Damping Ring

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for

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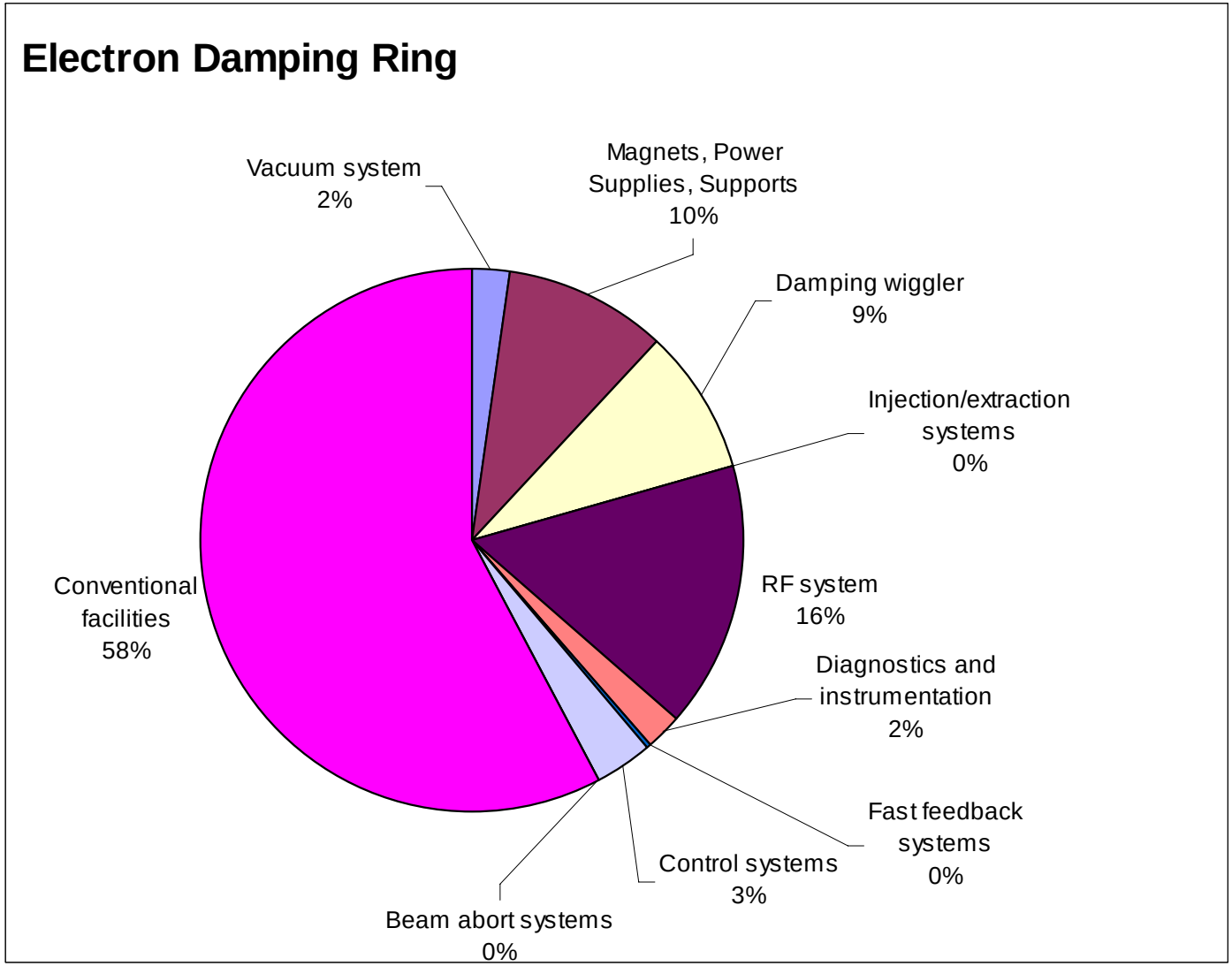
and Mike Zisman (LBNL)

Design Status

Cost estimate presented at Vancouver VLCW06 based on:

- Two DR tunnels at linac ends
- 1 e^- ring and 2 e^+ rings
- "OCS6" version of lattice with nearly six fold symmetry, posted at https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/WebHome
- Injection/extraction placed in one long straight section
- 4 sections for RF and wigglers with alcove and shaft

Vancouver Cost Distribution



e-Cloud Suppression

- At Vancouver a DR session was dedicated to the possibility to eliminate the second ring for positrons
- Recent work on mitigation techniques gives good hope of handling e-cloud instability in single PDR
  - **weak solenoids for drifts**
  - **clearing electrodes and/or grooved chambers in magnets (+ NEG coating)**

- CCR submitted after Vancouver meeting
- Class II request, saves 16% of VLCW06 baseline cost
- Approved September 06
  - **CCB asked that ECI R&D have high priority to validate efficacy of proposed cures**
    - until then, design should preserve option to return to 2 PDRs? (under discussion)

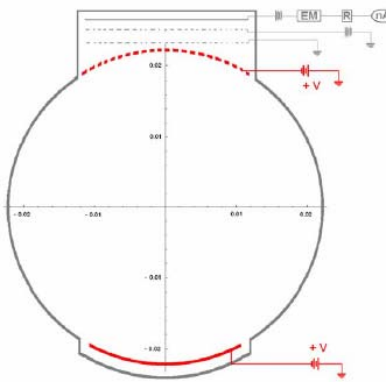
E-cloud session at VLCW06

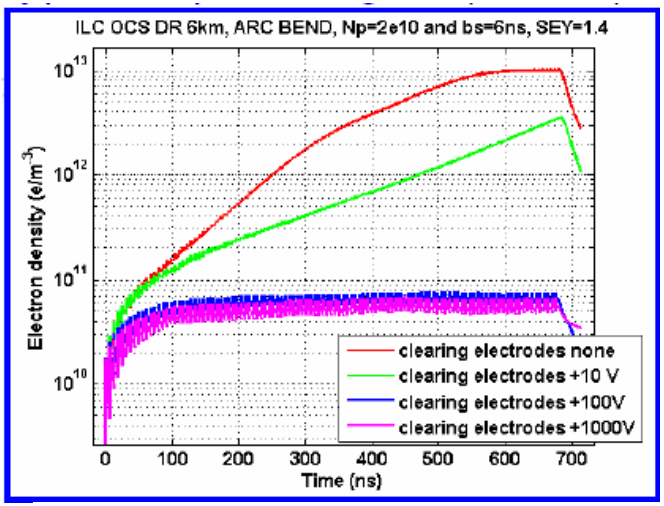
- The baseline configuration should be changed to specify a single positron damping ring
- The design of the damping rings systems should not preclude later installation of a second positron ring
- R&D on the full range of electron cloud mitigation techniques, including experimental demonstration in test facilities (Φ and B-factories, possibly CESR-TF), must be a very high priority:
- grooved chamber surfaces
- clearing electrodes
- coatings with low secondary yield (vacuum properties and impact on impedance)
- Solenoids in the field-free regions

e-Cloud Suppression

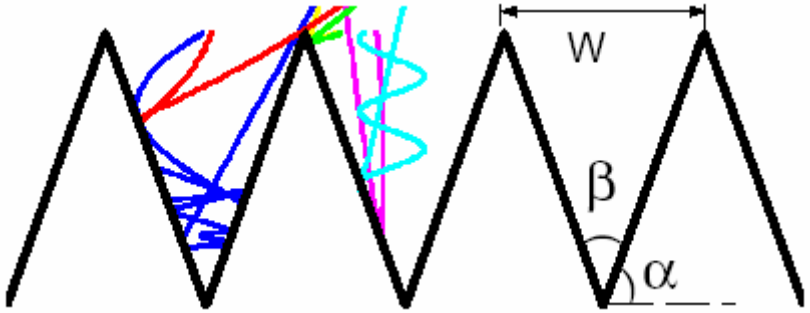
- Possible “cures”

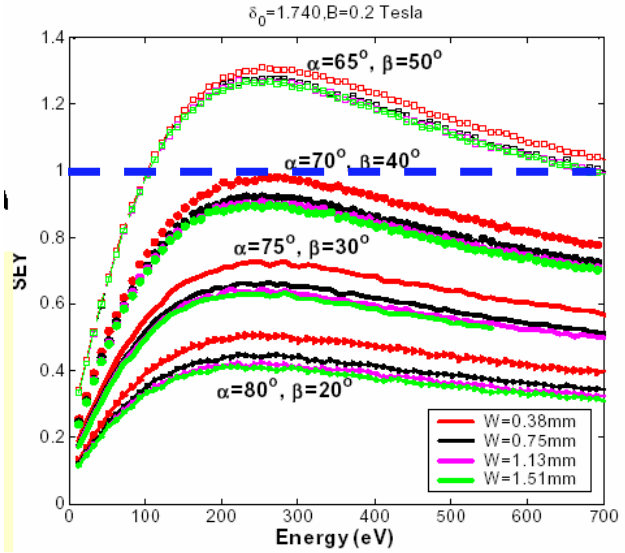
Pivi, Raimondi





Wang, Raubenheimer



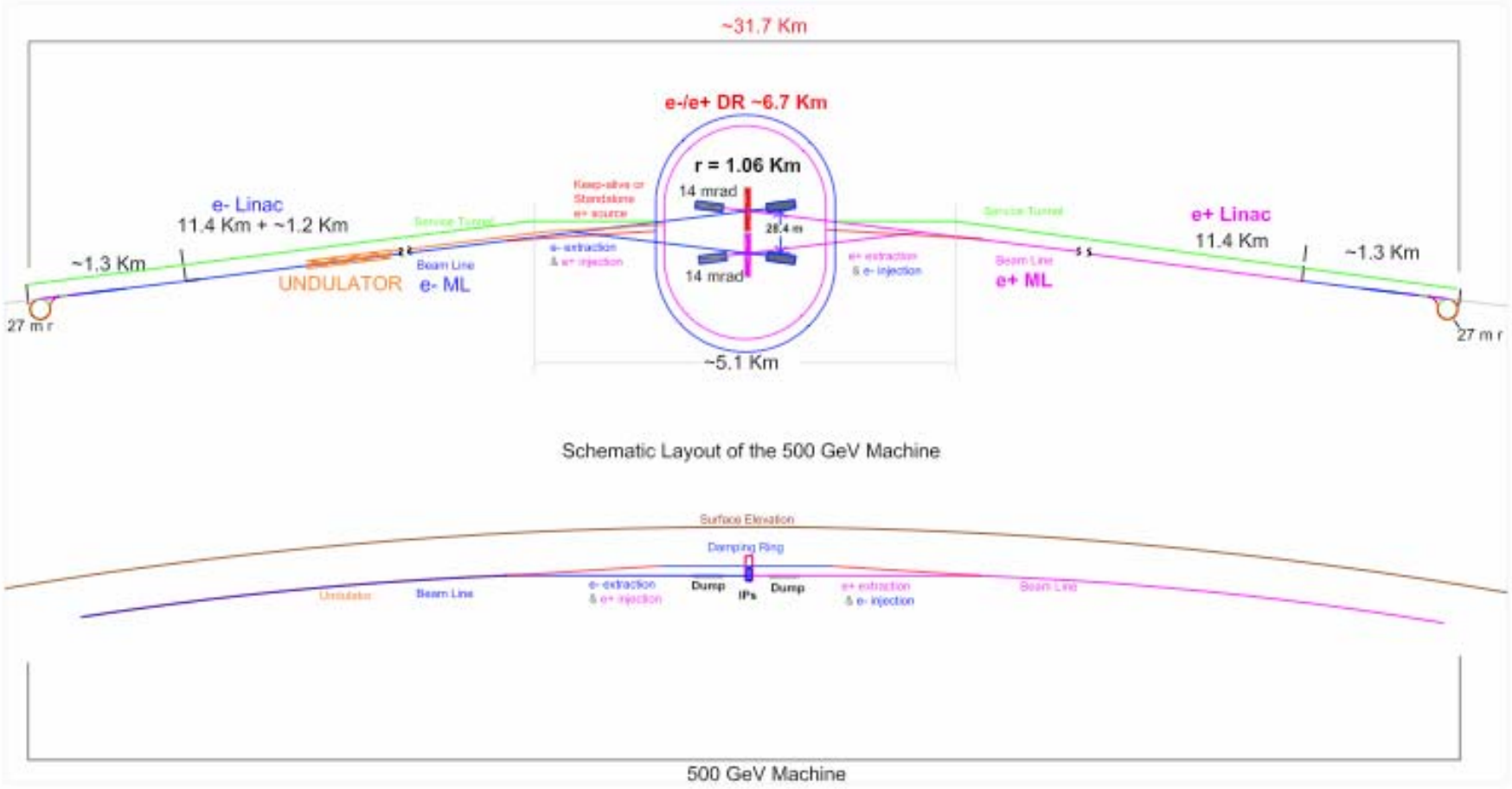


B=0.2 Tesla (dipole magnet of ILC)

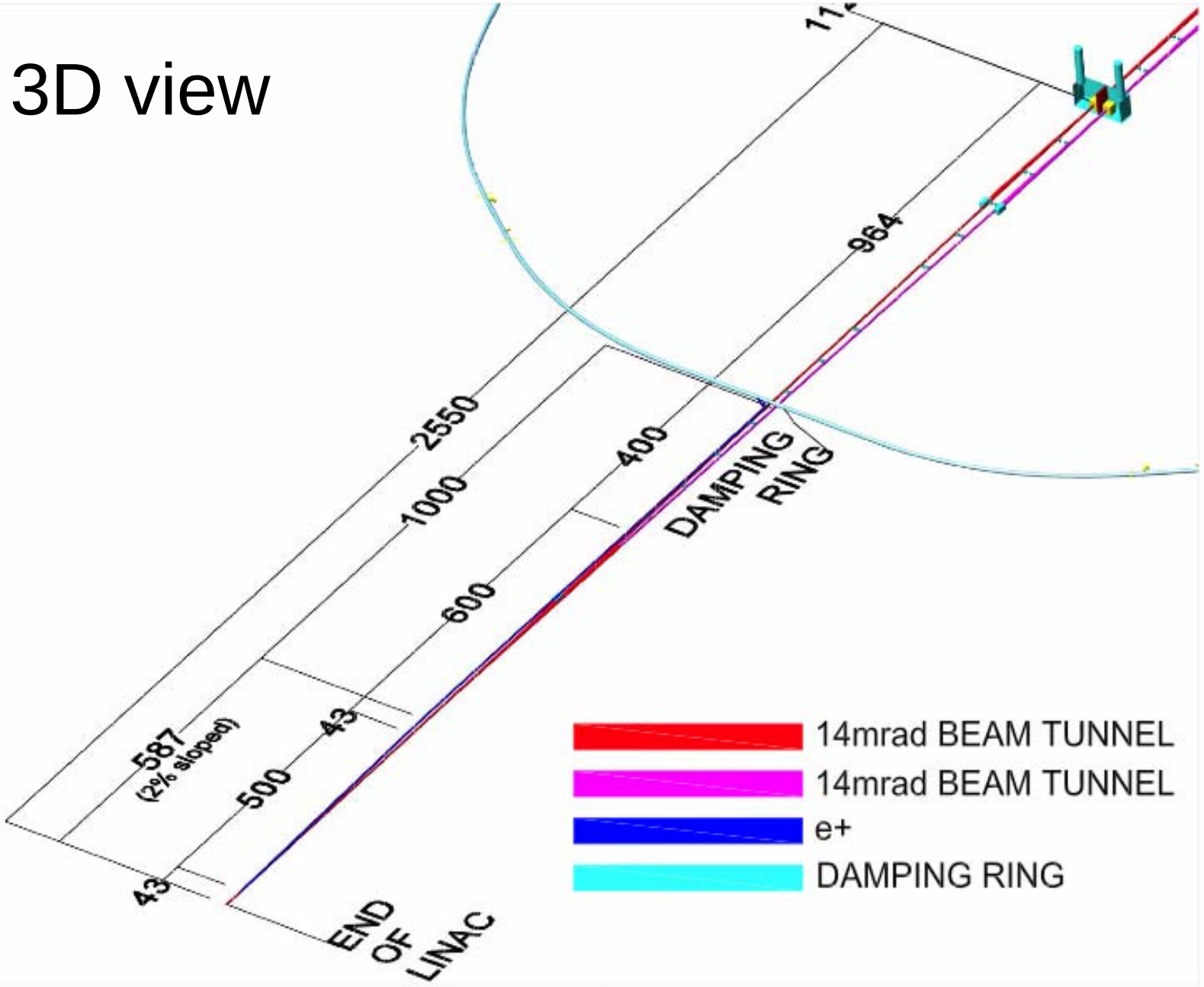
Centralized Damping Rings

- A CCR for a Central Injector/Damping Ring complex presented by Ewan Paterson for the RTML, Sources, BDS and DR Area Systems
- One electron and one positron ring in the same tunnel located centrally between the linacs and above the level of the beam delivery system
- Both the e- source and the Keep Alive e+ source remain the same and become part of a new DR/INJ Complex
- The RTMLs now extend from the central DR to the beginning of the Main Linac.
- CCR level II, saves 17.6% of the VLCW06 DR baseline cost

Schematic Layout of the 500 GeV ILC



3D view


964
2550
1000
400
600
DAMPING RING
587
(2% sloped)
500
43
43
END OF LINAC
14mrad BEAM TUNNEL
14mrad BEAM TUNNEL
e+
DAMPING RING

3D overview

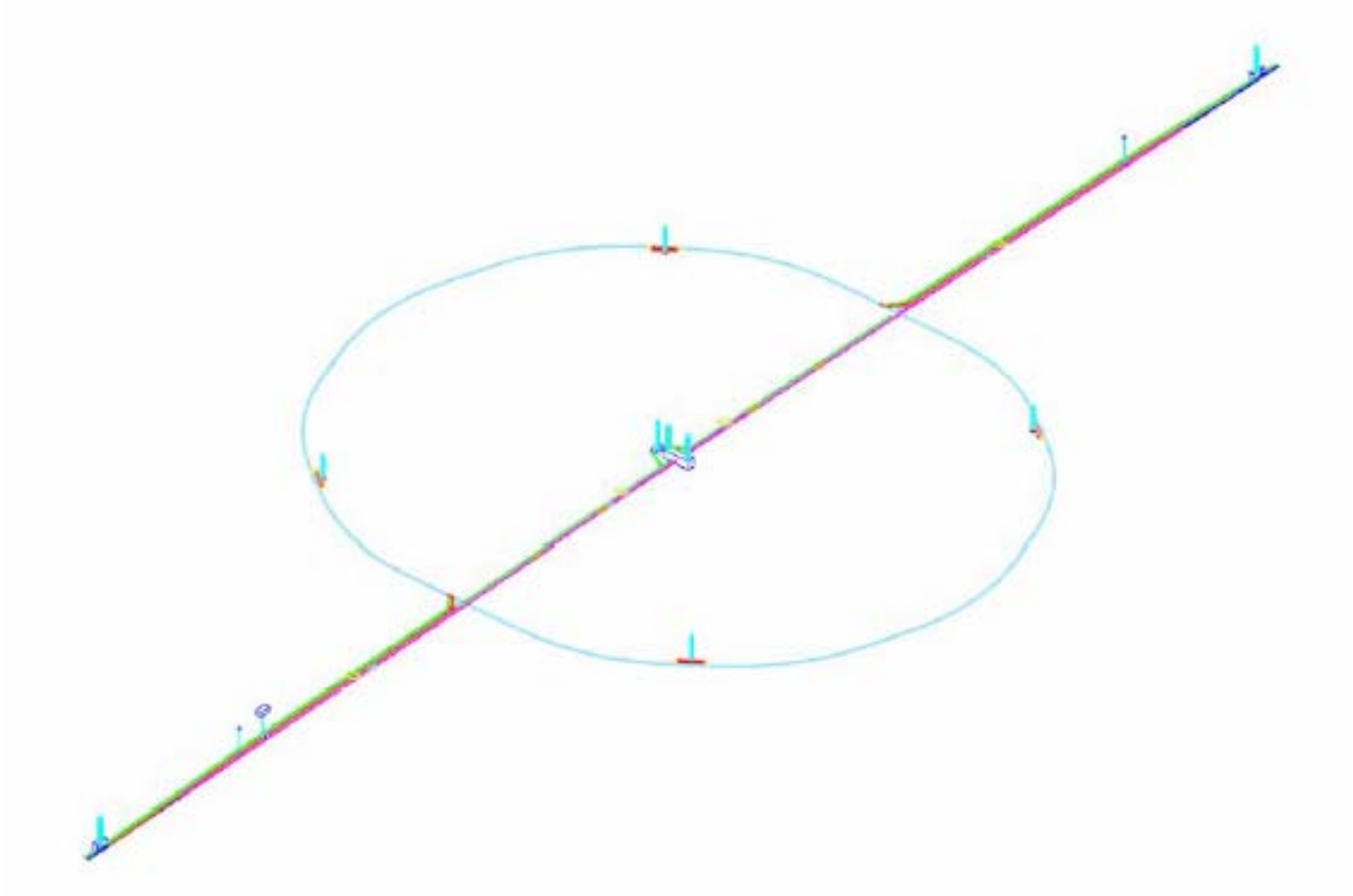
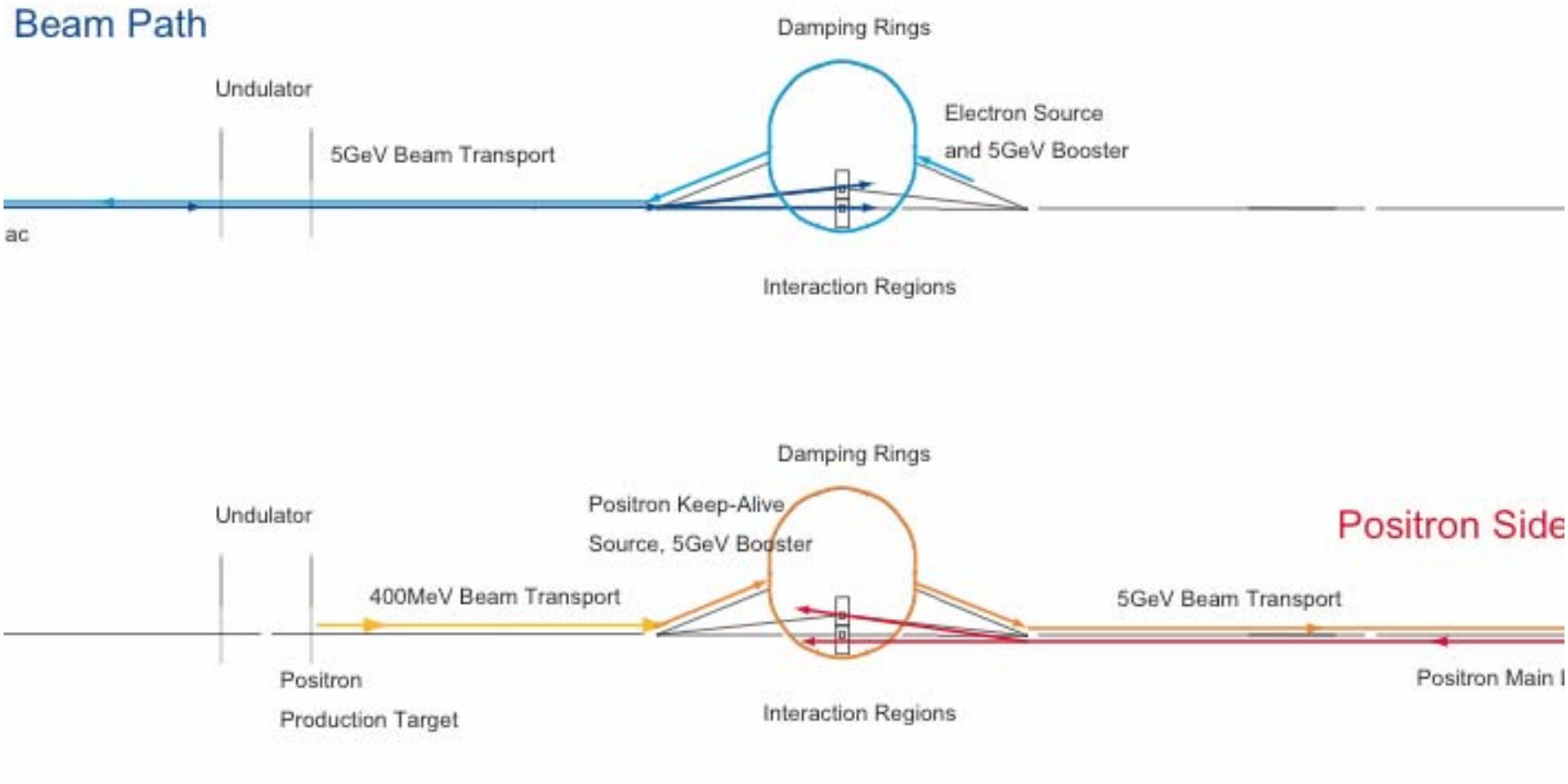


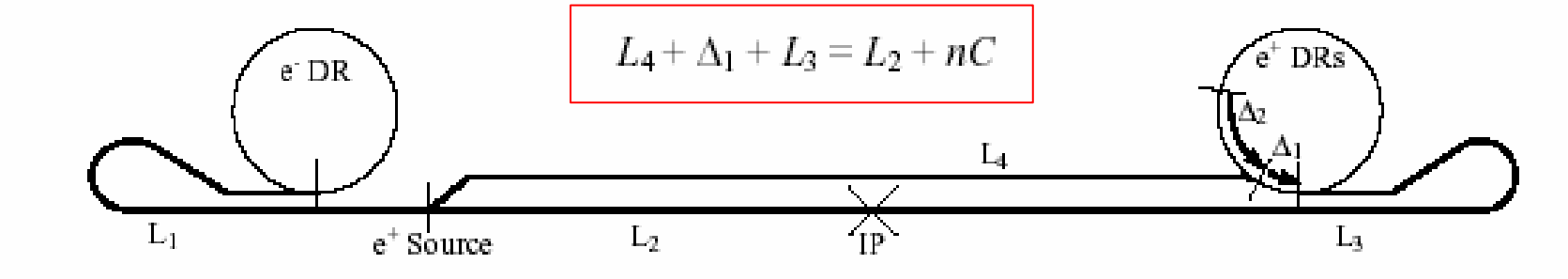
Diagram of Beam Path

Electron Side



Timing Constraint

- undulator positron source
- **"self-reproducing"** fill (each damping ring bucket is refilled by its electron collision partner bunch)



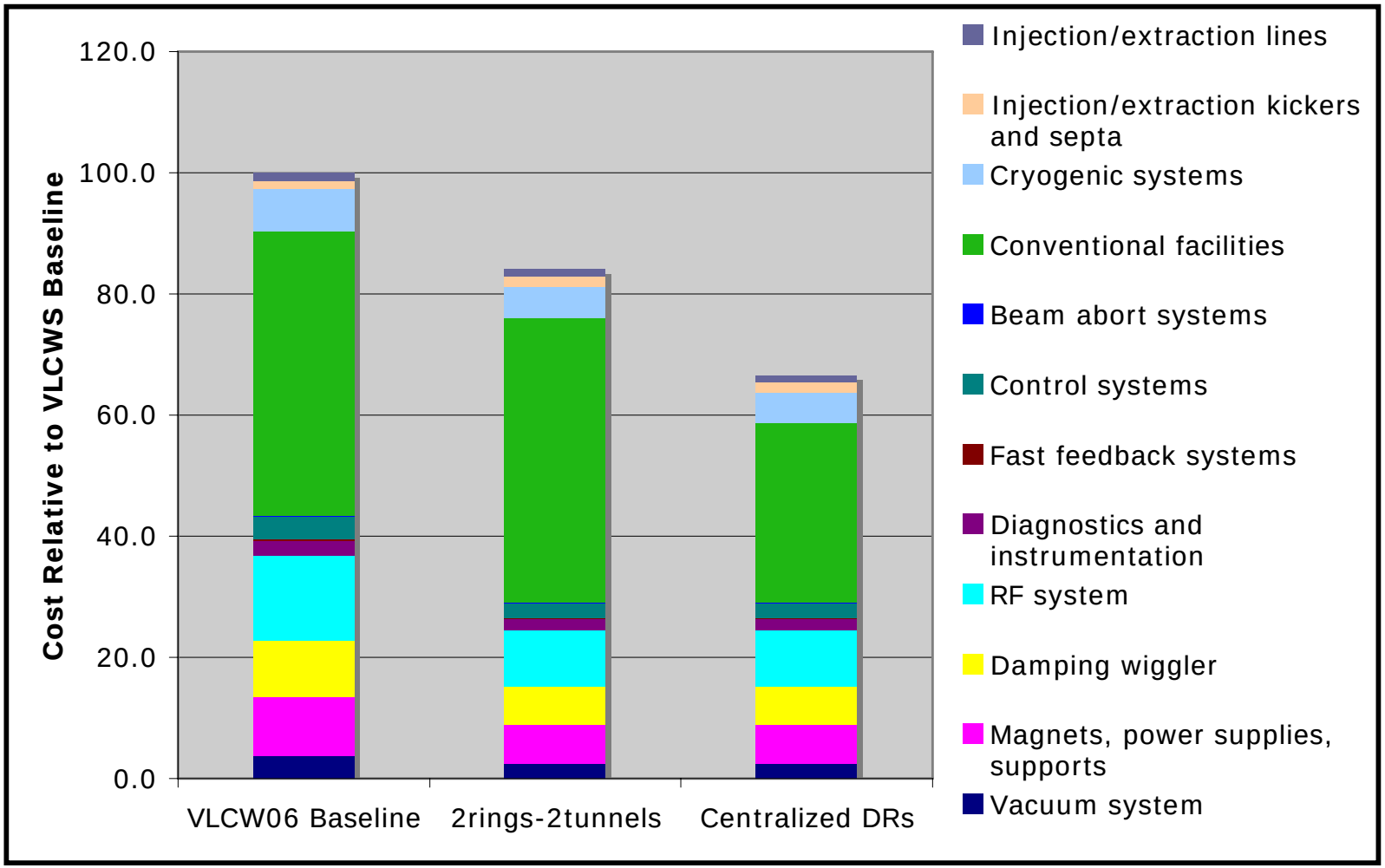
- Longitudinal (parallel to the main linacs) relocation of the DR does not affect the timing constraint
- Relocation of the DR transverse to the main linacs will change timing solutions

"Recommendations for ILC Configuration Satisfying Timing Constraints,"
H.Ehrlichmann, S.Guiducci, K.Kubo, M.Kuriki , A.Wolski,

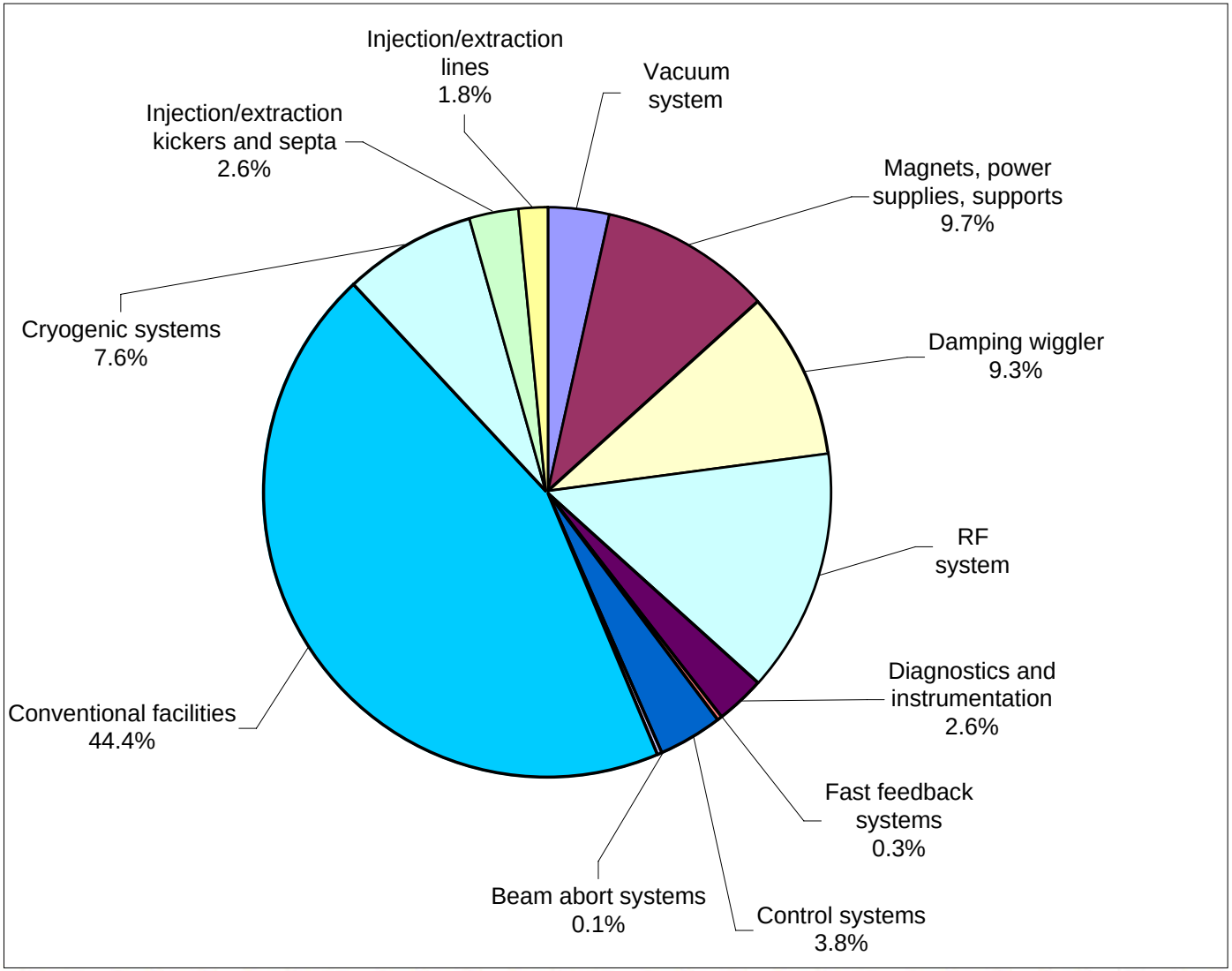
Central INJ/DR

- The general concept of the Central INJ/DR, ccr#18, is approved but can still be optimized
- A joint session between the ASL involved, organized by Axel Brachmann will be held on Thursday at 11-13 ADEIT, room 2.2
- The discussion will address:
  - **alternative configurations for optimization of central injector complex**
  - **consistency of the CF&S drawings for all the systems**
  - **establish the RDR configuration**

Comparison of Configuration Options Costs

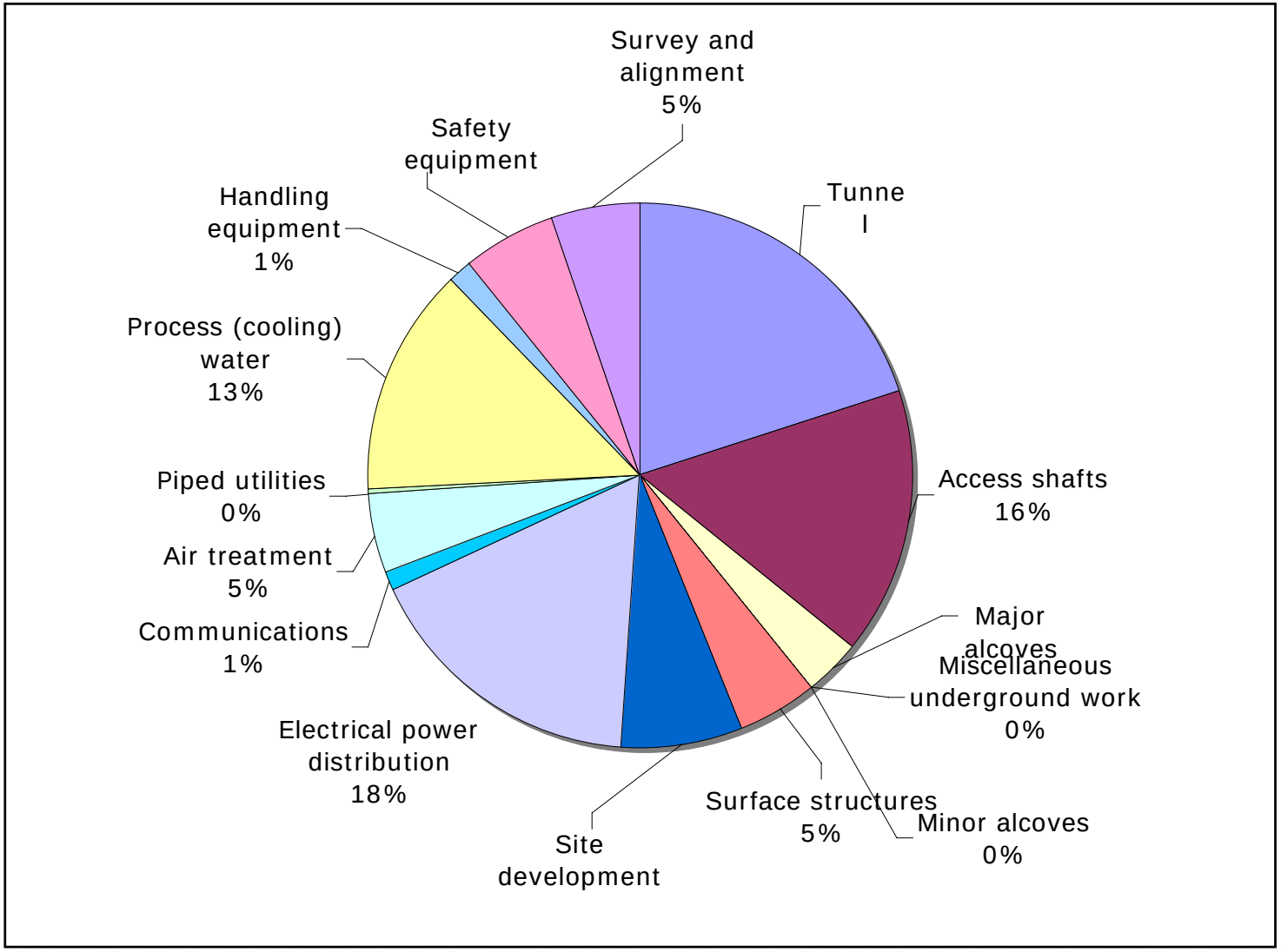


Cost Distribution for Centralized DRs



Cost Distribution for Conventional Facilities

Centralized DR



DR possible cost savings

Preliminary estimate of cost saving as a fraction of central DR option

Remove RF margin	1.60%
Reduce momentum compaction by 30%	4.20%
Use higher harmonic RF	
Increase bunch length to 9 mm	7.30%
Increase bunch length to 9 mm and reduce mom. comp.	9.40%
Combining RF cavities in cryomodules	0%
Modify layout to remove 2 shafts per ring	4.30%
Reduce number of magnets	<1%
Reduce number of bunches and circumference by 20%	10-20%

DR possible cost savings

- Following the advice of the RDR management we are pursuing the following two:
  - **Increase bunch length to 9 mm (7.3%)**
  - **Modify layout to remove 2 shafts per ring (4.3%)**

Increase bunch length to 9 mm

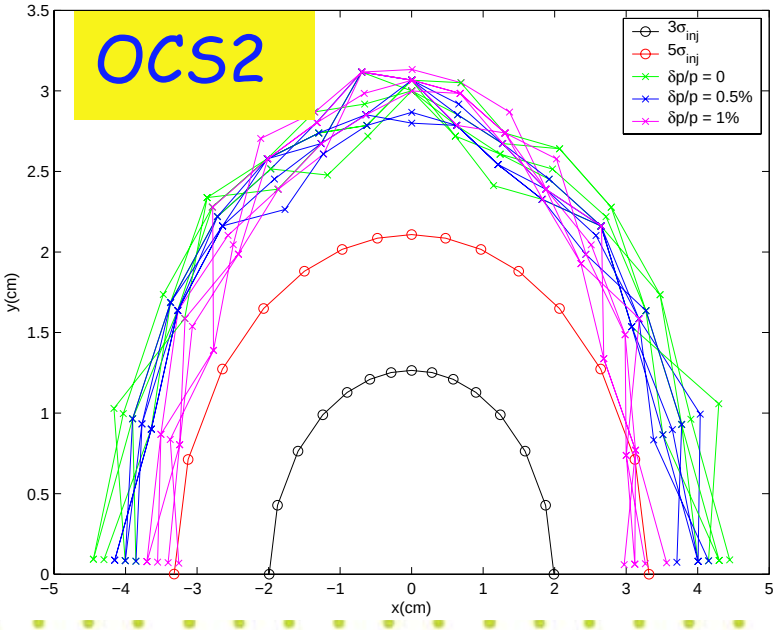
- Increase bunch length from 6 to 9 mm (factor 1.5)
- Reduce RF voltage, and therefore RF system cost by ~ a factor 2
- reduce the peak current, raising the instability thresholds for the bunch charge
- reduce the number of cavities in proportion to the voltage might lower the impedance of the ring
- Involves RTML since puts additional pressure on the bunch compressors:
  - **requires 2 stage bunch compressor**
- eliminates “low power” parameter set (150 μm at IP)
- Upgradeable (design should preserve option to double the RF system)

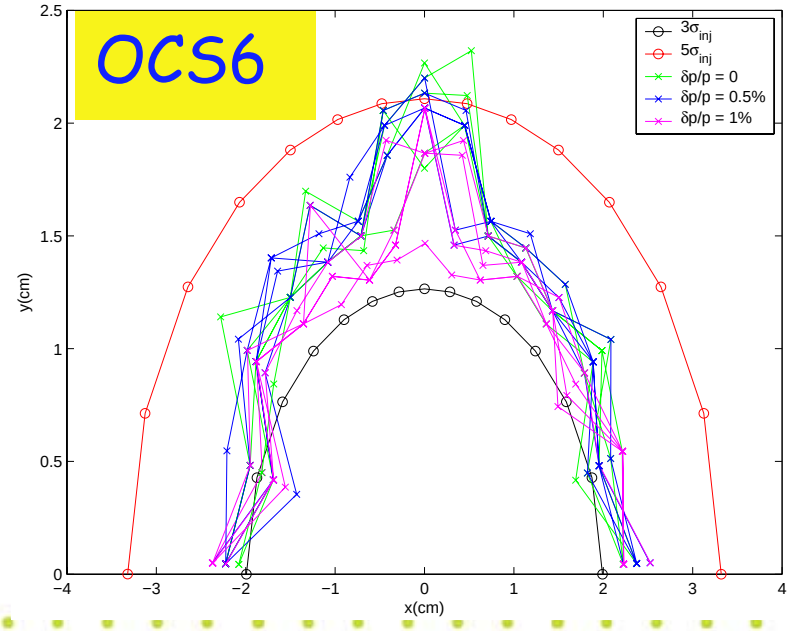
Modify layout to remove 2 shafts

- Present lattice has 4 straight sections for wigglers and RF each with access shaft (9 m) and alcove (25 m length)
- Concentrate wigglers and RF in 2 straights
- Increase the length of the alcove (50m)
- In the present ‘OCS6’ lattice reducing the number of straights reduces the dynamic aperture, because of reduction in lattice symmetry from 10 to 6
- The number of locations for the power supplies is reduced, so increasing the length of magnet cables and the power losses

OSC6 Lattice Issues

- Large α_c good for beam stability
  - **but substantial RF (48 MV) needed for 6 mm bunches**
- Reduction in lattice periodicity has markedly decreased dynamic aperture
  - **under investigation now**



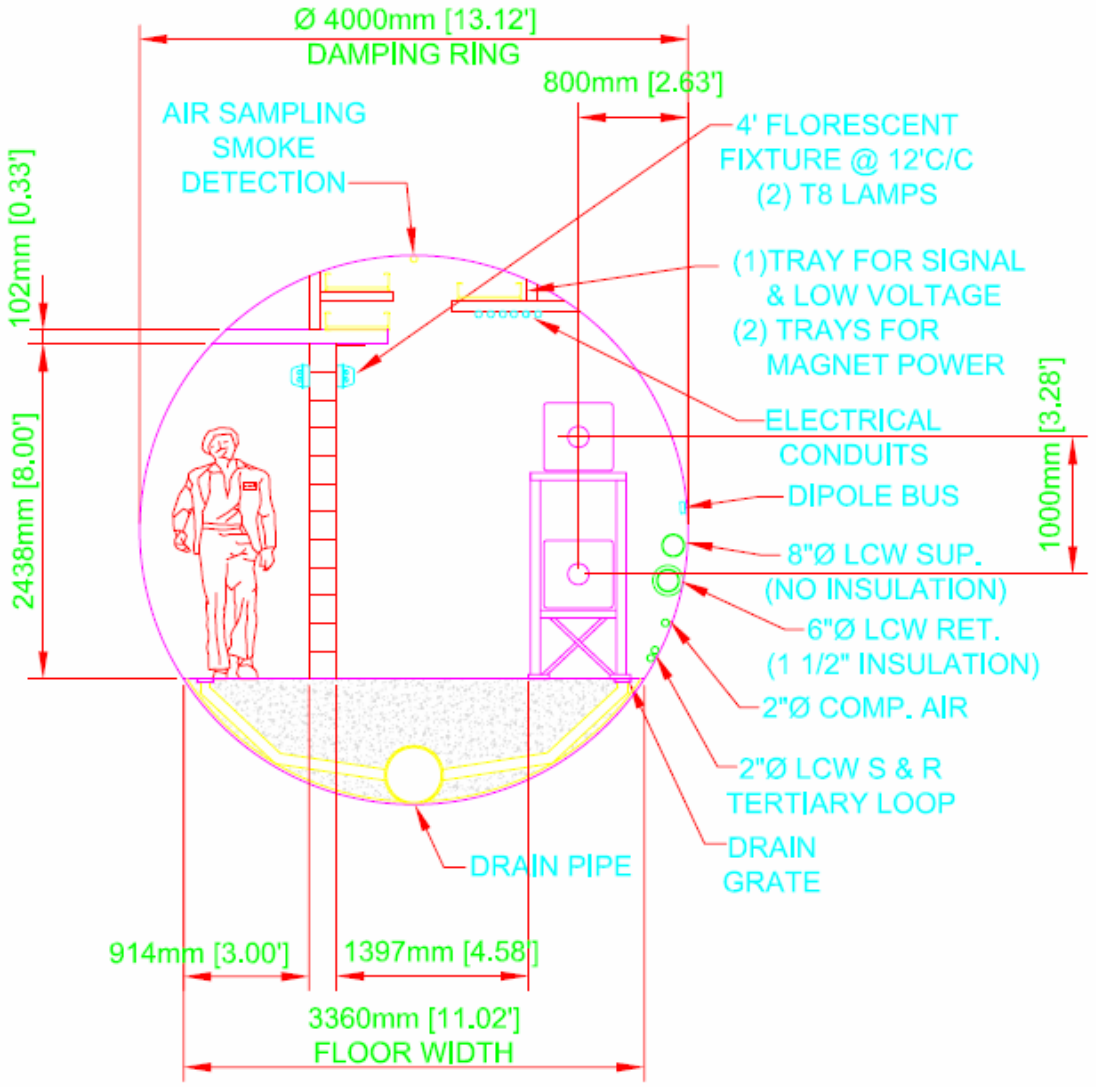


Modify layout to remove 2 shafts

- A FODO lattice with only 2 RF and wiggler sections (~ 4-fold symmetry) is under study (Y. Sun, A. Wolski)
- Satisfies the baseline parameters and is available for the RDR and cost estimate
- Dynamic aperture has less safety margin with respect to the OCS lattice, further optimization work is needed
- Dynamic Aperture evaluation with realistic field errors is needed

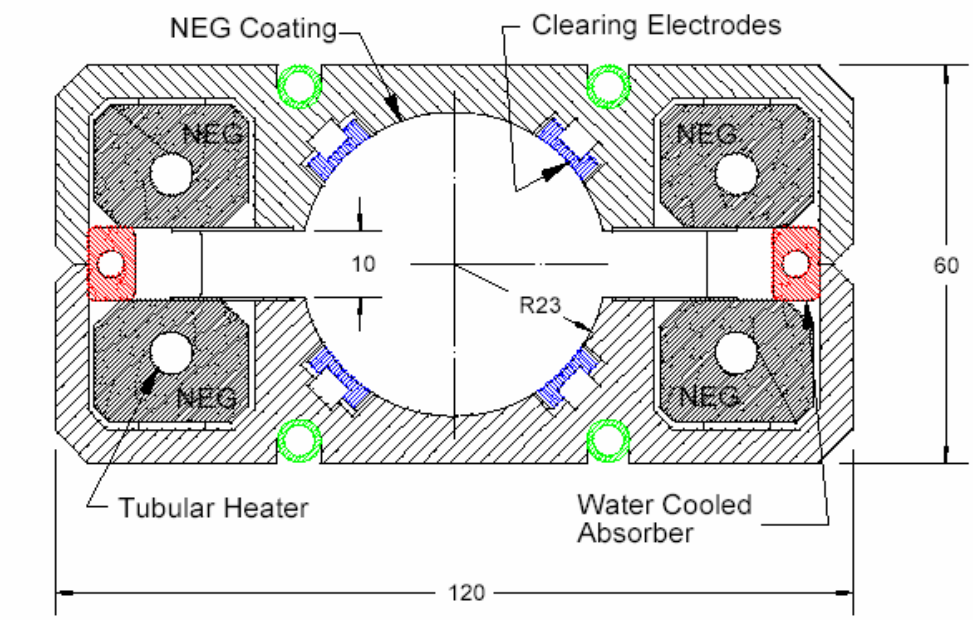
Tunnel Layout

- layout for 2 PDRs
  - **vertical spacing too small to accomodate RF criomodules**
- DR and CF&S session on Thursday: 2 rings tunnel layout (and diameter)



Wiggler Design

- Baseline design based on Cornell SC wiggler (Urban)
  - **permits high field with large aperture**
    - alternative designs still being examined (PM or resistive)
  - **vacuum chamber concept to handle heat load and provide adequate pumping developed (Marks, Plate)**



Material: welded Al, NEG coated

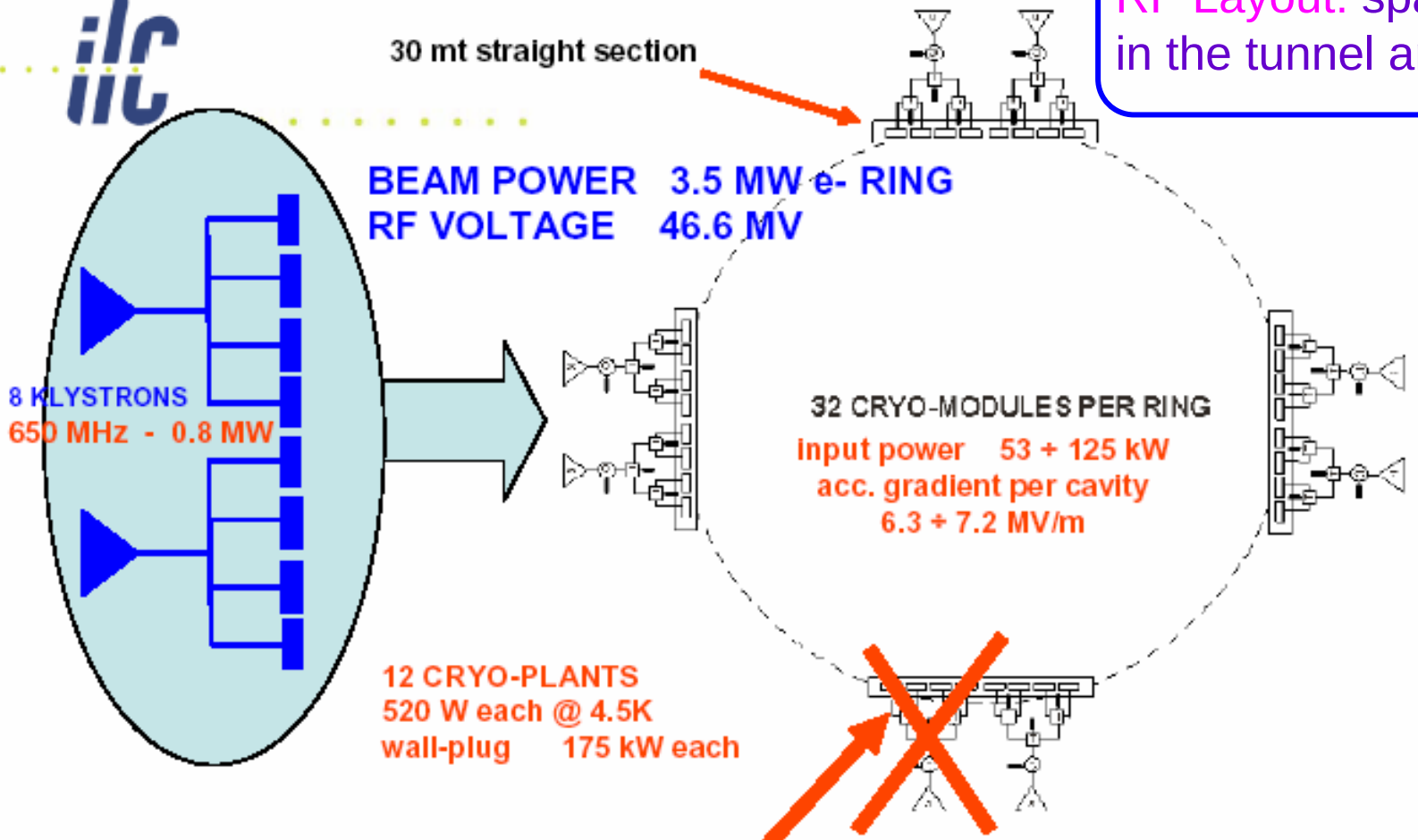
P_{CO} = 0.7 nTorr

Power density: 3 W/mm^2

Power: 26 kW/wiggler (13 kW each absorber)

RF System

Thursday 9:00 DR/CF&S
RF Layout: space needs in the tunnel and alcove

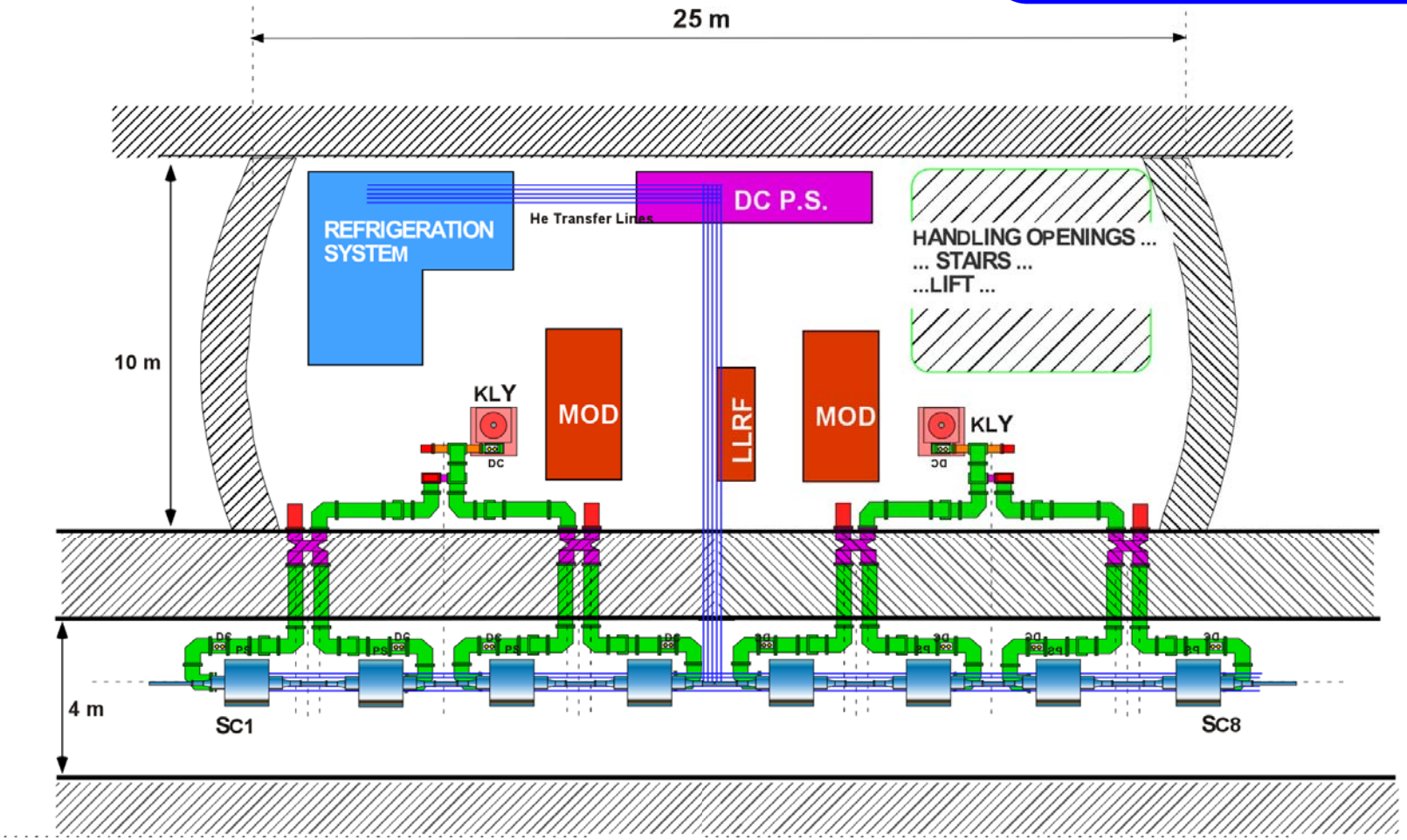


The system is powerful enough to meet the specifications in case of one RF station fault

R. Boni

Thursday 9:00 DR/CF&S
RF Layout: space needs in the tunnel and alcove

ILC DAMPING RINGS
ALCOVE ARRANGEMENT LAYOUT
TOP VIEW



Other systems

- Magnets have been defined, some modification have reduced power dissipation.
- Kickers parameters for cost estimate based on 5KV, 3MHz, pulse duration < 6ns, stripline length 20 cm: 132 striplines and 264 pulsers for positron injection and extraction. Final configuration will be provided by R&D results
- Vacuum system, based on NEG coating, has been defined. e-cloud mitigation tecniques will be defined by R&D
- **R&D plan** is in preparation by **S3 task force** (see Andy Wolski's talk)

RDR Completion

- For the DR important CCR have been approved since Vancouver with ~ 33% cost saving:
  - **Single positron ring**
  - **Centralized INJ/DR complex**
- Two other possible cost savings are under consideration
- Cost estimate for the various systems has been completed
- Discussion at the meeting will check for consistency between different systems and finalize the RDR configuration