# Program of the 3rd LC School

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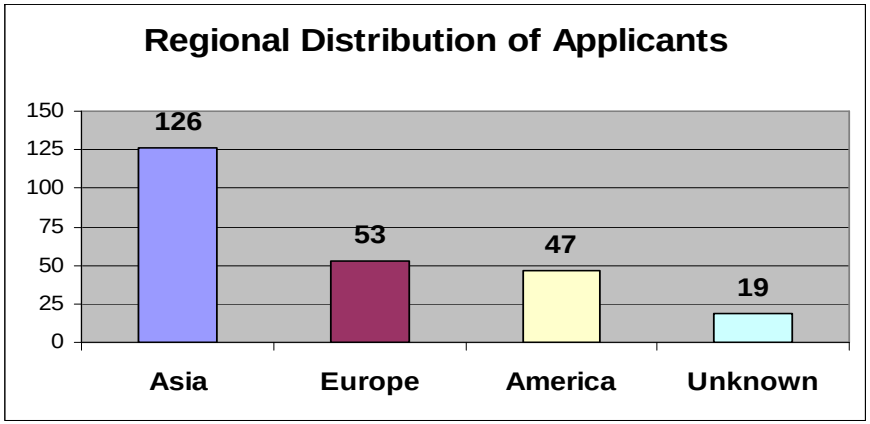
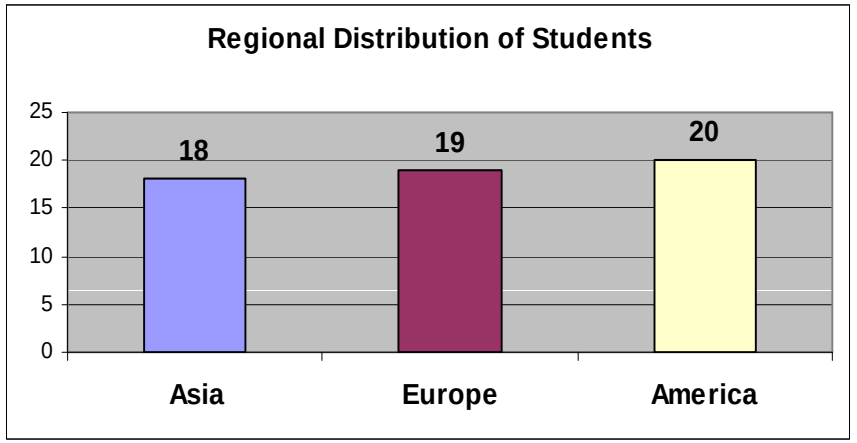
# Goal of the School & Why You are Here

- **To train the next generation for future big accelerators in the high-energy physics field**
- **Construction of the LHC has been completed**
- **The next "Big One" is likely to be a TeV Linear Collider**
- **The construction period is usually very long (in the order of 15-20 years). We need to prepare the army and leaders now**
- **In your application, you said you want to work on it**
- **In the recommendation, your supervisor said you are *very* good**

# How You Were Selected

- The school received 245 applications from 37 countries.
- Due to limited resources, only 57 students from 14 countries were accepted. The average acceptance ratio is about one third.
- Unfortunately, 9 students did not receive visa and 2 dropped out due to personal reasons.
- Admission was “need blind” – no student should be turned away just because he/she can’t afford it.
- The committee members read every CV and recommendation letter before they made the decision if one should be selected or rejected.



**Third International Accelerator School for Linear Colliders – Curriculum** (v.3, 03/18/2008)

October 19-29, 2008, Oak Brook Hills Marriott Hotel, Oak Brook, Illinois, U.S.A.

Daily Schedule

| | |
|---|---|
| Breakfast | 08:00 – 09:00 |
| Morning | 09:00 – 12:30, including ½-hour break |
| Lunch | 12:30 – 14:00 |
| Afternoon | 14:00 – 17:30, including ½-hour break |
| Dinner | 17:30 – 19:00 |
| Tutorial & homework | 19:00 – 22:00 |

List of Courses

| | Morning | Afternoon | Evening |
|---|---|---|---|
| October 19 | | *Arrival, registration* | *Reception* |
| October 20 | Introduction | Sources & bunch compressors | Tutorial & homework |
| October 21 | Damping ring I | Linac I | Tutorial & homework |
| October 22 | Damping ring II | Linac II | Tutorial & homework |
| October 23 | LLRF & high power RF | Beam delivery & beam-beam | Tutorial & homework |
| October 24 | *Site visit to Fermilab* | *Site visit to Fermilab* | *Free time* |
| October 25 | Superconducting RF & ILC I | *Excursion* | Tutorial & homework |
| October 26 | Superconducting RF & ILC II<br>Room temperature RF & CLIC I | Room temperature RF & CLIC II | Tutorial & homework |
| October 27 | Instrumentation & control | Muon collider | Tutorial & homework |
| October 28 | *Final exam* | Operations;<br>Physics & detectors | *Banquet;*<br>*Student Award Ceremony* |
| October 29 | *Departure* | | |

**Lecturers of the 2008 LC Accelerator School** (v.9, 07/23/2008)

| Lecture | Topic | Lecturer |
|---|---|---|
| 1 | Introduction | Carlo Pagani (INFN/Milano) |
| 2 | Sources & bunch compressors | Masao Kuriki (Hiroshima Univ.) |
| 3 | Damping ring | Mark Palmer (Cornell Univ.) |
| 4 | Linac | Toshiyasu Higo (KEK) |
| 5 | LLRF & high power RF | Stefan Simrock (DESY) |
| 6 | Beam delivery & beam-beam | Deepa Angal-Kalinin (Daresbury) |
| 7 | Superconducting RF & ILC | Nikolay Solyak (Fermilab) |
| 8 | Room temperature RF & CLIC | Frank Tecker (CERN) |
| 9 | Instrumentation & control | Toshiyuki Okugi (KEK) |
| 10 | Muon collider | Bob Palmer (BNL) |
| 11 | Operations | Tom Himel (SLAC) |
| 12 | Physics & detectors | Rolf Heuer (DESY/CERN) |
| Special | How the Fermilab accelerator complex works | Roger Dixon (Fermilab) |
| Special | Hands-on training | Bob Mau (Fermilab) |

# Program

| | Monday, October 20 | Tuesday, October 21 | Wednesday, October 22 | Thursday, October 23 |
|---|---|---|---|---|
| Morning<br>09:00 – 12:30 | **Opening remarks** (10)<br>**Young-Kee Kim** (Fermilab/Univ. of Chicago)<br><br>**Lecture 1 – Introduction** (180)<br>**Carlo Pagani** (INFN/ Univ. of Milano)<br>• Why LC<br>• What's ILC<br>• Layout of ILC<br>• Parameter choices & optimization<br>• Overview of accelerator issues<br>• Other future lepton colliders: CLIC and muon collider | **Lecture 3a – Damping ring I** (180)<br>**Mark Palmer** (Cornell Univ.)<br>• Role of damping rings<br>• High-level overview of structure, and principles of operation<br>• Review of basic linear beam dynamics<br>• Damping ring lattice<br>• Radiation damping (derivation of damping times, and the need for a damping wiggler in LC damping rings)<br>• Quantum excitation and equilibrium beam emittances | **Lecture 3b – Damping ring II** (180)<br>**Mark Palmer** (Cornell Univ.)<br>• Brief overview of technical systems<br>• R&D challenges for selected technical components<br>➢ injection/extraction kickers<br>➢ damping wiggler<br>• Brief overview of beam dynamics issues<br>• Selected beam dynamics issues<br>➢ impedance effects<br>➢ electron cloud effects | **Lecture 5 – LLRF & high power RF** (180)<br>**Stefan Simrock** (DESY)<br>• RF system overview<br>• LLRF<br>• Timing and synchronization<br>• Modulators<br>• Klystrons<br>• RF distribution |
| Afternoon<br>14:00 – 17:30 | **Lecture 2 – Sources & bunch compressors** (180)<br>**Masao Kuriki** (Hiroshima Univ.)<br>• e- gun<br>• e+ sources<br>• Polarized sources<br>• Bunch compressors<br>• Spin rotator | **Lecture 4a – Linac I** (180)<br>**Toshiyasu Higo** (KEK)<br>• Phases & superposition<br>• Basics of RF cavities<br>• Lumped circuit analogy, metrics<br>• RF Pillbox cavity<br>• Coupled rf-cavities, mode structure<br>• Shunt impedance, transit-time factor<br>• Standing wave linacs and structures<br>• Beam loading and power coupling<br>• Slow wave structures | **Lecture 4b – Linac II** (180)<br>**Toshiyasu Higo** (KEK)<br>• Traveling wave linacs<br>• Structure parameters<br>• Scaling relationships for TW linacs<br>• Power flow & beam loading<br>• Multi-bunch energy gain<br>• Wakefields & impedances<br>• Linac lattice<br>• Emittance preservation & instabilities<br>• Beam based alignment | **Lecture 6 – Beam delivery & beam-beam** (180)<br>**Deepa Angal-Kalinin** (Daresbury)<br>• Overview<br>• Beam-beam interaction and crossing angle<br>• Collimation<br>• Accelerator-detector interface, shielding and beam dump<br>• Background and detector protection<br>• Beam monitoring and control at final focus<br>• Luminosity optimization |
| Evening<br>19:00 – 22:00 | Tutorial & homework | Tutorial & homework | Tutorial & homework | Tutorial & homework |

# Program (cont…)

| | Friday, October 24 |
|---|---|
| Day | **Site visit to Fermilab** |
| 09:00 | Bus leaving hotel for Fermilab |
| 09:30 – 10:30 | **Special lecture – How the Fermilab accelerator complex works** (60)<br>**Roger Dixon** (Fermilab) |
| 10:30 – 17:00 | Students will be divided into 6 groups. Each group has ~9 students and will receive ~50 minutes hands-on training in the Main Control Room. The instructor is **Bob Mau** (Fermilab). Students will have lunch at Fermilab and visit several facilities. Details will come later. |
| 17:00 | Bus leaving Fermilab for hotel |
| Evening<br>19:00 – 22:00 | *Free time* |

Fermilab tour:

- Hands-on training in the Main Control Room
- Wilson Hall 15th floor
- Linac gallery
- CDF and D0
- Industrial Buildings
- SCRF sites

# Program (cont…)

| | Saturday, October 25 | Sunday, October 26 | Monday, October 27 | Tuesday, October 28 |
|---|---|---|---|---|
| Morning<br>09:00 – 12:30 | **Lecture 7a – Superconducting RF & ILC I** (180)<br>**Nikolay Solyak** (Fermilab)<br>• Superconductivity basics<br>• Cavity design & SRF constraints<br>• Lorentz force detuning in SCRF<br>• Microphonics & vibration issues<br>• Cavity fabrication and tuning<br>• Surface preparation<br>• Gradient limit and spread<br>• Cryogenics<br>• ILC cryomodules<br>• Alignment issues | **Lecture 7b – Superconducting RF & ILC II** (90)<br>**Nikolay Solyak** (Fermilab)<br>• Power Coupler<br>• HOMs & HOM Couplers<br>• Slow and fast tuner<br>• ILC design & challenges<br><br>**Lecture 8a – Room temperature RF & CLIC I** (90)<br>**Frank Tecker** (CERN)<br>• Gradient limits at X-band<br>• Breakdown mechanism<br>• Pulse heating<br>• Pulse train formats<br>• Klystron *vs.* beam driven<br>• RF power manipulation options | **Lecture 9 – Instrumentation & control** (180)<br>**Toshiyuki Okugi** (KEK)<br>• Beam monitoring<br>• Precision instrumentation<br>• Feedback systems<br>• Energy stability<br>• Orbit control<br>• Electronics<br>• Data processing | **08:00 – 12:30 Final exam** (270) |
| Afternoon<br>14:00 – 17:30 | **Excursion to Downtown Chicago** | **Lecture 8b – Room temperature RF & CLIC II** (180)<br>**Frank Tecker** (CERN)<br>• CLIC layout<br>• Cavity fabrication and tuning<br>• HOM out-coupling<br>• Thermal stability<br>• Driver beam stability<br>• Power coupling<br>• Alignment issues<br>• CLIC design & technical challenges | **Lecture 10 – Muon collider** (120)<br>**Bob Palmer** (BNL)<br>• Muon collider basics<br>• Machine layout<br>• Major sub-systems<br>• Challenges<br><br>**Study time** (60) | **Lecture 11 – Operations** (90)<br>**Tom Himel** (SLAC)<br>• Reliability<br>• Availability<br>• Remote control and global network<br><br>**Lecture 12 – Physics & detectors** (90)<br>**Rolf-Dieter Heuer (DESY/CERN)**<br>• Tera scale physics<br>• Physics beyond 1 TeV<br>• ILC vs. LHC<br>• Detectors |
| Evening<br>19:00 – 22:00 | Tutorial & homework | Tutorial & homework | Tutorial & homework | Banquet;<br>Student Award Ceremony |

# Lectures, Homework and Exam

- All lectures are in seminar style, no text books.
- Latest version of the lectures is available on the web.
- There are homework assignments. But they will not be graded.
- Each lecturer will be available for one evening during the tutorial and homework time.
- There will be a final exam on Oct 28. Some of the exam problems are similar to those in the homework, some are new.
- Based on the exam grade, the curriculum committee will select top 10 students and have an award ceremony on October 28.

# 8 Characteristics of a Good School

1. High expectations for every student
   - Learn as much as you can
   - Make as many new friends as you can
2. Community support
3. A rigorous curriculum and fair assessments
4. Sufficient resources to help all students achieve
5. Safe, healthy and supportive learning environments
6. Classrooms equipped for teaching and learning
7. Qualified teachers in classrooms
8. Strong school leadership