

Status and Plans for the Motional Stark Effect Diagnostic on NSTX

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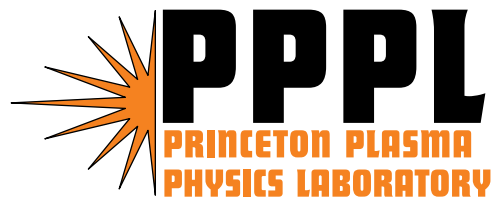
Greg LeMunyan, Technician, Nova Photonics, Inc.

Karen Hirst, Technician, Nova Photonics, Inc.

David Card, Technician, Nova Photonics, Inc.

Vincent Corso, Mechanical Designer, ULTRA-VAC

Dr. Eugene Oks, Auburn University, (Theory/Modeling)



Presented at the 13th NSTX PAC MEETING

September 30 - October 1, 2002

Princeton, NJ

Outline

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- Motivation and strategy of MSE-CIF and MSE-LIF diagnostics.
- Status and schedule of MSE-CIF.
- Status of MSE-LIF.
- MSE-LIF plans.
- MSE-LIF schedule.

Motional Stark Effect (MSE) Diagnostic

Strategy: **MSE-CIF** & MSE-LIF

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- The collisionally induced fluorescence (MSE-CIF) system is estimated to have 5 ms time resolution and 0.2° uncertainty.
 - Tangential view of the heating beam.
- Special considerations due to low magnetic field:
 - Novel optics design to reduce geometric Doppler broadening.
 - Development of high throughput, high resolution birefringent filter.
- The MSE-CIF diagnostic will provide;
 - Measure $q(0)$.
 - Pitch angle profile – E_R correction from neo-classical calculation for poloidal flow and CHERS.

Motional Stark Effect (MSE) Diagnostic

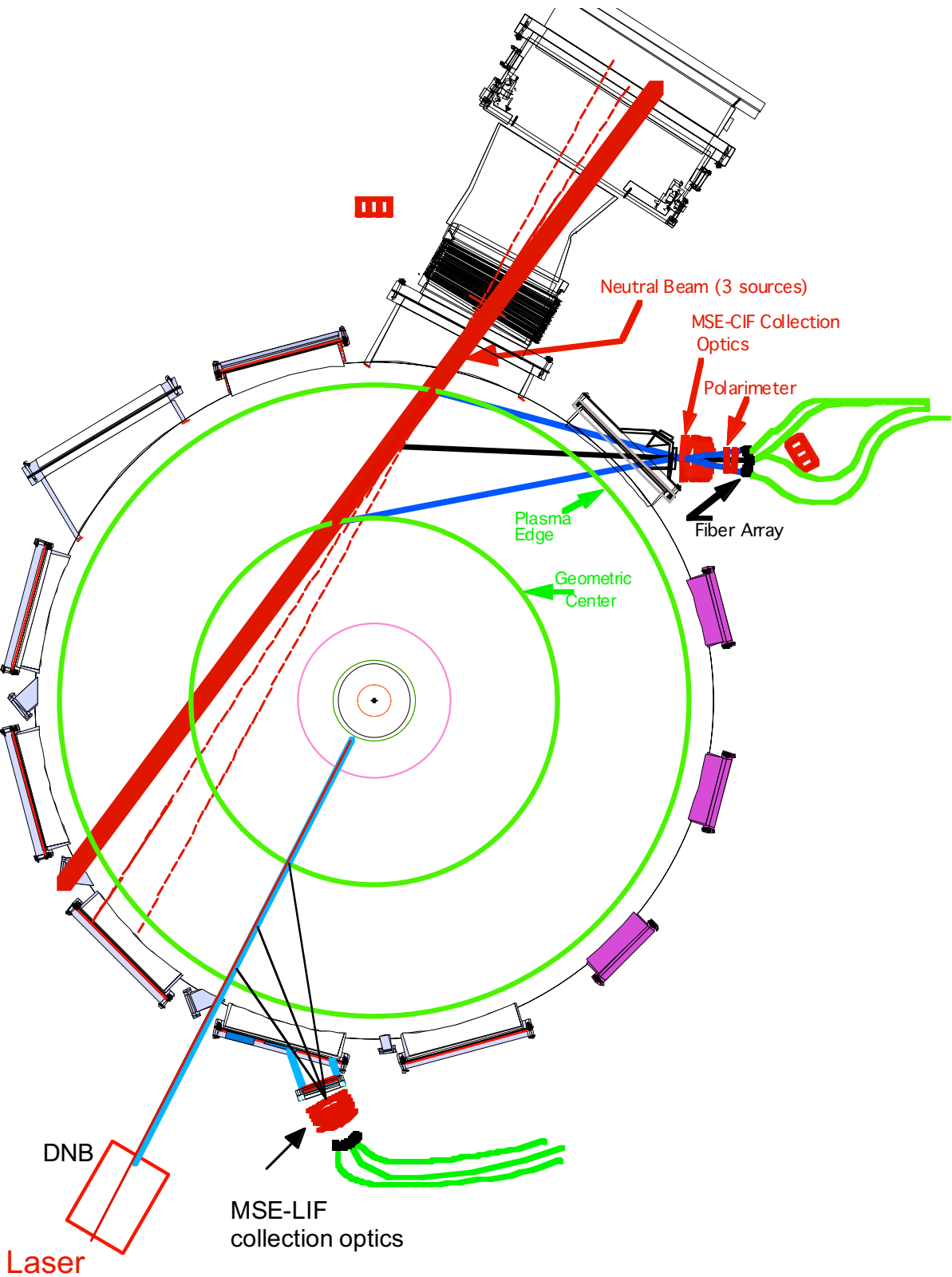
Strategy: MSE-CIF & **MSE-LIF**

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- MSE via laser-induced fluorescence (MSE-LIF) is estimated to have comparable time resolution and pitch angle uncertainty as MSE-CIF system.
 - New approach under *development* ; using a diagnostic neutral beam (RF source) and laser-induced fluorescence (LIF).
- Provide enhanced measurement capability;
 - E_r ($\sim \pm 1$ kV/m) combined with MSE-CIF.
 - $|B|$ ($\leq \pm 0.1\%$) to obtain the diamagnetic profile and hence $P(R)$.
 - Magnetic field pitch angle profile without heating beam.

MSE Diagnostics Layout

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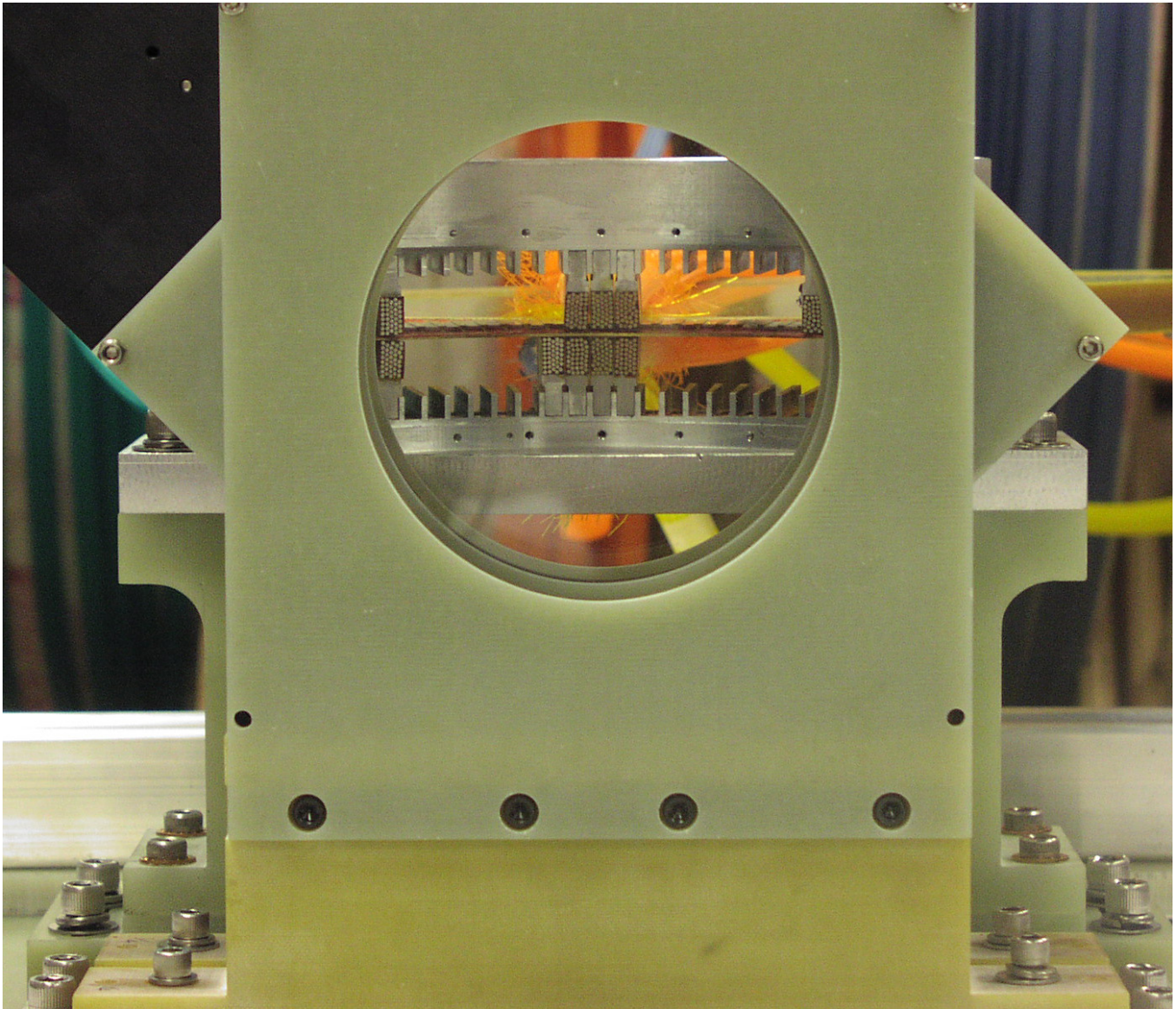
Current Status and Schedule: MSE-CIF

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- Installation of fiber optics is complete. Final alignment and spatial calibration scheduled for early October.
- Birefringent filter: All aspects of filter successfully demonstrated. Integration and testing underway.
- Schedule;
 - First light – Jan. 2003 (2-3 channels).
 - Increase to 10 channels during 2003 run (available March/May 2003).
 - Increase to 19 channels in 2004 (pending proposal/budget approval).

Fiber Optic Holder

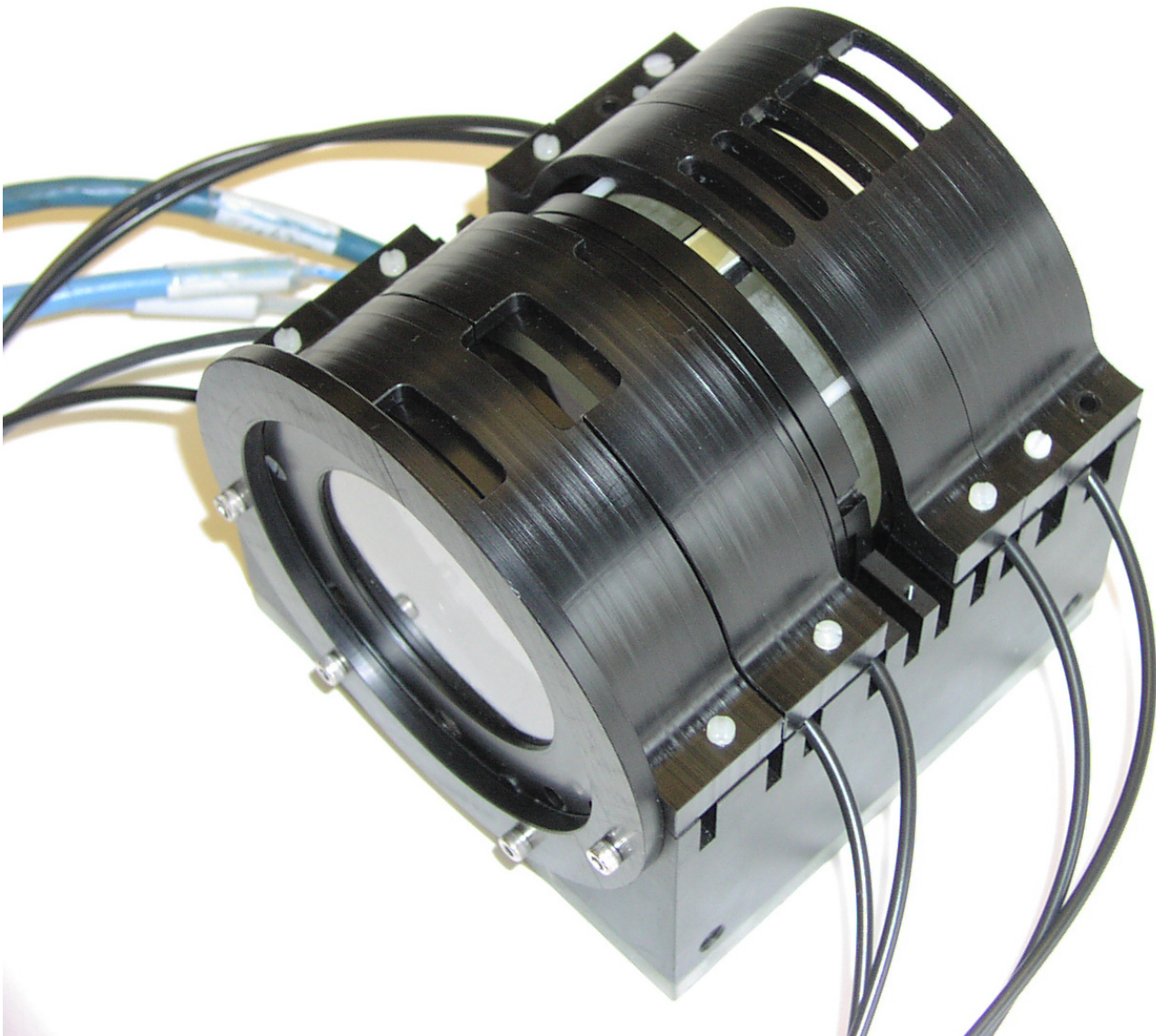
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- View of fiber holder with a few fiber ferrules installed.
- Fiber holder is now fully populated and installed on NSTX.

Birefringent Filter Prototype

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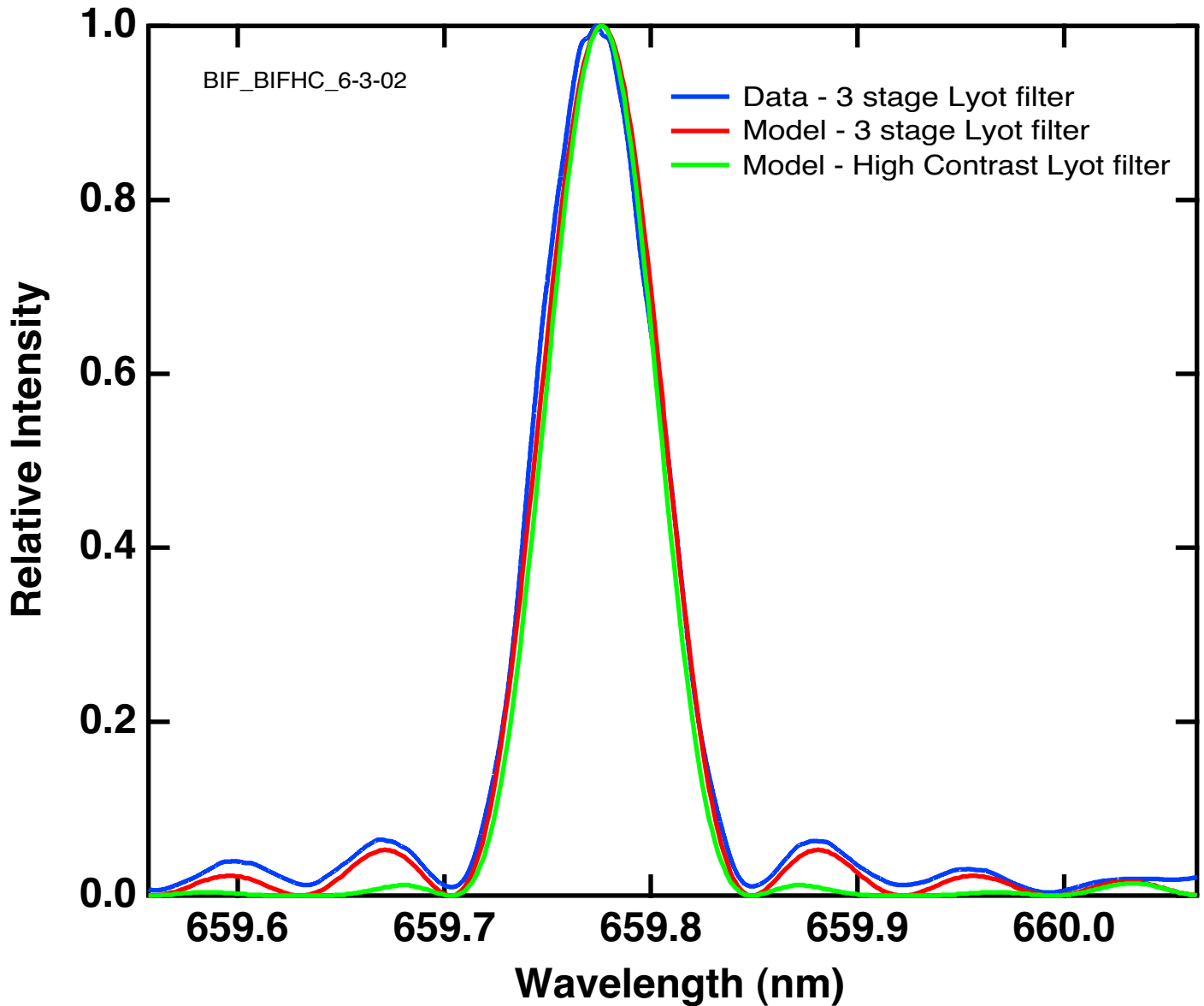


- Prototype filter.
- Birefringent crystals are 3 inch diameter. The clear aperture is 2.5 inches.
- Tuning is done electro-optically. Possible future upgrade: scan filter on a kHz time scale.

Three Stage Filter for MSE-CIF

Compared to Model

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- Data agrees well with model.
- A high contrast modification can reduce side lobes, if necessary.

Issues for MSE-CIF Schedule

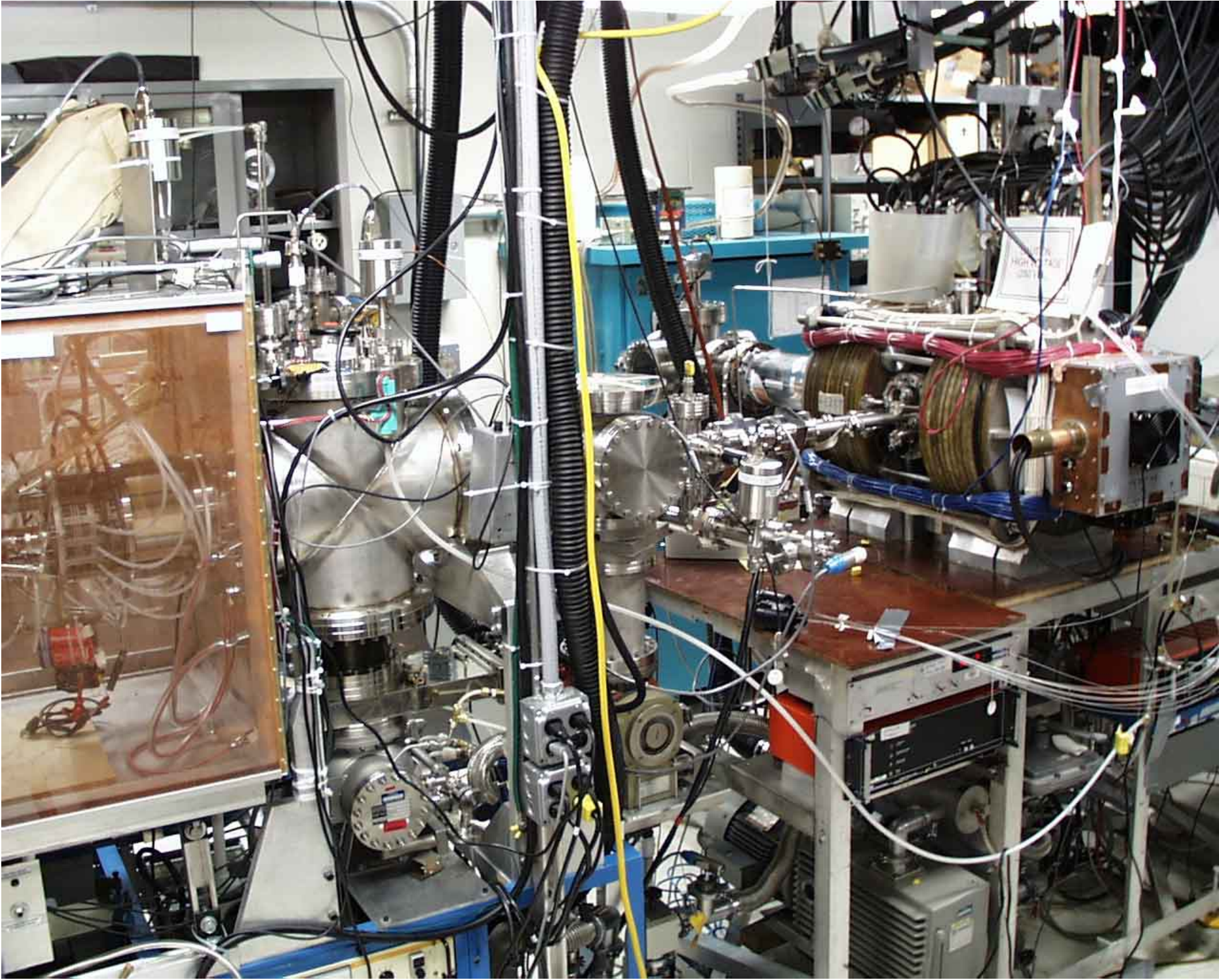
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- Key issues.
 - Technician is leaving. Plan to hire two new people. Karen Hirst has just started and David Card will begin Oct. 1, 2002.
 - Search for physicist in progress to support MSE-CIF diagnostic.
 - Lots of work remaining...fabrication, assembly, testing, software,...etc.

Present Status: MSE-LIF

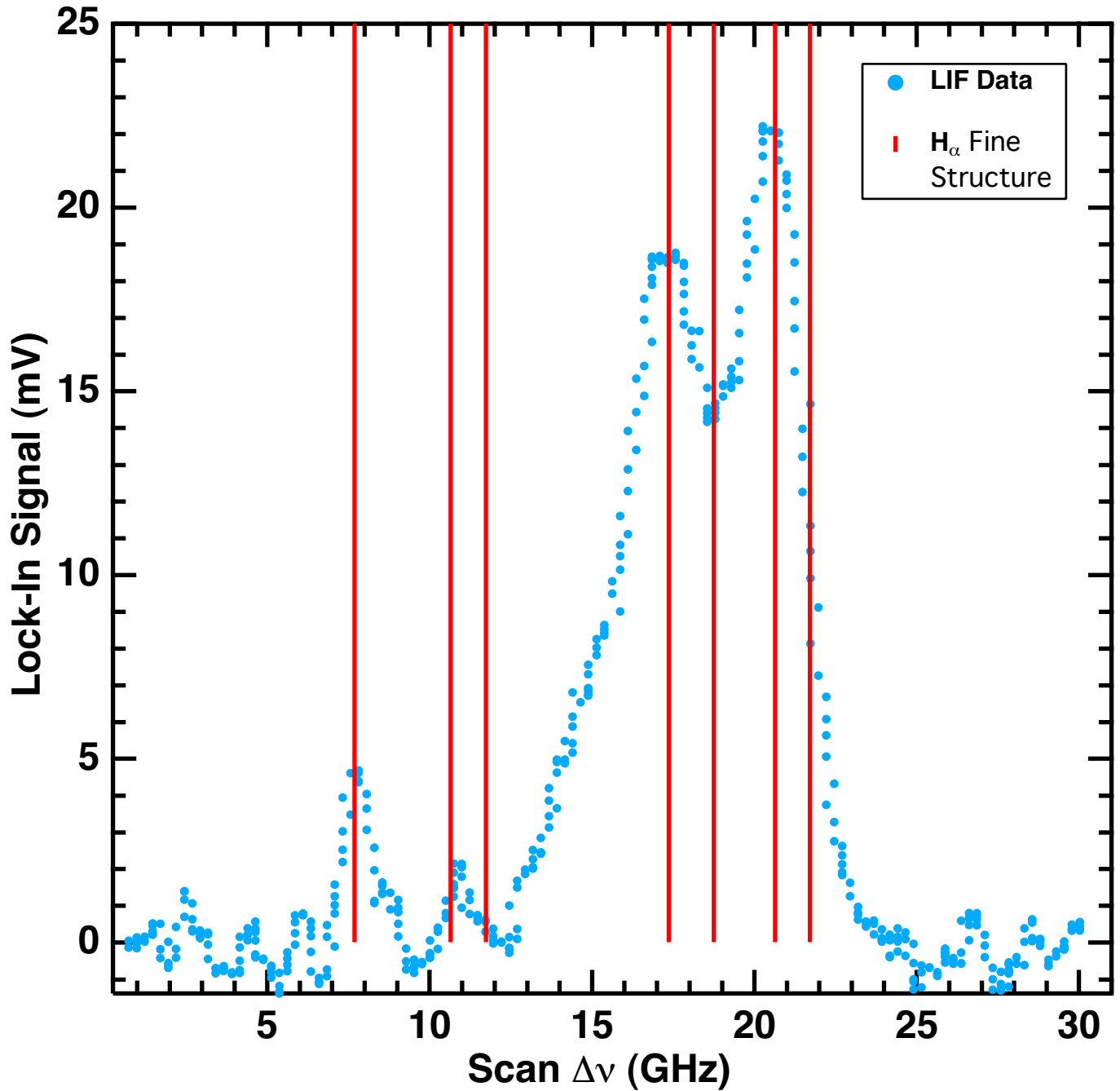
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- Project is funded under DoE Diagnostic Development...was renewed a few months ago after a competitive solicitation process.
- LIF signal observed from beam into neutral gas. Broad linewidth due to ripple from high voltage power supply and RF coupling to beam.
- We are using a borrowed power supply and have reduced the power supply ripple and RF coupling to < 10 Volts with filters and added fault protection. Would like the ripple to be $\leq 1 V_{pp}$.
- Our original power supply was returned to vendor to be refurbished and ripple reduction improvements incorporated. This has not gone well and it appears they will not be able to deliver.



LIF From Neutral Beam

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- Data consistent with observation of H $_{\alpha}$ fine structure
- ~ 4 GHz linewidth believed to be due to ripple on beam acceleration power supply voltage

Present Status: MSE-LIF

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- Several technical problems associated with the RF source, including...
 - RF feedthru on neutral beam source failed. This has been redesigned and replaced.
 - Reliability problems with internal antenna and protective insulation over the antenna.
 - Unreliable and variable RF coupling to plasma.

MSE-LIF Plans

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- The plan was to build a new RF source for the beam, incorporating several improvements that the Berkeley group has developed over the last 20 years.
- New features include;
 - Magnetic filter for high atomic fraction ($>70\%$) and low axial energy spread.
 - Line cusp (instead of ring cusp) for better uniformity across extraction grid.
 - External RF antenna.
 - Improved RF matching circuit to reduce RF coupling to beam and axial energy spread (< 2 eV).























Accelerated MSE-LIF Schedule

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- In order to accelerate MSE-LIF development and NSTX installation schedule;
 - Subcontract to Berkeley group: design, fabricate, and test a new source, including optimizing electrode design to maximize current density and minimize beam divergence.
 - Purchase/design new low ripple power supply 40 kV and 60 ma ($\sim 1 V_{pp}$).
 - Additional technical support from PPPL (or budget increase for Nova Photonics) in FY03 for MSE-LIF development.

MSE-LIF Schedule

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Task	FY03	FY04	FY05	FY06
Laboratory development				
Modify existing DNB source Procure source from Berkeley	 			
Modify existing power supply Procure commercial ps	 			
Assemble & test DNB				
Upgrade laser	 			
LIF in neutral gas & plasma		  		
Experimental work/complete dissertation				
NSTX preparation and installation				
NSTX site preparation		 		
Fabricate optic/fibers/detectors		 		
Install DNB/laser/optics				
Shakedown/calibrate		 		
Produce calibrated data			 	



key decision point



Old plan



Modified plan -with additional technical support from PPPL

MSE-LIF Schedule/Cost

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- The proposed schedule is very aggressive and dependent on additional PPPL support.
- FY03: Technical support to accelerate MSE-LIF development and keep the MSE-CIF on schedule.
- FY04: Technical support for MSE-LIF preparation (second DNB fabrication if required?).