Laboratory for Elementary-Particle Physics (LEPP)

Particle Physics,
Accelerator Physics,
Particle Theory
(xray science)

Mainly NSF-funded + some important DOE pieces

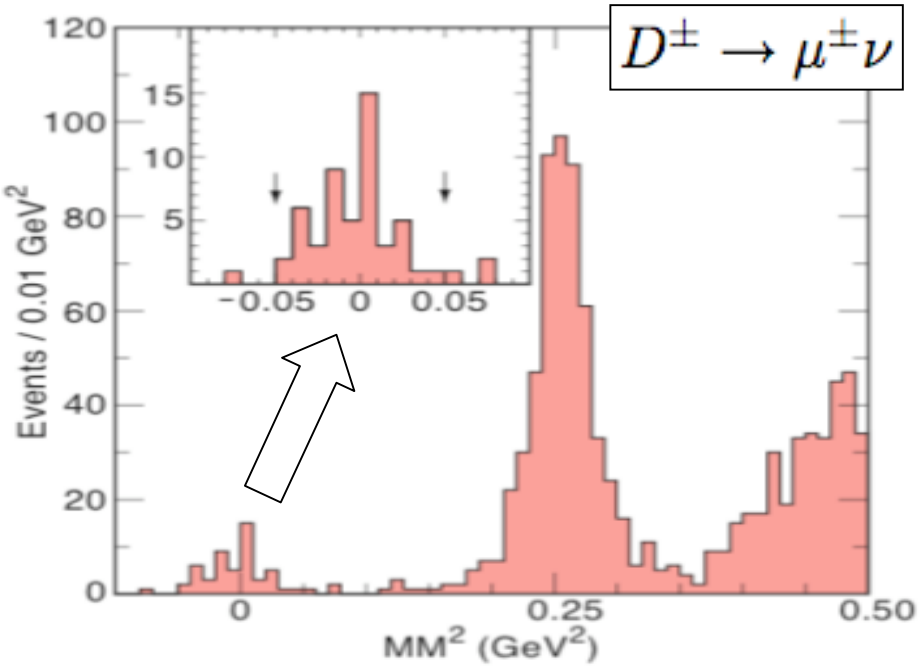
Wilson Laboratory
- accelerator complex
  - CESR e+e- storage ring
  - CLEO experiment
  - CHESS - xray facility

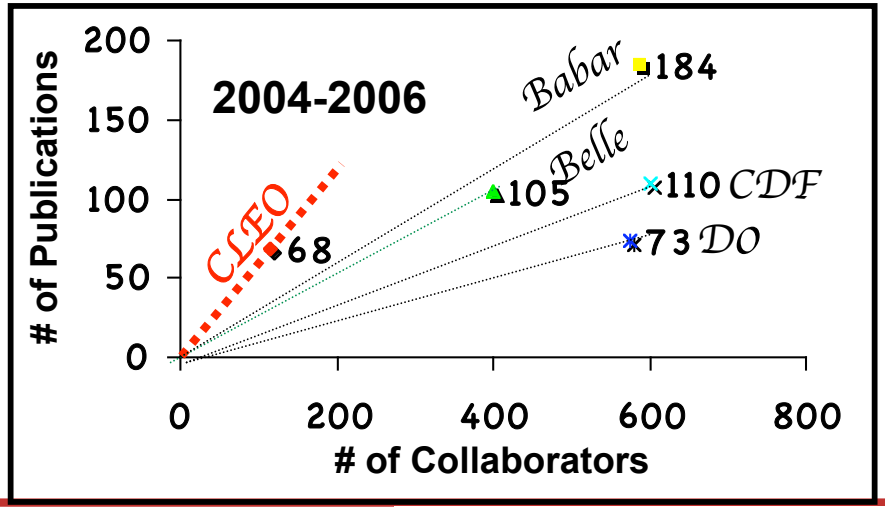
A Lab in Transition

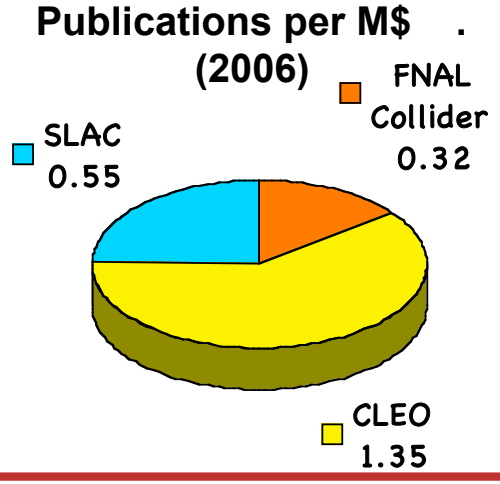
- CESR-CLEO program has run for 28 years, but all good things come to an end. CLEO turned off for the last time on Monday, March 3rd
- CLEO-c proposed in 2002, funded in 2003, was by design the end of the line for on-site particle physics at Cornell:
  - The frontier of the field is moving on; we want to be there.
  - Set sights on LHC & ILC. Joined CMS in 2005.
- Accelerator expertise: apply to
  - Xray science. Energy Recovery Linac - high brilliance, highly coherent source
  - Future particle physics: ILC accelerator R&D + generic SRF R&D
- Vision of the long term future:
  - Xray science will dominate the local facility at Cornell.
  - Experimental particle physics will be carried out where the energy frontier is.
  - Accelerator physics will have both an xray and particle physics component.

CESR-CLEO

- **Since 2003: CLEO-c**
  - Weak decays of Charm Mesons D, D_s
  - Lattice QCD Benchmarking
- **CLEO ended data taking this week*.**
  - 20 PhD, 30-50papers in the pipeline
  - Collaboration size now about 110
- **Historical accomplishments of CLEO**
  - $b \rightarrow u$, $b \rightarrow s$, ... $b \rightarrow c$
  - 466 papers, 255 PhD theses



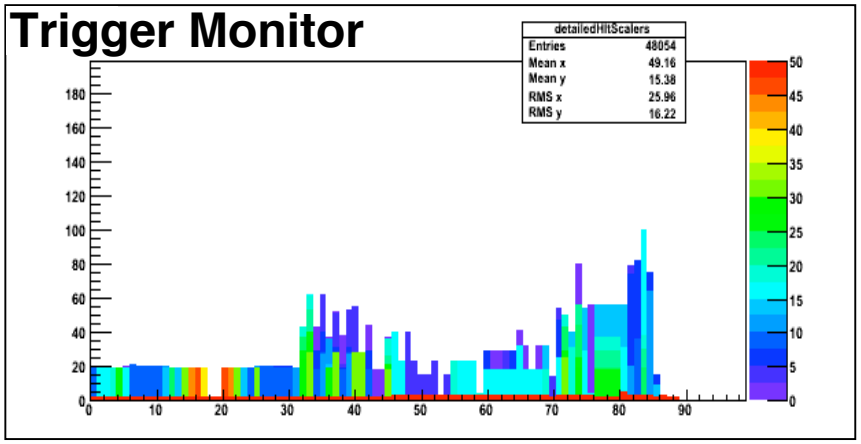


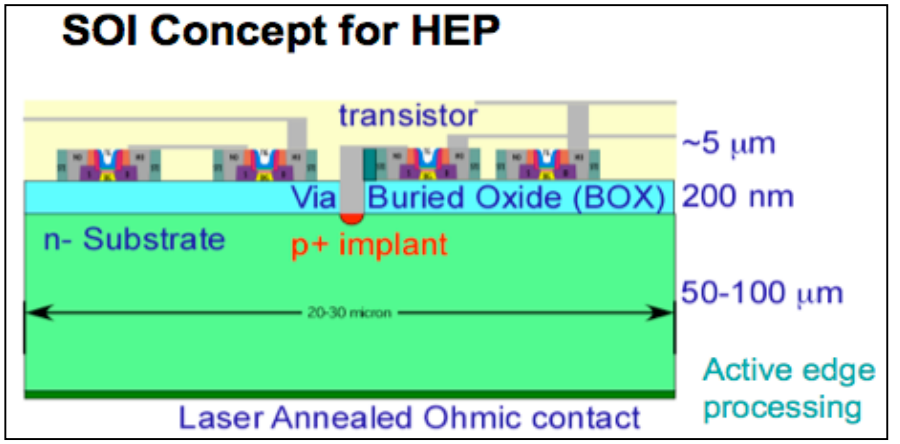


* One month early due to FY08 budget shortfalls

- Cornell joined CMS 3 years ago
- Responsibilities:
  - Pixel calibration/online software
  - ECAL geometry & alignment
  - Trigger - monitoring, emulation, HLT algorithms
  - Core Software - Framework, Physics Tools, Data Bookkeeping Service, user help

- Physics
  - Leptons + Jets + MET
  - SUSY
  - Little Higgs
- Upgrade (SLHC) projects:
  - Monolithic pixel sensor R&D (SOI)
  - New track-trigger studies/design

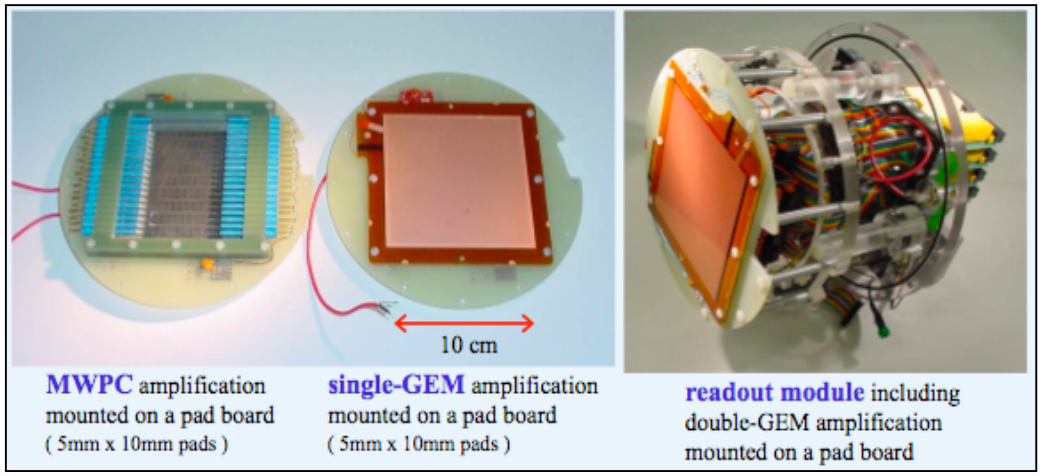


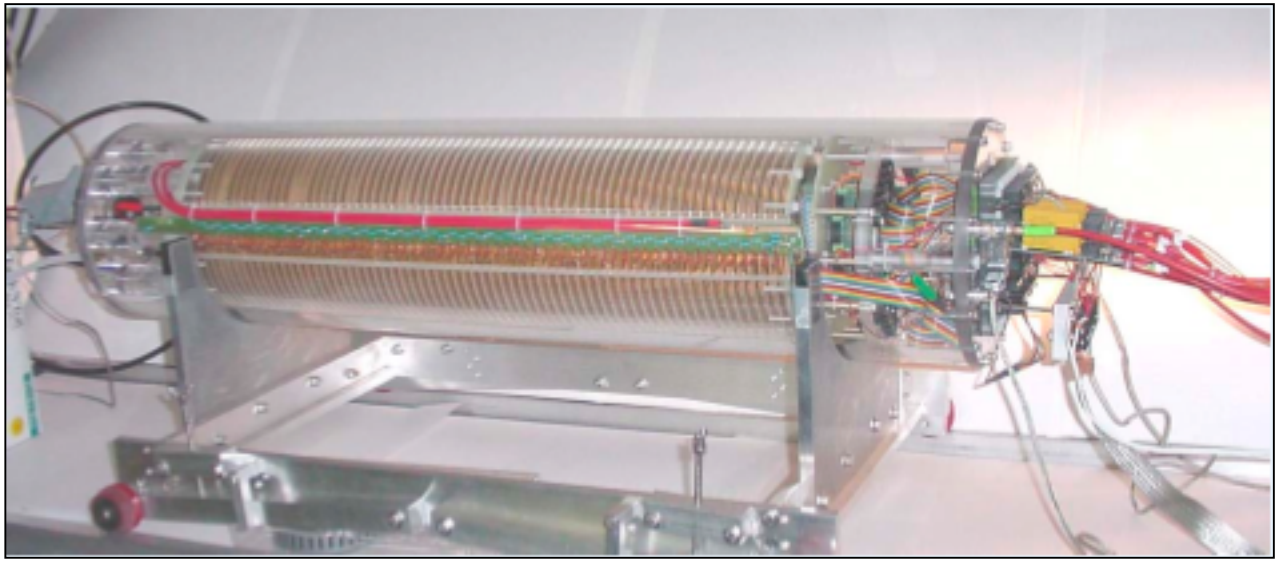


ILC Detector R&D

TPC development

- Small prototype: tests sensor technologies (GEM, μMEGAs, etc)
- Large Prototype (DESY, 2009) Precision endplate
- TPC tracking software (first principles)

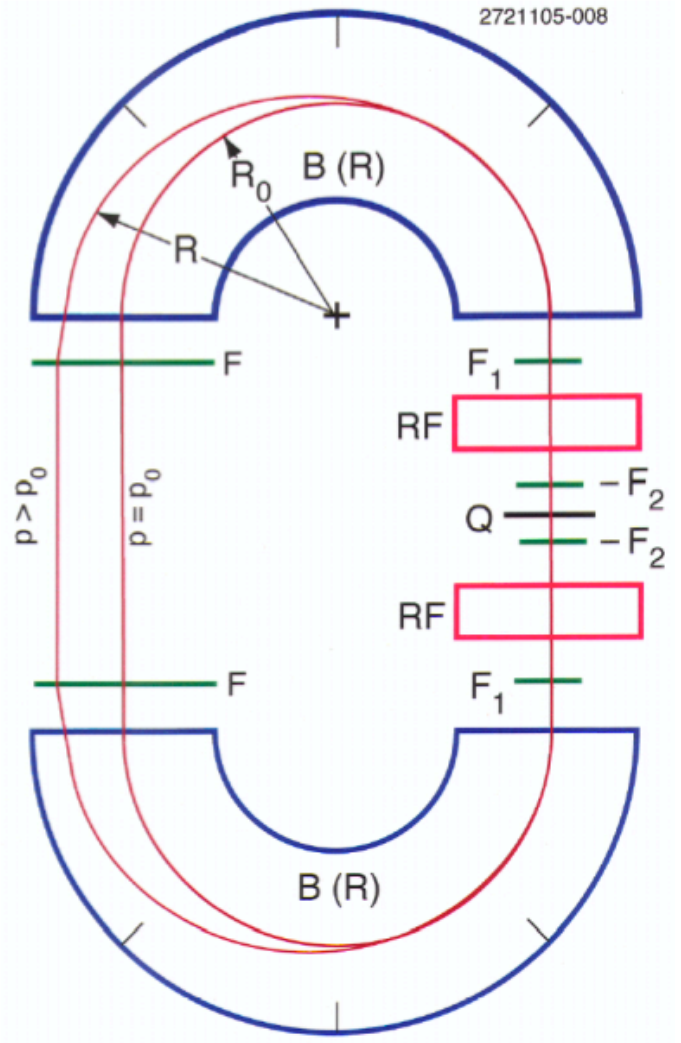




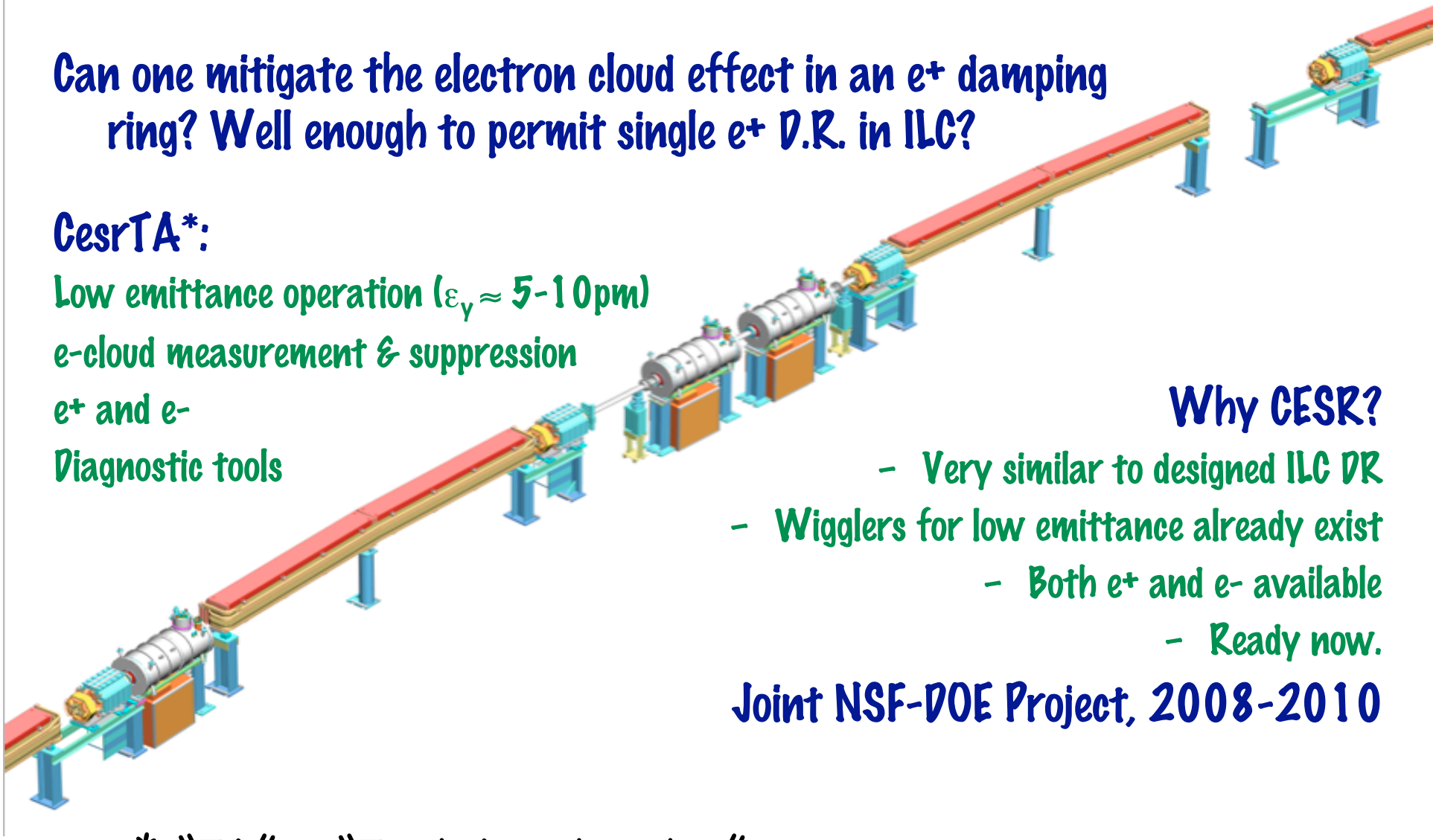
Builds on CLEO drift chamber experience.

Fundamental Probes - @BNL

- Cornell (Orlov) participates in BNL experiments that probe fundamental physics:
  - g-2
  - muon and deuteron electric dipole moments
- Each of these is a deep probe of fundamental physics & a beautiful marriage of accelerator physics and experimental particle physics.



CesrTA: ILC DR Studies



Can one mitigate the electron cloud effect in an e+ damping ring? Well enough to permit single e+ D.R. in ILC?

CesrTA*:

Low emittance operation ($\varepsilon_y \approx$ 5-10pm)

e-cloud measurement & suppression

e+ and e-

Diagnostic tools

Why CESR?

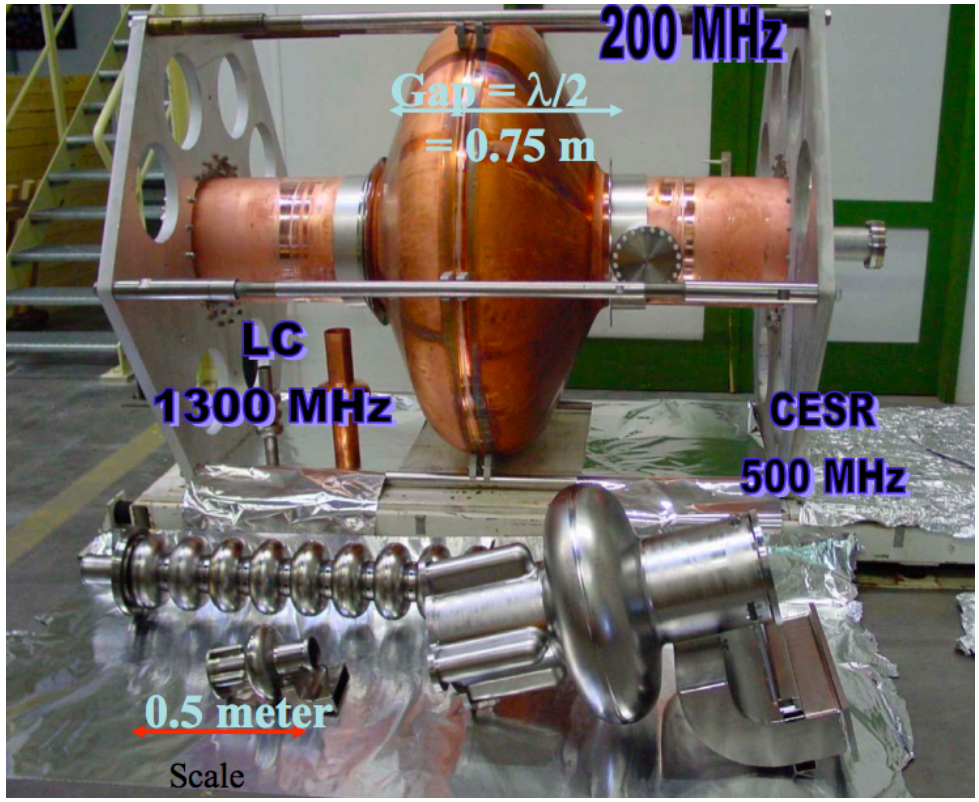
- Very similar to designed ILC DR
- Wigglers for low emittance already exist
- Both e+ and e- available
- Ready now.

Joint NSF-DOE Project, 2008-2010

* "TA" = "Test Accelerator"

Superconducting RF

- Probe physics of superconducting surfaces for achieving maximal E fields
- Develop surface preparation methods & cavity design to push back the limit of accelerating gradients
- Provide cavities for various facilities (CESR, Jlab, ERL,...)
- ILC SC cavity development



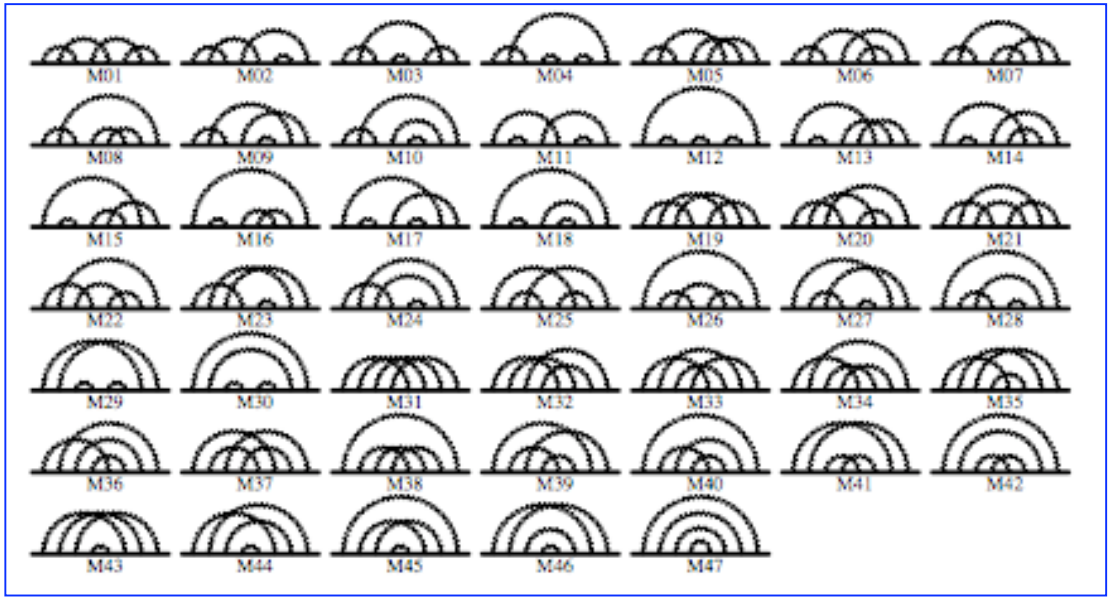
Various cavities

Re-entrant design,
Achieved 59MV/m

- Wide range of topics
  - String theory, brane cosmology
  - Flavor physics
  - Beyond-Std-Model
  - Field theory, mathematical physics
  - Lattice QCD
  - Extreme QED

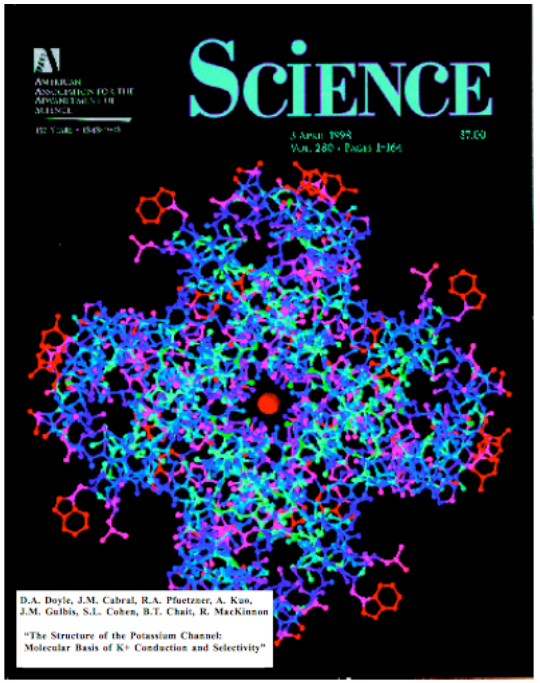
A few 8th order diagrams in electron g-2 calculation from Kinoshita et al, (Feb 08)

arXiv:0712.2607v2



CHESS - Xray Facility

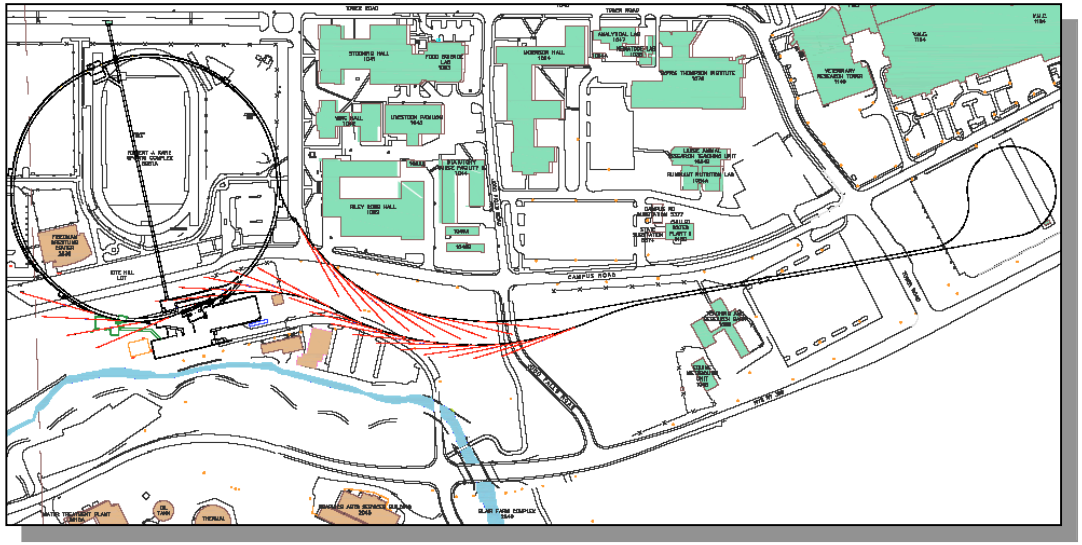
- Xray sources: CESR dipoles & dedicated wigglers
- Separate running periods, 120days/year
- Active community:
  - 700 user-visits/year
  - 2 publications per xray-day
  - 540 PhDs
  - 1 Nobel Prize (so far)
- Active technology development, close user support
- Wide range of science:
  - Material science
  - Biology, biochemistry
  - Engineering
  - Other... (art history, archeology...)

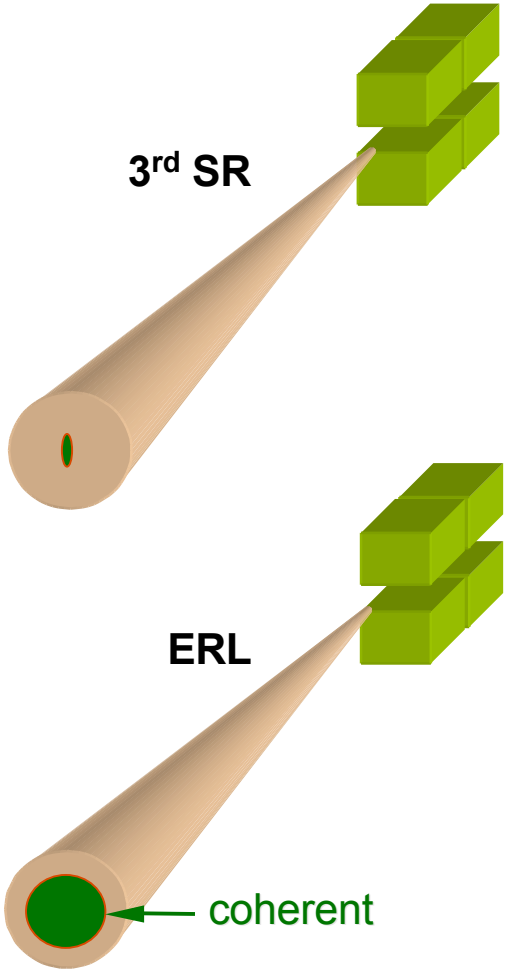


Structure of the potassium channel

Future: Energy Recovery Linac

- **Advanced xray source:**
  - High average brilliance (photons/sec/mm^2/mrad^2)
  - Highly coherent wave front
  - Ultra-short pulse length
  - High current, rep rate
  - Many simultaneous users
- **Based on ultra-low-emittance electron beams**





Comments - 1

- **Energy Frontier must (still) be our top priority.**
  - New physics will be seen directly: new particles, new phenomena
  - A superpartner world, new spatial dimensions, direct hands-on study of dark matter... these will excite the world (not just physicists)
  - Indirect searches in the flavor sector have been rich and fascinating in their own right, but haven't turned up the new physics we believe is out there

- **Astrophysics and cosmology are an important part of particle physics**
  - Dark matter, inflation, baryon asymmetry are all unequivocably particle physics -- and unequivocably astrophysics and cosmology
  - Distinguish between astrophysics that shares particle physics goals and science, and astrophysics that happens to use particles or hep techniques
  - The scientific overlap of the two fields of inquiry has been and will continue to be fantastically productive and exciting
  - These issues retain the perennial power to excite the public (as well as ourselves)

Comments - 2

- P5 should pay attention to the "cost per result" and "cost per physicist".
  - In richer times this might be dismissed as philistine; in a tight budget scenario it must be considered.
  - If we don't pay attention to it, someone else probably will.
- EPP2010 and previous P5 have already articulated what we understand to be the consensus of the field.
  - This P5 should be seeking ways to realize the vision, not rewrite it.
- The FY08 budget is a serious challenge for our near-term tactics but it shouldn't change our long-term strategy.
  - The long term scientific visions of the field remain vibrant and inspiring
  - Changes are coming (eg: LHC results). Things could get better.
  - P5 should reaffirm commitment to the field's priorities