NSLS-II INSERTION DEVICE CONTROLS PLAN

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Abstract

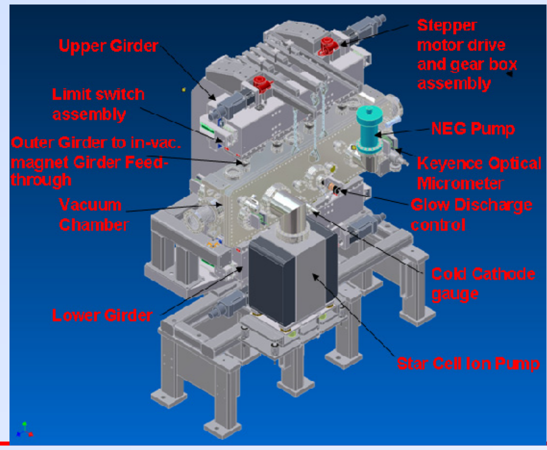
Controls on insertion devices (IDs) usually comprise of motor controls, encoders, cooling water for in-vacuum devices, various sensors such as limit switches and temperature sensors. Interlocks are provided independently from the device controls. They have been considered "slow" control elements and very little attentions have been paid to the response and latency of ID controls. However, current project scope of National Synchrotron Light Source –II (NSLS-II) project demands very tight tolerance of beam movement of submicron level. More frequent use of elliptically polarizing undulators (EPUs) also requires synchronized movement between gap and phase motions to ensure the stability. Furthermore, future demand for synchronization of ID state and beamline components prompt more sophisticated schemes. Synchronous Device Interface (SDI) is originally proposed for fast feedback I/O interface and integration of some ID controls to SDI is considered as well as other options.

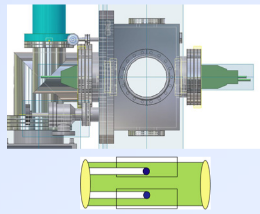
Planned Insertion Devices for NSLS-II (Phase-I) as of 10 / 2009

Name	U20	U22(IXS)	EU49	U21(SRX)	DW-1.8T	3PW
Type	IVU	IVU	EPU	IVU	PMW	PMW
Photon energy range	Hard x-ray (1.9-20keV)	Hard x-ray (9.1keV)	Soft x-ray (250eV-7keV)	Hard x-ray (1.9-20keV)	Broad band (<10eV-100keV)	Broad band (<10eV-100keV)
Type of straight section	6.6m	9.3m	6.6m	6.6m	9.3m	near 2nd Dipole
Period length (mm)	20	22	49	21	90	-
Length (m)	**3.0**	3.0 x 2	2.0 x 2	1.5	**3.5 x 2**	0.25
Number of periods	148 or 58	272	38 x 2	69	37 x 2	0.5
Magnetic gap (mm)	**5**	7.0	**11.5**	5.5	**12.5**	**28**
Peak magnetic field strength B (T)	1.03	0.78	0.57(Heli) 0.94 (Lin) 0.72(vlin) 0.41 (45°)	0.9	1.80	1.14
Keff	1.81	1.52	2.6(Heli) 4.3 (Lin) 3.2(vlin) 1.8 (45°)	1.79	15.2	-
hν fundamental, eV	1832.8	1802	230 (Heli) 180 (Lin) 285 (vlin) 400 (45°)	1560		
hν critical, keV					10.7	6.8
Total power (kW)	8.0	10.3	8.8	3.6	64.5	0.34

IVU System Components

- 4 Motors for gap control
- Limit switches (optical, mechanical)
- Vacuum monitor

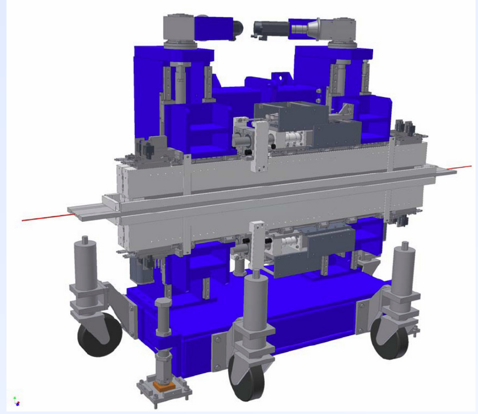




- Optical sensor for in-situ gap measurement (see above)
- Temperature sensors (array, water, shafts)
- Heater for shafts

Apple-II Advanced Conceptual Design

- 4 Motors for gap control
- 3 Motor for phase control ← Need Coordinations
- Limit switches (optical, mechanical)



Very Tight Beam Stability Requirement

- Planar DW has strong intrinsic vertical focusing $K_y \sim 1/\rho_w^2$ to be compensated.

Orbit Stability Requirements

$$\Delta x < 0.1\sigma_x \quad \Delta x' < 0.1\sigma_{x'}$$
$$\Delta y < 0.1\sigma_y \quad \Delta y' < 0.1\sigma_{y'}$$

•Magic fingers style quadrupole

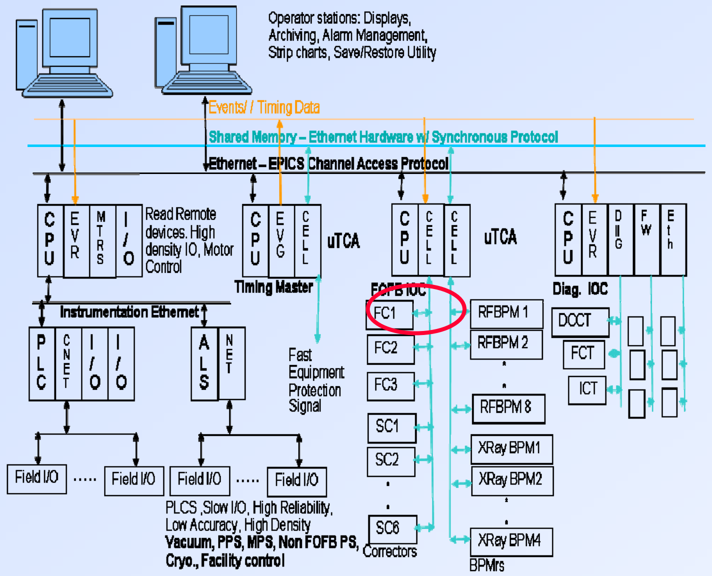
Electron Beam Sizes & Divergences

Types of source	9.3m ID	1-T 3-Pole wiggler	Bend magnet	6.6m ID
σ_x (μm)	108	175	44.2	29.6
$\sigma_{x'}$ (μrad)	4.6	14	63.1	16.9
σ_y (μm)	4.8	12.4	15.7	3.1
$\sigma_{y'}$ (μrad)	1.7	0.62	0.63	2.6

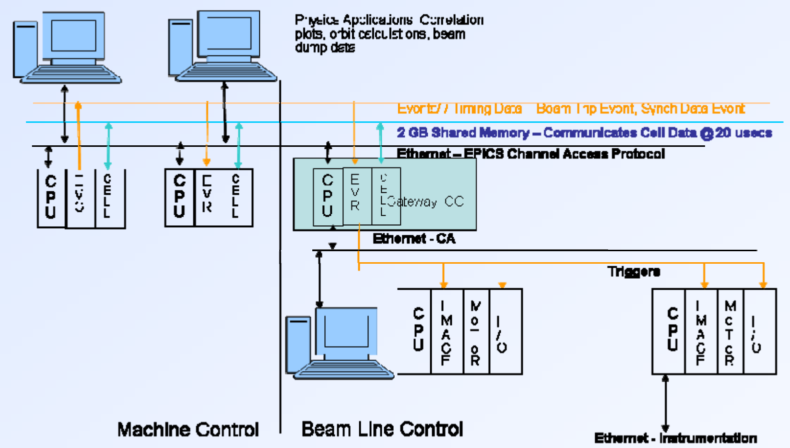
Most challenging Beam stability Requirements = ~ 0.31 μm

•Corresponding 2nd integral =310 G.cm.cm !!
•Require fast & fine feed-forward response for ID corrector magnets

NSLS-II Ring Controls Architecture



NSLS-II Beamline Controls Architecture



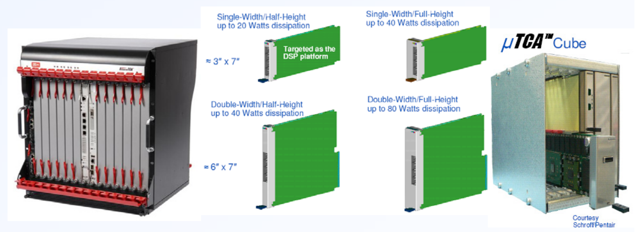
- NEOMAX new P-53CR magnet delivered.
- Standard Vanadium Permendur Poles ready
- BNL-VTF for accurate Hall probe mapping

TCA Solutions

•Advanced TCA (latest PICMG-3.5)
Originally for Telecommunications
Cf. xTCA for Physics under development

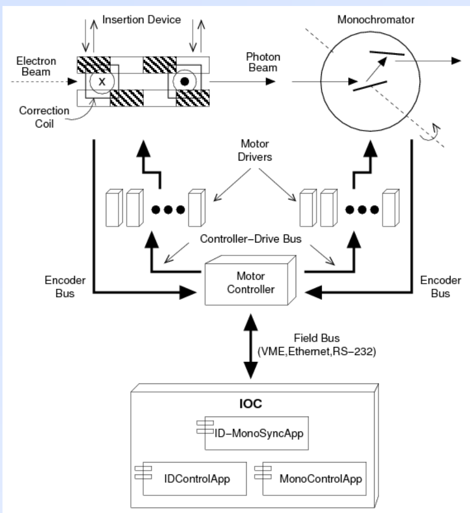
•Advanced MC
AMC Carrieers and Hot Swappable Mezzanine Card

•Micro TCA (MTCA.0)
Shelf and Infrastructure to Support the direct use of AMC Modules into the Backplane

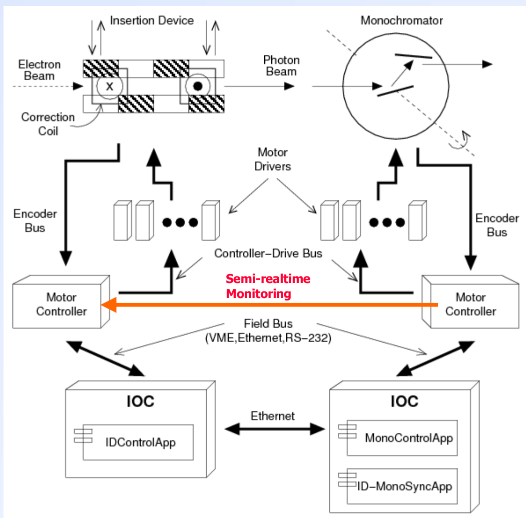


Undulator Gap / Monochromator Synchronization

- Single IOC / Motor Controller Option

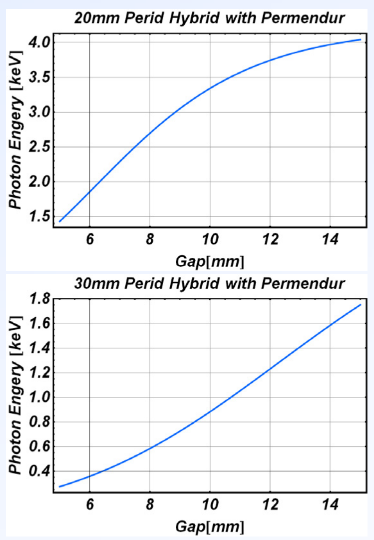


- Dual IOCs / Motor Controllers Option

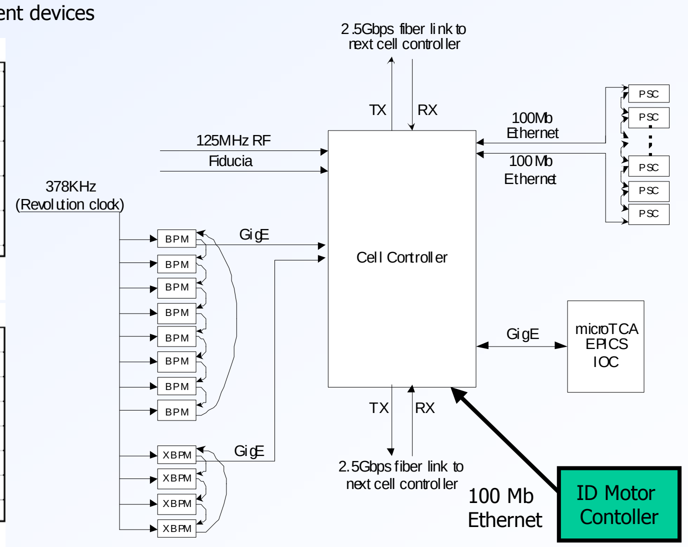


Photon Energy as a Function of ID Gap

- E (gap) could be very different for different devices



FOFB with SDI



Summary

- Baseline Insertion Devices consist of 6 DWs, 2 EPUs and 4 IVUs. One 3PW will be built for test purpose.
- Cryo-IVU may require additional control components such as feed back loop for temperature regulations as well as other standard IVU control elements
- Apple-II type EPU could have up to 8 axes of motor controls which must be coordinated among themselves and PS controls.
- Synchronization of motions between undulator gap/phase and monochromator angle in semi-real time is envisioned with various schemes.
  - Plan 1) Low level dedicated connection between two identical motor controllers with position synchronized signals.
  - Plan 2) Using a bridge between shared memory networks in accelerator and beam line to share the ID gap/phase data.
  - Plan 3) Join ID motor/ PS control & monochromator controls to SDI network.

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