

APS Upgrade Update

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APS Stakeholders Meeting
26 August 2013

BESAC Future Light Sources Review, July 2013

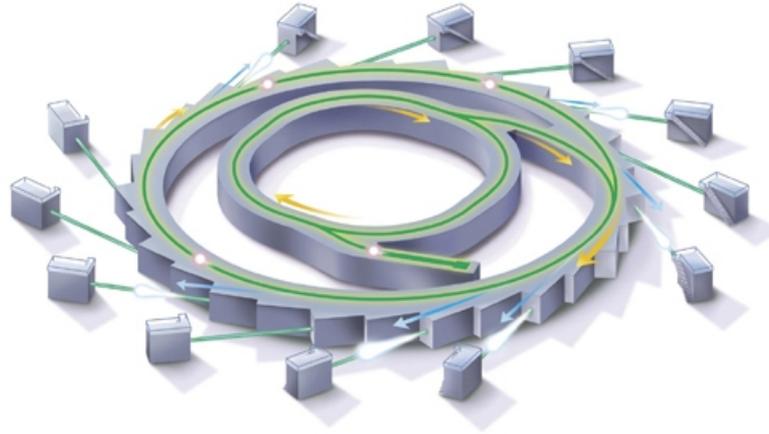
BESAC Light Sources Charge

- January 2, 2013– Bill Brinkman charged BESAC to provide advice on the future of photon sources and science, which will require formation of a panel of experts and a workshop and will consider both new science opportunities and new photon source technologies in parallel. The specific charge includes:
 - Assessment of the grand science challenges that could best be explored with the current and possible future SC light sources.
 - Evaluate effectiveness of the present SC light source portfolio to meet these grand science challenges.
 - Enumerate future light source performance specifications that maximize the impact on grand science challenges.
 - Prioritized recommendations on which future light source concepts and the technology behind them are best suited to achieve these performance specifications.
 - Identify prioritized R&D initiatives to accelerate the realization of these future light sources in a cost effective manner.

- This BESAC report should be delivered by July 15, 2013.



Grand Challenge Science on Diffraction-Limited Storage Rings



A consensus report on future opportunities from scientists at

ALS, LBNL

APS, ANL

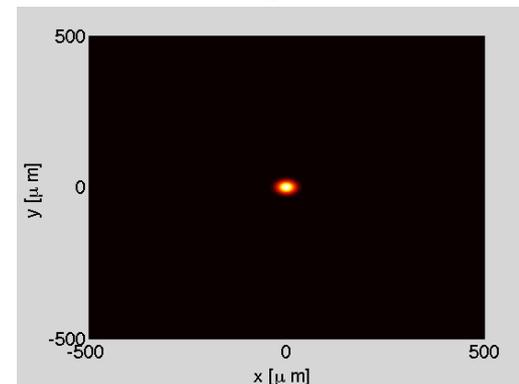
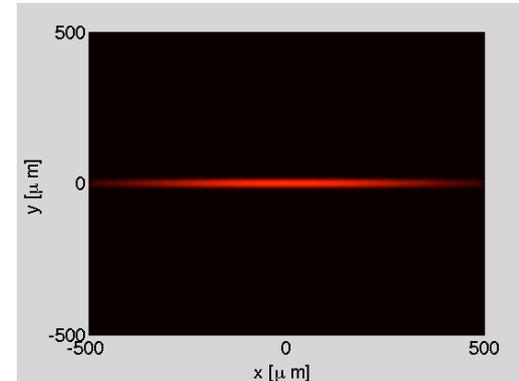
NSLS-II, BNL

SSRL, SLAC

together with a broad community of scientists
at laboratories and universities.

Recent Advances Enable Ultra-Bright Rings

- Storage ring light sources have not reached their practical limits of brightness and coherence.
- Dramatic improvements are on the horizon due to transformational advances in accelerator design.
- **What's Changed:**
 - Tightly-packed multi-bend achromat lattices via new magnet and vacuum technology.
 - Success of top-up, better understanding of storage ring scaling, advances in simulation, optimization, and alignment.
- **Outcome:**
 - High confidence that diffraction-limited rings are feasible.
 - International community is now upgrading existing facilities and building new facilities with diffraction limited capability that will enable new science.

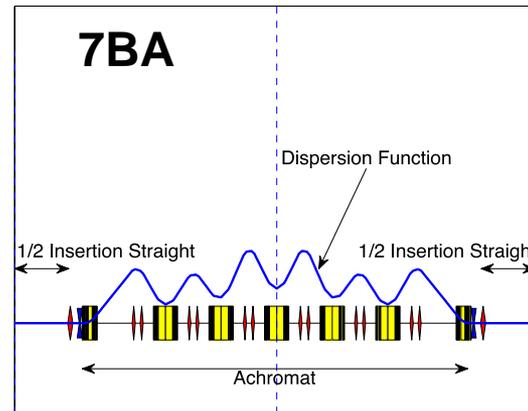
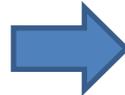
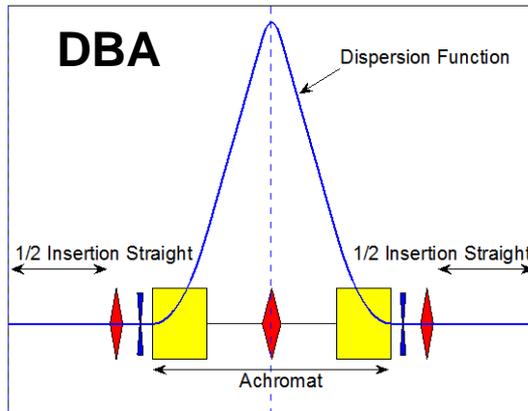


Multi-bend Achromats Pave the Way to the Diffraction Limit

Lattice design evolution from double- and triple-bend achromats (DBA, TBA) to multi-bend achromats: increase N_D .

$$\epsilon_x = C_L \frac{E^2}{N_D^3}, \quad \epsilon_x \underbrace{\propto}_{\text{Fixed } E} \frac{1}{C^3}$$

C_L = lattice constant
 N_D = # dipoles
 C = Circumference



Strong Focusing and Low Dispersion

First used for MAX-IV.

D. Einfeld *et al.*, Proc. PAC 95, Dallas TX



Multi-bend lattices are becoming a reality:

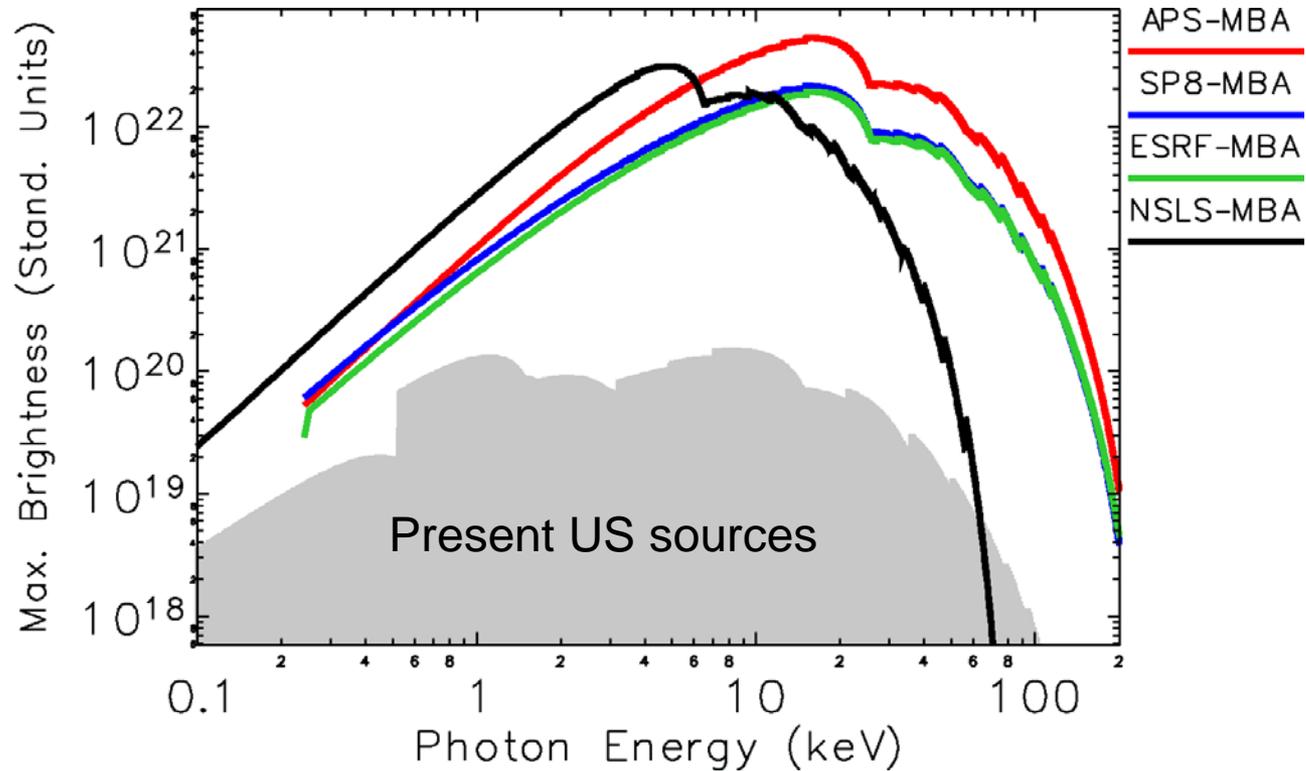
- MAX-IV (Sweden), pioneering, under construction
- Sirius (Brazil) just started construction
- Plans for ESRF (France), SPring-8 (Japan), BAPS (China), and SLS (Switzerland)

Findings of BESAC Future Light Sources Review (7/25/13)

- FELs: Recommend development of a high-rep-rate superconducting-linac-driven FEL with x-ray energy from 200 eV to 5 keV, multiple independently tunable lasers
- *Diffraction Limited Storage Rings and U.S. Storage Ring Upgrades:*
*At best the present plans for upgrades of U.S. storage rings will leave the U.S. behind the international community in this area of x-ray science. The Office of Basic Energy Sciences should ensure that U.S. storage ring x-ray sources reclaim their world leadership position. **This will require a careful evaluation of present upgrade plans to determine paths forward that will guarantee that U.S. facilities remain at the cutting edge of x-ray storage ring science.***



Opportunity for APS: World-Leading Brightness



MBA lattice offers major improvements in brightness, coherent flux needed for nanoprobe, coherent imaging and dynamics

We plan to work with DOE Office of Science and the scientific community to study incorporating an MBA lattice into the APS Upgrade and develop options for evaluation

