CESRTA Collaboration

M. Billing

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<table>
<thead>
<tr>
<th>Collaborators</th>
<th>Institution</th>
<th>Participation</th>
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<tr>
<td>K. Harkay</td>
<td>ANL</td>
<td>Collaborative research and personnel exchange: electron cloud measurements and simulations with a particular focus on validation of the primary photoelectron models.</td>
</tr>
<tr>
<td>R. Dowd</td>
<td>Australian Synchrotron</td>
<td>Collaborative research: low emittance tuning.</td>
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<tr>
<td>W. Guo, S.Y. Zhang</td>
<td>BNL</td>
<td>Collaborative research: low emittance optics design.</td>
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<tr>
<td>R. Holtzapple</td>
<td>CalPoly</td>
<td>Collaborative research, in-kind contributions, and personnel exchanges: instrumentation and beam dynamics measurements.</td>
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<tr>
<td>D. Asner*</td>
<td>Carleton U.</td>
<td>Collaborative research: secondary electron yield measurements.</td>
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<tr>
<td>J. Jones, A. Wolski</td>
<td>Cockroft Institute</td>
<td>Collaborative research and personnel exchanges: low emittance tuning.</td>
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<tr>
<td>M.C. Ross, C-Y. Tan, R. Zwaska</td>
<td>FNAL</td>
<td>Collaborative research and personnel exchanges: electron cloud measurements and secondary electron yield measurements.</td>
</tr>
<tr>
<td>Theo Demma</td>
<td>INFN-LNF (Frascati, IT)</td>
<td>Collaborative research and personnel exchanges: electron cloud measurements and simulations.</td>
</tr>
<tr>
<td>A. Garfinkel</td>
<td>Purdue U.</td>
<td>Collaborative research and personnel exchanges: electron cloud simulations with a particular focus on validation of the primary photoelectron models.</td>
</tr>
<tr>
<td>D. Kharakh, J. Ng., M. Pivi, L. Wang</td>
<td>SLAC</td>
<td>Collaborative research, in-kind support and personnel exchanges: electron cloud measurements and simulations, dipole and wigglers chambers for electron cloud suppression, secondary electron yield measurements.</td>
</tr>
<tr>
<td>L. Schächter</td>
<td>Technion-Haifa (Israel)</td>
<td>Collaborative research and personnel exchanges: electron cloud measurements and analysis.</td>
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<tr>
<td>Student</td>
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<td>Participation</td>
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<td><strong>Graduate Students</strong></td>
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<tr>
<td>Joseph Calvey</td>
<td>Cornell</td>
<td>Electron cloud measurements &amp; simulations</td>
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<tr>
<td>Nicholas Eggert</td>
<td>Cornell</td>
<td>xBSM development</td>
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<tr>
<td>Michael Ehrlichman</td>
<td>Cornell</td>
<td>Intrabeam and Touschek scattering</td>
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<td>Richard Helms</td>
<td>Cornell</td>
<td>Accelerator design</td>
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<td>Walter Hopkins</td>
<td>Cornell</td>
<td>xBSM development</td>
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<td>Benjamin Kreis</td>
<td>Cornell</td>
<td>xBSM development</td>
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<td>James Shanks</td>
<td>Cornell</td>
<td>Low emittance tuning</td>
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<td>Jeremy Urban</td>
<td>Cornell</td>
<td>Accelerator design</td>
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<tr>
<td>Yanay Yariv</td>
<td>Cornell</td>
<td>Low emittance tuning</td>
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<tr>
<td>Laura Boon</td>
<td>Purdue</td>
<td>Electron cloud simulations</td>
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<tr>
<td>Puneet Jain</td>
<td>KEK</td>
<td>Electron cloud simulations</td>
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<tr>
<td><strong>Undergraduate Students</strong></td>
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<tr>
<td>Kaitlin Butler</td>
<td>Cornell</td>
<td>Electron cloud simulations</td>
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<td>Noah Kaminsky</td>
<td>Cornell</td>
<td>Electron cloud simulations</td>
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<td>Jin-Sung Kim</td>
<td>Cornell</td>
<td>Secondary electron yield measurements</td>
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<tr>
<td>Zhidong Leong</td>
<td>Cornell</td>
<td>Electron cloud simulations</td>
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<td>Hongwan Liu</td>
<td>Cornell</td>
<td>xBSM development</td>
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<tr>
<td>Jesse Livezey</td>
<td>Cornell</td>
<td>Electron cloud measurements &amp; simulations</td>
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<tr>
<td>Junki Makita</td>
<td>Cornell</td>
<td>Electron cloud measurements &amp; simulations</td>
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<tr>
<td>Michael McDonald</td>
<td>Cornell</td>
<td>xBSM development</td>
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<tr>
<td>Gabriel Ramirez</td>
<td>Cornell</td>
<td>Electron cloud measurements &amp; simulations</td>
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<tr>
<td>Steven Santos</td>
<td>Cornell</td>
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<td>Robert Schwartz</td>
<td>Cornell</td>
<td>Electron cloud measurements &amp; simulations</td>
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<tr>
<td>Siarhei Vishniakou</td>
<td>Cornell</td>
<td>Software support</td>
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<tr>
<td>William Whitney</td>
<td>Cornell</td>
<td>Electron cloud measurements</td>
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<tr>
<td>Heather Williams</td>
<td>Cornell</td>
<td>Beam dynamics studies</td>
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<tr>
<td>Leah Fabrizzo</td>
<td>CalPoly</td>
<td>Instrumentation development</td>
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<tr>
<td>Matthew Randazzo</td>
<td>CalPoly</td>
<td>Instrumentation/beam dynamics studies</td>
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# REU Student Participation

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<thead>
<tr>
<th>Student</th>
<th>Institution</th>
<th>Project</th>
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<tbody>
<tr>
<td>Johan Bonilla</td>
<td>Stanford University</td>
<td>Beam dynamics simulation</td>
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<tr>
<td>Daniel Carmody</td>
<td>Carnegie Mellon</td>
<td>Electron cloud simulations</td>
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<tr>
<td>Chris Cude</td>
<td>Indiana University</td>
<td>Electron cloud measurements</td>
</tr>
<tr>
<td>Danielle Dugans</td>
<td>Gordon College</td>
<td>Microwave measurements of electron cloud</td>
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<tr>
<td>Emily Hemingway</td>
<td>S. Olaf’s College</td>
<td>Electron cloud measurements</td>
</tr>
<tr>
<td>Pauli Kehayias</td>
<td>Tufts</td>
<td>Beam dynamics simulation</td>
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<tr>
<td>Matthew Lawson</td>
<td>Harvey Mudd College</td>
<td>Low emittance tuning</td>
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<tr>
<td>Benjamin Carlson</td>
<td>Grove City College</td>
<td>Microwave measurements of electron cloud</td>
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<tr>
<td>Daniel Gonnella</td>
<td>Clarkson</td>
<td>Intrabeam and Touschek scattering</td>
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<tr>
<td>Eric Wilkinson</td>
<td>Loyola</td>
<td>Electron cloud simulations</td>
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<tr>
<td>Laurel Hales</td>
<td>University of Utah</td>
<td>Low emittance tuning</td>
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<tr>
<td>Kenneth Hammond</td>
<td>Harvard University</td>
<td>Microwave measurements of electron cloud</td>
</tr>
<tr>
<td>Neboysa Omcikus</td>
<td>American River College</td>
<td>Electron cloud simulations</td>
</tr>
<tr>
<td>Zoey Warecki</td>
<td>Towson University</td>
<td>Low emittance simulation</td>
</tr>
<tr>
<td>Kiel Williams</td>
<td>Guilford College</td>
<td>Electron cloud measurements</td>
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• Meetings required Web-based communications to encourage participation
• Collaboration Web-site:
  – Contains meeting notes for Technical & Research areas
  – Schedules: CESR’s & Machine Studies shifts
  – ILC DR Group design & planning pages
• Web-based Logbook – available to collaborators
• Remote Experimental Operations of CESR
• Long-term Archives for CESR TA Data
  – Database constructed for results of measurements
  – Accessible to all collaborators
Organization of Collaboration

• Routine Meetings
• Special ad hoc Design Efforts:
  – Production of Wiggler Vacuum Chambers
  – Production of Clearing Electrode
  – Design of new RFAs
• Participation in Planning for ILC DR
  – Optics design
  – Wiggler design
  – Magnet & PS design
  – Vacuum Chamber design
  – EC modeling
Total of 99 papers & reports to date

- by subject:
  - 68 Electron Cloud
  - 17 Low Emittance and Intra-beam Scattering
  - 14 CESRTA Project, Instrumentation, Other

- by classification:
  - 84 Conference or Workshop Papers
  - 9 REU Student Reports
  - 5 Journal Articles
  - 1 Other (ICFA Beam Dynamics Newsletter)

Contributors for ILC Design

- DR design:
  - Optics
  - Magnets/PSs
  - Vacuum Chamber & Mitigation
  - Electron Cloud Modelling
  - Archives for Entire Design effort
Participation in Conferences & Workshops

• Conferences
  – PAC09
  – IPAC10
  – IPAC11
  – PAC11
  – IPAC12
  – IBIC12

• Workshops
  – ECLoud 10
    • Incl. ILC DR Satellite Meeting
  – IWLC 2010
  – LC 2010
  – LCWS10
  – BIW10
  – ECLoud 11
  – LCWS11
  – LER 2011
  – ECLoud 12
  – BIW12
• Report exceeds 400 pages
  – Nine chapters
    Introduction
    The CESR Conversion
    Low Emittance Tuning
    Description of the Electron Cloud Model
    Electron Cloud Growth and Mitigation
    Electron Cloud Induced Beam Dynamics
    Status of Our Understanding of the Electron Cloud Model
    Recommendations for the ILC Positron Damping Ring
    Conclusions and Future Plans

• Final draft undergoing revisions now
A Few Examples of Collaborative Efforts

- Hardware development
  - Design/production of RFAs - APS, Los Alamos, SLAC, CU
  - Clearing electrode - KEK, SLAC, Berkeley, CU
  - Vacuum chamber coatings - CERN, SLAC, Berkeley, CU
  - Grooved chamber - KEK, SLAC, Berkeley, CU
  - L3 Chicane chambers – SLAC, CU
  - Beam size instrumentation – CERN, KEK, Cal Poly, CU

- Experimental collaboration (capable of remote access)
  - EC Tune shifts of trains – Cal Poly, CU
  - EC Instabilities – KEK, Cal Poly, CU
  - LET – CERN, Berkeley, CU

- Software development
  - CMAD, ECLOUD, POSINST, Synrad3D, BMAD

- Data archive (& collaboration web-site)

The next section illustrates examples using slides from concurrent meetings
Design/Production of RFAs: Quadrupole Chamber

APS, Los Alamos, SLAC, CU

- Collaborative design using Web-Ex
• Aluminum beampipe fabricated and welded
• TiN coating in January 2010
• RFA Assembly in Jan/Feb 2010
• Single retarding grid
Design/Production of RFAs: Wiggler

APS, Los Alamos, LBNL, SLAC, CU

- Sophisticated design effort using Web-Ex
- Material from SLAC
- Integrated design & machining tools
- Machining at LBNL
Dawn Munson, Rick Kraft and wiggler chambers 1 & 2
SCW RFA Beampipe
Assemble Grids
Ceramic head pins to position the flex circuit collectors w.r.t to hole patterns
Flex circuit (with both sides taped) and 3 grid wires fed through the ‘tunnel’ duct-under into the connector port.
Small amount of UHV solder flux (Accu-Glass) had to be used. The flux residue was rinsed off.
Wiring Checkout and Connected

Checked all 45 connections from pins to pads, many times
A final air-side pin-to-circuit wiring check out was done before tightening the two flange joints.
Final Wiring Check and Leak Check
Clearing Electrode

KEK, SLAC, LBNL, CU

- Collaborative design using Web-Ex
- Material from SLAC
- Integrated design & machining tools
- Machining at LBNL
- Ceramic & Electrode deposition at KEK
L0 Vacuum Modifications

- Install a RFA wiggler with clearing electrode
- Enhance vacuum pumping at Q2W
EC Clearing Electrode Tests

- Two welding tests went successfully at LBNL. One assembly will be at Cornell for further measurement (capacitance, TDR, etc.)
- Cornell-style will be used for final chamber
• Still need to decide what is the best and practical way of isolating the flexible circuit – Kapton with or without adhesive
• Assemble contact pin before EB-weld?
Chamber Coatings: Titanium-Nitride, NEG, Diamond-like Carbon

KEK, SAES, CERN, SLAC, CU

- TiN coating from SLAC
- NEG coating from SAES
- Diamond-like Carbon coating from KEK
- Amorphous Carbon coating from CERN
TiN Coating at SLAC

Dan Wright, Chamber #1 (14BE), and the Ti Electrode
NEG Coated Beampipes @ L3

NEG coating by SAES

- Beampipe fabricated, welded and baked.
- Beampipe string was shipped out 1/5/2010
- Need ready three APS RFAs
- Q15W chamber coated with DLC coating (by CERN)
- Q15E RFA chamber is a reference chamber, with bare aluminum extrusion
- Both chambers with dipole-style RFAs, but with reversed wiring (in error, needing new special cables)
Grooved Wiggler Beam Pipe with RFA

KEK, SLAC, LBNL, CU

- Collaborative design using Web-Ex
- Material from SLAC
- Integrated design & machining tools
- Machining at LBNL
- Groove machining at KEK
Grooved RFA SCW Beampipe

- Finished RFA assembly and RFA cover EBW
- In the final stage of assembly, scheduled for 7/20 installation
RFA Assembly for Grooved Wiggler Beam Pipe
L3 Chicane Magnet Studies

SLAC, LBNL, CU

• Planning via Web-Ex
• Magnets & PSs from SLAC
• TE-Wave measurements – LBNL, CU
L3 Region Iso View
Time Resolve Dipole Chamber
Electron Cloud Instability Measurements

Cal Poly, KEK, CU

- Instrumentation – CU
- Local (CU) & Remote (KEK) **Online Data Acquisition**
- Local (CU) & Remote (KEK, Cal Poly) **Offline Analysis**
- Remotely available Data Archival at CU
Reflection around \( \frac{1}{2} F_{\text{rev}} \)

30 bunch train
0.5mA/bunch (0.8\( \times \)10\(^{10}\)/bunch)
Part of study of dependence on chromaticity and feedback
Nominal vertical emittance at front of train: \(~20\text{pm}\)
Vertical beam size data acquired simultaneously by J. Flanagan (KEK) remotely
Future-Directed Collaborative Activities

• Hardware development
  – ODR/XDR Detector – CERN, Royal Hollaway (London), CU

• Experimental
  – Lower Emittance Tuning – CERN, CU
  – Intra-Beam Scattering – CERN, CU

• Improvements in Modeling & Simulation
Optical Diffraction
Radiation Detector

CERN, Royal Hollaway (London), CU

- Experimental Design via Web-Ex
- Vacuum Chamber Design & Construction – RH, CERN
- Vacuum System Integration – CERN, CU
- Instrumentation – CERN, CU
e- ODR Detector Components

• Internal movable-removable round beam pipe – slides to the radial inside of CESR
• Moveable fork having two different slit widths, tilted at 30° to the horizontal plane, e.g. 1 mm & 0.4 mm - arm projects slits inward from radial outside
• Bunch injected, then slit is moved around the beam
• Observation port pointing east at 45° to H-plane
• Laser alignment making use of a) an inline port, b) a movable mirror, which illuminates the front face of ODR
• BPMs and sliding joints on both sides of detector chamber
• Downstream radiation monitors
Future site for ODR detector
Observing Optical Diffraction Radiation angular distribution to measure Beam size

Integration of Chamber in the L3 straight section

- Replacement chamber
- Slit-mask assembly

Simulation of the optical distribution

- Mask to stop SR photons
- Slit to generate ODR photons

Electron beam direction

ODR Photons

ODR Chamber in L3
Status of the Design of Optical System

Optical system schematic

1. Images the target
2. Obtains DR angular distribution
3. Considering either a) 200 nm (UV) or b) 400 nm (visible) detection

Visible camera:
To be decided, there are a few options.
ICCD.
e.g. http://www.proxivision.de/products/proxikit.html

UV camera:
Hamamatsu C8484-16C
http://sales.hamamatsu.com/assets/pdf/parts_C/e_c848416c.pdf

June 8, 2012
Conclusions from Experiences with CesrTA

- This is a collaboration of many individuals and many institutions contributing to a variety of research efforts at CesrTA.
- All collaborators have access to all materials and meetings.
- The collaboration functions well:
  - Components have been cooperatively designed, built and operated.
  - Research and data acquisition and analysis have been jointly undertaken.
  - Simulation and modeling have benefitted from unified efforts.
Finally, we strongly welcome anyone or institution, who may wish to collaborate in common research.