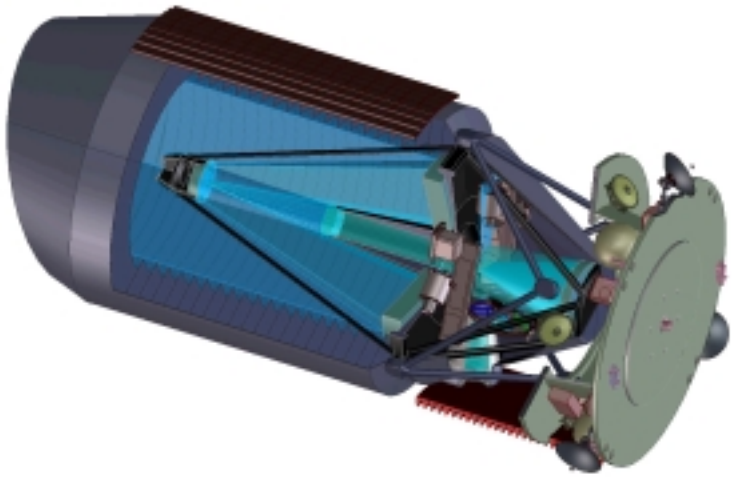
SNAP: An Example of LBNL Innovation at Work



- **CCD development – A new instrument for science**
  - **Very heavy support from LBNL discretionary funds**
  - **New capability with broad potential impact outside HEP**
- **Berkeley's Space Sciences LAB (SSL)**
  - **Extensive experience in space missions**
  - **SSL & LBNL form engineering backbone for the team**

FY03: CDØ, progress on open R&D issues, move toward conceptual design and costing in FY04.

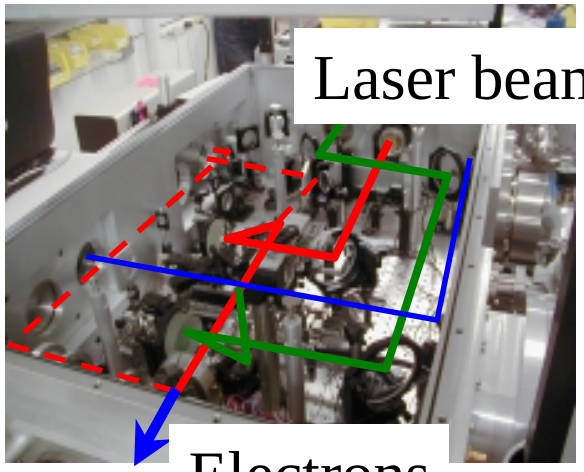
Rapid progress requires the effort to ramp up.



Laser Driven Accelerator R&D at l'OASIS Lab

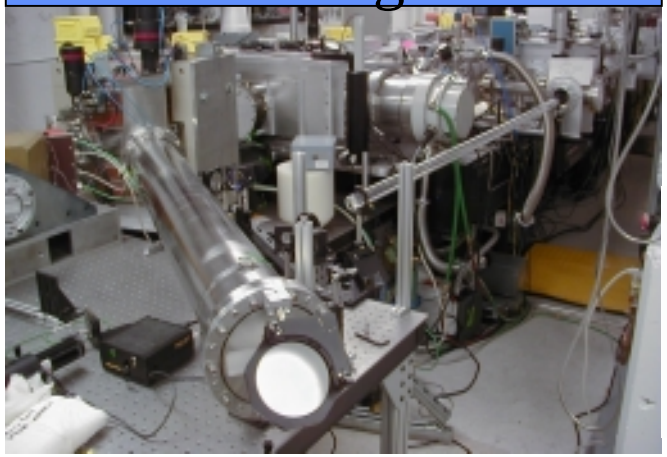
Test bed for R&D concepts towards 1 GeV module of a laser accelerator
Training of postdocs and graduate students
Facility includes 10 TW, 50 fs laser system @ 10 Hz (100 TW under development)

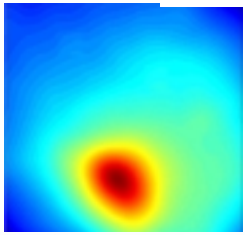
10 TW Ti:sapphire



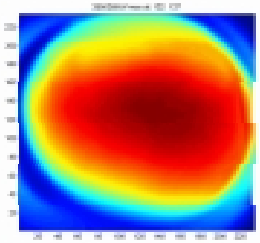
100 TW Ti:sapphire Under construction

Shielded target room





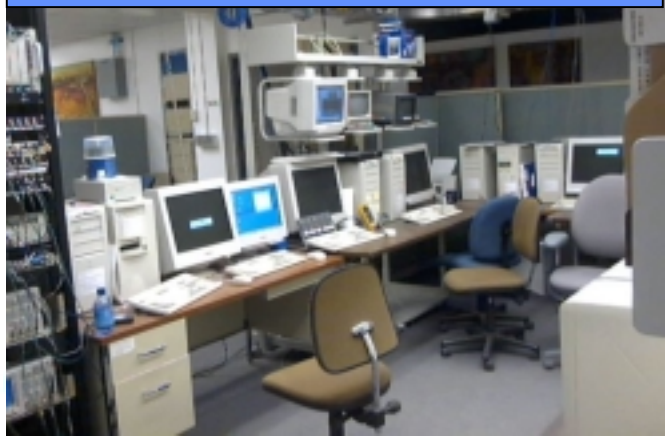
High energy
< 10 mrad



Low energy
100 mrad

NATIONAL LA

Control Room



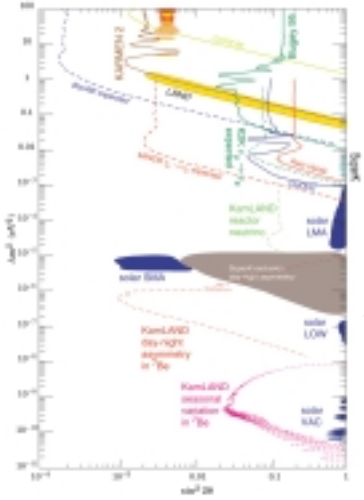
Particle Data Group

Review of Particle Physics
Census/Survey Activities
Education/Outreach Programs

More than 100 authors, 700 contributors.
Substantial CERN, Japan & other involvement.
Resembles leading a medium-sized experiment.

PDG Collaboration meeting

Neutrino Data



RPP has 650 new papers, 2000 new measurements, 98 reviews.
Book is 900 pages, booklet is 300 pages.
28,000 Booklets, 14,000 RPP books, website: 5-10 million hits/year.
10,000 citations.

- **Improved coverage though vital PDG workshops: Neutrino, CKM, and Extra-dimensions Workshops**
- **Growing coverage of Astrophysics and Cosmology**

Service to the Community

Nygren, Perlmutter	National Academy of Sciences
Gaillard	National Science Board
Barnett	Vice-Chair, APS Calif. Sec.
	VP AAPT No. Calif. Sec
	Chair, ATLAS Outreach
Roe, Jackson	HEPAP
Roe	FNAL PAC
Trilling	APS Past-President
Sessler	Spokeperson, Muon Collider/ν source
Barletta	Executive Committee, APS DPB
	Chairman, USPAS
Leemans	Chair, ICFA Panel on Advanced & Novel Accelerators
Barletta, Turner	US-LHC working group
Hinchliffe	US ATLAS Physics Coordinator,
	ATLAS deputy physics coordinator
Siegrist	US ATLAS Institutional Board Convener
Oddone	MUCOG, LHC oversight
Zisman	Muon Collider/ν, Program Manager

Prospects

We look forward to great physics!

CP violation

Higgs

SUSY

Dark energy

Extra dimensions and even more

And great technology

All optical accelerator at 1 Gev and beyond

Practical Superconducting materials & magnets at >15 Tesla