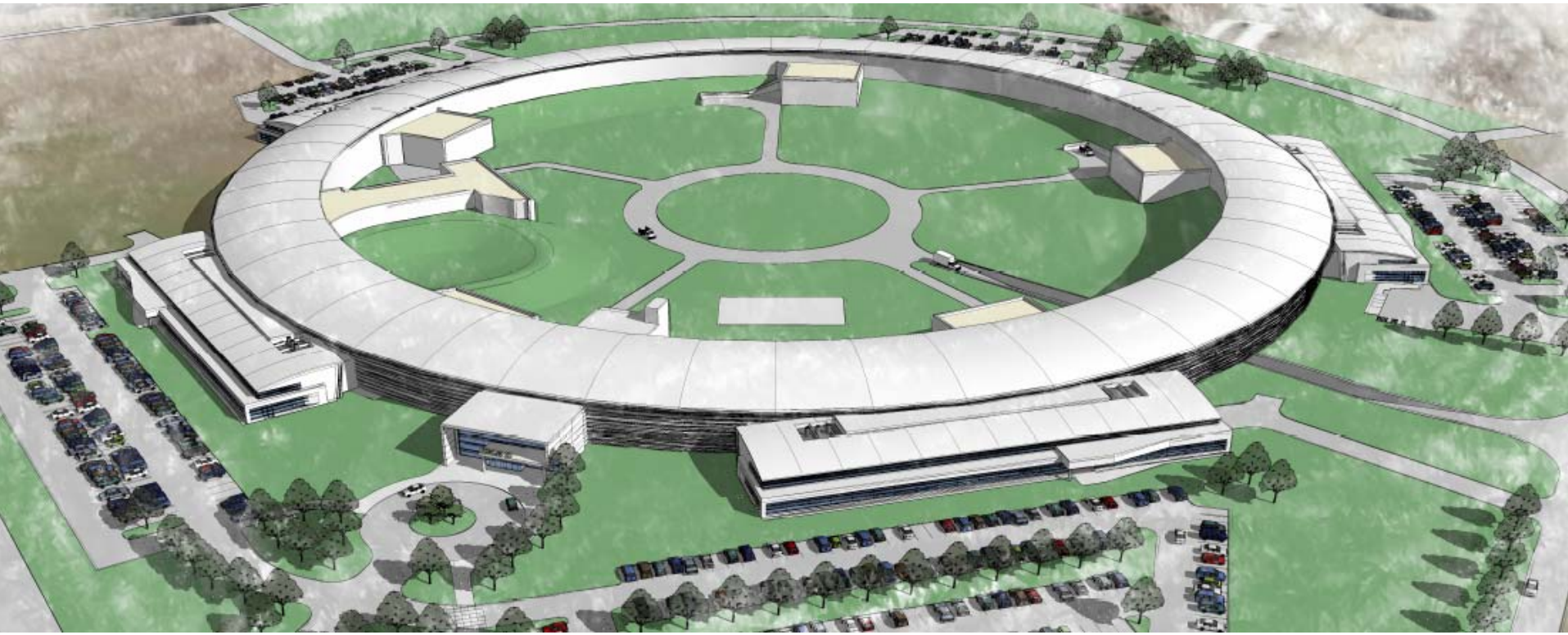
# NSLS-II Overview



John Hill
Experimental Facilities Division Director
NSLS-II
Chemical and Energy Sciences February 1st 2008

Office of Science
U.S. DEPARTMENT OF ENERGY



BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES

# NSLS-II Flyover

# NSLS-II Design

## Design Parameters

- 3 GeV, 500 mA, top-off injection
- Circumference 791.5 m
- 30 cell, Double Bend Achromat
  - 15 high-$\beta$ straights (9.3 m)
  - 15 low-$\beta$ straights (6.6 m)

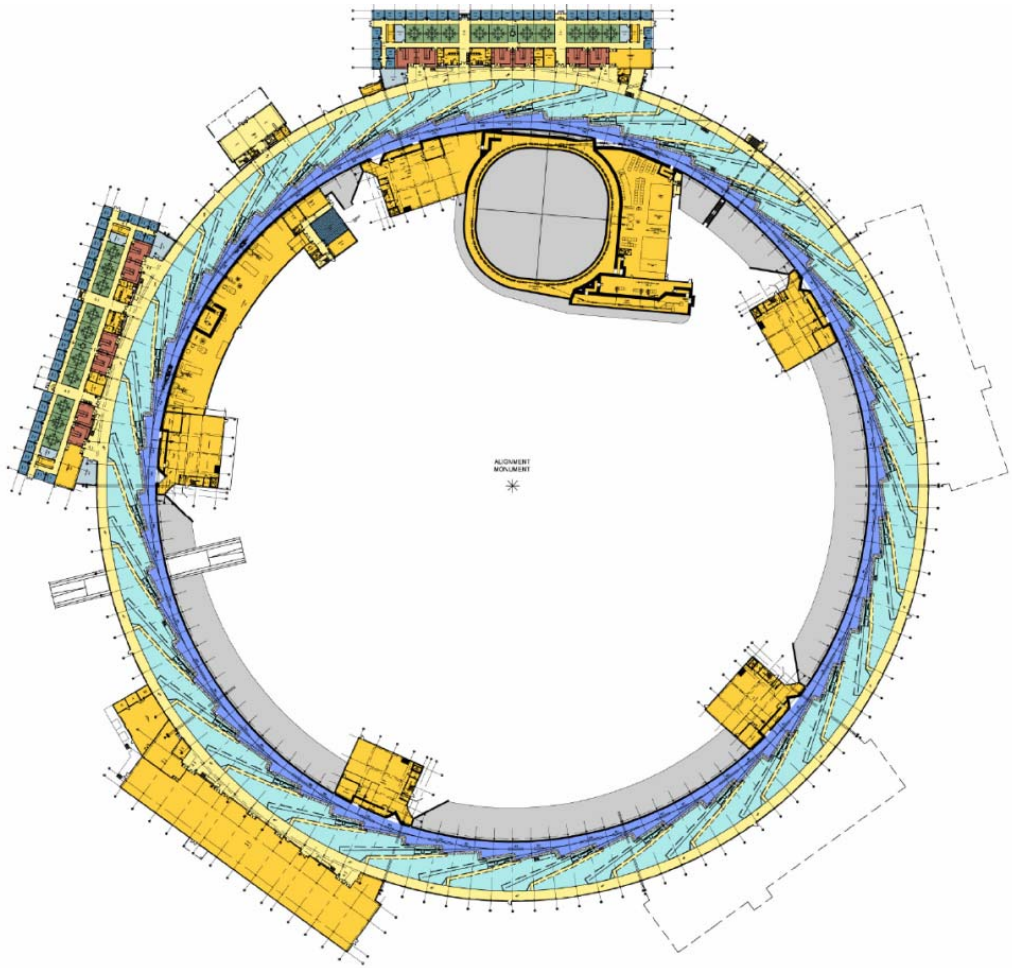
## Novel design features:

- damping wigglers
- soft bend magnets
- three pole wigglers
- large gap IR dipoles

## Ultra-low emittance

- $\varepsilon_x$, $\varepsilon_y$ = 0.6, 0.008 nm-rad
- Diffraction limited in vertical at 10 keV
- 2.6 $\mu$m x 28 $\mu$m (low-$\beta$)

## Pulse Length (rms) ~ 15 psec



# NSLS-II Beamlines

## 19 straight sections for undulator beamlines

- Fifteen 6.6 m low-$\beta$ and four 9.3 m high-$\beta$
- Highest brightness sources from UV to hard x-ray

## 8 straight sections for damping wiggler beamlines

- Each 9.3 m high-$\beta$
- Broadband high flux sources from UV to hard x-ray

## 27 BM ports for IR, UV and Soft X-rays beamlines

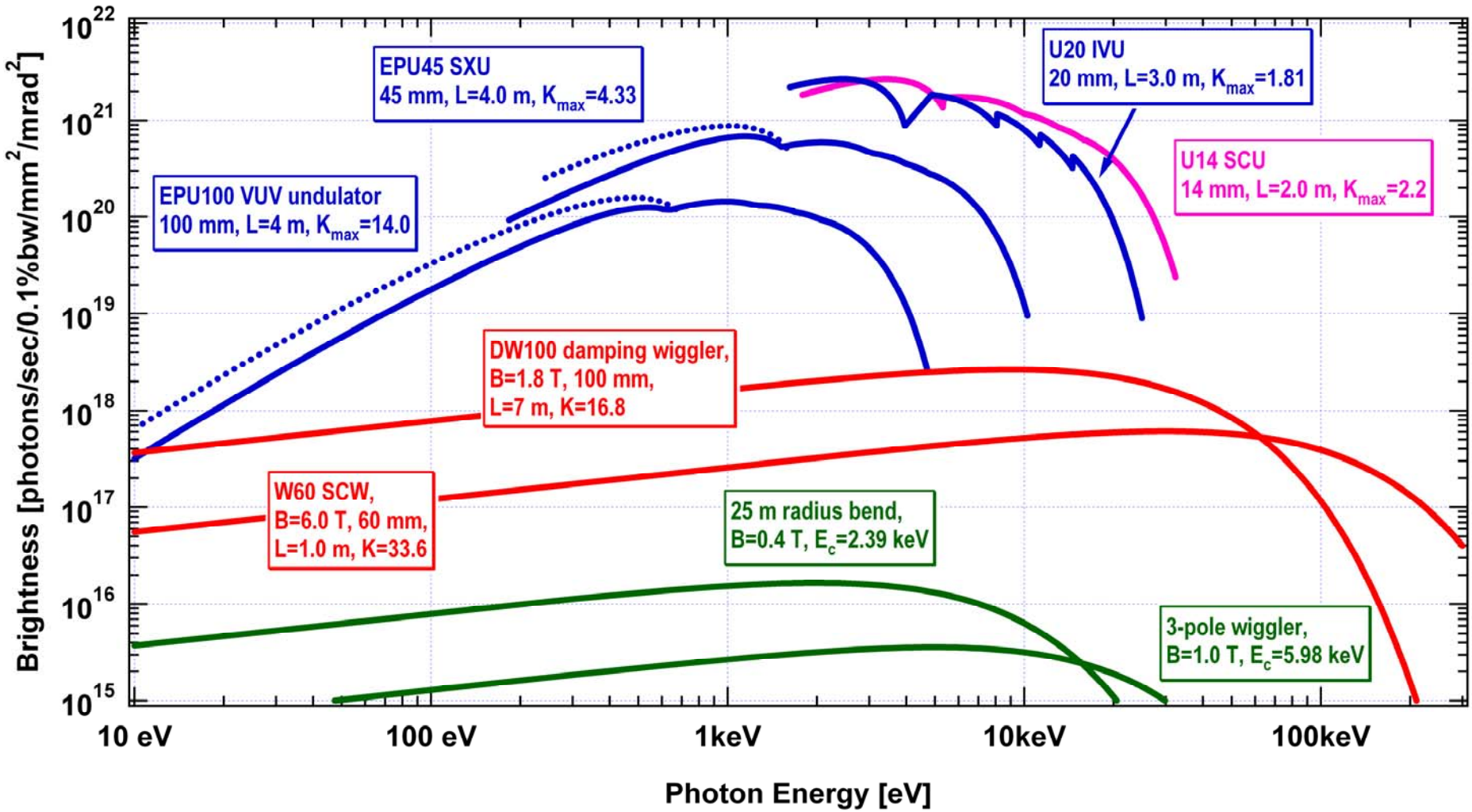
- Up to 15 of these can have three pole wigglers for hard x-rays

## 4 Large Gap BM ports for far-IR beamlines

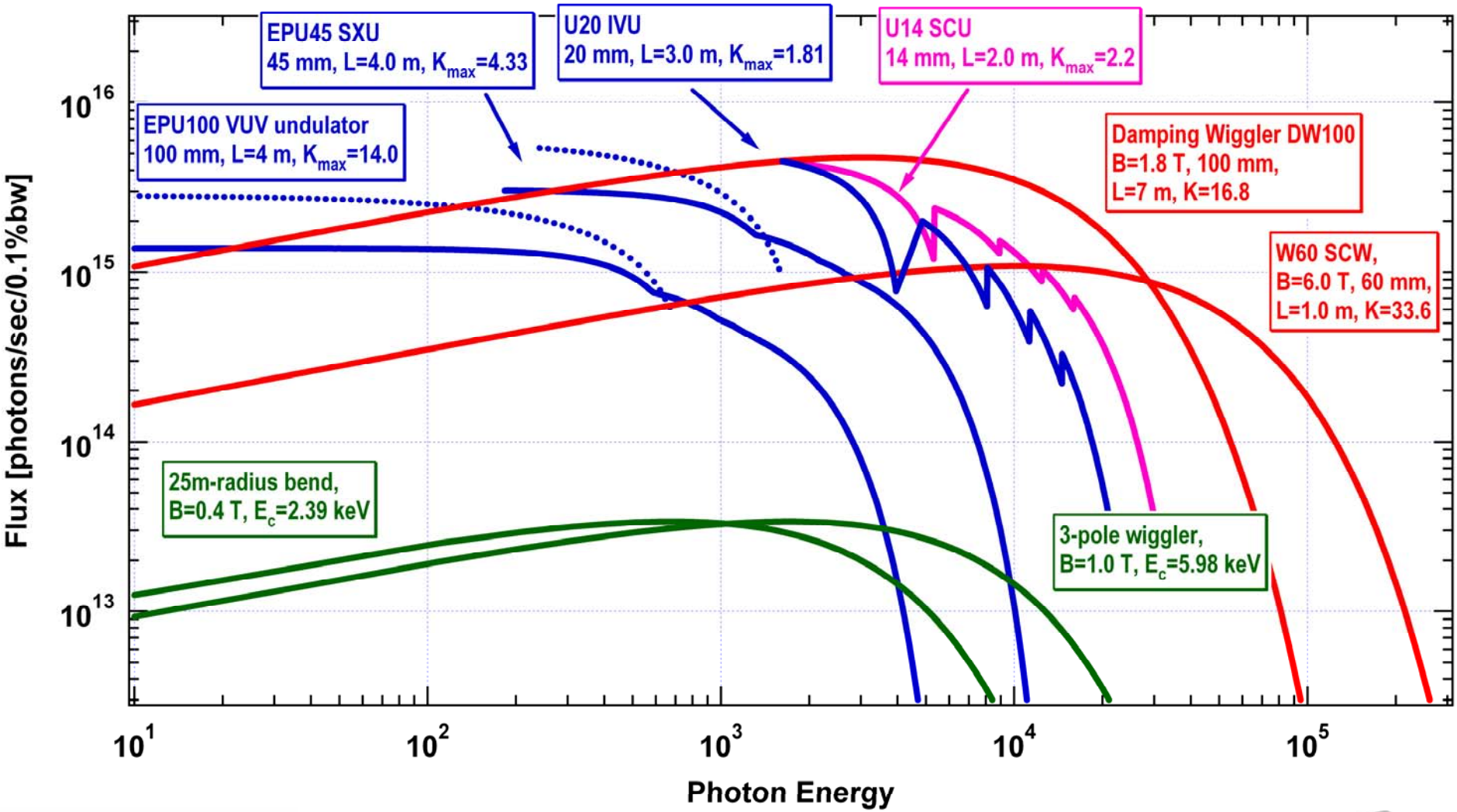
At least 58 beamlines
More by canting multiple IDs per straight
Multiple hutches/beamline are also possible

For comparison, NSLS has 65 operating beamlines

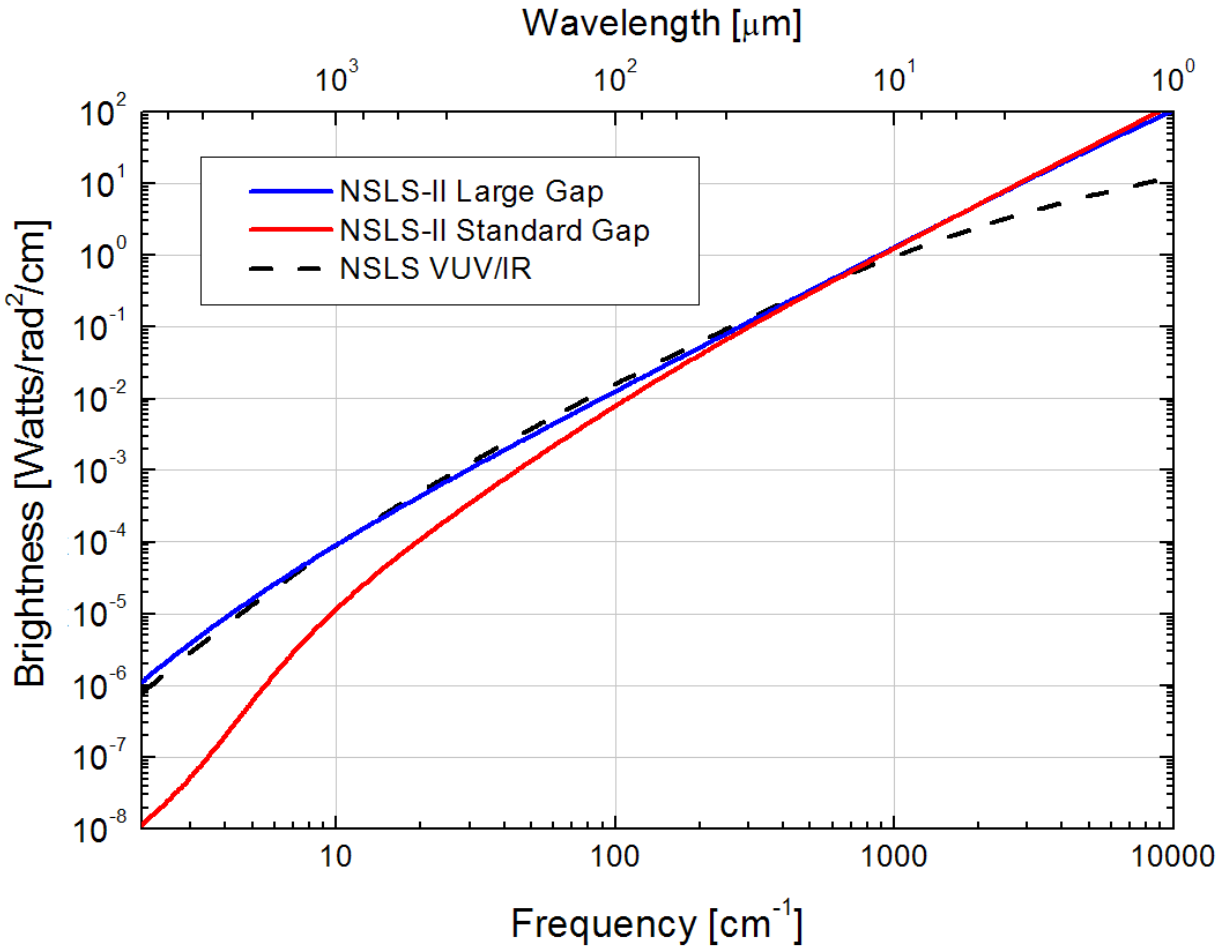
# Radiation Sources: Brightness



# Radiation Sources: Flux

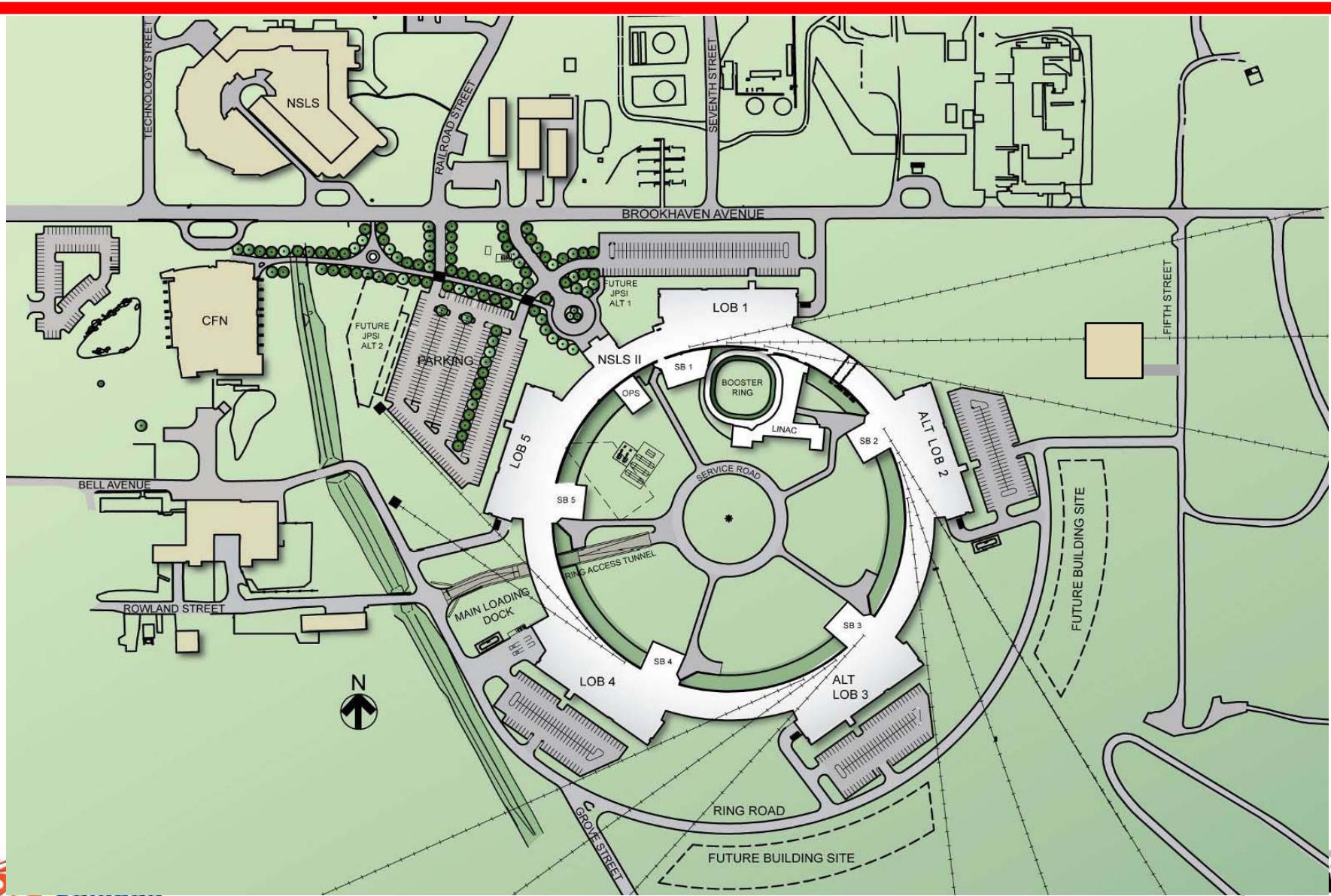


# Radiation Sources: Infra-Red




- World leading IR extracted from Bend Magnets
- Large gap dipoles (90 mm) boost performance in far-IR

# Master Site Plan



# Lab-Office Building

Total = 23,800 gsf

Labs = 480 nsf

Lab Office Building - each nominally has:

- 72 Offices
- 6 labs
- Machine shop
- 4 Conference Rooms
- Loading/storage area

# Key Milestones

| | | |
|---|---|---|
| Aug 2005 | CD-0, Approve Mission Need | (Complete) |
| Oct 2006 | Complete EA/FONSI; Internal Advisory Committee Reviews | (Complete) |
| Nov 2006 | Complete Conceptual Design Report, Preliminary Baseline | (Complete) |
| Dec 2006 | Review, Preliminary Baseline | (Complete) |
| Jul 2007 | CD-1, Approve Alternative Selection and Cost Range | (Complete) |
| Oct 2007 | Complete Performance Measurement Baseline | (Complete) |
| Nov 2007 | Review, Performance Baseline | (Complete) |
| Dec 2007 | CD-2, Approve Performance Baseline | (Complete) |
| Dec 2008 | CD-3, Approve Start of Construction | |
| Jun 2009 | Issue Ring Building Notice to Proceed | |
| Mar 2010 | Contract Award for Booster System | |
| Feb 2011 | Ring Building Pentant #1 Beneficial Occupancy | |
| Feb 2012 | Beneficial Occupancy of Experimental Floor | |
| Aug 2013 | Conventional Facilities Construction Complete | |
| Oct 2013 | Start Accelerator Commissioning | |
| Jun 2014 | Early Project Completion; Ring Available to Beamlines | |
| Jun 2015 | CD-4, Approve Start of Operations | |

# Project Beamlines

Project goal: To provide a minimum suite of insertion device beamlines to meet physical science needs that both exploit the unique capabilities of the NSLS-II source and provide work horse instruments for large user capacity.

- The beamlines are:

| | |
|---|---|
| • Inelastic x-ray scattering (0.1 meV) | U20 undulator |
| • Nanoprobe (1 nm) | U20 undulator |
| • Soft x-ray coherent scattering and imaging | EPU45 undulator |
| • Hard x-ray coherent scattering and SAXS | U20 undulator |
| • Powder diffraction | Damping wiggler |
| • XAS | Damping wiggler |

# Beamline Development

All beamlines to be developed using **Beamline Advisory Teams**

- Small teams formed by submitting a Letter of Interest (reviewed by EFAC)
- Propose scientific mission and technical requirements for beamline
- Facility hires beamline staff, designs & builds beamlines
- BAT meets every 6 months, working closely with the facility to advise them during design, construction, commissioning, and early operations
- Represent a particular User community
- Report to XFD Director

# Letters of Interest

A brief proposal (10 page limit) from the BAT. Contains:

1. **The scientific case for the beamline.**

   Key scientific drivers for this beamline. How does NSLS-II impact this field. What unique capabilities will it provide and which scientific questions will these address?

2. **The technical requirements and specifications of the beamline.**

   What requirements flow from the scientific justification? (q-ranges, energy resolution, sample environments, need to take full undulator beam…).

3. **How does it meet the needs of the user community?**

   Documentation of User demand for the beamline. User workshops held. White papers written. Appendix: containing a list of supporters/potential users (not included in page count)

4. **What source does it need and why?**

   Discussion of performance and high level parameters. Choice of straight section.

5. **Summary of Team members and their expertise.**

   Brief description of what each member brings to the team.

   Appendix: One page bio for each member (not included in page count)

# Letters of Interest

- Letters of interest may also propose a suite of beamlines to meet a particular need.
- Such LOIs should lay out overall scientific case for the suite and address how each of the particular beamlines meets a component of the scientific mission.
- Expectation is that such LOIs would be rare and that single BATs would not encompass disparate beamlines.

# Criteria for Beamline Selection

- Excellence of scientific case and engagement of user community in its articulation
- Best-in-class performance, with characteristics well matched to NSLS-II source (meets or exceeds relevant world-wide benchmarks, based on realistic simulations)
- Technical feasibility of reaching scientific objectives
- Alignment with overall utilization of facility
- Quality of team

Same criteria used regardless of funding source

# LOIs (continued)

For non-DOE-BES funded beamlines, for which external funding will need to be secured, NSLS-II will require a detailed Memorandum of Understanding (MOU) be developed between NSLS-II and the Partner User.

This will ensure that all the requirements of the facility are met, including

1) Policy requirements regarding beamline development and flow of funding, user access, and operations models

2) Technical, staffing, and scientific requirements.

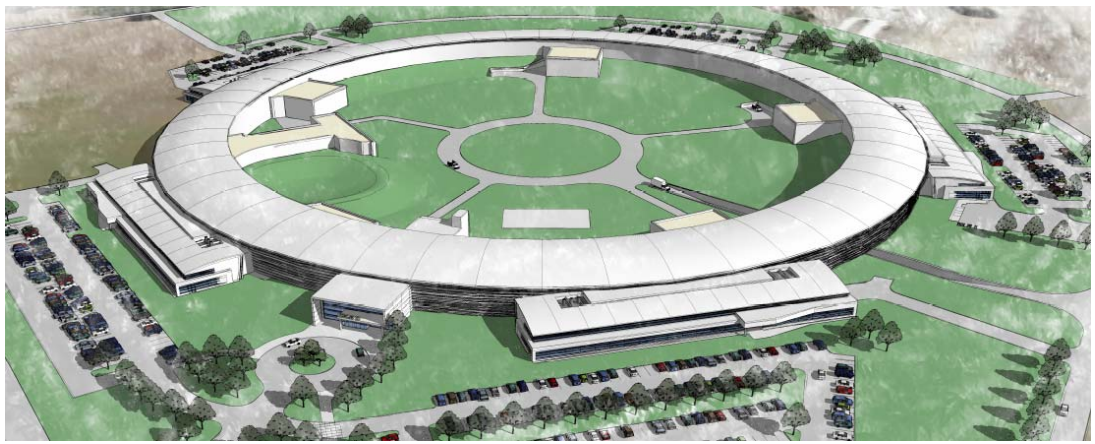
In cases where a funding proposal is to be submitted to an external agency, it will be necessary for the PU to gain the approval of NSLS-II before submitting to a funding agency.

# Timeline

| | |
|---|---|
| • LOI for 6 project beamlines | March 30th 2008 |
| • EFAC review | April 2008 |
| • Oral presentations to EFAC | May 5th – 7th 2008 |
| • Recommendation by EFAC | May 2008 |
| | |
| • Next round of LOIs due | ~August 31st 2008 |
| • EFAC review | Sept 2008 |
| • Oral presentations to EFAC | Oct 2008 |
| • Recommendation by EFAC | Oct 2008 |

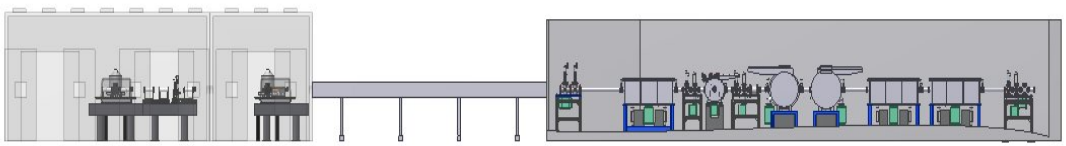
# Summary

- NSLS-II will provide a superb source of extremely bright photons over a wide energy range
- It is a near ideal source for XAS, diffraction, XPS, etc, etc offering big increases in performance over existing sources
- The facility is looking to you, the users, for input and advice on the design, construction and operation of the beamlines.
- This workshop (and others to follow) is one mechanism for this.
- The Beamline Advisory Teams will formalize this.



# Wiggler Beamlines

## XAS



- 90 mm wiggler (high β straight), 5-90 keV

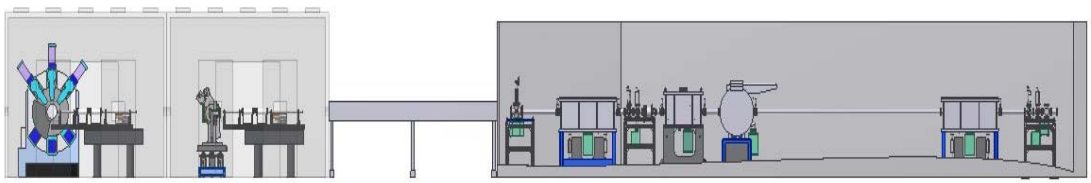
- Bulk XAS and micro-EXAFS
- Materials science and catalysis
- Nanomaterials research
- Environmental science and geology

$4x10^{12}$ in 1 micron spot for micro-XAS

Diamond anvil cell capability

In-situ capabilities, high energy-resolution mode

## Powder



- 90 mm wiggler (high-β straight) 20–100 keV

- High-resolution scattering and in-situ PDF
- Materials science, nanomaterials, chemistry, pharmaceuticals, microstructure, residual strain…

0- 50 $A^{-1}$ q-range

Spot size < 1 μm for DAC work

4 – 4000 K sample temperature range

Robotic sample changer

# Letter of Interest (cont.)

Following the blessing of the LOI by the EFAC, the project would then assign resources to work with the BAT for BES funded beamlines to develop the following:

1. Pre-Conceptual Design for Beamline

   Provides preliminary BL layout. More detailed requirements and specifications for the beamline. Identifies any particular design challenges that are beyond current state-of-the-art.

   - This already exists for the project beamlines.

2. Preliminary Cost Estimate

   Developed on the basis of the pre-conceptual design.

   - This already exists for project beamlines.

3. Alignment with NSLS-II Strategic Plan.

   Addresses the question of how this capability would fit in with the strategic vision for the facility. Interactions with other beamlines and other user communities, synergies, etc.