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# **Update on A0 Photoinjector and Progress at NML**

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FNAL / APC**

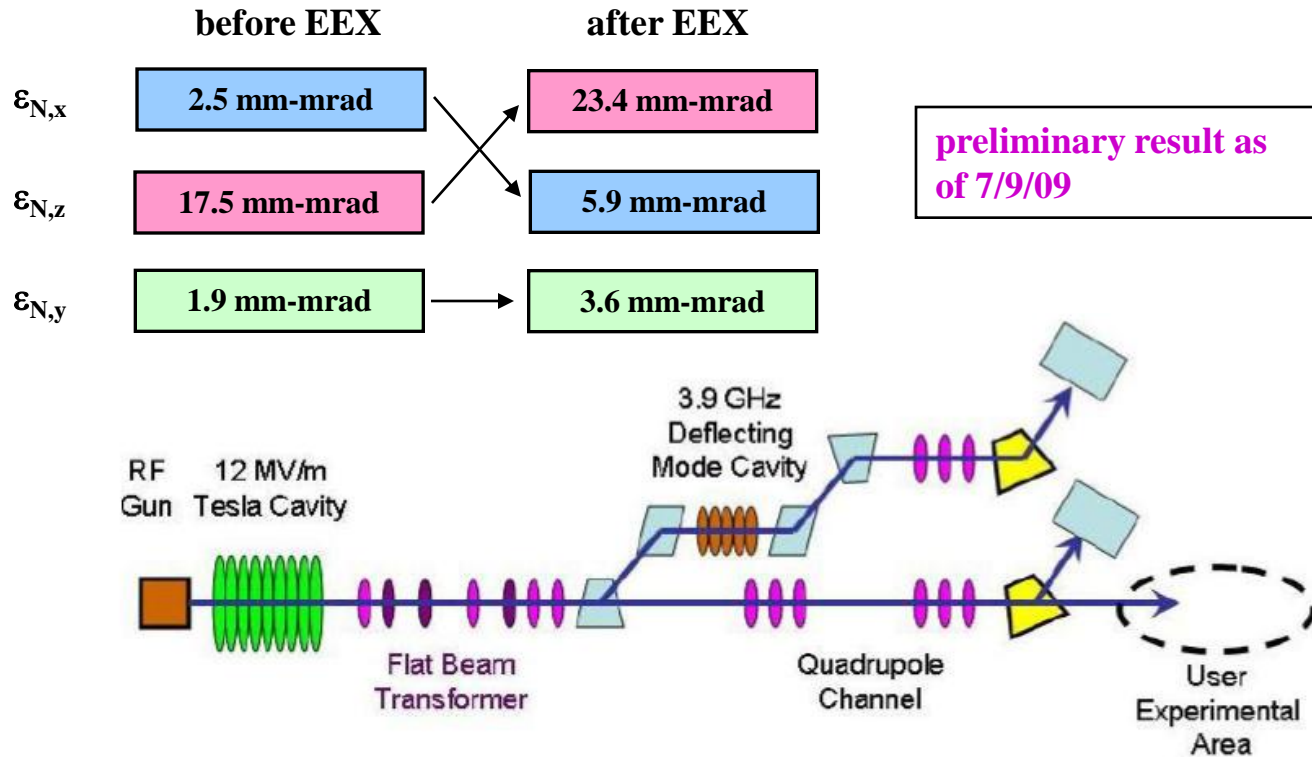
# Status of A0PI Program

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- **Emittance Exchange Experiment (EEX) – H. Edwards, *et. al.***
- **Slit microbunch generation – Y-E Sun, *et. al.***
- **Ellipsoidal beam generation – P. Piot, *et.al.***
- **Electro-optical BPM – T. Maxwell, *et. al.***
- **Test of prototype instrument cross for NML (and possibly other instrumentation) -- M. Wendt, *et. al.***
- **Upgrades (or lack thereof)**

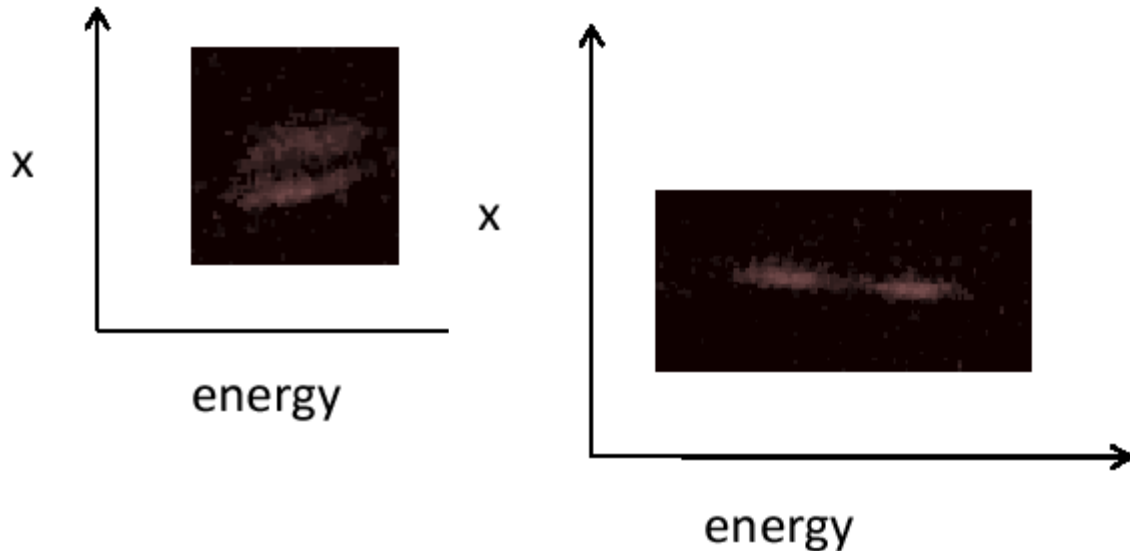
# Emittance Exchange

- First emittance exchange results were obtained and presented at PAC09 (T Koeth, *et. al.*)
- Tim Koeth graduated and moved on to UMER. New graduate student (Amber Johnson) will hopefully take up the mantle and continue this experiment.
- Improved measurement of the beam and better understanding of the instrumentation will improve results (we think).

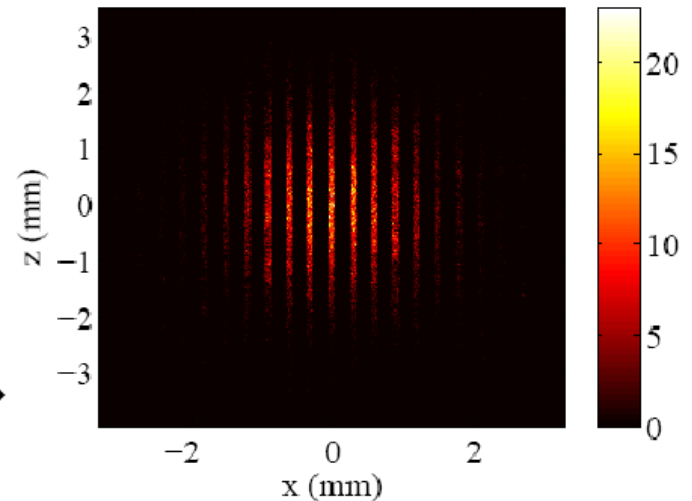
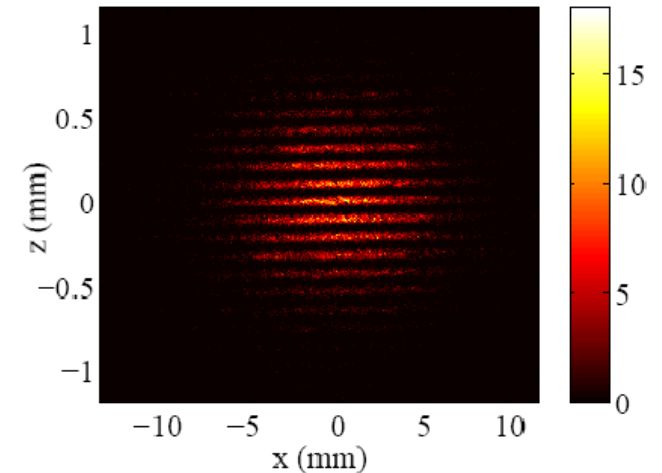


# Slit Microbunch Generation

- Horizontal slit mask is placed in the beam, creating transverse beam structure; beam is then passed through EEX, producing longitudinal beam structure
- Experiment is just starting up; intensified camera and cryogenic bolometer have been purchased; expect early results this Fall



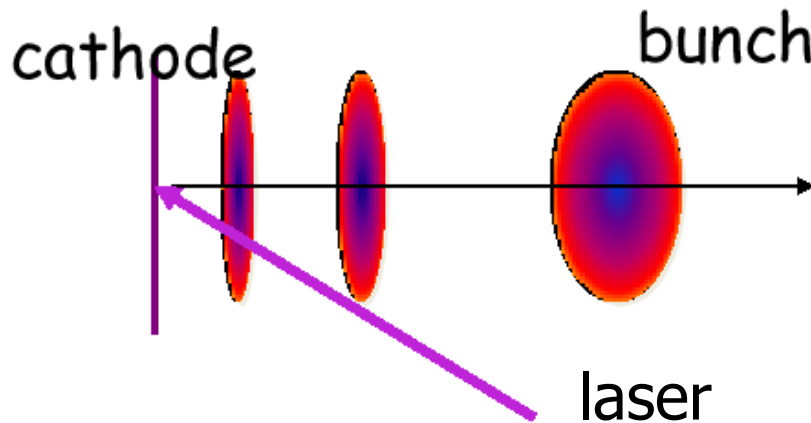
preliminary 2-slit data



optimized multi-slit simulation

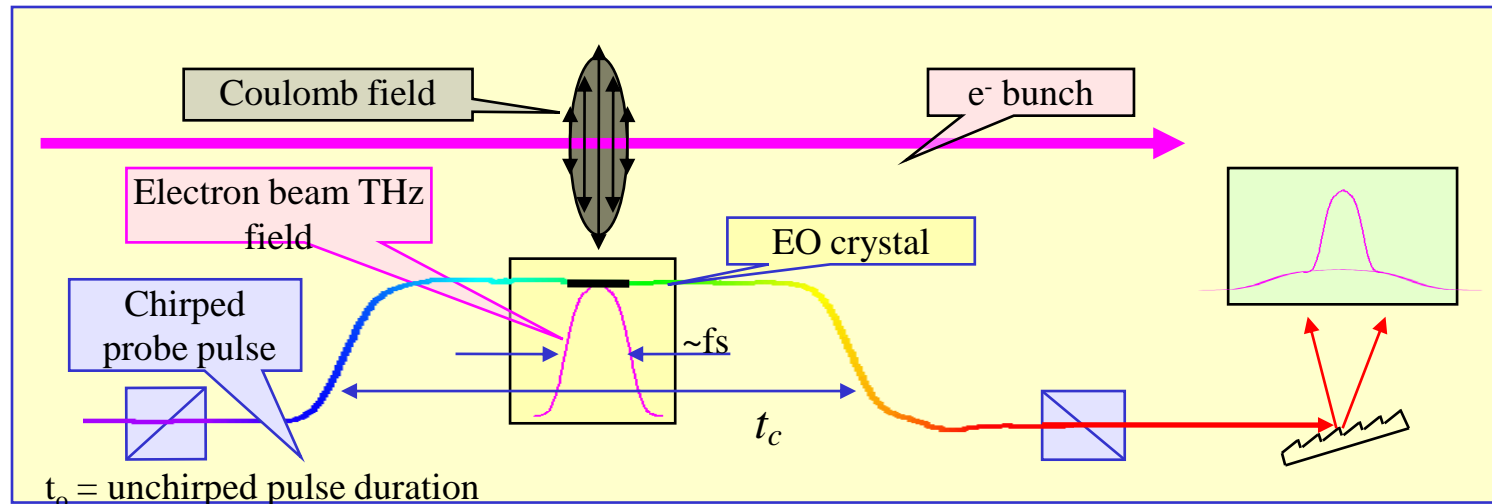
# Ellipsoidal Beam

- In uniform ellipsoidal distributions, space charge forces are linear with respect to position, so ideally there is no emittance growth due to space charge near the photo-cathode
- Recently demonstrated with metallic cathodes in an RF gun [Musumeci, *et. al.* in PRL 100 (2008); Luiten, *et. al.* in AAC08]
- Requires Ti:Sa laser to produce the appropriate bunch characteristics at the photocathode (~50 fs bunch length)
- NIU has recently purchased a Ti:Sa laser; will be commissioned for A0 operations by January 2010



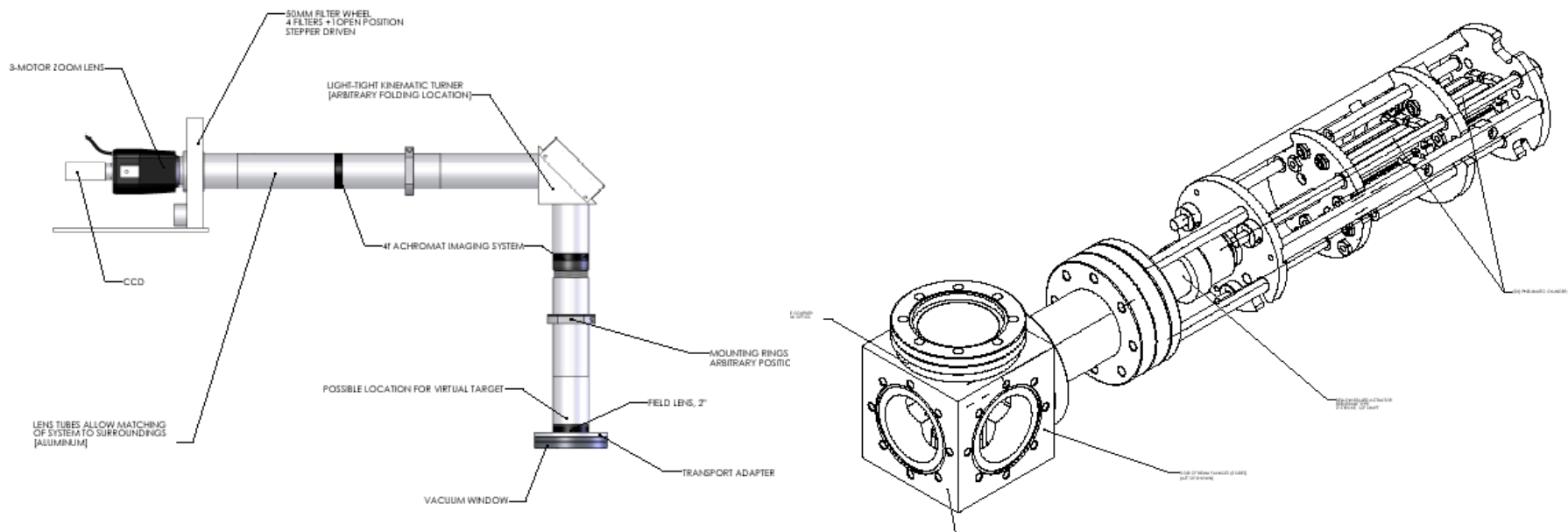
# Electro-optical BPM

- This will be the thesis experiment of Tim Maxwell (NIU)
- Will attempt to measure bunch centroid as function of longitudinal position within the bunch utilizing ultrashort Ti:Sa laser. Laser light will be transported from laser room to beamline via optical fiber
- Have assembled and tested single-shot laser autocorrelator; have purchased FROG (Frequency Resolved Optical Gating (measures  $\lambda$  vs. time in laser pulse)); developing laser pulse stretcher/compressor for fiber compensation and spectral decoding
- BPM will be installed in recommissioned “user beamline”; need to investigate wakefield effects to minimize experimental background



# Test of Prototype Instrument Cross for NML

- We have contracted with Radiabeam to produce a prototype instrument cross to be used at NML. It is a 6-port device: 2 ports for beam, 1 port for vacuum, 1 port for a 3-position actuator insertion of YAG/mirror and OTR/mirror assembly, and 1 port for output of light and optics transport. This will be the primary device for measuring beamsizes at NML for both the injector line and high energy test lines. Various deficiencies of instrument cross at A0PI are being corrected.



# Upgrades

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- **The current schedule is to shut down operations at A0PI at end of FY10 and start moving required equipment to NML. (Major items from A0PI required at NML are CC1 (1.3 GHz SC acc. cavity), laser equipment, and 3.9 Gz deflecting mode cavity.)**
- **New PITZ style electron gun was originally proposed to be conditioned and installed at A0PI. The gun will not be ready for conditioning until 2/10, so we will now install it directly at NML.**
- **CC1 was originally proposed to be replaced by CC2 at A0PI to increase the beam energy. CC2 has now been installed directly at NML for recommissioning there. CC1 will be upgraded when it is removed from A0PI.**
- **Only upgrade in progress at A0PI is to reconfigure and recommission the downstream user beamline for prototype instrumentation tests. (Almost complete.)**



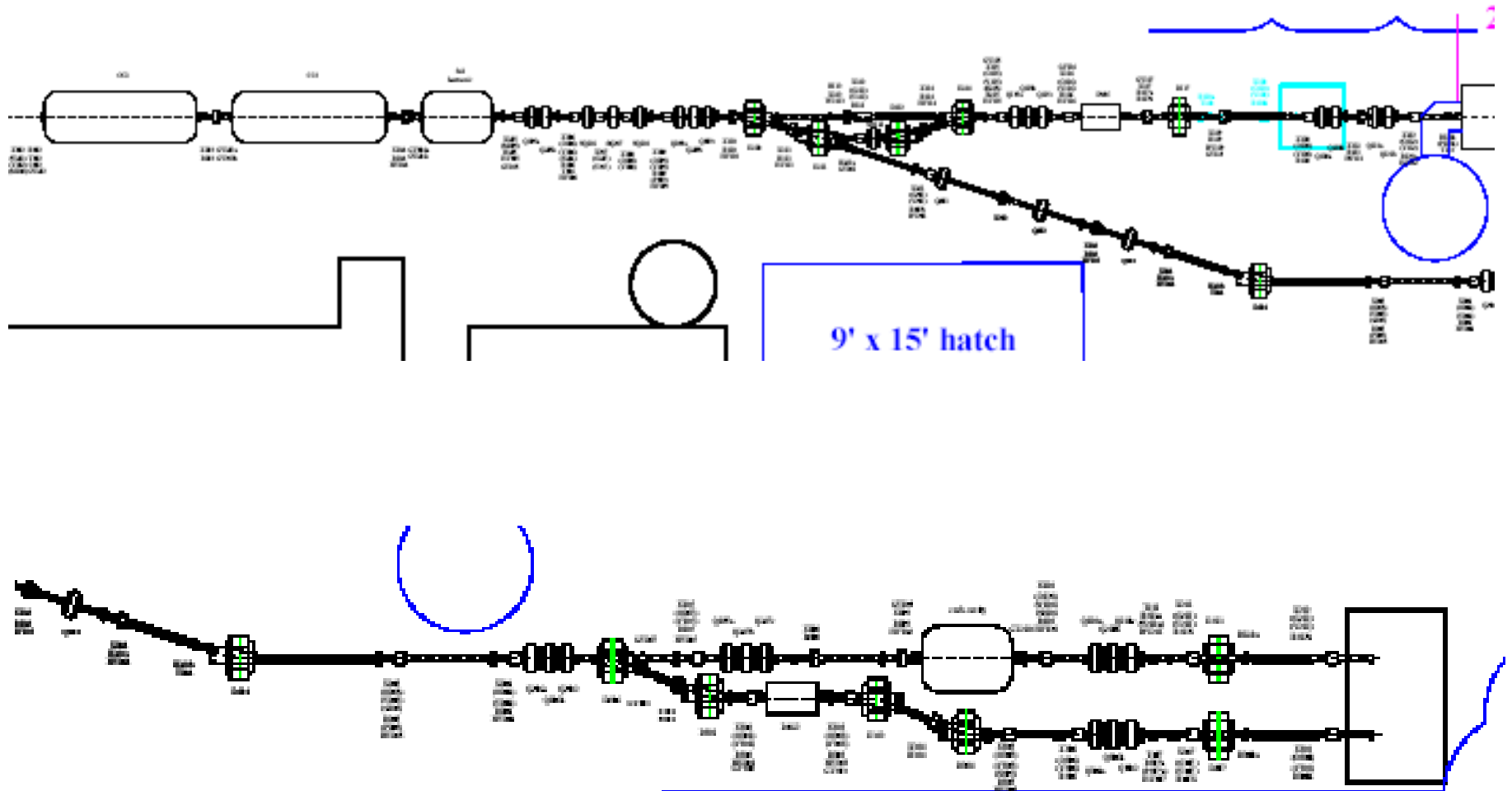
# Proposals for NML (from 5/09 Workshop on Acc. R&D at Fermilab)

<b>Experiment</b>	<b>Energy</b>	<b>proponent</b>	<b>Motivation/ application</b>
Long. → transverse EEX	low	FNAL/ANL	Proof-of-principle; possible application in FELs and X-ray sources
Slit microbunching generation	low	FNAL	For wakefield investigations;
Ellipsoidal beam generation	low (egun)	NIU	Low emittance beams
Microbunching investigations	low, high	ANL	Beam physics; diagnostics
ODR instrumentation development	high	ANL	Non-invasive emittance diagnostic
Flat beam transform and image charge undulator	low	FNAL/NIU	Compact UV/ soft X-ray source
Flat beam transform	high	LANL	Proof-of-principle for MaRIE
Emittance exchange	high	LANL	Proof-of-principle for MaRIE
6-D muon cooling	high	IIT	Proof-of-principle for muon collider
Optical stochastic cooling	high	IIT	Proof-of-principle; muon collider
γ-ray enhancement by crystal channeling	high	ANL	Unpolarized e <sup>+</sup> source
High gradient wakefield acceleration with dielectric structures	Low?, high?	ANL/NIU	many

## Proposals for NML (from 5/09 Workshop on Acc. R&D at Fermilab)

<b>Experiment</b>	<b>Energy</b>	<b>proponent</b>	<b>Motivation/ application</b>
PIC lattice test	high	Muons Inc	Muon collider
Reverse emittance exchange	Low, high	Muons Inc	Muon collider
Dielectric Wall Accelerator section	Low- high	FNAL	Muon collider; induction linac
Measure plasma wakes with long bunch trains	high	USC	Application to 2-beam plasma acceleration
Measure plasma wakes with laser interferometry	high	USC	Application to 2-beam plasma acceleration
Photoproduction of muons @ 300 MeV	high	FNAL	Homeland security; verify production model
Test of integrable beam optics	high	FNAL	Proof-of-principle; future high current proton machines
Study HOM absorprtion	high	FNAL	Project-X and Muon Collider; ADS
Study coupler kicks on beams	low	FNAL	ILC, Pr-X, Muon collider, ADS
Study cavity BPM	Low-high	FNAL	ILC, Project-X , Muon Collider; ADS
High charge bunch loading	high	FNAL	Muon Collider (acceleration of 1e12)
MC IR optic method test	Low - high	FNAL	Muon collider, ADS

# Injector Beamlines at NML



# Progress towards Beamlines at NML

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- **Injector beamline layout is maturing. Calculations in progress by M Church, Y-E Sun, P. Piot, and NIU graduate student to understand instrumentation resolution, effects of SCR, etc.....**
- **ARRA funds will allow us to order all magnets, power supplies, vacuum equipment, and laser hut in FY10.**
- **CC2 is in position and will be cooled down starting this week. Egun installation will start in 2/10.**
- **Instrumentation is under development – instrument cross, button-style BPMs, loss monitor for machine protection system, toroid for beam current measurement.**