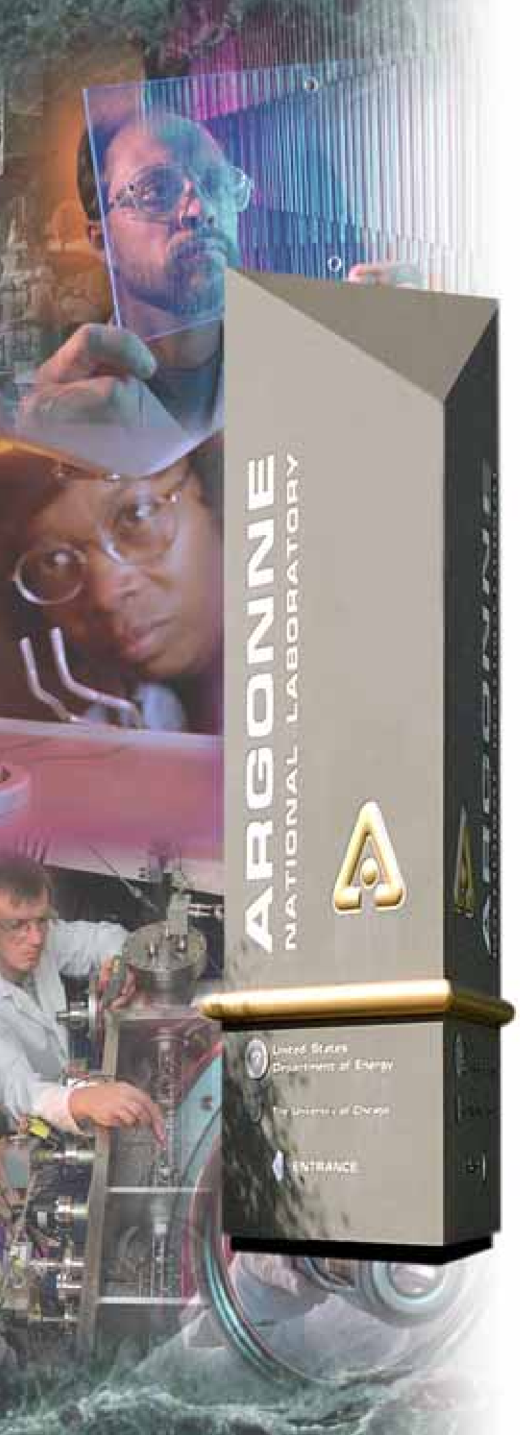


Update on the Short Pulse Activities

Dennis Mills
Deputy Associate Laboratory Director
Advanced Photon Source

APS/User Operations Meeting
November 18, 2004

Argonne National Laboratory

Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago

People Doing the Work

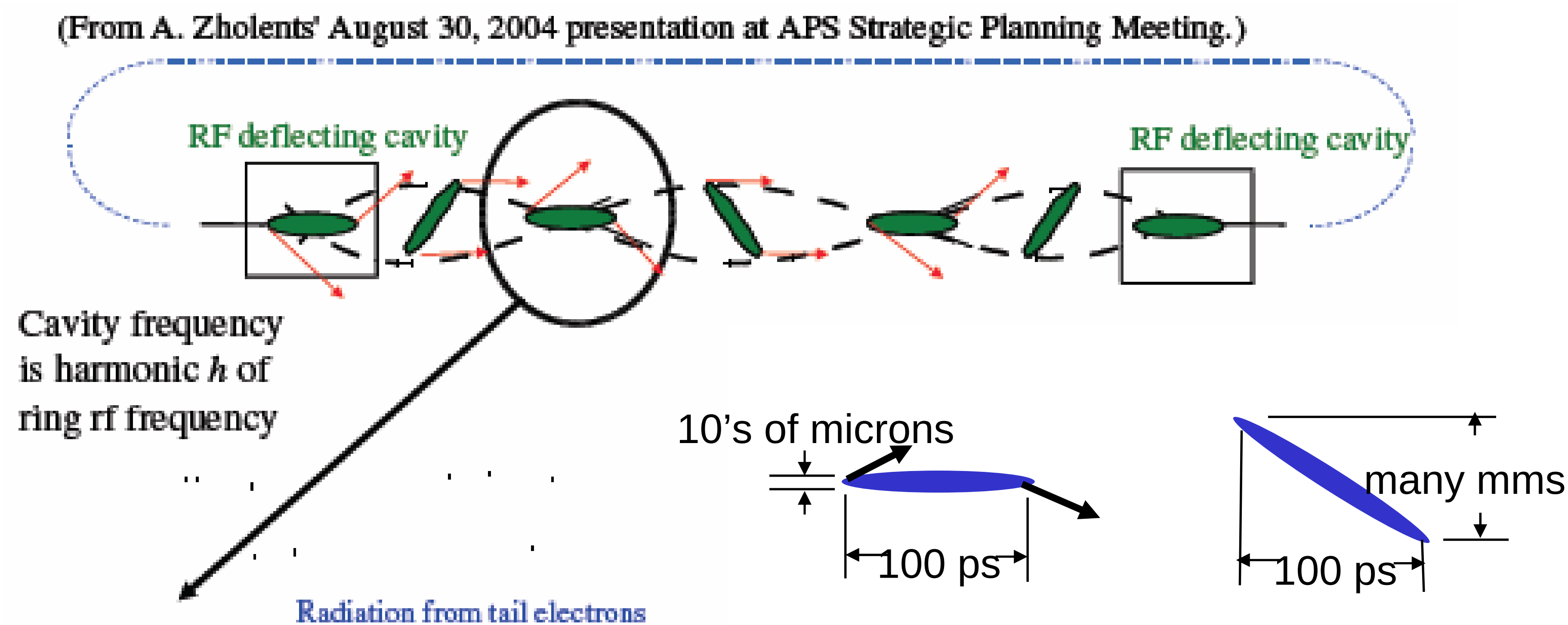
- **Accelerator physics issues**
  - Mike Borland
  - Louis Emery
  - Kathy Harkay
  - Vadim Sajaev
  - Yong-chul Chae
  - Bingxin Yang

- **RF requirements**
  - Doug Horan
  - Geoff Waldschmidt

- **Insertion devices and radiation properties**
  - Roger Dejus
  - Liz Moog

- **Optics for pulse compression**
  - Sarvjit Shastri
  - Dennis Mills

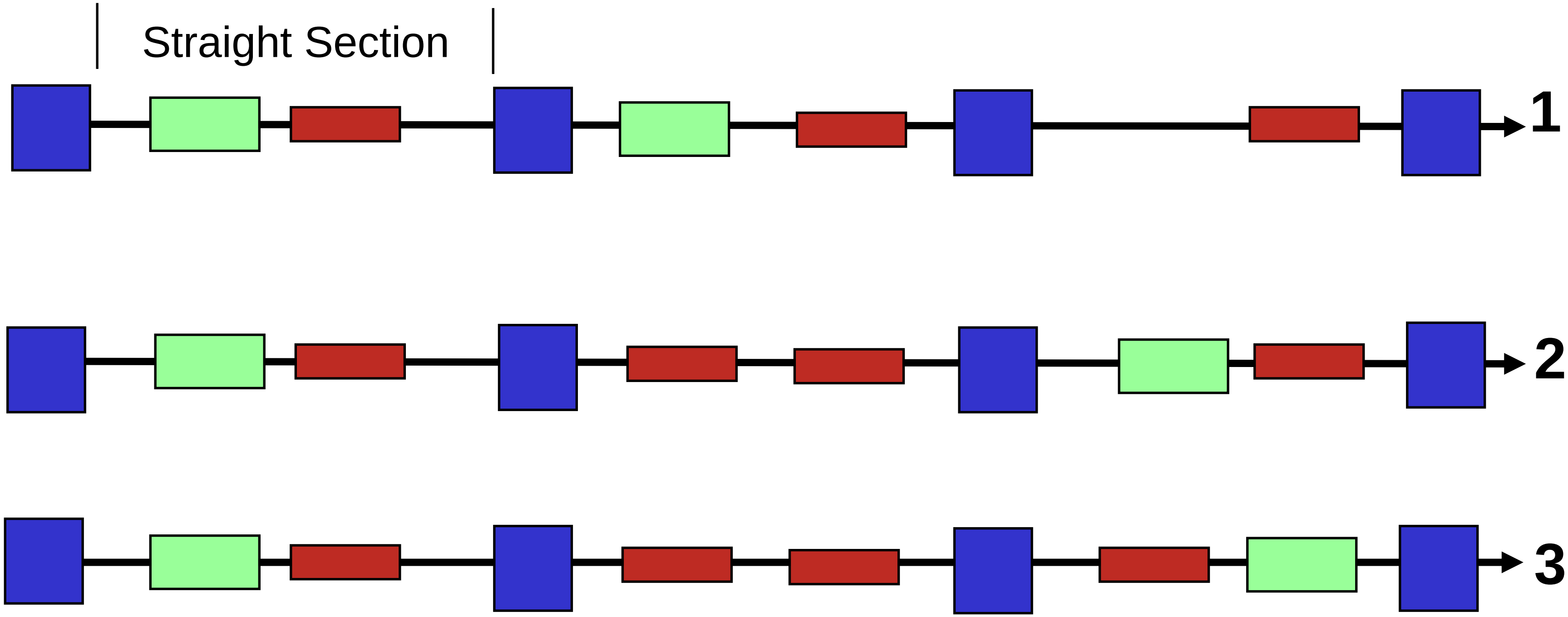
The Concept

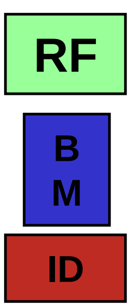


Beam in straight section. Front and back now have a different Py.

Beam after drifting for a distance L. If angle between head and tail is 1 mrad and L= 40m then y = 40mm.

Possible Options for RF Cavity Placement





Option #1: RF in sectors effected (2 ID &1 BM source)

Option #2: RF steals space from uneffected sector (2 ID & 2 BM sources)

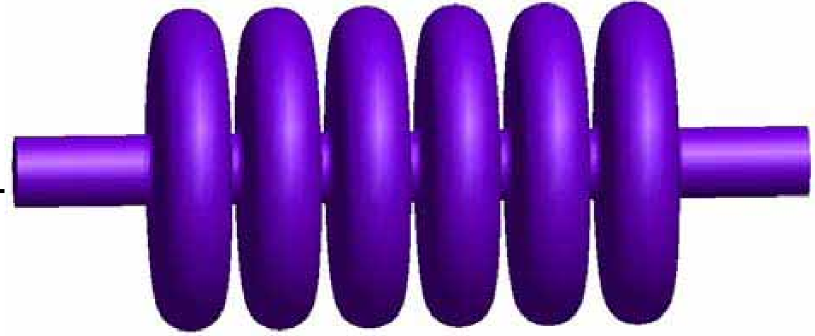
Option #3: RF in sectors effected (3 ID & 2 BM sources)

Accelerator Issues

- Magnitude of the kick (Aiming for 0.2 mrad over rms Δt of 40 psec)
  - Increase RF voltage?
  - Increase harmonic number?
- Beam lifetime effects appear manageable
- If kick cancellation is not exact, vertical emittance is increased
  - Compensation through adjustment to coupling
  - Linear lattice errors can change the phase advance
  - Coupling may affect cancellation of kicks
  - Sextupole nonlinearities are the worst problem
- Phase and frequency stability need to be looked at in more detail
- Effect of impedance on vertical emittance

But no show stoppers……

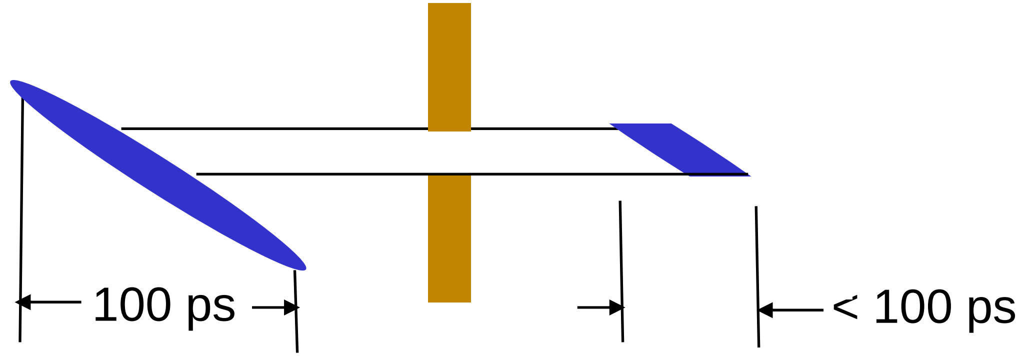
RF Cavity Studies



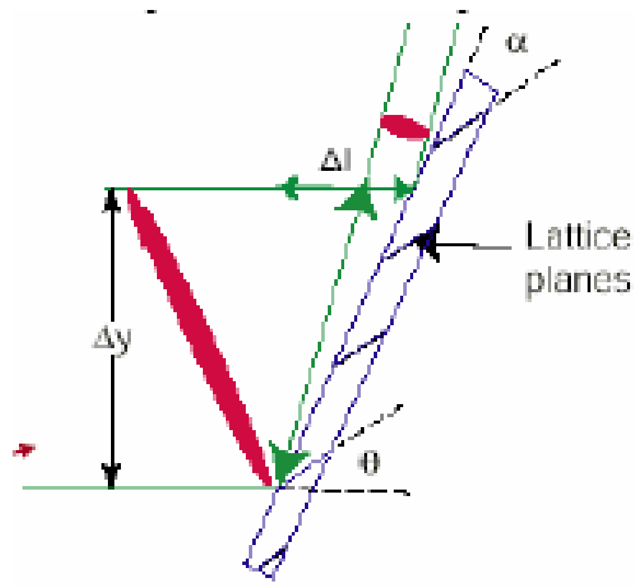
- Superconducting cavity at 4.2K should be sufficient for removing power due to rf losses.
- Two 6-cell or possibly a single 9-cell accelerating structure will be necessary to reduce peak surface fields.
  - Each structure will be 0.65 –0.95 meters long.
  - Additional space will be necessary for input couplers, dampers, and structure spacing if needed.
- HOM and LOM damping as well as TM110 degeneracy will require cavity modification.
- RF amplifiers and power supplies are available at appropriate frequency and power levels.

Pulse Length Reduction

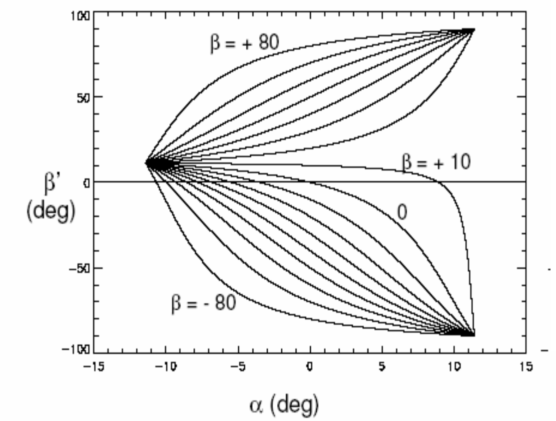
- **The pulse length can be reduced by:**
  - *Slits*
    - easy to do
    - white beam compatible

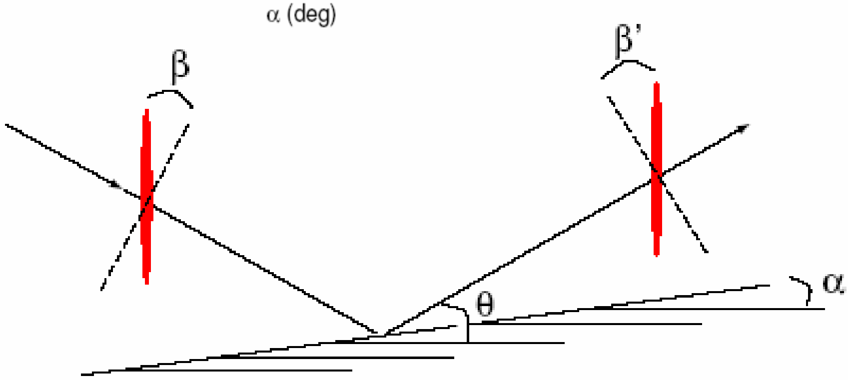


- **Asymmetrically cut crystals**
  - Uses pathlength differences of top and bottom rays



Asymmetrically Bragg Reflections





<u>Bragg geometries not look too promising</u>

- size of beam requires a large xtal
- Low-order reflections require negative (glancing angle) asymmetries which further expand an already large beam
- 2 crystal geometries can help size expansion but involve dispersive arrangements…

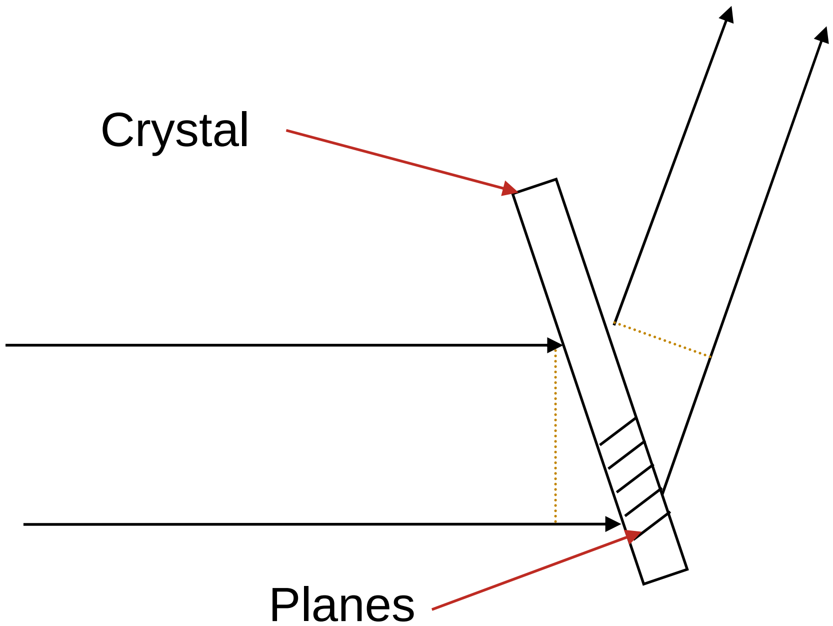
Θ = Bragg angle

α = angle between surface and Bragg planes

β (β') = angle of major axis of beam w/res to normal to incident (diffracted) beam

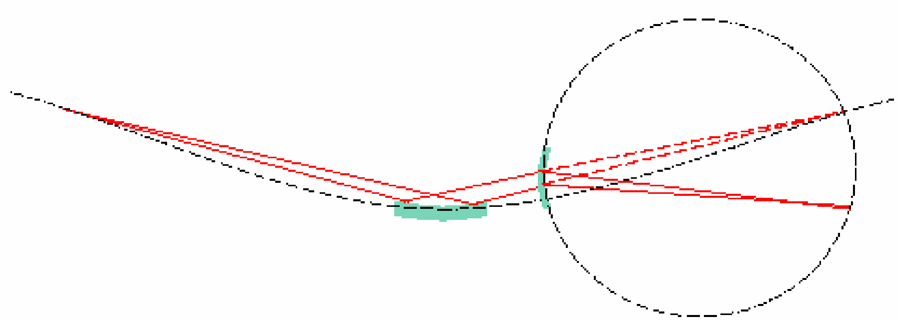
From Shastri

Pulse Compresssion with Laue Crystals



Laue geometries look more promising

- Spatial acceptance can be large
- Focusing can be accomplished without bending
- However, by bending you can satisfy the Roland conditions and reduce the energy spread in the beam.



Summary

- At this point there seems to be **no show stoppers from the accelerator physics** point of view, although a few technical details need to refined.
- Need to explore the optics compression ideas to look at all the options and **calculate expected throughput**.
- Detailed radiation spectral and spatial distributions from the undulator **have not yet been calculated**.
- The **cost estimates** have not yet begun on the RF cavities, power supplies, cryogenic systems, etc.