APS Upgrade Ideas in Progress

- Near-term possibilities (no/minor hardware modification required)
  - Lower emittance lattice
  - Longitudinal injection lattice
  - Converging beta lattice
  - Improved sextupole configurations
  - 130mA beam current
  - Higher rate orbit correction
  - Round beams
  - Lower emittance booster
  - 6 GeV operation

APS Upgrade Ideas in Progress

- Mid-term possibilities (substantial hardware modification required)
  - Long straight section with possible 4mm gap
  - Mini-beta insertion for short ID with small gap
  - Subharmonic capture in booster
- Long-term possibilities (major hardware modification required)
  - Replacement lattice with 40, 10m straights and flexible beta functions
  - Very low emittance booster
  - XPS: "Extreme Photon Source"

Near-Term Upgrade Possibilities

- Lower emittance lattice (Borland, Emery, Sajaev)
  - 3nm effective emittance, down from 3.9nm in the present low emittance lattice.
  - Some beam stored, dynamic aperture poor.
  - Will work on sextupole configuration (below).
  - Optics correction needs to be performed.

Near-Term Upgrade Possibilities

- Longitudinal injection lattice (Chae, Emery, Sajaev)
  - Should reduce injection disturbance and improve efficiency.
  - Attempted several times in studies with some success.
  - Poor lifetime and low single bunch limit.
  - Work continues on optics correction.

Near-Term Upgrade Possibilities

- Converging beta lattice (Emery, Sajaev)
  - Has been attempted in studies with 100mA singlets.
  - Low lifetime (dynamic aperture).
  - Large horizontal beta functions cause beam losses in converging beta sector.
  - Little benefit when combined with low emittance.
  - Might be improved with zero dispersion in the converging beta straight.

Near-Term Upgrade Possibilities

- Improved sextupole configuration (Emery, Borland)
  - To maximize lifetime, need method to determine sextupole configuration when there is dispersion everywhere
  - Developed "genetic" optimization algorithm to maximize dynamic aperture for specified chromaticities.
  - Has been run for 3.9nm and 3.0nm lattices, but results not tested yet.

Near-Term Upgrade Possibilities

- 130mA beam current (Borland, Cherbak, Emery, Harkay, Horan, Nassiri, Sereno, Singh, Yao, ...)
  - Practise shift with users on 4/1/2002.
  - Requires high output from injector due to short lifetime.
  - Reliability remains unproven---more practise is needed.

Near-Term Upgrade Possibilities

- Higher-rate orbit correction (Borland, Carwardine, Decker, Emery, Lenkszus, Shang, Singh, Soliday)
  - sddscontrollaw now runs on IOC or workstation
  - sddscontrollaw supports vectorized channel access
  - datapool provides BPM data at high rate
  - correctors controlled through RT feedback IOCs
  - work remains on BPM polynomial consistency

Near-Term Upgrade Possibilities

- "Round" beams (Crosbie, Emery, Harkay, Sajaev)
  - Optical solution found but had large beta functions
  - Ring acceptance will probably be reduced resulting in injection losses
  - Another idea (Emery) is to use skew quadrupoles or solenoids to rotate and unrotate the beam in the ID straight.
  - Incompatible with small gap chamber

Near-Term Upgrade Possibilities

- Lower emittance booster (Borland, Sereno)
  - Should improve SR injection efficiency.
  - 20% reduction expected from raising horizontal tune one unit.
  - Limited by transductor on QF power supply (replacement ordered).

Near-Term Upgrade Possibilities

- 6 GeV Operation (Borland, Emery, Shenoy)
  - Would improve brightness for most users.
  - Touschek lifetime will suffer (~E^6 or E^7).
  - Instability threshold will drop (~E, ~E^3 ?).
  - Method for ramping down study has been determined.

Mid-Term Upgrade Possibilities

- Long straight section with possible 4mm VC gap (Borland, DenHartog, Emery, Moog)
  - IXS CAT desires 9.6m of ID with 4mm VC gap in one straight section
  - Linear optics solution done for 6.5mm VC gap
  - 4mm VC gap is difficult if we want to preserve acceptance
    - requires quadrupoles between IDs
    - emittance difficult to preserve
    - impedance needs to be evaluated (high-conductivity chamber needed?)
    - in-vacuum ID may be required

Mid-Term Upgrade Possibilities

- Mini-beta insertion (Borland)
  - Preliminary optics solution provides 2.6m for ID
  - Beta functions at center are 5.0m (x) and 1.3m (y)
  - VC gap can be as small as 3mm without changing the ring acceptance
  - Requires four additional quadrupoles. Strength may be a problem.

Mid-Term Upgrade Possibilities

- Subharmonic capture cavity for booster (Borland, Horan, Nassiri, Sereno)
  - Idea originally proposed in APS CDR
  - Should improve reliability and bunch purity while allowing injection directly from linac
  - Design with 39MHz cavity being optimized now
  - Should not require modification to power supply ramps
  - Will require new 352-MHz system rf ramp ("easy")

Long-Term Upgrade Possibilities

- Replacement lattice with 40 longer straights (Borland)
  - Supports 7m-long IDs
  - Has very flexible beta functions
  - Effective emittance of 2nm
  - Chromatic correction needs to be done
  - Requires four additional quadrupoles per sector
  - Requires new 1.5m-long dipoles

Long-Term Upgrade Possibilities

- Very-low emittance booster (Borland, Emery, Sereno)
  - 3nm lattice cell design exists with gradient dipoles
  - Requires rewiring QDs as QFs
  - Still considerable lattice work to do
  - Chromatic correction may be difficult

Long-Term Upgrade Possibilities

- XPS: Extreme Photon Source (Borland)
  - Fits in APS tunnel with present ID locations
  - Long straight sections
  - 75 pm effective horizontal emittance
  - IBS looks ok for 100mA in 130 bunches
  - Quadrupoles and sextupoles are very strong
  - Dipoles with substantial gradients (two types)
  - Initial chromatic correction done
    - provides small dynamic aperture
    - genetic optimizer not yet applied