3 ARCHITECTURE

3.1 Design Criteria

3.1.1 Codes and Standards

The latest edition of the codes, standards, orders, and guides referred to in this section will be followed, with a reference point of August 2008 being the anticipated design completion date. All work will be in accordance with BNL's Implementation Plan for DOE 413.3, "Program and Project Management for the Acquisition of Capital Assets."

3.1.2 DOE Orders

DOE O5480.4 – Environmental Protection, Safety and Health Protection Standards
DOE O413.3A – Program and Project Management for the Acquisition of Capital Assets
DOE O414.1C – Quality Assurance
DOE O420.1B – Facility Safety
DOE O420.2B – Safety of Accelerator Facilities

3.1.3 Codes, Standards, and Guides

Building Code of New York State (NYSBC) – 2002 Edition
American Concrete Institute
Building Code Requirements for Structural Concrete (ACI 318-99)
BNL Standards Based Management System Subject Areas
New York State and Suffolk County Department of Health Codes
American National Standards Institute
ANSI 117.1 Accessible and Useable Buildings and Facilities
American Society for Testing Materials Standards
ASHRAE Standard 90.1-2001 Energy Standards for Buildings Except Low-Rise Residential Buildings
Factory Mutual
National Institute of Standards and Technology
National Fire Protection Association (NFPA) Standards
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratory
New York State Fire Prevention Code - 2002 Edition
Energy Conservation Code of New York State - 2002 Edition
Americans with Disabilities Act Accessibility Guideline (ADAAG)
Leadership in Energy and Environmental Design (LEED) 2.2
LEED for Labs

3.2 Architecture

3.2.1 Building Envelope

The building envelope will be designed to meet at a minimum the prescriptive requirements of the Energy Conservation Code of New York (ECCNY). Brookhaven National Laboratory is located in Climate Zone 11B of the ECCNY. The thermal design parameters for envelope elements are dependent on the ratio of fenestration to overall wall area. The Ring Building has a window-wall ratio of less than 10 % and the LOBs and the Operations Center have window-wall ratios greater than 10%. This ratio affects the prescriptive requirements of the ECCNY, as shown in Tables 3.1 and 3.2. Window to wall ratios of 0 to 10% are considered low fenestration area buildings and ratios of 25 to 40% are high fenestration area buildings.

Table 3.1 R-Values for High Fenestration Area Buildings – ECCNY

Building Component	Prescriptive R-Value
Exterior wall	R-11
Exterior wall below grade	R-11
Glazing	R-2 (U=0.5)
Roof (continuous insulation)	R-24
Slab on grade edge	R-8

Table 3.2 R-Values for Low Fenestration Area Buildings – ECCNY

Building Component	Prescriptive R-Value
Exterior wall	R-11
Exterior wall below grade	R-11
Glazing	No requirement
Roof (continuous insulation)	R-19
Slab on grade edge	No requirement

More stringent criteria will be used in most locations as required to meet the temperature stability performance of the building and to help achieve sustainability (LEED) goals. Targeted design R-values for wall and roofing systems will match or be slightly higher than the prescriptive values shown above:

- Target R-value for Exterior wall system R-20
- Target R-value for Roofing system R-24

3.2.2 Building Occupancy

NSLS-II will be in operation 24 hours a day, 7 days a week; however, occupied hours for most staff are 8:00 AM to 5:00 PM. The overall building will be classified, per the Building Code of New York State, as a Business (“B”) Occupancy. The anticipated populations of the various areas are shown in Table 3.3:

Table 3.3 Building Office Capacity

Building	Population
Operations Center	75 (Alt 3rd floor)
Ring Tunnel / Experimental Hall	0
Lab Office Building 1	72
Lab Office Building 2	72 (future)
Lab Office Building 3	72 (future)
Lab Office Building 4	72 (future)
Lab Office Building 5	72
Booster / Linac Building	TBD
RF Building	0

3.2.3 Parking

Parking will be provided for the Operations Center, the future JPSI building and for each of the Lab Office Buildings. LOBs 1, 4, and 5 will have approximately 100 parking spaces provided for employees and visitors. The main parking area for the Operations Center and the future JPSI will provide approximately 200 parking spaces for employees and visitors. Parking at LOBs 2 and 3 will be future and added when LOB 2 and 3 are added. A drop-off loop will be provided to the entrance of the Operations Center. Each parking lot will be barrier free and provide the required number of ADA-compliant parking spaces to meet current LEED requirements. Requirements for parking spaces are as shown in Table 3.4.

Table 3.4 Parking Requirements.

Building	Parking Spaces
Operations Center & future JPSI*	210
Lab Office Building 1	100
Lab Office Building 2	Future
Lab Office Building 3	Future
Lab Office Building 4	100
Lab Office Building 5	84
Total	494
*Not part of NSLS-II Project	

3.2.4 Vibration Criteria

The vibration limits of the Experimental Hall are those criteria associated with the user-supplied research instruments, which are not well defined at this time. Therefore, the vibration requirements of this space will be established to meet general vibration criteria for similar physical science research centers. The vibration requirements of the vast majority of research equipment available today would be satisfied by a floor meeting vibration criterion VC-E or the more stringent NIST-A. The NIST-A criterion is more stringent than VC-E at frequencies less than 20 Hz. A minimum target of VC-E will be established for the Experimental Hall.

The vibration requirements for the accelerator tunnel have been provided in a much different manner. The storage ring is most sensitive to frequencies in the range of 4 to 50 Hz. The criterion for the storage ring vibration is defined in terms of R, the area beneath the power spectral density (PSD) spectrum $\Delta(f)$, between cutoff frequencies f_1 and f_2. The RMS amplitude, R, is to be less than 25 nm. R is defined as

$$R = \sqrt{\sum_{f_1=4}^{f_2=50} \Delta(f) \times \delta f}$$

where $\Delta(f)$ is the displacement power spectral density spectrum (in units such as m^2/Hz, where the frequency term in the denominator is the measurement bandwidth) and δf is the frequency resolution of the spectrum, 0.25 Hz. The lower and upper bounds of the summation are 4 and 50 Hz, respectively. Frequency components outside this range may be neglected.

3.2.5 Noise Criteria

One of the primary goals of the NSLS-II is to provide world-class research facilities. One aspect of this requirement is to provide a very quiet Experimental Hall. The facility will have two primary types of noise sources: 1) the facility's mechanical systems, such as air handlers, and 2) the user-provided research equipment. The noise control associated with the first group is within the purview of the NSLS-II design team, but the ability to mitigate noise associated with the second group is somewhat limited. It can be anticipated via passive room noise control measures incorporated into the design, but it cannot be controlled via mechanical constraints such as airflow velocities, fan selection, or silencers, concepts typically employed for the first group.

Studies carried out during the design of the Advanced Photon Source determined that final operational room noise in the Experimental Hall would be a mix of sound from both groups of sources, and that NC-60 to NC-65 would be achievable from a combination of mechanical system noise control measures on the proposed air handling system and room absorption incorporated into walls and ceiling. In the absence of absorptive material, the noise at APS was predicted to be on the order of NC-70. This assumed a degree of localized noise control (with regard to user equipment) similar to what was used in NSLS I. APS elected to require noise control to be provided by users as part of the instrumentation and/or hutches, and omitted plans for absorbent material.

In March 2007, a program of measurements was carried out at APS, determining that the mean+σ noise in operational areas of the Experiment Hall was NC-61 (67 dBA), with a total range of only 4 NC points and a σ of one point. In an undeveloped area (representing a noise contribution only from building facilities), the noise was found to be NC-56 (62 dBA).

NSLS-II will utilize absorptive material and appropriate mechanical system design to achieve NC 55 or better in the As-Built stage (prior to operation of user equipment), with a goal of providing a Mean+σ noise environment of NC-58 or better. Noise Criteria (NC) level guidelines for other spaces in the facility will be as shown in Table 3.3.5.

Table 3.5 Acoustic Noise Criteria.

Space Type	Noise Criteria (NC) Level
Office	35–40
Laboratory	45–50
Conference rooms	30
Interaction space	40
Common use areas	40–45
Accelerator tunnel	None
Experimental Hall	55 or better
Mechanical / electrical rooms	Per ACGIH TLVs

3.2.6 EMI / RFI Criteria

No universal EMI/RFI design criteria has been established for the NSLS-II facility, although individual beamlines or experiments may have specific requirements. Shielding, if required will be the responsibility of the researcher at the individual beamline or laboratory.

3.3 Functional Program

Adjacencies of the various functional areas within the NSLS-II complex have been established through detailed discussions with the Accelerator Systems Division, the Experimental Facilities Division, the Conventional Facilities Division, Plant Engineering, Environmental Safety & Health, Maintenance, and Management.

Relationships between the areas will meet the requirements outlined in the following sections.

3.3.1 Ring Tunnel

- Requires access from the Ring Building infield for tunnel equipment installation.
- Shielding is required on the inboard, outboard, and top of the ring tunnel. This can be achieved with high-density concrete, normal weight concrete, or soil. This can also be achieved with a combination of these materials. The primary shielding material will be standard weight concrete.
- Access to the tunnel from the Experimental Hall is required at each beamline. This access will be included on the initial 15 beamlines (IDs 14-29) and be through sliding shielded doors. On the remaining 15 beamlines (IDs 1-13 and 30) will be blocked up with shield block and installed when a beamline is added at them.
- Storage ring power supplies will be located on the tunnel mezzanine directly above the ring tunnel.
- Easy access from the Operations Center control room to the ring tunnel is desirable.
- Access from the Experimental Floor to the ring mezzanine will be from stairs or ships ladders running parallel to the interior ring tunnel ratchet wall at locations where there is no active beam line.
- Walls of the ring tunnel must provide radiation shielding from the rest of the facility.

3.3.2 Experimental Hall and Access Corridor

- The Experimental Hall will have 30 sectors (a sector includes a straight section and the adjacent bending magnet) and must accommodate 25 to 30 60 m insertion device beamlines and hutches and another 25 to 30 bending magnet beamlines. The Experimental Hall must be able to accommodate future beamlines that will extend outside the building.
- Floor height with respect to the tunnel must allow beamlines to be 1.4 meters above the finished floor in the Experimental Hall. The floor must be constructed to limit differential settlement, as the beamlines must be maintained at 1.4 meters along their entire length.
- The Experimental Hall must have line-of-sight access into the tunnel for beamline set-up and alignment.
- A perimeter access corridor for equipment and personnel access to the beamlines is required. Beamlines must have easy access to nearby LOBs and Operations Center.
- The access corridor should provide space for informal interaction between researchers.
- An outdoor public space with seating will be provided near LOB 1 for lunch, coffee breaks, etc. A sandwich grille with a service window to the outdoor space and into the Experimental Hall will be provided to serve light meals.

3.3.3 Operations Center

- The Operations Center should provide visitors a viewing gallery overlooking the Experimental Floor.
- The control room and small conference room, should be grouped together on the second floor with easy access to the Booster / Linac and Ring Tunnel areas.
- The computer room should be below the control room.
- Provision for future covered access to the Joint Photon Sciences Institute building should be considered.
- The Operations Center should have an entry lobby for displays and a reception area for new users and guests.

- A third floor including offices and meeting spaces will be designed as a bid alternate. The decision to accept the alternate will be made prior to construction.

3.3.4 Lab Office Buildings

- Laboratory space and offices should be near to their respective beamlines.
- LOBs needs an entrance and parking lot.
- Individual laboratories in the LOBs should have access to the Experimental Hall through double doors.
- Informal interaction space should be provided in each LOB, as well as conference rooms.
- Laboratory space within a LOB will be shared by all six sectors using the LOB.
- Laboratories will require chemicals and gases to be delivered to them. Provision for delivery and storage of these materials is required. A high hazard storage area is provided adjacent to LOB-4 adjacent to the main loading dock.
- LOBs must be configured to allow for future expansion requiring additional labs and offices.
- LOBs 1 and 5 as well as future LOBs will have an at-grade loading platform.
- The main loading dock replaces the at-grade loading platform for LOB 4.
- Each LOB will have a gas bottle storage area.
- HVAC for the LOBs will be air handling units in each LOB mechanical mezzanine.
- Each LOB will have two fume hoods. One HEPA-filtered laboratory fume hood for working with nanomaterials and the second capable of being retrofitted with HEPA filtration.

3.3.5 Service Buildings

- Service buildings will house mechanical and electrical equipment supporting the Ring Building and must therefore be equally spaced around the interior side of Ring Building.
- Service buildings require access for large equipment moves.
- Access to the ring tunnel for both equipment and personnel will be provided through the service buildings from both the tunnel mezzanine and the Ring Building infield.
- Service buildings must be located so utilities can be easily and efficiently routed to them.
- Service Buildings will have a hoist/crane located on the second floor and accessible to the outside through double doors for hoisting materials for the Tunnel Mezzanine up onto the second floor.
- The ductwork leading from the Service Building into the Accelerator Tunnel must run through a labyrinth for radiation shielding.
- Pedestrian access from the Service Building into the Accelerator Tunnel must run through a labyrinth for radiation shielding.

3.3.6 Injection and RF Buildings

- The Injection and RF Buildings must be adjacent to the storage ring tunnel.
- The Injection Building must be shielded due to radiation during linac and booster operation.
- The RF Building must have a shielded test area
- The RF Building must have a small cryo equipment enclosure nearby (but separate for vibration isolation) and concrete pad for associated Helium storage tanks.
- HVAC for the RF Building and Booster Service Building will be by roof mounted AHU’s.
- HVAC for the Injection Building will be by AHUs located in rooms within the buildings. The ductwork leading into these buildings must run through a labyrinth for radiation shielding.

3.4 Space Program

3.4.1 Building Program

NSLS-II will have distinct components that make up the final building plan. They are the Ring Building, the Operations Center, the Lab Office Buildings, the Service Buildings, the Injection Building and the RF Building. Each of these buildings has separate space and utility requirements. It is also important to note that the existing NSLS will continue to be utilized to provide administrative and engineering office, workshop and technical space that will support the needs of NSLS-II. The net additional building program requirements for NSLS-II include the User and Facility beamline office and lab space, NSLS-II operations space and the physical support space to house the operating machinery, accelerator and beamlines.

3.4.1.1 Definitions

Net Square Feet (NSF): The sum of all areas that are required to meet general or specific functional needs. NSF is calculated based on the interior dimensions of the rooms and spaces.

Gross Square Feet (GSF): The total area of all spaces in the building including wall thicknesses. GSF is calculated based on the exterior face of the building spaces and includes non-assignable spaces such as building circulation, mechanical/electrical rooms, restrooms, janitor closets, and the area of interior and exterior walls.

Building Efficiency: Building efficiency is calculated as the ratio of NSF/GSF.

Table 3.6 Summary Program of Spaces.

Space Description	NSF	GSF
Operations Center	9,232	11,600
Injection Building	17,693	22,440
RF Building	10,182	10,630
Ring Building (incl. Service Buildings)	268,018	293,715
Lab Office Buildings* (3)	50,358	71,536
Total Square Feet	355,483	411,921
Building Efficiency: 86%		

* 2 additional LOBs are future

3.4.2 Operations Center

The Operations Center will be a two-story structure, with an alternate third story, that serves as the focal point of the facility. It includes a two story high entry lobby space for reception and displays. The Operations Center will contain the accelerator control room with associated conference room, lunch room, and computer room, support space and a visitor's viewing gallery located on the second level overlooking the Experimental Floor. Figure 3.1 illustrates the layout of the Operations Center first floor and Figure 3.2 shows the second floor layout.

An optional third floor will accommodate offices for administration and accelerator physicists associated with storage ring operations. This will include the area over the entrance lobby that could be used for a Director's suite or a large Conference Room.

Table 3.7 Operations Center Program of Spaces.

Room Name	Size NSF	No. of Spaces	Total NSF	GSF	Notes
First Floor					
Lobby	2,415	1	2,415		
Computer room	976	1	976		
Telecom	409	1	409		
Switchgear	655	1	655		
Break room / Kitchenette	512	1	512		
Unisex Toilet	78	1	78		
Second Floor					
Control conference room	676	1	676		
Control room	1,547	1	1,547		
Toilets & Showers	76	2	152		
Men's Locker Room	128	1	128		
Women's Locker Room	126	1	126		
Storage	108	1	108		
Bridge & Viewing Gallery	1,450	1	1,450		
Operations Center		15	9,232	11,600	
Efficiency – Operations Center: 79%					
Alternate Third Floor			132		
Private office			2,561		
Open office			2,469		
Toilets			284		
Kitchenette	126	1	126		
Directors Office	301	1	301		
Conference Rooms			943		
Director's Assistant	221	1	221		
Alternates		55	6,753	10,310	

3.4.3 Injection Building

The Injection Building (Booster / Linac) consists of spaces for the compact booster, the linac, klystron gallery and support for these in a single story building. Two Service Buildings are adjacent to the Booster ring and will provide services for it and the linac. The Booster ring and linac require shielding. This is accomplished by a combination of concrete walls and earthen berms. The layout of the Injection Building is shown in Figure 3.4.

Table 3.8 Injection Building Program of Spaces.

Room Name	Size NSF	No. of Spaces	Total NSF	GSF	Notes
Linac Room	1,715	1	1,715		
Klystron Gallery	1,620	1	1,620		
Booster Service Building - East	6,102	1	6,102		
Booster Service Building – West	1,568	1	1,568		
Booster Ring Tunnel	6,688	1	6,688		
Injection Building		5	17,693	24,440	
Efficiency: 72%					

3.4.4 RF Building

The RF Building is located inside the ring on the west side of the Operations Center and connected to the Operations Center by a double door. This building houses the RF cavities which are located on ID 22A and 24A. The space requires at least 6 meter height clearance and a crane or temporary gantry for installing equipment. There is also a concrete shielded room for doing RF testing located in this building. The RF Building layout is illustrated in Figure 3.3.

Located adjacent to this building on the inner part of the ring is the Helium tank yard that services the RF cavities and a pre-engineered pump building to serve the Helium Tank Yard.

Table 3.9 RF Building Program of Spaces.

Room Name	Size NSF	No. of Spaces	Total NSF	GSF	Notes
RF Cavity Room	9,756	1	9,756		
RF Test	426	1	426		
RF Building		2	10,182	10,630	
Efficiency: 96%					

3.4.5 Ring Building

The Ring Building, shown in Table 3.7, will consist of four main space components, the Ring Tunnel, the Tunnel Mezzanine, the Experimental Hall, and the Access Corridor. Additionally, the main loading dock, stock room and hazardous materials storage are also included in the Ring Building and located adjacent to LOB 4.

The ring tunnel, housing the booster ring and the storage ring, occupies the inner most area of the Ring Building. The beamlines used by the experimental stations extend tangentially from the ring at select locations. The Experimental Hall is designed to accommodate beamlines that are approximately 60 m long from the center of the straight section to the intersection at the access corridor. Outboard of the Experimental Hall will be the access corridor. Above the ring tunnel is the tunnel mezzanine. Power supplies for the accelerator will be located on the tunnel mezzanine with electrical power feeds dropping through the floor into the tunnel.

Beyond the ring tunnel is the experimental floor where the beamlines and hutches for the experiments are located. The floor in this area will be designed to reduce transmission of vibration and prevent differential settlement of the floor which can be detrimental to the performance of the beamlines.

Along the periphery of the experimental floor is the access corridor which is approximately 10 ft wide and designed for fork truck and pedestrian traffic. This will be a continuous aisle that runs the circumference of the Ring Building. It is from this aisle that the experimental floor and LOBs will be accessed. The access corridor between LOB 1 and 2 will accommodate future long beam lines that will interrupt the corridor where they penetrate it. Access over the long beamlines will be accomplished by a raised steel bridge over the beamline sized for forklift traffic. The bridge will include an equipment lift on one end closest to the LOB, access lifts to each of the beam lines, and a ramp on the other end. The access corridor between the other LOBs will have a thickened slab design that will allow for installation of the raised platform in the future.

An outdoor public space with seating will be provided for lunch, coffee breaks, etc. A sandwich grille will be provided to serve light meals. It will be located on the Ring Building between LOB One and the Operations Center.

A typical Ring Building Pentant is illustrated in Figure 3.5.

Table 3.10 Ring Building Program of Spaces.

Room Name	Size NSF	No. of Spaces	Total NSF	GSF	Notes
Ring tunnel	37,300	1	37,300		
Experimental Hall	94,235	1	94,235		
Access Corridor	33,018	1	33,018		
Tunnel mezzanine	50,950	1	50,950		
Grille	257	1	257		Located near LOB 1
Loading dock	2,060	1	2,060		Located near LOB 4
Stock Room	1,618	1	1,618		Located near LOB 4
Hazardous materials storage	450	1	450		Located near LOB 4
Ring Building		8	219,888	240,075	
Efficiency: 92%					

3.4.5.1 Service Buildings

There will be five two-story service buildings located inboard of the ring. These buildings will house the mechanical and electrical equipment to service the experimental floor, the ring tunnel, and the tunnel mezzanine. The Service Building first floor will provide personnel access to the ring tunnel through a labyrinth, and equipment access to the ring tunnel at two of these service buildings through a shielded door. The other three Service Buildings will each have an opening filled with removable, pre-engineered concrete shield block to accommodate a future shielded door. The inner road access will connect to the service buildings through the first floor.

The Service Building second floor will house air handlers for the experimental floor area. The second floor will be serviced by a equipment hoist and double exterior doors located on the second floor and fire stairs from the first floor. It will provide equipment access to the tunnel mezzanine via an a double six foot wide hollow metal door. Mechanical equipment rooms for the Lab Office Buildings, Booster, and Operations center are included with their respective buildings.

The layout of a typical Service Building is shown in Figure 3.6.

Table 3.11 Service Buildings Program of Spaces.

Room Name	Size NSF	No. of Spaces	Total NSF	GSF	Notes
Service Building # 1	9,626	1	9,626		
Service Building # 2	9,626	1	9,626		
Service Building # 3	9,626	1	9,626		
Service Building # 4	9,626	1	9,626		
Service Building # 5	9,626	1	9,626		
		5	48,130	53,640	
Efficiency: 90%					

3.4.6 Lab Office Buildings

There will be three single-story Lab Office Buildings (LOB), two fully built out (LOBs 1 and 5) and one shelled (LOB 4). There will be two future LOBs that can be constructed when the beamlines are built in their area of the building. LOBs include open-plan offices for the scientists and technicians, (a VE items that eliminates all enclosed offices in LOBs 1 and 5 has been incorporated here and on the drawings by note only) twelve laboratory modules (two modules per typical laboratory) plus interaction areas, conference rooms, machine shop, and shipping/receiving and storage. The shipping/receiving area will be eliminated in LOB 4 and a stock room and main loading dock added that will service LOB 4 as well as the rest of the facility. The layout typical to LOB 1 and 5 is shown in Figure 3.7.

LOB 4 will be a shelled space in the base building work with just the exterior envelope constructed. This includes exterior walls, roofs, doors and windows. Minimum mechanical, electrical lighting and power rough-in and plumbing rough-in that provides minimum life safety for exiting and to prevent freezing of sprinkler piping in the winter.

3.4.6.1 Laboratory Design

Each built-out LOB will have six laboratories, which will be shared with all the beamlines associated with that particular LOB. These labs are based on a 12 ft wide and 20 ft long lab planning module with each lab being two modules wide. These labs will have access to the Experimental Hall through recessed double doors 6 ft wide (two 3 ft wide leaves). The labs will be accessed from the LOB by a single recessed 3 ft wide door.

At least two labs in each LOB will be wet labs, either chemistry or biology, which will require a fume hood. At least one of these hoods will be HEPA filtered in each LOB, and one more will be upgradeable with HEPA filtration. Additionally, each LOB will have the capability to provide at least one HEPA filtered fume hood designated for nanomaterials work. The other labs will be dry labs with cabinetry and equipment but a fume hood is planned for only one of the four dry labs. These labs may be equipped with elephant trunk exhausts or glove boxes as needed by the laboratory type.

Chemistry wet labs will include ventilated chemical storage cabinets incorporated into the fume hood base. Each wet laboratory will also be furnished with a safety shower/eyewash station. Floor drains will not be provided in laboratory spaces.

Since the LOB labs are going to be shared labs, it is necessary to make the labs as generic as possible while still serving the requirements of the research being performed.

Table 3.12 Lab Office Buildings Program of Spaces.

Room Name	Size NSF	No. of Spaces	Total NSF	GSF	Notes
Lab Office Building					
Private office	110	48	5,280		
Open office space	90	24	2,160		
Laboratory – Wet	480	2	960		
Laboratory – Dry	480	4	1,920		
Storage	110	1	110		.
Conference room	560	2	1,120		
Conference room	220	2	440		
Lobby & interaction spaces	600	1	600		
Break rooms / kitchenettes	240	2	480		
Shipping Receiving & Storage	960	1	960		
Toilet/shower	250	2	500		
Electrical / Data	153	1	153		
Janitor Closet	63	1	63		
Access Corridor Interface	2,090	1	2,090		
Machine Shop	270	1	270		
		93	17,106		
Lab Office Buildings 1 & 5		186	34,212		
Lab Office Building 4 (Shelled)		1	16,146		
			50,358	71,536	
Efficiency: 70%					

3.4.7 Construction Alternates

Some components of the NSLS-II will be bid as Alternates to the Base Building. These will be designed as part of the Title II Design and constructed as budget allows. Other components are identified as Future construction and will not be designed at this time.

- Operations Center Floors 1 and 2 Base
- Operation Center Floor 3 Alternate
- Injection Building Base
- RF Building Base
- Ring Building Pentants 1-5 Base
- Lab Office Building #1 Base
- Lab Office Building #2 Future
- Lab Office Building #3 Future
- Lab Office Building #4 Shell Base
- Lab Office Building #4 Fit-out Future
- Lab Office Building #5 Base

3.4.8 Circulation

Entry points into the Ring Building are provided around the circumference of the building both from the outside and the inside of the ring. The main entrance to the Ring Building will be from the Operations Center lobby. Other entrances to the complex are available from the LOBs and from the service buildings. Within the two-story Operations Center, two elevators will provide vertical transportation – a passenger elevator in the lobby and a service elevator inside the ring.

When the accelerator is operating, access to the ring tunnel is not allowed, for safety reasons. Doors into the ring tunnel will be interlocked with the accelerator to prevent entry into the tunnel when the beam is operating.

Primary circulation within the Ring Building will be provided by the access corridor that circumscribes the outside of the building. It will provide for both pedestrian and vehicular (bicycle, forklift, etc.) traffic. The access corridor will have points of entry from each LOB and from each laboratory within the LOBs. Emergency exit doors are located on the perimeter of the ring (both inside and outside walls) that meet the current NYS Building Code. A elevated bridge with ramps and equipment platform lift is located between LOB 1 and future LOB 2 to accommodate long beamlines being installed in this area. Provisions for elevated bridges in other area where long beamlines are anticipated in the future are included the design and sized for all anticipated traffic in these areas.

Access to the Tunnel mezzanine from the Experimental Hall will be via steel stairs located at the ratchet for the bending magnets. There will be one per pendant (approx. every 600' to meet NYSBC for travel) except that the bridge at the Operations Center will take the place of one of these stairs.

Control room personnel require ready access to the tunnel mezzanine and the ring tunnel itself. The tunnel mezzanine will provide the means of circulation around the ring from the control room. A pedestrian bridge will be provided from the Operations Center second floor across the Experimental Hall to the tunnel mezzanine. Entrance to the accelerator tunnel will be via the service buildings. Stairs in the service buildings will provide circulation between the mezzanine level and the tunnel level. Personnel will access the accelerator tunnel through a personnel labyrinth on the first level.

3.4.9 Building Floor Elevations

The floor elevation for the Ring Building (experimental floor) is the functional baseline for the elevations of the adjoining buildings and spaces. This elevation is set to minimize the need for engineered fill while also considering the balance of cut and fill on the site. The floor elevations for the components are given in Table 3.13.

Table 3.13 Building Floor Elevations.

Building Component	Floor Elevation
Experimental floor and access corridor	+ 70 ft
Ring tunnel	+ 71 ft 4 in.
Tunnel mezzanine	+ 83 ft 7 in.
Lab Office Building	+ 70 ft
Operations Center	--
First floor	+70 ft
Second floor	+ 83 ft 7 in.
Third floor	+98 ft
Service buildings	--
Lower level / Ring tunnel access	+ 71 ft 4 in.
Upper level	+ 83 ft 7 in.
Booster / Linac Building	+ 71 ft 4 in.
RF Building	+ 71 ft 4 in.

3.5 Preliminary Design

3.5.1 Operations Center

3.5.1.1 Architectural Concepts

The Operations Center lobby will serve as the front door to the NSLS-II complex. It is envisioned to be two stories in height and will provide a welcoming environment for guests.

3.5.1.2 Future Expansion

The Operations Center will be designed for an optional third floor, that will house a combination of open plan and private offices along with a large conference room and director's suite above the lobby area. The design does not provide for future expansion horizontally or vertically, however, connectivity to future adjacent buildings is possible.

3.5.1.3 Space Program

The first floor will consist of the lobby with space for displays, elevator and restroom on the front side of the ring. An outdoor seating area with coffee bar and sandwich grille will be adjacent to the Lobby. The computer room, break room switchgear and telecom rooms are on the first floor on the inside of the ring. The second floor includes the control room, a conference room, toilets and the viewing gallery overlooking the Experimental Hall, a bridge across the Experimental Hall. The alternate third floor will house a combination of open plan and private offices.

3.5.1.4 Circulation

The primary point of entry will be the main entrance and lobby that will draw in pedestrian traffic from the parking lot and drop-off loop. Sidewalks are envisioned for pedestrian traffic to and from the adjacent future JPSI and to the CFN across Groves Street and the NSLS across Brookhaven Avenue. Interaction areas will be incorporated adjacent to key circulation areas of the building. The building also provides the primary entrance into the Experimental Hall. A bridge accessed from the second floor will span across the Experimental Hall and provide access to the control room as well as the accelerator tunnel, tunnel mezzanine, Linac and RF Building. Two elevators will provide vertical circulation within the building.

3.5.1.5 Quality of Life

Building orientation, sustainable materials, and the use of natural light will be integrated into the design to promote a comfortable and productive environment. Unlike the Ring Building, the Operation Center's envelope will consist of large areas of glass, allowing for visual transparency and to provide an inviting front door to the NSLS-II complex. The lobby will be a space for informal interaction and social events. An outdoor seating area can be provided between the Operations Center and the future JPSI building as a comfortable place to enjoy coffee or lunch.

3.5.1.6 Building Construction

The exterior of the Operations Center will be constructed of an insulated metal wall panel and stud system. The wall system on the entrance lobby will be comprised of the exterior panel system to match Type A without the liner panel, exterior sheathing, air barrier, 6 in. metal studs, fiberglass batt insulation, and interior gypsum board. The minimum thermal resistance of the system will be R-20.

The wall system on the inner ring portion of the Operations Center will be comprised of the exterior panel system to match Type A without the liner panel, exterior sheathing, air barrier, 6 in. metal studs, fiberglass batt insulation, and interior gypsum board. The minimum thermal resistance of the system will be R-20.

The roof of the Operations Center will be a flat TPO membrane roofing system that meets current LEED requirements and the energy code minimum R-value. A built-up roofing system is an option in place of the TPO system but not meet LEED requirements for Heat Island, Energy Star Roofing.

The curtain wall windows at the Operations Center will consist of 1 in. clear tempered insulated glass with a low-E coating in a thermally broken aluminum frame. The thermal transmission value for the glazing will be a U value of 0.30 in the summer and 0.30 in the winter. The visible light transmission will be 69% and the shading coefficient will be a maximum of 0.44.

The exterior doors will be curtain wall aluminum insulated doors to match the windows at the entrance, and insulated hollow metal doors and frames on the inner ring portion of the Operations Center.

3.5.1.7 Interior Finishes

The Operations Center will have gypsum board walls with wood doors and hollow metal frames. The offices will have a side light or interior window to allow natural light into the interior spaces. The interior finishes are as follows:

- Floor finishes office area and conference rooms – carpet tile
- Floor finishes control room and computer room – raised floor
- Floor finishes lobby – porcelain ceramic tile
- Floor finishes toilet rooms – porcelain ceramic tile
- Exterior walls - painted
- Interior walls typical – painted
- Interior walls conference rooms – paint or wall coverings
- Interior walls of toilet rooms – ceramic tile
- Ceiling system – suspended acoustical tiles and grid
- Doors – wood, stained
- Door frames – painted
- Floor surfaces shall have a wet slip coefficient of 0.5 or greater.

3.5.2 Ring Building

3.5.2.1 Architectural Concepts

The Ring Building is the scientific and visual focal point for the NSLS-II facility. The halo-shaped building will dominate the site by its sheer breadth, although its height is not proportionally commanding.

3.5.2.2 Future Expansion

The Ring Building is designed for future expansion by the addition of LOBs or support buildings to its outer or inner periphery. It is also possible that future beamlines will be added with a length of up to 1000 m, which will extend substantially beyond the limits of the building. The facility is being designed to allow these long beamlines to be installed in the future with minimal impact on the current building. Accommodation for the long beamlines will include an elevated access corridor between LOB 1 and 2 which will enable pedestrian and forklift traffic to transit the area with the use of ramps and lifts.

3.5.2.2 Space Program

Within the Ring Building are the Injection Building, the RF Building, the Ring Tunnel, the Tunnel Mezzanine, and the Experimental Hall. Service buildings connected to the inboard side of the Ring Building will provide HVAC, mechanical, and electrical services to some building components. The Injection and RF Buildings will have their own HVAC systems.

On the exterior of the ring there will be the Loading Dock, Stock Room and Hazardous Material Storage, located adjacent to LOB four. There is also a Grill area for food vending and lunch services, this Grill will be located adjacent to LOB one between LOB one and the main entrance.

3.5.2.3 Circulation

The access corridor around the outside perimeter of the Ring Building provides the primary circulation route for the building. It will be designed to handle both pedestrian and forklift traffic. The corridor will provide access to the Operations Center, all of the LOBs, individual laboratories within the LOBs, and the adjacent Experimental Hall. Stairs from the Experimental Hall will provide access to the tunnel mezzanine and the service buildings. The pedestrian bridge spanning the Experimental Hall will allow operators to conveniently walk between the control room and the lobby. Stairs within the service building will provide a means of accessing the ring tunnel from the tunnel mezzanine level.

Egress from the Experimental Hall will be through the four LOBs, the Operations Center, across the tunnel mezzanine and through the service buildings, or through intermediate emergency exit doors spaced around the exterior perimeter of the Ring Building.

The access corridor will incorporate provisions for the long beam lines between the LOBs. This will be a raised steel ramp and corridor that will allow the beam line to run underneath it. There will be a ramp on one end and an access platform lift on the other. Running between the beamlines from this raised corridor will be platform lifts and stairs for access to the beamlines.

3.5.2.4 Quality of Life

Although the focus of the Ring Building is the enhancement of scientific inquiry, it is desirable to make the space an environment that researchers will enjoy occupying. Comfort facilities for the Ring Building are provided in the Operations Center and in the five LOBs (two in the base build) within a reasonable distance from all beamlines. An alternate for perimeter windows will bring natural lighting into the space . Exterior shading will prevent direct sunlight from impacting experimental performance.

3.5.2.5 Building Construction

3.5.2.5.1 Experimental Hall

The Ring Building exterior walls will be comprised of a built-up sandwiched pre-formed metal wall panel system with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20. The panels profiles will be Type A on the exterior side of the Ring and Type B on the inner side of the Ring Building (Tunnel mezzanine).

The roof of the Ring Building will be a curved standing seamed metal roof system. The system will be comprised of the standing seamed roof over R24 rigid insulation, gypsum board sheathing, and structural metal roof deck.

The optional clerestory windows at the Ring Building will consist of 1 in. clear tempered insulated glass with a low-E coating in a thermally broken aluminum frame. The thermal transmission value for the glazing will be a U value of 0.30 in the summer and 0.30 in the winter. The visible light transmission will be 69% and the shading coefficient will be a maximum of 0.44. These clerestories will be included in the design and a bid alternate.

The exterior doors of the Ring Building will be insulated hollow metal doors and hollow metal frames.

Acoustical treatments will line the ceiling and walls to maintain an acceptable noise level in the Experimental Hall.

The Grill area will be of similar construction to the ring building.

The Loading Dock and Stock rooms will be of similar construction to the adjacent LOB. See the building construction for the LOBs in section 3.5.3.

The Hazardous Storage will be made of concrete or concrete block with the appropriate fire rating. The roof will be a poured concrete flat roof with TPO roofing above the concrete. A built-up roofing system is an option in place of the TPO system but not meet LEED requirements for Heat Island or Energy Star Roofing.

3.5.2.5.2 Ring Tunnel

The ring tunnel will be constructed of poured in place standard weight concrete as described in the Building Superstructure section. Additional shielding will be provided in specifically identified areas as required. A shielded door (boronated polyethylene and lead filled steel) will be provided at each beamline allowing access to the Ring Tunnel from the Experimental Hall. Where no door is provided the opening will be blocked up with radiation shield block.

The roof of the Ring Tunnel will have embedded uni-strut at four feet on center for hanging ductwork, cable tray, piping, etc.

3.5.2.5.3 Service Buildings

The service buildings' lower level will be constructed of poured in place concrete walls with a soil berm to the height of the second level. The second level exterior walls will be a built-up metal wall panel system Type B with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20.

The roof of the service buildings will be a sloped standing seam metal roofing system. It will consist of a standing seamed roof over R24 rigid insulation, gypsum board sheathing, and structural metal roof deck.

The exterior doors of the service buildings will be insulated hollow metal doors and hollow metal frames.

Each service building will be provided with an opening into the Ring Tunnel that may be filled with concrete block as portable shielding, or be used for a superdoor (radiation shield door made of boronated polyethylene and lead-filled steel door) installation. Initially two doors will be installed.,

A one ton hoist or lift will be provided at each service building for lifting power supplies and other electric gear to the mezzanine level.

3.5.2.5.4 Injection and RF Buildings

The Booster tunnel will be constructed of poured in place standard weight concrete, which will be covered with earth as additional shielding.

The Linac Building will be constructed of a combination of poured in place standard weight concrete and a built-up metal wall panel system Type B with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20.

The exterior walls of the Booster Service building and the RF Building will be a built-up metal wall panel system Type B with rigid insulation and interior metal liner panel. The minimum thermal resistance of the system will be R-20.

Interior walls shared with the ring tunnel will be concrete of sufficient thickness to provide adequate radiation shielding.

The roof of these buildings will be a TPO membrane roofing system. It will consist of a mechanically adhered TPO roof over R24 rigid insulation, gypsum board sheathing, and structural metal roof deck. Earth covered structures will include a fluid applied water proofing system.

The exterior doors of the Booster Service building, the Klystron Galley and the RF Building will be insulated hollow metal doors and hollow metal frames.

3.5.2.6 Interior Finishes

3.5.2.6.1 Experimental Hall

The Experimental Hall will have the following interior finishes:

- Floor finishes – sealed concrete with a wet slip coefficient of 0.5 or greater.
- Exterior walls – factory-finished wall panels
- Interior walls – factory finished steel or concrete or gypsum board walls – painted.
- Steel – painted
- Roof Structure – painted
- Doors and frames– painted
- Shield doors – factory finish

3.5.2.6.2 Ring Tunnel

The ring tunnel will have the following finishes:

- Floor finishes – sealed concrete with a wet slip coefficient of 0.5 or greater.
- Interior and exterior concrete walls – painted or sealed
- Concrete roof structure – painted or sealed

3.5.2.6.3 Service Buildings

The service buildings will have the following finishes:

- Floor finishes – Sealed concrete with a wet slip coefficient of 0.5 or greater.
- Exterior and interior metal wall – Factory-finished wall panels
- Interior and exterior concrete walls – painted
- Steel – painted
- Doors and frames– painted or factory finished.
- Shield doors – factory finish

3.5.2.6.4 Injection and RF Buildings

The Injection and RF Buildings will have the following finishes:

- Floor finishes – Sealed concrete with a wet slip coefficient of 0.5 or greater.
- Exterior wall – Factory-finished wall panels
- Interior walls – factory-finished steel or concrete or gypsum board walls – painted
- Steel – painted
- Roof Structure – painted
- Doors and frames– painted
- Shield doors – factory finish

3.5.2.6.5 Loading Dock, Hazardous Storage and Stock Room

These buildings will have the following finishes:

- Floor finishes – Sealed concrete
- Exterior wall Loading Dock/Stock Room– Factory-finished wall panels
- Exterior wall Hazardous Storage – Concrete or Concrete Block
- Interior and exterior concrete walls – painted
- Steel – painted
- Doors and frames– painted or factory finished.
- Overhead Doors – Factory Finished.

3.5.2.6.6 Grille

The Grille will have the following finishes:

- Floor finishes – Sealed concrete
- Exterior– Factory-finished wall panels
- Interior walls – painted, see section 3.3.5 for acoustical requirements
- Steel – painted
- Doors and frames– painted or factory finished.

3.5.3 Lab Office Buildings

3.5.3.1 Architectural Concepts

Five LOBs (three base build and two future) will be spaced around the exterior of the Ring Building. The LOBs will be the primary entrance for many researchers and beamline staff. A focus on interactive spaces will provide an environment where collaboration is encouraged.

3.5.3.2 Future Expansion

The five Lab Office Buildings are being designed with the intent of future expansion. Each LOB is being initially programmed to support six sectors, with one insertion device and one bending magnet beamline per sector. If additional beamlines are added by canting insertion device beamlines, the LOBs will need to expand to support these. The LOBs are designed to expand horizontally along the outside of the Ring Building as future need demands. Services to any expansion, including HVAC, plumbing, power, etc. will be added at the time of the expansion. They are not included in the initial scope of the project.

3.5.3.3 Space Program

LOBs 1 and 5 will contain 72 offices, 12 laboratory modules (2 modules per lab for six total labs per LOB), conference rooms, storage, a kitchenette, a machine shop and a delivery / staging space adjacent to the loading berth. The Experimental Hall will have direct access to the staging space via a six foot wide double door. The intent of the Lab Office Buildings is to provide support space for experimentation that is close to the beamlines. Each LOB will support six sectors in the Experimental Hall. The LOB will provide offices for each supported sector. The six laboratories will be shared by all six sectors to minimize duplication of space requirements and lab equipment. Each laboratory will have direct access to the Experimental Hall access corridor via double doors for moving equipment between them. There will be two wet labs per LOB which will have fume hoods. One of these fume hoods will be HEPA filtered.

LOB four will be a shelled space in the base building work with just the exterior envelope included, this includes exterior walls, roofs, doors and windows. Minimum mechanical, electrical lighting and power rough-in and plumbing rough-in that provides minimum life safety for exiting and to prevent freezing of sprinkler piping in the winter.

Each of the three LOBs as well as the two future will be designed to be a separate control area from the Ring Building with a one hour fire separation wall between the LOB and the Ring Building. It will then be up to the NSLS-II administration to determine which of the LOBs is designated one of the three remaining Control Areas. See section 12.4.5 for the code requirements for Control Areas.

3.5.3.4 Circulation

Each Lab Office Building will be primarily one story high with an exception for an upper level mechanical attic (accesses by stairs on the access corridor side of the LOB) and have a parking lot adjacent to the building and an exterior entrance that will be the primary entrance for most researchers and visitors. Direct access to the Experimental Hall will be provided from the lobby/interaction area and will be a controlled access point. Equipment and materials will be brought into the building from a loading area that will also allow equipment to be conveniently moved into the Experimental Hall. Pedestrian traffic to other LOBs or to the Operations Center will be via the access corridor around the perimeter of the Ring Building.

3.5.3.5 Quality of Life

The Lab Office Buildings will be home to staff and visitors who frequently work long and irregular hours. The glass storefront exterior walls will bring natural light into the office space. The glass façade and the relatively small size of the LOBs will create a contrast to the massive form of the Ring Building and will break down the scale. Open space with comfortable seating will encourage cooperative interactions between research teams. A kitchenette will include a sink, refrigerator, and microwave for preparing simple meals. Comfort facilities will include toilets and a shower in each LOB. The building materials and use of natural lighting will provide the Lab Office Buildings with a pleasant work environment.

3.5.3.6 Building Construction

The exterior walls of the LOBs will be comprised of the exterior panel system to match Type A without the liner panel, exterior sheathing, air barrier, 6 in. metal studs, fiberglass batt insulation, and interior gypsum board. The minimum thermal resistance of the system will be R-20. Portions of the LOB exterior will be an aluminum and glass curtain wall.

The roof of the LOBs will be a standing seamed metal roof system. The system will be comprised of the standing seamed roof over R24 rigid insulation, vapor barrier, and structural metal roof deck. There will be an AHU mezzanine within the roof space for air-handling equipment serving the LOB.

The curtain wall windows at the LOBs will consist of 1 in. clear tempered insulated glass with a low-E coating in a thermally broken aluminum frame. The thermal transmission value for the glazing will be a U value of 0.30 in the summer and 0.30 in the winter. The visible light transmission will be 69% and the shading coefficient will be a maximum of 0.44.

The exterior doors will be curtain wall aluminum insulated doors to match the windows or insulated hollow metal doors and frames.

The laboratory walls and doors leading from the LOB to the Ring access corridor will be one-hour rated construction. Walls will be metal stud and gypsum board and the doors will be hollow metal doors and frames.

3.5.3.7 Interior Finishes

The LOBs will have gypsum board walls with wood doors and hollow metal frames. The offices will have a side light or interior window to allow natural light into the interior spaces. The interior finishes of the LOBs are as follows:

- Floor finishes, office area and conference rooms – carpet tile
- Floor finishes, laboratories – sheet linoleum
- Floor finishes, lobby – porcelain ceramic tile
- Floor finishes, toilet rooms – porcelain ceramic tile
- Exterior walls - painted
- Interior walls, offices and labs – painted
- Interior walls, conference rooms – paint or wall coverings
- Interior walls, toilet rooms – ceramic tile
- Ceiling system – suspended acoustical tiles and grid or gypsum board at high ceilings
- Acoustical treatments – see section 3.2.5 for acoustical requirements
- Doors – stained wood
- Door frames – painted
- All floor surfaces shall have a wet slip coefficient of 0.5 or greater.