# Damping Rings:
# Vacuum System Sessions Overview & EC Mitigation Plan

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# Today's Sessions

- AM Sessions
  - **8:30-10:00**
    - This presentation
    - DR Vacuum System Overview – Y. Li, J. Conway
    - DR Vacuum Component Overview – J. Conway
  - **10:30-12:30**
    - SuperKEKB Vacuum System – Y. Suetsugu
    - Vacuum System Discussion
- PM Sessions
  - **14:00-15:30**
    - DR Vacuum System Costing Plan – M. Palmer
    - DR Vacuum Chamber Costing – J. Conway, Y. Li
    - Comments on SuperKEKB Costing – Y. Suetsugu, K. Kanazawa
  - **16:00-18:00**
    - ECLOUD Evaluations for the ILC DR – M. Pivi
    - Costing Discussion

# Primary Goals For Today

- Principal focus is a review of the DR Vacuum System
  - **Design and Components**
  - **Comparison with SuperKEKB plans**
  - **DR Costing**
  - **Improving the cost estimate with inputs from the SuperKEKB vacuum system**
- Ultimately, we are targeting a complete cost estimate for the TDR on the early May timescale
- We will also get an update on the status of the EC evaluations for the new ILC DR lattice
  - **Ultimately, these evaluations will help us determine whether we can operate a single e+ damping ring after the planned high current upgrade**

# DR EC Mitigation Outline

- DR Parameters
- EC Working Group Recommendations
- Expected Performance for the 3.2 km DR
- Introduction to the conceptual design

# DR Parameters

| | | | TDR Operational Baseline | | | | Upgrade | |
|---|---|---|---|---|---|---|---|---|
| | | | Nominal 5 Hz mode | | 10 Hz mode for low $E_{cm}$ running | | Luminosity upgrade (5Hz) | |
| | | | e– | e+ | e– | e+ | e– | e+ |
| Number of damping rings | | | 1 | | 1 | | 1 | 2 |
| Number of bunches per ring | $n_b$ | | 1312 | | 1312 | | 2625 | 1312 |
| Particles per bunch | $N$ | $\times 10^{10}$ | 2.0 | | 2.0 | | 2.0 | |
| Average bunch separation | | ns | 8.23 | | 8.23 | | 4.12 | 8.23 |
| Average current | | mA | 389.2 | | 389.2 | | 778.6 | 389.2 |
| **Extracted beam** | | | | | | | | |
| Extracted horizontal emittance | $e_x$ | nm | 0.57 | 0.57 | 0.60 | 0.61 | 0.57 | 0.57 |
| | $ge_x$ | mm | 5.5 | 5.5 | 5.9 | 6.0 | 5.5 | 5.5 |
| Extracted vertical emittance* | $e_y$ | pm | 2.00 | 2.04 | 2.06 | 2.14 | 2.00 | 2.04 |
| | $ge_y$ | nm | 19.6 | 20.0 | 20.1 | 20.9 | 19.6 | 20.0 |
| RMS rel .energy spread | | % | 0.110 | | 0.12 | 0.137 | 0.110 | |
| RMS bunch length | | mm | 6.0 | | 6.0 | 6.0 | 6.0 | |
| Maximum allowed transverse jitter | $s_{x,y}$ | | 0.1 | | 0.1 | | 0.1 | |
| * Calculated assuming each ring is corrected to 2pm equilibrium vertical emittance | | | | | | | | |
| **Damping times & Equilibrium Emittance** | | | | | | | | |
| Vertical damping time | $\tau_y$ | ms | 23.9 | | 17.7 | 12.9 | 23.9 | |
| Horizontal damping time | $\tau_x$ | ms | 23.9 | | 17.7 | 12.9 | 23.9 | |
| Longitudinal damping time | $\tau_s$ | ms | 11.9 | | 8.8 | 6.4 | 11.9 | |
| Equilibrium horizontal emittance | $e_x$ | nm | 0.57 | | 0.60 | 0.64 | 0.57 | |
| Normalized eq. horizontal emittance | $ge_x$ | mm | 5.5 | | 5.9 | 6.3 | 5.5 | |
| Equilibrium vertical emittance | $e_y$ | pm | 2.0 | | 2.0 | | 2.0 | |
| Normalized eq. vertical emittance | $ge_y$ | nm | 19.6 | | 19.6 | | 19.6 | |
| **RF & Wiggler** | | | | | | | | |
| Total energy loss per turn | | MeV | 4.5 | | 6.1 | 8.40 | 4.53 | |
| Wiggler energy loss per turn | | MeV | 3.8 | | 5.4 | 7.66 | 3.79 | |
| Arc energy loss per turn | | MeV | 0.7 | | 0.7 | 0.74 | 0.74 | |
| Ring Duty Cycle | | % | 100% | | 100% | 50% | 100% | |
| Beam power | | MW | 1.76 | | 2.38 | 1.63 | 3.53 | 1.76 |
| Wiggler period | | m | 0.30 | | 0.30 | | 0.30 | |
| Wiggler length | | m | 2.10 | | 2.10 | | 2.10 | |
| Number of wigglers | | | 54 | | 54 | | 54 | |
| Total length of wiggler | | m | 113.4 | | 113.4 | | 113.4 | |
| Wiggler field | $B$ | T | 1.51 | | 1.8 | 2.16 | 1.51 | |
| Momentum compaction | $a_p$ | | 3.3E-04 | | 3.3E-04 | 3.3E-04 | 3.3E-04 | |
| Total RF voltage | $V_{RF}$ | MV | 14.0 | | 17.0 | 22.0 | 14.0 | |

# Key Points

- Our principal EC evaluations have been carried out for the "5 Hz Low Power" operation
  - **Status update from M. Pivi this afternoon**
- 2 additional challenging operating modes
  - **10 Hz operation with significantly increased photon load in the wiggler region**
  - **High power operation with nearly double the operating current in the DR**
    - The 2 positron ring option is our baseline option in this case
    - Would prefer, however, to have sufficiently good EC control that a 2$^{nd}$ positron ring is not necessary

# EC Working Group Baseline Mitigation Plan

Mitigation Evaluation conducted at satellite meeting of ECLOUD`10
(October 13, 2010, Cornell University)

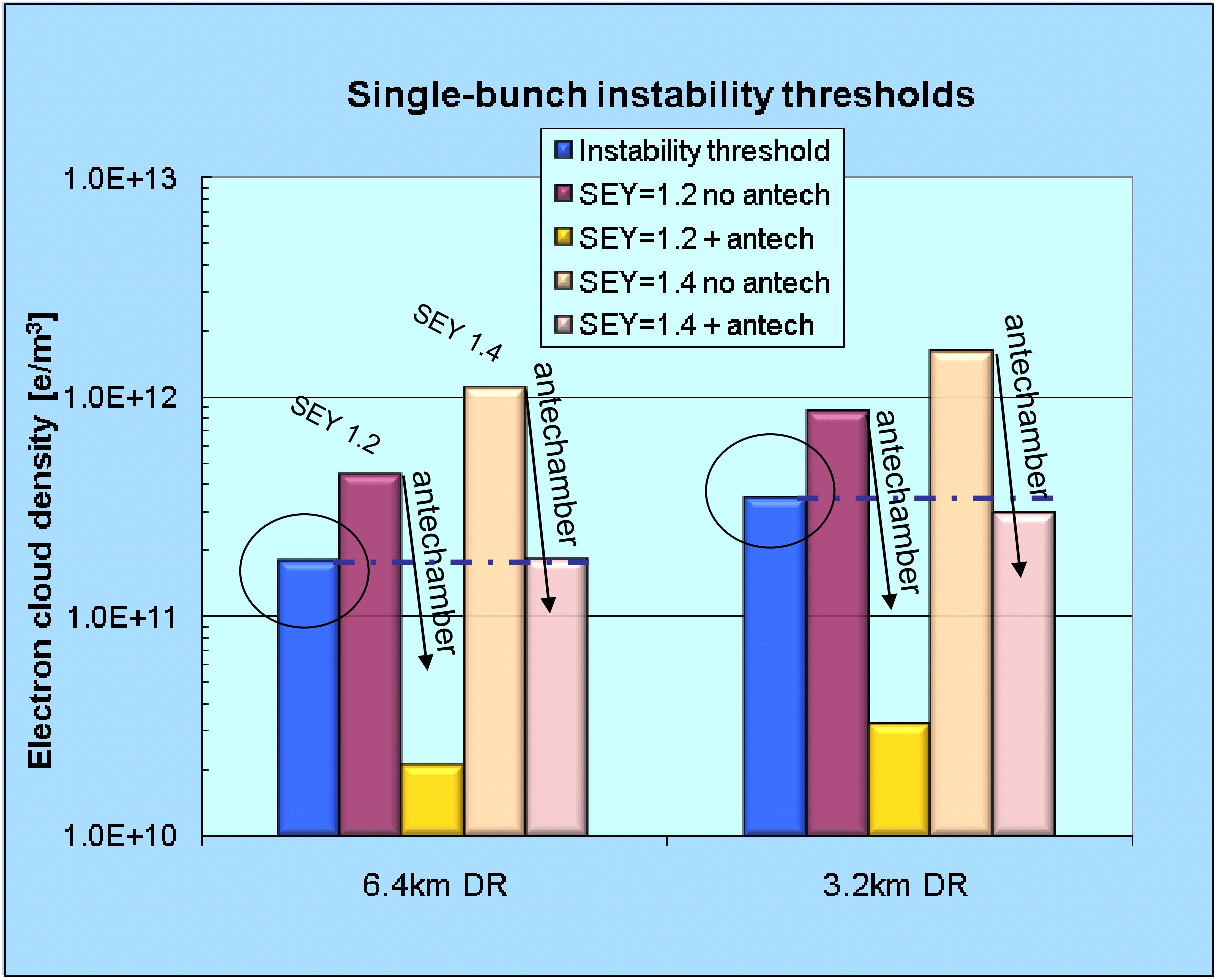
| *EC Working Group Baseline Mitigation Recommendation* | | | | |
|---|---|---|---|---|
| | Drift* | Dipole | Wiggler | Quadrupole* |
| **Baseline Mitigation I** | TiN Coating | Grooves with TiN coating | Clearing Electrodes | TiN Coating |
| **Baseline Mitigation II** | Solenoid Windings | Antechamber | Antechamber | |
| **Alternate Mitigation** | NEG Coating | TiN Coating | Grooves with TiN Coating | Clearing Electrodes or Grooves |

*Drift and Quadrupole chambers in arc and wiggler regions will incorporate antechambers

- Preliminary CESRTA results and simulations suggest the presence of *sub-threshold emittance growth*
  - Further investigation required
  - May require reduction in acceptable cloud density ⇨ reduction in safety margin
- An aggressive mitigation plan is required to obtain optimum performance from the 3.2km positron damping ring and to pursue the high current option

S. Guiducci, M. Palmer, M. Pivi, J. Urakawa on behalf of the ILC DR Electron Cloud Working Group

# Comparison of 6.4 and 3.2 km DR Options




**Summer 2010 Evaluation**

- Comparison of Single Bunch EC Instability Thresholds for:
  - 6.4km ring with 2600 bunches
  - 3.2km ring with 1300 bunches
  - ⇨ same average current
- Both ring configurations exhibit similar performance

⇨ 3.2km ring (*low current option*) is an **acceptable** baseline design choice

S. Guiducci, M. Palmer, M. Pivi, J. Urakawa on behalf of the ILC DR Electron Cloud Working Group

# Vacuum System Design Approach

- Recently completed ERL conceptual design at Cornell
  - **Utilize design concepts and costs from that effort wherever possible**
  - **Implement EC mitigation methods based on chambers developed for SLAC and CESRTA R&D efforts as well as SuperKEKB designs**
- Prepare a preliminary costing
- Cross-check with SuperKEKB costs
- “Official” cost roll-up needed by May 8 or 9
- Document for the TDR by late May or early June