Argonne NATIONAL LABORATORY

... for a brighter future

Brief Update on Upgrade

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APS-PA
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Review of Accelerator Upgrade Options

- **Advisory committee will meet on November 16,17**
- **Committee consists of:**
  - **Vic Suller (Chair)** Center for Advanced Microstructures and Devices, Louisiana State University: Louisiana
  - **Klaus Balewski** DESY: Hamburg, Germany
  - **Max Cornacchia** Retired from Stanford Linear Accelerator Center: California
  - **John Galayda** Stanford Linear Accelerator Center: California
  - **Georg Hoffstaetter** Cornell University: New York
  - **Andrew Hutton** Thomas Jefferson National Accelerator Facility: Virginia
  - **Sam Krinsky** National Synchrotron Light Source, Brookhaven National Laboratory: New York
  - **Annick Ropert** ESRF: Grenoble, France
  - **Elaine Seddon** Daresbury Laboratory: Cheshire, UK

Tentative charge to Advisory Committee

- Can the proposal deliver the technical performance claimed?
- Is the claimed performance technically revolutionary, and how does it compare with “green-field” proposals?
- What are the technical R&D challenges needed to successfully deliver the upgrade?
- What is the expected disruption to users associated with implementing this option, and what can be done to mitigate risk?
- Are there other proposals that should be considered?

Boundary Conditions – Storage Ring Replacment

If possible the following will be maintained:

- Will utilize the existing APS storage ring tunnel
- Beam energy will be at least 6 GeV, but with a goal of 7 GeV.
- Existing beamlines will be preserved
- Existing beam stability will be maintained

- Beamlines will be able to continue operation with no changes to equipment, if that is desired, and without any reduction in performance.
- Existing capabilities for bunch patterns will be preserved, including single bunch current of up to 16 mA in hybrid mode.

Boundary Conditions – Energy Recovery Linac

If possible the following will be maintained:

- Will utilize the existing APS storage ring tunnel
- Beam energy will be at least 6 GeV, but with a goal of 7 GeV.
- Existing beamlines will be preserved
- Existing beam stability will be maintained

- Existing flux will be maintained
- The storage ring will be able to run in its present “storage ring mode” for as long as is necessary after the ERL has been commissioned.

Storage Ring Replacement Options

Low emittance lattice

- **Significantly reduced horizontal beam emittance, to below 1 nm.**
- **Increased beam current, to at most 200 mA.**
- **Controlled short x-ray pulses tunable from tens to a few picoseconds, available at a few sectors using rf transverse chirping scheme.**
- **Enhanced coherent imaging, particularly, with larger imaging area available at a few sectors using rf transverse chirping scheme.**
- **Extended straight section length to support innovative sources**

Additional Straight Sections

Reduced horizontal emittance (~1.5nm)

- **Increased beam current, to at most 200 mA.**
- **2.1 m straight section parallel to existing BM line provides capability of ID beamline for all BM beamlines**
- **Three pole wiggler could be provided for BM beamlines that wish to retain bending-magnet-like source**

Summary: Ring Upgrade

- Pros
  - Well known technology, should deliver as promised
  - Long straight sections, possibly 3x number of IDs
  - Smaller horizontal beamsize (~120 microns)
  - Improved brightness (10~100x)
  - Support for ps pulses, large area coherent imaging
- Cons
  - Lattice flexibility very difficult to achieve
  - Considerable dark time required for installation
  - Brightness improvement is disappointing relative to
    - Detector/beamline improvements
    - ERL projections.

Possible ERL Beam Parameters at 7 GeV

Mode →	***High Flux***	***High Coherence***	***Ultrashort Pulse***
Average current (mA)	100	25	1
Rep. rate (MHz)	1300	1300	1
Bunch charge (pC)	77	19	1000
Emittance (pm)	22	6	365
RMS bunch length (ps)	2	2	0.1
RMS momentum spread (%)	0.02	0.02	0.4

Values per G. Hoffstaetter, FLS2006.


FEL
Hall
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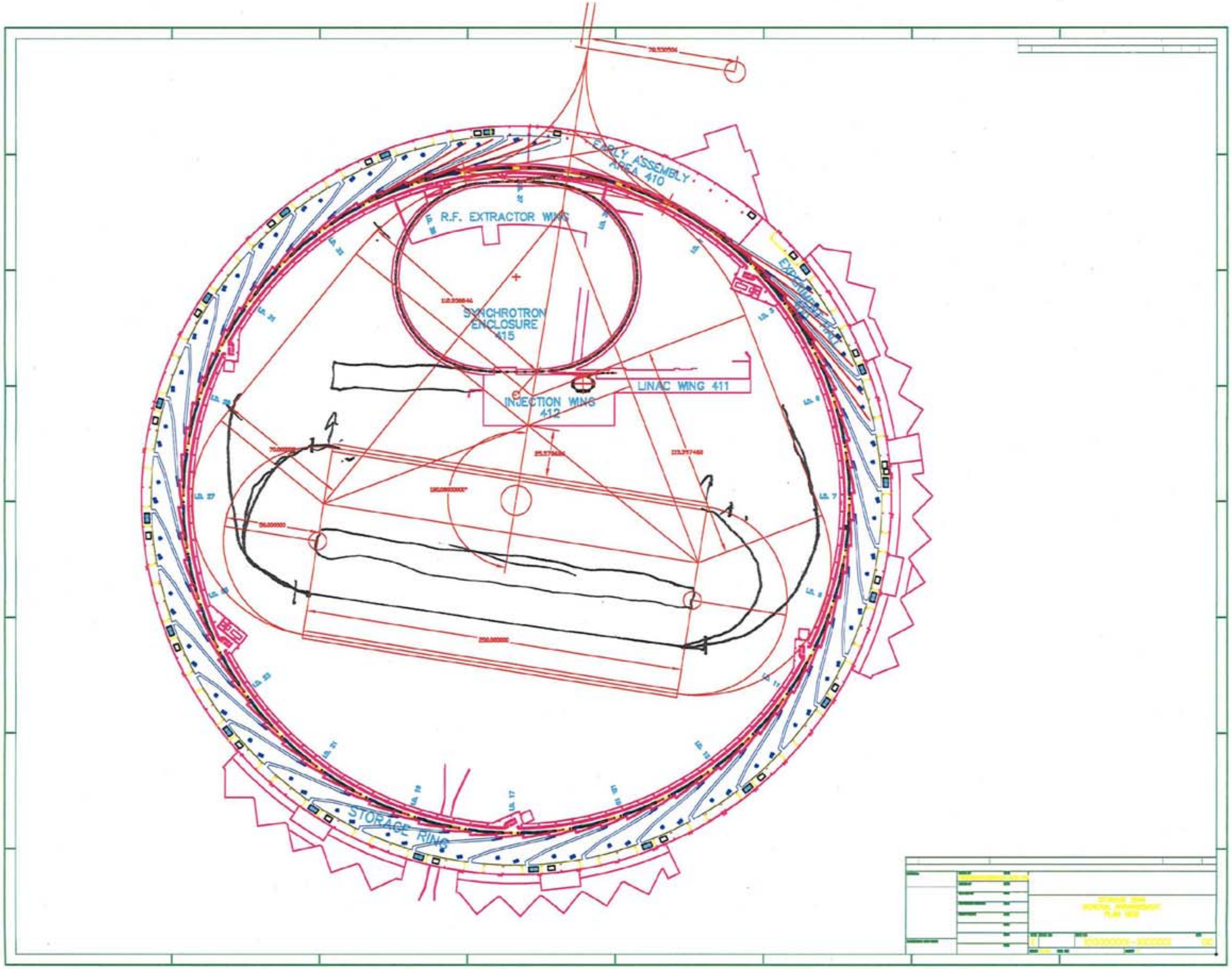
EARLY ASSEMBLY AREA 410
R.F. EXTRACTOR WING
SYNCHROTRON ENCLOSURE 415
LINAC WING 411
INJECTION WING 412
STORAGE RING

Greenfield Designs for Comparison

- The APS ring is designed for low stored beam emittance
  - Double-bend lattice
  - Minimize quantum excitation: strong-focusing optics and gradual bending better
  - Maximize damping: hard bending better
- An ERL arc is designed differently
  - Triple-bend lattice for CSR cancellation
  - Minimize quantum excitation
  - Don't get any damping, so advantage of gradual bending is greater
- Designing a Greenfield ERL (GFERL) lets us determine how far APS is from ideal…. 3x better than ERL@APS with 4.8 m device
- We can chart a path to improving the APS lattice toward GFERL level

- M. Borland

Summary: ERL Options

- Pros
  - 60~500-fold brightness increase in high-coherence mode
  - Short bunches (few ps to few 100 fs rms) in ultrafast mode
  - Greater flexibility of source size/divergence
  - No long dark time for installation
  - Options for facility expansion beyond present ring
- Cons
  - Unanswered issues about feasibility
  - Simulations so far show beam quality not well maintained with ultrashort mode
  - Incompatible operating modes (flux, coherence, ultrashort).

APS Upgrade Update

- Visit

  http://www.aps.anl.gov/News/Conferences/2006/APS_Upgrade/index.html

  accessible from the APS home page, for detailed information