Potential Users

Materials Research and Chemistry

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Topics

- New source photon beam properties
- Potential “transformational” applications
  - Chemistry (very brief)
  - Materials Research
  - Science of “Applied” materials

Relevant parameters of new sources

	Bunch length	Trans. Coherence
3rd Gen	~100 ps	small
ERL	<100 fs	~1
FEL	~ 10 fs	1

Assume no optics or detector limitations
Ignore rep rate and longitudinal coherence;
Photons/pulse highest for FEL

Applications

- The new x-ray beams are very different from
- Extrapolations from 3rd generation facility experience are necessary but inherently short sighted
- Science cases for the new sources give the best “view” of potential

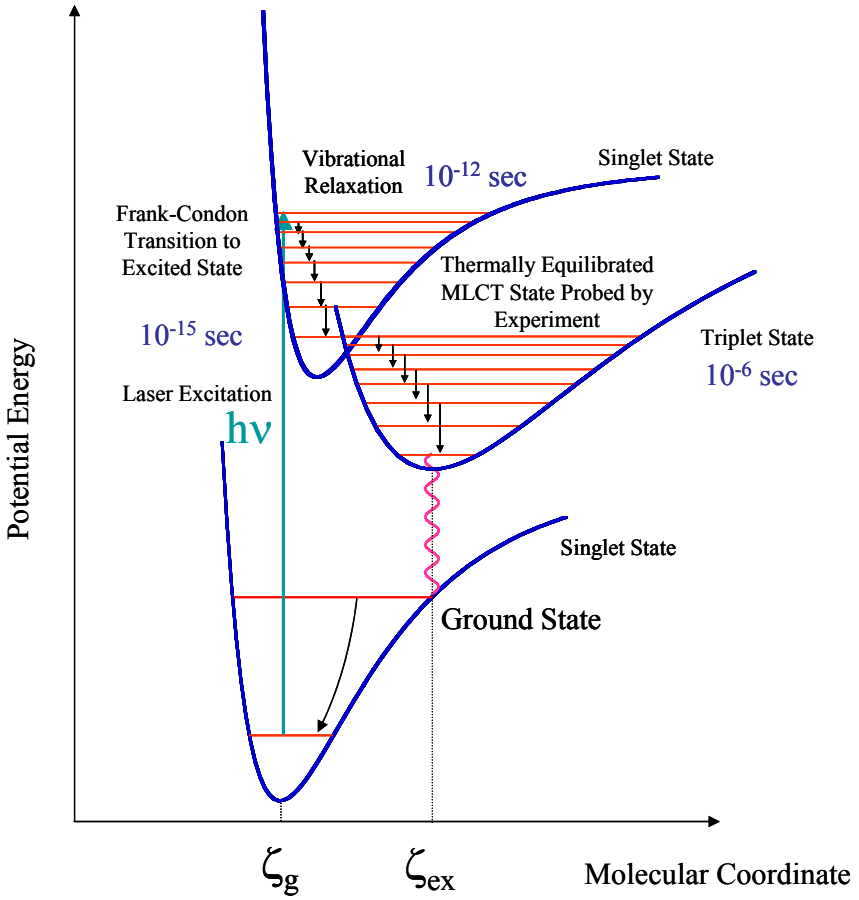
Chemistry

- Femtochemistry: understanding the pathways in chemical reactions
- Atomic motion/charge redistribution over short distances
- Photons/bunch & bunch length relevant

3rd generation experience:
Early < 100ps redistributions
not observable

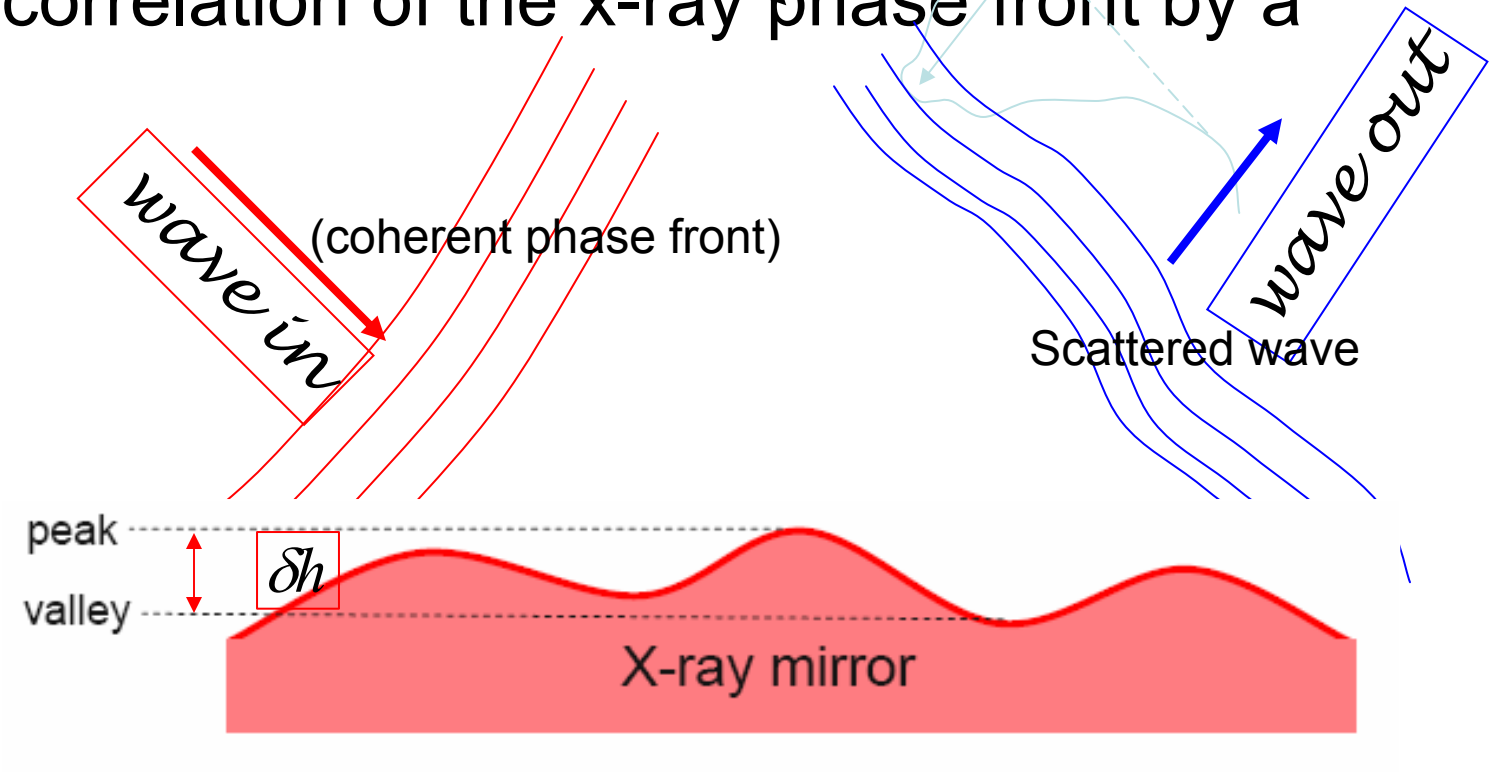
Time-resolution determined
in simplest case by pulse length

Common denominator is a series
of related problems extending to
biochemistry



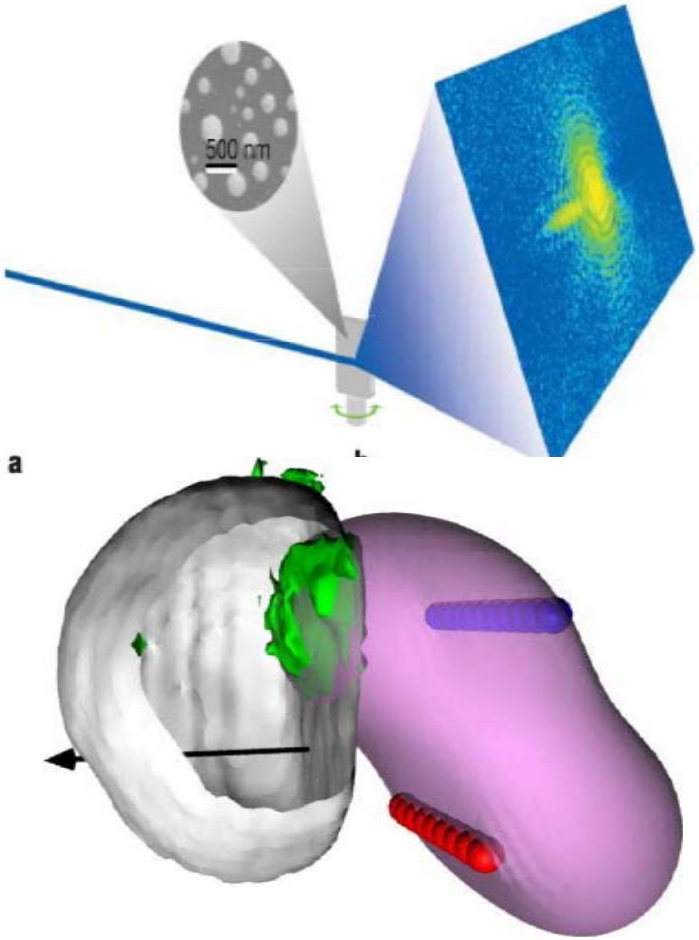
Material Science

- Coherence
  - The alteration of the nearly perfect 2-D spatial correlation of the x-ray phase front by a



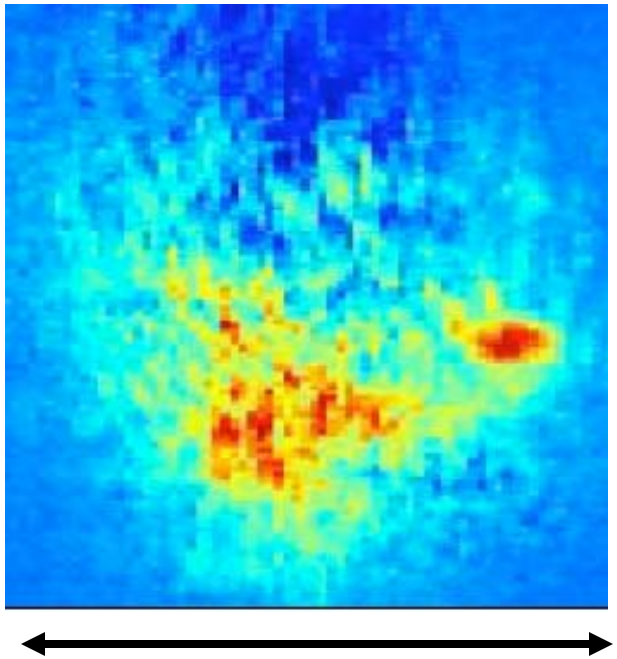
Science needing High Coherence Flux

Defects Inside a Nanocrystal



M.A. Pferferet al., Nature*442, 63 (2006)*

Speckle Resolution



$\Delta Q \sim 10^{-2}$ Å^{-1}

Resolution ~ $\pi/\Delta Q$ ~ 50 nm

G. K. Shenoy slide

Coherence

- Nano beams (with lots of photons) require coherent incident beams
  - X-ray nano probes (including 3-D nano ARPES) promise to provide relevant and unique information in the nanoscale area
    - Mechanical properties in nano machines
    - Single filament nano systems
    - Nano-nano boundries
    - Nano structure and properties
    - Quantum dots

Coherence

- Static imaging
  - Diffraction imaging will make a significant impact in understanding complex real materials (nano inclusions, polymers, glasses and disordered systems, etc.)
- Time resolved (photon correlation spectroscopy and related techniques)
  - Will provide relevant and unique dynamical information of complex systems
- A combination of the two would be “transformational”
- 3-D angle resolve photoemission (3D-ARPES)

Coherence-Static and Dynamic Probes

- The development of applied materials is making a huge leap forward
  - Resurgence of small scale
    - semiconducting systems
    - (nano) wires
    - Magnetic / ferroelectric devices
    - Interconnects

- We can make them but in most cases we don't understand the fundamental mechanisms governing the formation and function. We are still "cooking".
  - Quantum dots (they are really nano dots)
  - Self assembly of nano particles with properties not expected from "classical" matter concepts
  - Thin film systems of all kinds: ferroelectrics, CMR, mixed ferroelectric magnetic
  - Porous materials and nano confined liquids/nano particle flow
  - Composite polymer/nano particles
  - Organic electronics
  - Quantum entanglement in quantum dot like systems

- **A combination of the next generation static and dynamic probes/ techniques will enable fundamental understanding of this state of matter and focus the development to more efficient paths.**