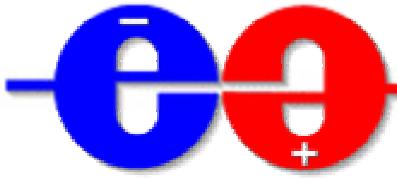

American Linear Collider Physics Group

University-Based Linear Collider Detector R&D (UCLC & LCRD)

Keith Riles
University of Michigan

ALCPG Workshop - SLAC
January 10, 2004

Will address UCLC(NSF) and LCRD(DOE) proposals for

Luminosity, Energy & Polarization (9 projects)

Vertex Detector (3 projects)

Tracking (11 projects)

Calorimetry (13 projects)

Muon System & Particle Identification (3 projects)

Total of 39 projects to cover in less than 15 minutes!

Cannot do justice to proposed work (see w.g. leader reports!)

Will merely summarize the projects briefly and their context

Will NOT address non-U.S. projects (e.g., Canadian research)

For each project, will list

- Short summary of proposed work
- Official contact person, institution, 3-year funding request, UCLC / LCRD affiliation
- Collaborating institutions, where applicable (not all collaborators request funding)

Luminosity, Energy & Polarization

Some issues:

Beamstrahlung uncertainty requires measuring energy-dependence of luminosity – cannot trust calculation

Want accuracy of 100-200 ppm on energy for a single-shot accelerator

Want accuracy of ~0.25-0.50% on polarization
(0.1% for Giga-Z option)

Luminosity, Energy & Polarization

Luminosity measurement projects:

Measuring integrated luminosity from parallel-plate avalanche detectors and from secondary emission detectors

Yaser Onel – Iowa $113K (LCRD)

[+ Fairfield, Bogazici, Cukurova, METU, INFN]

Measuring integrated luminosity bunch-by-bunch with a fast-gas Cerenkov detector (using shiny conduits for light transport to external photodetectors)

John Hauptman – Iowa State $125K (LCRD)

[+ SLAC, Texas Tech, Oregon, Purdue]

Luminosity, Energy & Polarization

Beam diagnostics projects:

Measuring beam shape from low-angle Bethe-Heitler pairs using thin, 3-dimensional, rad-hard and fast silicon radiation sensors

Sherwood Parker – Hawaii $93K (LCRD)

Measuring beam positions/sizes from polarization of visible beamstrahung (incoherent) and microwave beamstrahlung (coherent, for low beam strengths)

Giovanni Bonvicini – Wayne State $143K (UCLC)

Luminosity, Energy & Polarization

Beam energy measurement projects:

Upstream chicane spectrometer using precise BPM nano-movers to measure deflection in dipole magnet (periodic, invasive measurement) → $\Delta E/E \sim 10^{-5}$

Mike Hildreth – Notre Dame $357K (UCLC)

Extraction line (downstream) spectrometer via SLC-style synchroton radiation stripes, using fiber/pmt readout and new beam optics → $\Delta E/E \sim 10^{-4}$

Eric Torrence – Oregon $133K (LCRD)

[+ Massachusetts]

Luminosity, Energy & Polarization

Polarimetry measurement projects:

Quartz fiber calorimetry for scattered Compton photon & electrons, W asymmetry

Yaser Onel – Iowa $103K (LCRD)

[+ Fairfield, Iowa State, Karlsruhe, Bogazici, Cukurova]

Quartz fiber calorimetry for scattered Compton photon & electrons

Stefan Spanier – Tennessee $41K (LCRD)

Compton polarimeter backgrounds (realistic simulation of scattered beam, sychrotron radiation, beam-gas, radiative Bhabha, etc.)

William Oliver – Tufts $28K (LCRD) [+SLAC]

Vertex Detector

Some issues:

Heavy flavor tagging critical to important physics processes
→ Need excellent impact parameter resolution: **O(5 μm)**

Pattern recognition in vertex detector critical for projective-geometry central trackers

Low beam rates, low radiation allow thin, precise, segmented silicon → CCD's

But SLD-generation CCD's not rad-hard or fast enough

LHC-style active pixel devices too thick and coarse

→ Improve both technologies!

Vertex Detector

Projects:

Development of radiation-hard, faster, thinner CCD's, advanced readout chips; initiate CMOS development studies

Charles Baltay – Yale $375K (LCRD)

[+ Oregon, Oklahoma, SLAC, RAL, KEK, FNAL]

Development and design of a CCD readout ASIC with data reduction; DAQ interface development

Patrick Skubic – Oklahoma $245K (UCLC) [+Boston]

Development of thin, finer hybrid silicon pixels (bump-bonded); studies of the mechanical behavior of thin silicon

Daniella Bortoletto – Purdue $197K (UCLC)

Tracking

Some issues:

Need excellent p_t resolution: **$\sigma(1/p_t) \sim O(\text{few}\times 10^{-5}\ \text{GeV}^{-1})$**
→ Order of magnitude better than existing HEP detectors

Need good multi-track separation and trajectory extrapolation into calorimeter for energy flow

Need good forward tracking for high-energy t-channel processes (e.g., chargino production)

Want good θ resolution [**$\sigma_\theta \sim O(0.01\ \text{mrad})$**] for Bhabha acolinearity (differential luminosity)

Tracking

Silicon Detector Projects:

Tracking software optimization for a silicon strip detector (using vertex detector tracks as “seeds”)

Milind Purohit – South Carolina $116K (LCRD)

Development of a low-mass silicon strip central tracker (long shaping time readout, prototyping, design optimization with simulations)

Bruce Schumm – Santa Cruz $245K (LCRD)

[+Michigan, SLAC, LPNHE-Paris]

Tracking

Silicon Detector Projects: (cont.)

Development of a silicon drift detector central tracker (large wafer, thinner silicon, prototyping, simulations)

Rene Bellwied– Wayne State $462K (UCLC) [+ Brookhaven]

Development of silicon detector real-time alignment system (frequency-scanned interferometry); physics benchmarks for tracker performance

Keith Riles – Michigan $307K (UCLC)

Tracking

Time Projection Chamber Projects:

GEM development (increased gain, fabrication, performance studies, electronics, simulation)

Peter Fisher – MIT $142K (LCRD) [+Harvard]

TPC R&D (prototype studies, GEM / MicroMegas development)

Dan Peterson – Cornell $366K (UCLC) [+Purdue]

Development of a negative ion TPC (design optimization, prototyping)

Giovanni Bonvicini – Wayne State $280K (UCLC) [+Temple]

Tracking

Intermediate / Timing Layer Project:

Scintillating fibers for intermediate tracker (e.g., between TPC & vertex detector) with precise timing & bunch identification (prototyping, readout options, cosmic ray studies, simulations)

Rick Van Kooten – Indiana $113K (LCRD)

[+Fermilab, Notre Dame]

Tracking

Forward Tracking Projects:

Development & evaluation of forward tracking (simulation & optimization)

Mike Strauss – Oklahoma $128K (LCRD)

Straw tube chamber development for forward tracking (radiation studies, prototyping)

Keith Baker – Hampton $200K (UCLC)

Development of a GEM-based forward tracker (prototyping, test beam studies, simulations)

Lee Sawyer – Louisiana Tech $280K (LCRD)

Calorimetry

Some issues:

Need excellent dijet mass resolution: **$\sigma(M_{dijet}) \sim$ O(few GeV)**
→ Need **$\sigma_E/E \sim 30\%/\sqrt{E}$** for individual jets

Most jet energy in charged particles and π^0 photons
→ "Energy flow" algorithm should work well if detector permits
→ Suggests fine granularity (transverse/longitudinal) in electromagnetic calorimeter, e.g., 30 layers of 0.25 cm^2 cells

"Digital hadron calorimeter" may offer attractive trade of energy resolution for spatial resolution

Magnet costs may limit outer hcal radius
→ May need to rely on muon system as "tail catcher"

Calorimetry

Simulation and Optimization Projects:

Optimization of detector elements, energy flow algorithms; RPC studies

Mark Oreglia – Chicago $318K (UCLC)

Development of energy-flow algorithms, simulation & reconstruction tools, optimization of hadron calorimetry

Dhiman Chakraborty – N. Illinois $400K (UCLC)

Investigation, design optimization (energy, timing, spatial resolution) of calorimeters; examine silicon/scintillator hybrid (tungsten or lead converter)

Graham Wilson – Kansas $364K (UCLC)

Design study for an active mask (separate $stau^+stau^-$ from $\gamma\gamma \rightarrow \tau^+\tau^-$)

Teruki Kamon – Texas A&M $142K (LCRD)

Calorimetry

Electromagnetic Calorimeter Projects:

Development of a silicon-tungsten test module (silicon detectors, bump-bonded readout chips, gap optimization with simulations, mechanical issues)

Ray Frey – Oregon $245K (LCRD) [+SLAC]

Energy flow studies with silicon-tungsten and lead-tungstate crystal calorimetry; tests of crystal performance (resolution, linearity, uniformity)

Usha Mallik – Iowa $145K (LCRD)

Calorimetry

Hadronic Calorimeter Projects:

Scintillator/tungsten calorimeter (ecal&hcal) with novel geometrical design (staggered scintillating tiles with fiber readout); simulation, reconstruction, prototyping, electronics for readout – HV ASIC)

Uriel Nauenberg – Colorado $333K (LCRD) [+Fermilab]

Design & Prototyping of digital hadron calorimeter using scintillators (simulations, light yield measurements, fiber interface optimization)

Vishnu Zutshi – N. Illinois $533K (UCLC) [+Illinois-Chicago]

Fast response tile scintillation calorimetry development (focus on fiber: faster material, better readout geometry, multiplexing by geometry/timing correlation)

Mike Hildreth – Notre Dame $181K (UCLC)

Calorimetry

Hadronic Calorimeter Projects: (cont.)

Digital hadron calorimetry using GEM's (simulations, prototype geometries, new GEM sources, cosmic tests)

Andy White – Arlington $343K (LCRD)

Study of resistive plate chambers as active medium in a hadron calorimeter (build 1 m^3 prototype, ASIC design, DAQ)

Jose Repond – Argonne $780K (LCRD) [+Boston, Chicago, Fermilab]

Cerenkov Compensated Calorimetry (dual readout of ionization & Cerenkov signals via filters, design optimization)

Yasar Onel – Iowa $163K (LCRD)

[+Fairfield, Iowa State, Bogazici, Cukurova, METU, INFN]

Calorimetry

Hadronic Calorimeter Projects: (cont.)

Micro-machined vacuum photodetectors (investigate silicon micro-channel plates, diamond-based transmission secondary electron dynodes, intensifer tube construction)

Yasar Onel – Iowa $163K (LCRD)

[+Fairfield, Bogazici, Cukurova, META, INFN]

Muon System & Particle Identification

Some issues:

- Muon identification important to many new physics processes
- Need good operation over wide momentum range
  (high efficiency, good π rejection)
- May need to serve as calorimeter tail catcher
- Large subdetector! → Potential cost driver

Muon System & Particle Identification

Projects:

Iron/Scintillator based muon system R&D (simulations, test module construction, electronics, DAQ)

Paul Karchin / Gene Fisk – Wayne State / Fermilab $261K (LCRD)

[+Davis, N. Illinois, Notre Dame, Rice, Austin]

Iron/Scintillator based muon system R&D (optical fiber issues)

Mitchell Wayne – Notre Dame $173K (UCLC) [+N. Illinois]

Study of Geiger mode avalanche photodiodes for muon system readout (study performance, prototyping, industrialization)

Bob Wilson – Colorado State $216K (LCRD)

Category	UCLC	LCRD	Both
Luminosity, Energy & Polarization (9)	500	636	1,136
Vertex Detectors (3)	442	375	817
Tracking (11)	1,615	830	2,445
Calorimeter (13)	1,796	2,297	4,093
Muon System & PID (3)	173	476	649
Total (39)	4,527	4,614	9,141
Accelerator (29)	2,026	2,355	4,381
Grand Total (68)	6,553	6,969	13,522