PEP-II Lattices

U. Wienands

... for many others from AD, ARD, NLC ...

[Graphs showing lattice parameters β_x, β_y, and η_{X,Y}]
PEP-II Lattices

- Parameters & how we determine them
- Online Lattice Model
- Coupling
- Orbit Control
- Working point & MIA Lattice Correction
- Priorities for Run 4
# Lattice Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>HER</th>
<th>LER</th>
</tr>
</thead>
<tbody>
<tr>
<td>βx*(cm)</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>βy*(cm)</td>
<td>1.5</td>
<td>1.1</td>
</tr>
<tr>
<td>μx,arc(°)</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>μy,arc(°)</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>νx</td>
<td>24.62</td>
<td>38.57</td>
</tr>
<tr>
<td>νy</td>
<td>23.58</td>
<td>36.64</td>
</tr>
<tr>
<td>αp</td>
<td>0.00241</td>
<td>0.00124</td>
</tr>
<tr>
<td>ξx</td>
<td>n:-43 +2</td>
<td>n:-60 +2</td>
</tr>
<tr>
<td>ξy</td>
<td>n:-57 +4</td>
<td>n:-70 +2</td>
</tr>
<tr>
<td>εx (πmm^-1)</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>εy (πmm^-1)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>δp/p</td>
<td>6.1E-4</td>
<td>7.7E-4</td>
</tr>
<tr>
<td>σx*(μm)</td>
<td>155</td>
<td>155</td>
</tr>
<tr>
<td>σy*(μm)</td>
<td>5.5</td>
<td>5</td>
</tr>
<tr>
<td>τx (ms)</td>
<td>37</td>
<td>61</td>
</tr>
<tr>
<td>τs (ms)</td>
<td>19</td>
<td>30</td>
</tr>
</tbody>
</table>

No wiggler!
Lattice-function measurement

- Measure 1024-turn phase advance/BPM
- Compare to online model
- Calculate $\beta$, a relative to the model used.
- Method pioneered at CERN (Castro-Garcia)
  - Worked well for HER, not well for LER with 90°/cell.
- SLAC extension for 90°/BPM (M. Donald)
- Now implemented online (Zelazny, Himel)
Online beta functions

LER X

LER Y
HER $\beta_x$ at waist

Derived from support-tube BPMs

M.H. Donald

Measured BETA and Model BETA in Meters
Excitation Plane Y, Display Plane Y

SOLID - Measured BETA
DASHED - Model BETA

PR06  PR04  PR02  PR12  PR10

V. Wienands, PEP-II MAC
Dispersion (LER, vertical)

$L \approx 6.3 \times 10^{33}$
Dispersion (HER, vertical)

$L \approx 6.3 \times 10^{33}$
Online Lattice Model

• To model PEP rings, need too include orbits
  - New models created from the design
  - Running on dedicated Linux computer networked to VMS
  - Can use saved magnet configurations and orbits
  - Can put results back into online (SCP) DB
  - (J. Turner, M. Woodley, M. Donald, U.W.)

• Compare to phase-advance measurements
  - Local fit using model as a beam line
  - Can we identify magnet errors?
HER Model/Actual Settings
under development

M. Woodley

\( \beta_y \)

\( \eta_y \)

Orbit x

Orbit y

9-Oct-03

U. Wienands, PEP-II MAC
Coupling

• Global coupling easily corrected to $\leq 100$ Hz
  - Usually not the highest luminosity
  - Operationally, 400…1000 Hz is best

• Measured using closest-tune approach

• Have also scanned beam height

• Local coupling measured by “orbit coupling”
  - Global orbit wave in one plane couples into other plane
  - Used originally to tune the solenoid compensation (Y. Cai)
Coupling Resonance Scan (HER)

Width: 93 Hz

Reswidth: 0.000689328

Beam height (mm)

\[ \partial \nu \]
Orbits

Relatively large orbit offsets

“Golden” orbits, known to give good lumi.

Relatively large unknown BPM offsets in IR 2

In the LER, affects coupling
Orbit Control

• Need to maintain collisions
  - IPXY, centers x & y, also aligns the yp
  - Dither feedback acting on luminosity signal

• Biggest source of drift are the IP quads
  - => HERO, LERO,
  - acting on one X and one Y corr. in IR

• Biggest concern is at the local sextupoles
  - => HSXT, LSXT loops in Arcs 1/3

• Want orbit stable at TFB pickups
  - HTFB, LTFB loops in IR 4
Orbit Control (cont’d)

• Main concern with these loops: crosstalk
  - HERO, LERO have global effect
  - Directly interfere with IPXY as IP not maintained
  - Other loops nominally closed bumps.

• New, global auto-steering loop: GOF
  - SVD steer each ring about every 10 min.
  - “IP transparent” to avoid losing collisions
  - Avoid interference with other f/b loops
  - Watch corrector and energy creep!
Orbit shift after 1 week

With GOF running

Some locations are subject to tuning (e.g. in Arc-1, Arc-3 sexts, collim.).

General shift requires IR steer every few days
Energy drift due to GOF

Energy can be reset by “dialing in” a dispersion-like corrector pattern.
IR 2 Surveying vs HERO/LERO

A. Seryi, S. Ecklund
Measured IP Beam Sizes

Measured by beam-beam scans ($\Sigma$ scans)

Diagonal scans also give average IP roll (F.-J. Decker)

$\Sigma_x = 117\mu m$

$\Sigma_y = 6.8\mu m$
Change of Working Point(s)

- Lower LER $\nu_x$ to 0.52...0.53
- Strong $\beta$ beat prevented luminosity gain
- Fixed using MIA technique

LER tune-scan simulation (I. Reichel)
LER tune move (cont’d)

• LER move successful
  - Using MIA technique to control $\beta$-function beating in $x$
  - Essential to move HER $x$ tune as well!!
  - But this causes large HER beta beat($\approx 2:1$)...
  - which lowered HER $\beta^* x$ to $\leq 30$ cm.

• Need to use MIA to fix HER $\beta$ beat
  - Want to maintain $\beta^*$ at 25...30 cm
  - And also maintain state of coupling.
Tune Scans (B-B Simulation)

LER-only (I. Reichel)

LER & HER equal tunes

Electrons
SPH vs 2 (Data Orbit 363) (PEPHER)
P=1.0, Bunch=1, Bunch delay=0.00 ns, TS=454, NAV=1 XLY RMS= 0.625 0.633
PEP2 Bucket=1704, NTurns=1024, Read every turn, Start Turn=8000, Fid Stor
Spectra in Collision

LER

HER

9-Oct-03

U. Wienands, PEP-II MAC
LER $\beta$ at low $v_x$

After moving tune

After $\beta$ fix

blk: $\beta$ measured, red: $\beta$ model
MIA Analysis & Correction

Find model of extant lattice from 1024-turn BPM data ("Virtual Machine").

Fit to "wanted machine" finding magnet changes

Measure changed machine to verify
Machine Acceptance

- Sufficient beam life times (at production current) suggest good acceptance:
  - HER: $\approx 15$ hrs single beam, $\approx 7$ hrs in collision beam-gas (bremsstrahlung) & beam-beam limited
  - LER: $\approx 3...4$ hrs single beam, $\approx 1.5...3$ hrs in collision Touschek limited, some beam-beam,

- Momentum acceptance: Touschek expt:
  - LER: $\approx 0.7\%$, as design
  - HER: not known but likely as good or better.
Lattice Priorities for Run 4

• **Have an accurate lattice model**
  - will make lattice MD more efficient

• **Fix our beta beats (mostly HER x, now)**
  - “Re-commission” ORM to aid in diagnosis of mag. errors

• **Control and lower β as far as possible**
  - aim for $\beta_y = 0.9$ cm, $\beta_x \approx 28$ cm
  - Eventually will be aperture or chromaticity limited

• **Better stabilize & control our orbits**

• **Control coupling in the IR & at the IP**
  - D. Sagan/Cornell here in two weeks.
Lattice Priorities (cont’d)

• Be able to “taylor” the beam emittance
  - Important when beam-current limited

• I’d like to characterize the lattice 1/week
  - Will cost about one hour of program time
  - $\Sigma$, $\beta$ (ph. Adv.), $\eta$, $\nu$, “Yunhai orbits”, coupling

• The more we ask from the machine, the tighter we will have to control our lattices.