CESR-c

CORNELL UNIVERSITY LEPP
LABORATORY FOR ELEMENTARY-PARTICLE PHYSICS

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Plans for CESR (or *Life Without CLEO*)

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Outline

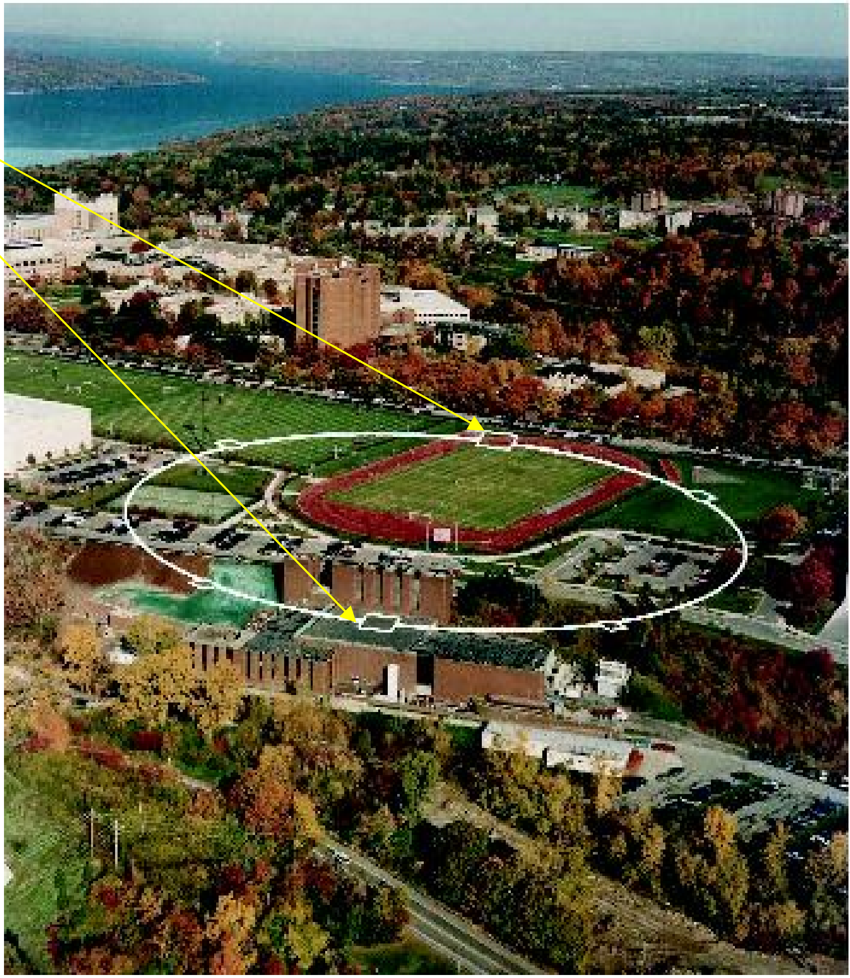
- CESR-c/CLEO-c Schedule
- Preliminary Concept
- Possibilities for CESR as a Test Facility
- Low Emittance Optics for CESR
- Unique Features
- Conclusion

CESR-c/CLEO-c Schedule

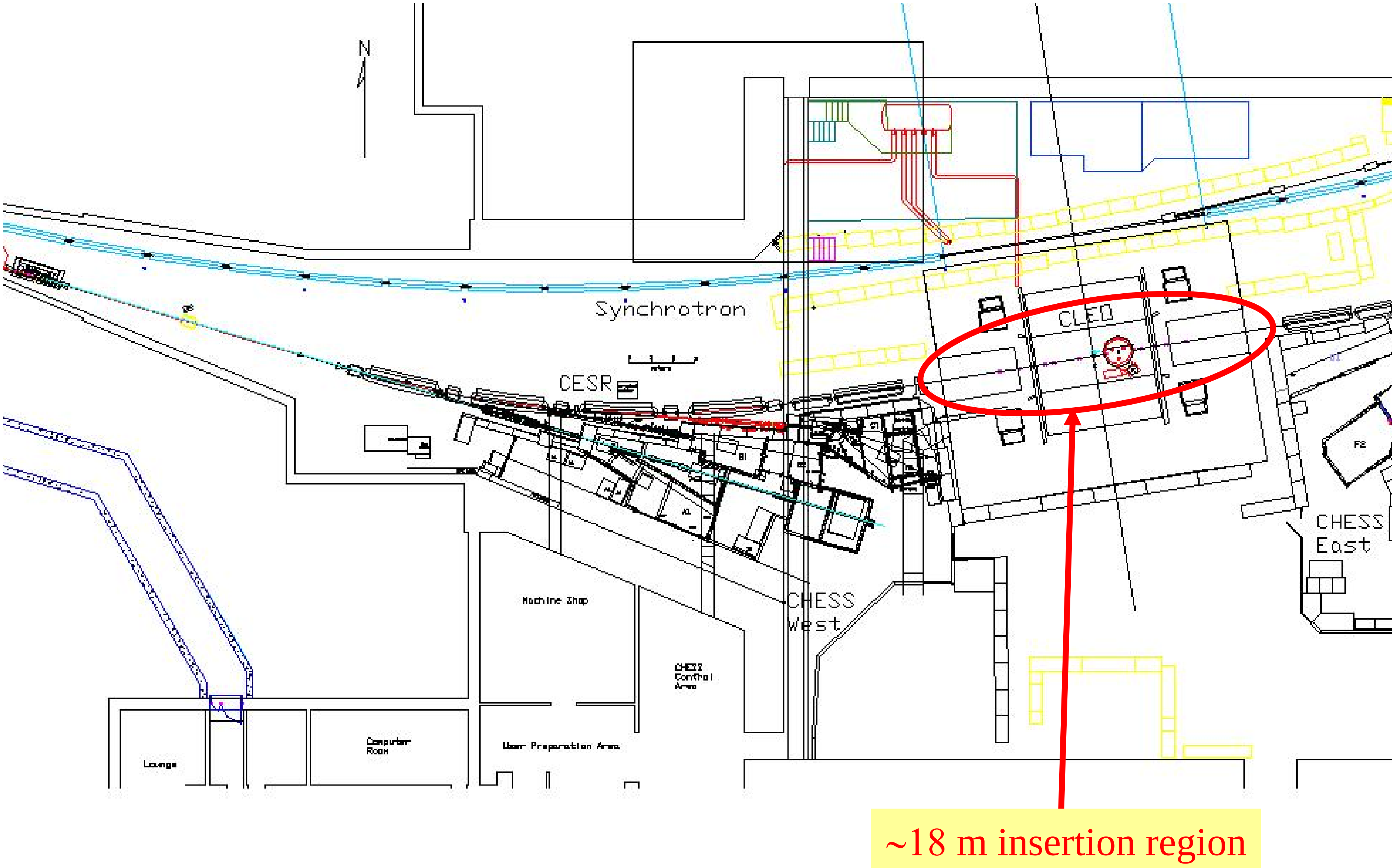
- CLEO-c high energy physics running to end in first half of 2008
- Starting in roughly June 2008, primary CESR operation will be for CHESS (Cornell High Energy Synchrotron Source) users
- Part-time operation as an ILC Damping Ring Test Facility is also possible

Preliminary Concept

- North and South Interaction Regions
  - South IR provides dispersion-free insertion region in standard optics
    - Remove CLEO ⇨ South IR provides ~18 m of “free” space
    - Cryogenic support locally available
  - North IR can be configured similarly
    - Also ~18 m insert region
    - No cryogenic support (*at present*)



South IR



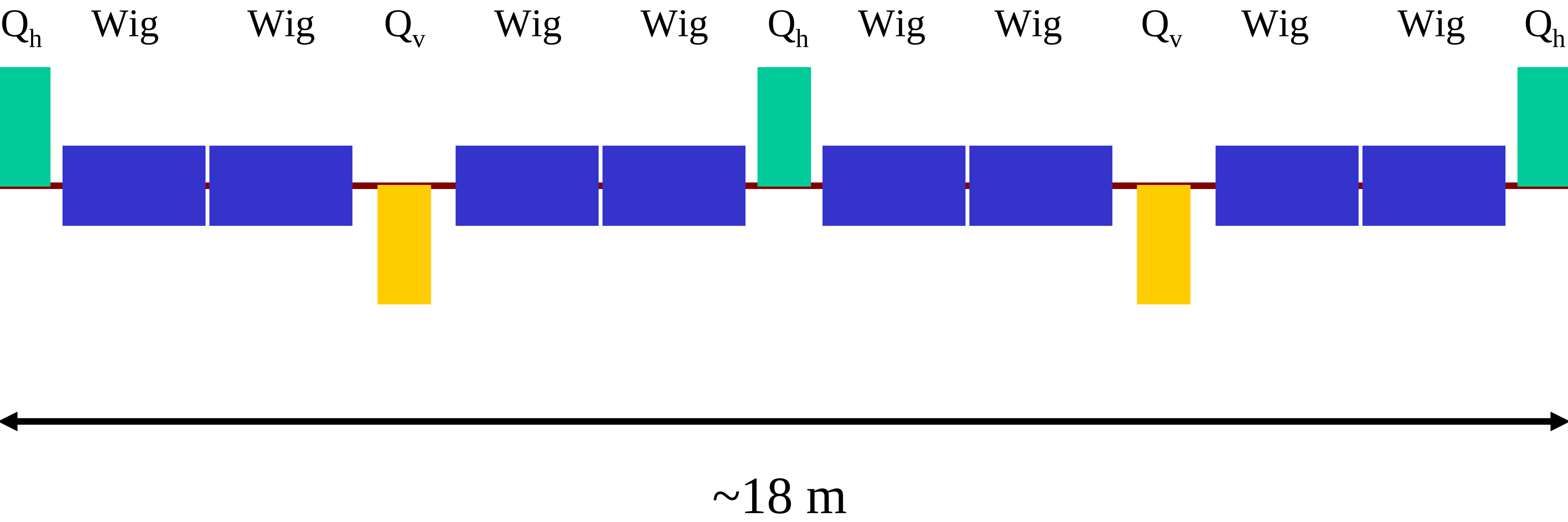
N
Synchrotron
CESR
CLEO
CHESS
East
CHESS
West
Machine Shop
CHESS
Control
Area
Computer
Room
Lounge
User Preparation Area
~18 m insertion region

Low Emittance Lattice

- Proof of Concept Design
  - Place 8 (of 12) wigglers in the South IR
  - Optimize for low emittance operation
  - Most parameters maintained at conservative values
    - ⇨ Do not expect that present values represent the limits of what can be done
    - ⇨ Further exploration of lattice options is planned/needed
- NOTE:
  - Use of all 12 wigglers in non-dispersive regions will reduce ε_h by a factor 2/3 from this trial configuration

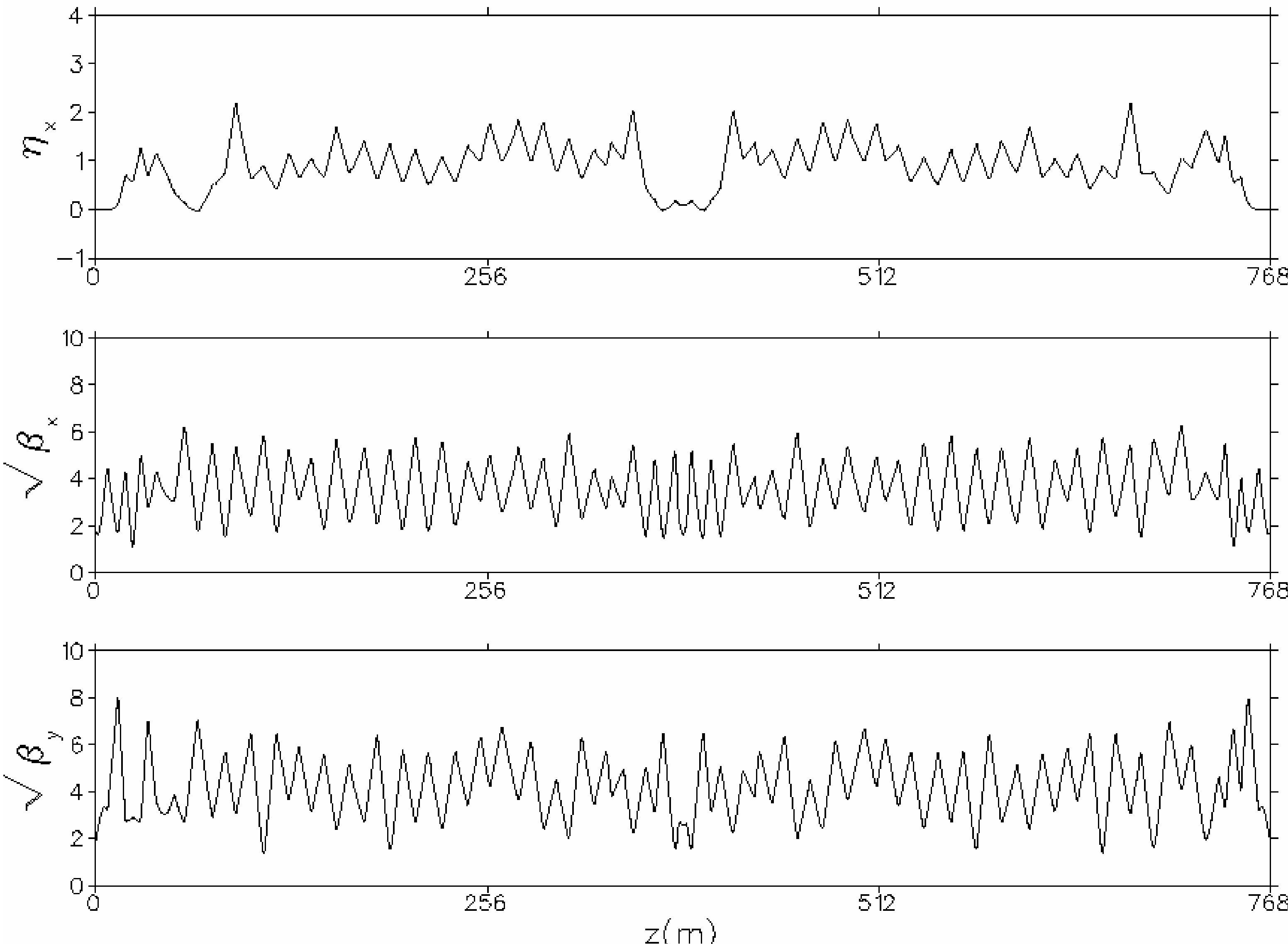
South IR Layout

- First Pass Trial Layout
  - Strong vertical focusing of concentrated set of wigglers has serious implications for quadrupole arrangement in insertion region
  - Need to optimize insertion region layout



Low Emittance Lattice Functions

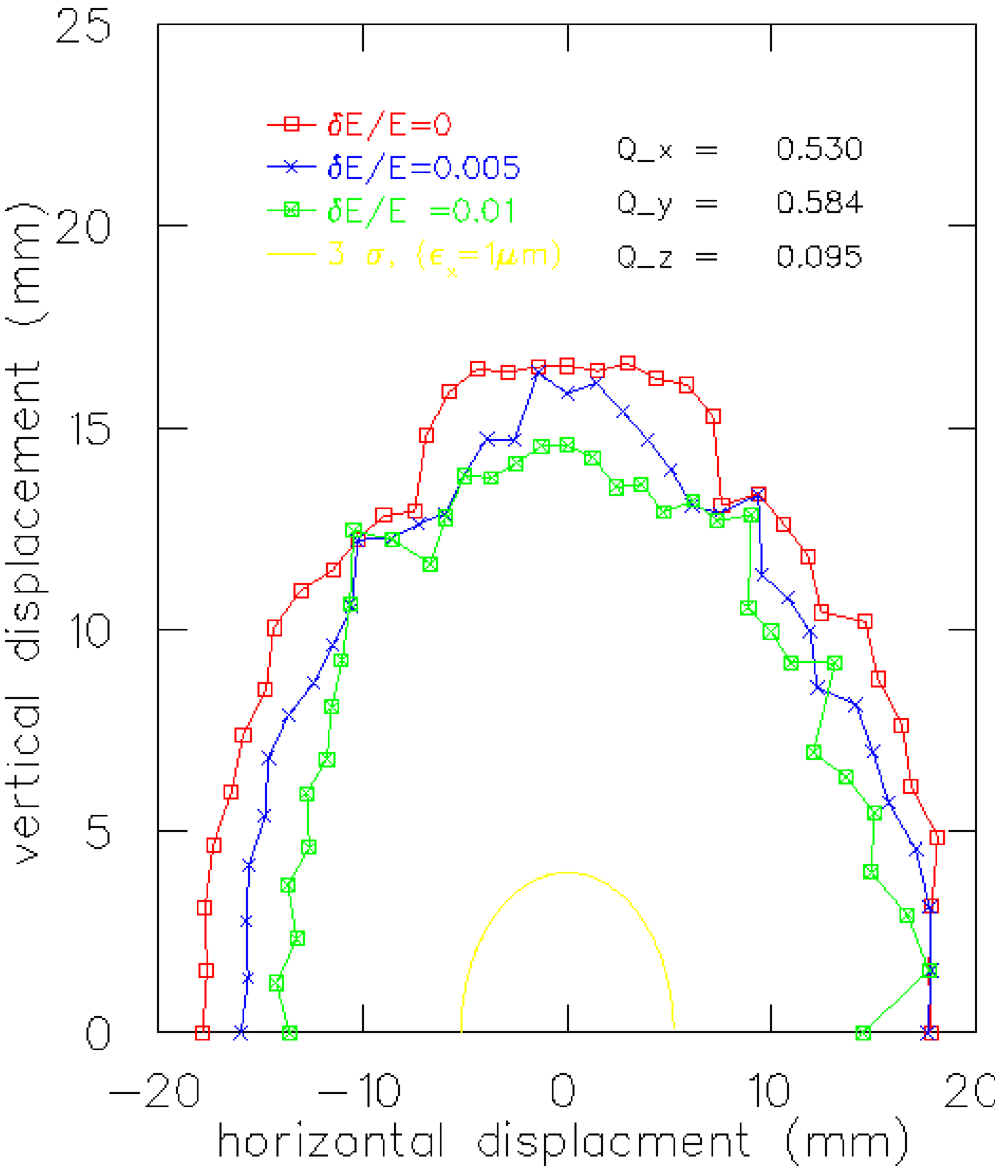
Note E-W asymmetry



Dynamic Aperture

- Tracking
  - Symplectic integration map through standard CESR-c wiggler map
  - Yellow ellipse is 3σ of injected beam
    - Assume coupled injected beam with:
    - ε_h=1000 nm
    - ε_v= 500 nm
- No problems with DA

  ⇨ Room to further optimize lattice for low emittance



Low Emittance Lattice Parameters

Parameter	Value	Comment
Wigglers	8 @ 2.1T	Expect that this can be raised to 12
Beam Energy	2.0 GeV	
σ_E/E	8.4×10^{-4}	
ε_x	1.7 nm	Reduction by 2/3 with full wiggler complement
$\tau_{x,y}$	67 ms	Further reduction with full wiggler complement
Q_x	13.53	Need to investigate higher tune options. Not constrained by usual CESR pretzel issues
Q_y	9.59	
Q_z	0.098	Requires higher RF voltage than we typically employ.
σ_z	7.5 mm	
α_c	7.1×10^{-3}	

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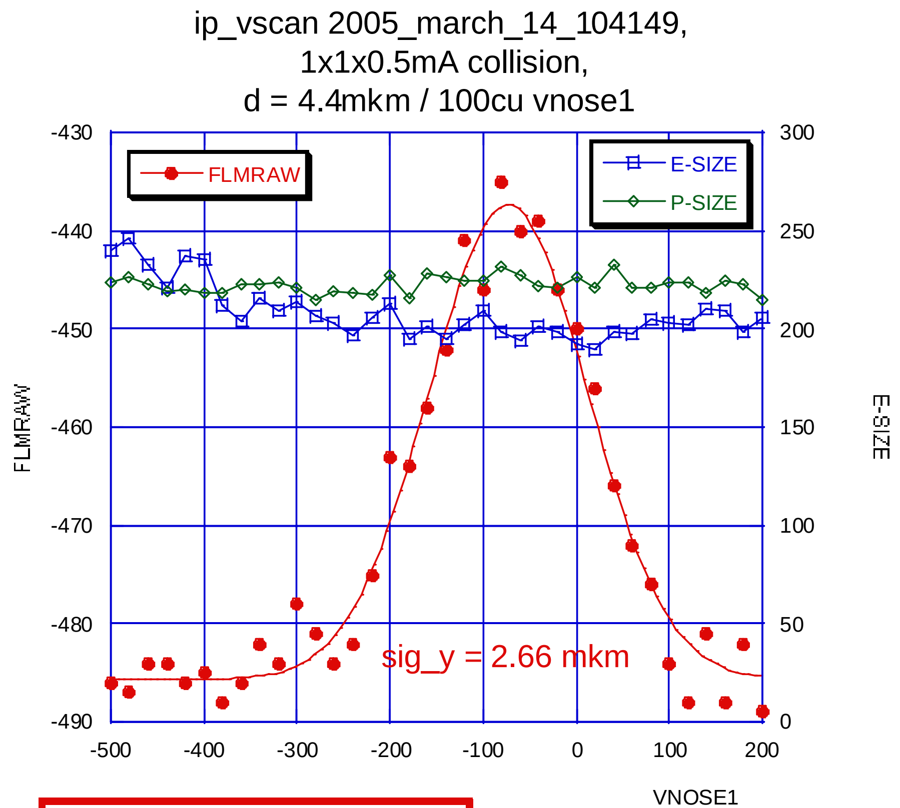
Vertical Emittance Estimates

- Beam-Beam Scan with 1-on-1 Collisions in 1.88 GeV HEP Conditions
  - Differential vertical displacement controlled by phase advance between vertical separators in North
  - Fast Luminosity Monitor provides measurement of overlap
- Measure $\sigma_y = 2.66\ \mu m$

⇨ $\varepsilon_y = 0.64$ nm

⇨ $\varepsilon_y / \varepsilon_x \sim 0.005$



y = m1 + m2 * exp(-(M0-m3)^2/4/m4^2)		
	Value	Error
m1	-485.72	0.85505
m2	48.351	1.5231
m3	-72.909	2.8486
m4	60.442	2.509
Chisq	314.67	NA
R	0.98501	NA

eps_y = 6.4e-10m,
eps_y / eps_x = 4.7e-3

Low Emittance Lattice Estimates:

- With ε_x=1.7 nm ⇨ $\varepsilon_y \sim 9$ pm
- With ε_x=1.0 nm ⇨ $\varepsilon_y \sim 5$ pm
- Possible improvement w/o CLEO solenoid?

Much Still To Do

- Further optimization of lattice parameters
- Exploration of alternate layout options
- Better evaluation of space and cryogenic support issues
- Beam dynamics estimates
- Lattice development for full range of energies
- Evaluation of Touschek Lifetime
  - Rough scaling from CESR-c modeling at 2 GeV (CLNS 01/1742):

	CESR-c	DR Test
N_b	6.5×10^{10}	2×10^{10}
σ_E/E	8.1×10^{-4}	8.4×10^{-4}
σ_z	10.2 mm	7.5 mm
ε_x	214 nm	1.7 nm
ε_y	920 pm	8.5 pm
τ Touschek	6 hrs	442 sec

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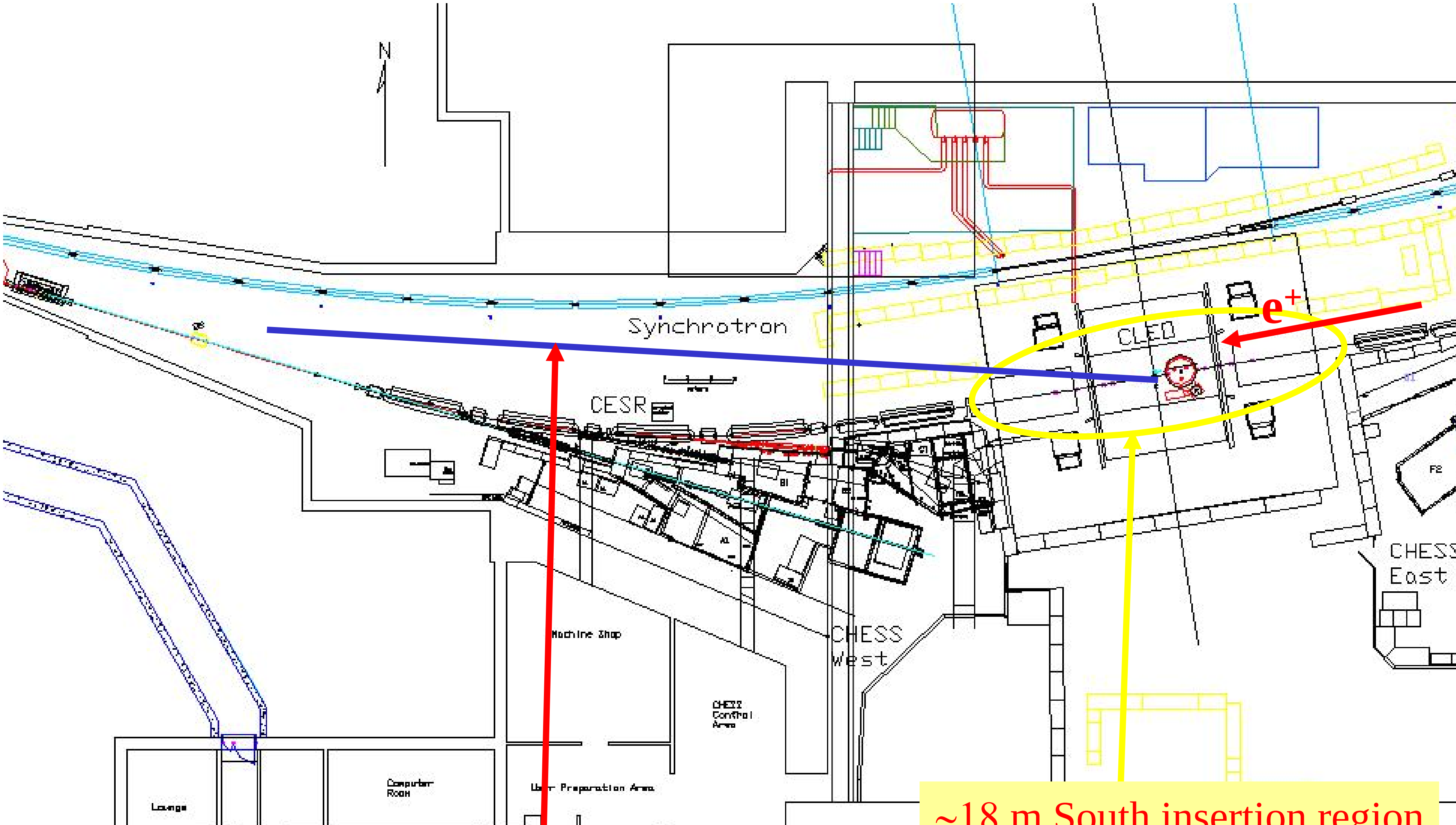
Experimental Configuration I

- North and South IRs offer ~36 m of insertion area
  - 12 wigglers require ~19 m
    - Can perhaps reduce this requirement if can create a low dispersion point near one of the existing wiggler locations
  - Quadrupoles and Correctors will need ~ 8 m
  - This nominally leaves ~9 m for other devices
  - Ideally will want this last region to be in South IR
    - Ease of access
    - Cryogenic Support
- South IR also offers the possibility of an extraction line for diagnostics
  - SCIR quads (48.4 T/m) available if desired for highly focused beam tests

South IR Extraction Line Option

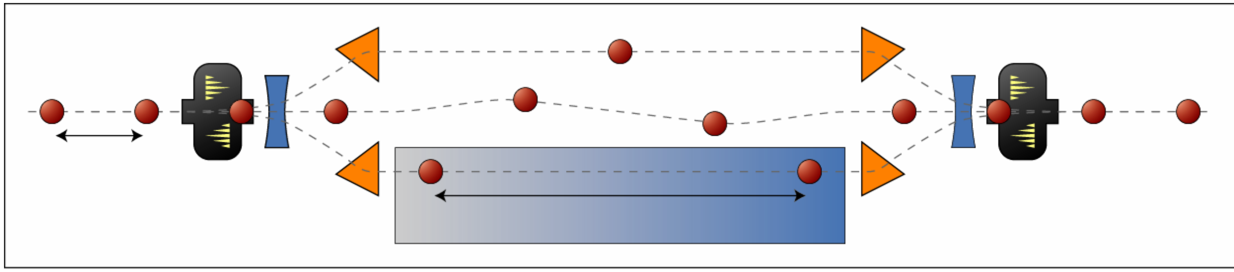


~18 m South insertion region

~40 m available for extraction line and diagnostics

Experimental Configuration II
Items to Test

- Extraction Technologies
  - Kickers
  - Deflecting Cavities
    - HOM
    - Beam Stability



  - Tests can be done in-ring (pinger mode, turn-by-turn diagnostics)
  - If extraction line looks favorable can also consider kicker extraction into diagnostics-equipped line
  - ILC DR wigglers
- Probe e^+ dynamics at low emittance
  - Intrabeam scattering
  - Electron cloud effects
  - Range of bunch spacings can be tested (granularity of 2ns RF buckets)

Experimental Configuration III Diagnostics

- CHESS lines offer infrastructure for additional ring diagnostics
  - "Free" during low energy operations
  - Example: XRAY beam profile monitor (see next slide)
- Longitudinal diagnostics
  - Streak camera
  - Coherent Radiation Measurements in the Far IR (A. J. Sievers, *etal)*
    - Tested in CESR's Linac
    - More advanced system being tested at TTF
    - Possible use in CESR or in extraction line
- Provide stations to install other devices

Testbed for New Instrumentation

- X-ray Beamsize Monitor (Alexander, Ernst, Palmer)
- Diode array
- Devices in hand
- Readout electronics in hand
- Final assembly and testing in ring this fall
- Initial configuration: Pinhole optics setup in CHESS line

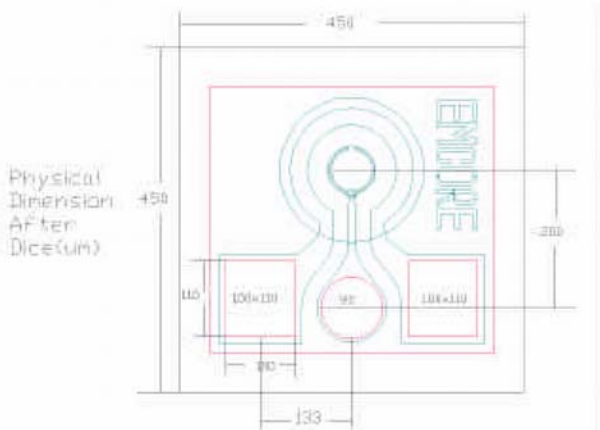
10 Gbps GaAs PIN Photodiode*

Product Description

EMCORE's 10 Gbps Gallium Arsenide (GaAs) PIN photodiode is designed for multimode fiber applications. Utilizing EMCORE's own state-of-the-art MOCVD wafer foundry and device fabrication facility guarantees a reliable high volume fabrication source of package ready die to meet the growing needs of fiber optic component manufacturers. Excellent device performance and robust operation makes this the superior device for high speed multimode optical communication applications.

Features

- Data rates of 10 Gb/s
- Excellent responsivity
- Large aperture size
- Low capacitance
- Low dark current



Product Specifications

Electro-Optical Characteristics (T = 30°C)

	Conditions	Min.	Typical	Max.	Unit
Speed	-1.6 V		8.5		GHz
Responsivity	3 to -26 dBm, 850 nm Epoxy coated, n=1.6		.5		A/W
Active Area (aperture)	-		60		µm
Rise/Fall Time	20% / 80%, -1.6 V bias		30/35		ps
Dark Current	-1.6 V, -70 dBm		<.2	1	nA
Capacitance	-1.6 V, 1 MHz		.28		pF
Reverse Breakdown	1 µA	20	50		V
Reflectivity	Epoxy coated, n=1.6			1	%

Unique Features of a CESR Test Facility

- Flexible energy operation
  - 1.5 – 2.5 GeV/beam with wigglers
  - Explore energy dependence of parameters
- Will be configured for e^+ operation
  - Explore e^+ only effects
  - Allows for extraction line into available space in “flare”

Summary

- CESR can be configured for low emittance operation after CLEO detector removal
- Significant insertion space can be made available for DR hardware studies
- The most interesting (and straightforward) setup is to study positrons
- Significant amount of further evaluation is needed
- Would welcome input and participation from all interested parties