# ASTA:

## (Advanced Superconducting Test Accelerator )

# Accelerator R&D Facility and Program

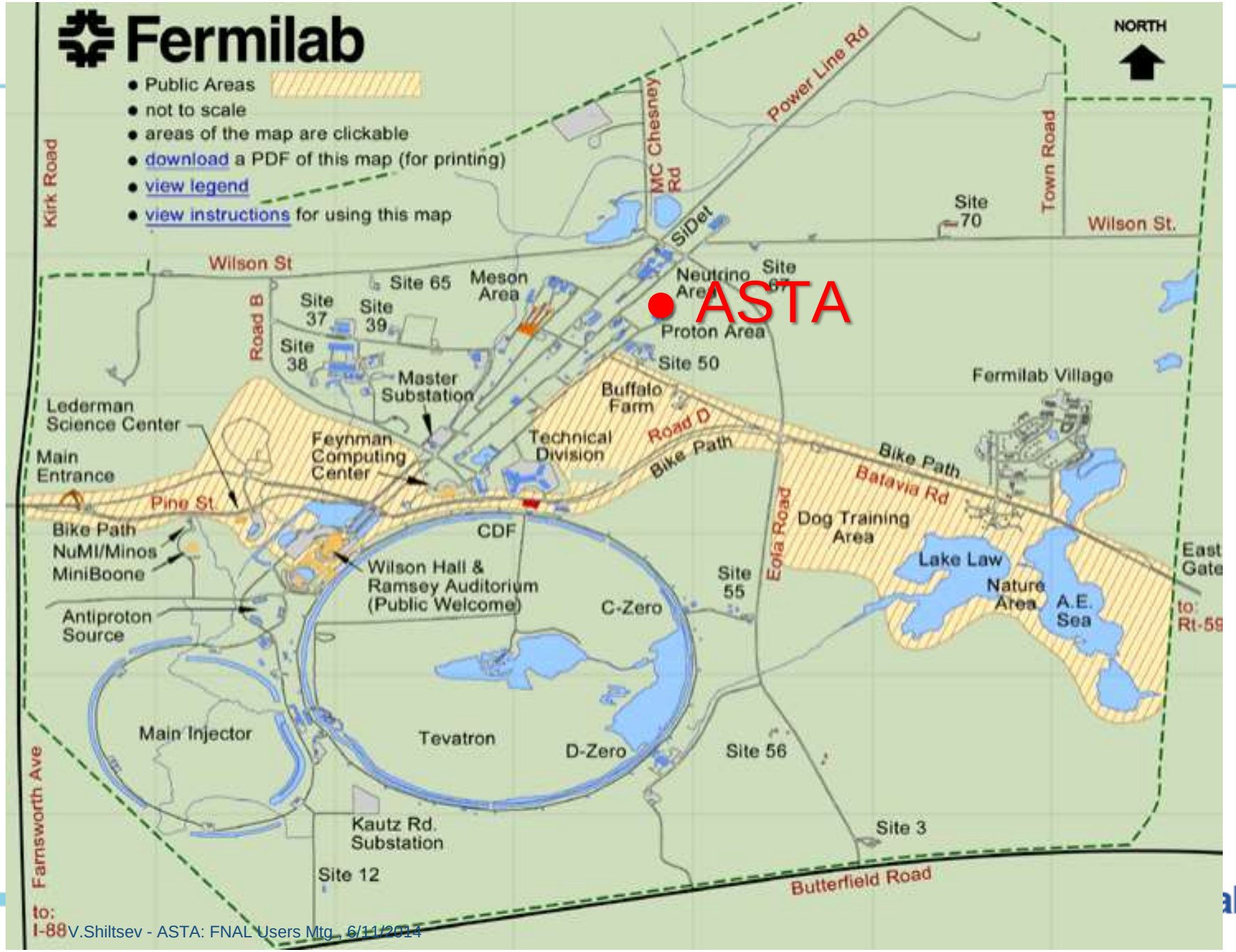
Vladimir Shiltsev

Accelerator Physics Center, Fermilab

ASTA Director (Interim)

# ASTA Facility

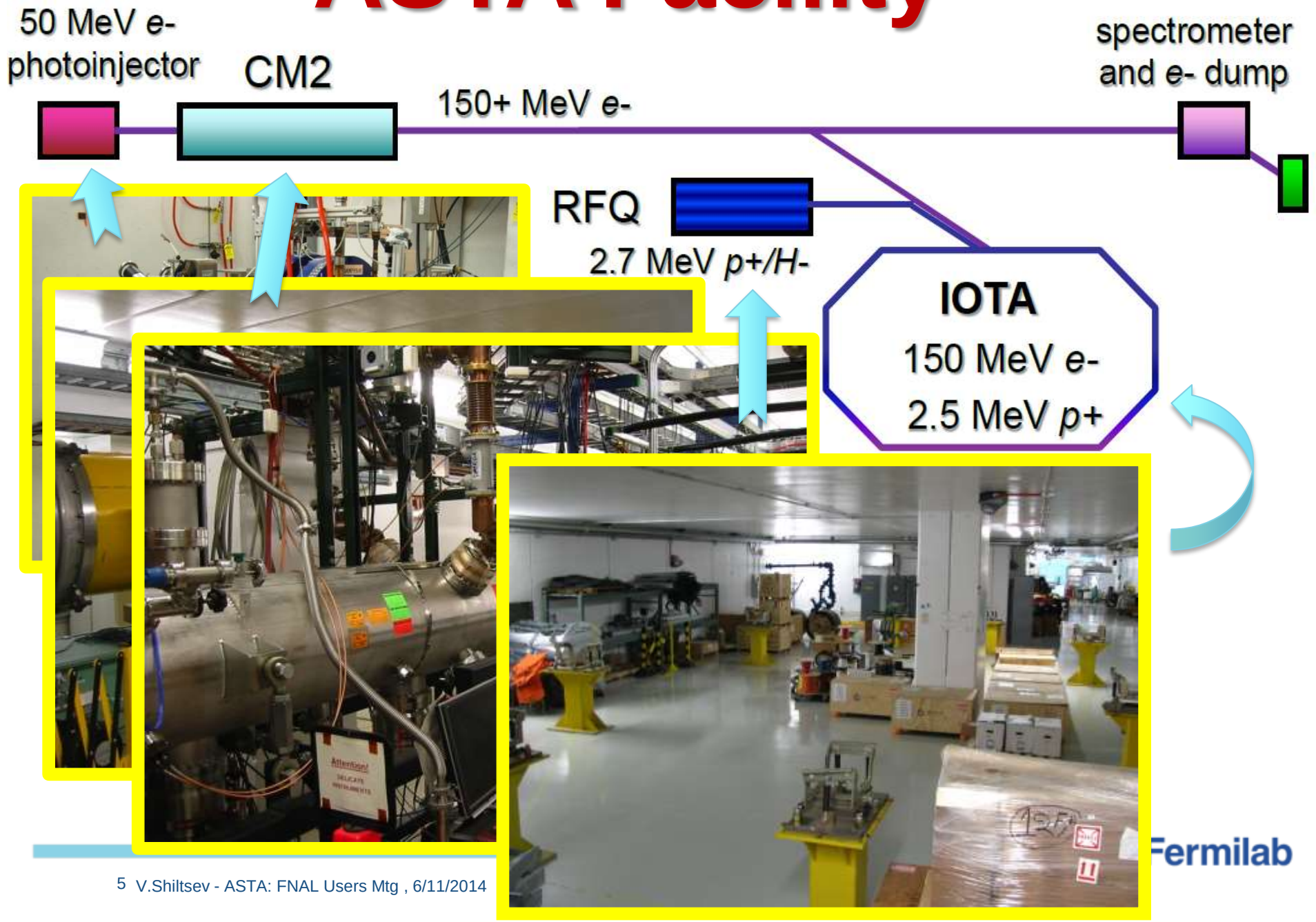
## Advanced Superconducting Test Accelerator


Fermilab
Public Areas
not to scale
areas of the map are clickable
download a PDF of this map (for printing)
view legend
view instructions for using this map
NORTH
ASTA
Kirk Road
Power Line Rd
MC Chesney Rd
Town Road
Wilson St.
Site 70
SiDet
Wilson St
Site 65
Meson Area
Neutrino Area
Site 67
Proton Area
Site 50
Road B
Site 37
Site 39
Site 38
Master Substation
Buffalo Farm
Fermilab Village
Lederman Science Center
Main Entrance
Feynman Computing Center
Technical Division
Road D
Bike Path
Batavia Rd
Pine St
Bike Path NuMI/Minos MiniBoone
CDF
Wilson Hall & Ramsey Auditorium (Public Welcome)
Eola Road
Dog Training Area
Lake Law
Nature Area
A.E. Sea
East Gate
to: Rt-59
Antiproton Source
C-Zero
Site 55
Main Injector
Tevatron
D-Zero
Site 56
Kautz Rd. Substation
Site 3
Site 12
Farnsworth Ave
to: I-88
Butterfield Road

# ASTA Accelerator R&D Facility




# ASTA Facility

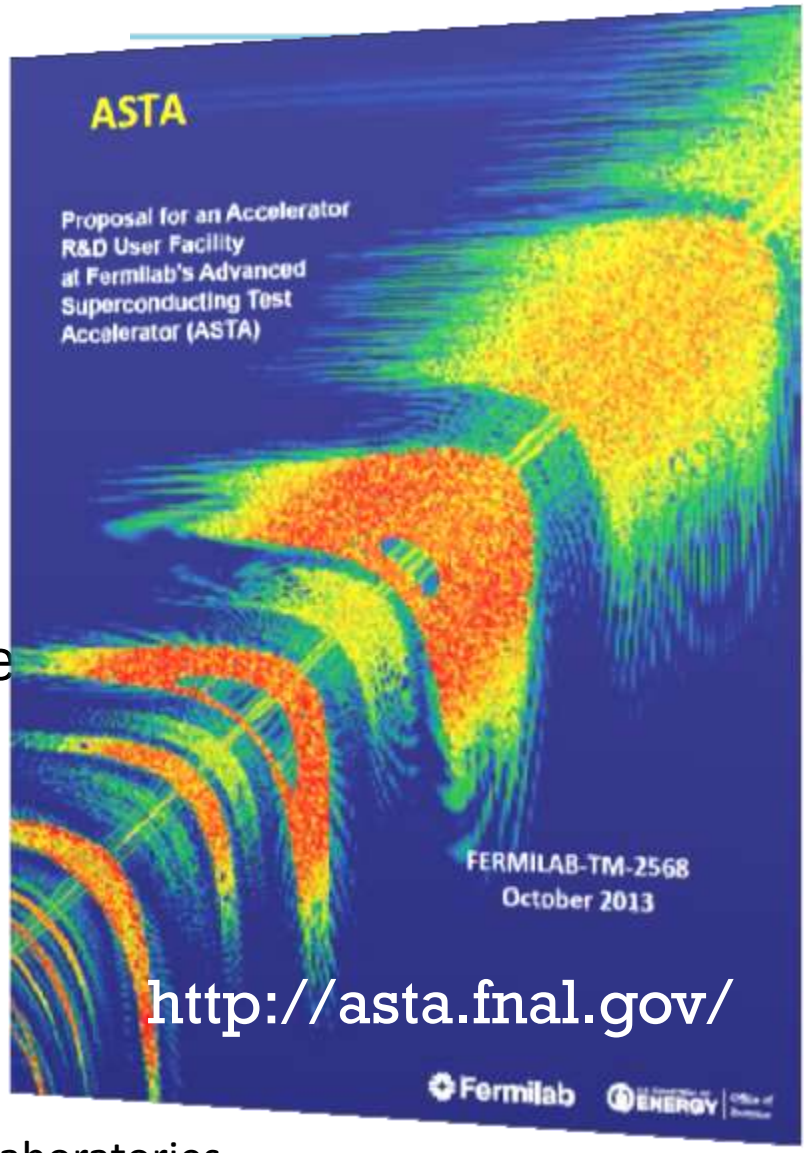


# Background

- Construction of ASTA and NML began in 2006 as part of the ILC/SRF R&D Program and later American Recovery and Reinvestment Act (ARRA).
- The Facility was motivated by the goal of building, testing and operating a complete ILC RF unit
- To date, an investment of ~$90M has been made, including $18M of ARRA funding, representing ~90% completion of the facility
- It was recognized early in the planning process that ASTA is of a great interest to the wider Advanced Accelerator R&D community because of its unique *e- beam* meeting the ILC performance parameters and a small research storage ring, capable to operate with protons and electrons.

# 2013: ASTA Proposal (FNAL-TM-2568)

- 97 co-authors from 18 institutions:
  - 24 APS Fellows
  - 10 Accelerator Prize winners
  - >25% young researchers
- 31 proposals & LOIs:
  - 13 most developed, high-impact proposals presented in in Sec.8
  - 18 proposals and LOIs in Attachme
- At three ASTA experimental areas
  - Exp Area 1 (50 MeV) (14)
  - Exp Area 2 (300-800 MeV) (18)
  - Exp Area 3 (IOTA Ring) (7)
- Broad spectrum of proponents:
  - University groups
  - SBIR companies
  - Large National Laboratories
  - Detector R&D groups
  - National Programs , Int'l

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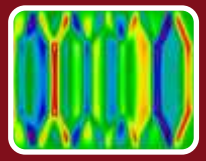
# R&D Opportunities at ASTA

## Intensity Frontier of Particle Physics

- Nonlinear, integrable optics
- Space-charge compensation

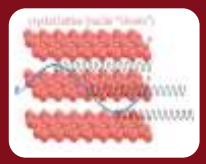


## Energy Frontier of Particle Physics

- Optical Stochastic Cooling
- Advanced phase-space manipulation
- Flat beam-driven DWFA in slabs

## S perconducting A celerators for Science

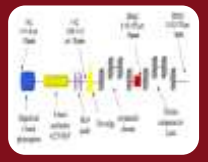
- eam-based system tests with igh-gradient cryomodules
- Long-range wakes
- Ultra-stable operation of SCLs



## Novel Radia on Sources

- High-brightness ray channeling
- Inverse Compto Gamma Ray source

DOE GARD Review – March 2013



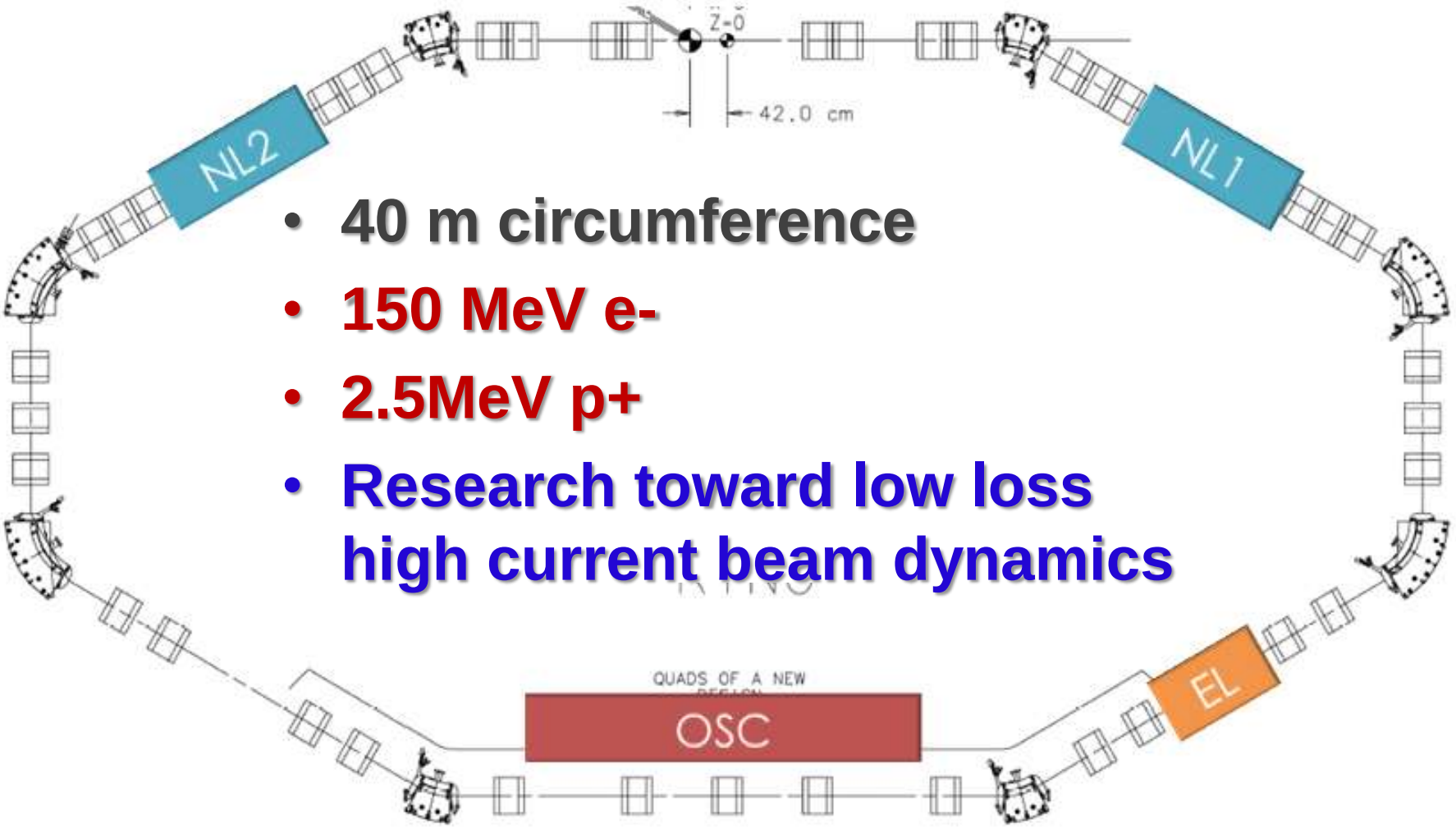
## Stewardship and Applications

- Generation and Manipulation Ultra-Low Emittance Beams for Future Hard X-ray FELs
- XUV FEL Oscillator

DOE Facilities Review – October 2013

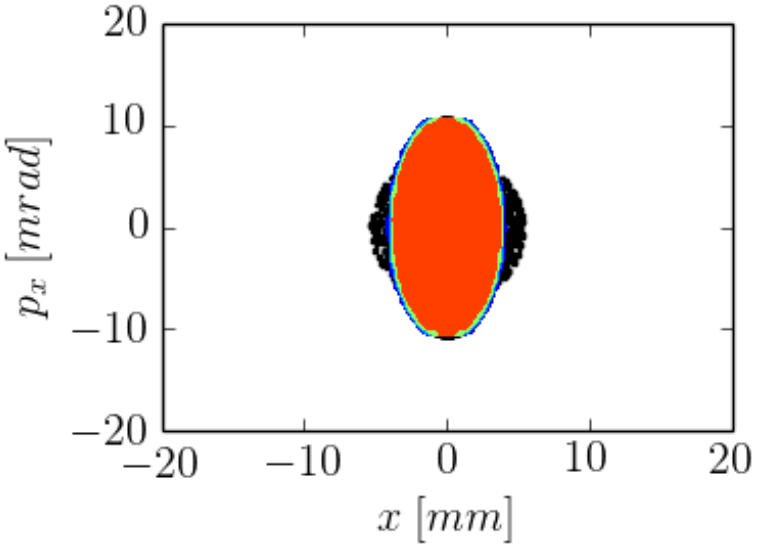
# IOTA Ring: to test new beam methods

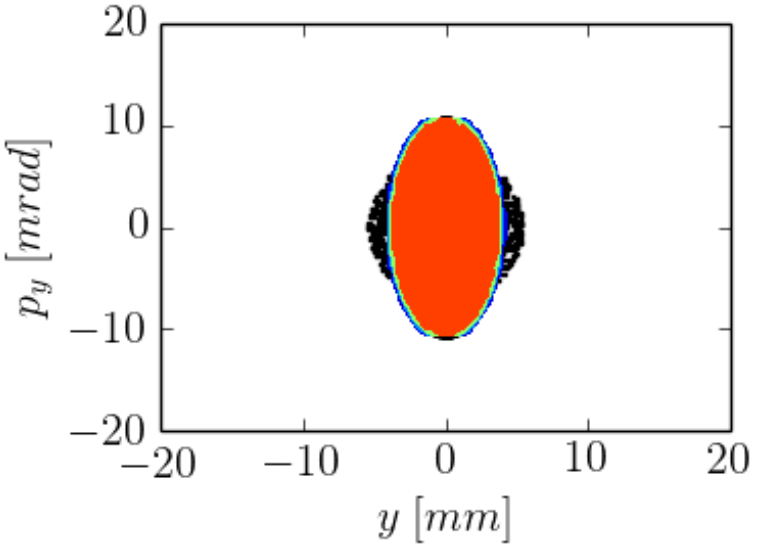
## Integrable Optics and Space-Charge Compensation

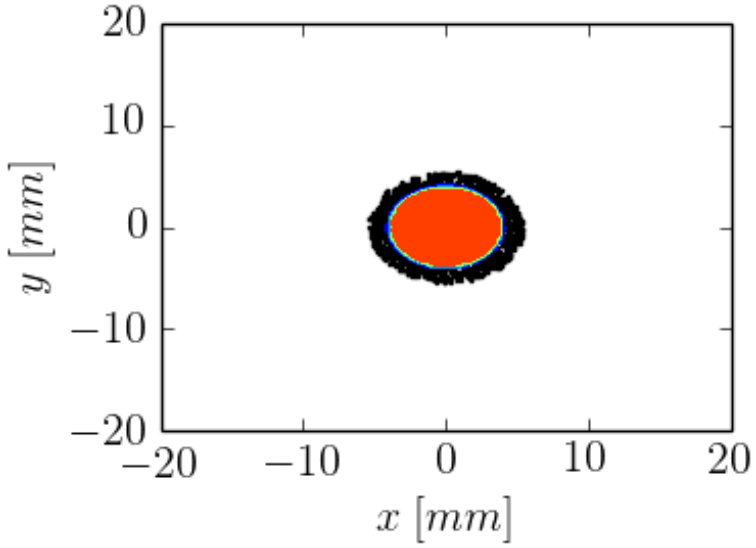


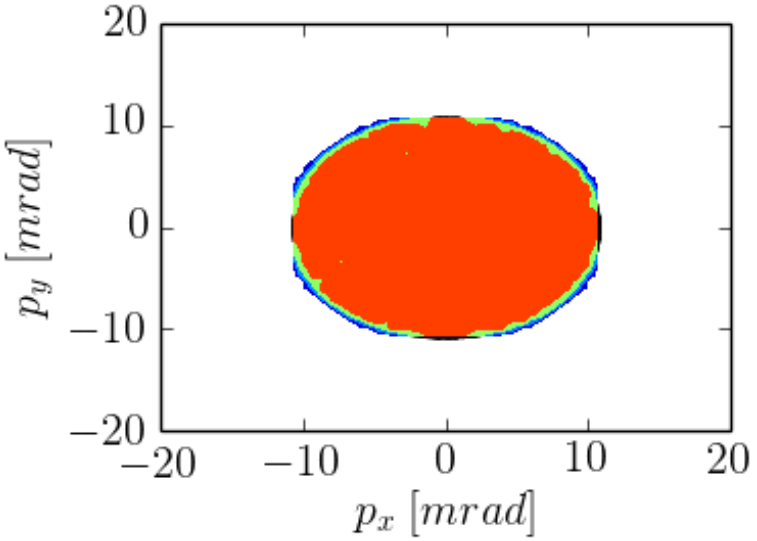

- 40 m circumference
- 150 MeV e-
- 2.5MeV p+
- Research toward low loss high current beam dynamics

# *In a traditional linear lattice, beam core mismatch oscillations quickly drive particles into the halo*



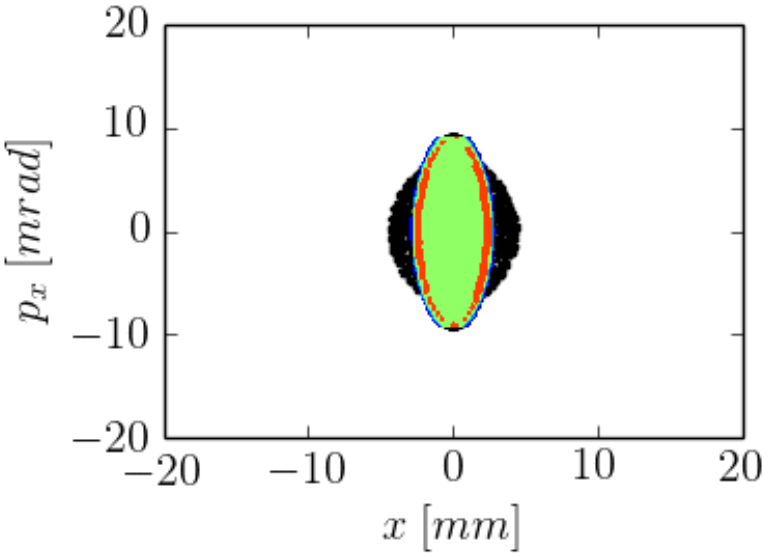



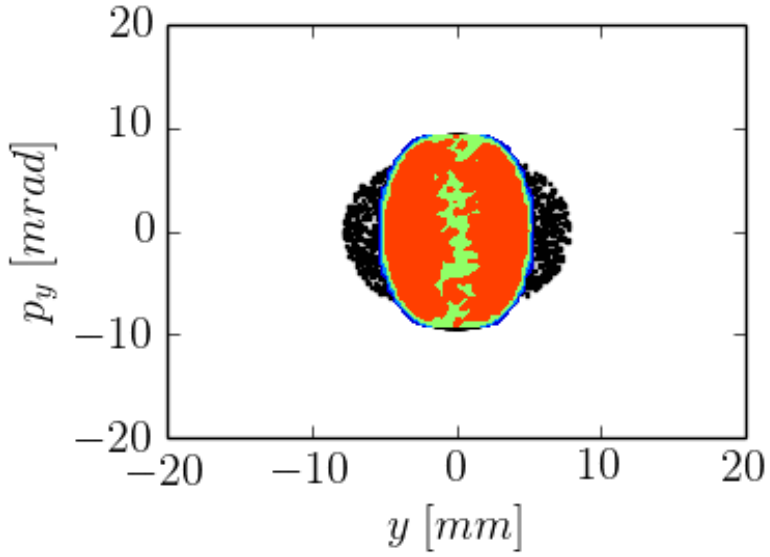



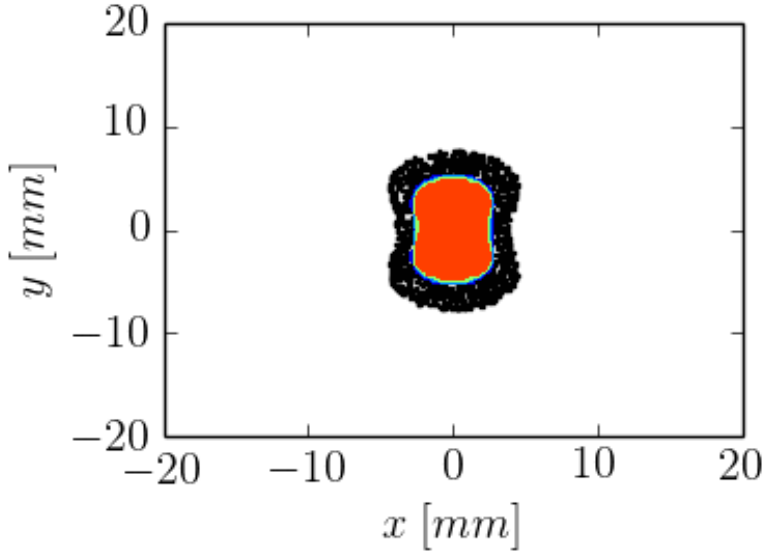



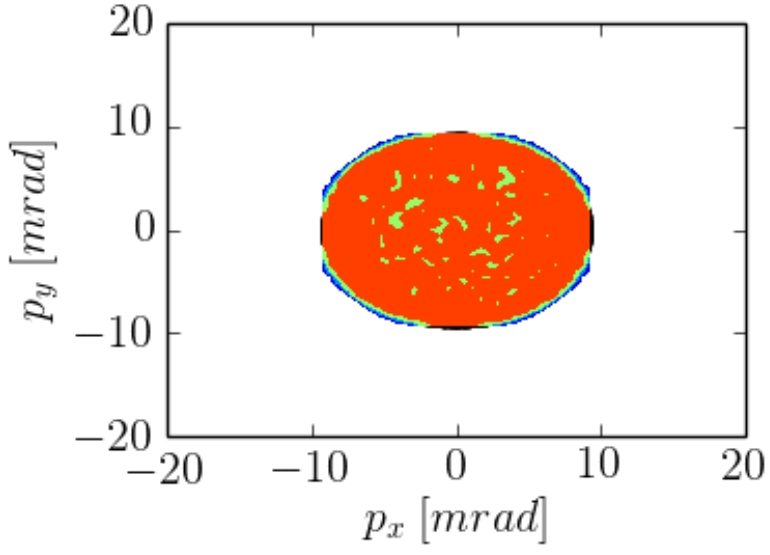

D.Bruhweiler, et al Phys Rev ST-AB (2014)

# For integrable nonlinear magnetic fields, nonlinear decoherence suppresses halo formation




D.Bruhweiler, et al Phys Rev ST-AB (2014)

# IOTA Collaboration

THE UNIVERSITY OF CHICAGO

UNIVERSITY OF COLORADO 1876

OAK RIDGE National Laboratory

radiasoft

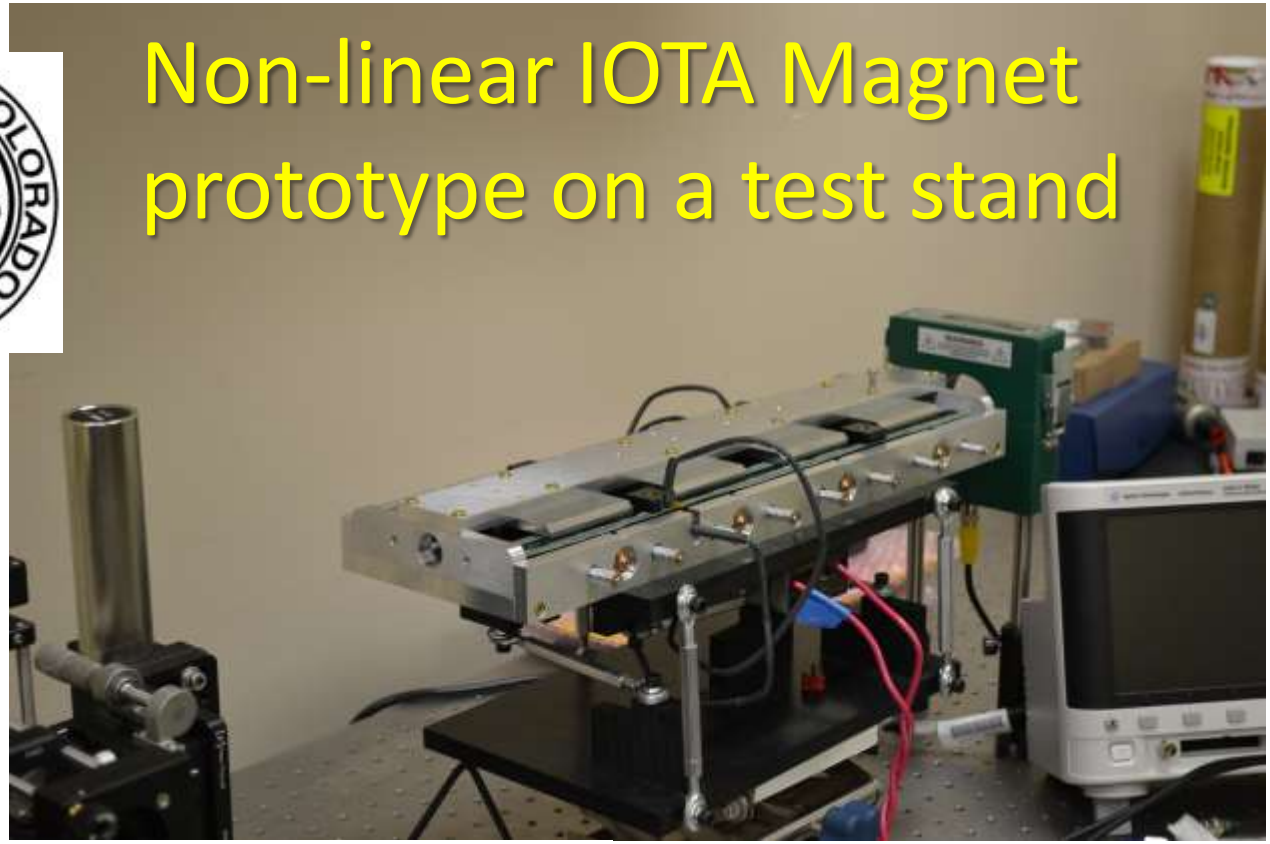
Fermilab

JINR

Massachusetts Institute of Technology

UNIVERSITY OF MARYLAND 18 56

TECH-X



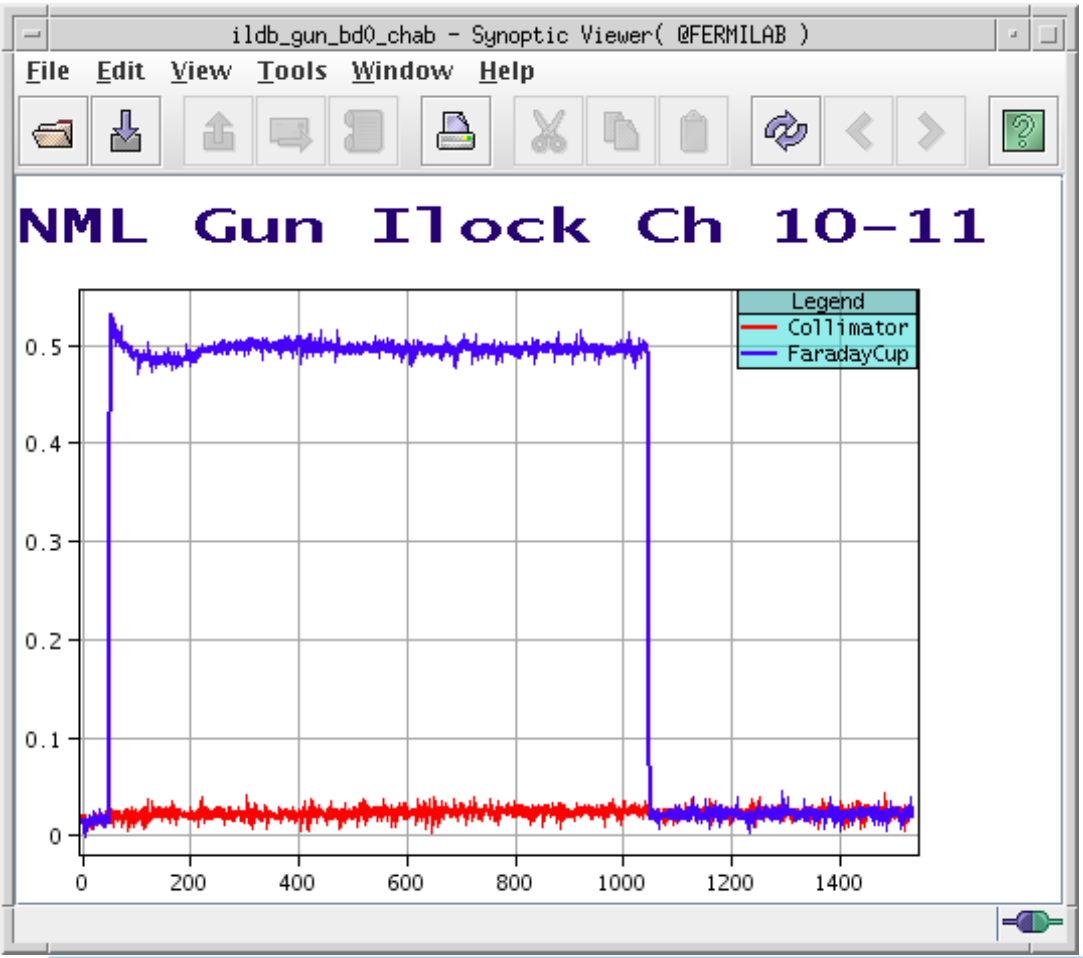
# Role of ASTA

- ***Leading*** **DOE OHEP Accelerator R&D facility for:**
  - medium-term research, to bring new concepts to practice which can be used for the design of a new low-cost IF facility
  - long-term, exploratory research aimed at developing advanced concepts for acceleration and beam manipulation
  - the training of accelerator physicists, engineers, and technologists

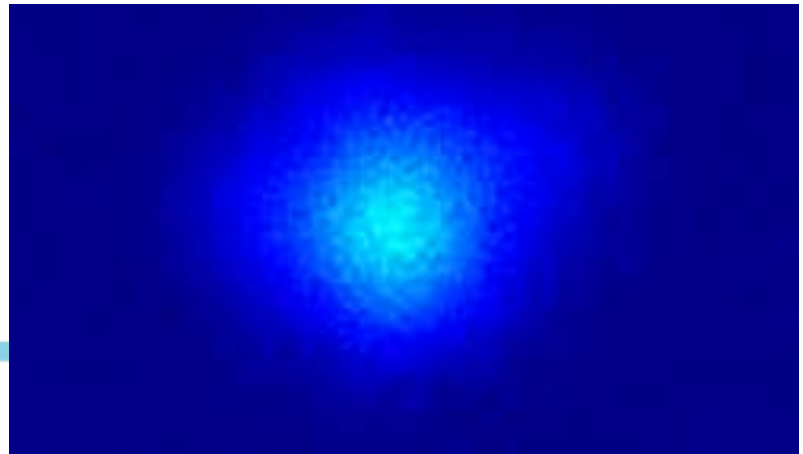
# 2nd ASTA Users Meeting, *FNAL 06/9-10/14*

# PhotoInjector – full *Q*/macropulse at 5 MeV !

- Full RF power, ~3000 high charge bunches in 1ms
- (ILC specs: 3000 bunches, 1 ms, 3.2 nQ /bunch)

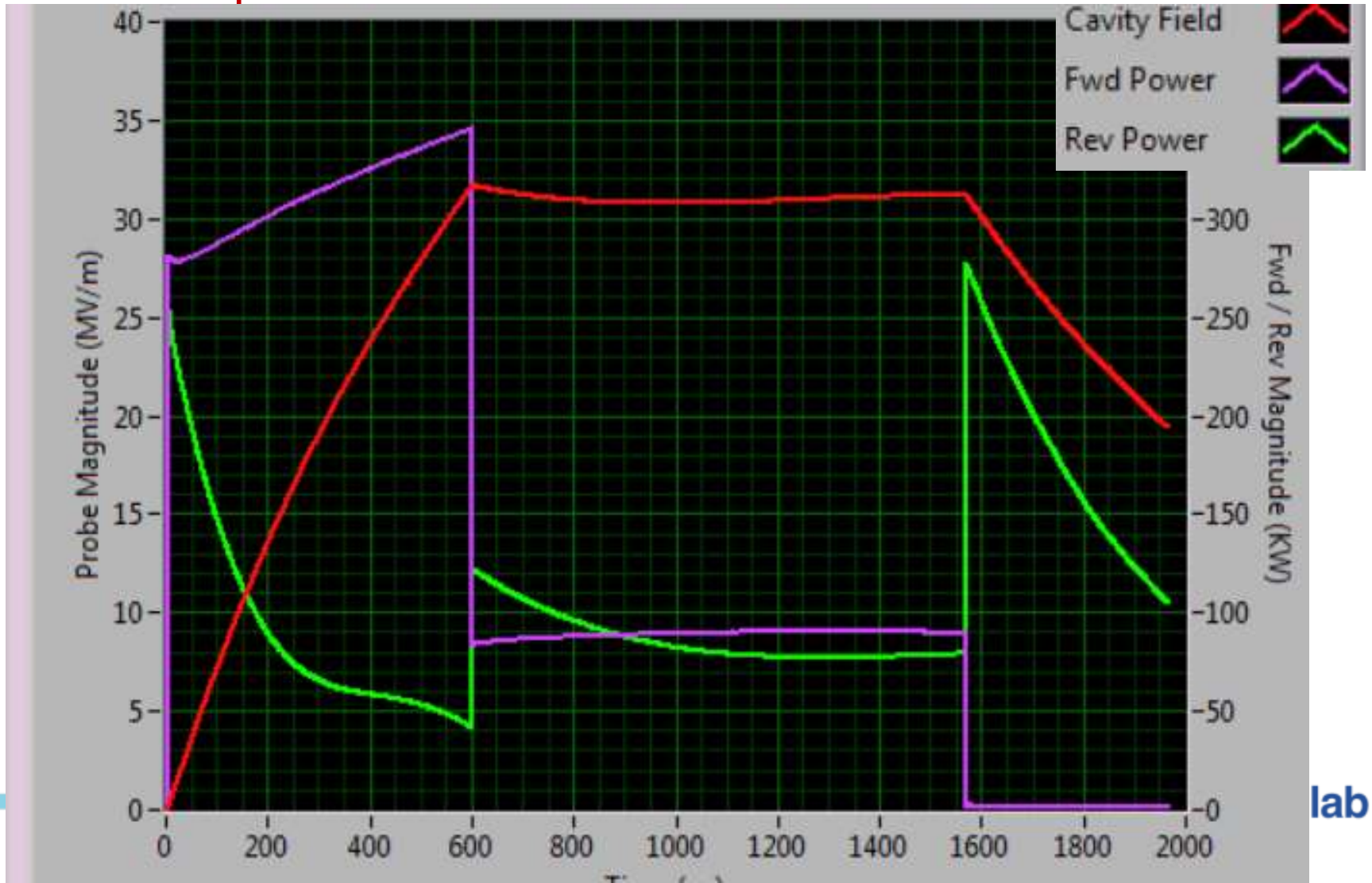


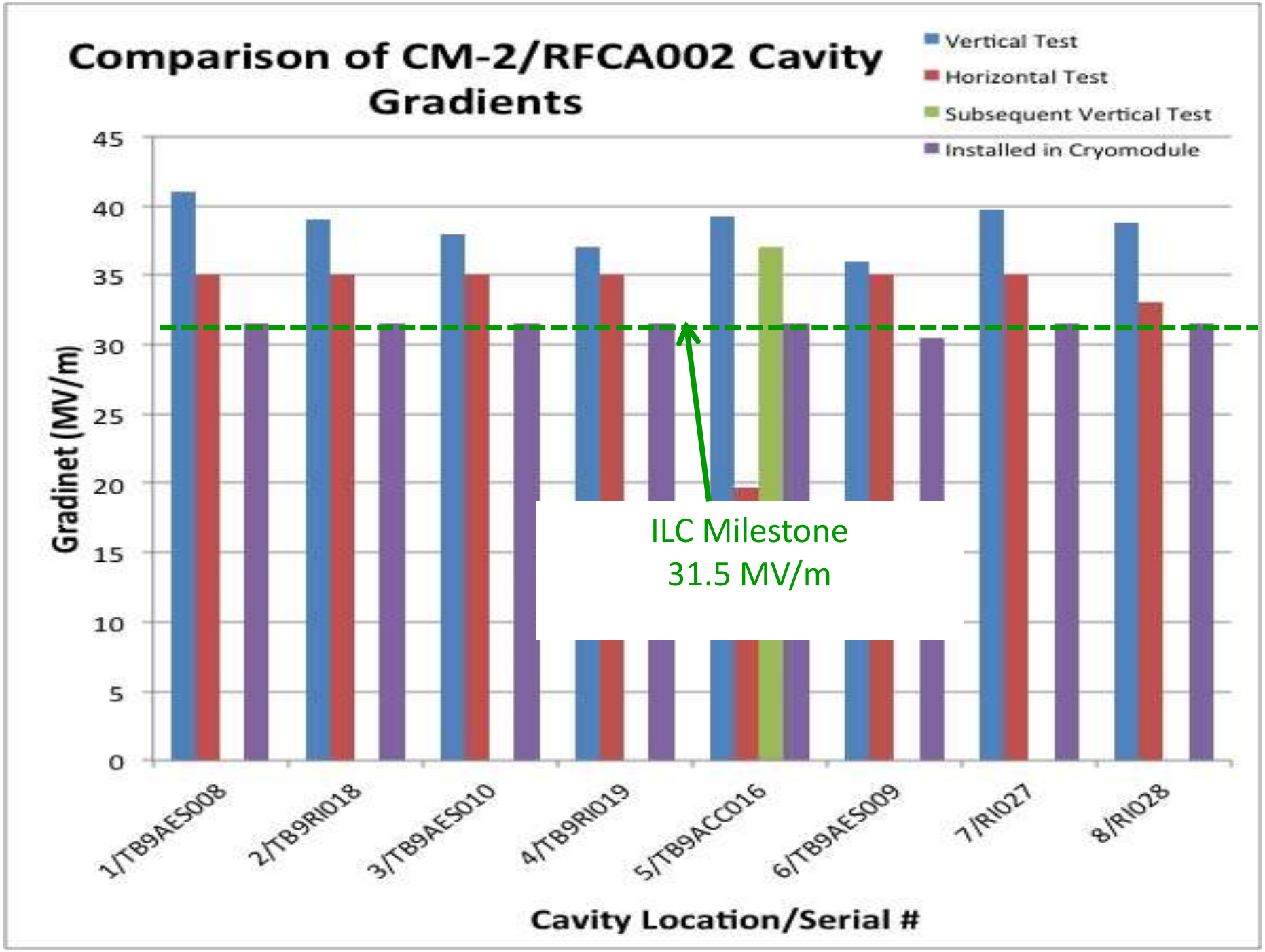

(Left) **4 June 2014:** 3000 Electron bunches from the ASTA Photoelectron Gun as seen on the Faraday cup downstream of the gun.
(Below) YAG screen image of first electrons from a Cs2Te cathode



# 1.3 GHz SRF Cryomodule – Best in the World!

- June 4th, 2014: last cavity (#8) commissioned
- Meets ILC specifications: 31.5 MV/m 1ms 5 Hz




Comparison of CM-2/RFCA002 Cavity Gradients
Vertical Test
Horizontal Test
Subsequent Vertical Test
Installed in Cryomodule
45
40
35
30
25
20
15
10
5
0
Gradinet (MV/m)
ILC Milestone
31.5 MV/m
1/TB9AES008
2/TB9RI018
3/TB9AES010
4/TB9RI019
5/TB9ACC016
6/TB9AES009
7/RI027
8/RI028
Cavity Location/Serial #

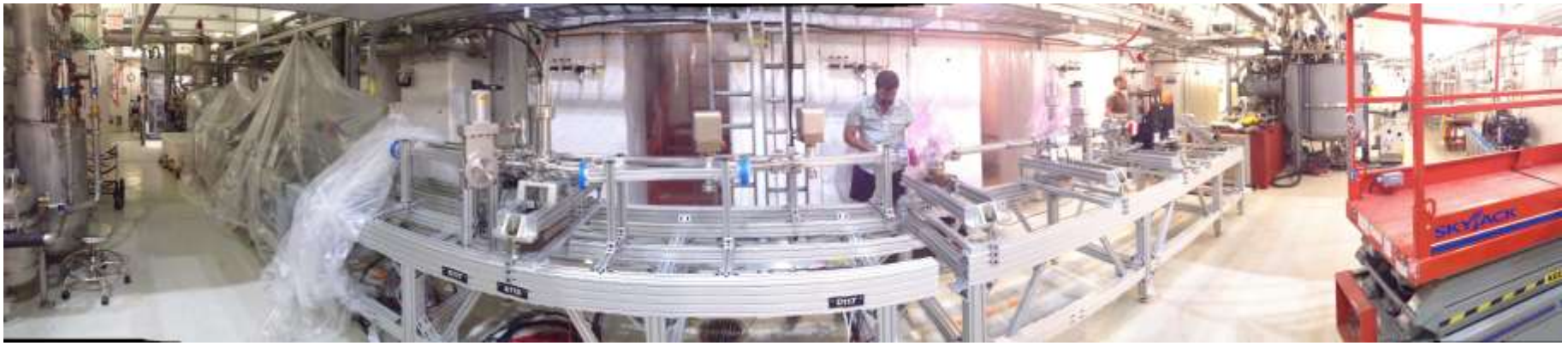
# IOTA Ring – Accumulation of Subsystems

- Stands, vacuum system, quads, dipoles (in work), RF, PSs, etc

32 IOTA quadrupole magnets from JINR
+ Stands from MIT

# ASTA Research Program Begins

- **1st beam experiment – Xray Radiator (NIU, Vanderbuilt)- 2014**



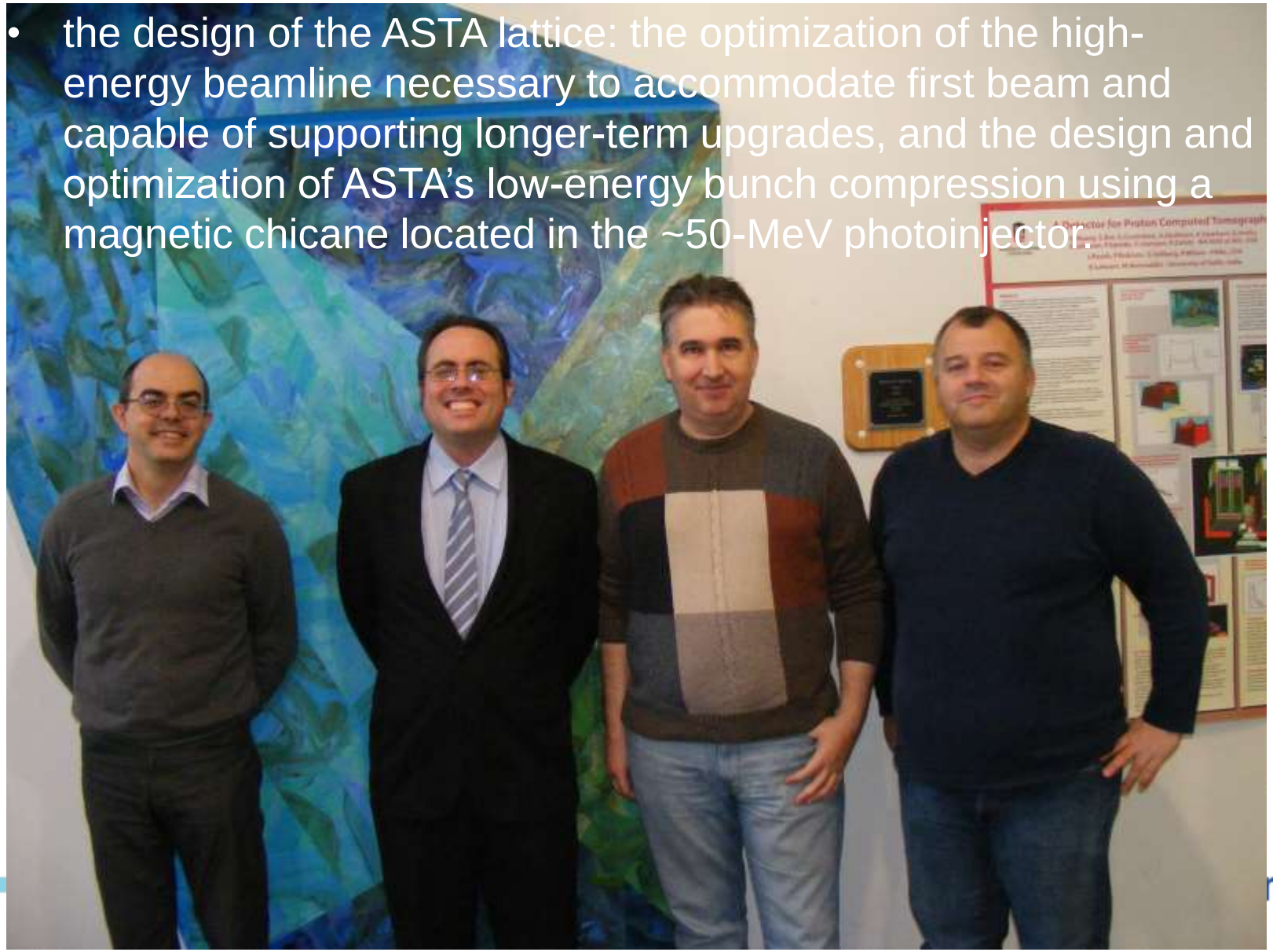
- **1st SRF research user and collaborators**

**Auralee Morin** of Colorado State University carries out her PhD thesis research at ASTA.


Ayaka Kuramoto and Mathieu Omet, PhD students from KEK, spent 3 weeks at ASTA as visiting researchers.

# Dr. Chris Prokop (NIU) — the first PhD based on ASTA-related research !

- the design of the ASTA lattice: the optimization of the high-energy beamline necessary to accommodate first beam and capable of supporting longer-term upgrades, and the design and optimization of ASTA's low-energy bunch compression using a magnetic chicane located in the ~50-MeV photoinjector.



# June 2014: Auralee Morin (CSU, right) and Summer Interns Kevin Kenny (U.Illinois) and Silva Straughter (East Mich.Un.)

# ASTA Technical Plan

- **By the end of FY14:**
  - Complete 50 MeV injector and **bring beam** to 50 MeV dump
  - 20-50 MeV beam to the 1st experiment (NIU/vanderbilt)
  - Begin installation high-energy beamline from CM2 to HE dump
- **FY15:**
  - finish HE beam line installation
  - beam commissioning of CM2
  - Finish construction/fabrication of IOTA elements
- **FY16:**
  - Finish IOTA installation and commissioning, 150 MeV e-beam to IOTA
  - Move and install the HINS proton injector (50% completion)
- **FY17:**
  - HINS commissioned, inject protons in IOTA
  - Full accelerator research program at IOTA (first – with electrons)

# ASTA : Summary

- Unique facility for transformative accelerator R&D
  - Will shape the next generation facilities for intensity frontier / neutrino research
- VERY substantial investment to date ($$, people)
- Great technical progress, esp. recently :
  - Photoinjector and SRF Cryo Module work, IOTA
- Beam to the 1st experiment in 2014
- Aggressive plans for FY15-17 (to finish construction)
- ASTA collaboration grows – more Universities, Int'l partners, SBIRs, other labs, individuals, …

**We are committed to make ASTA a success, and Invite YOU to join the team!**

# ASTA Offers Unique Research Opportunities