Developments for Cornell's X-Ray ERL

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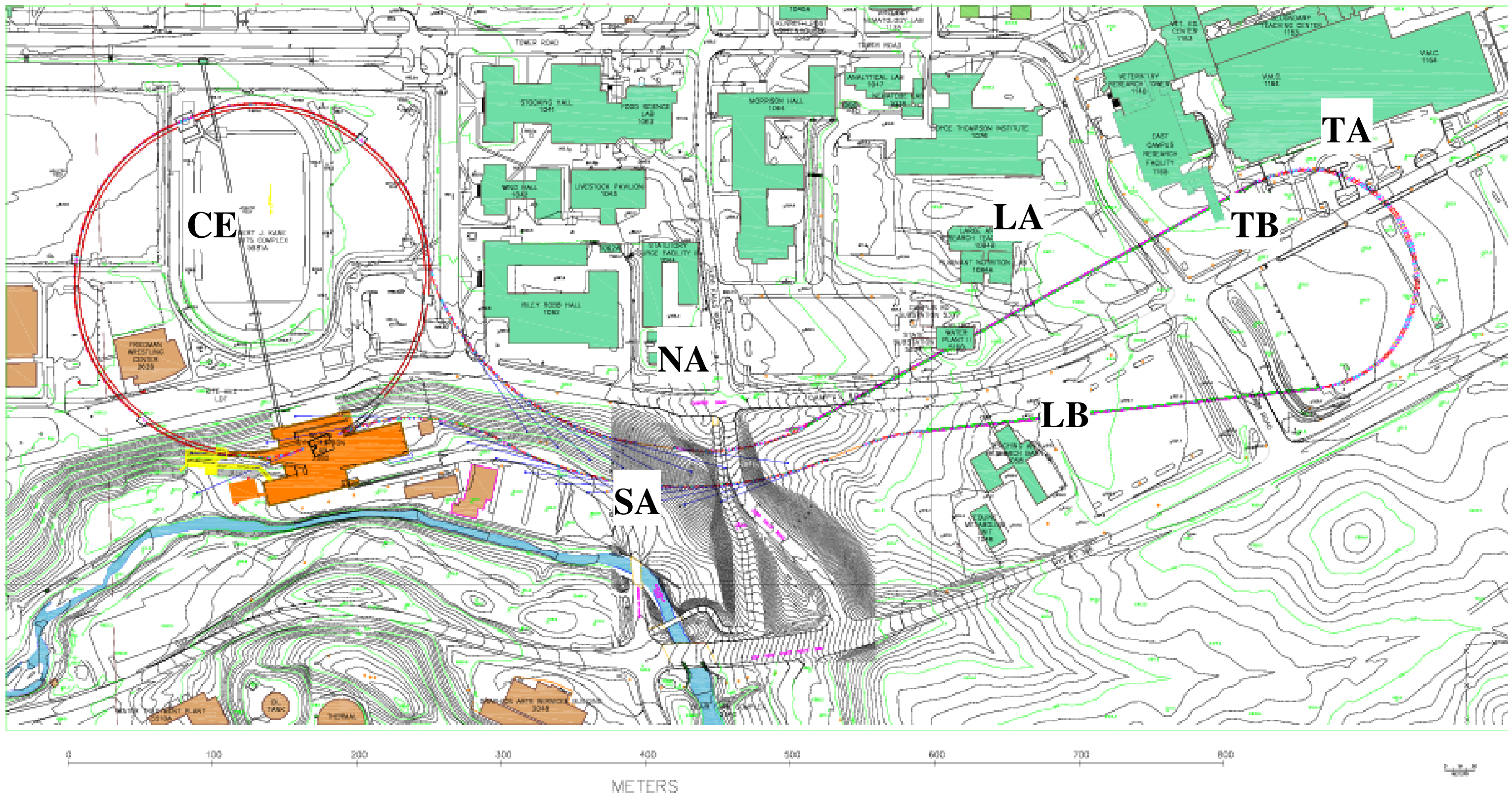
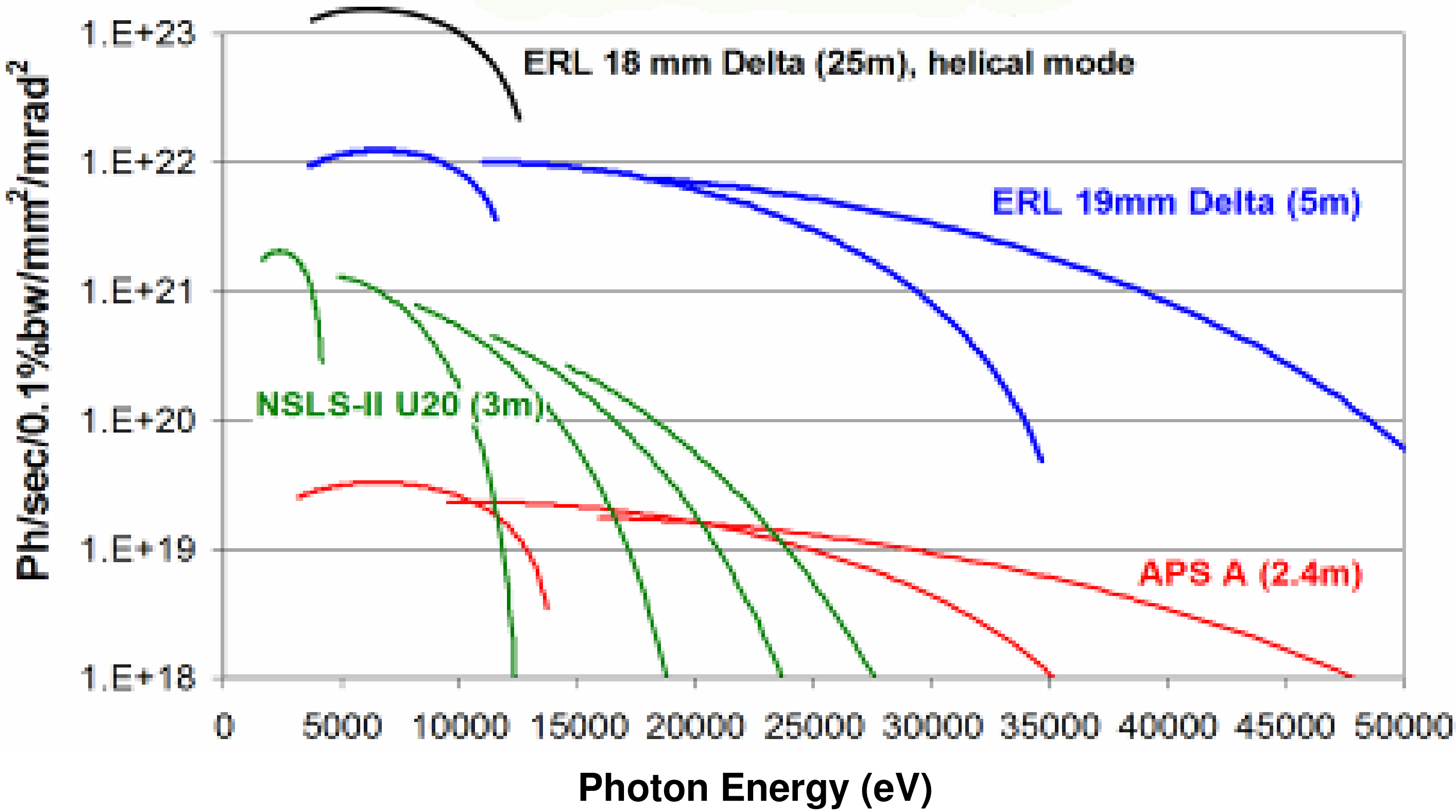
4 May 2009



Performance of an ERL-Based X-Ray Source

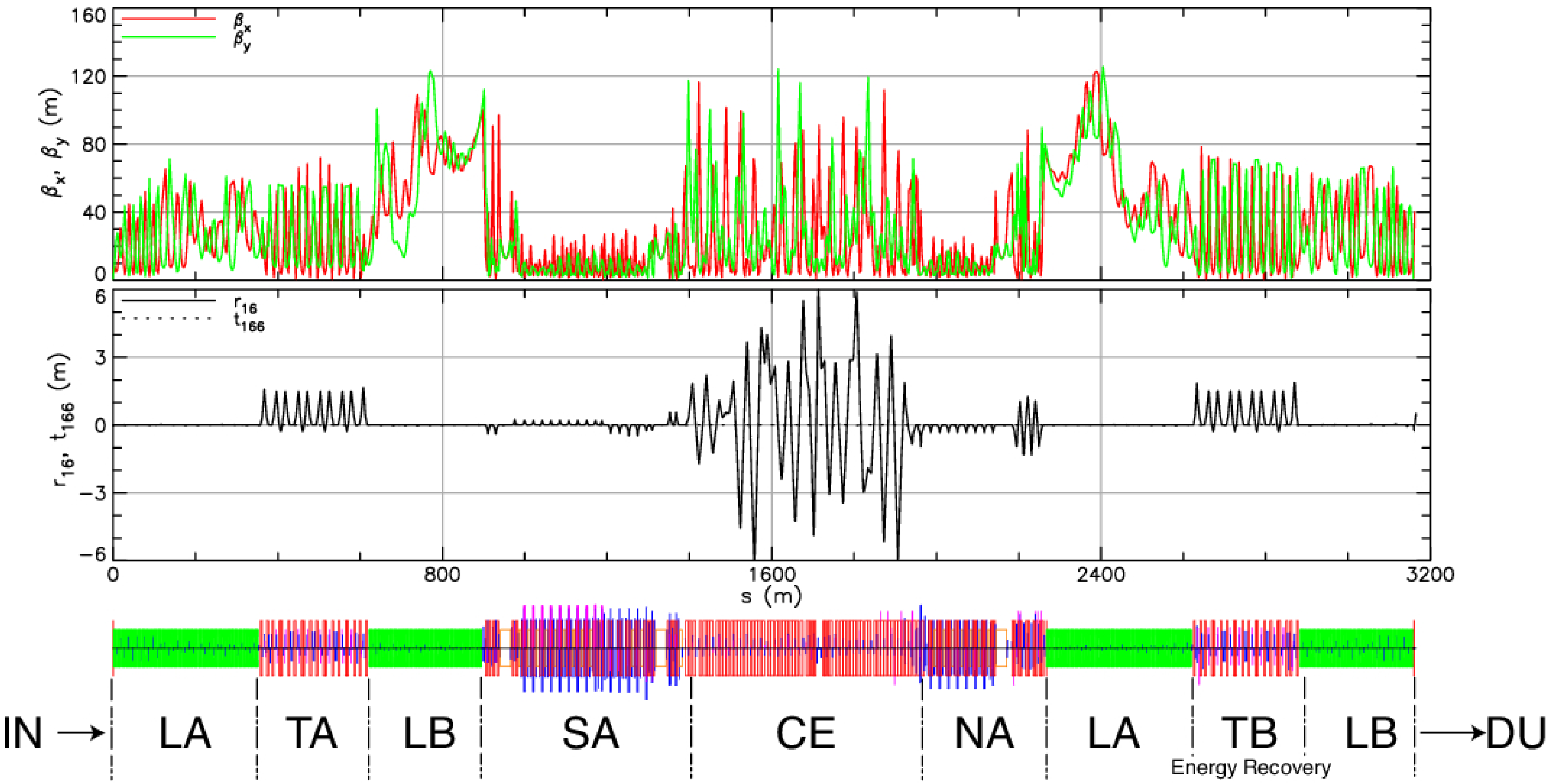
Lower emittance ***Smaller beams*** ***Higher brightness*** ***Higher coherence***



Complete Optics

C.E.Mayes, Ph.D. Dissertation, Cornell University (2009)

Complete linear and second-order optics for dual-pass Cornell ERL incorporating 70% of exising CESR/CHESS ring and a dual turnaround

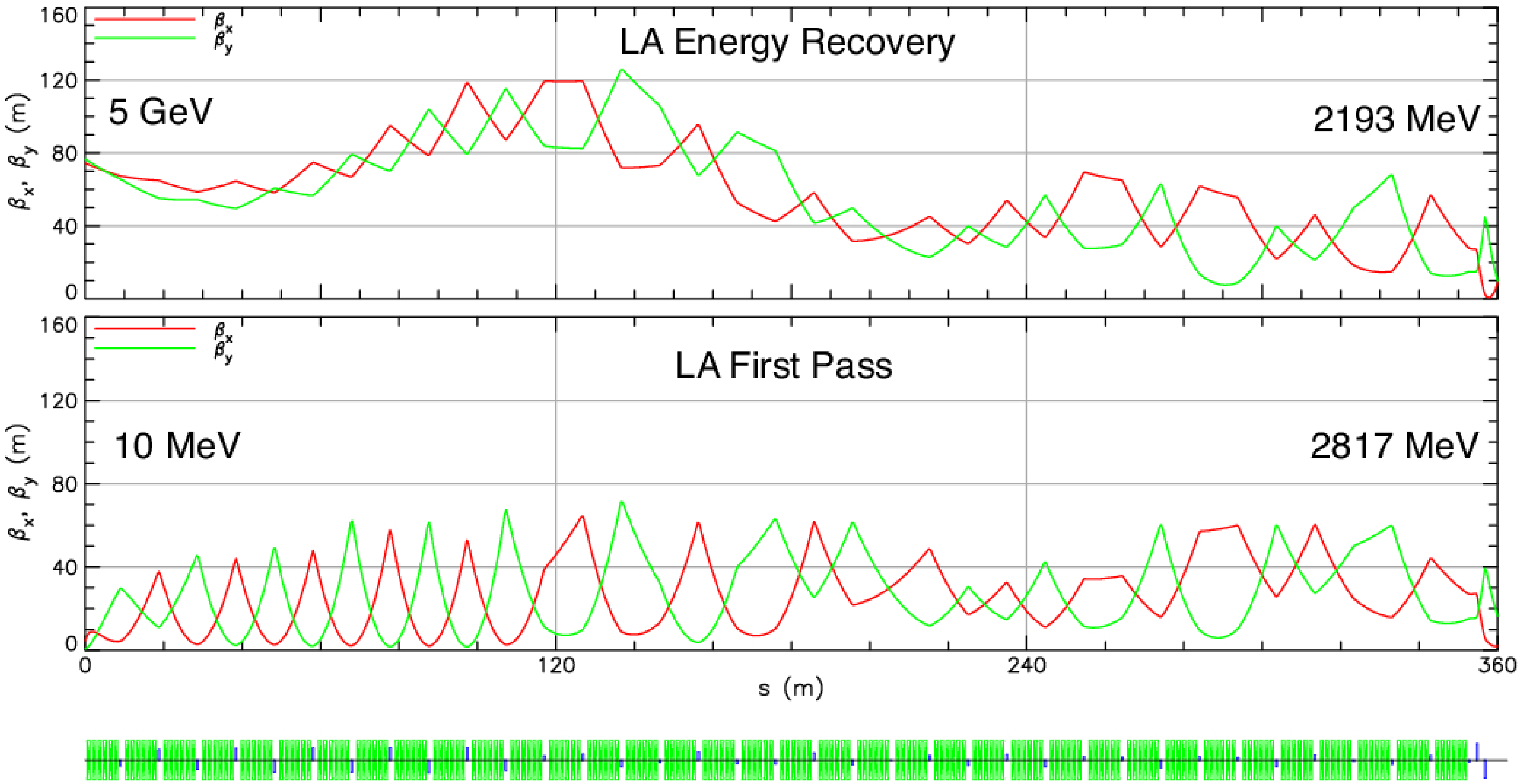


North Linac Dual-Pass Optics

Simultaneous optimization of 36 North Linac quadrupoles

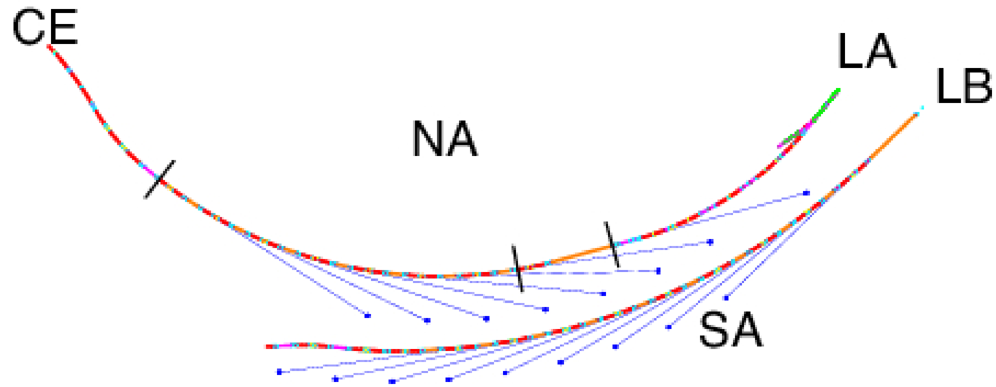
First Pass: Matched to injector and high-energy turnaround TA

Second Pass: Matched to North Arc and low-energy turnaround TB



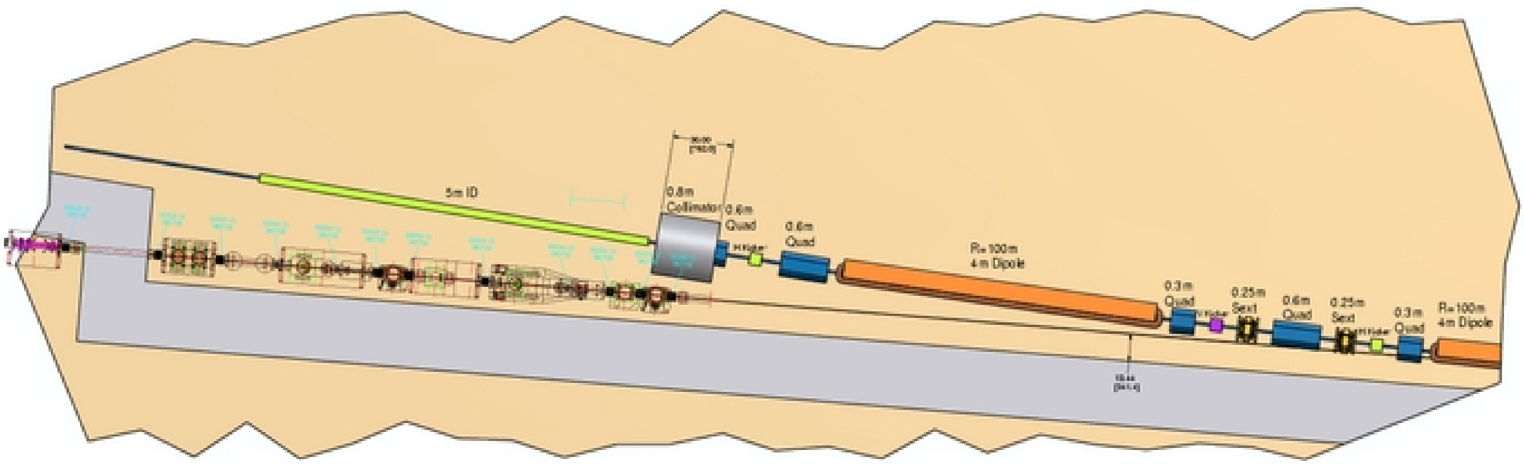
X-Ray Beamline Layout and Shielding

M.P.Ehrlichman and G.H.Hoffstaetter, *Collimating Touschek Particles in an Energy Recovery Linear Accelerator,* PAC09



Modelling results show full collimation reduces the Touschek losses in the user regions to less than 3 pA/m.

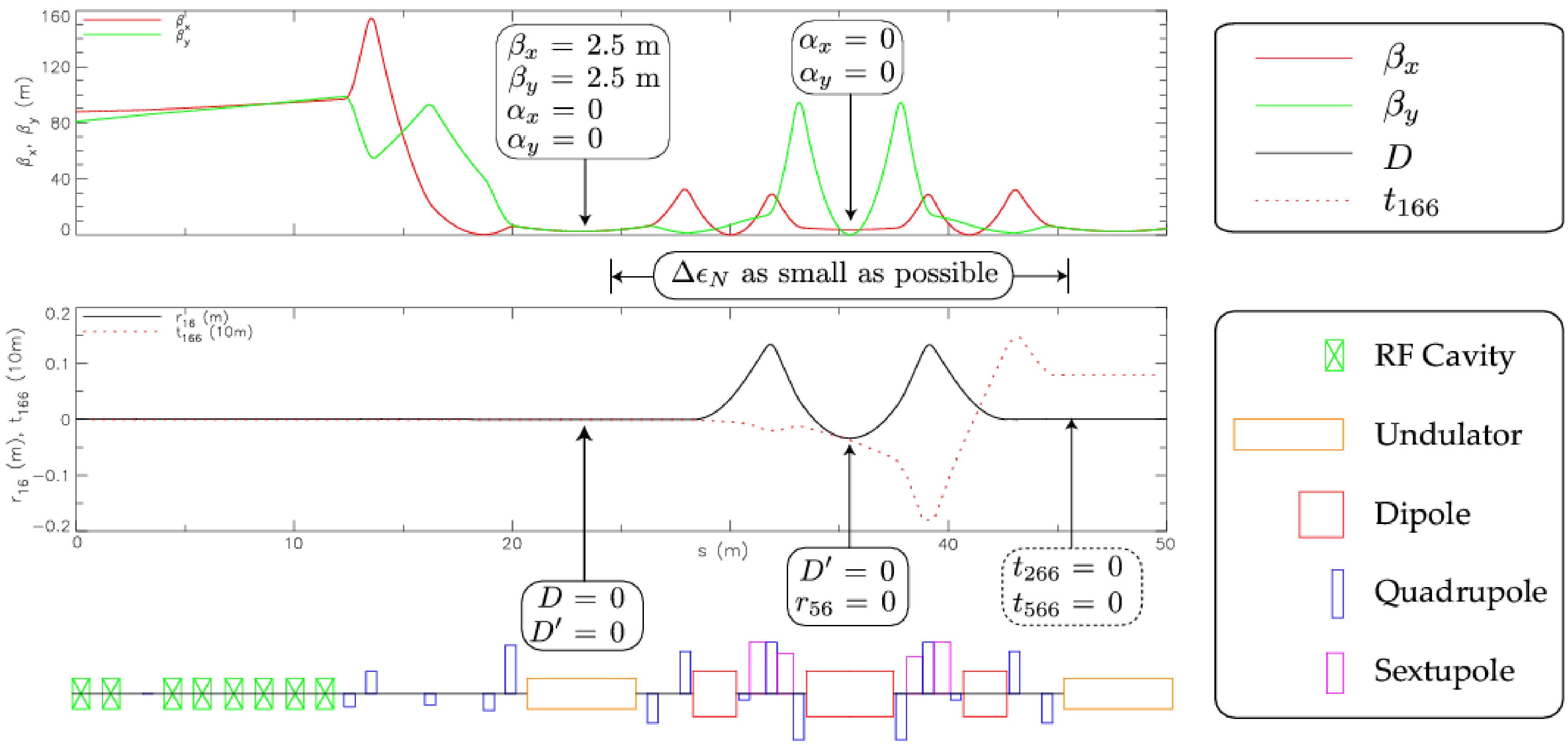
Present X-ray beamline shielding design is 32 inches of concrete and 2 inches of lead



Lattice File: CERL 7.2
X-ray to wall distance 13.5"
Dipole to wall distance 8.5"
Shielding wall to ID center 26.2m

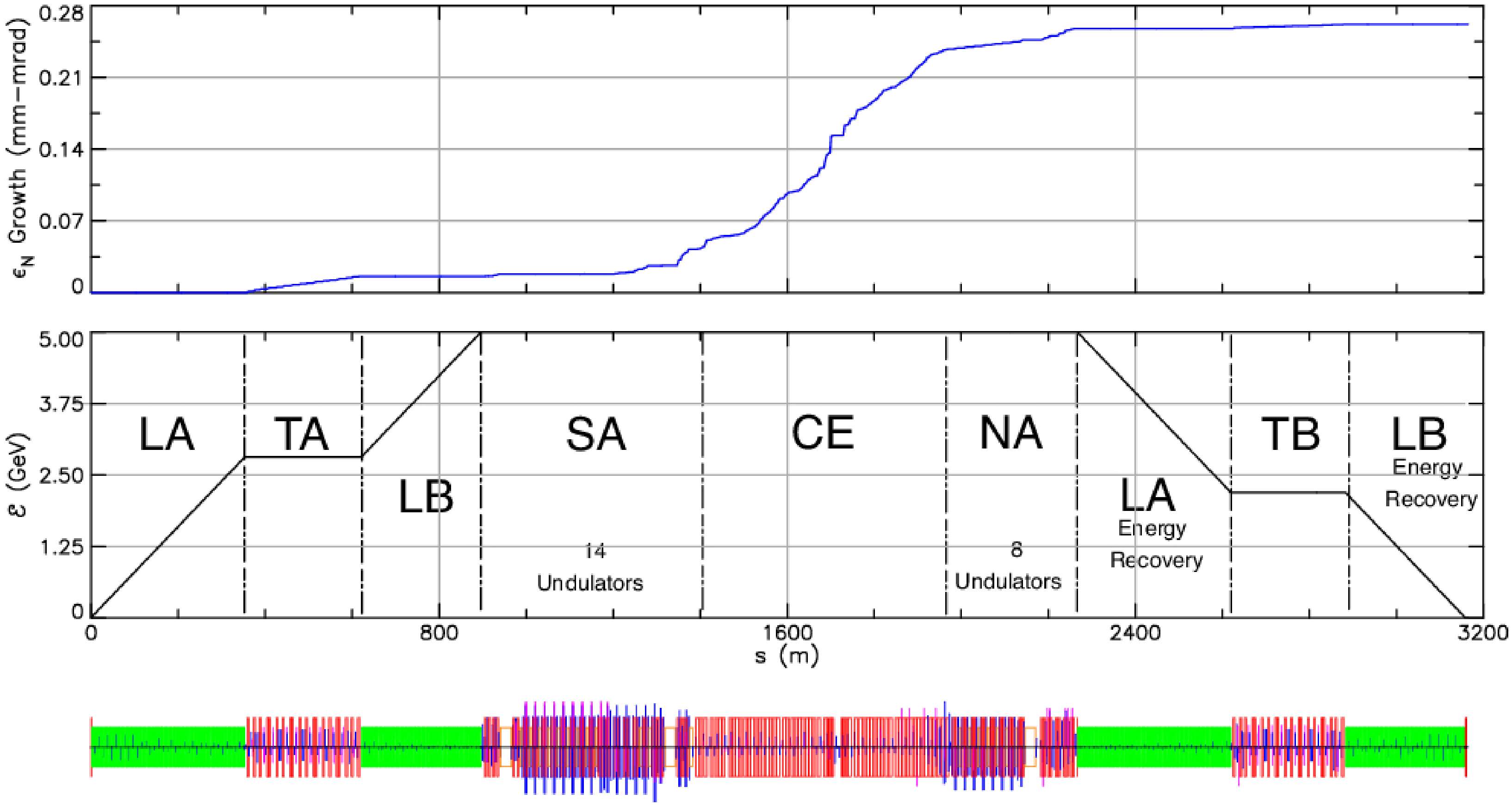
Undulator-Cell Optics

- *Flexible source size adjustment*
- *Achromat: Low emittance growth*



Complete Emittance Growth

- Emittance small in South Arc undulators
- Emittance growth significant only in CESR
- Low-emittance custom design of CESR layout exists



Optics modeling and tracking software tools TAO and BMAD

D.Sagan, *The TAO Accelerator Simulation Program*, PAC05

- ***Multi-pass beamline elements***
- ***Calculations of beam-breakup stability thresholds***
- ***Tracking through wake fields***
- ***Modeling of coherent synchrotron radiation***
- ***Modeling of intra-beam and Touschek scattering***
- ***Simultaneous optic optimization for multiple beams in a linac***
- ***Spurs for extracted beams***
- ***X-ray beamline design***

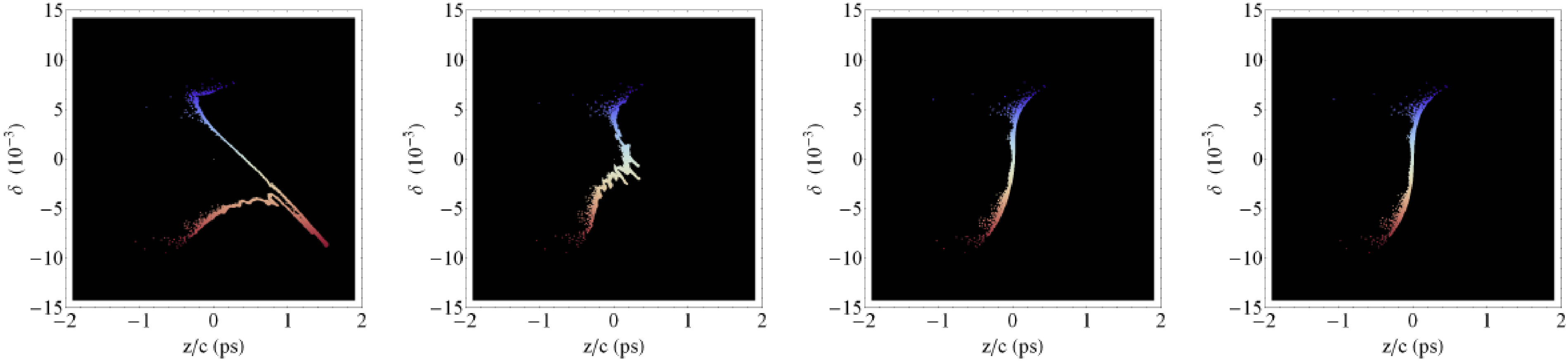
Cornell Laboratory for
Accelerator-based Sciences and Education (CLASSE)

Coherent Synchrotron Radiation Modeling

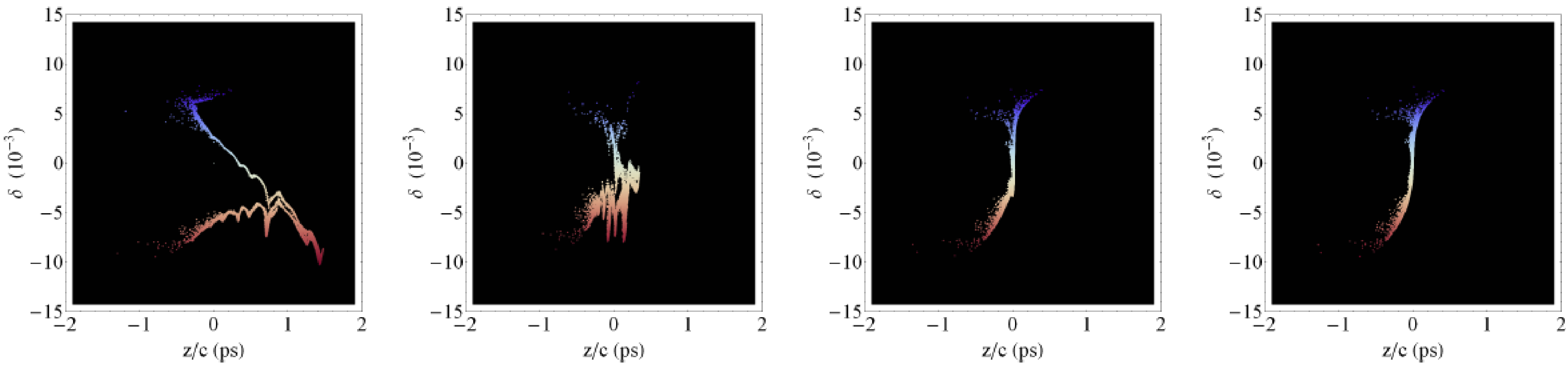
C.E.Mayes and G.H.Hoffstaetter, Phys.Rev. ST-AB **12**, 024401, 2009

C.E.Mayes, *Exact CSR Wakes for the 1-D Model*, PAC09

Longitudinal phase space slices in first (top row) and last (bottom row) short-pulse undulators



(a) 1 nC free space (b) 1 nC shielded (c) 77 pC shielded (d) No CSR



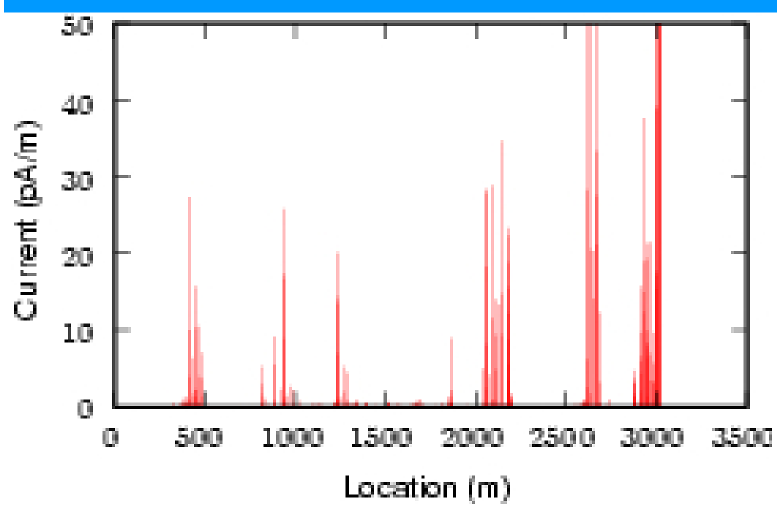
(e) 1 nC free space (f) 1 nC shielded (g) 77 pC shielded (h) No CSR

M.P.Ehrlichman and G.H.Hoffstaetter, *Collimating Touschek Particles in an Energy Recovery Linear Accelerator,* PAC09

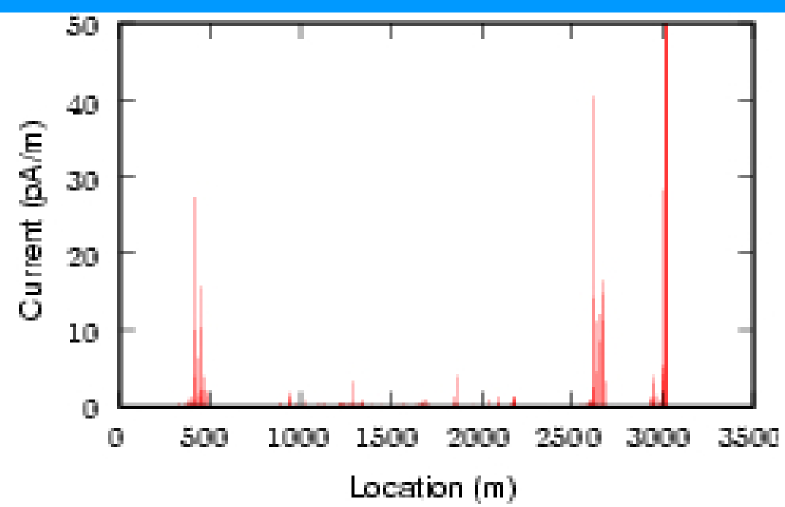
Touschek losses in the full ERL model

User regions: [808m, 1284m] and [1889m, 2207m]

Without collimation



With collimation

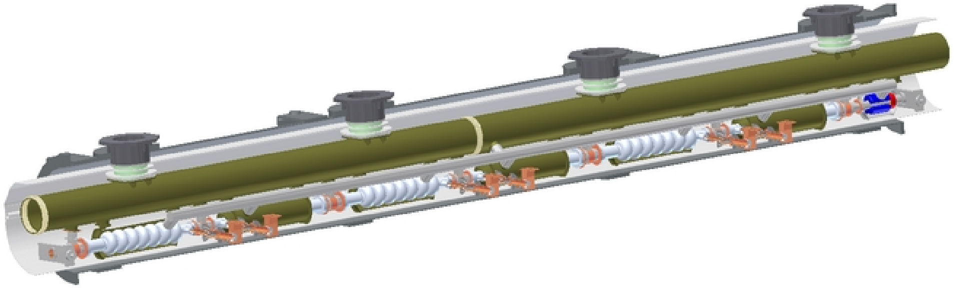


Injector Cryomodule and SRF Cavity Design

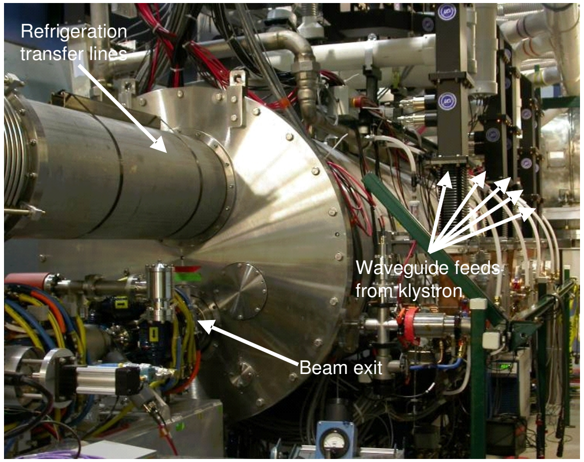
M.Liepe, *SRF Experience with the Cornell High-Current ERL Injector Prototype*, talk tomorrow afternoon
I.Bazarov, *Initial Beam Results from the Cornell High-Current ERL Injector Prototype,* talk tomorrow morning

E.Chojnacki, *Design of an ERL Linac Cryomodule,* PAC09
V.Shemelin, *Superconducting Multicell Cavity Design for the Energy Recovery Linac at Cornell,* PAC09

Transport from Newman Lab to Wilson Lab



Cryomodule installed at Wilson Lab



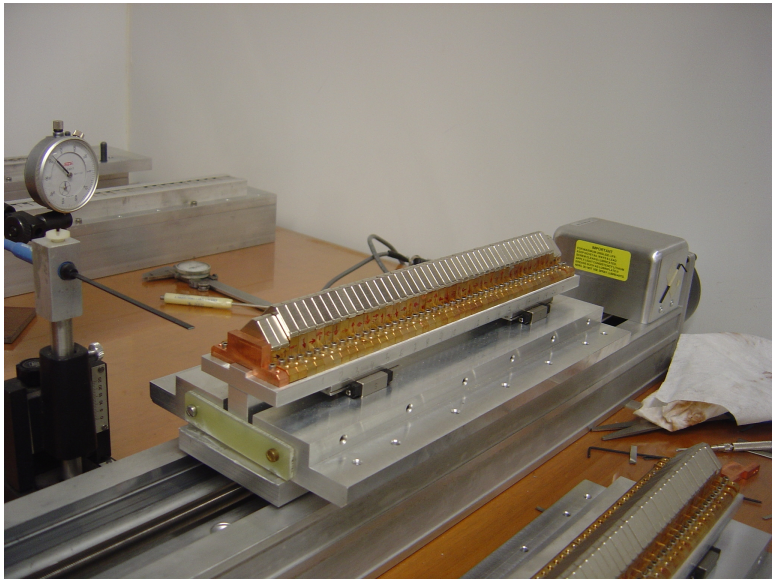
Design for 7-cell SRF cavity obtained

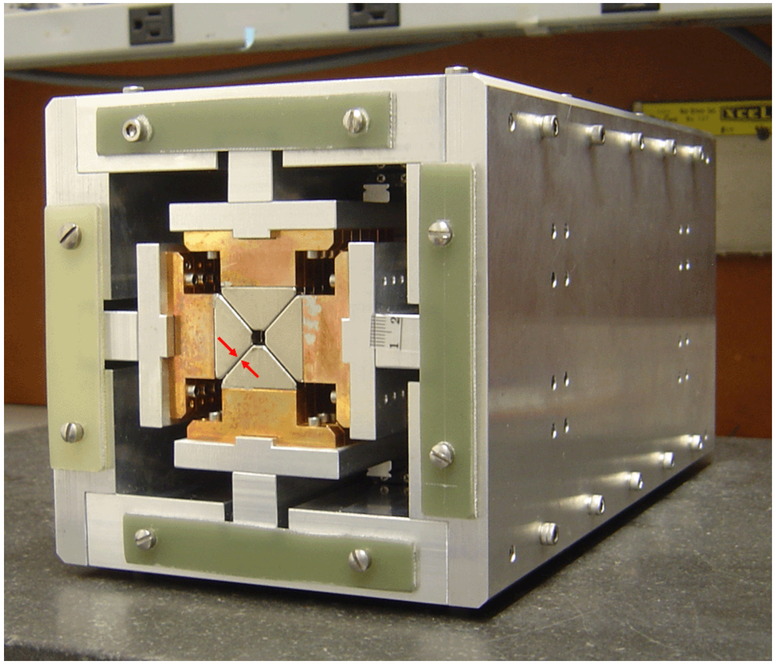
Injector cryomodule design for six such cavities developed

Injector prototype with five 2-cell cavities commissioned

Delta Undulator Design and Model

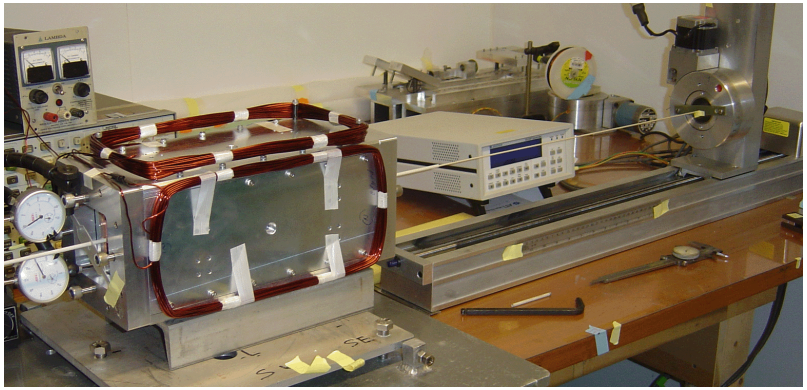
A.Temnykh, *Delta Undulator Magnet for Cornell Energy Recovery Linac,* PAC09





Compact round-bore design with adjustable field strength and X-ray polarization control via relative longitudinal adjustment of magnet arrays

New soldering technique for NdFeB blocks allows 40% higher field for linear polarization and doubles the field for circular polarization compared to undulators with similar gap



Summary

- *Progress in many areas during past year*
- *Active ongoing design effort*
- *Much to be learned from operating injector prototype*
- *Goal: Conceptual design report*

Undulator-Cell Optics (II)