Highlights of BIW10

10th European Workshop on Beam Diagnostics and Instrumentation for Particle Accelerators

Hamburg, Germany, May 16th—18th, 2011

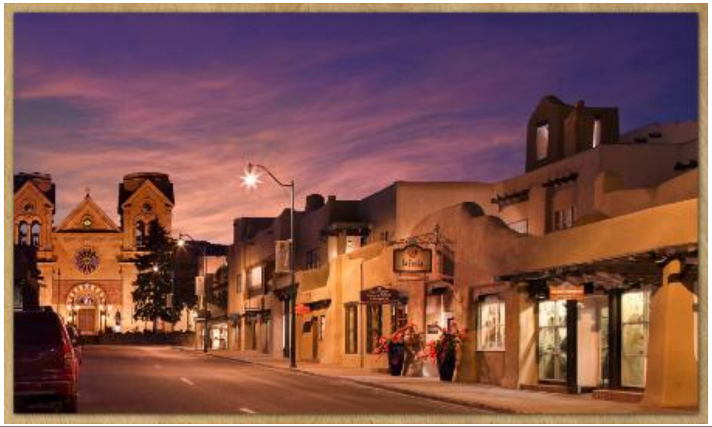
Doug Gilpatrick

Agenda

- **Introduction**
- **Description and Program Statistics**
- **Vendors and Sponsors**
- **Personal Presentation Impressions**
  - Invited Oral
  - Contributed Oral
  - Poster
- **Banquet and LANSCE Tour**
- **Final Remarks**

BIW10 was held on May 3 – 6, 2010 in the La Fonda in Santa Fe, NM and sponsored by Los Alamos National Laboratory.

- **BIW10 offered...**
  - Small size (< 200 participants)
  - No parallel sessions
  - Orals
    - 3 Tutorials (75+15)
    - 8 Invited Orals (35+10)
    - 10 Contributed Orals (20+10)
    - Special Presentation (DITANET)
    - Vendor Technical Orals
  - Tuesday afternoon poster session
  - Wednesday evening banquet (more later)
  - LANSCE facility tour (more later)



BIW statistics shows a greater participation in recent years.

Year	Primary Sponsor	Location	Participants	Tutorial Orals	Invited Orals	Cont. Orals	Posters	Discussions
2010	LANL	La Fonda Hotel, Santa Fe	177	3	8	10	92	Working Lunch
2008	LBNL	Granlibakken Conf. Cntr., Lake Tahoe	115	3	8	7	53	Yes, 4 to 6
2006	FNAL	FNAL (on site), Batavia	119	3	7	7	40	Yes, 4 to 6
2004	SNS	Marriott Hotel, Knoxville	120	3	2	12	37	Yes, 4 to 6

BIW10 also provided....

a Tuesday working lunch,

free WiFi at La Plaza, and

two BIW10 web sites.

http://www.lanl.gov/conferences/biw10/, LANL, tutorials streamed from web site

http://accelconf.web.cern.ch/AccelConf, JACoW

1 ½ days of sponsor & vendor representation which provided interaction time between participants.

Sponsored receptions ...

Additional Sponsors & Vendors ...

Initial oral presentations included ……

- **Keynote oral given by Kevin Jones (LANL) described the Materials Radiation in Extreme (MaRIE) future facility**

- **Rhodri Jones (CERN) provided an update of CERN and a description of "the incident".**
- **Faraday Cup Oral Presentation**
  - Kirsten Elaine Hacker (DESY) and Florian Loehl (CLASSE), "Femtosecond Resolution Beam Arrival Time Monitor"
- **Plus other invited orals.....**

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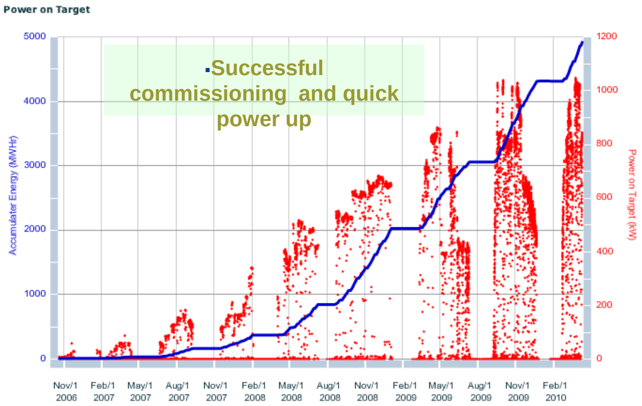
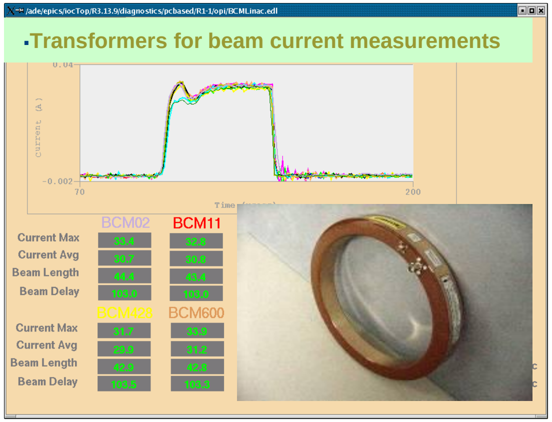
Alexander V. Aleksandrov, “The SNS Beam Diagnostics Experience and Lessons Learned”

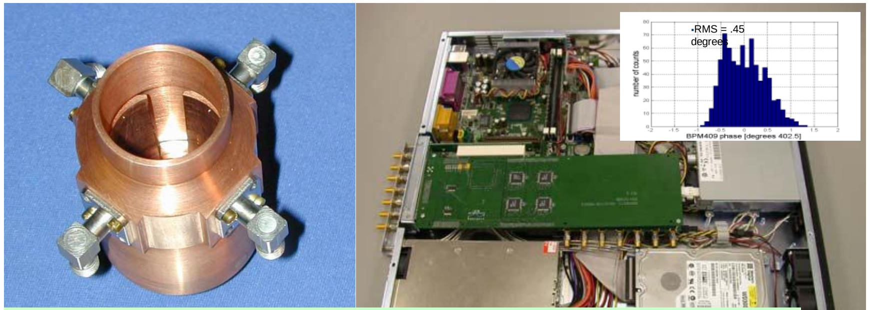


▪Successful commissioning and quick power up

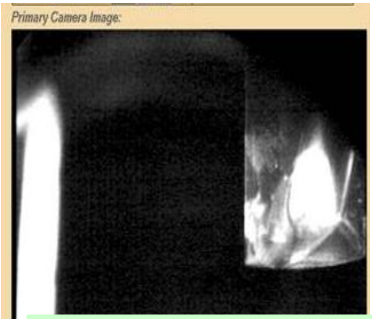


▪Transformers for beam current measurements

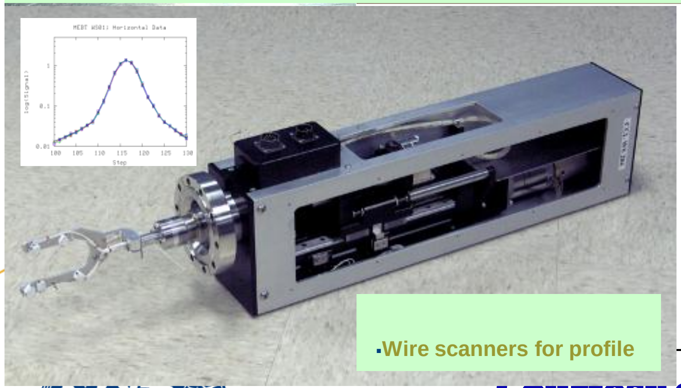
▪Ionization chambers and VME data acquisition for beam loss



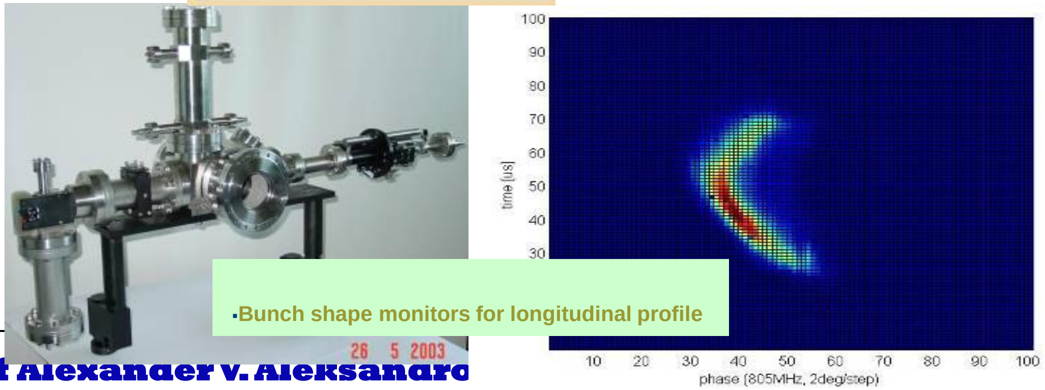
▪Strip-line pick-ups and PC based data acquisition for phase and position



▪Injection foil Imaging system



▪Wire scanners for profile



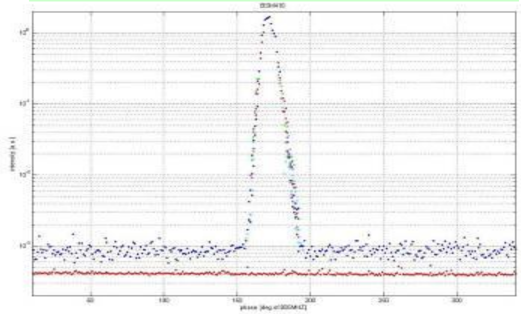
▪Bunch shape monitors for longitudinal profile

Courtesy of Alexander V. Aleksandro

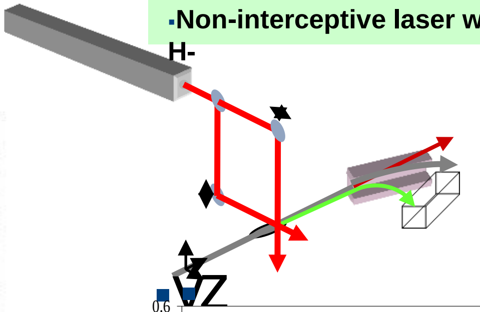
Alexander V. Aleksandrov, “The SNS Beam Diagnostics Experience and Lessons Learned”

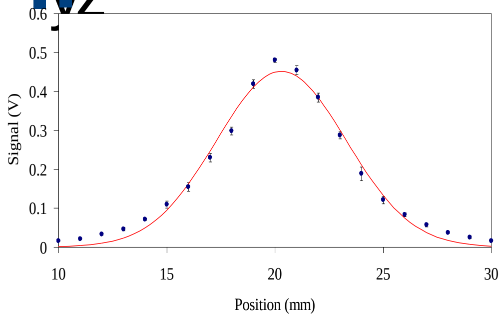
- Large dynamic range transverse profiles

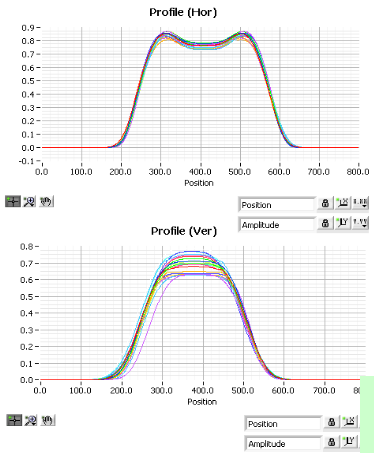
- Large dynamic range longitudinal profiles

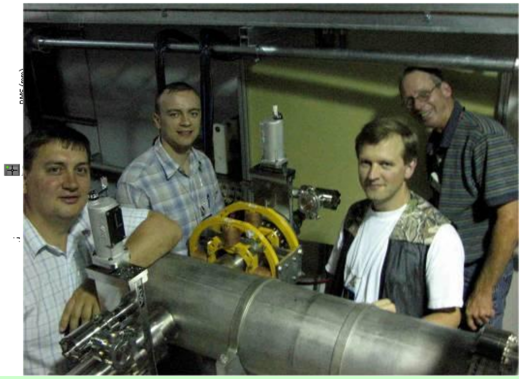


- Non-interceptive laser wire for H-



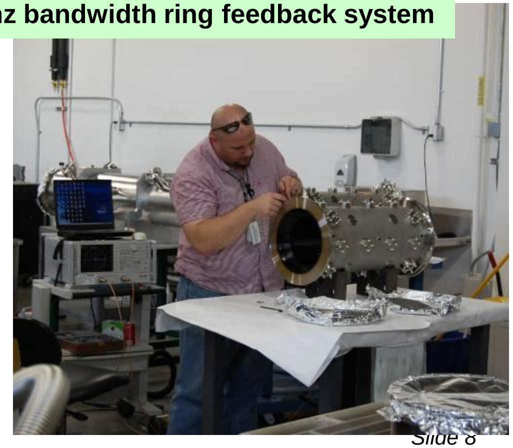






- Non-interceptive electron beam wire for protons

- 1-300Mhz bandwidth ring feedback system



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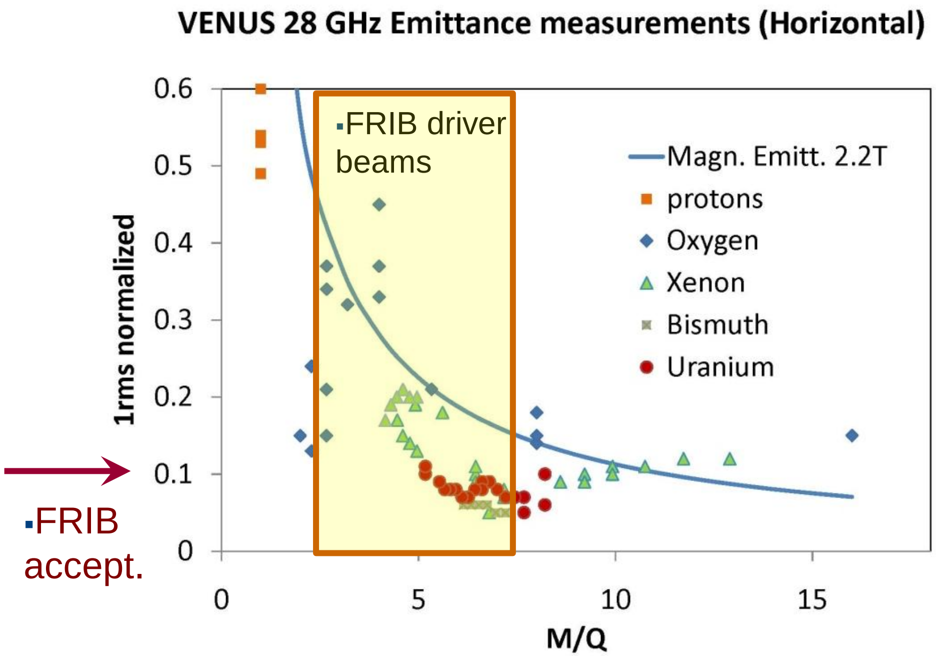
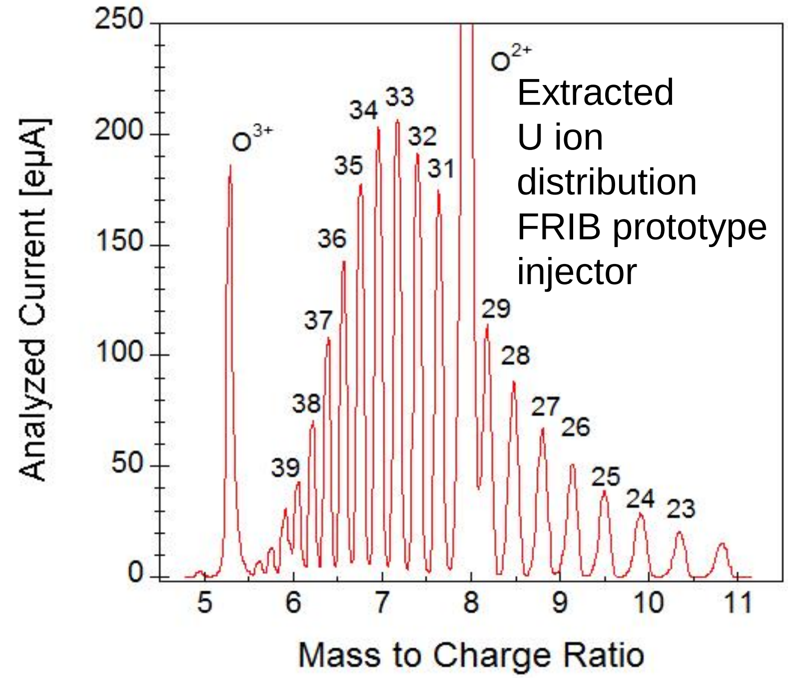
Courtesy of Alexander V. Aleksandrov (SNS/ORNL)

Daniela Leitner, “Ion Beam Diagnostics for ECR Ion Sources”.

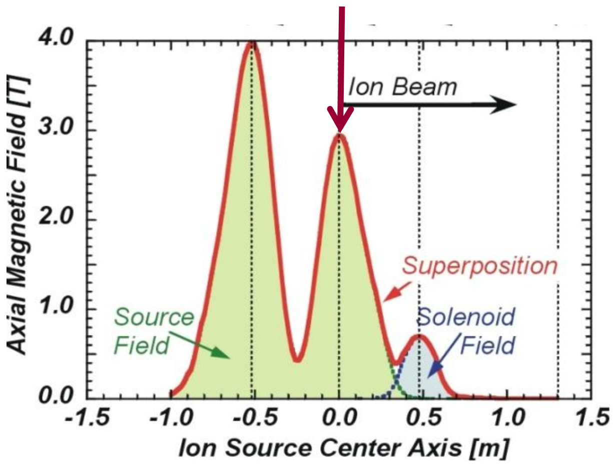


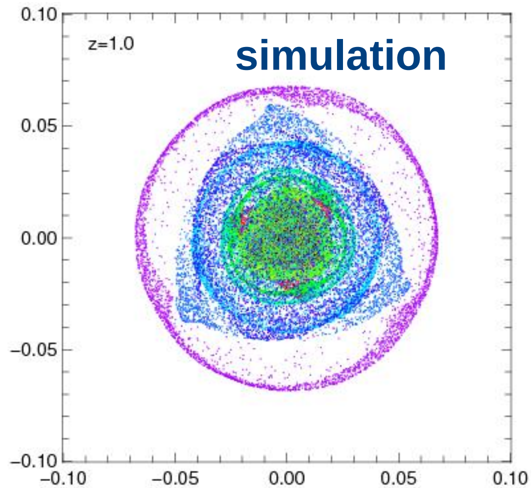


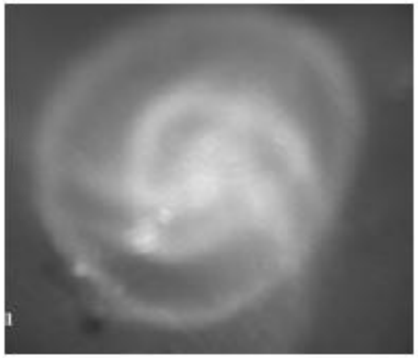
- ECR ion sources are multi species and multi charge state ion plasma sources
- Heavy ion beam facilities need a wide variety of beams (eg 47 beams for FRIB)
- Emittance values is dependent on the mass and charge of ions
- Magnetic field plasma confinement structure shapes ion beam profile at extraction and determines the ion beam emittance for different species

Daniela Leitner, “Ion Beam Diagnostics for ECR Ion Sources”.

Magnetic plasma confinement field shapes the ion beam extracted from ECR ion sources, dominant factor for initial beam conditions







experiment

Multi species beam profile 1 m after the extraction

Diagnostic Needs

- 4D emittance scanners, viewers etc. to measure the coupling of the transverse phases
- Need to support matching of transverse phase space for transport of two different charge state ions (FRIB)
- Wide dynamic range (nA to mA)

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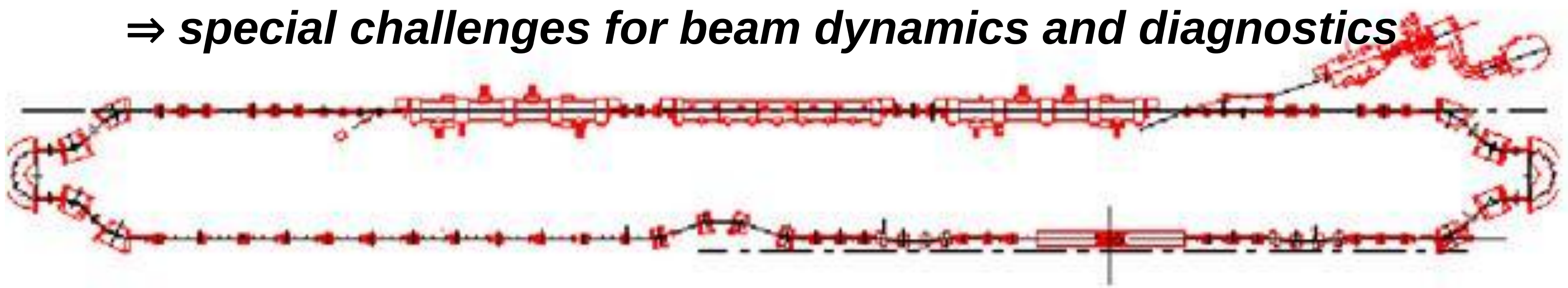
Courtesy of Daniela Leitner (FRIB, LBNL)

David Douglas, “An Instrumentation Wish List for High Power/High Brightness ERLs”.

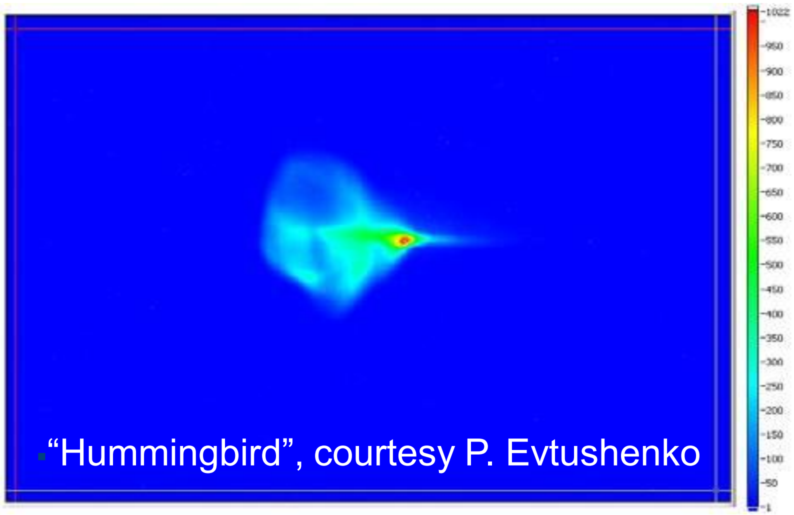
- **ERLs: Superconducting-RF based accelerators with high (~linac quality) brightness/power beams at high (~storage ring) wall-plug efficiency**
- **Many unique features:**
  - beam doesn’t go to equilibrium (~ like linac)
  - not betatron stable; no uniquely defined Twiss parameters
  - “beam ≠ machine” (c e^- storage ring at equilibrium ⇔ beam defined by lattice)
- **fully coupled (6-d phase space) transport**
  - large acceptance ⇔ very nonlinear
- **multiple beams @ multiple energies in common transport**

⇒ *special challenges for beam dynamics and diagnostics*



“its like a snake eating its own tail” (S. Benson)

Two Typical ERL Idiosyncrasies


“Hummingbird”, courtesy P. Evtushenko

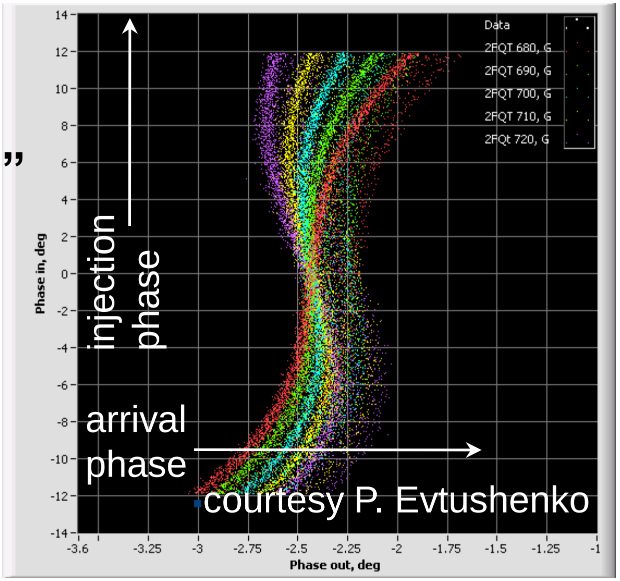
Inherently non-Gaussian beams

- **ERLs – act like injection line (“lossy”…)**
  - In contrast to storage ring,
    - ERL beam *never reaches equilibrium;*
    - *acts like injection into ring,* ***not*** *like stable ring operation*
  - “σ” not good measure of beam extent
- **High power ⇒ halo control imperative**

Longitudinal Matching (e.g., FEL drivers)

- **Inject long, low $\delta p/p$ bunch (avoid space charge); accelerate on rising side of RF waveform ⇒ “chirp”**
- **Compress σ_l using recirculator compactions**
  - Sextupole/octupole compensation of RF/lattice curvature
- **Compress $\delta p/p$ during energy recovery**
  - Again – use 2nd, 3rd order magnetic corrections

⇒ harmonic RF unnecessary!!!



M_{55}, T_{555}, W_{5555}… measurement; must control lattice *as well as* beam

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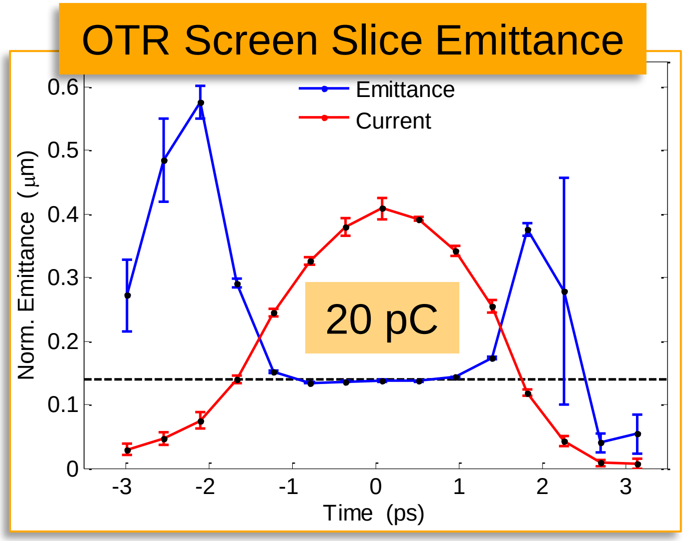
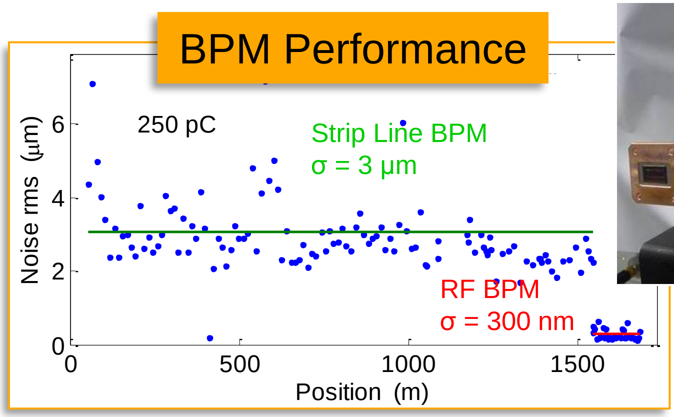
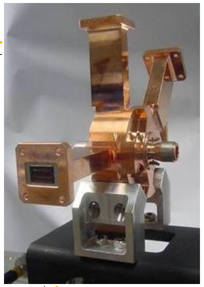
Courtesy of David Douglas (TJNAF)

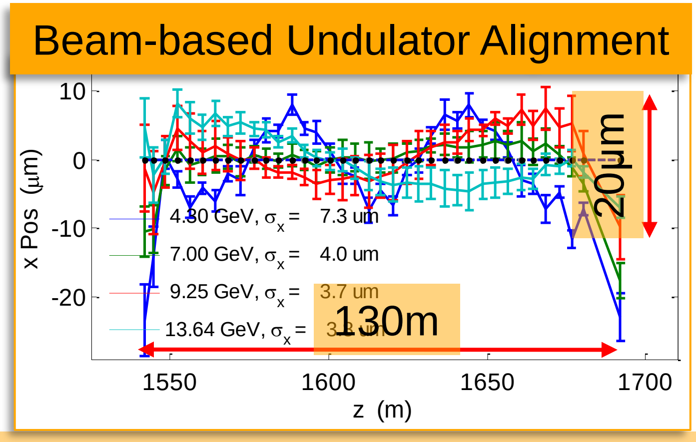
Henrik Loos, “Operational Performance of LCLS Beam Instrumentation”

- **Well developed suite of transverse and longitudinal diagnostics available for all beam parameters necessary for FEL operation**
- **All diagnostics integrated in EPICS control system**
- **Used by high level Matlab applications for automated measurements**







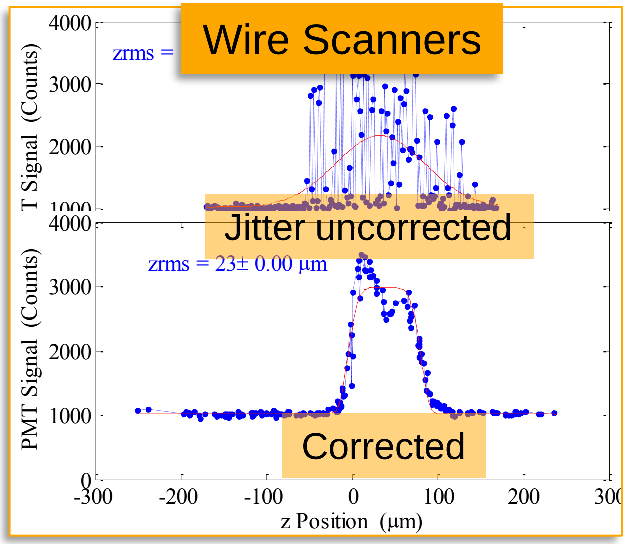


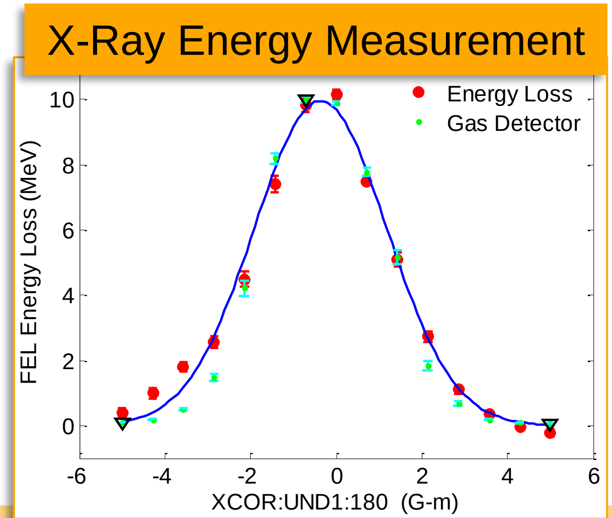
RF BPMs enable <4μm orbit over 130 m

Courtesy of Henrik Loos (SLAC)

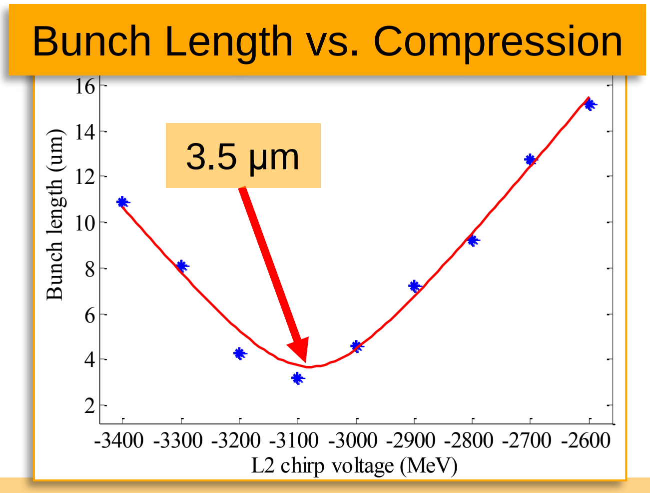
Henrik Loos, “Operational Performance of LCLS Beam Instrumentation”

- **COTR issue of OTR diagnostics mitigated by use of wire scanners**
- **Wire scanners for beam emittance, energy spread & bunch length**
- **Diagnostic challenge for < 10fs bunch length**
- **X-ray energy measurements complemented by e-beam diagnostics**





X-ray gas detector calibration with measurement of e-beam energy loss



Wire scanner & transverse deflector

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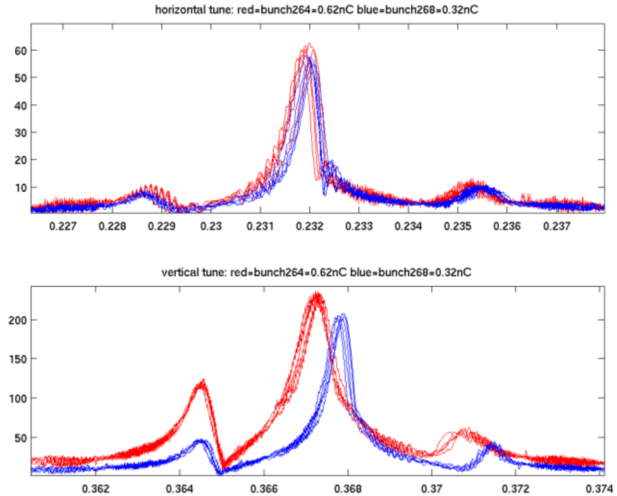
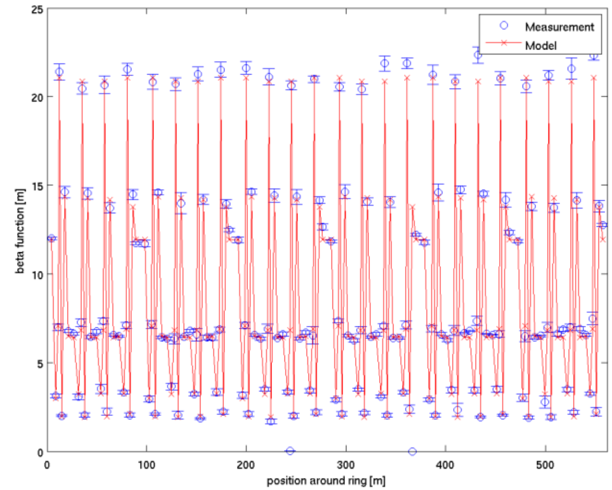
Courtesy of Henrik Loos (SLAC)

Common Principle

- Injection of a **small** sinusoid disturbance (**less than beam size** so invisible to users) using an actuator (stripline, corrector magnet)
- Detection of this frequency component in a data stream (bunch-by-bunch position, turn-by-turn position, fast orbit data) using a **digital I/Q detector**



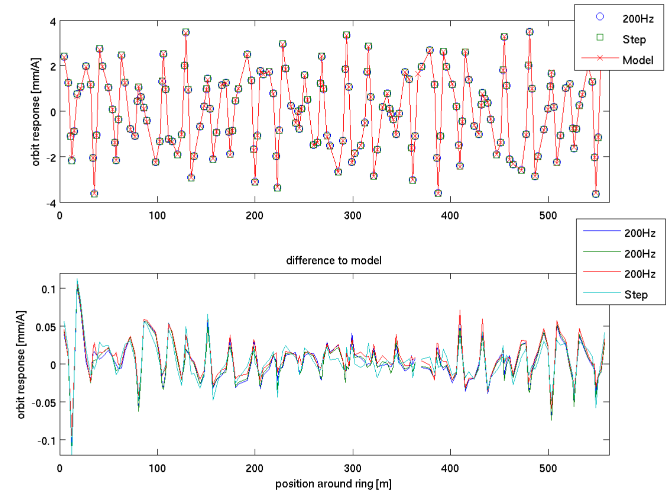
Tune Measurement of individual bunches



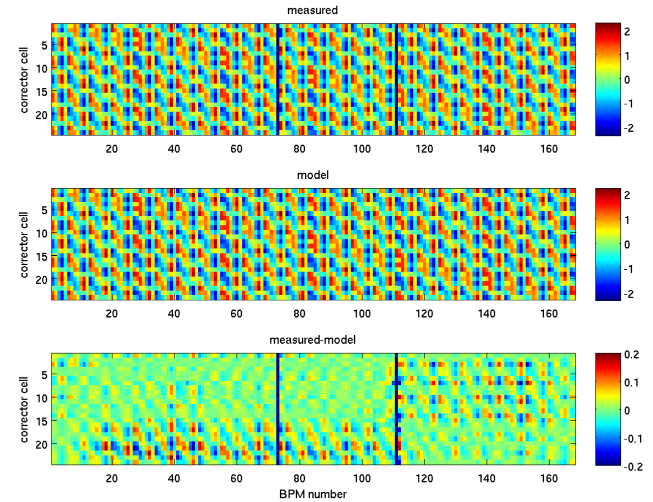
Betafunction from T-b-T amplitudes

Orbit Response

- Excite using sine wave added to corrector set point **with FOFB running**
- Detect I/Q in fast orbit readings from all BPMs
- Multiple correctors can be excited and detected **in parallel** by using **different frequencies**



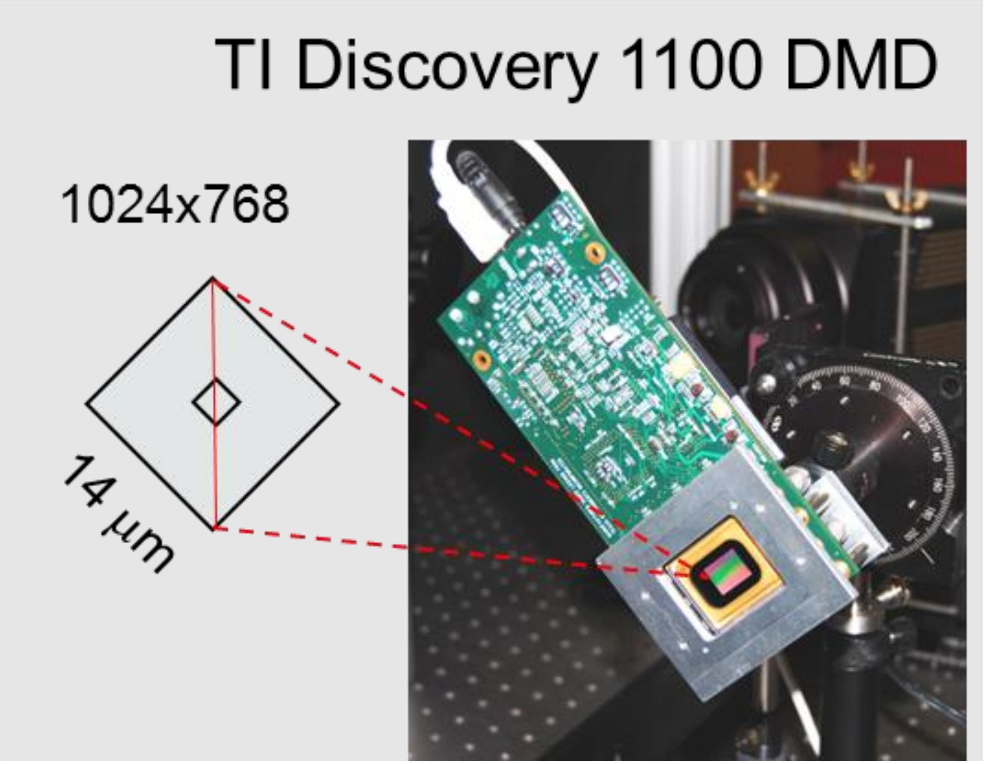
Single corrector response from 200Hz or step



24 corrector response from 24 frequencies

“Beam Halo Imaging with an Adaptive Optical Mask”

R.Fiorito, H.Zhang, A.Shkvarunets, et. al. - U. Maryland
C. Welsch, S. Artikova - U. Liverpool and MPI/Heidelberg



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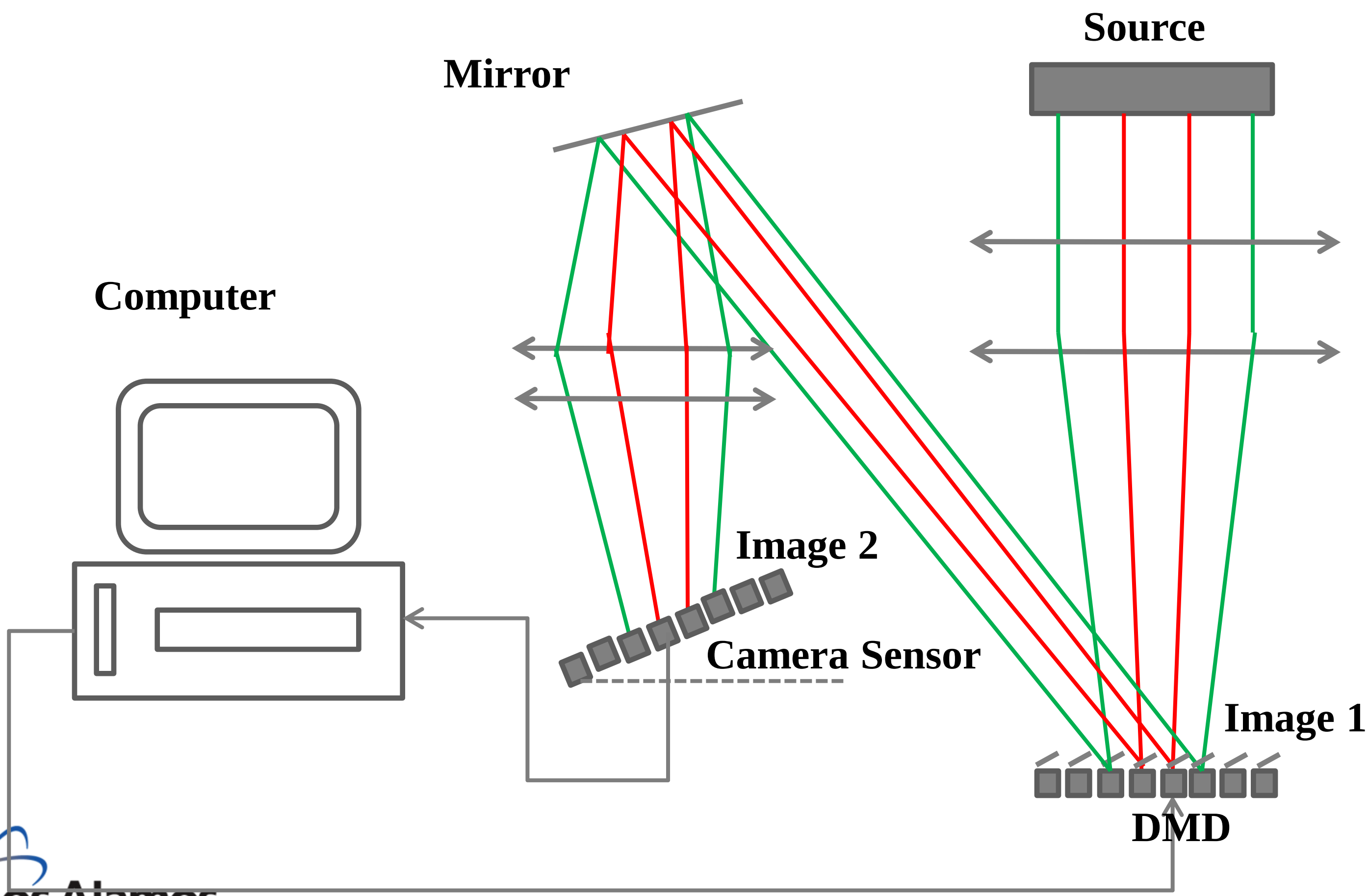

Courtesy of Ralph Fiorito (UMD, College Park)

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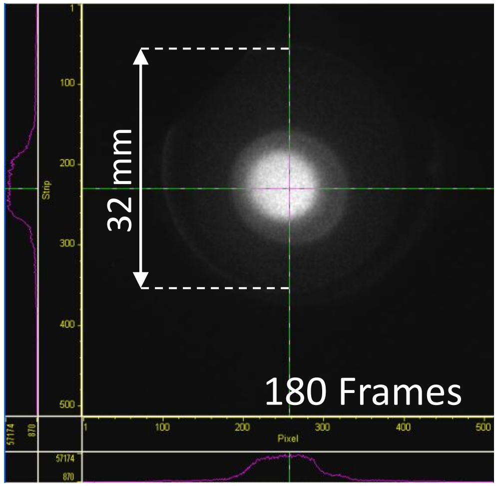

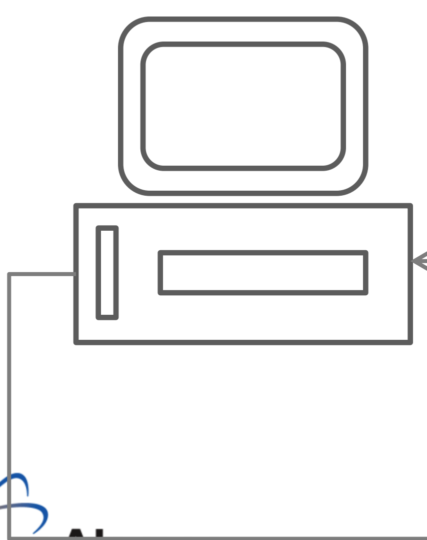

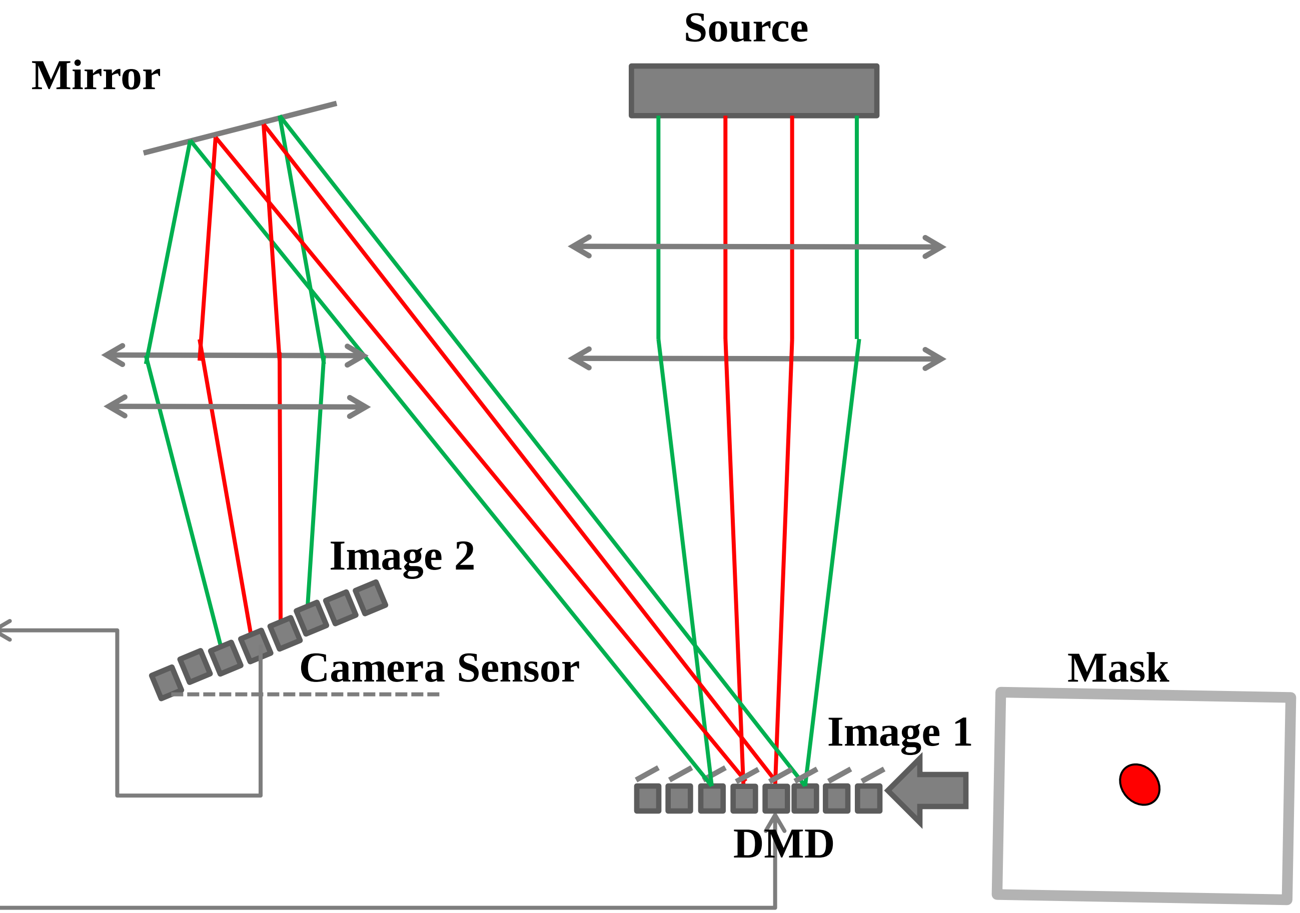

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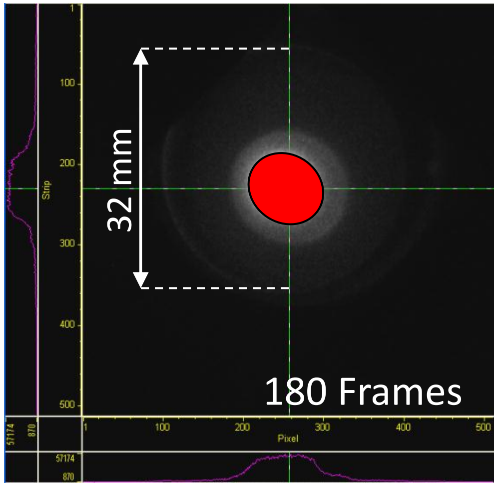

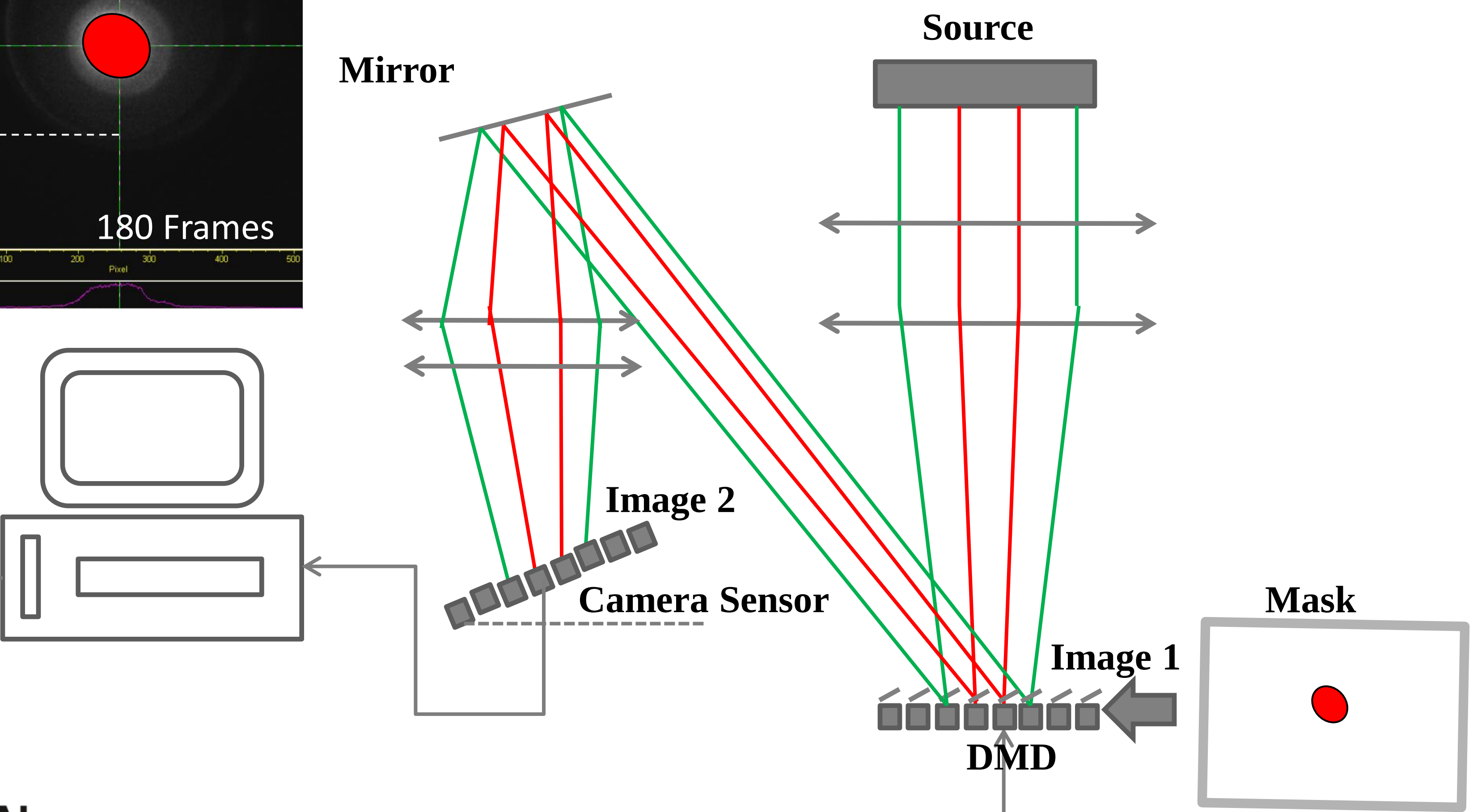

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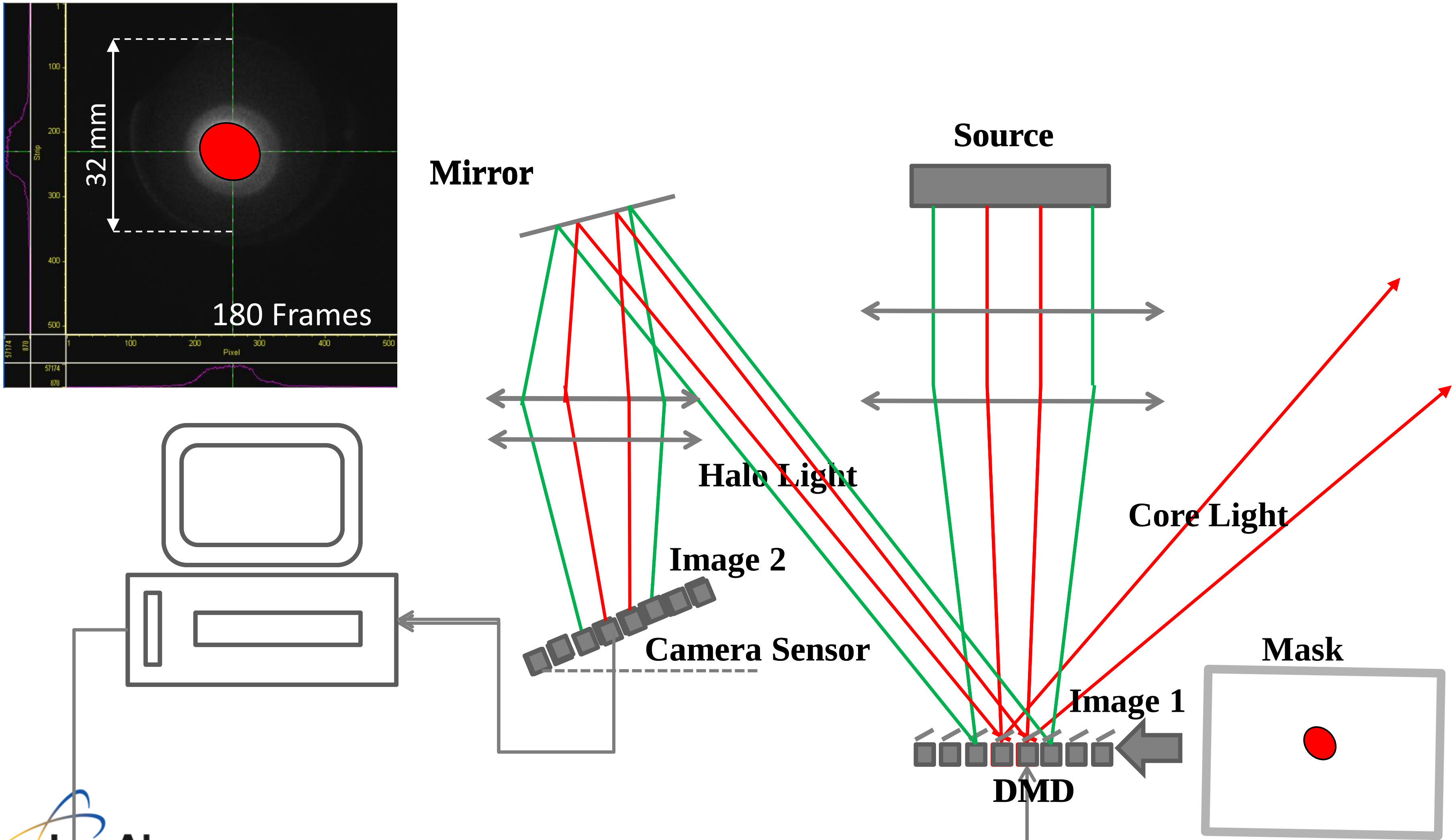

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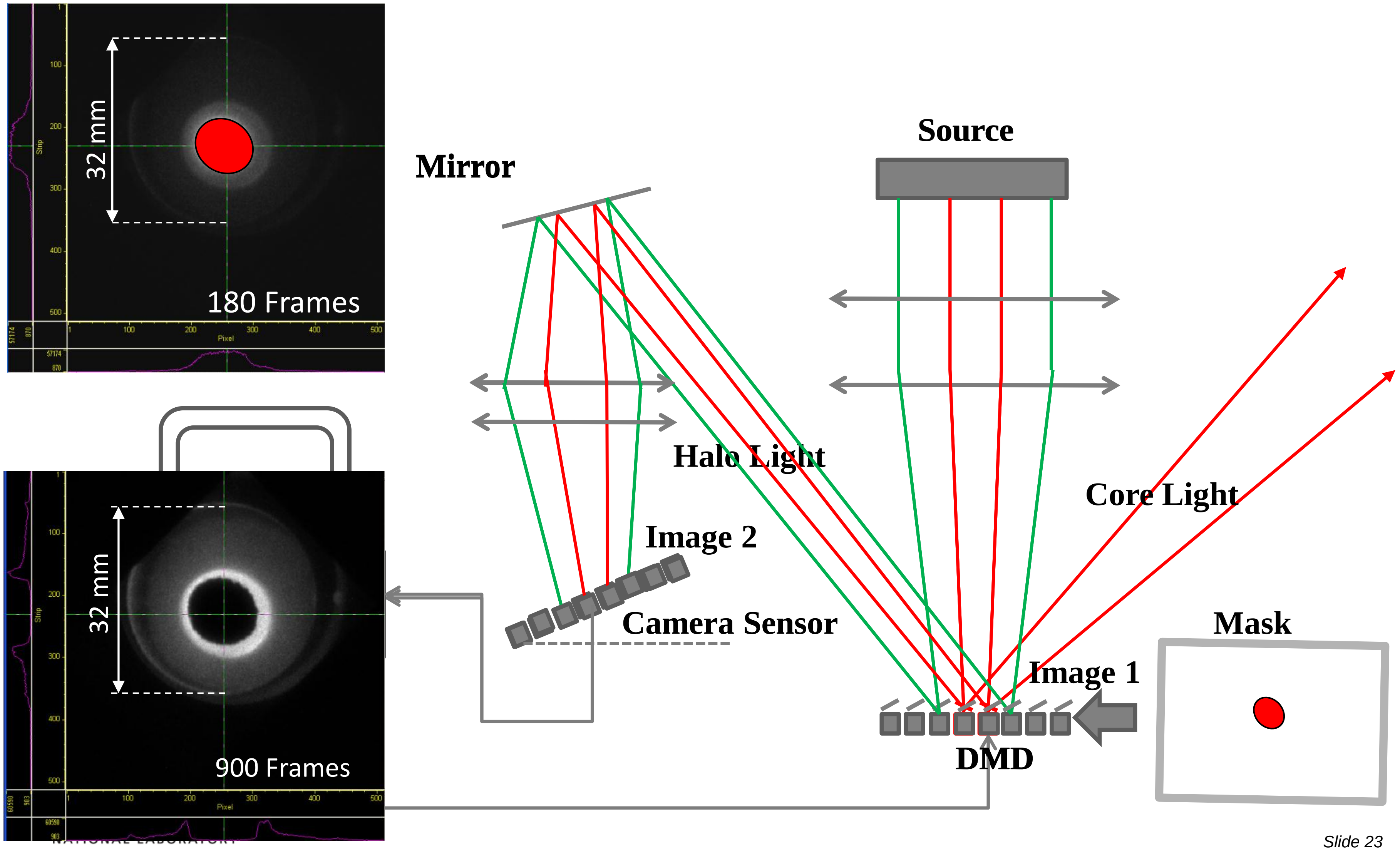

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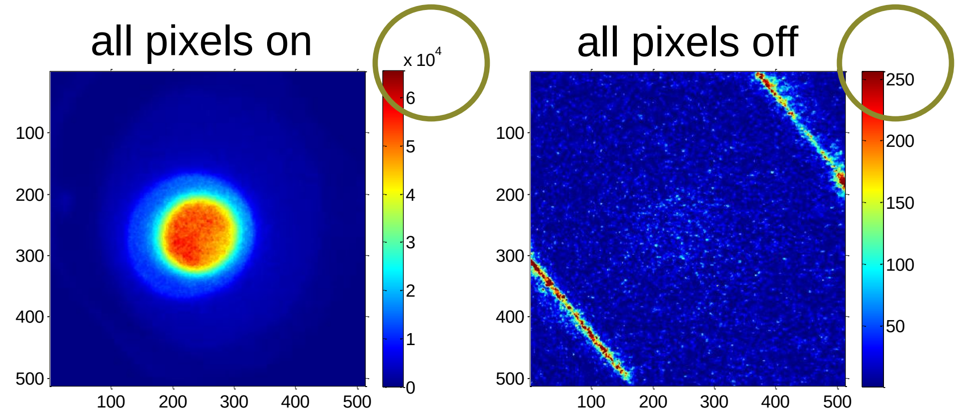
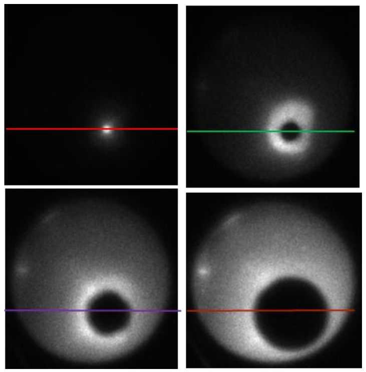
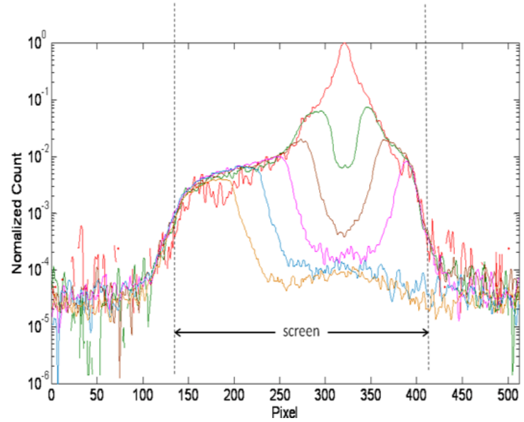
DMD Imaging Test Results*

1. Extinction ~ 10^5



2. Dynamic Range ~ 10^5





{*For more recent results see, H. Zhang, et. al., Proc. PAC11}

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Courtesy of Ralph Fiorito (UMD, College Park)

Some beam profile poster papers I personally found interesting include……

- **“GAS SCINTILLATION BEAM PROFILE MONITOR AT COSY JÜLICH,” C. Boehme, et al. (TUPSM005); and “BEAM INDUCED FLUORESCENCE MONITOR - SPECTROSCOPY IN NITROGEN, HELIUM, ARGON, KRYPTON AND XENON GAS,” F. Becker, et al. (TUPSM020)**
- **“A NON DESTRUCTIVE LASER WIRE FOR H$^-$ ION BEAMS” C. Gabor, et al. (TUPSM006); and “BEAM-ENERGY AND LASER BEAM-PROFILE MONITOR AT THE BNL LINAC” R. Connolly, et al. (TUPSM011)**
- **“RESIDUAL-GAS-IONIZATION BEAM PROFILE MONITORS IN RHIC,” R. Connolly, et al. (TPSM009); and “OPERATIONAL USE OF IONIZATION PROFILE MONITORS AT FERMILAB,” J. Zagel, et al. (TUPSM010)**
- **“LIGHT YIELD, IMAGING PROPERTIES AND SPECTRAL RESPONSE OF INORGANIC SCINTILLATORS UNDER INTENSE ION IRRADIATION,” E. Gütlich, et al. (TUPSM019)**
- **“**

Wednesday Evening Banquet & Thursday Afternoon LANSCE Tour

Mariachis Sonidos del Monte serenaded BIW10 guests with traditional music.

Thursday afternoon LANSCE Tour

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Final Remarks

- **As in previous DIPACs, BIW10 also showed an increase in beam instrumentation interest - field is growing.**
  - Wide variety of oral presentations
    - Included oral presentations about atypical facilities (for example, ERL's or ECR Ion Sources)
  - ~50% increase from previous years in poster presentations
- **BIW10 had a larger participation in vendor and exhibitors than in previous years.**
  - 1 ½ days of 22 industrial participants
- **All of the presentations, oral and poster, are on now published on 2 web sites.**
  - http://www.lanl.gov/conferences/biw10/, LANL site – videos and embedded movies
  - http://accelconf.web.cern.ch/AccelConf, JACoW site – archive
- **3 Tutorials – different types of audiences**
- **BIW12 will be sponsored by TJNAF, http://conferences.jlab.org/BIW12/**

Thank You!