Status of Thomson X-ray Program

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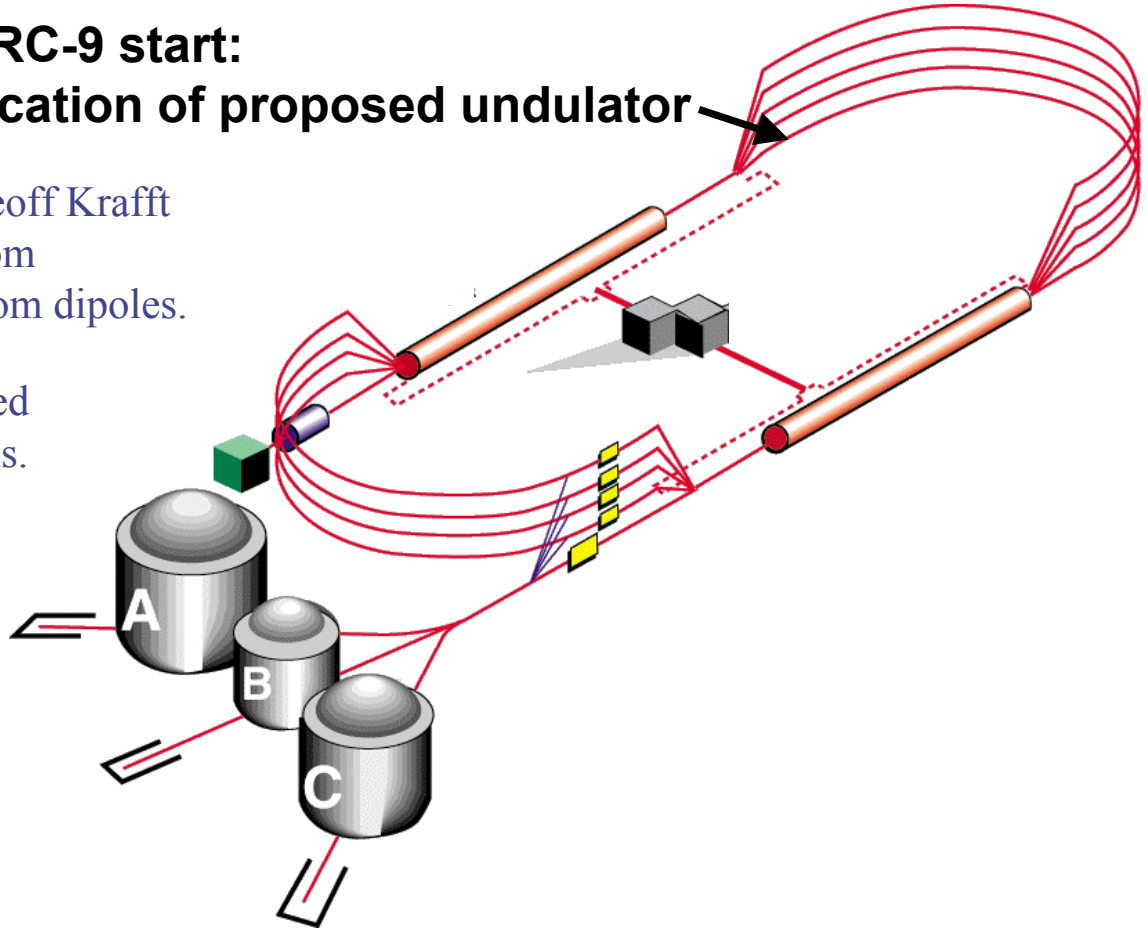
Outline

- High brightness x-rays from CEBAF accelerator
- Pump-probe possibilities with Upgrade FEL
- “Two color” Thomson X-ray source

CEBAF x-rays

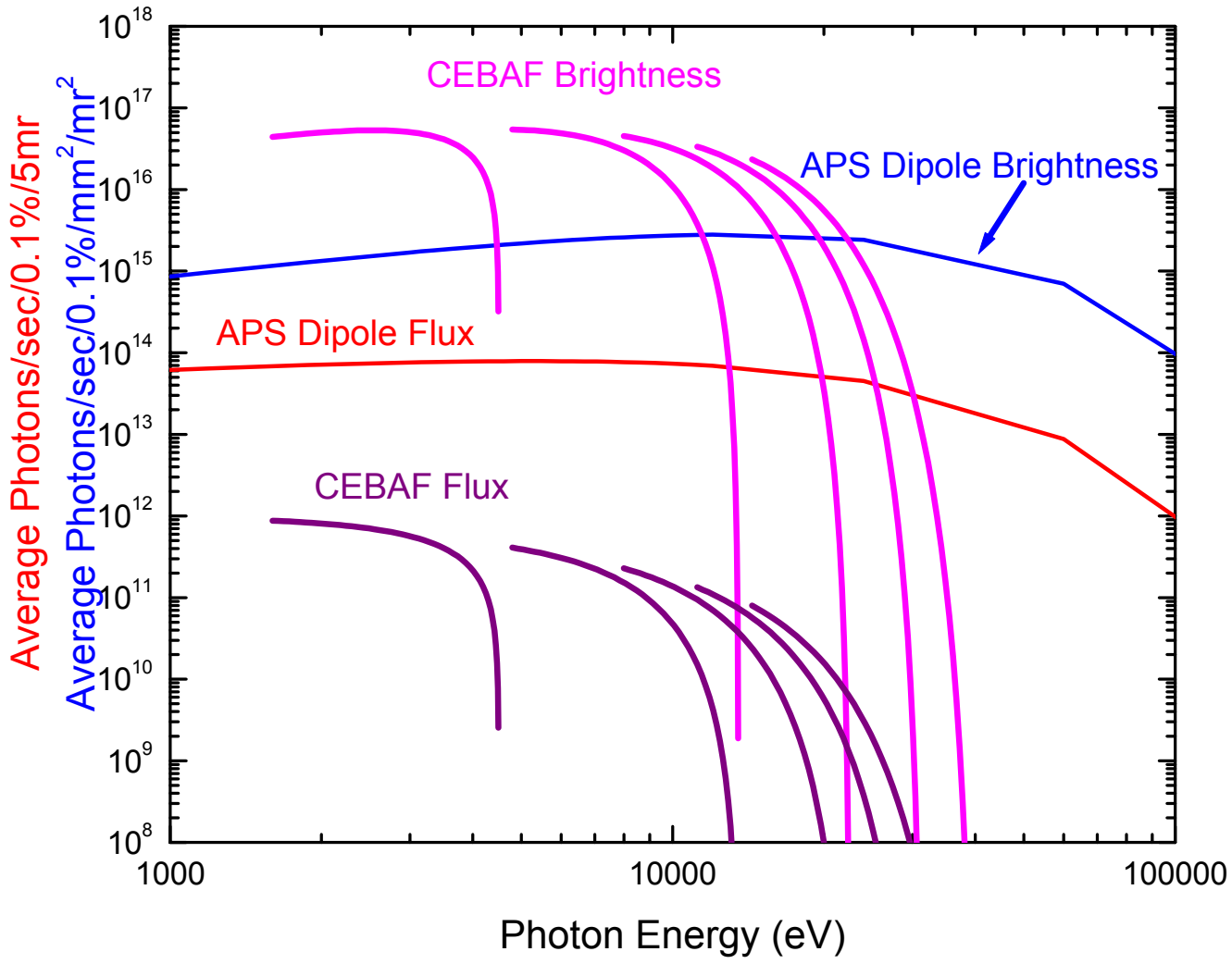
ARC-9 start:
location of proposed undulator



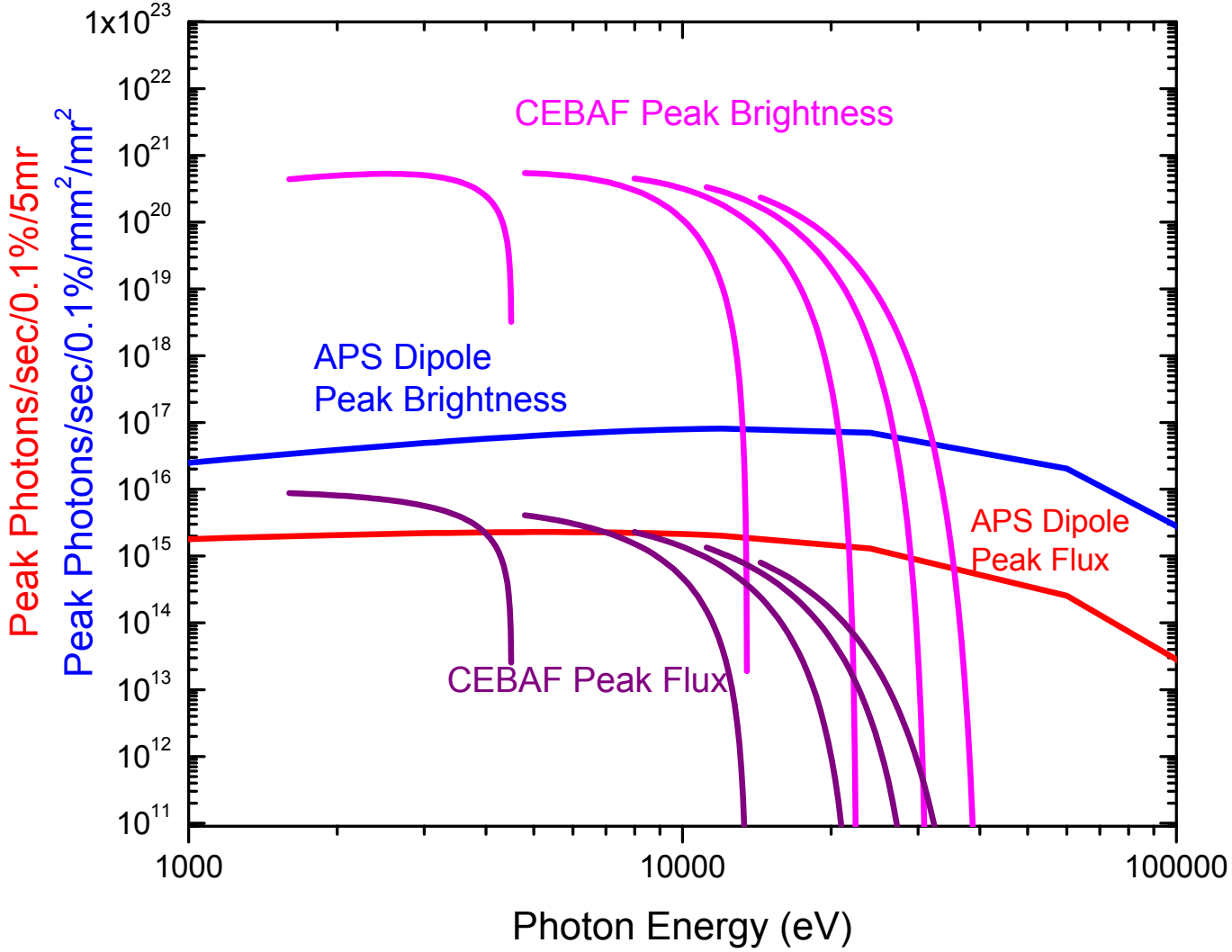
- 1999 PAC paper by Geoff Krafft calculated brightness from synchrotron radiation from dipoles.

- 2003 white paper added undulator to calculations.

Calculated Average Brightness & Comparisons

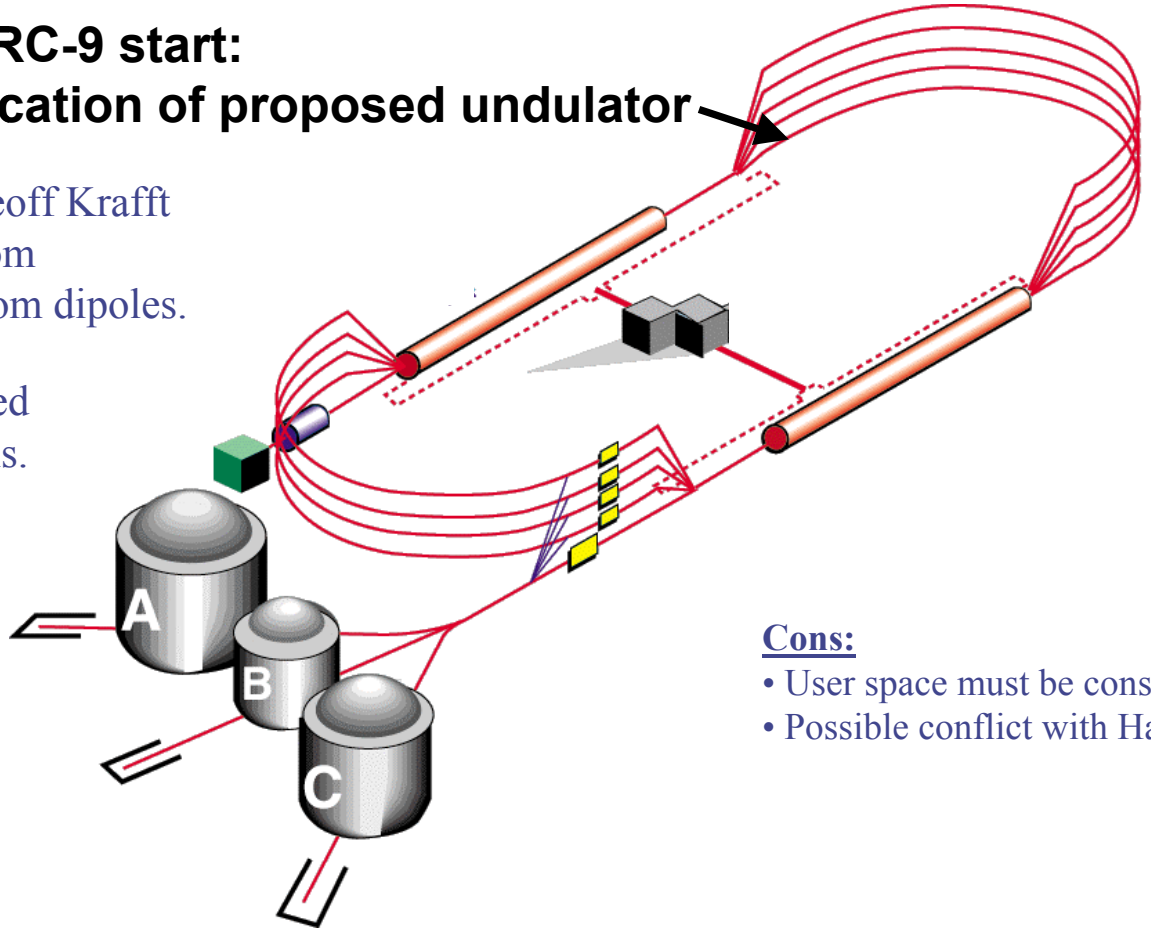


Calculated Peak Brightness & Comparisons



CEBAF x-rays

ARC-9 start:
location of proposed undulator



• 1999 PAC paper by Geoff Krafft calculated brightness from synchrotron radiation from dipoles.

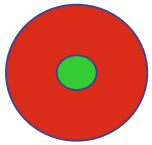
• 2003 white paper added undulator to calculations.

Pros:
• High brightness
• fsec x-rays
• don't have to wait, e.g., for lcls
• Possible pump probe w/ FEL (this is a stretch!)

Cons:
• User space must be constructed.
• Possible conflict with Hall D.

Status: On hold. Not included in any photon science proposals.

Pump-probe possibilities with Upgrade FEL



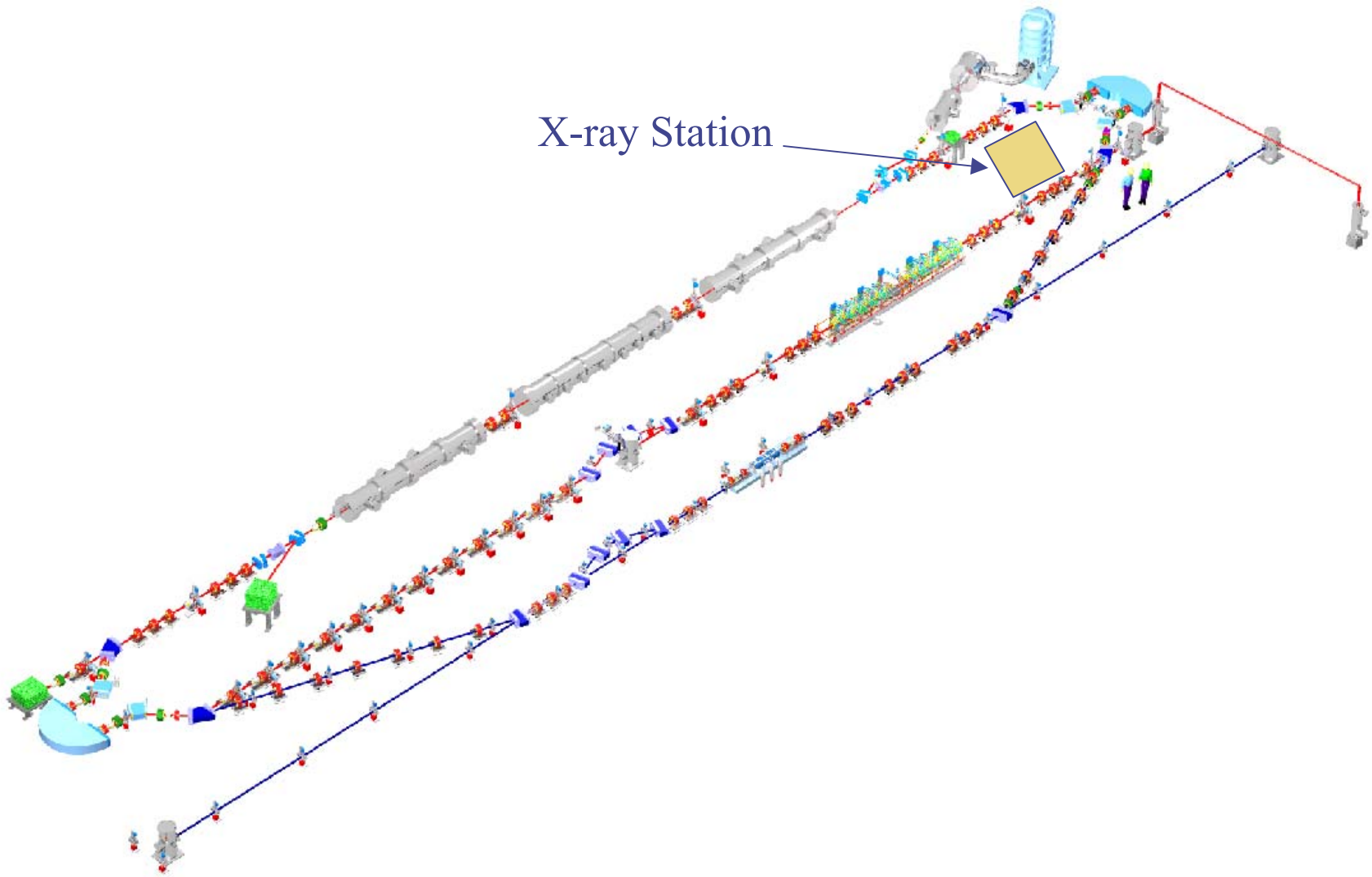
IR(intra-cavity) ~ 10 x IR (extracted)

IR/e-beam overlap limited.

IR can be focused to e-beam spot
minimum e-beam size is 200 μm.

Conclusion: Intra-cavity flux = 2.5 x Outside flux.

FEL Upgrade X-ray Station



Pump-probe program summary

Collaboration:

LLNL

Fred Hartemann
Winthrop Brown

JLab

Jim Boyce
Dave Douglas

Columbia University

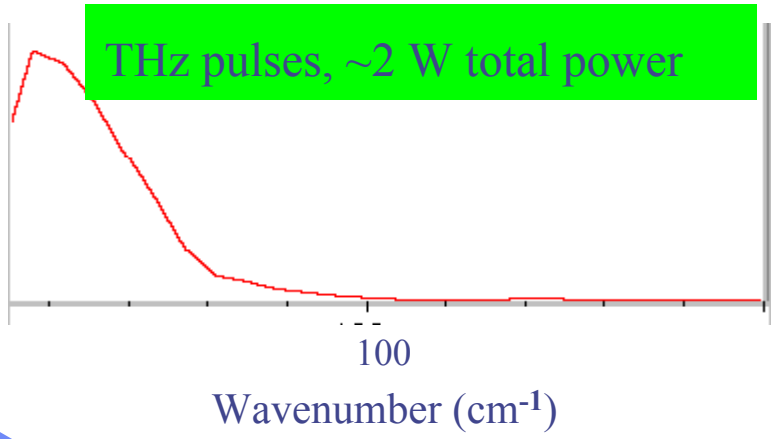
Wayne Hendrickson
Joseph Lidestri

Paper submitted to SRI 2003

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

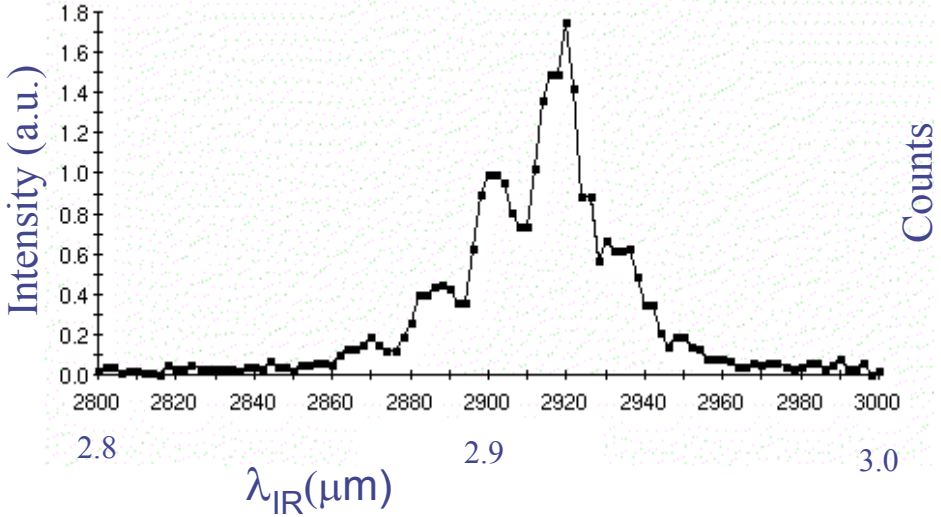
- Picosecond pulses at 37.4 MHz
- Synchronized to femtosecond levels

THz pulses, ~2 W total power

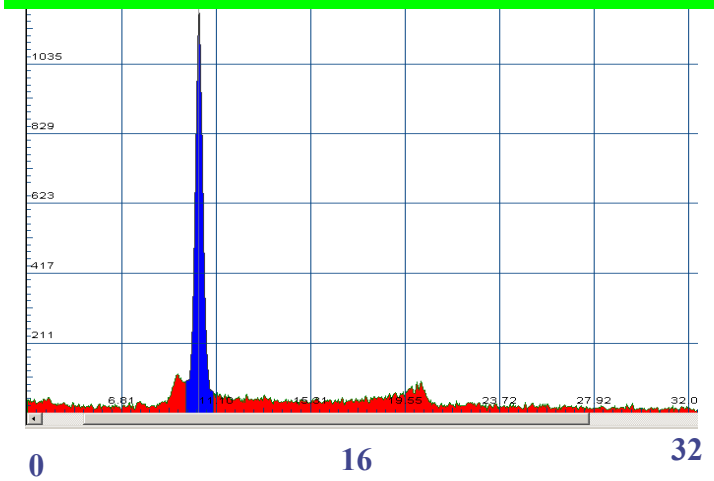


Sample

3 micron lasing >1 kW



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



"Two color" Thomson X-ray source

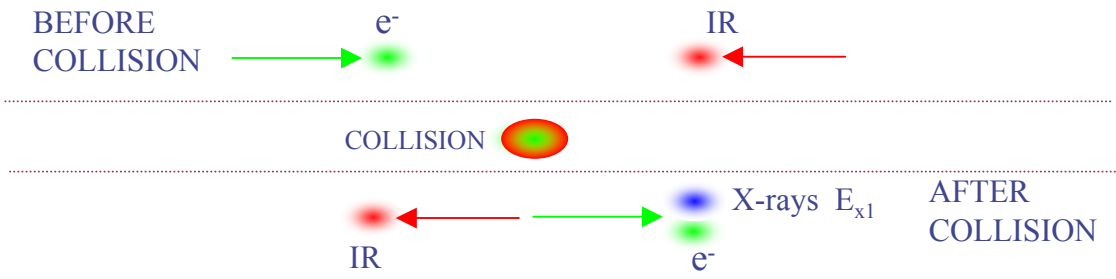


Fig. 1. "Standard 180° Thomson Scattering. X-rays produced are traveling with electron bunch after IR scatters off electrons at interaction region.

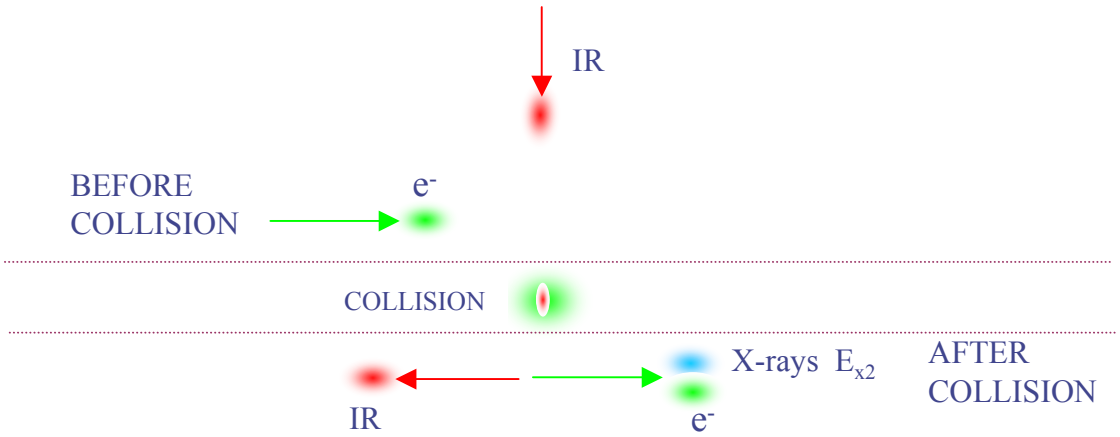


Fig. 2. "Standard 90° Thomson Scattering. X-rays produced are traveling with electron bunch after IR scatters off electrons at interaction region, but with $E_{x2} \approx \frac{1}{2} E_{x1}$.

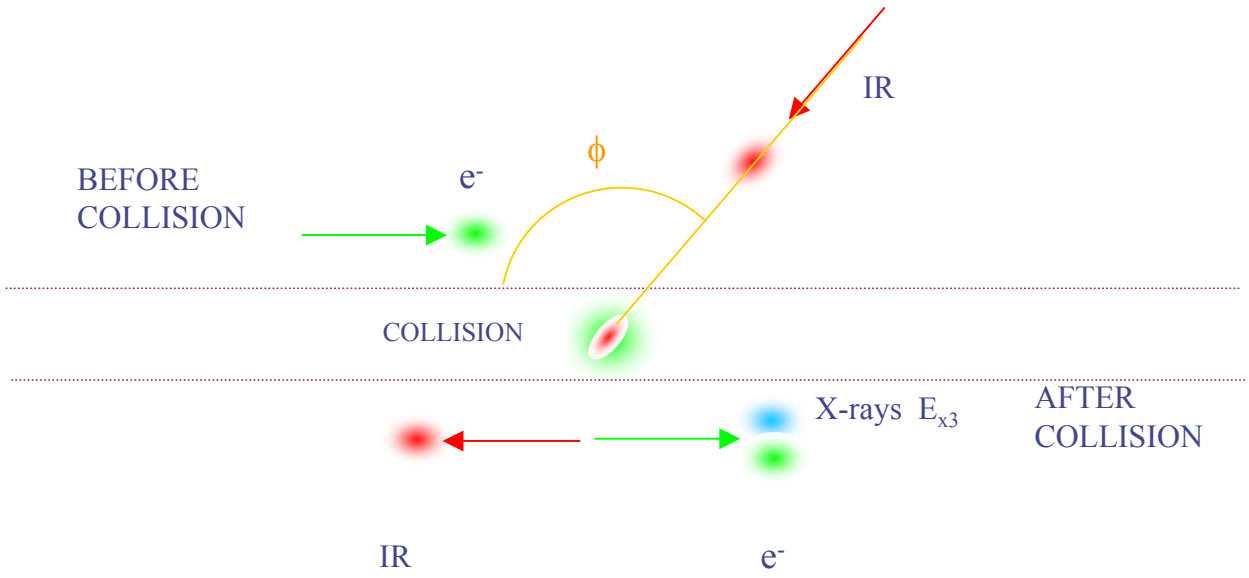


Fig. 3. Thomson Scattering through an angle ϕ. X-rays produced are traveling with electron bunch after IR scatters off electrons at interaction region, but with

$$E_{x3} = E_{x1}[\cos(\phi)+1/\beta].$$

Simultaneous Thomson x-rays

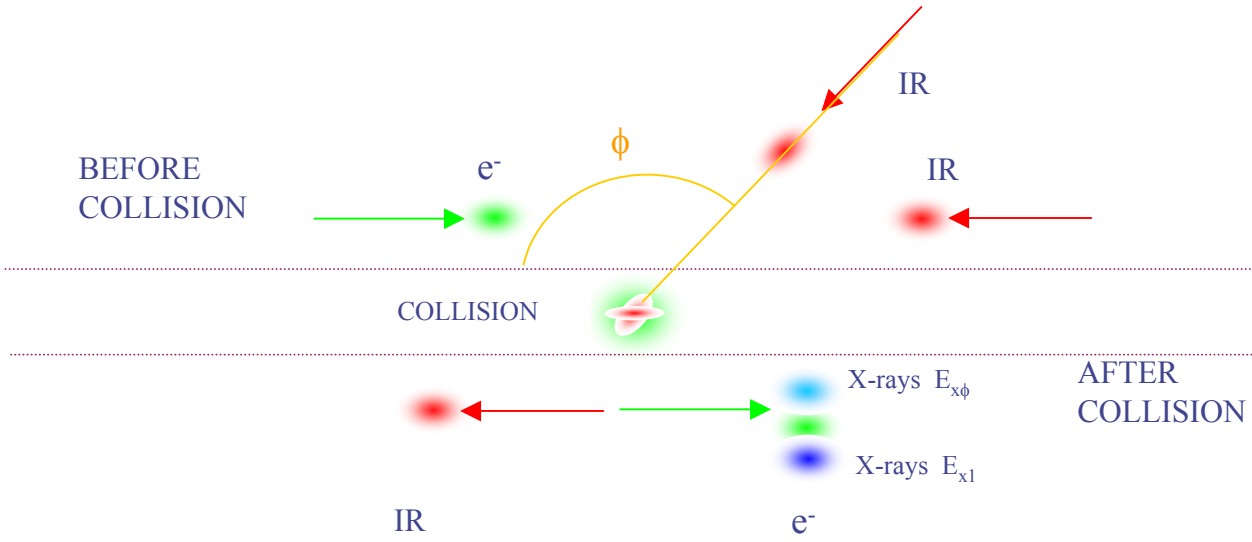


Fig. 4. Simultaneous Thomson Scattering with IR at an angle ϕ AND "head-on". X-rays are produced at two different energies and are traveling with electron. The lower energy x-rays are tuneable since the angle ϕ can be independently varied using suitable IR optics.

Controling arrival times between x-ray bunches

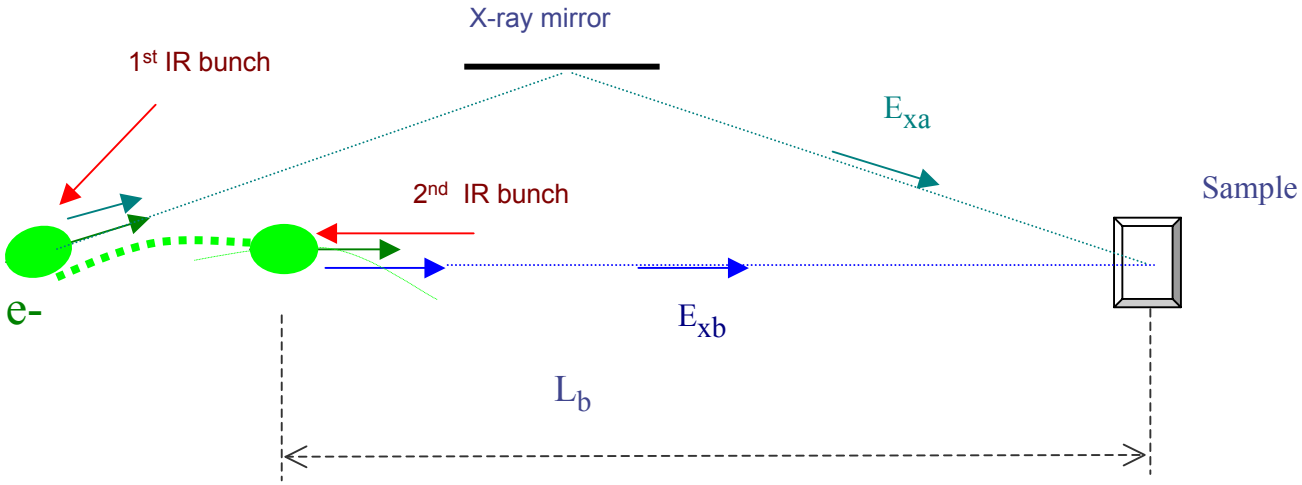


Figure 6: The time difference between the two x-ray bunches can be varied by changing the path length difference the two x-rays travel.

Acknowledgements

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