Compton X-ray Update

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Jefferson Lab

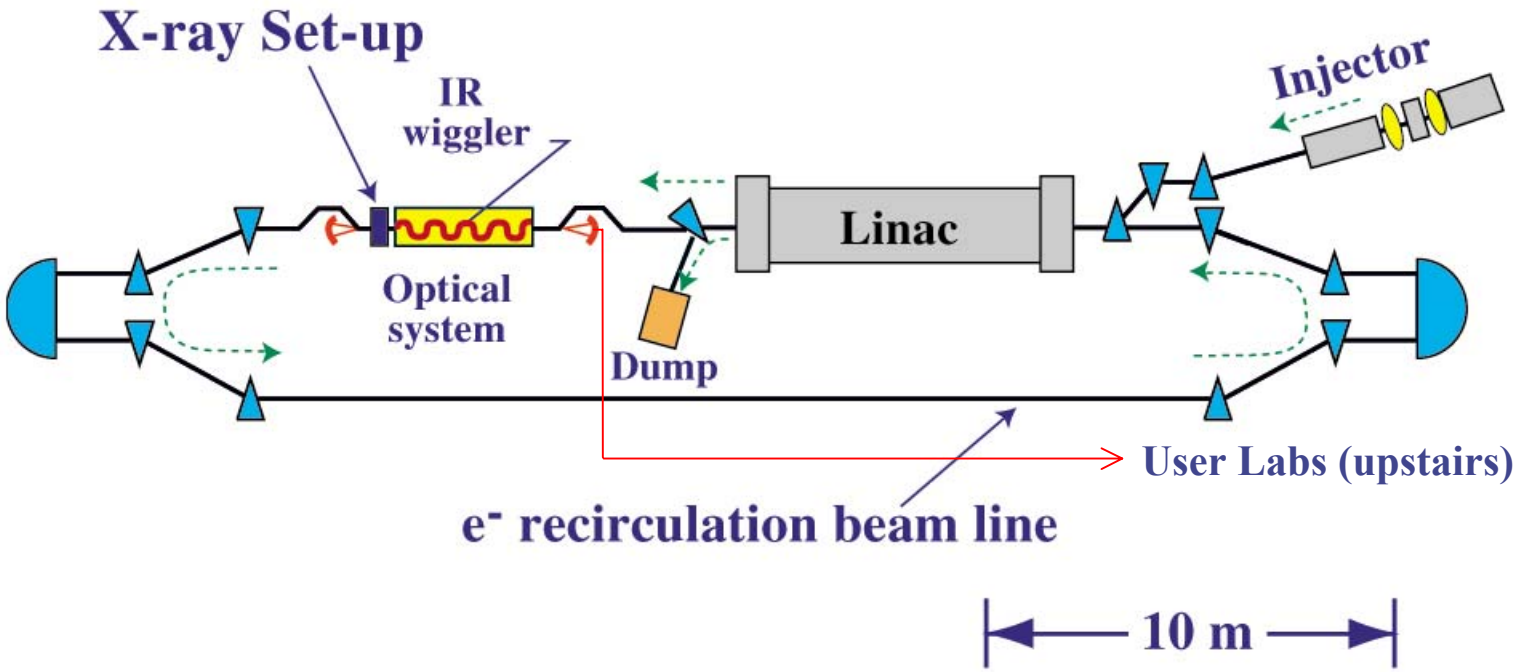
User/LPC Meeting, January 17-18, 2002

Outline

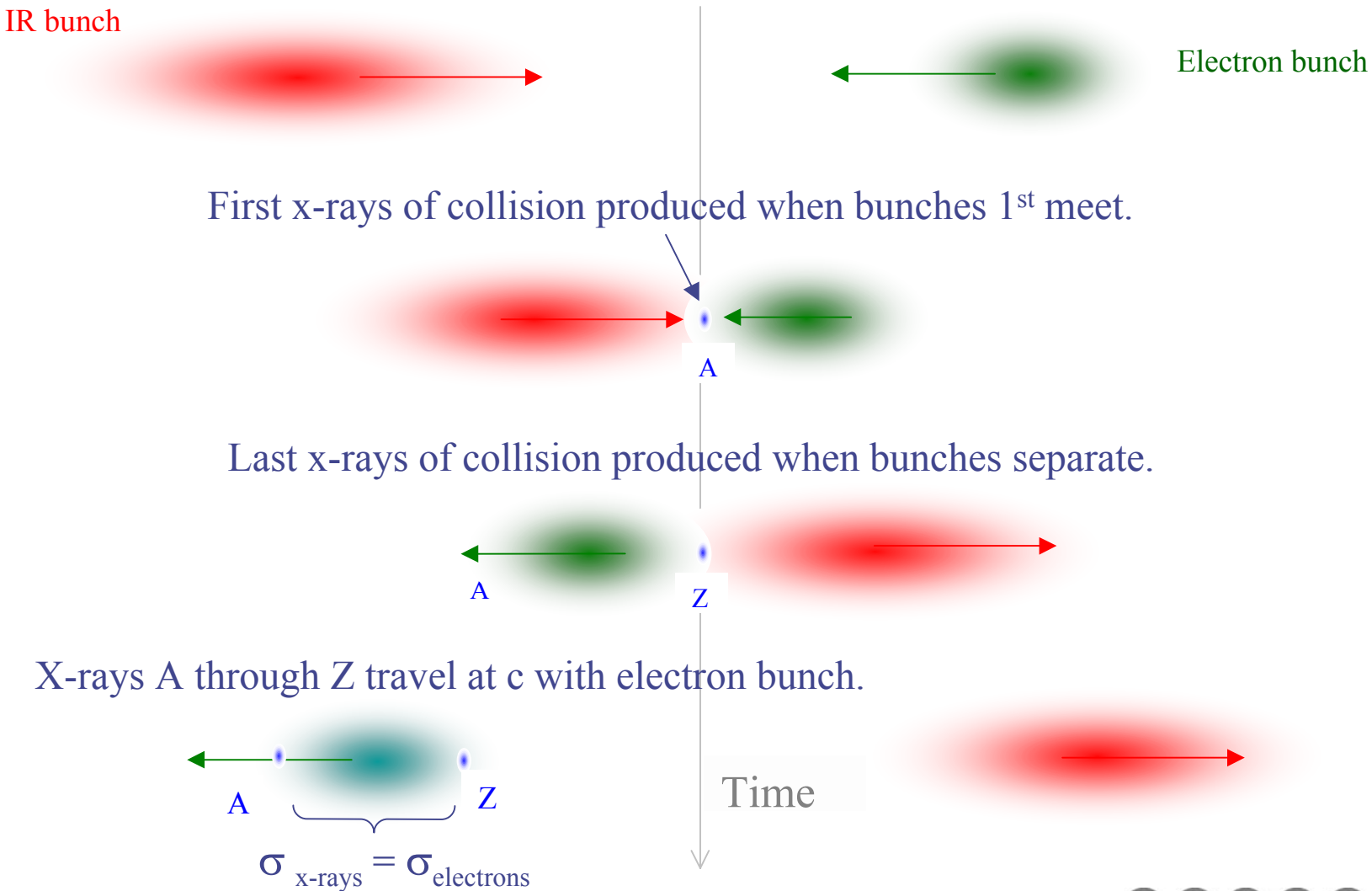
- Concept review
- Summary of IRDEMO results

  (most data taken in parallel with other Users)
- Future X-ray User Station

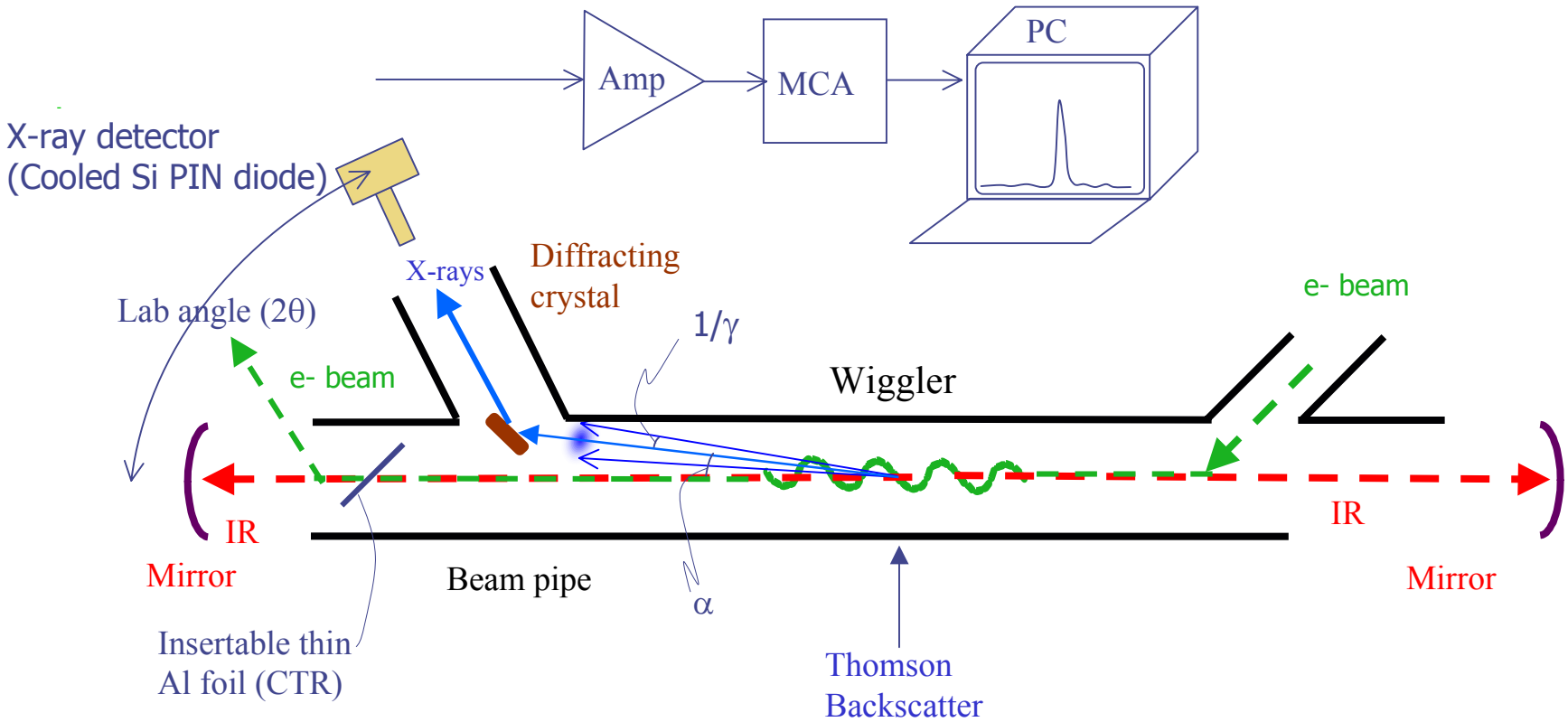
Jefferson Lab FEL LAYOUT

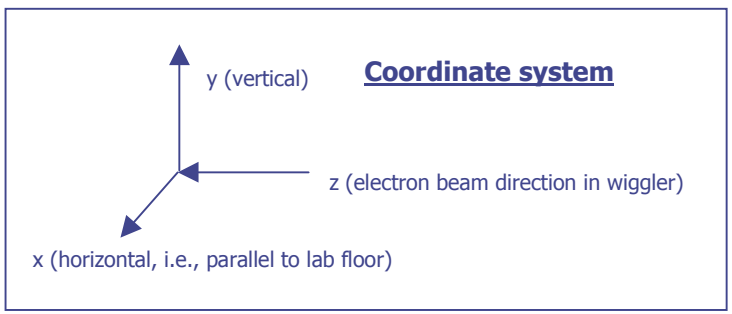


IR-electron bunch collision

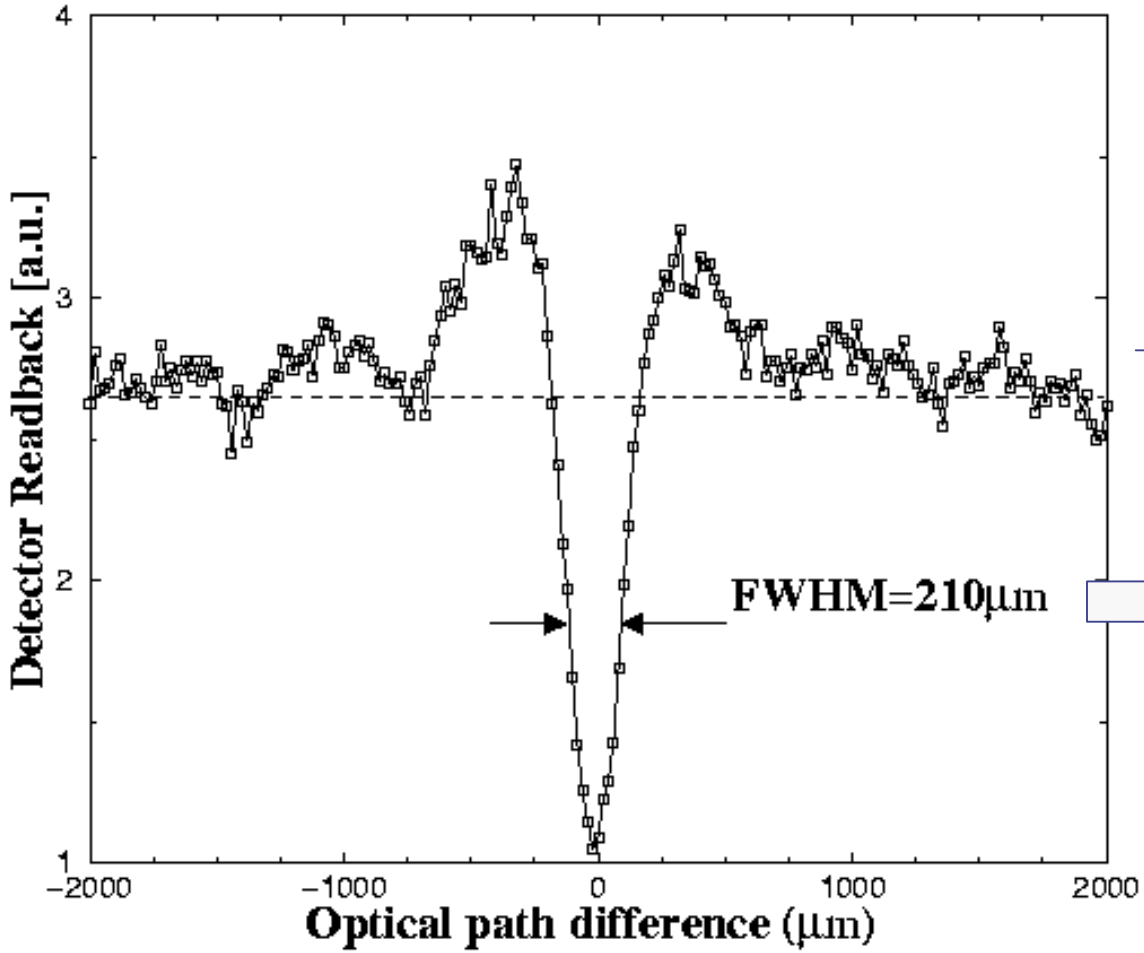


Basic Laboratory Geometry – Side View





CTR electron bunch length measurement

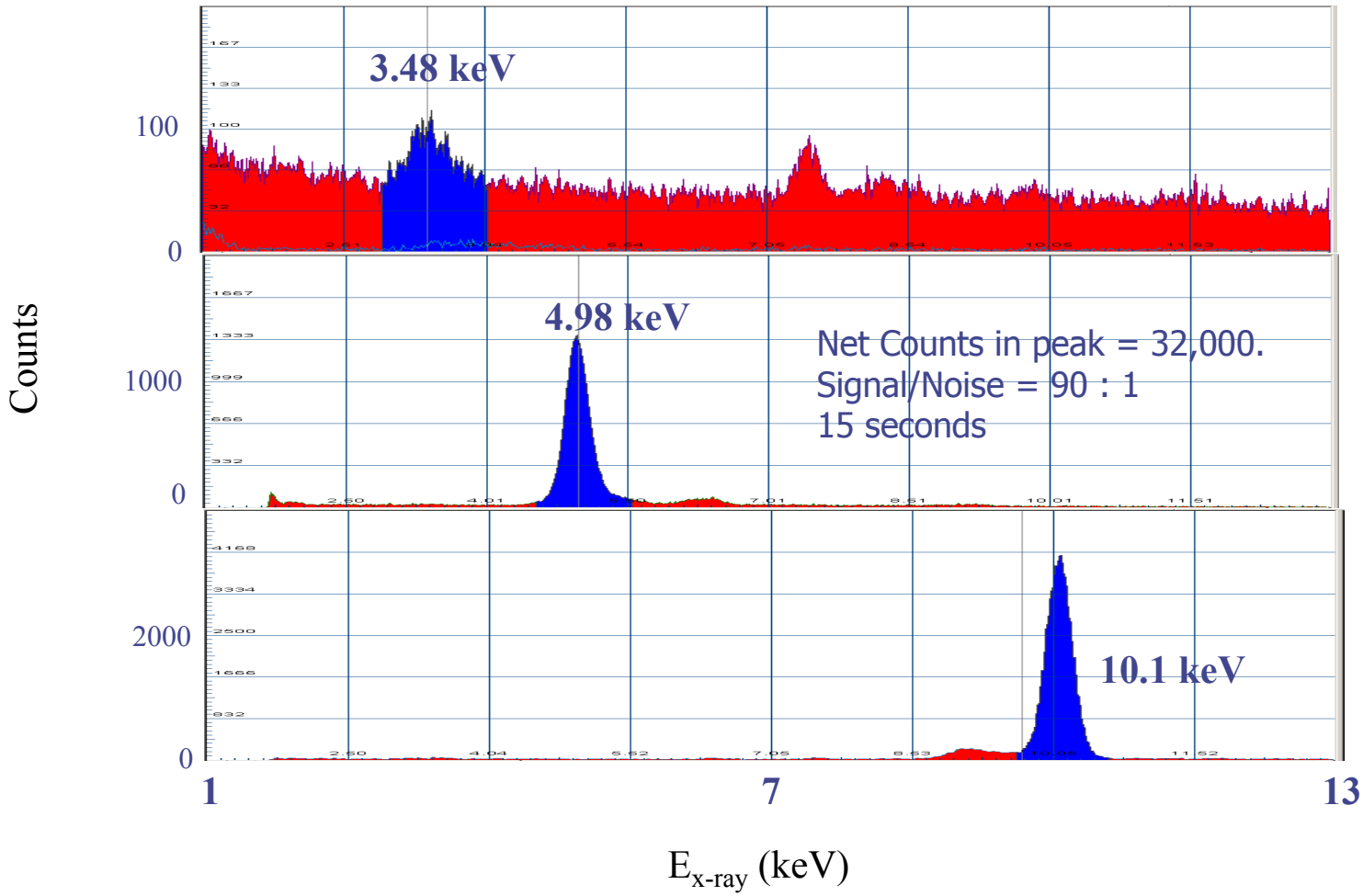


$$\sigma_{bunch} = \frac{FWHM}{2.354} = 89.2\ \mu m$$

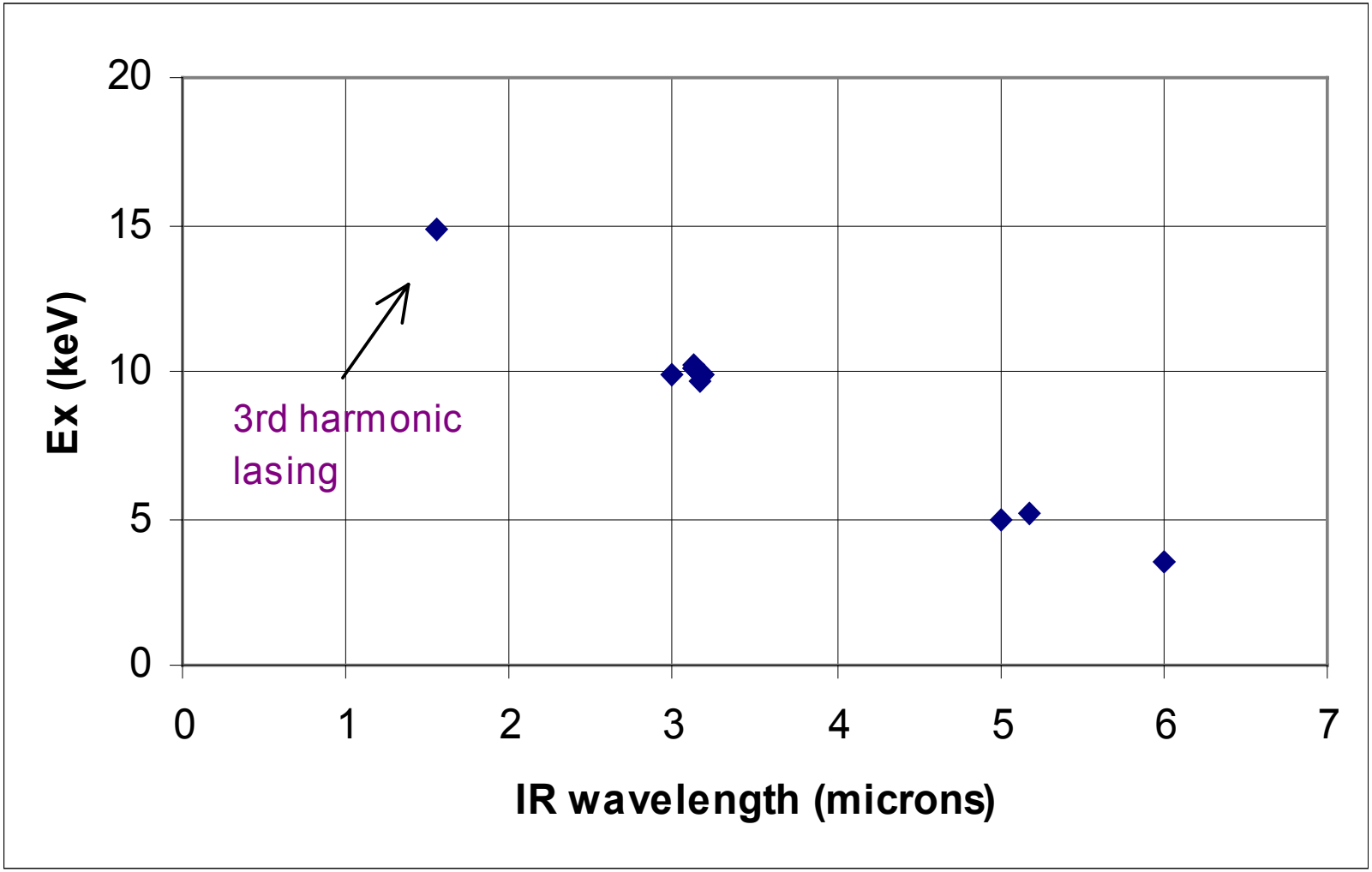
$$\frac{\sigma_{bunch}}{c} = 298 \times 10^{-15}\ sec$$

300 fsec

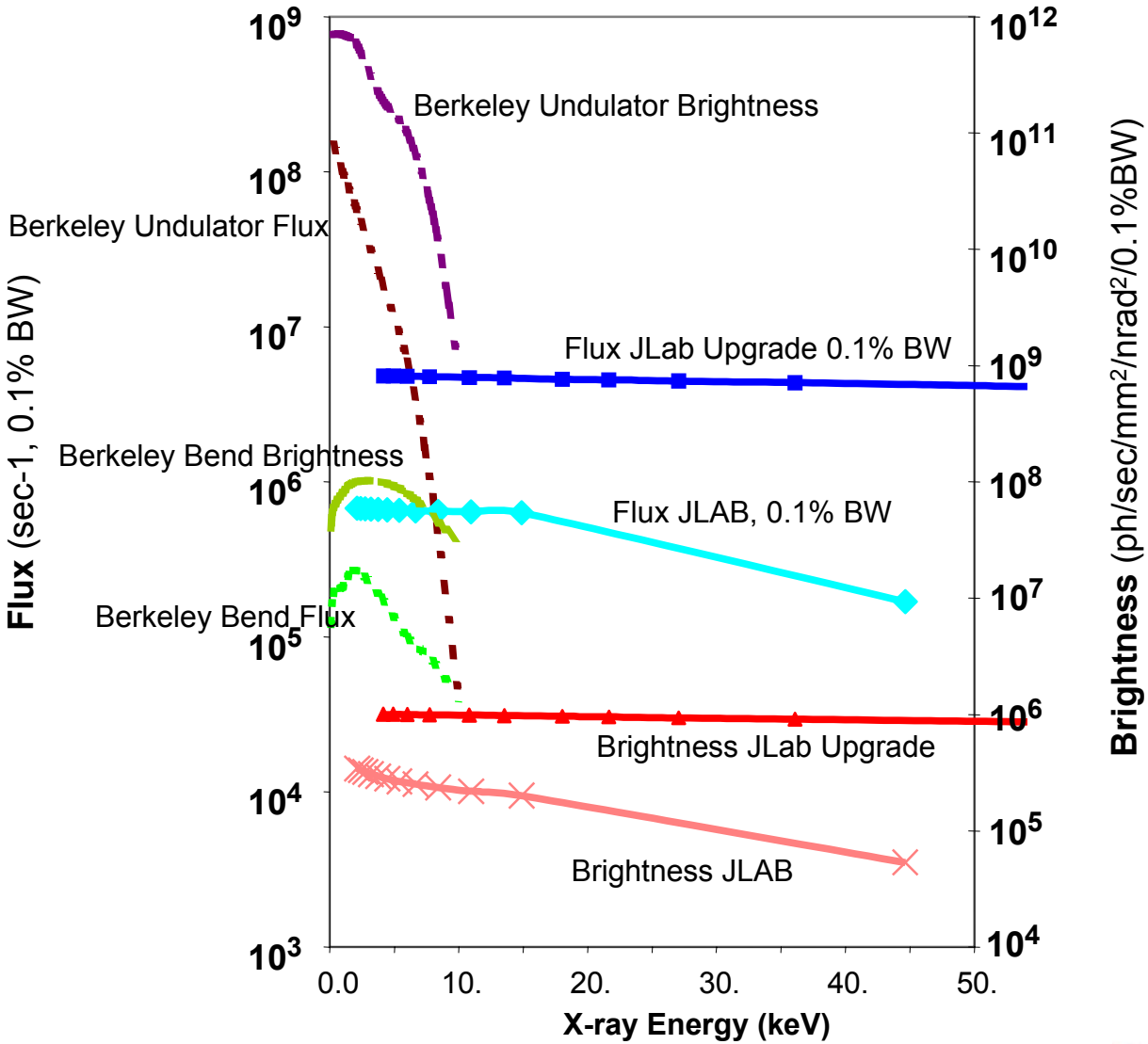
Actual Typical spectra



Measured X-rays



Present FEL vs FEL Upgrade (2002)

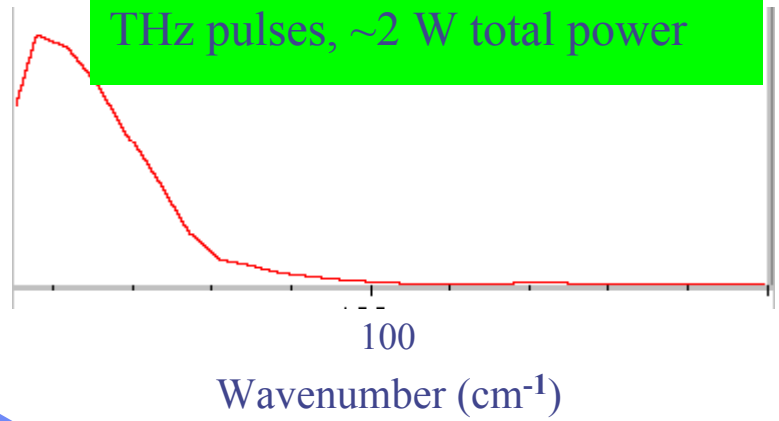


Simultaneous production of THz, 3 micron, and 10 keV X-rays

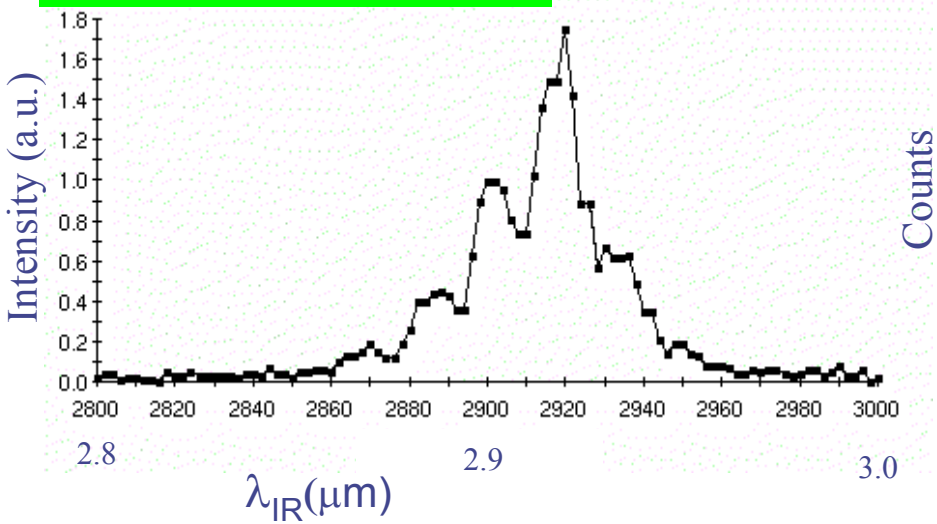
- Picosecond pulses at 37.4 MHz
- Synchronized to femtosecond levels

Sample

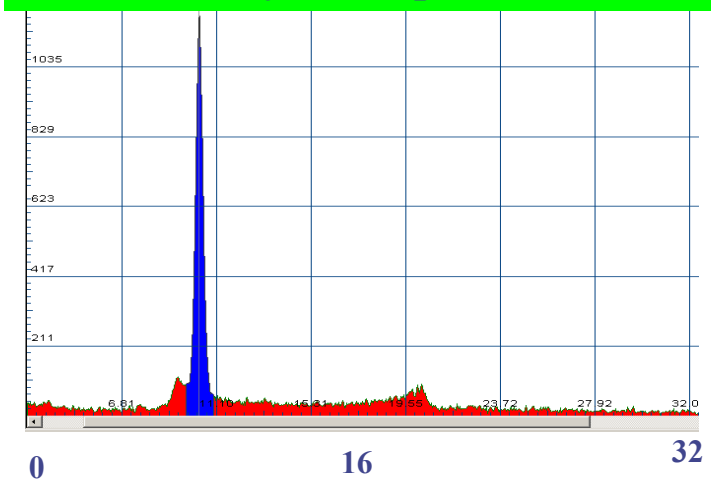
THz pulses, ~2 W total power



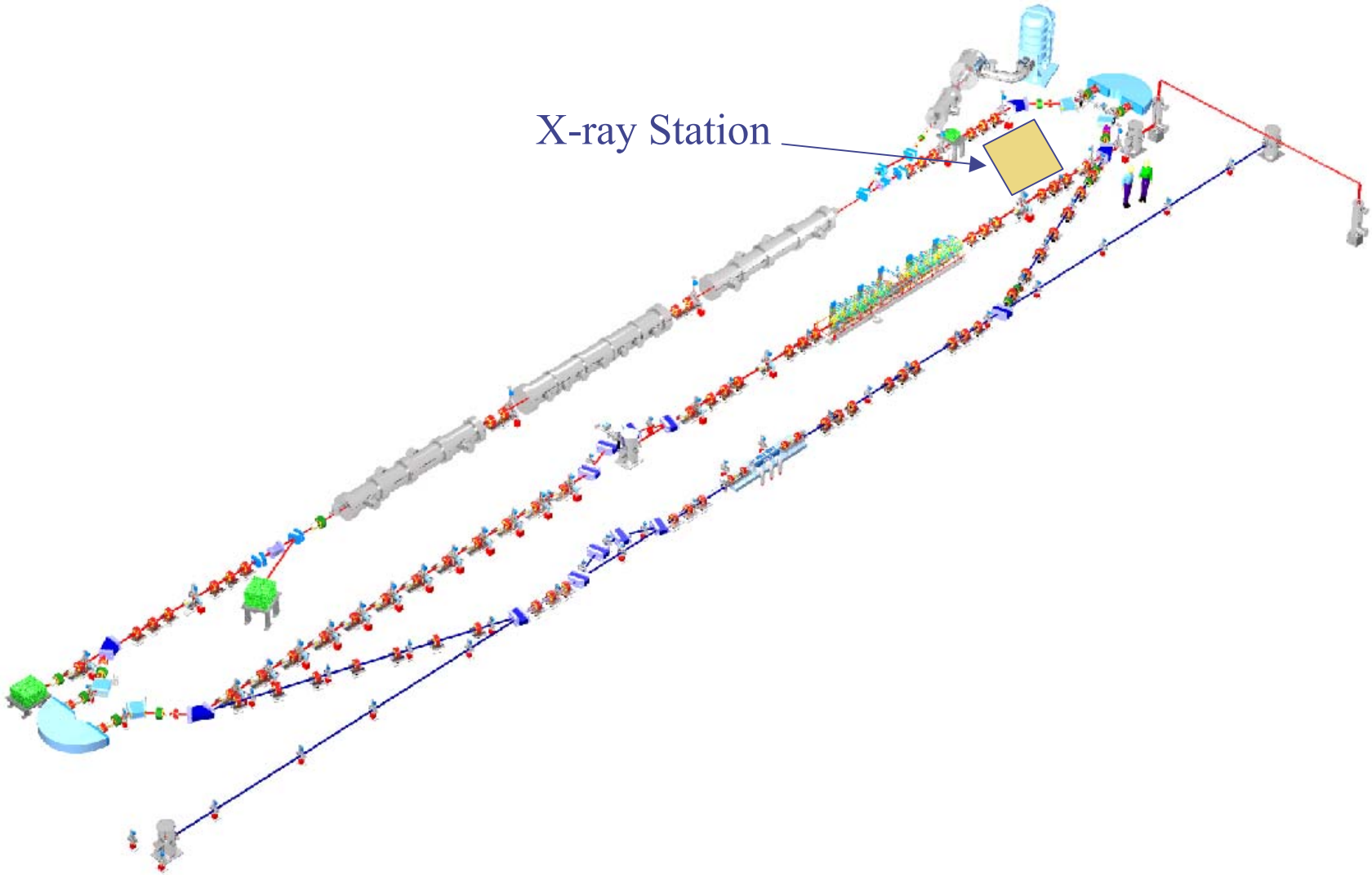
3 micron lasing >1 kW



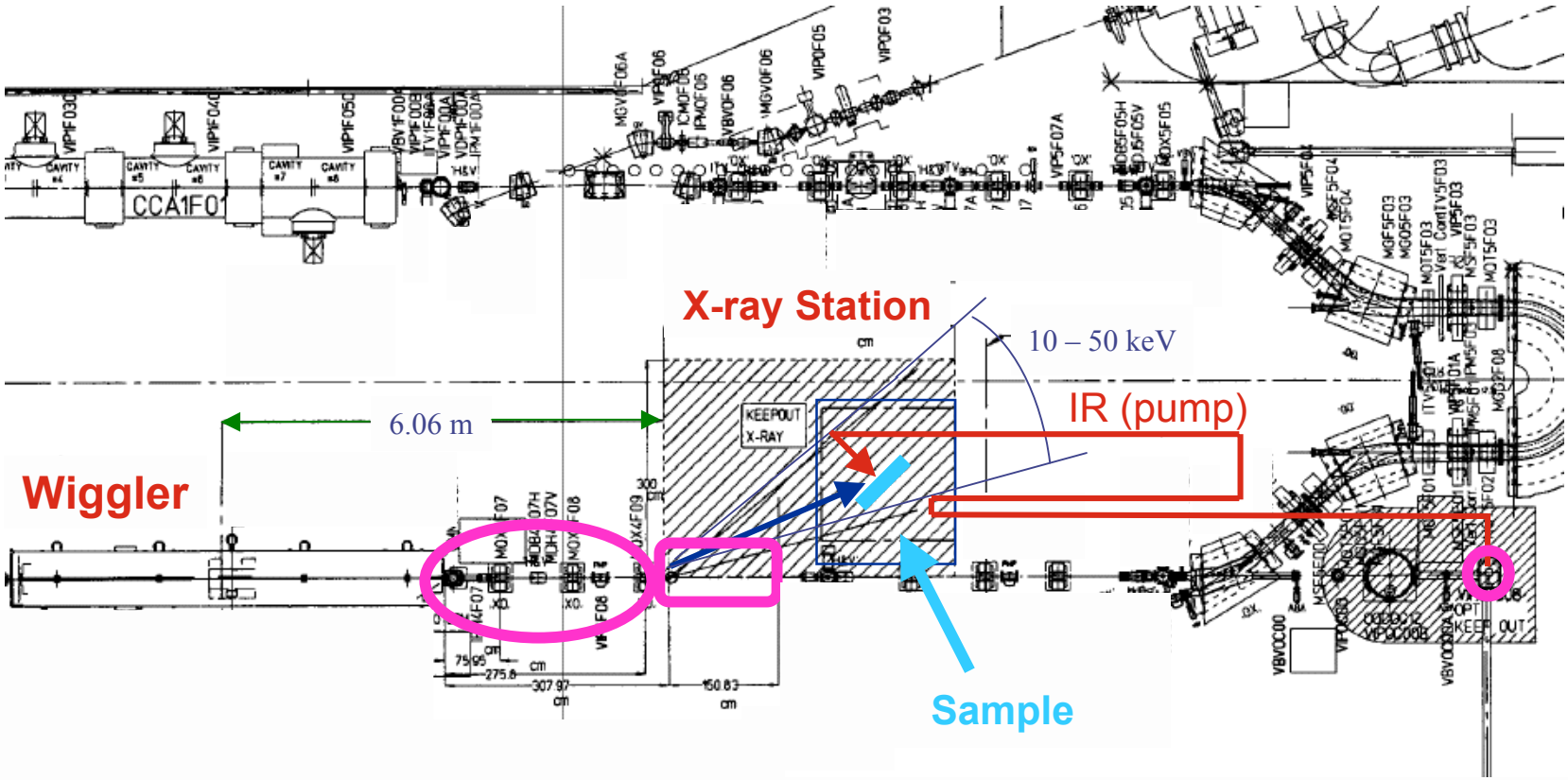
10 keV X-ray > 10^5 ph/sec/0.1% BW



FEL Upgrade X-ray Station



Proposed X-ray Station for Users



Research & Collaborations

Potential Fields of Research

- Solid State Physics/Material Science
  - -Temporal dynamics of condensed matter phase transitions
  - - Monitoring structural changes in materials with ultra-fast time resolution
  - - Heat propagation at sub-micron dimensions
- Biology & Chemistry
  - - Short-range order changes in chemical reactions
- Fast X-ray detectors

Collaborations

Solid State Physics/Material Science
-University of Georgia (Prof. Uwe Happek)

Biology & Chemistry
-East Carolina University (Prof. John Sutherland)

Invitation

- We invite anyone interested in ultra fast phenomena to partner with Jefferson Lab in the exploration of this new field of science.

Summary

Jefferson Lab FEL was high flux source of short pulse X-rays

IRDEMO X-ray source:

- Signal to noise ratio ~ 90:1
- X-rays time correlated with IR
- Tuneable from 3.5 keV to 18 keV
- X-ray bunch length is ~ 300 fsec long
- $>10^{10}$ X-rays/sec at 75 MHz (2 kW)

Future:

- Incorporating X-ray capabilities into FEL upgrade design
  (X-rays 10 to 50 keV)
- IR-X-ray pump-probe station (now in design stage)

FEL X-ray Team & Contributors

(alphabetical)

- George Biallas
- Steve Benson
- Jim Boyce
- Dave Douglas
- Fred Dylla
- Phillip Folk (RPI)
- Archie Fripp (NASA – ret.)
- Uwe Happek (U. of GA)
- Kevin Jordan
- Geoff Krafft
- Stan Majewski
- Lia Merminga
- George Neil
- Michelle Shinn
- Tim Siggins
- Richard Walker
- Gwyn Williams

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