

# Near-Term Storage Ring Improvements

---

## Lattice and Single-Particle Dynamics (Mostly)

---

M. Borland, L. Emery, N. Sereno  
April 19, 2002

With comments from attendees of the  
4/19/2002 SR R&D meeting

# Outline

- List of objectives
  - High-level goals
  - Which projects serve each goal
- Discussion of projects
  - Status
  - Studies and other needs
  - Personnel
  - Cost/benefit

# Objectives and Projects

- Increase brightness of photon beams
  - 3nm lattice (all users benefit)
  - Further emittance reductions (simulation studies)
  - Converging beta lattice (few users can benefit, others may suffer)
  - Long straight sections (many can benefit)
  - Rounder beams (microfocusing users benefit)
  - 6-GeV configuration (most users benefit)
  - Routine lattice correction
  - Vertical emittance wiggler (should allow smaller gaps, hence higher brightness for hard x-rays)

# Objectives and Projects

- Improve stability of beam parameters
  - Skew quads at ID locations
  - Emittance-compensating wiggler
  - Make top-up quieter
  - Improve lifetime

# Objectives and Projects

- Make injection cleaner, reduce trips, and reduce ID damage
  - Center beam in BPLDs
  - Add vertical emittance wiggler (should allow lower linear coupling)
  - Implement longitudinal injection lattice
  - Reduce booster emittance
  - Implement a workable beam collimation system (ring or BTS)

# Objectives and Projects

- Increase beamline productivity
  - Commissioning canted ID
  - Long straight sections
  - Implement bunch cleaning (few users benefit)
- Improve injector reliability
  - Eliminate PAR with subharmonic cavity in booster
  - Commission linac waveguide switching system

# Format of Project Lists

- Each page discusses a single improvement idea
  - Status
  - Personnel involved or required. (May not include originator of the idea.)
  - Studies required (for delivery to user): scale from 0-4, where 0 is little or none while 4 is major
  - Other requirements
  - Anticipated benefits to users
  - Anticipated costs to users and accelerator
  - Originator
- Audience participation required!

# 3nm Effective Emittance Lattice

- Status:
  - 60mA stored recently, <2mA single bunch limit
- Personnel: Borland, Emery, Sajaev
- Studies required: 3
- Other requirements:
  - Lattice correction New sextupole design?  
Sextupole PS upgrade?
  - Not clear if sextupoles are strong enough
- Benefits: 25% higher brightness
- Costs:
  - shorter lifetime
  - more charge needed from injector BESOCM upgrade
- Originator: Borland

# Further Emittance Reductions

- Status: Borland working on simulations
- Personnel: Borland
- Studies required: 0
- Other requirements: none at this time
- Benefits: 10-20% reduction in emittance from 3nm lattice
- Costs: **NB: NanoCAT wants constant vertical emittance for life (MB)**
  - May have to move Q4 and/or Q5 magnets
  - May require stronger correctors than we have
  - May require stronger sextupoles than we have
- Originator: Yang

# Converging Beta Function

- Status:
  - early tests had fair success, but poor lifetime
  - presently not actively pursued
- Personnel: Emery, Sajaev
- Studies required: 3
- Other requirements: lattice correction
- Benefits: increased x-ray intensity to a lucky user working at 3<sup>rd</sup> harmonic or above
- Costs: distortion of lattice in two sectors, lifetime/injection problems, stronger sextupoles, possible emittance degradation
- Originator: Sajaev

# Long Straight Sections

- Status: awaiting management decision
  - Personnel: Borland, Den Hartog, Emery, Moog
  - Studies required: 0
  - Other requirements: in-vacuum ID
  - Benefits: beat ESRF and SPring8
  - Costs: new magnets, new chambers, ring distortion,  
...
  - Originator: Borland
- Opens many doors but @ a cost:  
flexible (e.g. converging) beta  
long period Ids (MB)

# Rounder Beam

- Status: waiting for user to decide on requirements
- Personnel: Maser (user), Borland, Emery, Harkay, Sajaev
- Studies required: 3
- Other requirements:
  - Lattice correction
- Benefits: improved performance of microfocusing optics
- Costs: probably minimal, with proper optics design
- Originator: Maser

# ~~6 GeV~~ Configuration

<7 GeV configuration (where is the optimum)? (SM)

- Status: plan developed for studies
- Personnel: Emery
- Studies required: 3
- Other requirements: eventual user participation in tests  
Need new Ids (EG)
- Benefits: higher brightness for most users if right IDs are available
- Costs: very bad for high-energy x-ray experiments and (probably) timing experiments
- Originator: Shenoy

# Routine Lattice Correction

- Status: more time needed to develop simultaneous beta/eta correction
- Personnel: Sajaev
- Studies required: 1 (gets incidentally studied in other lattice work).
- Other requirements: new computing cluster will help
- Benefits: ability to implement new configurations quickly
- Costs: none
- Originator: Sajaev

# Vertical Wiggler (etc)

- Status: Concept only
- Personnel: Borland, Emery, Moog, ASD-VAC, ...
- Studies required: 1
- Other requirements: computation of vertical emittance in elegant, explore other schemes (vertical bumps, asymmetric, chicane,...)
- Benefits: minimize linear coupling while keeping lifetime high by introducing vertical emittance with a wiggler
- Costs/problems: wiggler, vacuum chamber, PS, space, where to dump the radiation
- Originator: Borland/Emery

# Skew Quads at Each ID

- Status:
  - Concept only Probably few users who care (EG)
- Personnel: Emery
- Studies required: 1
- Other requirements: high-resolution vertical beamsize measurement
- Benefits: constant on-axis brightness
- Costs: more power supplies, magnets
- Originator: Emery

# Emittance Compensating Wiggler

- Status:
    - Concept only
  - Personnel: Emery
  - Studies required: 1
  - Other requirements: wiggler, chamber, place to dump radiation
  - Benefits: constant on-axis brightness
  - Costs: probably minor
  - Originator: Emery
- Can a damping wiggler do more than lattice adjustments? (VS)
- Users don't care much about small emittance changes. (EG)

# Top-Up Improvements

- Status: stalled (low priority)
- Personnel: Emery
- Studies required: 1
- Other requirements:
  - New ideas (e.g., bunch-by-bunch feedback)
  - New kicker chambers
  - Redo septum FF compensation
- Benefits: eventually do top-up at shorter interval
- Costs: unknown

# Center the Beam in BPLDs and Magnets

- Status
  - Decker developing concept
- Personnel: Decker, Emery, Singh, ASD-SVY, CATs
- Studies required: 4, with user participation
- Other requirements: ?
- Benefits:
  - fewer trips
  - easier optics correction
  - better injection efficiency
- Costs: need to realign beamline
- Originator: Decker

# Longitudinal Injection

- Status:
  - Needs studies time, but should work
  - Lifetime was a problem, not sure why
- Personnel: Chae, Emery, Sajaev
- Studies required: 2
- Other requirements: lattice correction
- Benefits: improved injection efficiency with smaller injection disturbance during top-up
- Costs: probably minor
- Originator: Chae

# Low-Emittance Booster Lattice

- Status
  - New quad transducers on order
  - Several candidate lattices generated
- Personnel: Borland, Sereno
- Studies required: 2
- Other requirements: ?
- Benefits: improved SR injection
- Costs: none
- Originator: Galayda

# Workable Beam Collimation

- Status
    - Idea only
  - Personnel: Borland, Emery, Sereno
  - Studies required: 2
  - Other requirements: perhaps new scrapers
  - Benefits: reduced radiation damage, fewer rad monitor trips, faster filling
  - Costs: none
  - Originator: Emery
- Best done in BTS  
Probably need new scrapers &  
new BTS optics.

# Canted ID Commissioning

- Status
  - Review process is finishing
- Personnel (for commissioning): Emery, XFD, CAT
- Studies required: 2
- Other requirements: special BPLDs
- Benefits: increased productivity per straight section
- Costs: no external costs
- Originator: not sure

# Bunch Cleaning

- Status:
  - Method based on tune splitting not successful
- Personnel: Yao, Sereno Not compatible with top-up (CY)
- Studies required: 1
- Other requirements:
  - New idea or bunch-by-bunch feedback system
- Benefits: clean bunches
- Costs: operational complexity (?)
- Originator: Galayda

# Booster Sub-harmonic Cavity

- Status
  - Sereno doing simulation studies
- Personnel: Borland, Sereno
- Studies required: 0
- Other requirements: booster sub-harmonic cavity
- Benefits: eliminate the PAR
- Costs: PAR eliminated ☹️
- Originator: Sereno