National Synchrotron Light Source II

1. Status of HXN IVU Repair
2. Planning future operations at 500 mA

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UEC Town Hall Meeting

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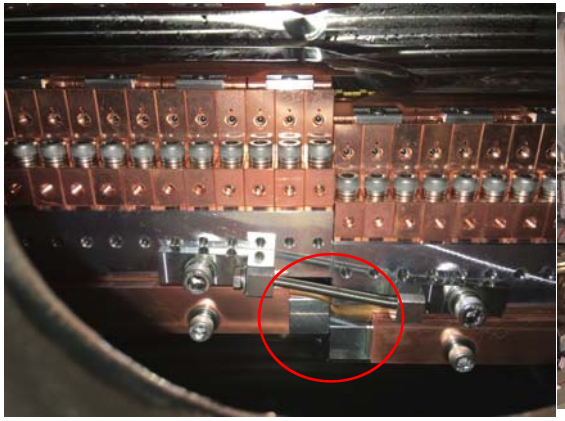
U.S. DEPARTMENT OF ENERGY | Office of Science

BROOKHAVEN NATIONAL LABORATORY

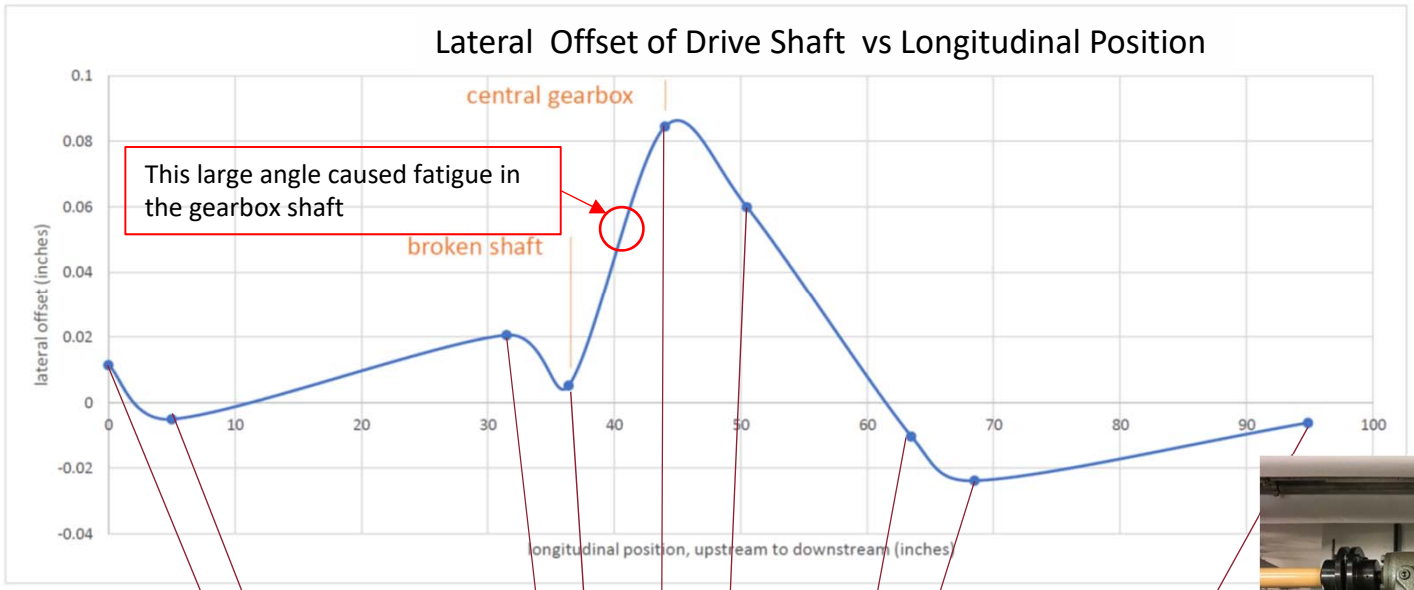
HXN (C3)-IVU Incident

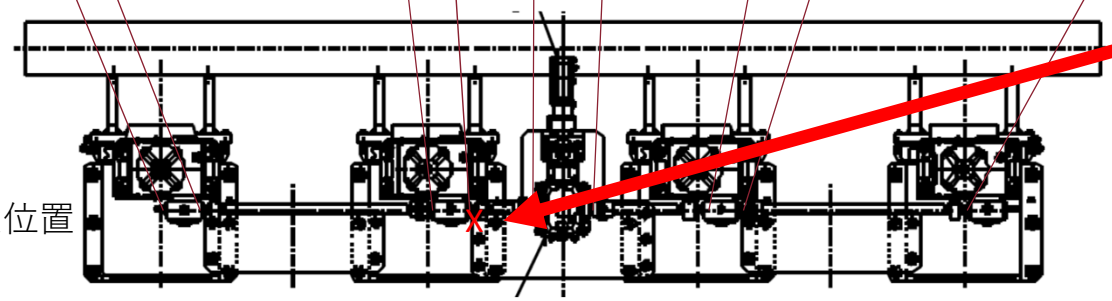
- Just after midnight (0:08) on 7/1/2018, C3-IVU gap stopped responding. Soon after (0:11) gate valves around the straight closed. Operator stopped water at 2:23am.
- With truly commendable effort by all the AD groups, the device was uninstalled and the straight was back to operation with only 30 hours of loss of operation.
- The device was transported to ID-MMF (bldg. 832) for repair.
- This was the first accident of this nature by this manufacturer with more than 30 IVUs of similar design.



Root cause

It was determined that the primary root cause of the gearbox shaft failure at Cell 3 is misalignment of the drivetrain. It was likely to be created during transportation.



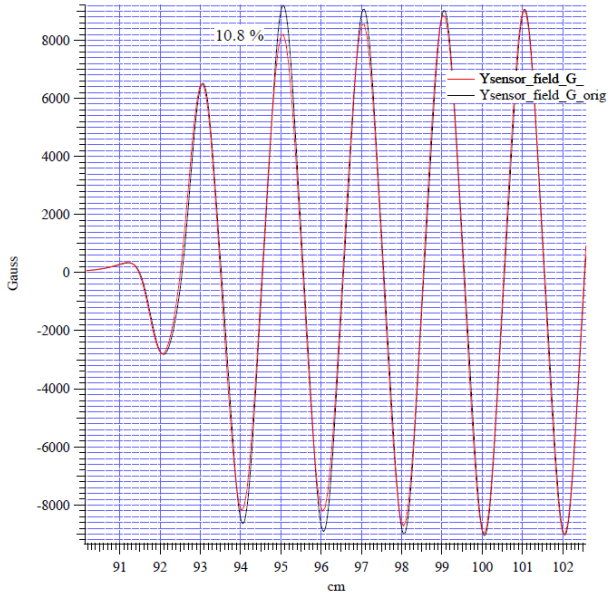


各測定位置

Recovery Efforts

- While waiting for a spare gear box to arrive, the damaged gear box was moved to the right most position to reconnect the drive train.
- Realign the drive train with a Faro-arm.
- Magnetic measurement found that the first six modules had been slightly demagnetized. They were replaced with spare modules.
- The following preventive measures have been implemented:

  - PLC in DeltaTau software which monitors the difference between US and DS linear encoder's reading even during the gap motion. If the discrepancy is greater than 100 microns, the motion will be stopped.
  - Switches which can detect slight shift between girders. Once detected, send signal to kill the motor.

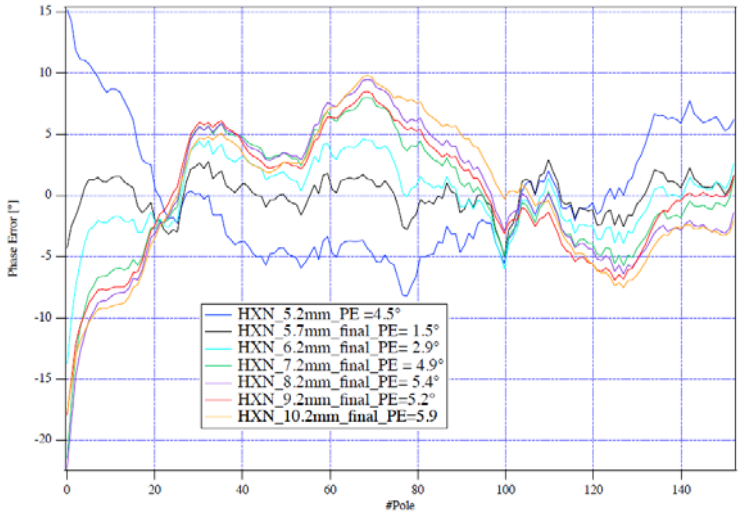


HXN-IVU Magnetic Performance

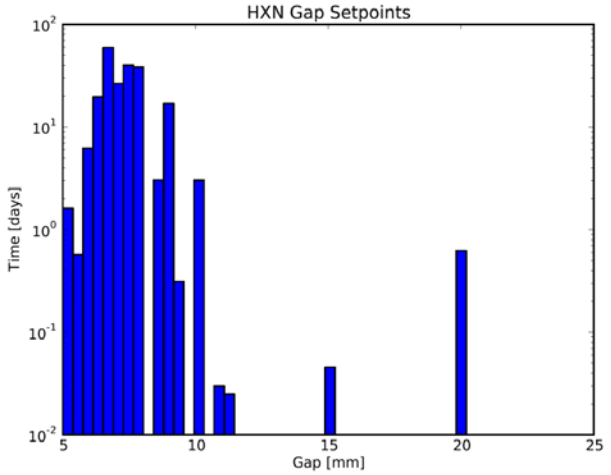
HXN - Multipole

Gap [mm]	5.2	5.7	6.2	7.2	8.2	9.2	10.2
ND [G cm]	-147	-163	-167	-174	-168	-170	-159
SD [G cm]	25	21	17	8	4	-0.2	-2.3
NQ [G]	53	10	-13	-69	-82	-28	-34
SQ [G]	-38	-65	-11	-3	38	11	38
NS [G/cm]	2	33	14	83	66	142	96
SS [G/cm]	-181	-159	-128	-34	-35	-94	-81

Phase Error vs Gap



PE optimized for most used gap range

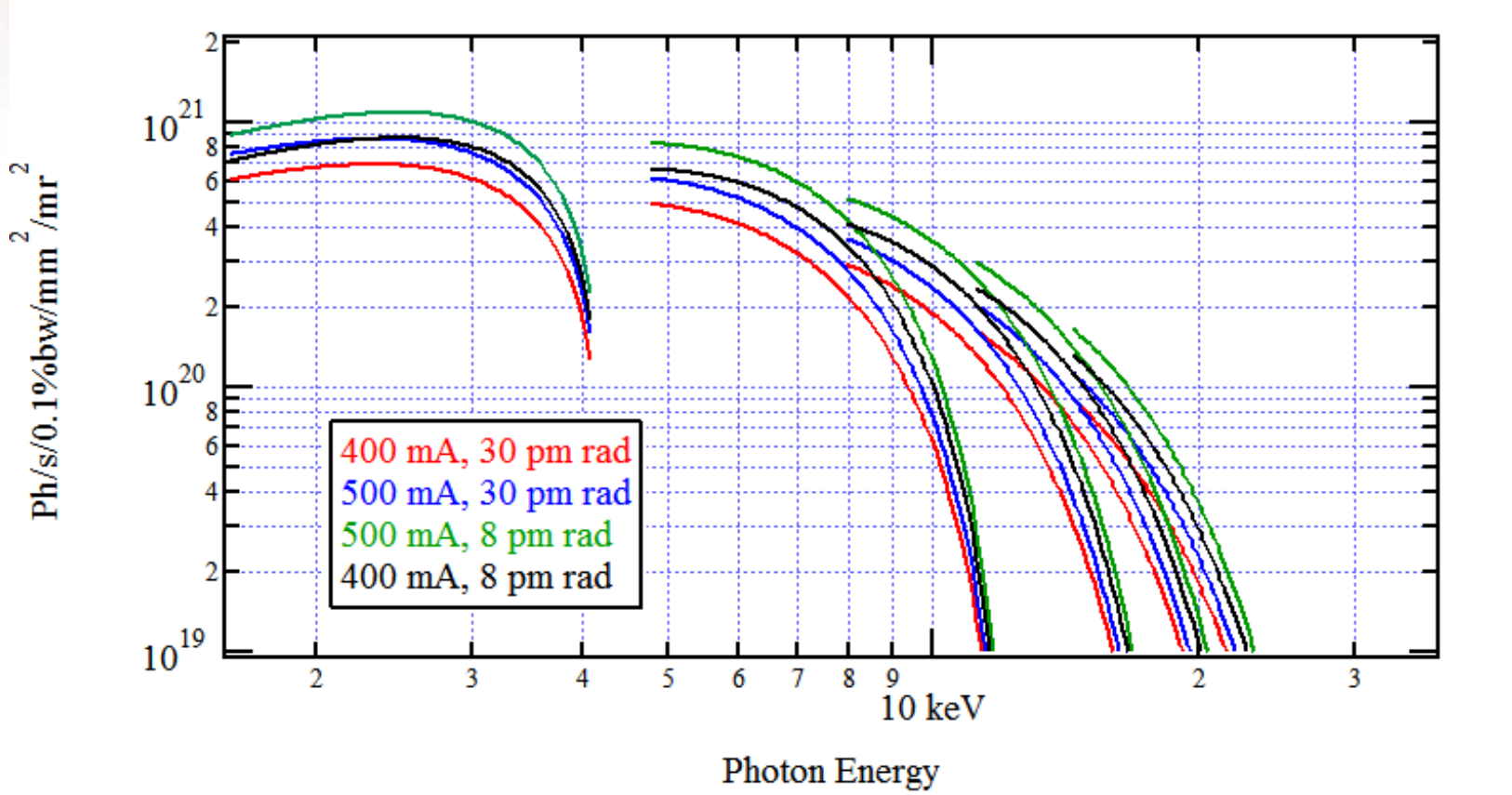


Plans for Coming Weeks

- Complete pre-baking in bldg. 832 by 12/15
- Move the device to SB2 on 12/18 and to Cell 3 on 12/19 while pulling cables
- Vacuum connection and baking until 1/3/2019
- Cable connection from 1/4 to 1/9
- Utility work on 1/7
- Final survey on 1/10
- Function tests from 1/18-22

Planning Future Operations at 500 mA

Brightness (HXN Example)



- Brightness increases with increasing current and with decreasing emittance
- One can choose which method has the greatest overall benefit

Considerations for planning parameters of future operations

Beam Current, Emittance, Peak Current and Lifetime

today's compliment of IDs	I	# of RF	3rd HRF	V-Emittance	Reliability	I limit, mA	total P	I peak I av'	Lifetime	TO interval	Q/shot	Voltage	Mom Aper
	mA			pm rad	%	if 1RFC failed	kW	A^2	hrs	min	nC	MV	%
400 mA, 2RF, no 3rd HC, 30 pm rad TODAY	400	2	no	30	95.97	280.83	230	11.992	9	2.7	7.54	3	2.84
400 mA, 2RF, no 3rd HC, 8 pm rad	400	2	no	8	95.97	280.83	230	11.992	5.2	1.5	7.54	3	2.84
500 mA, 3RF, no 3rd HC, 30 pm rad	500	3	no	30	95.97	500	460	19.75	9	2.7	9.42	3.3	3
500 mA, 3RF, 3rd HC, 8 pm rad	500	3	yes	8	95.97	500	460	7.8	11	3.3	9.42	3.3	3

- 500 mA operation without harmonic cavity creates heating issue in ring components due to high peak current
- 400 mA 8 pm rad operation without HC requires frequent top-off injections due to short lifetime, possibly impacting user scans

Accelerator Vulnerabilities Strategic Plan

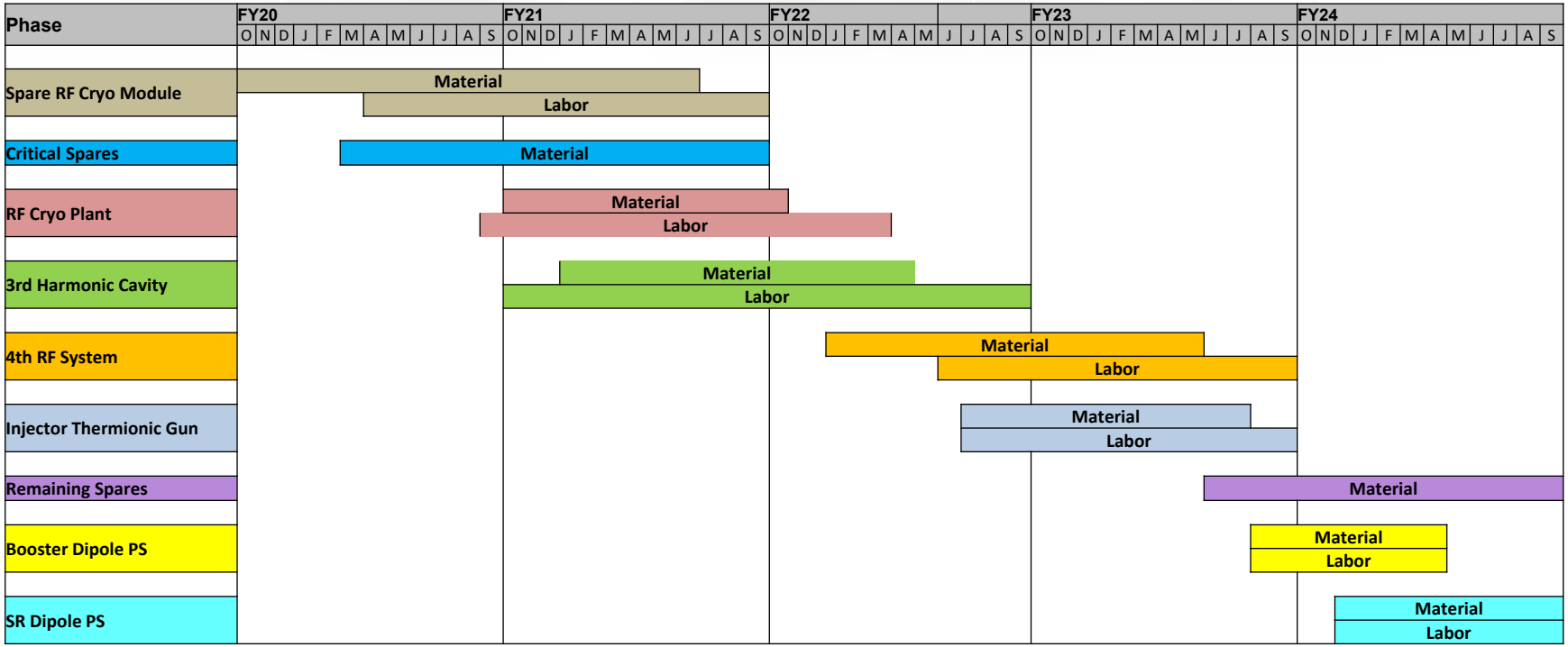
Project	Priority	FY complete if started in FY20
Spare RF Cryo module	1	FY22
Spares not in hand (critical)	2	FY20-22
Water system spares (CT)	3	FY20-22
RF Cryo plant	4	FY22
3rd Harmonic Cavities	5	FY22
4th RF system	6	FY23
Injector thermionic gun	7	FY23
Spares not in hand (priority 2)	8	FY22-24
Booster Dipole PS	9	FY24
Storage ring Dipole PC	10	FY24

Based on previous results of:

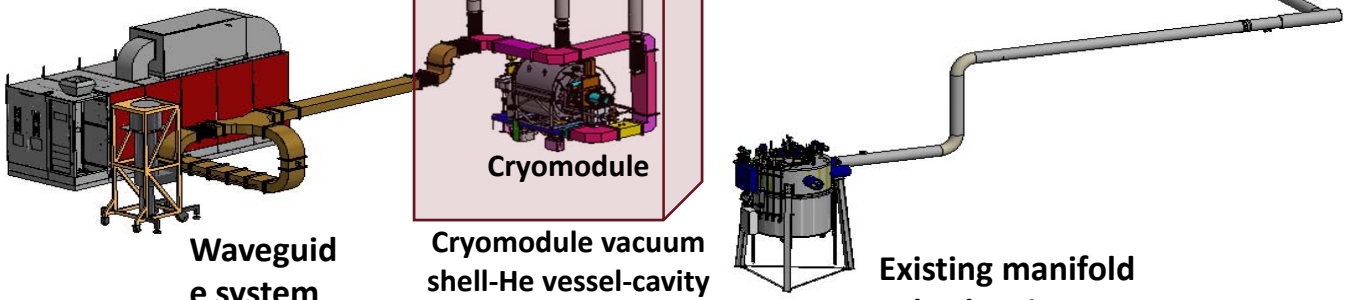
- beam current and emittance on brightness,
- lifetime,
- heating and
- potential downtime,

a set of accelerator improvements has been prioritized for further discussion

Proposed Accelerator Vulnerability Mitigation Schedule



3rd RF system components Status



300 kW 500 MHz
Solid State Transmitter
Preliminary design review
December 2018
Delivery to BNL March, 2020

Valve box on tunnel roof cell 22
In production
Complete May 2019

Multi-channel transfer line (MCTL) from Manifold box to Valve box and MCTL to cavities
Delivery ~February 2020

Waveguide system 90% complete

Cryomodule vacuum shell-He vessel-cavity assembly complete and cold tested. End group and waveguide final assembly in class 100 clean room in progress- Complete in January, 2019

Existing manifold valve box in RF Bldg

System operational FY2020