

ASTA User's Facility:

(Advanced Superconducting Test Accelerator)

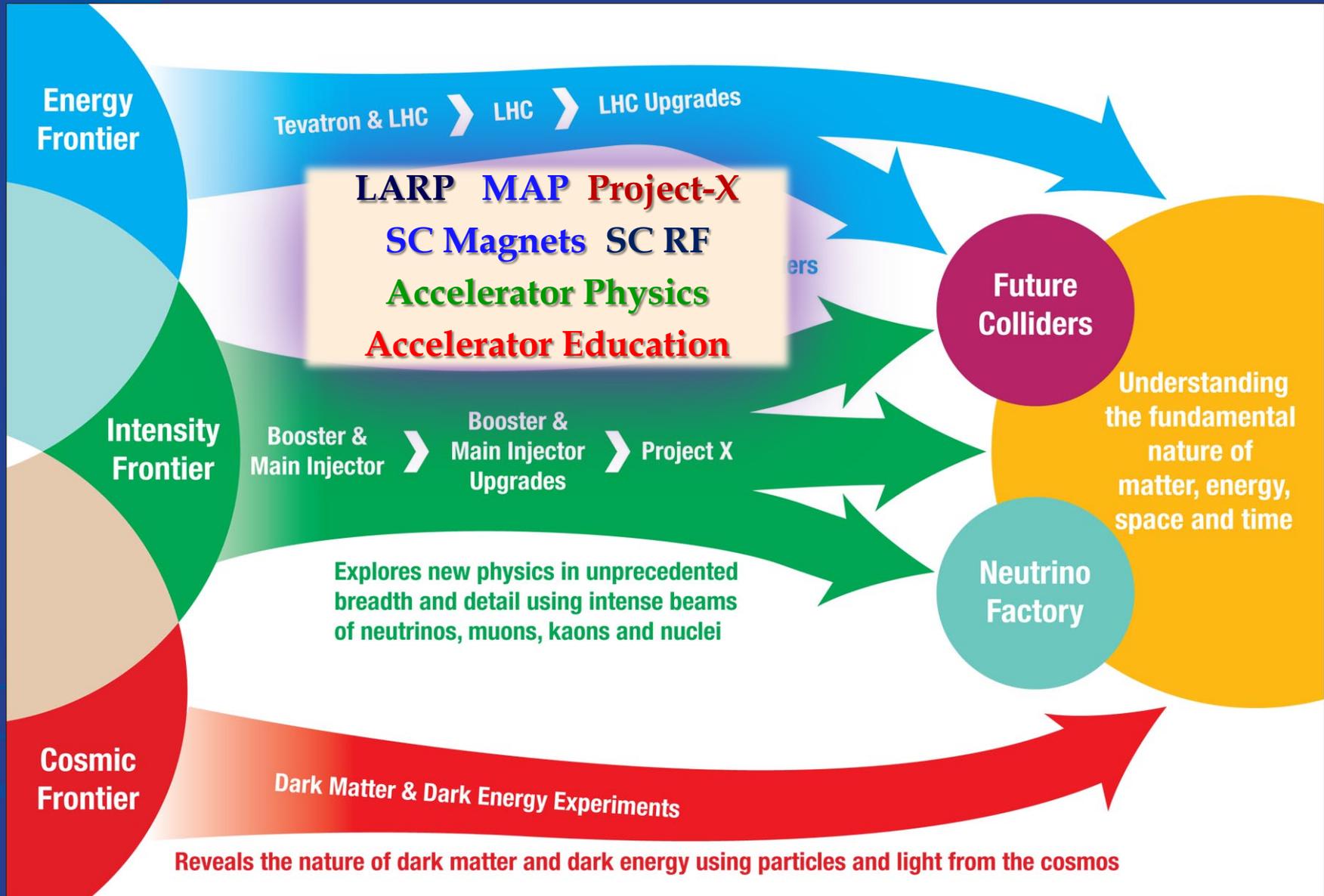
Overview/Status/Plans
Proposal Process
The 1st User's Meeting

Vladimir Shiltsev
ASTA Director (Interim)

1st ASTA Users & PAC Meeting
July 23, 2013



Accel. R&D and US HEP Long-Term Strategy

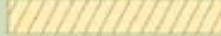


Fermilab's Scientific Strategy (for CSS'2013)

“Our plan for the future....”

- Accelerates the impact of US particle physics on society and enhances partnership with universities and industry on accelerator technology through IARC and ASTA...”

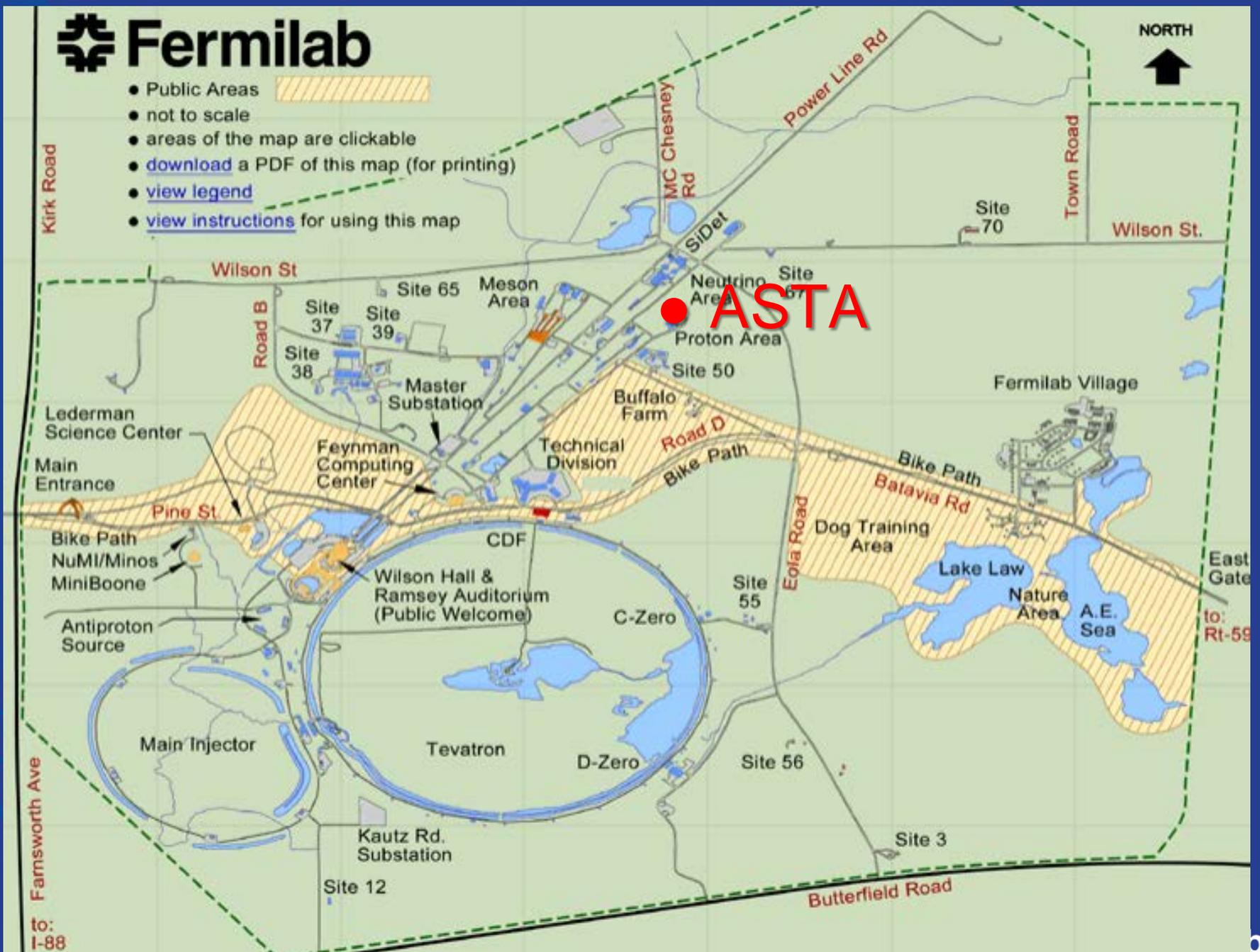
Fermilab

- 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



to:
I-88

to:
Rt-59

ASTA

(formerly known as NML... now significantly expanded)



1.3 GHz SC RF Cryomodule transportation to ASTA

Don't miss the ASTA tour tomorrow afternoon!

ASTA Accelerator R&D User's Facility

(Advanced Superconducting Test Accelerator)

- A world-leading facility for Accelerator R&D at Fermilab that
 - Is based on state-of-the-art, **modern SC RF technology**
 - Supports an extremely broad accelerator R&D program ranging from **HEP to photon sciences to applications**
 - Serves critical needs in **Intensity Frontier accelerator** physics, while helping to fulfill OHEP's Stewardship role
 - Is **cost-effective** to complete and operate.
 - Serves as a focal point for **accelerator science education**, not only for Fermilab, but for the nation.

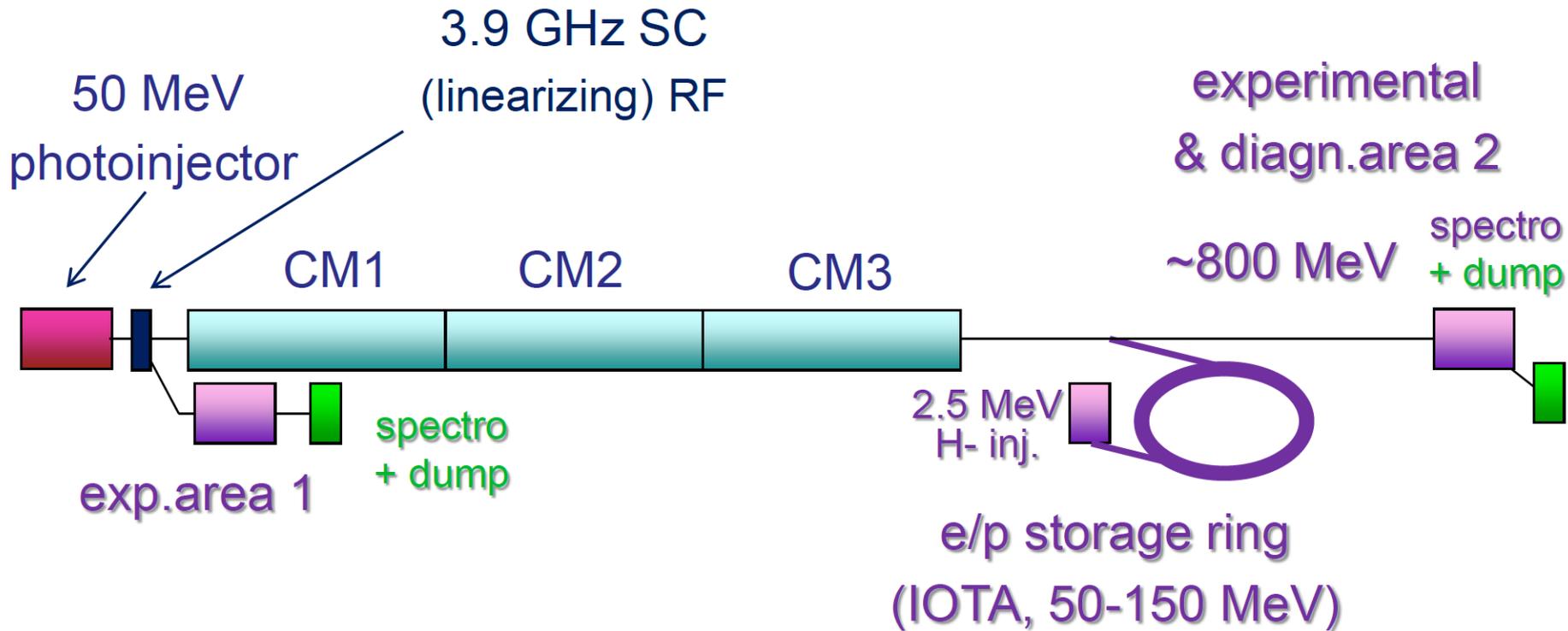
ASTA Accelerator R&D Users Facility



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 \$74M** has been made, including **\$18M** of ARRA funding, representing **~80%** completion of the facility
- It was recognized early in the planning process that an e- beam meeting the ILC performance parameters was itself a power resource of interest to the wider **Advanced Accelerator R&D** community.

ASTA Users Facility (Proposal)



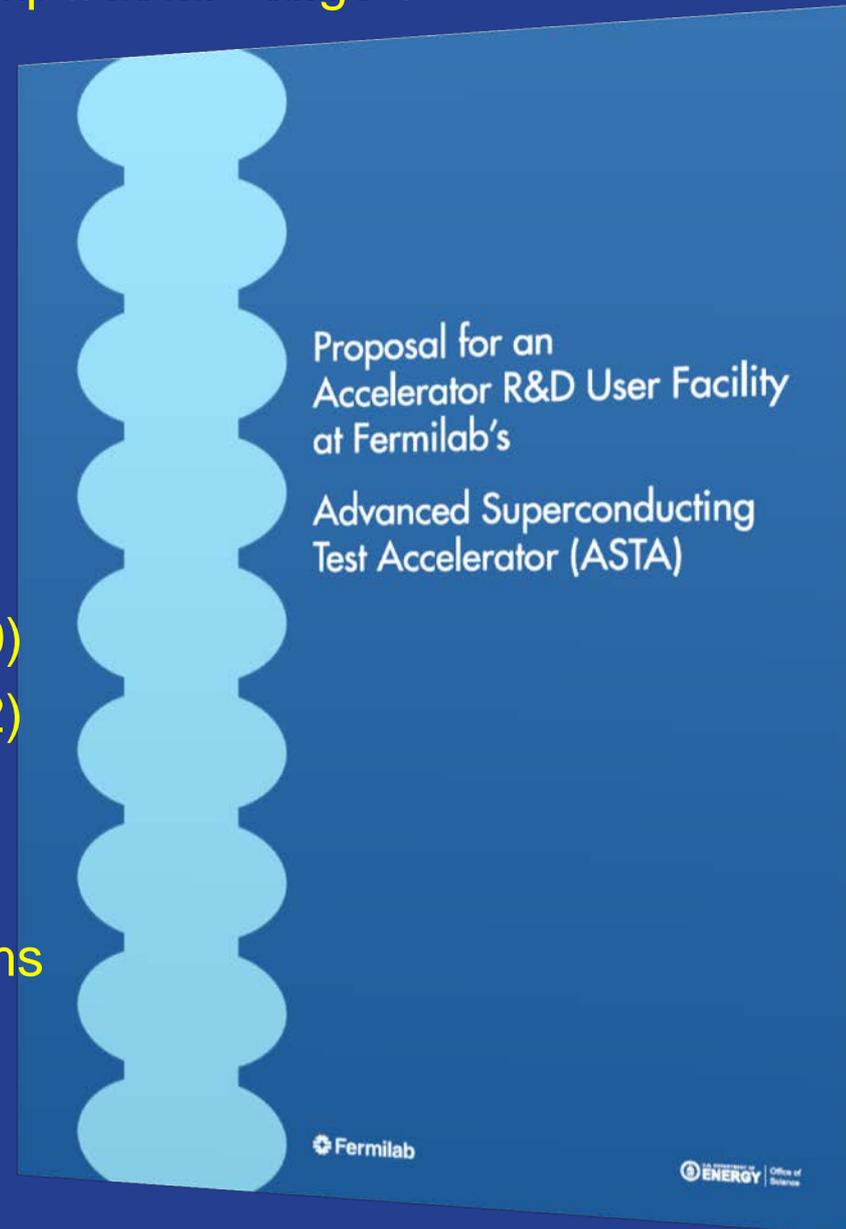
Three Experimental Areas capable of hosting 5-9 experiments at once
Can serve community of 100-150 users (in ~3-5 years)

Beam parameters for EA1-EA3 - see proposal , or back up slides

ASTA

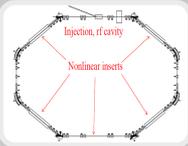
<http://asta.fnal.gov/>

- 60 co-authors from **13 institutions**
- **24 proposals** and growing
 - ~1/2 for HEP (IF, EF, SCRF)
 - ~1/2 – Stewardship and Applications
- At all ASTA experimental areas
 - **Exp Area 1 (50 MeV) (10)**
 - **Exp Area 2 (300-800 MeV) (12)**
 - **Exp Area 3 (IOTA Ring) (5)**
- Broad spectrum of proponents:
 - **University groups & National Programs**
 - **SBIR companies & International**
 - **Large National Laboratories**
 - **Detector R&D groups**



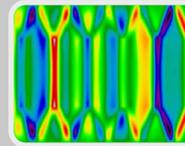
ASTA Science Thrusts

Intensity Frontier of Particle Physics



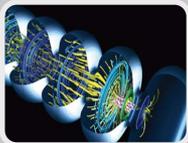
- Nonlinear, integrable optics
- Space-charge compensation

Energy Frontier of Particle Physics



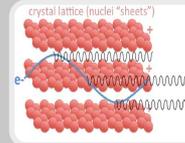
- Optical Stochastic Cooling
- Advanced phase-space manipulation
- Flat beam-driven DWFA in slabs

Superconducting Accelerators for Science



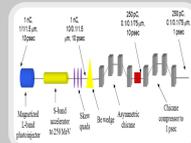
- Beam-based system tests with high-gradient cryomodules
- Long-range wakes
- Ultra-stable operation of SCLs

Novel Radiation Sources



- High-brightness x-ray channeling
- Inverse Compton Gamma Ray source

Stewardship and Applications



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

“Why ASTA?” (Uniqueness)

- **High repetition-rate:**
 - 1 msec long trains of 3000 bunches, with 3 MHz rep rate
- **High average power:**
 - the highest beam power and highest average brightness
- **High energy:**
 - ~ 1 GeV \rightarrow many experiments (eg photon-science and FEL)
- **Extremely stable beams**
- **Superconducting technology:** SRF and beams
- **IOTA Storage ring:**
 - very flexible storage ring capable of supporting a broad range of ring-based advanced beam dynamics experiments.

Strong Institutional Support of ASTA Proposal

Argonne National Laboratory

Brookhaven National Laboratory

CERN

Colorado State University

ComPASS

Illinois Institute of Technology

Indiana University

International Linear Collider (ILC)

John Adams Institute for Accelerator Science

Joint Institute for Nuclear Research

US LHC Accelerator Physics Program (LARP)

Lawrence Berkeley National Laboratory

US Muon Accelerator Program (MAP)

Northern Illinois University

Oak Ridge National Laboratory

Princeton Plasma Physics Laboratory

RadiaBeam Technologies, LLC

Tech-X Corporation

Thomas Jefferson National Accelerator Facility

US Particle Accelerator School (USPAS)

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J.Galambos

R.Davidson, E.Gilson, I.Kaganovich

S.Boucher

J.Cary

A.Hutton

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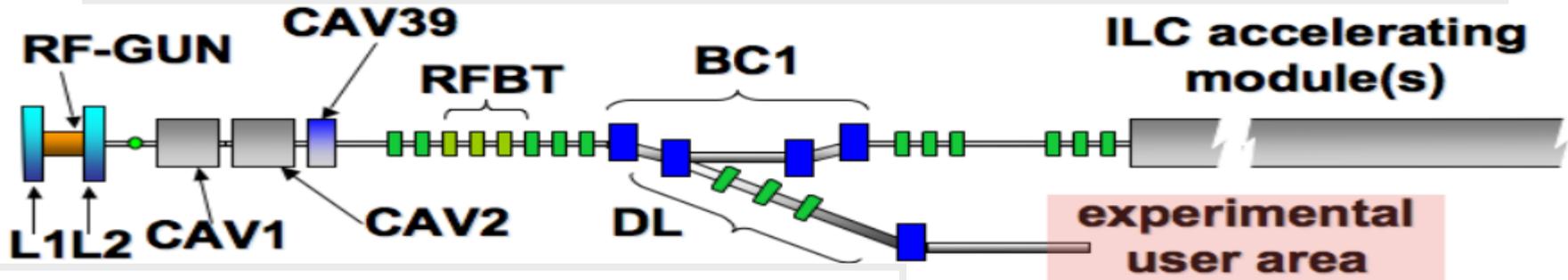
ASTA Developments

- 2012 - ASTA Proposal developed by Fermilab and prospective users
- Dec 2012 – DoE OHEP briefed on ASTA... encouragement...
- Feb 6-8, 2013 – Fermilab’s *Accelerator Advisory Committee* on ASTA:
 - *The AAC strongly encourages FNAL to pursue the ASTA Proposal.*
- Feb 26, 2013 - ASTA Proposal **submitted** to DOE
- Mar 8, 2013 - ASTA Proposal **reviewed by OHEP GARD** Review panel
- Apr 24, 2013 – NSF/NPS briefed on ASTA
 - “...very timely!” – NSF’s “Accelerator Science” program (June)
- Jun 14, 2013 – ASTA welcomed by *FNAL Users Executive Committee*
- Jun 20, 2013 – **First beam from ASTA photoinjector (!)**
- Jul 23-24, 2013 - **ASTA 1st Users and PAC meeting** at Fermilab
- Oct 21, 2013 – DOE OHEP review of ASTA Proposal

Where are we now?

- Commissioning 50 MeV injector
 - 1st beam → get design parameters
- Installation and commissioning SC RF Cryomodule
 - 1.3 GHz – aka “CM2”, it’s the 1st in sequence and the only one now
- Design and construction of IOTA Ring
- Buildup of ASTA Users’s community
 - 1st wave experiments
 - Planning for more
 - this User’s meeting

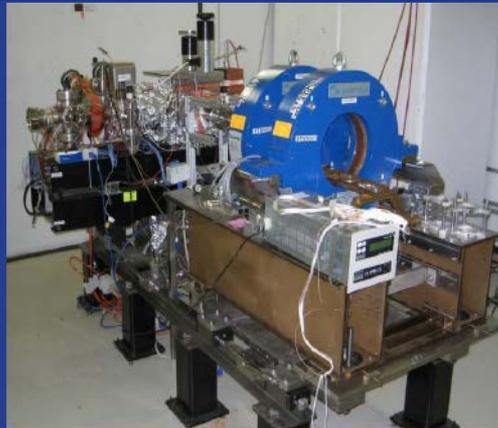
Installing & commissioning injector



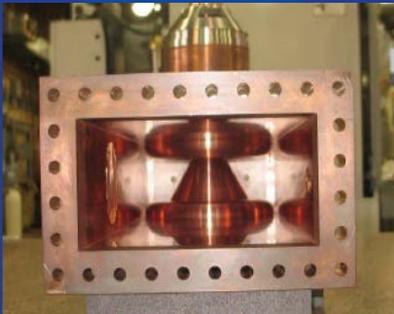
Gun operational, new cavity in CC1



gun cavity



Solenoids and PC transfer chamber



RF coupler



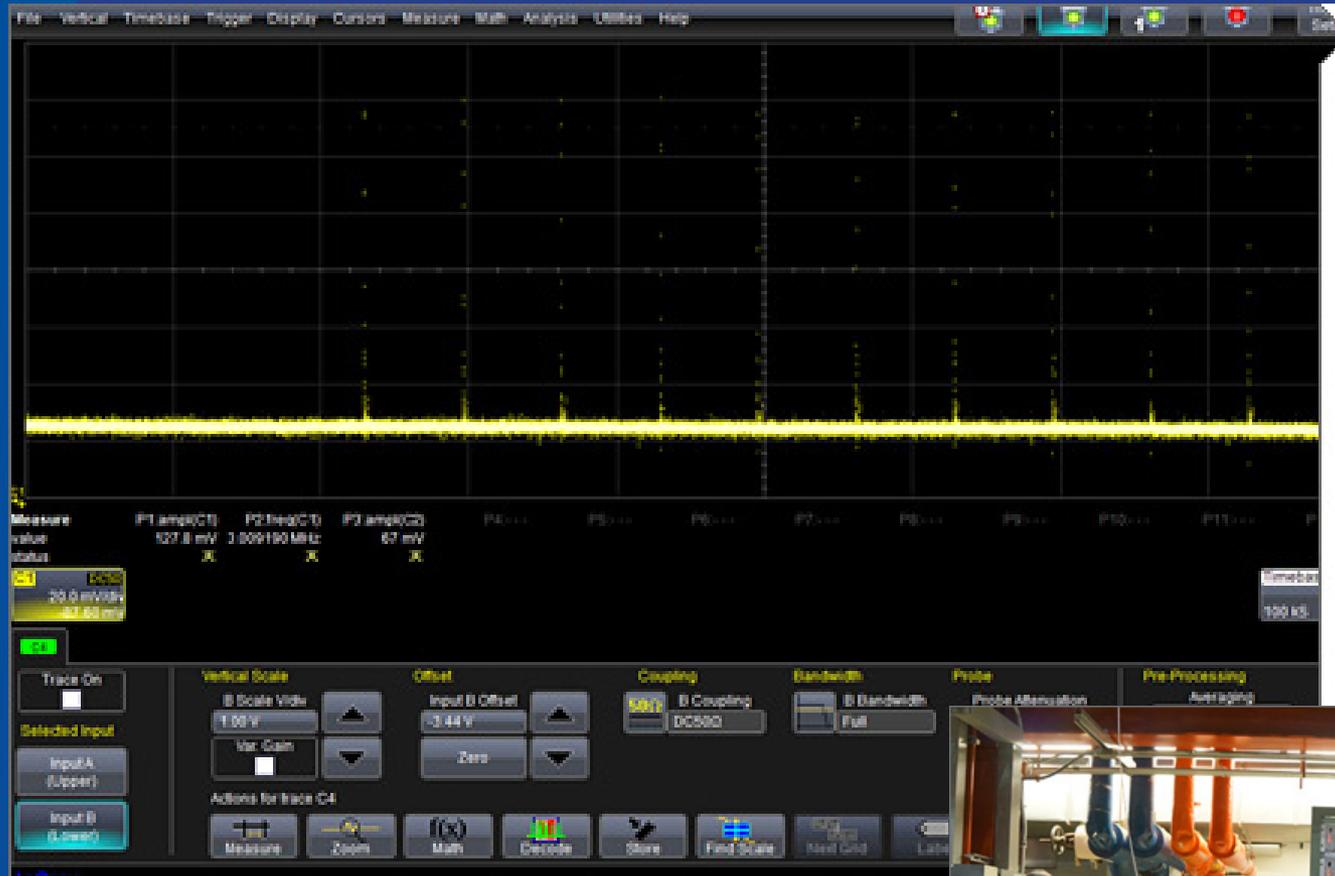
HEQ

LED



High Energy Beam Dump Core

1st Photoelectrons in ASTA (06/20/2013)

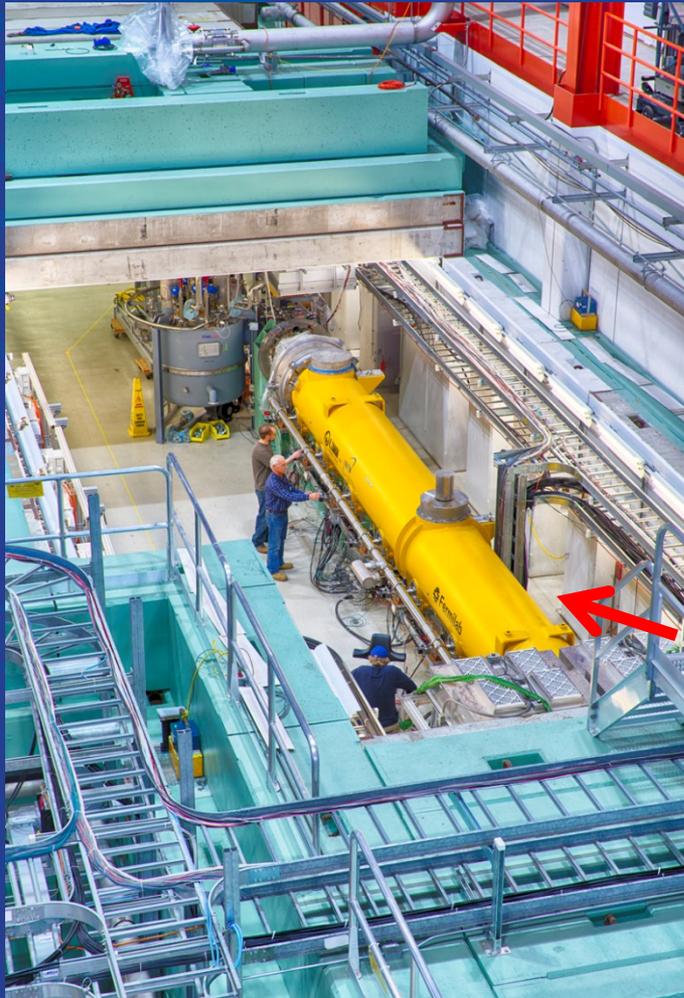


- Not yet at full RF power/ energy
- Not yet full current
- See Elvin Harms's talk

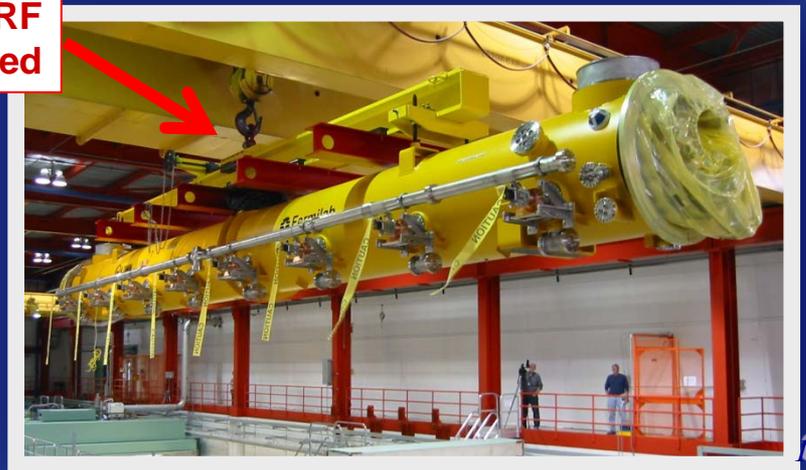


SCRF Cryomodule

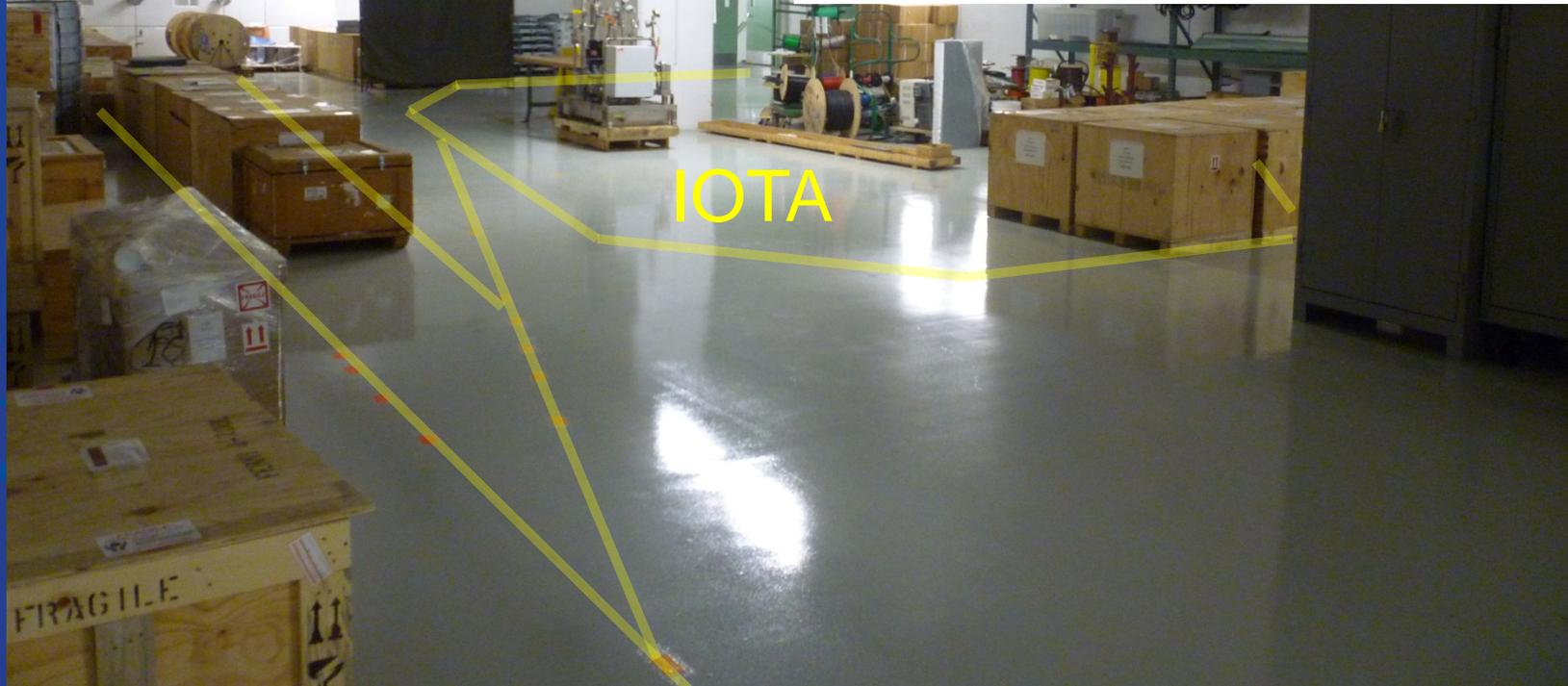
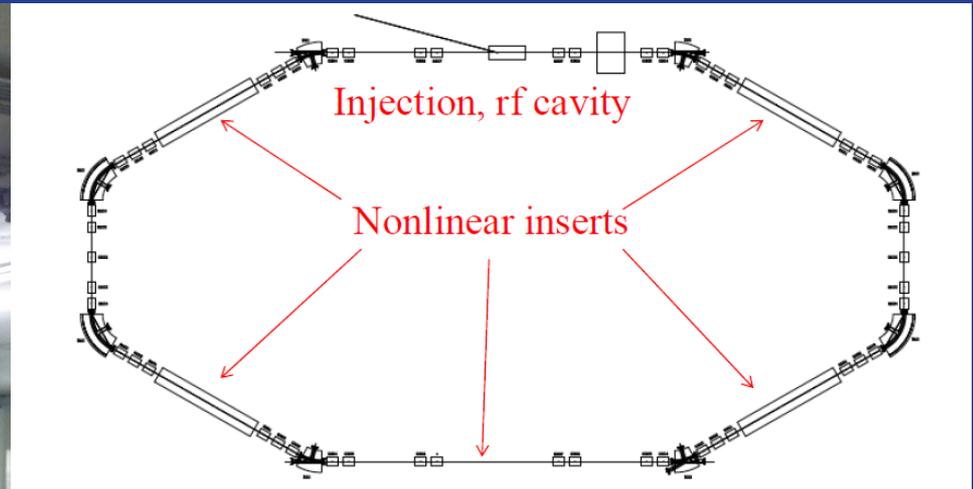
not yet cold ... RF commissioning to start soon



**1.3GHz SC RF
CM2 installed**



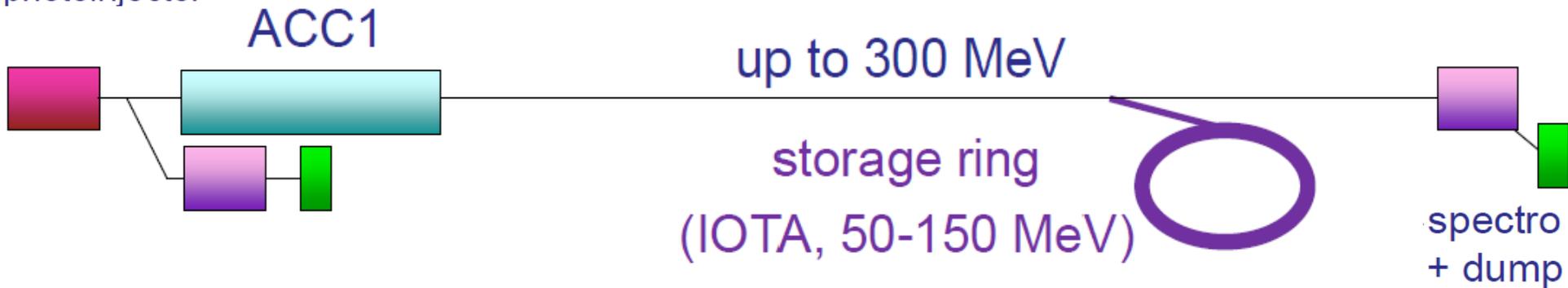
IOTA (Integrable Optics Test Accelerator)



ASTA FY14-15 plans (tent.)

Overall – Stage I (“barebone”) facility and experiments

photoinjector



- **FY13:** Start commissioning 50 MeV PI and install 1st experiments / start SRF CM commissioning
- **FY14:** 1st experiments at 50 MeV
RF commissioning of SRF cryomodule
Install 300 MeV beamline to dump
Continue IOTA construction
- **FY15:** More experiments at 50 MeV and 300 MeV beam
Finish IOTA construction and installation

The ASTA Team

ASTA Team:



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Installation &
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Philippe Piot
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Sergei Nagaitsev
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This and more info – see our permanent Web-site

<http://asta.fnal.gov/>

ASTA Program Advisory Committee



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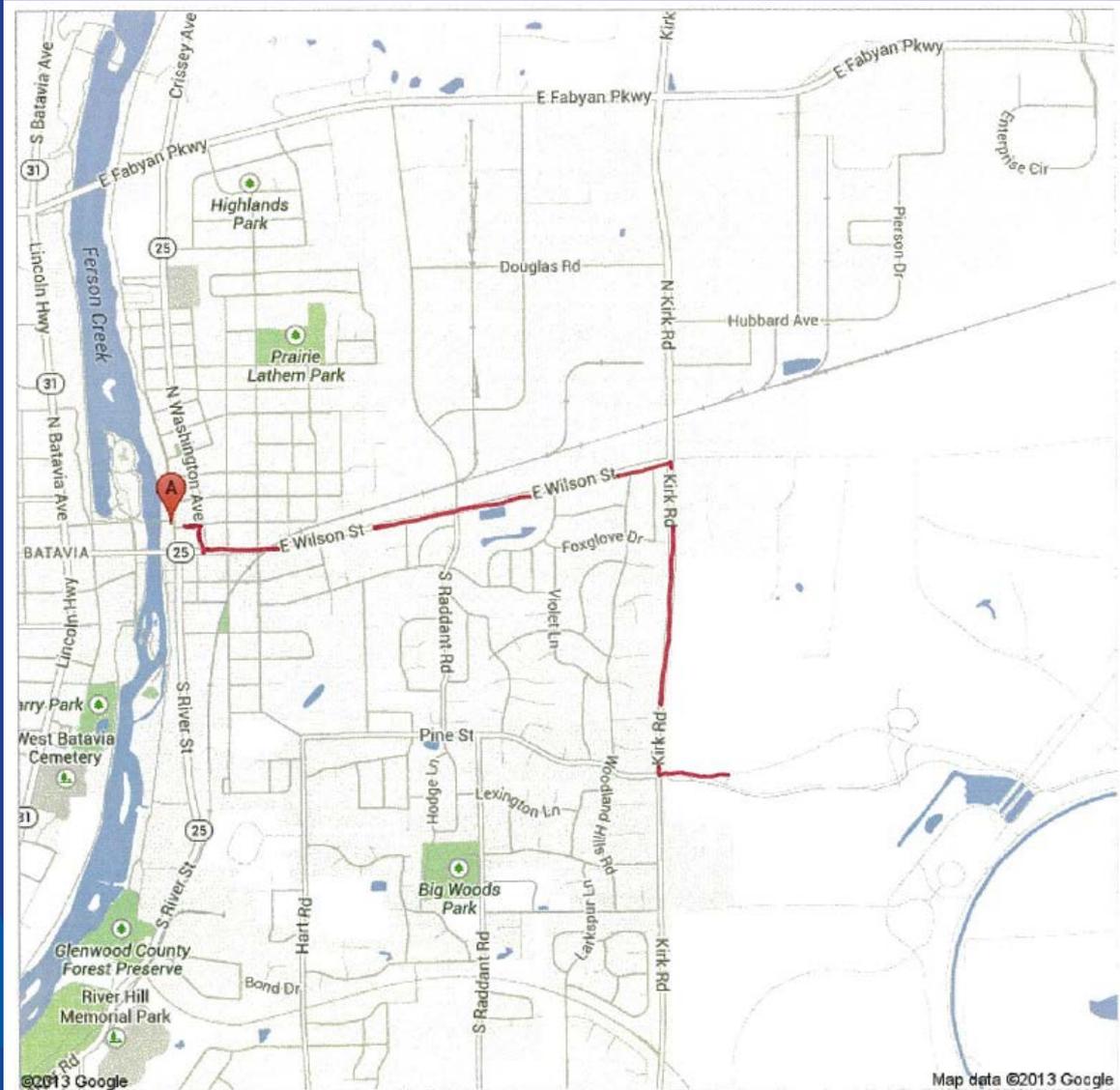
Charge to ASTA PAC

- 1) ASTA Proposal.** Proposal for Accelerator R&D User's Facility at ASTA has been submitted to DOE and will be reviewed in the Fall of 2013. Is the Proposal well-formulated? Are any modifications advisable? Is the Science Case strong and are there ways that it can be strengthened? Should any newly submitted experiments be added?
- 2) ASTA status and plans.** ASTA team has recently achieved 1st photoelectrons from the gun and is focused on a number of high level goals for the remainder of FY13, FY14 and FY15. Are these plans technically sound and achievable? Do they properly balance the construction and installation activities and the needs of the first experimental studies? Could the plans be modified/optimized in order to more firmly establish ASTA as a leading R&D facility?
- 3) Experimental studies at ASTA.** There are a number of previously proposed and newly proposed experiments with ASTA beams. ASTA PAC is asked to evaluate the scientific merit of the proposed experiments and EOI's, evaluate the feasibility of the proposed experiments in relation to the ASTA beam and facility capabilities, and advise on optimal order and priority of the studies.

ASTA Users Meeting Agenda

- Day and a half of presentations/discussions:
 - ASTA description, technicalities, commissioning status
 - “1st wave experiments”
 - Intensity Frontier – IOTA
 - Superconducting RF R&D
 - Energy and Intensity Frontier R&D (other than IOTA)
 - Novel radiation sources
 - Accelerator stewardship & other applications
- Also:
 - Group photo at 10:45 am today (1st coffee break)
 - Eric Colby’s talk today at 4pm (1 West)
 - Dinner at Pal Joey’s (6:30 pm) – out of pocket
 - ASTA tour tomorrow (Wed.) PM
 - (PAC closeout discussion with ASTA team)

Dinner 6:30pm *Pal Joey's* 31 N.River Str, Batavia



Final Comments

- We have 80 people registered:
 - Way more than we expected
 - $>2/3$ of them non-Fermilab – very encouraging!
- We ‘ll have many presentations:
 - We want all collaborators to have chance to speak up
 - Besides 24 original experimental proposals ~dozen new ones and updates
 - ...will be hard on PAC members
 - Speakers: pls fit within the time allocated - “time police”
- **Let’s have useful and productive meeting!**

Experimental Areas 1 & 2

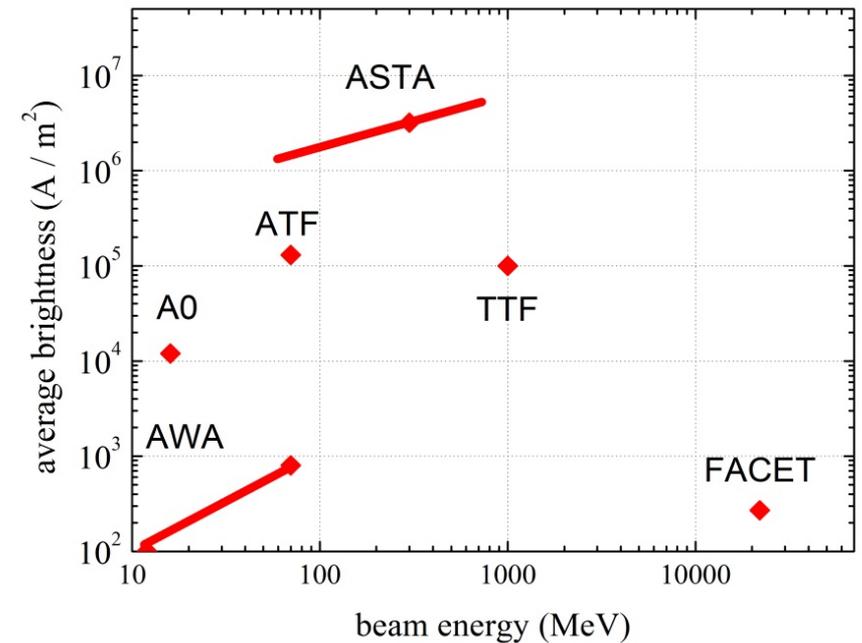
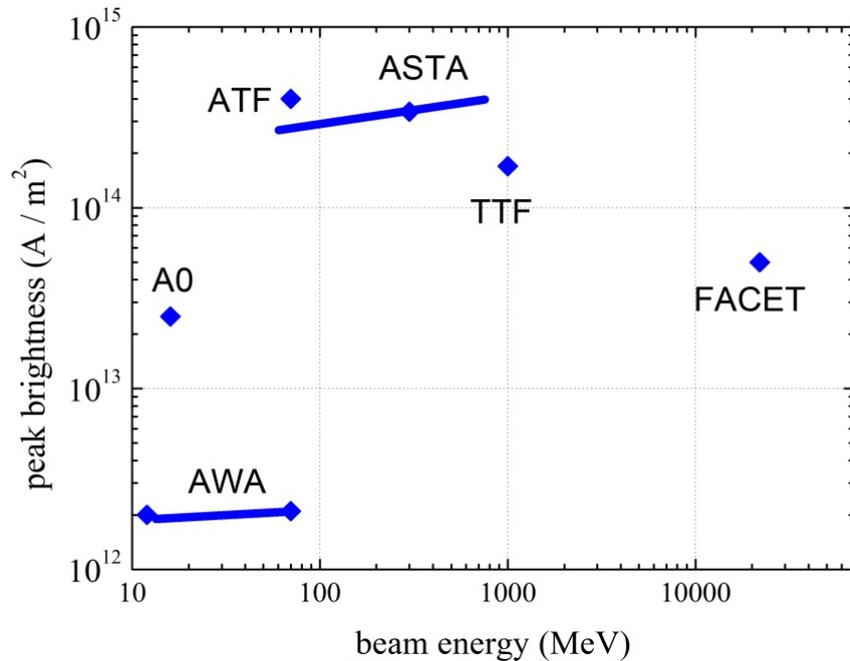
Parameter	Value	Range	Unit	Comments
Energy Exp A 1	50	5-50	MeV	maximum determined by booster cavity gradients
Energy Exp A 2	820	50-820	MeV	1500 MeV with 6 cryomodules
Bunch charge	3.2	0.02-20	nC	maximum determined by cathode QE and laser power
Bunch spacing	333	10-∞	ns	laser power
Bunch train <i>T</i>	1	1 bunch	ms	maximum limited by modulator and klystron power
Train rep rate	5	0.1-5	Hz	minimum may be determined by egun <i>T</i> -regulation and stability considerations
Emittance_{rms norm}	5	<1 ... >100	π μm	maximum limited by aperture and beam losses
Bunch length_{rms}	1	0.01-10	ps	min obtained with Ti:Sa laser; maximum obtained with laser pulse stacking
Peak current	3	>9	kA	3 kA with low energy bunch compressor; 9 kA possible with 3.9 GHz linearizing cavity

* $3.2\text{nC} \times 3000 \text{ bunches} \times 5 \text{ Hz} \times 0.82 \text{ GeV} = 40 \text{ kW}$

Experimental Area 3: IOTA

Parameter	Value	Unit
Circumference	38.7	m
Bending dipole field	0.7	T
RF voltage	50	kV
Electron beam energy	150	MeV
Number of electrons	$2 \cdot 10^9$	
Transv. emittance r.m.s. norm	2	$\pi \mu\text{m}$
Proton beam energy	2.5	MeV
Proton beam momentum	70	MeV/c
Number of protons	$8 \cdot 10^{10}$	
Transv. emittance r.m.s. norm	0.1-0.2	$\pi \mu\text{m}$

Comparison with Other Facilities: Peak and Average Brightness



* see Sec. 5.0 for detail comparison of ASTA to various Accelerator R&D facilities