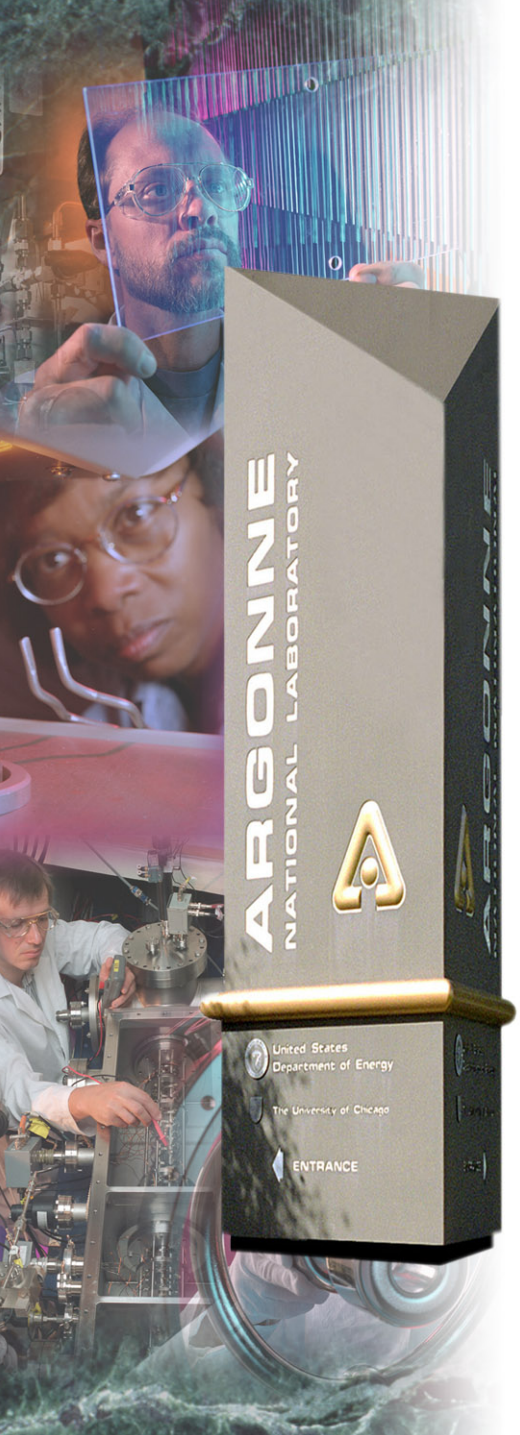


Report of Session I: Accelerator Physics Issues

Kwang-Je Kim

Workshop on Generation and Use of Short X-Ray Pulses at APS
2005 User's Meeting for the APS and CNM
May 6, 2005

Argonne National Laboratory

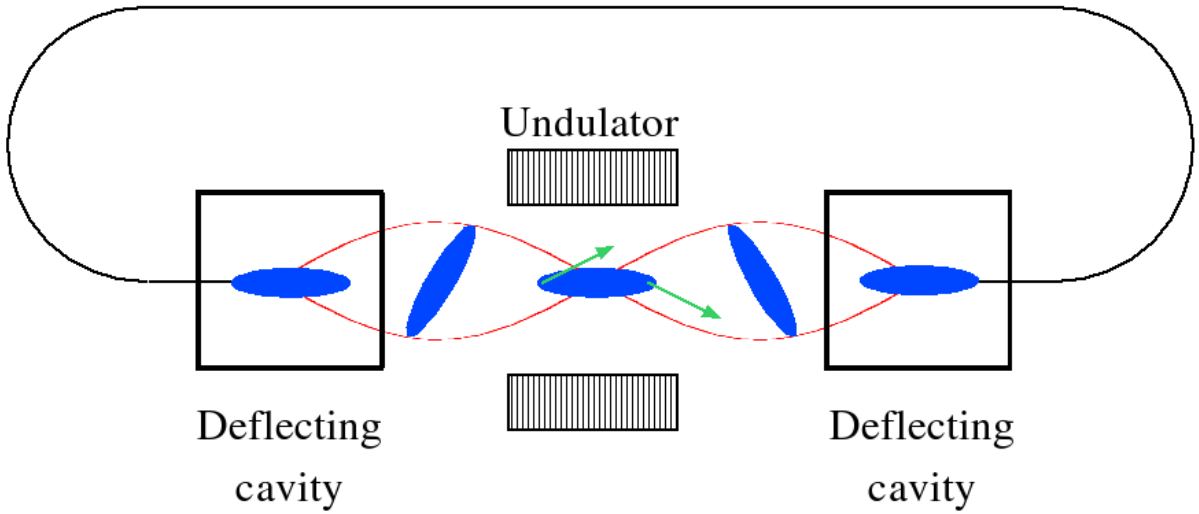
Office of Science
U.S. Department of Energy

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

Session I: Accelerator Physics Issues

- **APS Short Pulse Project…Kathy Harkay**
- **Accelerator Physics Aspects of Deflecting Cavity-Based X-Ray Compresion…Michael Borland**
- **Sextupole Optimization of Deflecting Cavity Scheme …Vadim Sajaev**
- **Parameters for SCRF Deflecting Cavity…Geoff Waldschmidt**
- **Crab Cavity Operation at the KEKB-Factory**
- **Discussion**

Crabbing scheme†



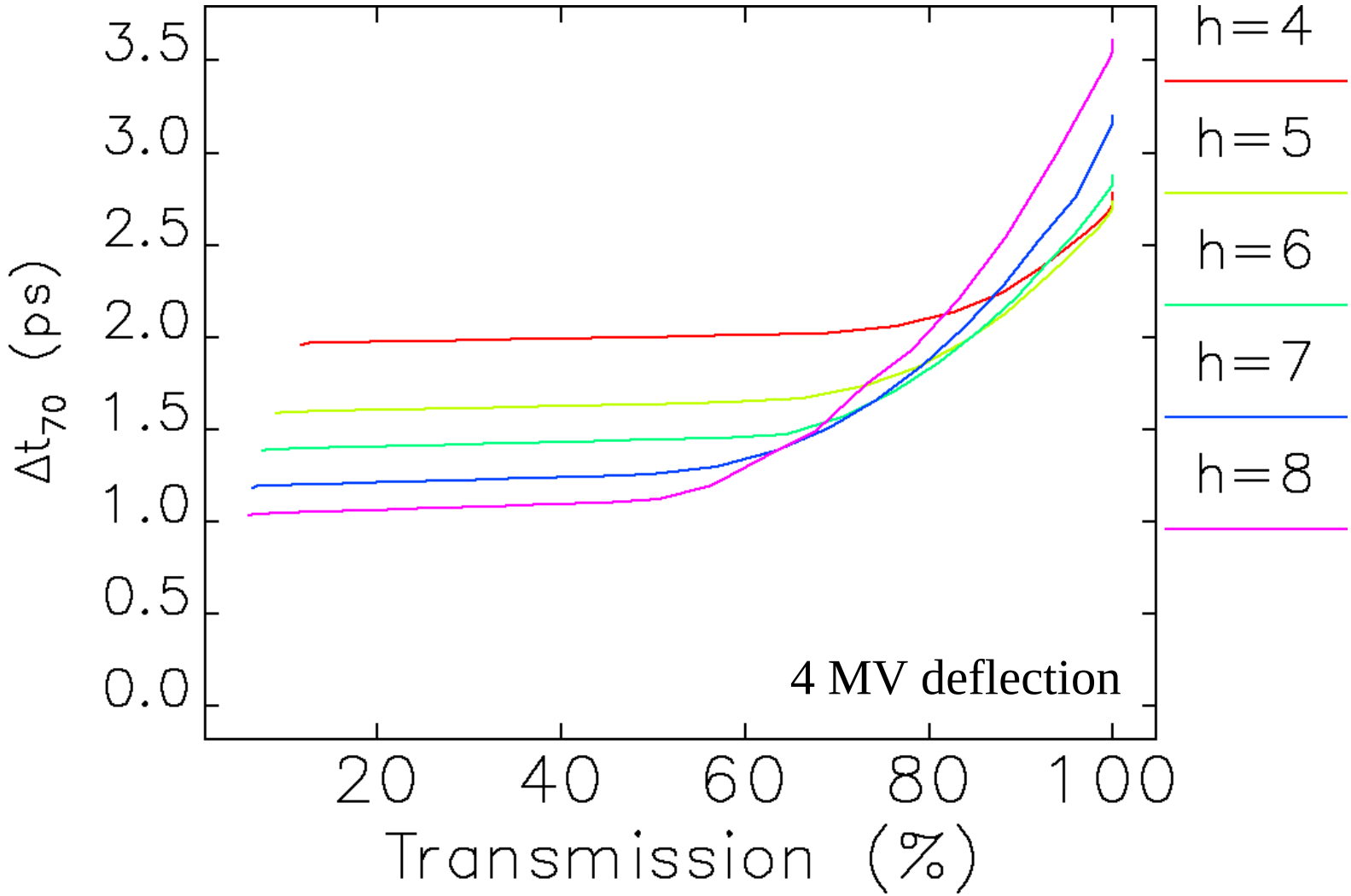
- Deflecting ("crab") cavity operating in TM_{110} mode; B_x kicks head and tail of bunch in opposite directions vertically
- Bunch evolution through lattice results in photons correlated with space or angle along the bunch length
- Ultrashort x-ray pulse either using slits or compression optics
- Second crab cavity at appropriate phase cancels kick; rest of storage ring nominally unaffected

† A. Zholents, P. Heimann, M. Zolotorev, J. Byrd, NIM A425 (1999)

Accelerator Physics Study

- **Goal ~1 ps in crab insertion; no impact elsewhere (100 ps)**
- **Exhaustive study by M. Borland on parameter optimization in the presence of various degradation effects**
  - Lifetime issues
  - RF curvature and frequency choice
  - Emittance degradation due to momentum compaction and chromaticity with energy spread
  - Sextupole nonlinearity
  - Lattice and cavity errors
- **Emittance degradation due to sextupoles was found to be correctable with further optimization (V. Sajaev)**
- **With 2.8 GHz & 4 MV cavity, x-ray pulse length about 1 ps (70%, can be achieved with about 50% transmission**
- **Taking into account the x-ray optics (Shastri) →< 1 ps, 20%**

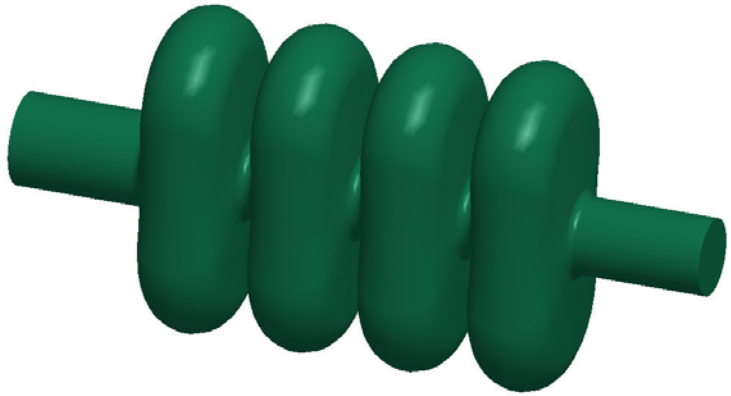
Compression Results for 10 keV, UA, Optics loss not included (M. Borland)



Discussion (What did we miss?)

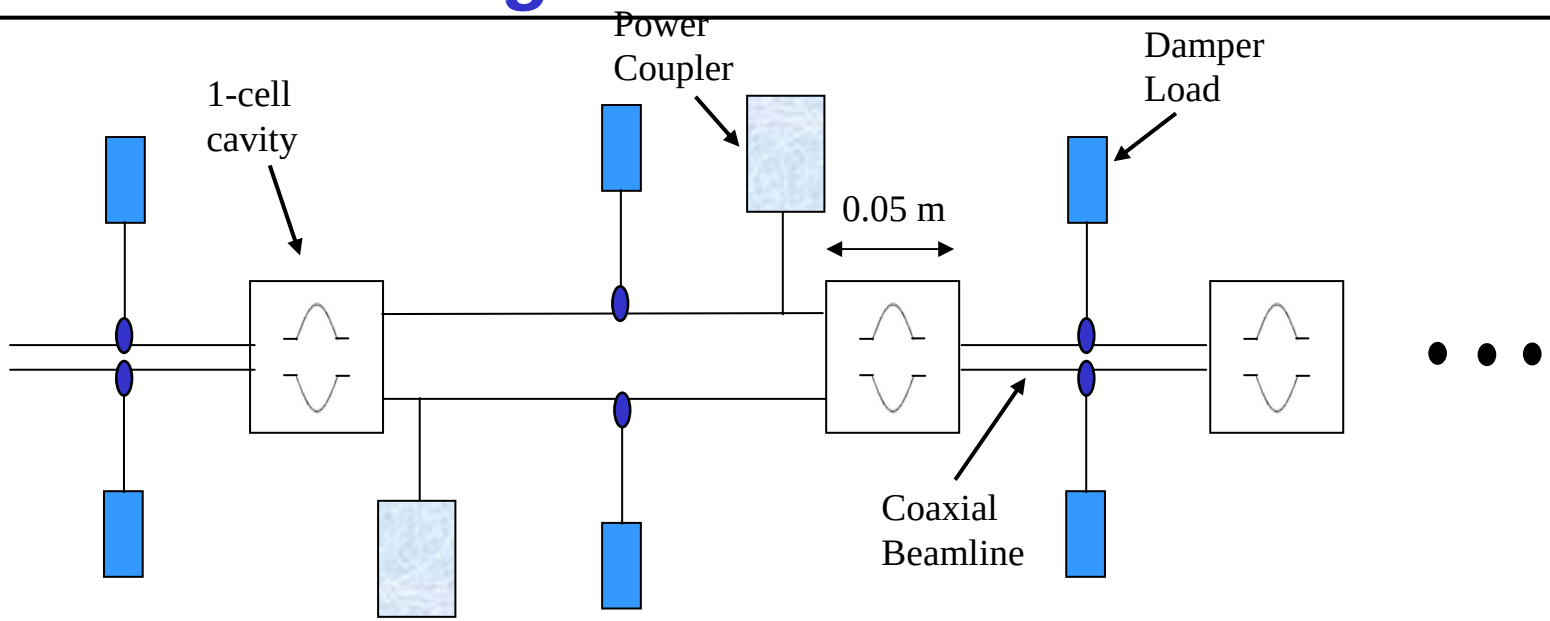
- **HOM, LOM Damping Design requirements need to be determined**
- **Beam loading transients need to be investigated**
- **Aperture (frequency choice)**

4-Cell Squashed Structure at 2.8 GHz Modeled after KEKB-Factory



Frequency	2.81GHz
V_T	4 MV
Avg. Gradient	19 MV/m
Active Cavity Length	21.3 cm
R_T/Q	230 Ω
Q	3×10^9
P_L @ 2 K	25 W
B_{MAX}	230 mT
Cell aspect ratio	1.8

APS 1-cell configuration



- **Seven 1-cell cavities are required. One cryomodule would be used for all cavities.**
- **Cavities would require 0.053 meters / each or 0.37 meters / total.**
- **HOM and LOM power would be extracted from beamline and transmitted to remote loads.**
- **2.1 meters available for seven power couplers, HOM / LOM pickups to loads, and rf separation to minimize coupling.**

Discussion

- **One-cell or four cell configuration?**
  - One cell simpler but need much more room
  - May be we can create more room

Project schedule overview: SCRF

Year 1

- begin new construction to house cryostation and rf power system
- order/receive cryostation and cryomodules
- order rf power system
- design rf deflecting cavity / fabricate prototype

Year 2

- complete new construction
- install cryostation / assemble cryomodules
- receive rf power system; begin installation
- test cavity & component prototypes
- fabricate final cavity & components / test
- begin integration of cryomodules/cavities

Year 3

- complete rf power system installation
- complete rf cavity test
- complete integration/assembly cryomodules/rf cavities, test, and install
- commission

Discussion

- **Can we compress 3 year ?**
  - Three year credible if RF design is done. Much design needs to be completed (beam dynamics, # of cells,..) before start
  - KEK: conception 1995, project start 2004, installation 2006
  - Take advantage of other labs' expertise—JLab, Cornell, KEK

- **NC pulsed ?---Are there strong science cases? Practice with pulsed operation in SR**
  - Prototype experiment NC pulsed using injector linac (400 MeV)?
  - What pulse format will be needed?

Normal or Superconducting?

- **Normal conducting**
  - Pulsed mode
  - Flexibility but low average flux
  - Stability concern
  - Fast implementation
- **Superconducting**
  - CW operation→High average flux
  - Operating mode cannot be changed rapidly
  - Need development time
- **A few SCRF and a few NC sections, starting with 1 nC section ?**

Discussion& Conclusions