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ERL Upgrade Options and Possible Performance

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September 18, 2006

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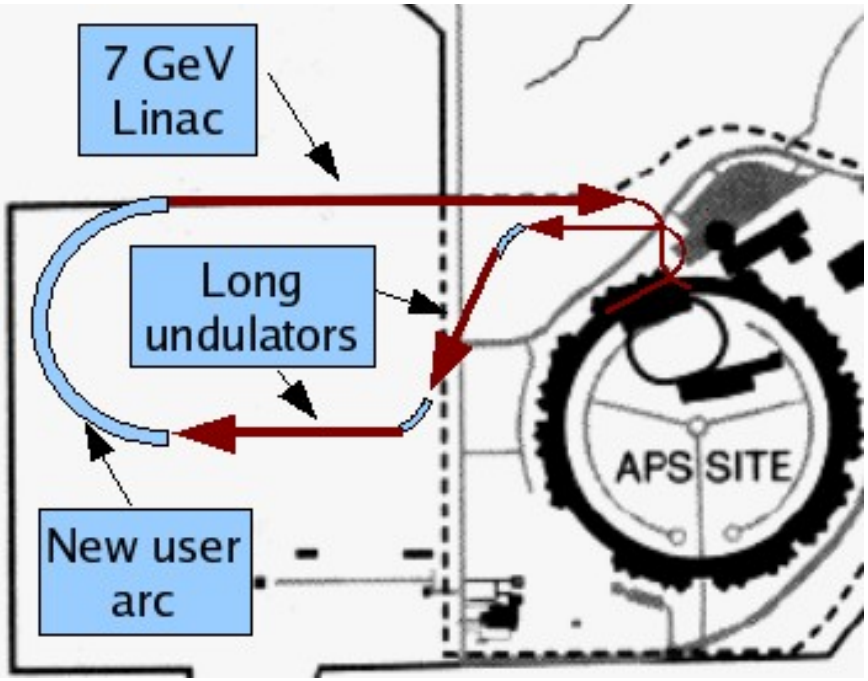
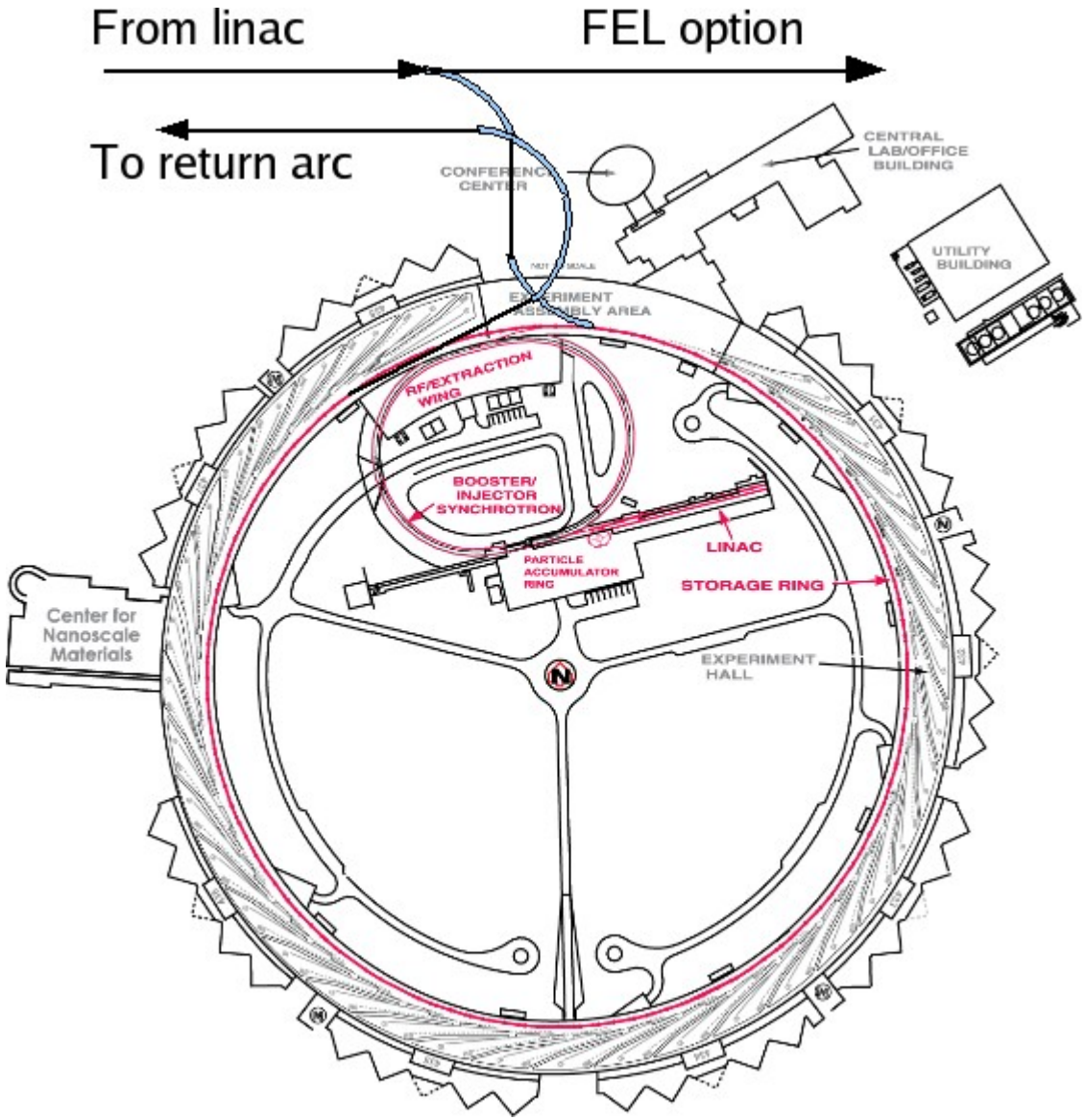
Outfield Option #1: Overall

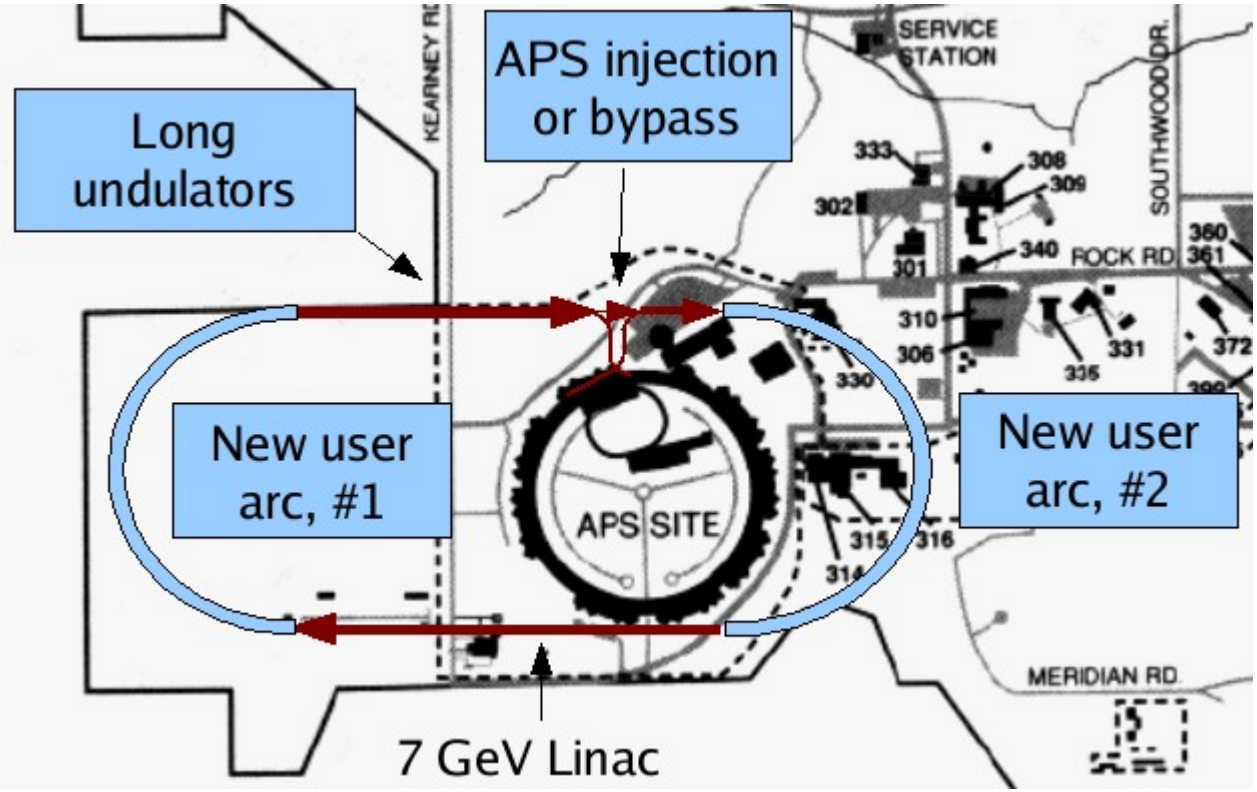
- Pros
  - Large new user arc
  - Space for long undulators
  - Minimal disturbance of existing APS injector and operations
- Cons
  - Complex transport lines needed to get beam into and out of ring may create issues for emittance preservation
  - Linac and new arc are somewhat cramped.



Outfield Option #1: Detail

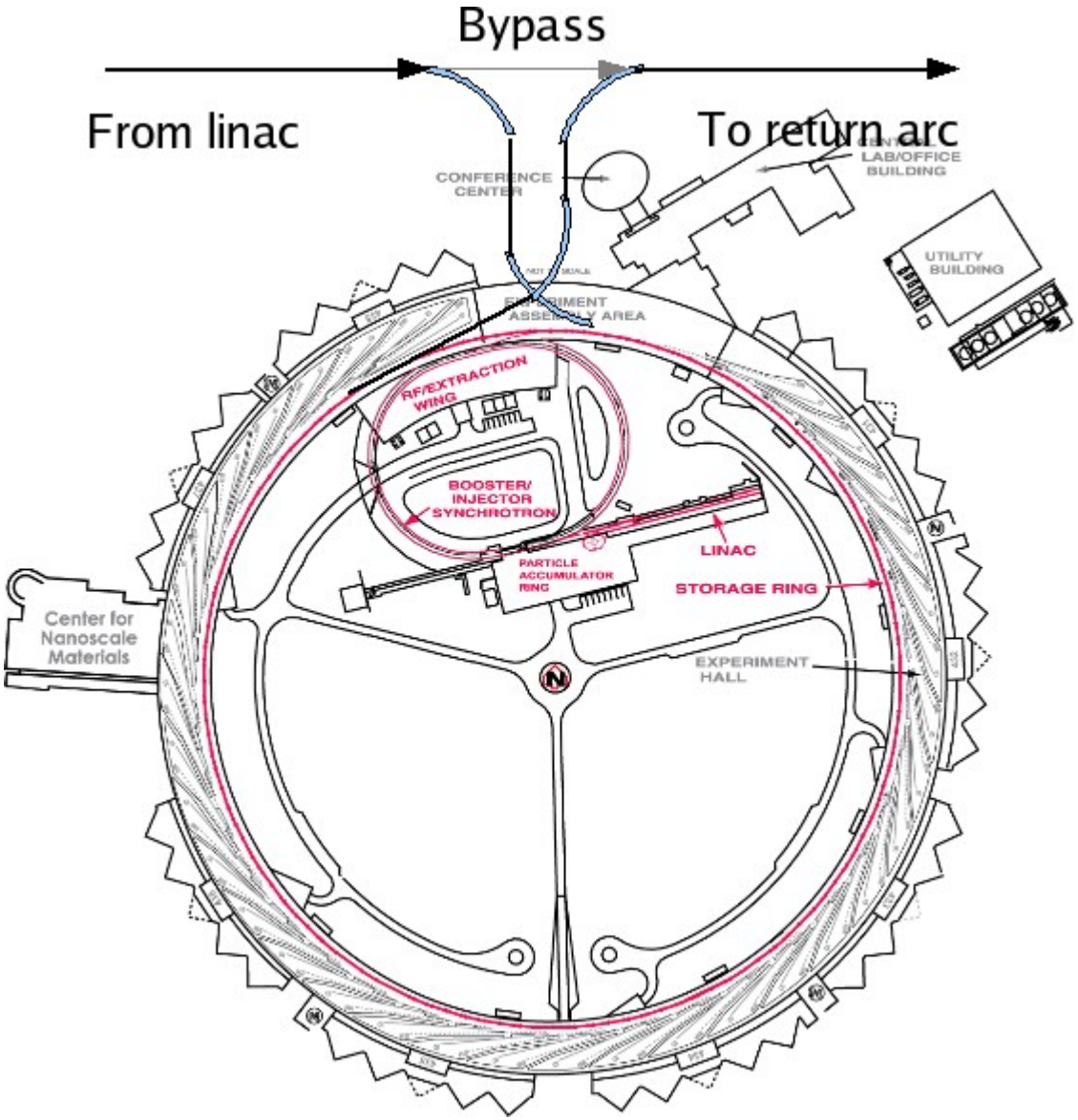


Outfield Option #2: Overall



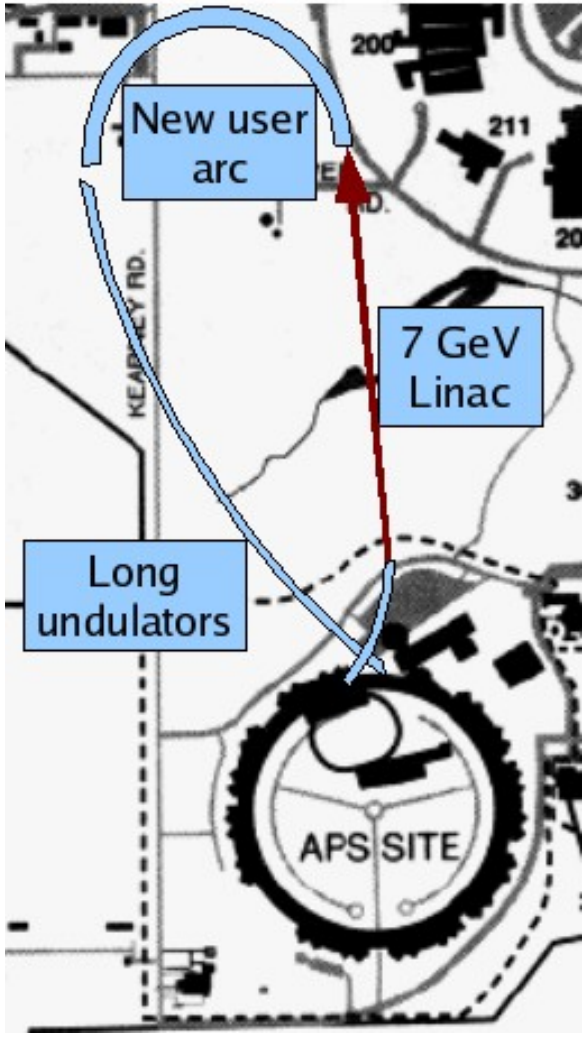
- Pros
  - Very large new arcs for beamlines
  - Space for long undulators
  - Minimal disturbance to operations
  - APS bypass mode option
- Cons
  - Very expensive
  - Must remove some existing buildings
  - Complex arcs for injection and extraction of beam

Outfield Option #2: Detail



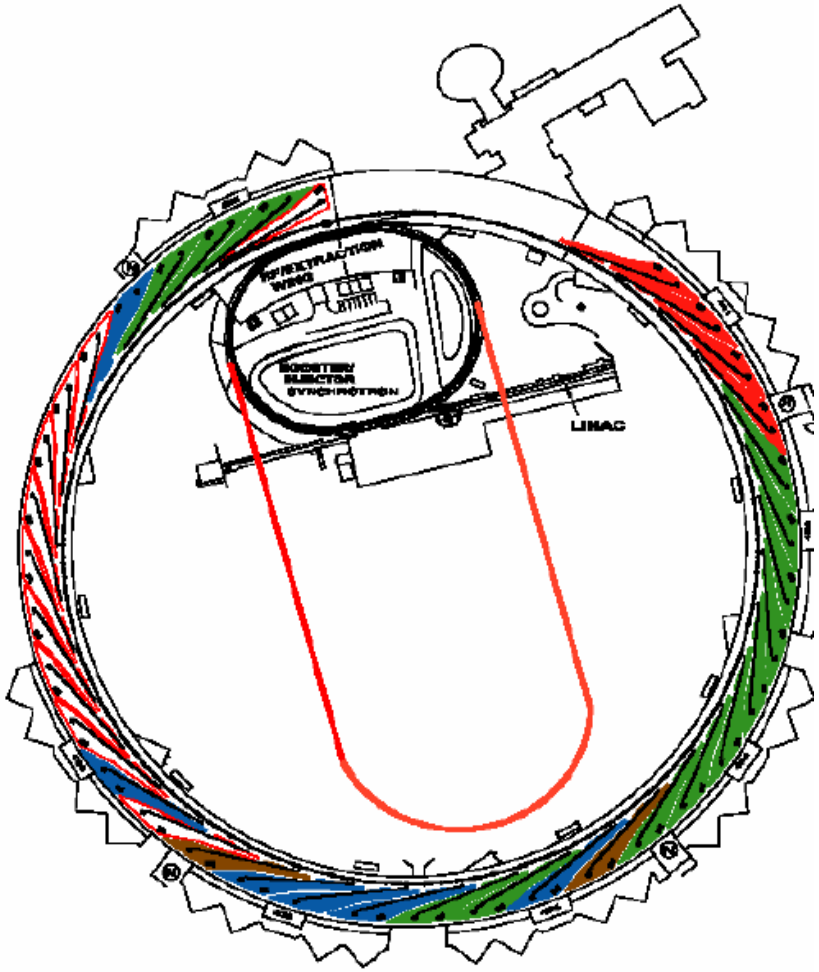
Outfield Option #3: Overall

- Pros
  - Less severe bending to get into ring
  - New user arc
  - New curved arc for long undulators
  - Can have straight-ahead option to north of figure
- Cons
  - Possible issues with wetlands and archaeological area
  - Possible conflicts with existing APS buildings.



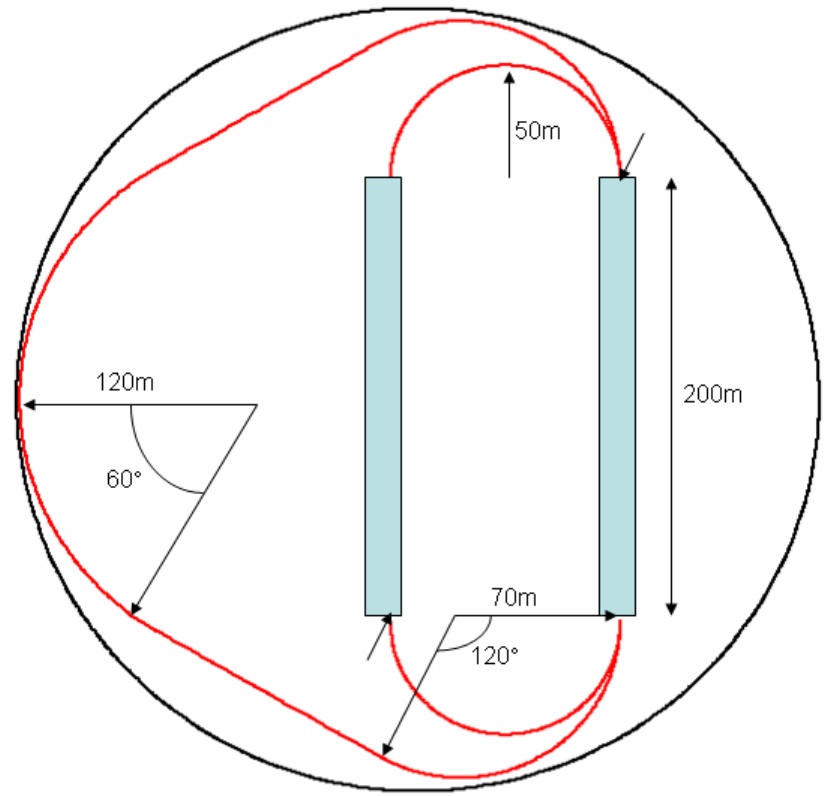
Infield Option #1

- Pros
  - Uses real estate we already own
  - Multipass option saves rf costs
- Cons
  - Multipass option requires several complex arcs on both ends
  - Emittance growth in 7 GeV arcs
  - Appears to involve major interference with existing linac
  - Construction in APS infield during user operations
  - No expansion of user facilities



From M. White and Y. Cho, ERL2005, WG2.

Infield Option #2



Concept from R. Gerig.
Figure courtesy V. Sajaev
(ASD/APG/2006-20).

- Pros
  - Uses real estate we already own
  - Multipass option (1 linac) saves cost on rf systems
  - Dual linac system reduces energy ratio
- Cons
  - Construction in APS infield during user operations
  - Complex transport lines with many magnets
  - No expansion of user facilities

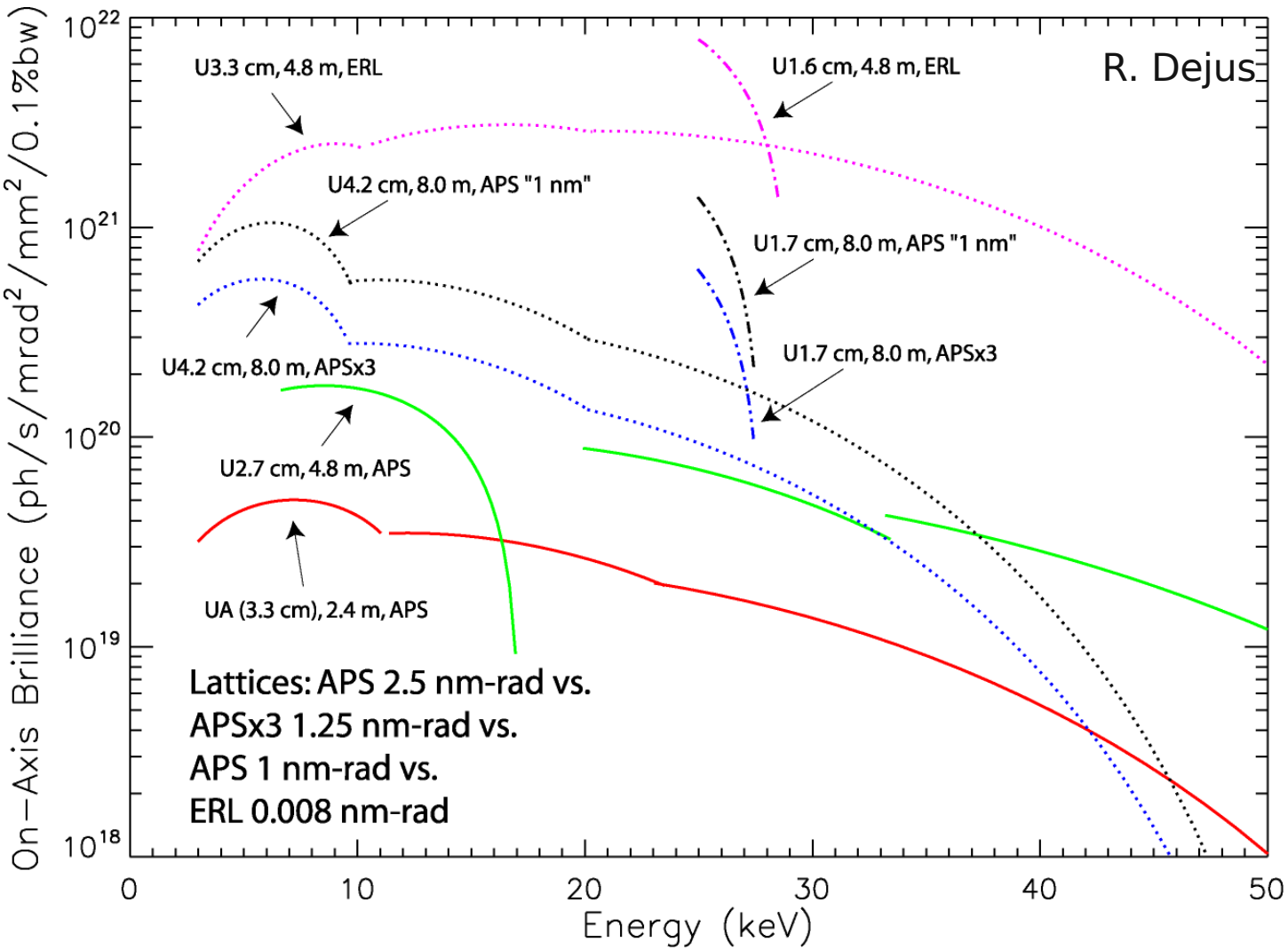
Possible ERL Beam Parameters at 7 GeV

Mode-->	*High flux*		*High Coherence*		*Ultrashort Pulse*	
Quantity	***Best***	***Conservative***	***Best***	***Conservative***	***Best***	***Conservative***
Average current (mA)	100	25	25	25	1	0.2
Rep. rate (MHz)	1300	325	1300	1300	1	1
Bunch charge (pC)	77	77	19	19	1000	200
Emittance (pm)	22	44	6	12	365	600
Rms bunch length (ps)	2	4	2	4	0.1	0.4
Rms momentum spread (%)	0.02	0.04	0.02	0.04	0.4	0.4

Best values per G. Hoffstaetter, FLS2006.

See M. Borland, OAG-TN-2006-036 for discussion.

Spectral Brightness Predictions (Best ERL Values)



- 100 mA (APS), 200 mA (APSx3, APS 1 nm-rad), 25 mA (ERL)

Summary: ERL Upgrade

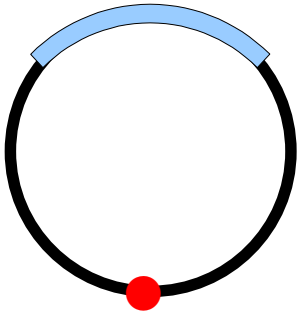
- Pros
  - 60~500-fold brightness increase in high-coherence mode
  - Short bunches (few ps to few 100 fs rms) in ultrafast mode
  - Greater flexibility of source size/divergence
  - No long dark time for installation
  - Options for facility expansion beyond present ring.

Summary: ERL Upgrade

- Cons
  - Many unanswered issues about feasibility
    - *Can injector deliver as promised?*
    - *Can beam quality be preserved?*
    - *Can gun sustain 100 mA?*
  - Simulations so far show beam quality not well maintained with ultrashort mode
    - *Impacts users downstream of compression point*
    - *May interfere with energy recovery even for 1 ps case*
    - *X-ray flux similar to crab cavity system.*
  - Incompatible operating modes (flux, coherence, ultrashort).

Hybrid ERL Modes

- Can we mix ERL operating modes?
  - Probably not, because injector configuration, compression, etc. are charge dependent
- Can we mix Ultrafast ERL and stored beam?
  - Partial solution to ERL operating mode issues
  - Run ring with stored beam crowded on one side as in present hybrid mode
  - Run ERL at 271 kHz to match ring revolution frequency
    - *Need fast kickers (<3 us)*
    - *Need high rate kickers (271 kHz)*
    - *Need highly stable kickers due to small emittance*
  - “Only” 2 MW, maybe full ER not needed?
  - No physics reasons this won’t work.



Acknowledgements

- Participants in upgrade discussions and computations:

  M. Borland, J. Carwardine, Y. Chae, G. Decker, R. Dejus, L. Emery, R. Flood, R. Gerig, E. Gluskin, K. Harkay, M. Jaski, E. Moog, A. Nassiri, V. Sajaev, N. Sereno, H. Shang, R. Soliday, N. Vinokurov, Y. Wang, A. Xiao, C. Yao

- Others:

  G. Hoffstaetter (Cornell)