Diffraction Limited Storage Ring Workshop
Breakout Session #5 Summary

Tom Fornek – Breakout Session #5 Chair
APS Upgrade Project

DLSR Workshop

November 19-21, 2014

Breakout Session #5 Presentations

- Overview of Recent Commissioning Experience for Storage Ring Light Sources – Michael Borland (APS)
- PETRA III Installation Experience – Michael Bieler (DESY/PETRA III)
- NSLS-II Accelerator Overview & Lessons Learned – Bill Wahl (BNL/NSLS-II)
- APS Upgrade Project Removal and Installation Plan – Chuck Prokuski (ANL/APS)
- MAX IV Installation – Pedro Fernandes Tavares (MAX IV)

Michael Borland's Talk – Overview of Recent Commissioning Experience for Storage Ring Light Sources

- Motivation for Survey
  - APS and other facilities are contemplating replacing operating rings
  - Plan to minimize time users are without beam
    - APS is targeting 12 months for removal, installation, and commissioning
    - 3 months set aside for commissioning
  - We want to determine
    - How realistic is this?
    - What factors are most likely to prevent this?
    - What steps can be taken to ensure rapid commissioning?
  - Toward this end, a survey of recently-commissioned light sources to understand their experience was conducted
    - "Recently-commissioned" was defined as within the last 10-15 years

Overview of Commissioning Survey (Cont'd)

- Facilities and Respondents
  - ALBA, BESSY-II, CLS, DLS, PLS-II, SOLEIL, SSRF, SPEAR3
  - Seven provided responses to questions

- What does commissioning mean?
  - Suggested Definition
    - Begins when beam is first injected into the ring
    - Ends when ring is capable of supporting meaningful beamline commissioning

Overview of Commissioning Survey (Cont'd)

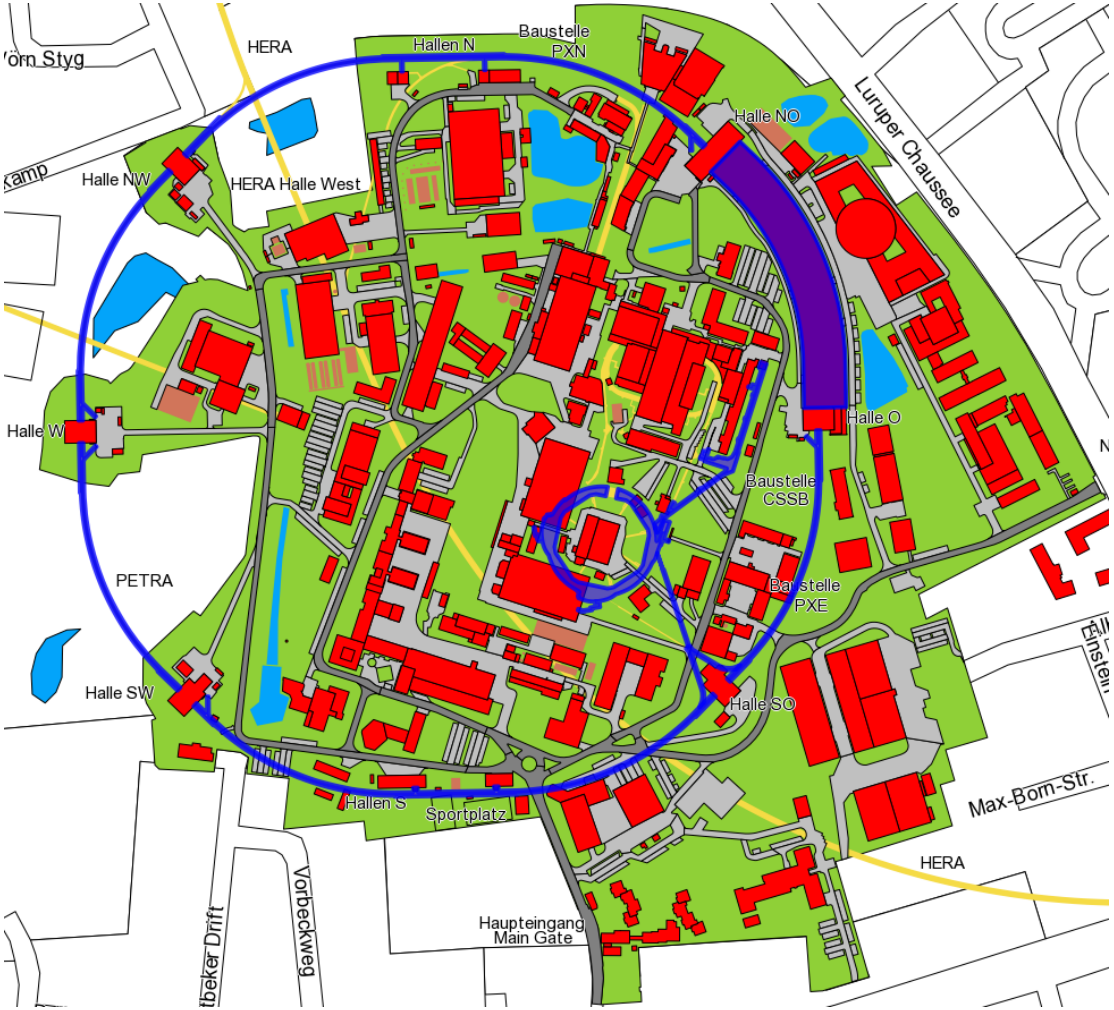
- Michael did a statistical analysis which you can look at in his posted presentation
- Summary of Results
  - Scheduled commissioning duration ranged between 4 and 12 months
    - In terms of planning, at least, a 3 month commissioning period is a factor of two shorter than typically contemplated
    - Shift schedule – Most 24/7
    - No obvious relationship between hours of shift work per week and time required for commissioning!
  - All but one facility completed commissioning in less than the scheduled time, five of the seven responding facilities reported commissioning in 4 months or less
  - Assuming no major issues, five of seven responding facilities thought commissioning could be done in 3 months or less

Michael Bieler's Talk – PETRA III Installation Experience

- Michael talked about the present PETRA Extension Overview
- Currently there are 14 photon beam lines concentrated in 1/8 of the ring
- This extension adds two new experiment halls with five beam lines each
- Installed storage ring components are similar to existing ring components

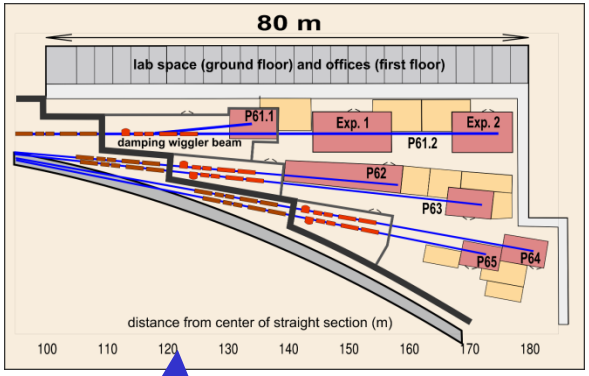
PETRA III Installation Overview

- Circumference 2.1 km
- Former use as
  - e+/e- collider (1978 – 1990)
  - e/p injector for HERA (1990 - 2007)
  - 3rd generation light source (since 2009)
- Horizontal emittance 1nm
  - Large circumference
  - 20 damping wigglers
- Full energy (6 GeV) injector, Top Up, 100 mA
- 14 photon beam lines, concentrated in 1/8 of the ring



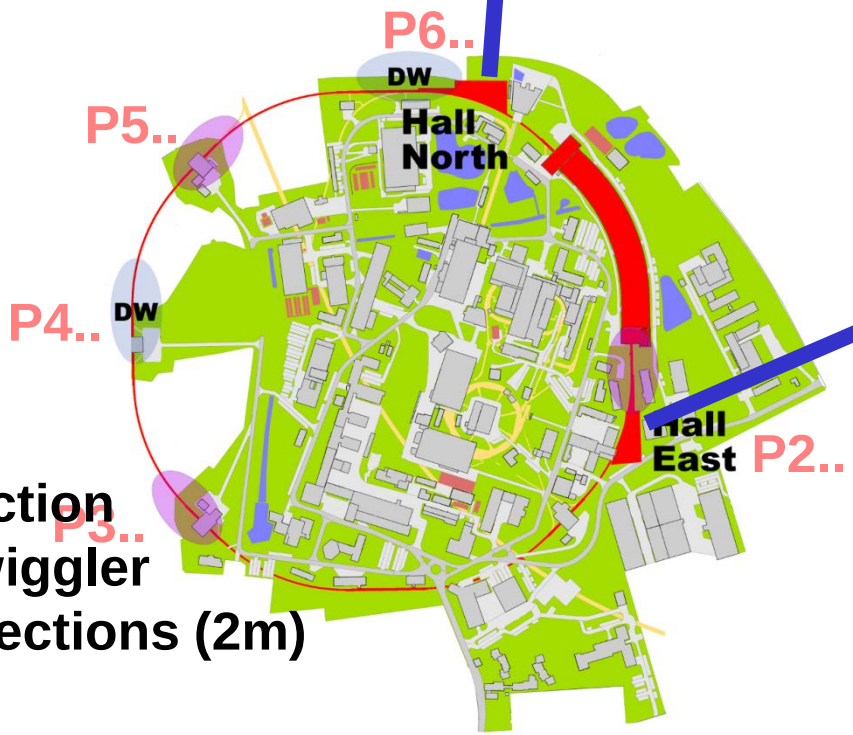
PETRA Extension 2014

Hall North

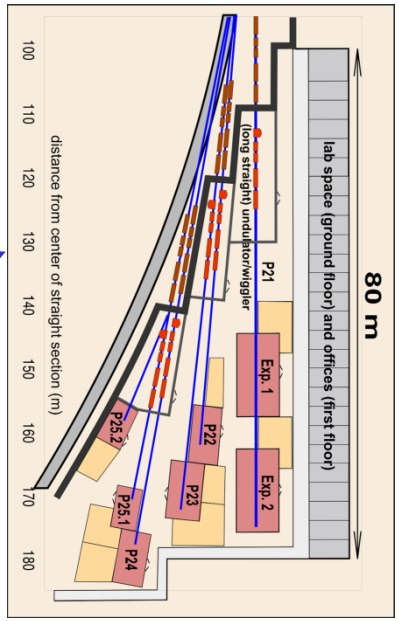


North

- o Damping wiggler section (existing)
- o 4 new straight sections (2m) in the arc



Hall East

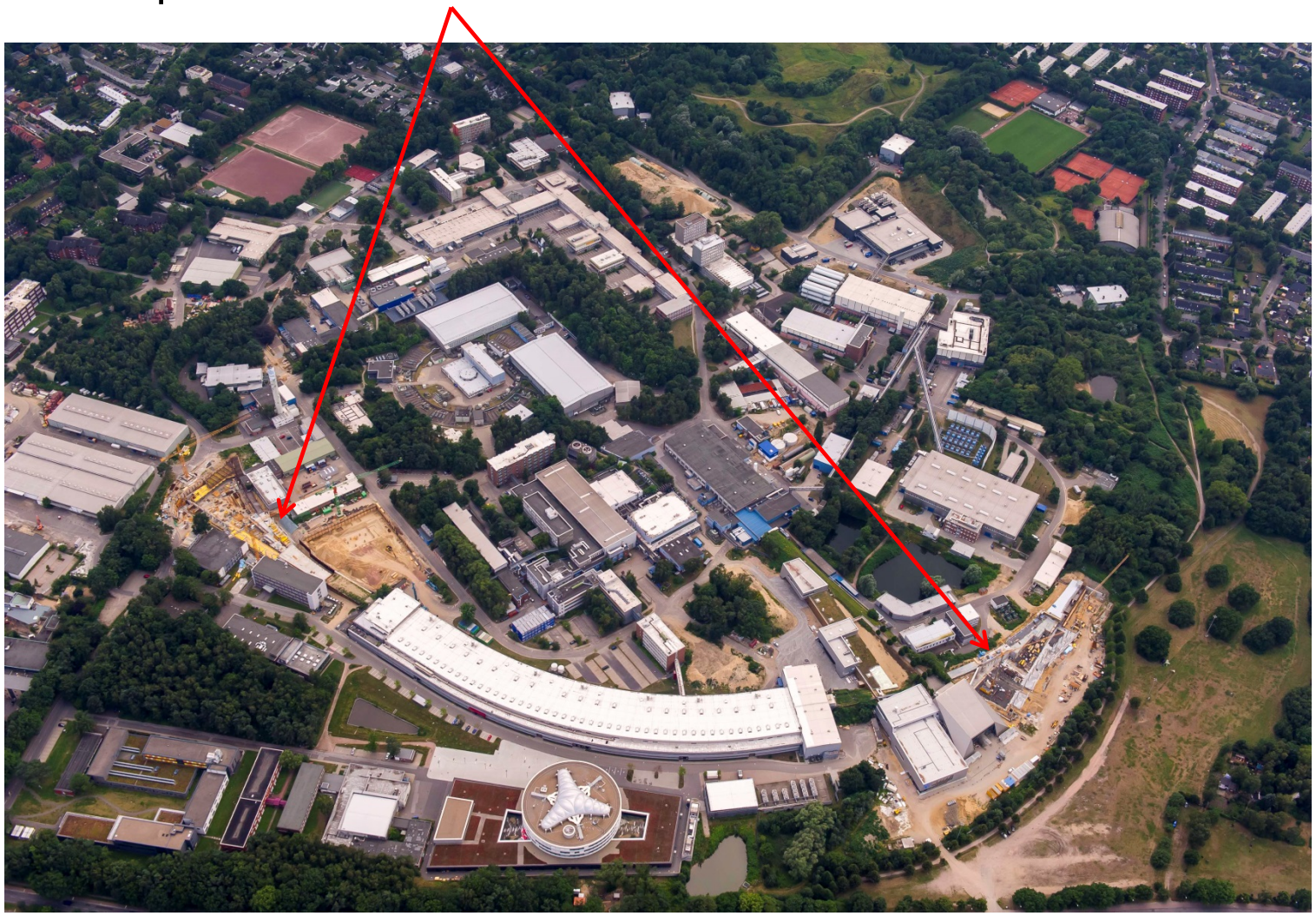


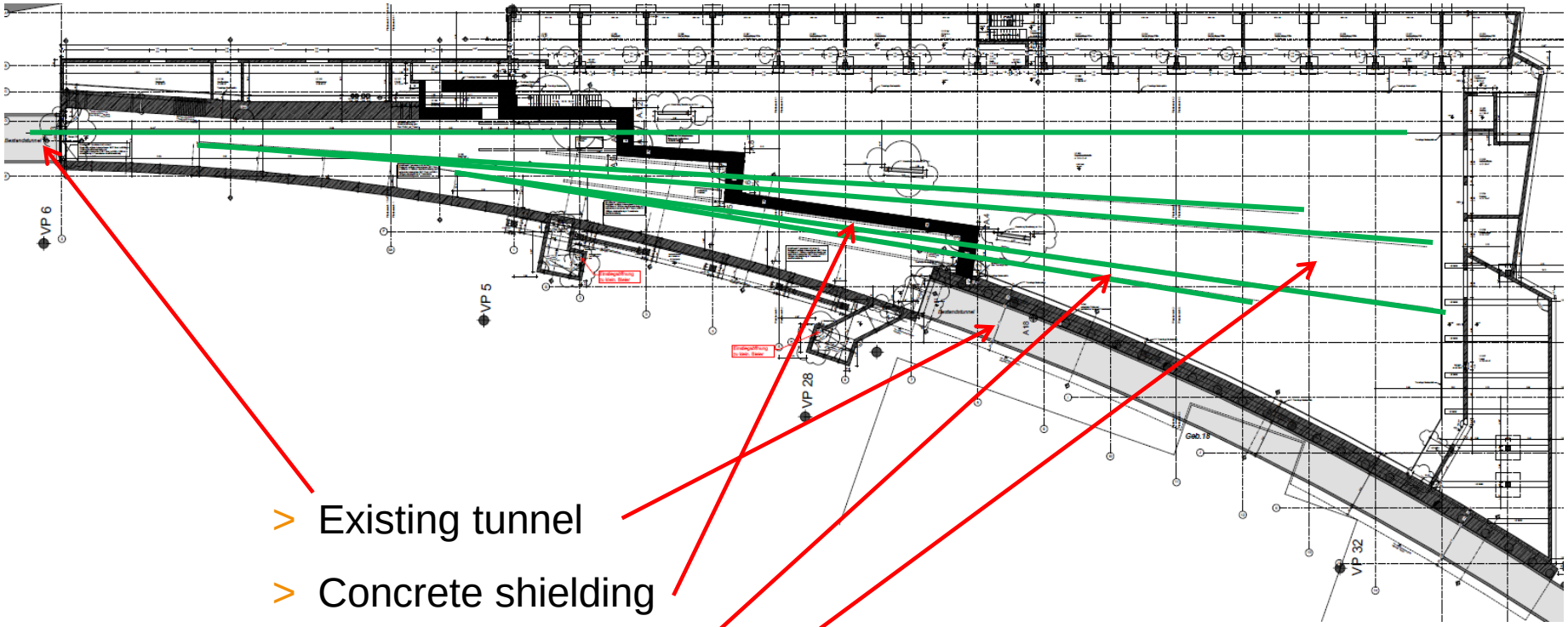
East

- o long straight section for undulator / wiggler
- o 4 new straight sections (2m) in the arc

PETRA Extension 2014

> 2 new experimental halls with 5 beam lines each





- Existing tunnel
- Concrete shielding
- Photon beam lines
- Experimental floor

Civil Construction – Would you like some concrete with your iron?

Concrete slabs (part 1) were poured on April 29th 2014

PETRA Project Schedule

- Beginning of shutdown Feb. 3, 2014 OK
- 1 month to clear the tunnel (200 meters) OK
- 5 months to dismantle and rebuild the tunnel OK
- ~ 4.5 month to build up machine and front ends mostly on schedule (potential problems with vacuum and cabling)
- ~ 3.5 month commissioning

  Interlock checks
  Power supplies
  Studies with beam

- User operation from end of March 2015 on

PETRA III Summary

- Extensive overview of the civil construction and installation in the tunnel
- Presented problem areas and solutions
- Valuable “lessons learned from PETRA III were also presented

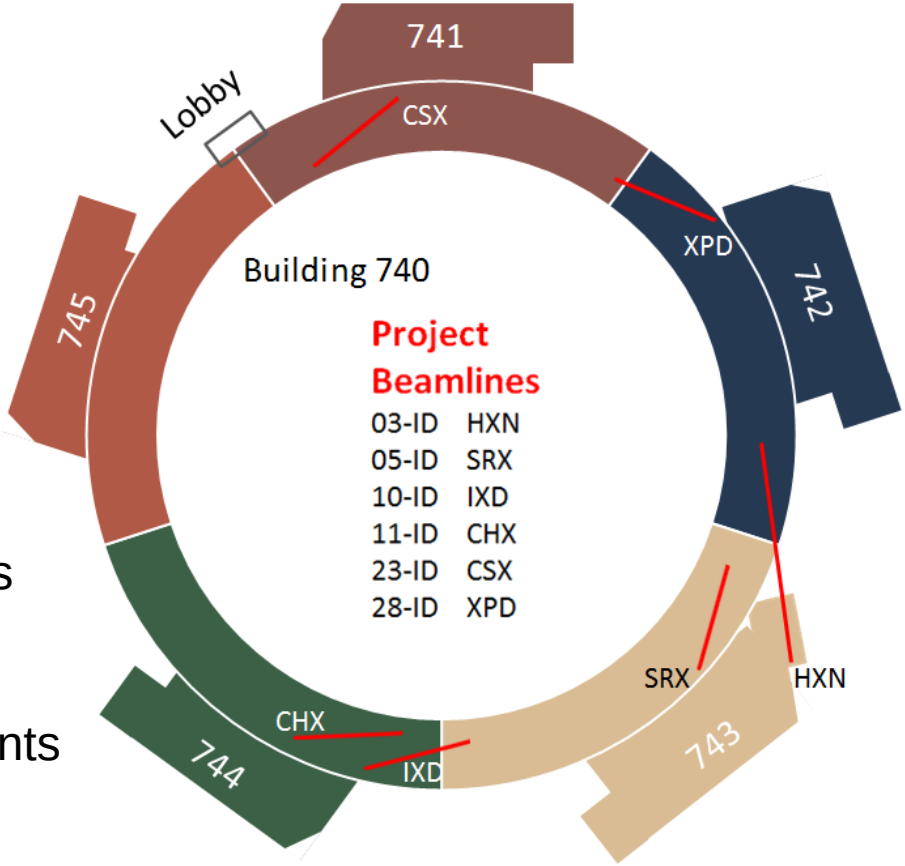
Bill Wahl's NSLS-II Presentation

Accelerator Systems
- Storage Ring – 792m circumference
- Top-Off Injection System

Conventional Facilities
- Ring Building and Service Bldgs
- (400,000 gsf)
- 5 Laboratory/Office Bldgs (190,000 gsf)

Experimental Facilities
- Capable of hosting <u>at least</u> 58 beamlines

Research & Development
- Advanced optics & accelerator components
- Initial suite of 8 beamlines (two canted) (XPD, SRX, CSX, HXN, CHX & IXS)



Total Project Cost $912M (Baseline)

Production and Installation Approach

Accelerator Production

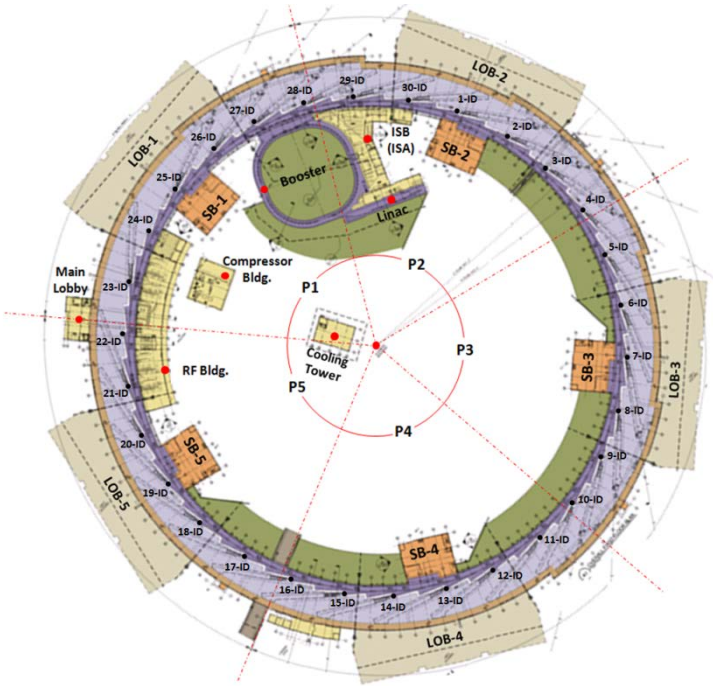
- BNL procured Injector sub-systems (Linac, Booster Ring)
- BNL built and integrated Transfer Lines, Booster RF and SR components

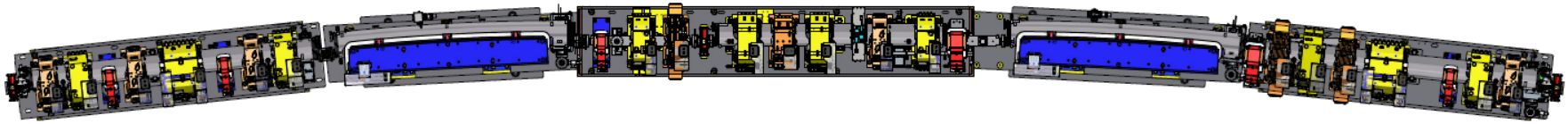
Accelerator Installation

Linac	Vendor w/ BNL oversight
Booster Ring	Vendor using BNL technicians for all hands–on work w/ vendor oversight
Booster RF	BNL
Transport Lines	BNL
Storage Ring	BNL
Storage Ring RF	Combination of BNL & Vendors

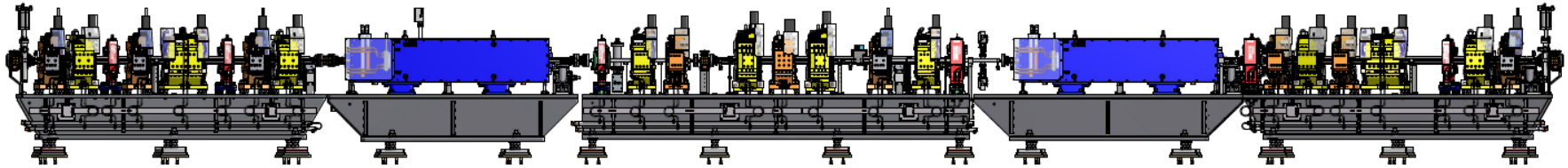
Storage Ring

- SR tunnel is comprised of five “Pentants” with each “Pentant” having six cells
- Each cell has one straight section and five Girders
- Straight sections will be occupied by IDs except at Injection and in two RF Cavity Straights (27 Straights will be available for IDs)
- Girders are equipped with magnets, vacuum components and advanced instrumentation





Double Bend Achromat Design



SR Girder/Magnet Installation

Dedicated Integration facility

- Assembly and Integration including vacuum chambers and some instrumentation.
- Magnet-magnet alignment (< 30um)

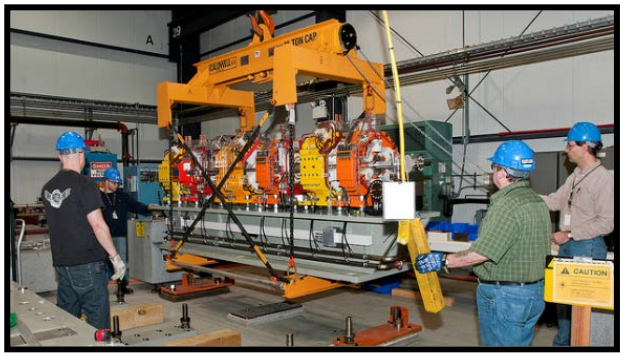
Dedicated magnetic measurement lab

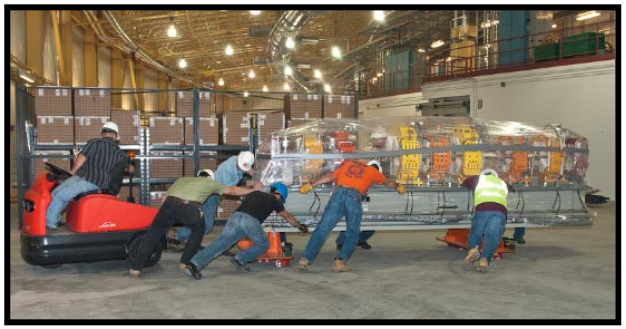
- Vibrating Wire
- Rotating Coil
- Hall probe

(150) Magnet Girders installed in tunnel

- Girder-girder alignment in tunnel (< 100uM)
  - 60 Dipoles
  - 300 Quadrupoles
  - 270 Sextupoles
  - 270 Correctors
  - 4 Bumps (Kickers)
  - 1 Injection Septum

Over 900 Magnets Installed





Readiness & Commissioning Achievements

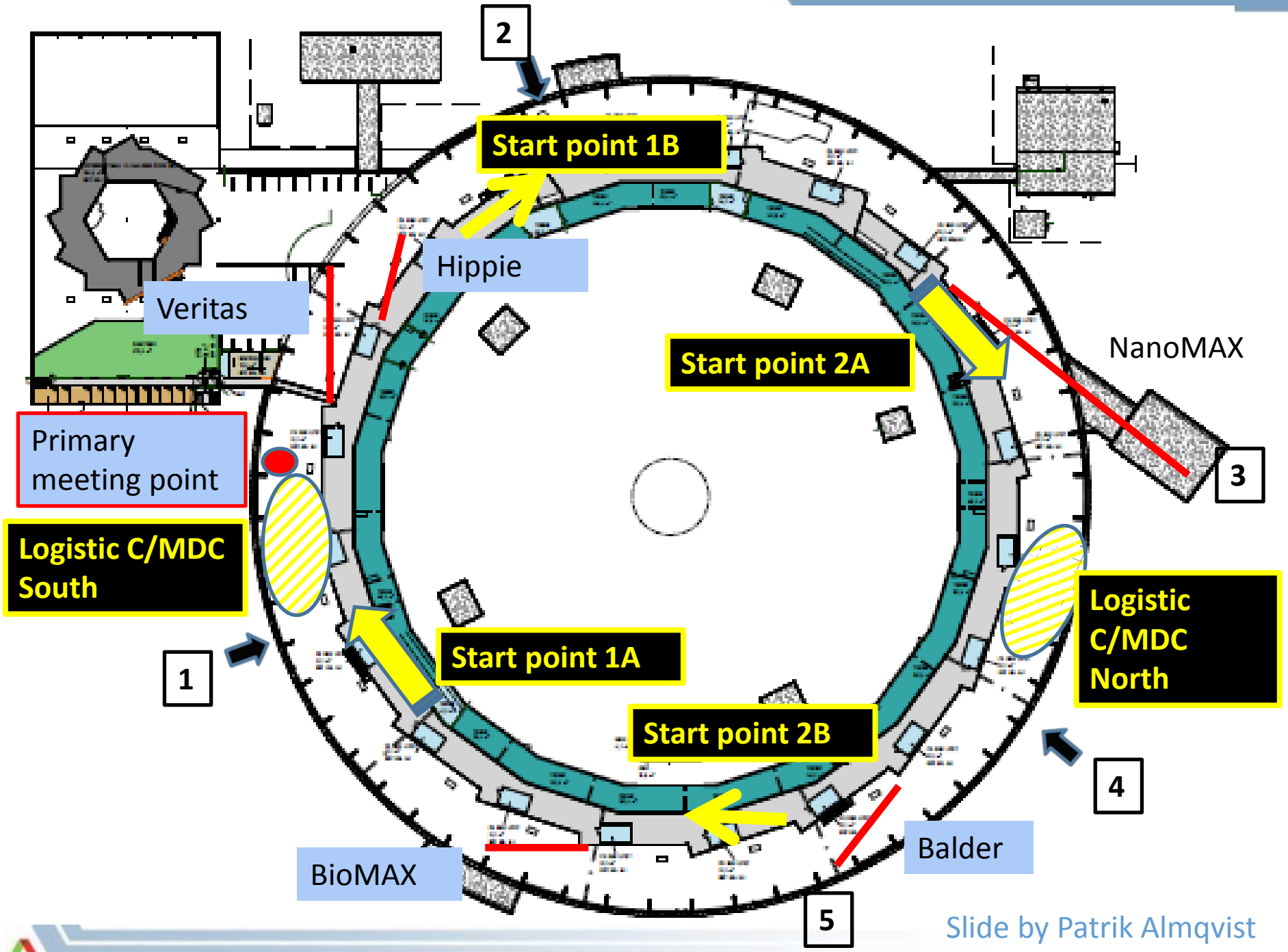
Booster	**Completion Date**
▪ IRR	Sept 2013
▪ ARR	Nov 2013
▪ Commissioning	Feb 2014
Storage Ring	
▪ IRR	Jan 2014
▪ ARR	Feb 2014
▪ Commissioning w/ 7 Cell Petra RF Cavity	May 2014
▪ Commissioning w/ Superconductive RF Cavity	Aug 2014
Beamlines & Operations	
▪ IRR Group A (XPD & CSX Beamlines)	Aug 2014
– Commissioning of IDs & FE	OCT 2014
▪ IRR Group B (HXN, SRX, IXS & CHX Beamlines)	Oct 2014
– Commissioning of IDs & FE	Dec 2014 (expected)

Lessons Learned

- Bill presented many valuable “lessons learned” and challenges experienced

Pedro Fernandes Tavares MAX IV Talk

- MAX IV Installation
  - Organization
  - Planning
  - Information Flow & Logistics
- Used lessons learned from LINAC Installation to help plan ring installation
- 3 GeV Ring Installation – Strategy, Sequence and Status



Slide by Patrik Almqvist

Installation Organisation

MAX IV Installation management

- **Patrik, Inst. Leader**
- Göran L, Dept. Inst. Leader
- Jakob, BL Inst. Leader
- Pedro F Tavares, PL
- Magnus Sjöström, Dept. PL
- Anders, Logistics & Cleaning
- Johan Rosdahl, Mtrl Leader
- Robert H/Mattias S, Pipes
- Mathias G, Cables

MAX IV Project managers

- Jerry Schmidt
- Claes Lenngren
- Johan Thånell
- Robert Nilsson
- Julio L Simon
- Jerzy Jamroz
- Aleksandar Mitrovic
- Anders Rosborg
- Lars Malmgren
- Åke Andersson
- Chiara Pasquino
- Leif Thånell
- Martin Johansson
- Linus Arvidsson
- Pawel Garsztka
- Tobias Lundquist

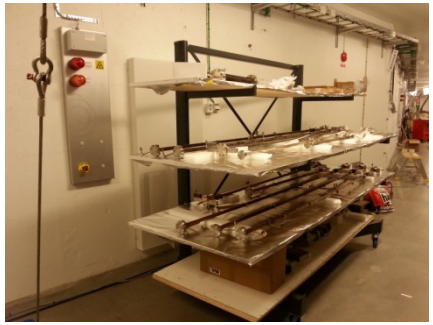
Sub-contractors

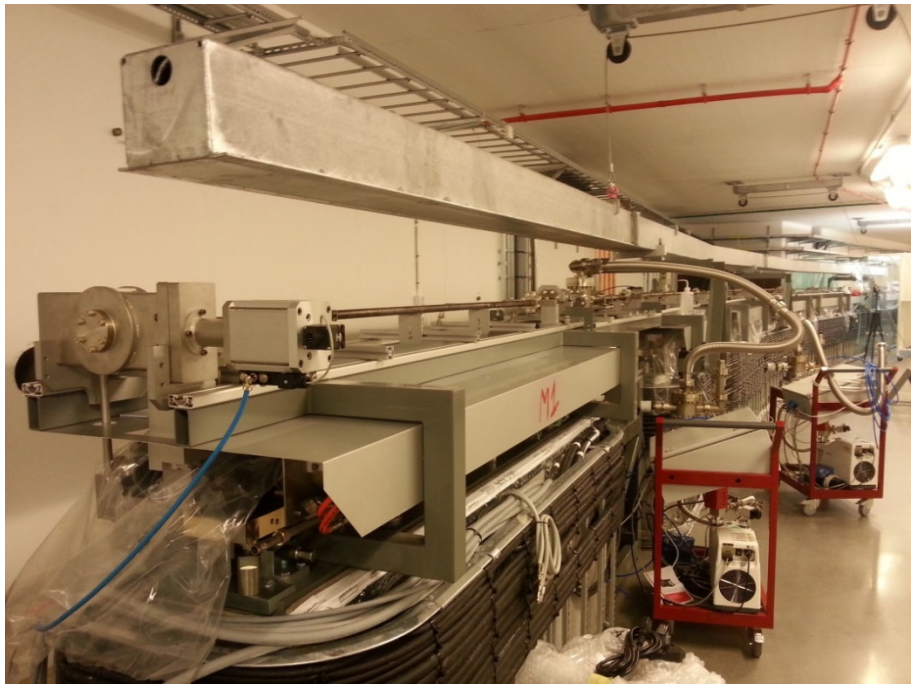
- Caverion Electricity
- Caverion Piping
- Tunga Lyft Supports
- Budker Institute

Slide by Patrik Almqvist

Installation Strategy – 3 GeV Ring

- Dedicated Logistics personnel.
- Quick stand-up meetings with contractors to solve collaboration issues.
- Compressed Installation time for low risk tasks to create air for high risk tasks.
- Installation procedures were tested at a full scale mock-up to
  - Validate time plan
  - Identify bottlenecks





Installation Status, w47.1 (after 10 weeks)

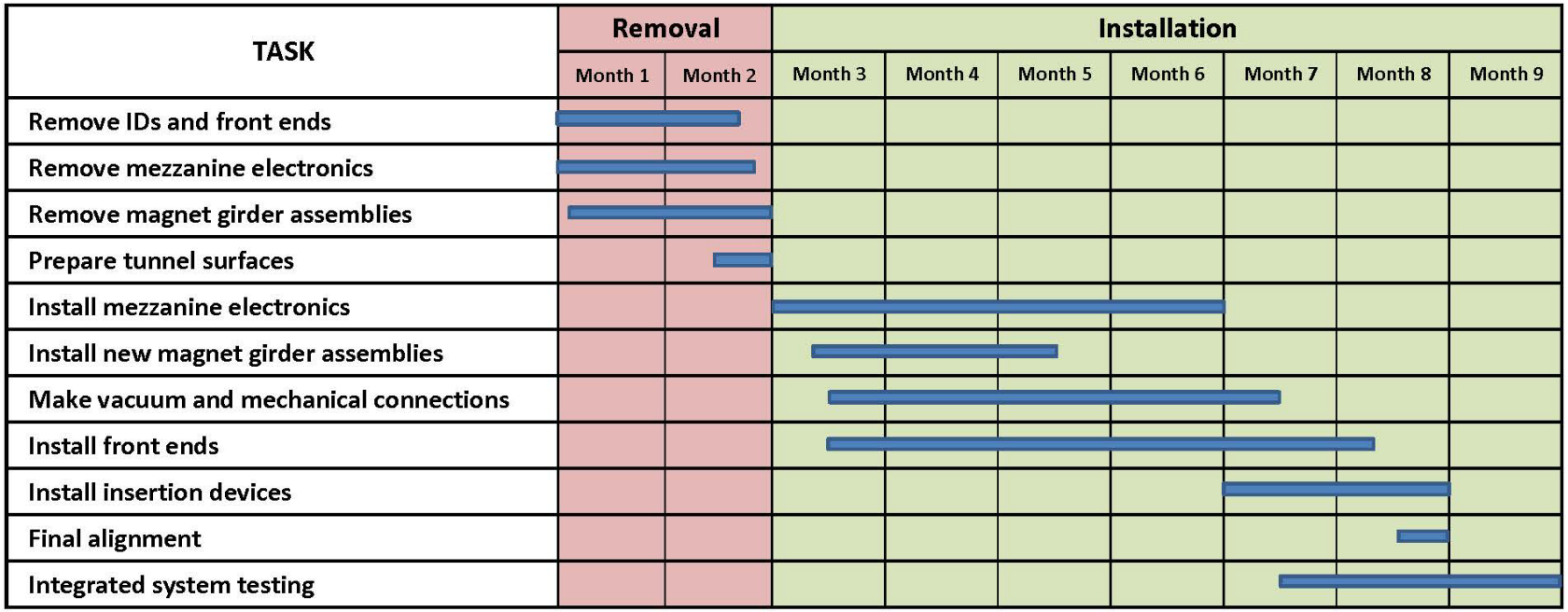
- All concrete stands in place.
- Cooling pipes are welded in 20 Achromats.
- Final review of cooling pipes in 8 achromats (after leak check and pressure test, 8 more week 47.2)
- Cable Ladders in 18 achromats
- Magnet cables in 6 achromats (8 achromats by 47.4)
- Process cables in 6 achromats.
- Magnets on stands in 4 achromats(alignment done in 2, 4 by 47.3).

Slide by Patrik Almqvist

The APS-Upgrade: Central to Argonne’s future

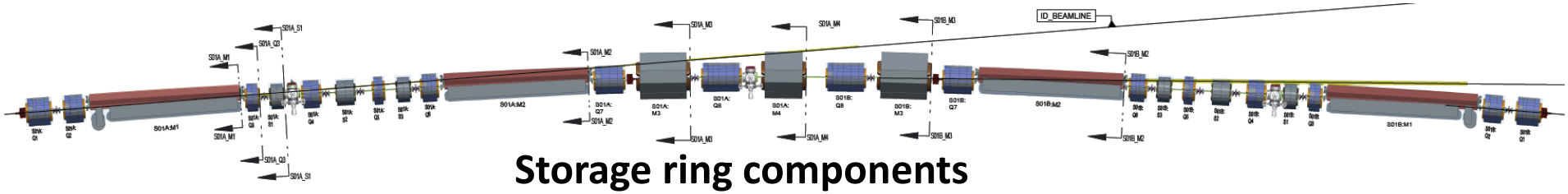
APS Upgrade Removal and Installation Summary

- **Minimizing down time is critical to our users.**
- **The APS Upgrade requires that the storage ring and associated systems be replaced within nine months in order to support a twelve month overall installation and commissioning period.**
- **To meet this schedule, all necessary components, equipment, resources and facilities must be ready prior to the start of the installation shutdown.**

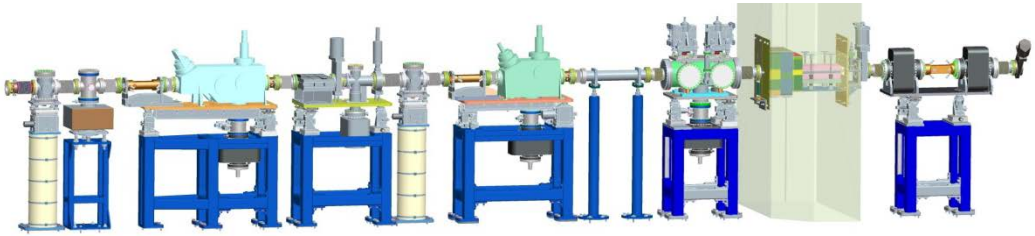


APS Upgrade Removal and Installation Summary

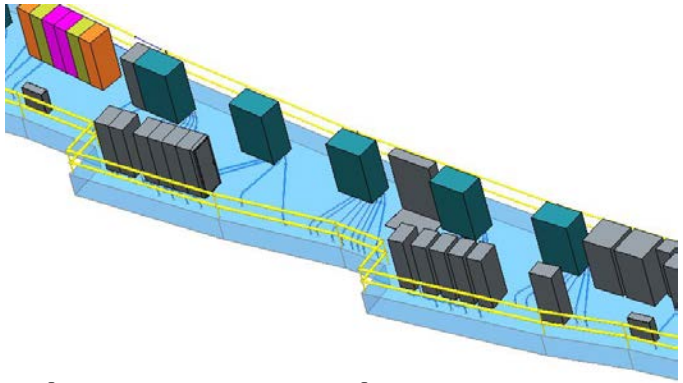
- **The major installation pieces:**



Storage ring components



Front ends



Electronics on the mezzanine

APS Upgrade Removal and Installation Summary

- **Work will be done on two eight hour shifts per day, five days per week.**
- **Roughly 100 personnel per shift will be needed throughout the removal and installation period.**
- **Plans are proceeding to provide for required work spaces.**
- **Comparison to other storage ring removal and installation projects worldwide indicates that the APS plan is achievable.**