ASTA Facility

Advanced Superconducting Test Accelerator

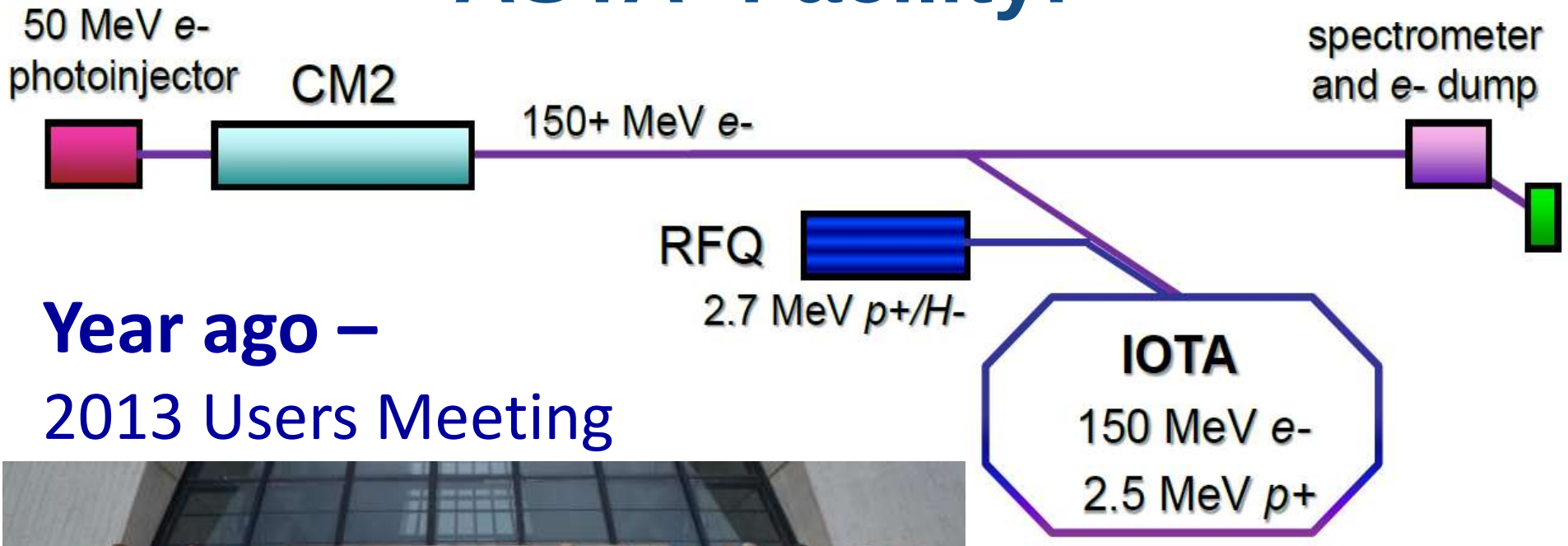
ASTA: Status and Plans

Vladimir Shiltsev
Fermilab/APC
ASTA Director (Interim)

Content

- **ASTA – Facility**
  - Technical progress PI, CM2 , IOTA
- **ASTA – Program**
  - DOE reviews and plans
  - 1st experiments, 1st PhD, PAC talks
- **ASTA – Team**
  - Personnel changes, visitors, students, SBIRs
  - ASTA Web-site and Newsletter
  - Talks, presentations
- **ASTA – Users Meeting**
  - Goals, schedule

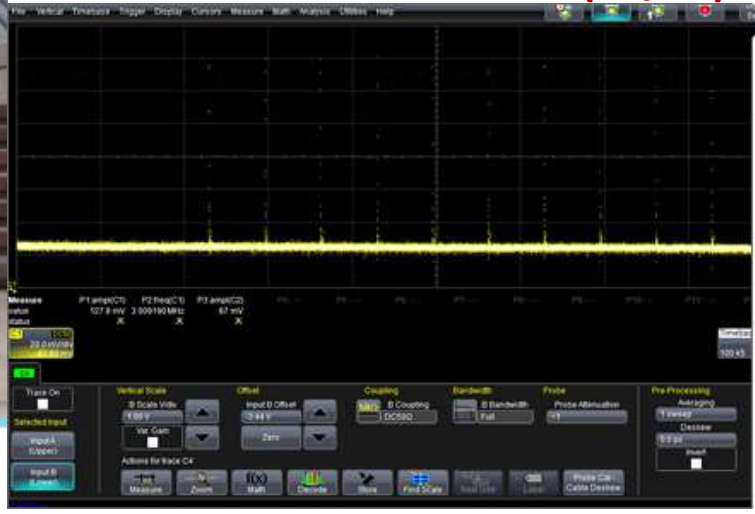
ASTA- Facility:



Year ago –

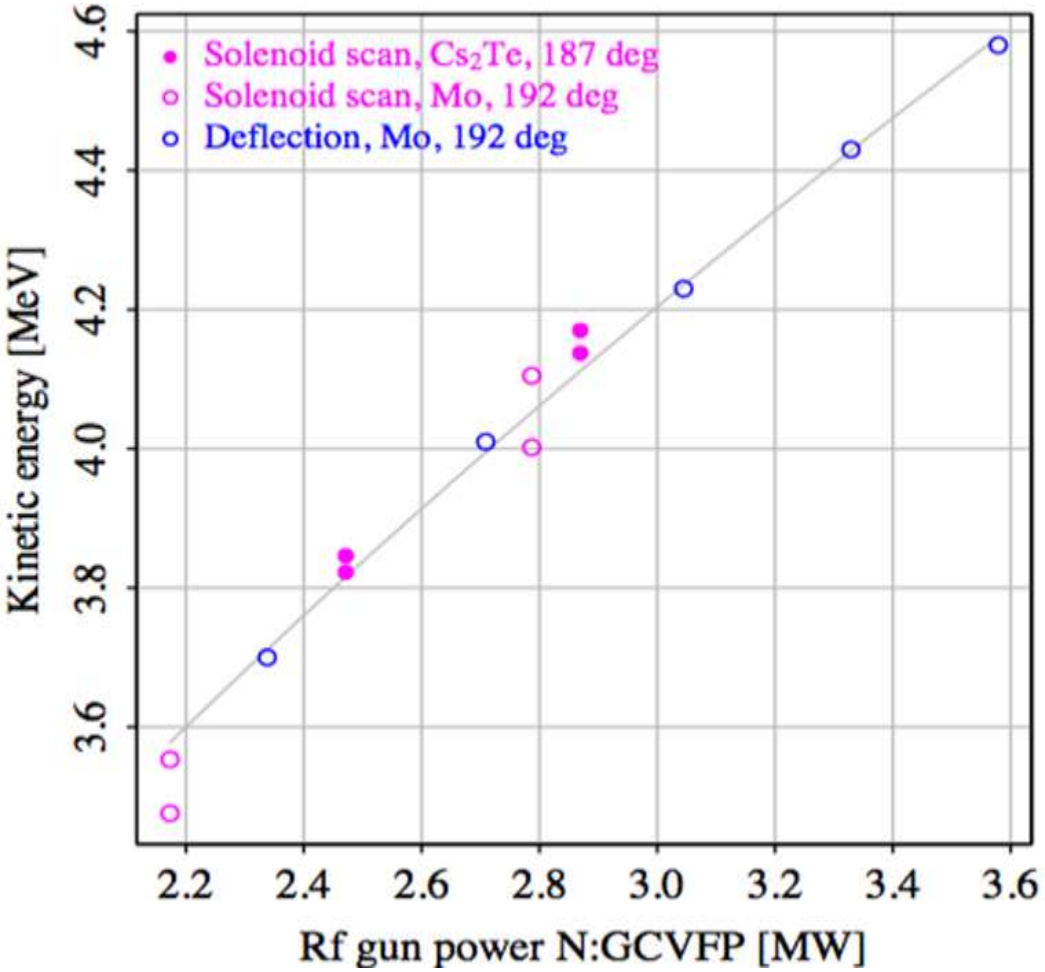
2013 Users Meeting

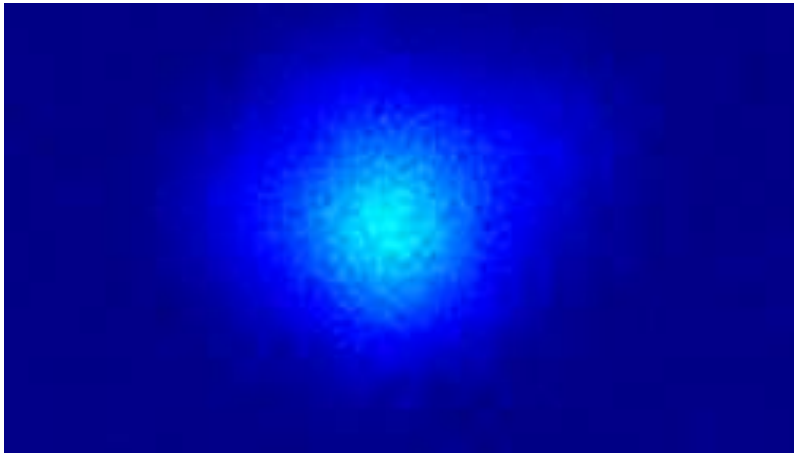
1st Photo e-'s (05/13)



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

- Full RF power, ~3000 full ILC-charge bunches in ~1ms
- See talks by Jinhao Ruan and Giulio Stancari





(Top) YAG screen image of first electrons from a Cs2Te cathode and (left) electron energy vs. RF gun power at ASTA.

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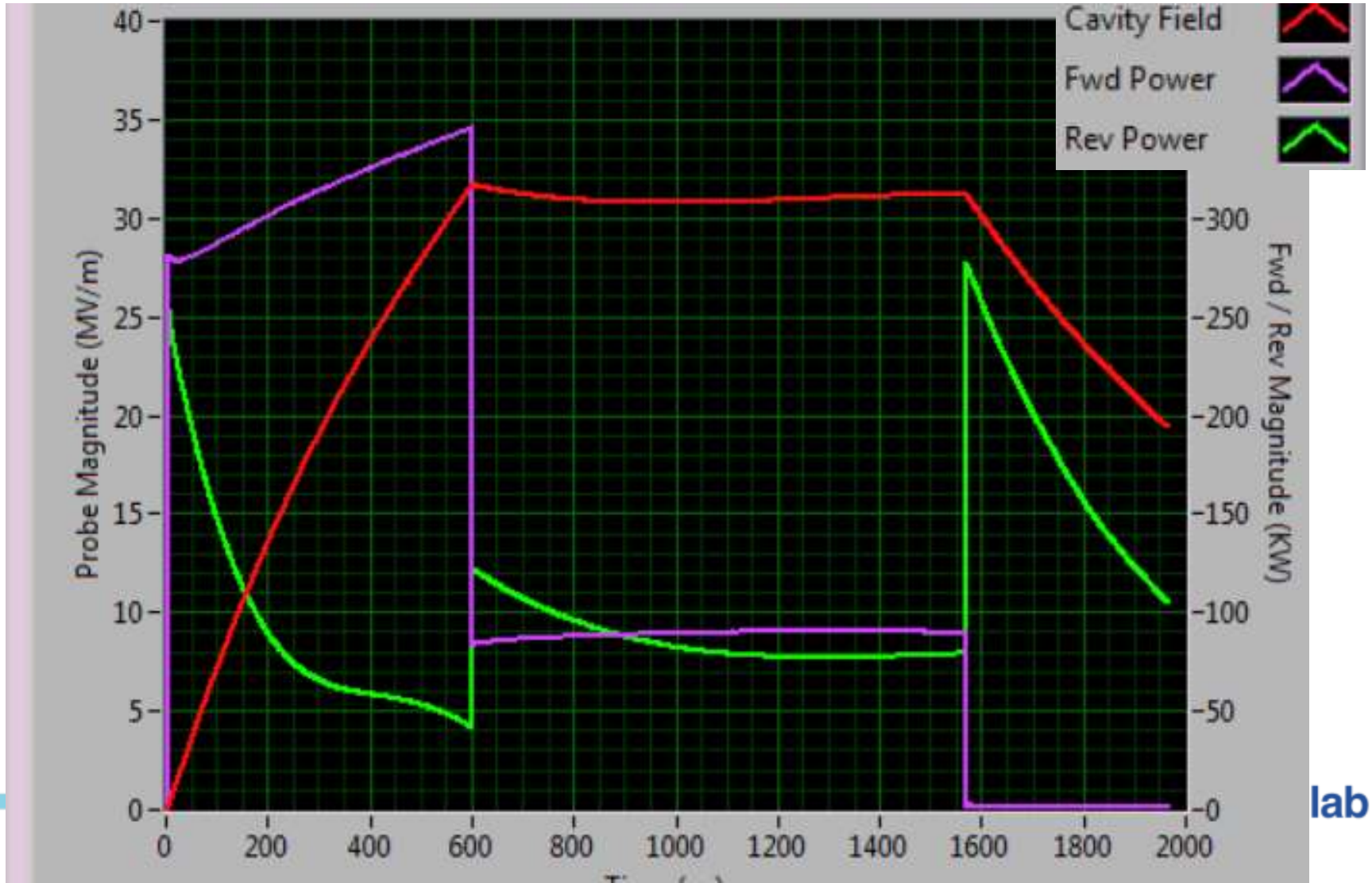
1.3 GHz SRF Cryomodule – Best in the World!

- June 4th, 2014 – last cavity (#8) achieved 31.5 MV/m 1ms
- More in Elvin Harms's talk



IOTA Ring – Accumulation of Subsystems

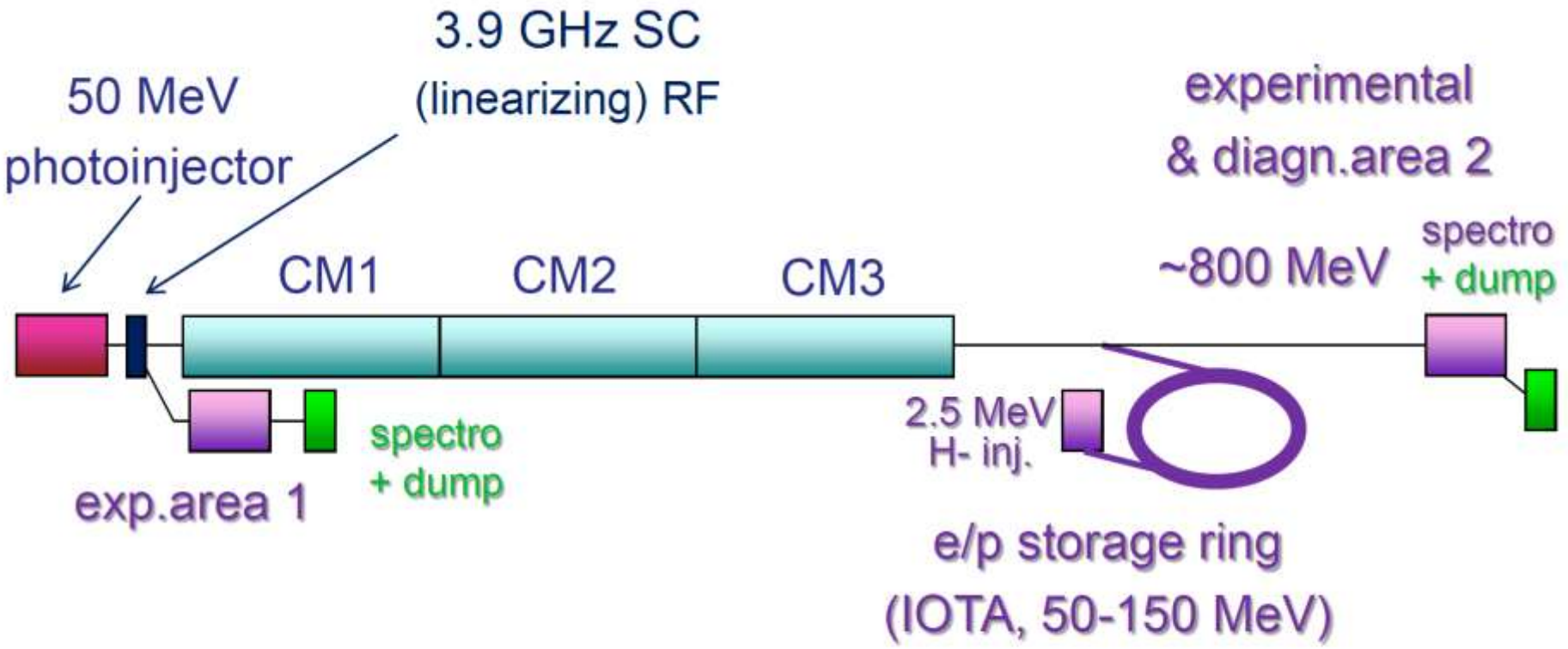
- Stands, vacuum system, quads, dipoles (in work), RF, PSs, etc
- More in Sasha Valishev''s talk

32 IOTA quadrupole magnets from JINR
+ Stands from MIT

ASTA – Program: Evolution

- DOE GARD Review – March 2013
- DOE Facilities Review – October 2013
- Revised Program – March 2014
- HEPAP Accelerator R&D Subpanel – Summer 2014

ASTA *Users* Facility (2013 Proposal)

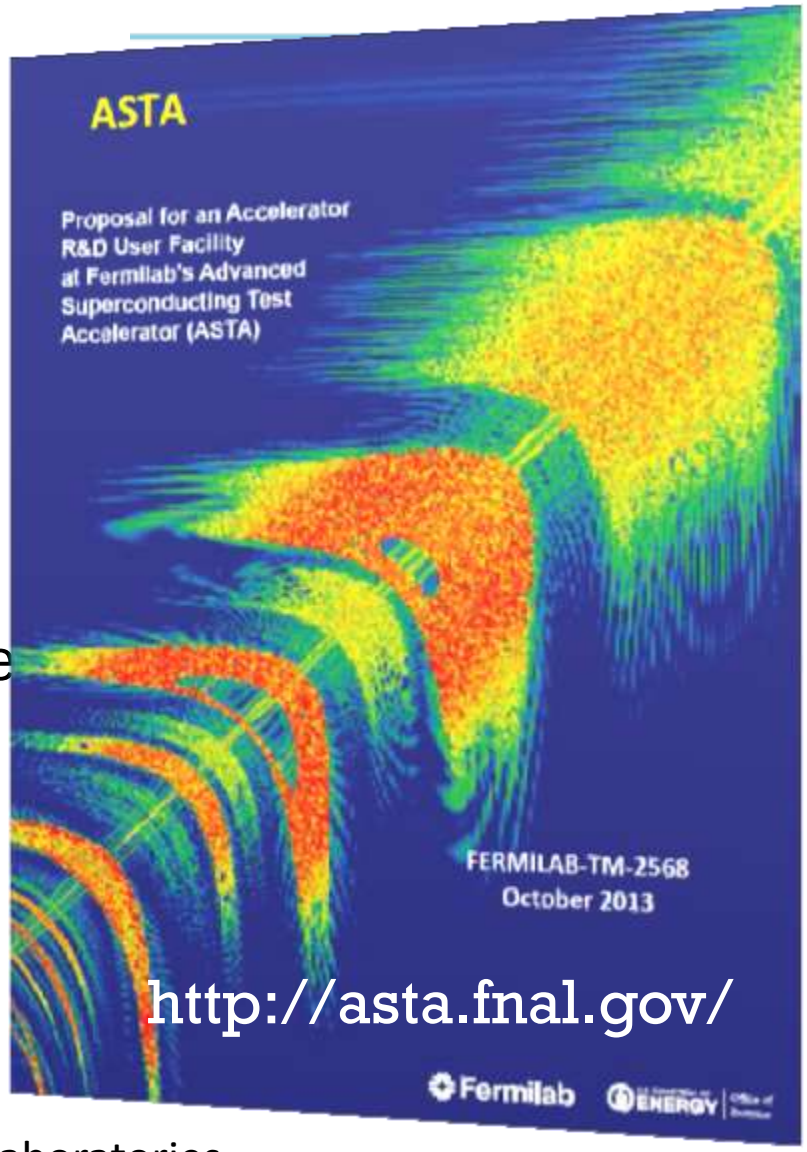


Three Experimental Areas capable of hosting 5-9 experiments at once

Can serve community of 100-150 users (in ~3-5 years)

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 all 3 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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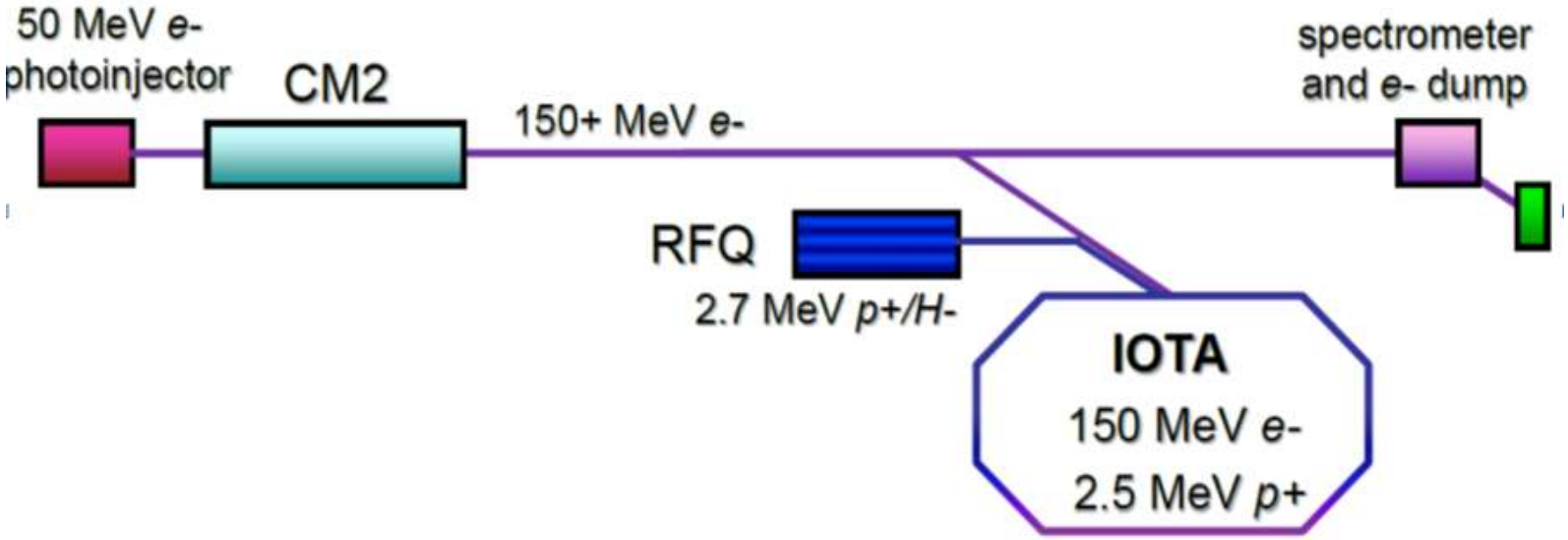
ASTA/IOTA Comments

- Feedback from the ASTA/ATF-II/FACET-II Review (10/2013):
  - "**It would be wasteful not to capitalize on this large investment**"
  - "Given the large investment in srf technology HEP has made at Fermilab, **making use of the infrastructure to carry out beam tests on a SRF cryomodule is a natural choice. "**
  - "We consider adding more cryomodules not to be well justified…reasonable to **de-scope the proposed activity to using only a single cryomodule… support should come from srf infrastructure funds** or other sources.."
  - "**The most attractive feature of ASTA is the IOTA ring**."
  - "**IOTA is the high priority aspect of the ASTA proposal**."
  - "...we believe that **cost optimization for this facility should involve funding only the IOTA ring as a standalone facility**, with its own proton source."
  - "…**the high priority R&D goal for Fermilab is to develop the standalone IOTA ring, including its proton source**. A revised cost estimate that includes these additional items [injection, instrumentation, experiments] should be provided…prior to finalizing a funding decision."

ASTA/IOTA Revised Plan (March 2014)

- New reduced scope ASTA facility and cost estimates for
  - IOTA ring
  - electron injector based on existing ASTA electron linac
  - proton injector based on existing HINS proton source.
  - [option of a standalone electron injector = extra 3M$ and 2 yr delay]
- So “reformulated” ASTA:



- The cost to complete construction ~6.5M$... + R&D and Ops

ASTA Revised Plan

- **By the end of FY14:**
  - Complete 50 MeV injector and **bring beam** to 50 MeV dump
  - Finish CM2 RF commissioning
  - 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)

Depends on budget ← on Subpanel ← on P5

http://usparticlephysics.org/p5/

P5 Outcome in Broad Strokes

- **Collider Physics - Overseas:**
  - LHC in Europe, J-ILC in Japan (if Japan moves)
- **Domestic thrust – Neutrinos:**
  - Increase the fraction of the budget for construction of new facilities.
  - Reformulate LBNE as LBNF - an internationally designed, coordinated, and funded program with Fermilab as host.
  - Redirect specific activities and efforts at Fermilab to the PIP-II program of improvements to the accelerator complex, which will provide proton beams with power over 1 MW for LBNF
  - Re-align activities in accelerator R&D with the new strategic plan, and emphasize capabilities that will enable creating future-generation accelerators at dramatically lower cost.

ASTA/IOTA is Exactly About That !

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ASTA/IOTA R&D for multi-MW Facility

- IOTA Experiments
  - Integrable Optics with NL magnets (first – with *e*- beam, them with *p*+)
  - Integrable Optics with E-Lens (*e*,*p*)
  - Space-Charge Comp'n with Integr.Opt.(NL&ELens) (with *protons*)
  - Space-Charge Comp'n with E-Columns (*with protons*)
  - OSC test (*e*-)

Enabling R&D (Accelerator R&D Alignment)

- **Recommendation 26: Pursue accelerator R&D with high priority at levels consistent with budget constraints. Align the present R&D program with the P5 priorities and long-term vision, with an appropriate balance among general R&D, directed R&D, and accelerator test facilities and among short-, medium-, and long-term efforts. Focus on outcomes and capabilities that will dramatically improve cost effectiveness for mid-term and far-term accelerators.**
- A HEPAP subcommittee on accelerator R&D will provide detailed guidance on the implementation of accelerator R&D aligned with P5 priorities.

Accelerator R&D

Subcommittee membership 18

- Co-chairs: Marty Breidenbach & Don Hartill
- Members from:
  - HEPAP
    - Ilan Ben-Zvi
    - Georg Hoffstaetter
    - Robert Tschirhart
    - Bruce Carlsten
  - Particle physics accelerator and experiment communities
    - William Barletta
    - Roger Dixon
    - Steve Gourlay
    - Young-Kee Kim
    - James Rosenzweig
    - Michael Syphers
    - Rik Yoshida
  - International accelerator community
    - Oliver Bruning (CERN)
    - Tadashi Koseki (KEK/J-PARC)
    - Lia Merminga (TRIUMF)
- Observers from Nuclear Physics & Basic Energy Sciences
  - Zhirong Huang (BES)
  - Geoffrey Krafft (NP)

Report (prelim) Nov'14
Final – March '15

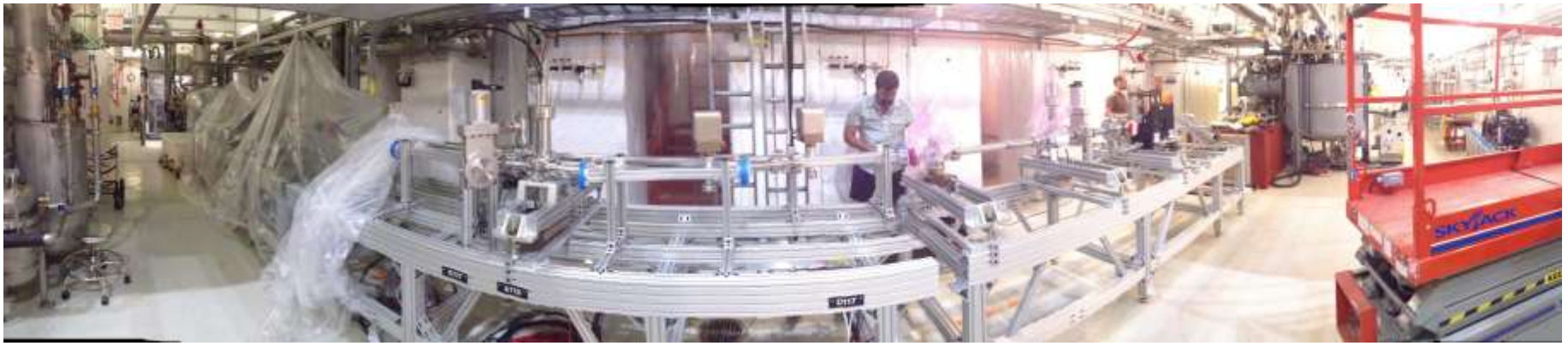
Main goals of R&D

- **medium-term research,** to bring new concepts to practice so that they can be considered for the design of a new facility;
- **long-term, exploratory research** aimed at developing new concepts for acceleration
- **new technologies, new materials, and advanced simulation techniques, training of accelerator physicists, engineers, and technologists**

***National Goals* described in the HEPAP-P5 report for Scenarios A and B**

ASTA Program

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



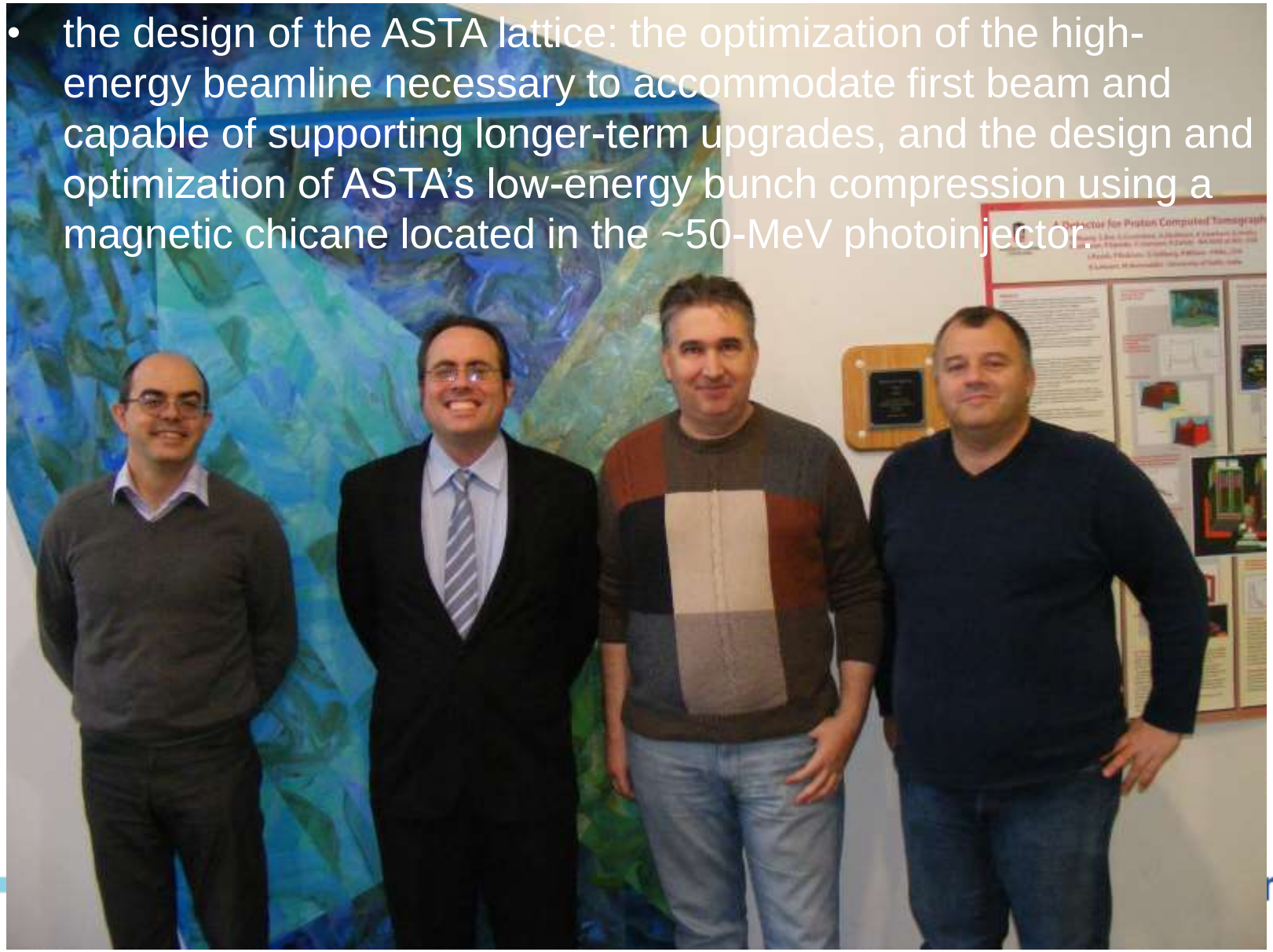
- **1st SRF research user and collaborators**

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 Program

- **Oral and poster presentations at:**
  - IPAC ’2013
  - NA-PAC ‘2014:
    - ~20 presentations reported on work related to ASTA.
    - One invited talk (*The Fermilab Advanced Superconducting Test Accelerator (ASTA) Facility* by P. Piot, NIU/FNAL)
    - 3 contributed talks describing the science opportunities at ASTA (*Space-charge Compensation for High-intensity Linear and Circular Accelerators at Fermilab*, M. Chung, FNAL; *Model Ring With Exactly Solvable Nonlinear Motion*, T. Zolkin, U. of Chicago; *Test of Optical Stochastic Cooling in the IOTA Ring*, V. Lebedev)
  - IPAC’2014
  - 2014 Advanced Accelerator Concept Workshop
  - LINAC’2014
  - Papers in *NIM-A, PRSTAB*, etc, etc

2013 APS DPB Fellows – Congrats!
3 out of 5 – Active ASTA Collaborators

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ASTA – Program and News

ASTA http://asta.fnal.gov/
Advanced Superconducting Test Accelerator

Fermilab: Home

- **ASTA Home**
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- Info for Fermilab Visitors
- Safety

Volume 2013, Issue 1 December 2013

Fermilab's Advanced Superconducting Test Accelerator

ASTA Newsletter

Impressive Progress at ASTA

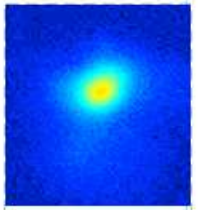
ASTA is cited as one of eight major Fermilab accomplishments of 2013:

- From Fermilab Director Nigel Lockyer article "Recognizing Accomplishments" (*Fermilab Today*, Dec.3, 2013): "...Pushing ASTA forward through the first photoelectrons from the ASTA injector, holding the first ASTA users meeting and developing a proposal for presentation to DOE."

ASTA got off to rousing start in 2013, and 2014 promises to provide even more advances.

The 2013 most notable achievements in bringing ASTA into operation include: a) completion of the first phases of Photoelectron Gun conditioning and first 3.5 MeV electrons produced and characterized; b) installation, cool down to 2K, and first operation of the 1.3 GHz SRF Capture Cavity-I; c) cool down to 2K and commissioning of the SRF "Capture Cavity 2" (CC2) to 21 MV/m; d) re-building of the SRF CC1 with a higher gradient cavity, which was tested to 29 MV/m; e) installation and conditioning of a new 5 MW klystron for the Gun.

The first **ASTA Users meeting** took place at Fermilab on July 23-24, 2013 and brought together more than 80 people with the wide interest in the ASTA beams. Simultaneously held meeting of the ASTA Program Advisory Committee had greatly helped to formulate the science case for the Proposal for an **Accelerator R&D User Facility** at Fermilab's ASTA (see FERMILAB-TM-2568 at *asta.fnal.gov*). The proposal has been co-authored by 97 people from 18 institutions, including 24 APS Fellows, 10 Accelerator Prize winners and over 25% young researchers representing large national and international laboratories, University groups, SBIR companies and detector R&D groups. It calls for modest support to complete the facility construction (more than 90% of the work is already done) and establishment of the nation-leading user facility for accelerator R&D towards future intensity and energy frontier machines and accelerator applications. It covers 31 individual beam study proposals and letters of intent—and that number is growing—which will take place at all three ASTA experimental areas: Exp.Area-1 with 50 MeV electrons (14 proposals), Exp.Area-2 with 300-800 MeV electrons (18) and Exp.Area-3 electron-proton IOTA storage ring (7). The proposal was reviewed by DOE OHEP in October 2013. The key elements of the **ASTA 2014 plan** include: a) gun commissioning with new klystron to get design energy high charge 4.9 MeV electron bunches from CsTe-coated cathode; b) beam commissioning of the CC2 and (later) CC1 and completion of the ASTA Injector to the 50 MeV beam absorber; c) the first round of beam experiments at 20 and then 50 MeV; d) full RF commissioning of the 1.3 GHz SRF cryomodule at the design gradient of 31.5 MV/m and pulse width/rate; e) construction of the cave extension for the high-energy portion of ASTA, f) the installation of the high-energy 300 MeV test beamline from the SRF CM to high power beam dump; g) continued design and construction of components of the IOTA ring.



ASTA 3.5MeV electrons as seen on the "9-way cross" YAG screen

Inside this issue:

IOTA Parts Arriving from Collaborating Institutes

Many collaborating institutions are providing components for the construction of IOTA ring at ASTA. The transverse focusing in the machine will be done by some 40 conventional quadrupole lenses. JINR (Dubna, Russia) is sending 32 high-quality quadrupoles (in exchange for electron cooling components). BINP (Novosibirsk, Russia) is ready to deliver an RF cavity if we determine that it meets the project specifications. A very important component of the IOTA physics program– the nonlinear magnet, is under development at Radiabeam Technologies, Inc. funded by a DOE SBIR Grant. The University of Maryland has expressed interest in developing a quadrupole pickup device for use at IOTA. Last, but not least, the entire ASTA high energy beam line and IOTA ring will be supported by 56 very nice stands (pictured) provided by MIT Bates, which arrived at the facility in October.

Volume 2, Issue 1 April 2014

Fermilab's Advanced Superconducting Test Accelerator

ASTA Newsletter

pressive Start in 2014; Users Meeting June 9-10

team contin- evaluated ASTA as a unique gress: we are facility with the greatest missioning of "...potential to seed or enhance and installa- future capability in support of V beamline, HEP" and the only one which n bunches are permits so-important advanced Cs_2Te photo- proton beam R&D. Following erated to ~5 the Committee recommenda- n. We are on tions, in March 2014 we have first beam to submitted a modified plan for mer (see *pg.2* ASTA which is centered at the rs **Meeting** is IOTA ring and its two injec- see *p.4*). The tors—the NML electron linac er 2013 DOE and the proton RFQ previously e ASTA facil- used by the HINS project in ctober 2013) MDB at Fermilab.

Northern Illinois University student Francois Lemery (right) talks with NIU President Douglas Baker (left) and Congressman Randy Hultgren during a visit to ASTA [from *NIU Today* 02/12/2014]

Prokop — the first PhD based on ASTA-related research !

of Northern beamline that could eventually successfully be included downstream of the issertation on first cryomodule. Finally, he His work in- investigated a single-shot longi- ed to the de- tudinal-phase-space diagnostics attice such as that might be part of future up- of the high- grades of the photoinjector. necessary to Chris's work was performed in beam and collaboration with Los Alamos rting longer- National Laboratory's Dr. Bruce d the design Carlsten as part of a lab-directed ASTA's low- R&D project to investigate ad- pression using vanced phase-space manipula- located in the tions for the Matter-Radiation jector. Chris Interactions in Extremes -physics top- (MaRIE) facility. Some of the velopment of studied phase space manipula- transverse-to- tions will be experimentally nce-exchange studied at ASTA.

Christopher Prokop (2nd from left) with his PhD defense committee : P. Piot (chair), B. Erdelyi, and O. Chmaissem.

Fermilab

Fermilab's main page *www.fnal.gov*

ASTA program is part of Fermilab Agenda for FY2014–FY2019: the document states *"...Accelerator research collaboration using ASTA/IOTA is established and program launched 2016"*

(see Fermilab Today column by FNAL COO V.White *04/08/2014*)

ASTA Tours + Visits of Dignitaries

- Northern Illinois University student Francois Lemery (right) talks with NIU President Douglas Baker (left) and Congressman Randy Hultgren during a visit to ASTA [from *NIU Today* 02/12/2014]

Dr. W.Colglazier - S&T Advisor to US Secr. of State

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Korean Dignitaries Tour of the ASTA Facility

Weekly Meeting of the ASTA Construction and Operations Team led by J.Leibfritz and E.Harms

ASTA Leadership Team

Organization

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Elvin Harms
Commissioning & Operations

J. Leibfritz
Installation & Engineering

Philippe Piot
Physics

Alex Valishev
IOTA

Peter Garbincius
Program Office

… One change

Alexander (Sasha) Valishev of Fermilab's APC took the lead over the ASTA's IOTA program in February 2014. Previous leader of the program, Sergei Nagaitsev has taken on the responsibilities of the Fermilab's Accelerator Division Head. Sergei will remain intellectually and scientifically involved in the IOTA. He will continue to supervise a PhD student from University of Chicago who is doing research on the integrable optics at ASTA. Alex and Sergei had several joint publications on the subject at recent PAC and IPAC conferences

Alex Valishev to lead IOTA program

Alexander Valishev

Sergei Nagaitsev

… (from ASTA NL #2)

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ASTA : Summary – since last Meeting

- Great technical progress (PI, CM2, IA)
- Beam to 1st exp't in 2014
- Aggressive plans for 15-17 (to finish construction)
- Important HEPAP *Accelerator R&D Subpanel* '14
- ASTA to lead Accelerator R&D for high power protons beams (focus: medium-term HEP facility)
- ASTA is important part of the ***Fermilab Agenda***
- ASTA collaboration team grows – more Universities, Int'l partners, SBIRs, other labs, individuals, …
- ASTA is already VERY visible, showcase of Acc R&D

Let's make ASTA a success, let 's make this *Users Meeting* a success!

ASTA – Users Meeting

- Session I: ASTA Description
- Session II: System Overview
- Session III: Current (Research) Activities
- Session IV: IOTA Based Experiments
- Session V: Linac Based Experiments

- Picture taking (today before lunch)
- ASTA Tour (tomorrow after lunch)

- Dinner (tonight at ~6pm, *Pal Joey's*, see map)
- [*Fermilab Users Meeting* Wed-Fri – ASTA talk Wed]

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