Report on Beam Instrumentation Workshop (BIW12): April 16-20, 2012 (continued)

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Presented at Department Seminar

May 24, 2012
   - 134 attendees from 22 countries
   - 17 vendors
   - 2 Tutorials, 10 invited, 19 contributed orals, 86 posters
   - Preliminary proceedings are posted on BIW12 website

II. Series will transition to International Beam Instrumentation Conference (IBIC). Merge BIW, DIPAC, Asian workshops.
List of classifications

- Beam Charge and Current Monitors
- Beam Loss Detection
- Beam Position Monitoring
- Data Acquisition Technologies
- Feedbacks and Beam Stability
- Longitudinal Diagnostics and Synchronization
- Other
- Overview and Commissioning of Facilities
- Transverse Profiles, Screens, and Wires
- Transverse and Longitudinal Emittance Measurements
- Tune Monitors and Measurements
FNAL Input to BIW12

- Tutorial by Nathan on DSP and algorithms.
- Invited talk by Vic on proton H beam diagnostics.
- Invited talk by Alex on Beam profiling techniques.
- Contributed talk by Charles Tobin on real time autocorrelation of coherent transition radiation at A0PI. Randy, Amber, Alex, co-authors.
- Contributed talk by B. Walasek-Hohne on first OTR imaging of non-relativistic heavy ions. AHL proposed experiment realized.
- Manfred W. and Jim Z. on organizing program committee.
Real-time Interferometer (RTI)

- RTI provides online spatial autocorrelation of coherent transition radiation with 32 element pyroelectric array.

Diagnostic Layout

Raw autocorrelation
I. Introduction

II. Beam profiling with YAG:Ce scintillation
   - Scintillator resolution
   - Depth-of-focus issue
   - Possible solution to coherent source interference

III. Optical Transition Radiation (OTR)
   - OTR basics
   - OTR point-spread-function (PSF) aspects
   - Microbunching instability and coherent OTR (COTR)
   - Non-intercepting aspect with optical diffraction rad. (ODR)
   - Non-relativistic beams

IV. Future tests

V. Summary
Prototype Imaging Station

- New developed imaging station in collaboration with RadiaBeam, Inc.
• Scintillator screen resolution vs. thickness after applying corrections discussed on page 6.
• OTR can be used for beam
  – profile / size  – energy,
  – position  – relative intensity
  – divergence  – bunch length

• Charged particle passing a media boundary (EM dipole).

OTR angular intensity distribution of a single charged particle
Estimation of OTR/COTR spectral effect for LCLS case.
Reduction of COTR effects with 400x40 nm BPF, but need more sensitive camera than 40dB analog CCD to see remaining OTR.
FLASH: Gated ICCD on COTR

- MCP gate used to reject prompt COTR emissions

Motivation

- Scintillation screen + gated camera

Camera image: FLASH, 13SMATCH section, 9 Jan 2011

- Al coated Si OTR screen, COTR light, Coherent SR

- LuAG screen, COTR & scintillation light

- LuAG screen +100ns delay
  Only scintillation light

Minje Yan | Influence of observation geometry on resolution | 15.2.2011 | Page 6
M. Yan, GSI WS 2011
Proposed OTR Application to Heavy Ions

- Consider applying technologies and concepts for ions.
- Take advantage of charge state for OTR generation.

For a non-relativistic charge $Q$, traveling with velocity $v$, the spectral energy density of transition radiation is,

$$W(\omega) = 4Q^2\beta^2/3\pi c,$$

where $\beta = v/c$ and $c$ is the speed of light.

Ginzburg and Tsyovich, (1984)

More than a “gedanken” experiment!
Experimental setup consists of an OTR target ladder (6 targets on one ladder) and image-intensified CCD camera system (ICCD) from PROXITRONIC.

• the exact ICCD gating feature (down to 10 μs) was used to select preferentially the prompt OTR signal versus any background sources in the scene.

*GSI slides provided by B. Walasek-Hohne

For future investigations we reduced beam current!
First results – first pictures

Beam parameters: Uranium, 11.4 MeV/u, $2.6 \cdot 10^8$ ppp in 300 µs

First, there is a signal!

→ transversal light distribution is observed
→ better signal by using stripping foil

From B. Walasek-Hohne
OTR is expected to show linearity to the number of charges crossing without risk of saturation.

**OTR signal strength as relative total ICCD intensity for different particle number**

**Beam parameters:** $U^{73+}$, 11.4 MeV/u, $1 \cdot 10^7 - 3 \cdot 10^8$ ppp in 300 µs

**From B. Walasek-Hohne**
Summary

• Scintillator resolution terms should be characterized,
  – Use normal incidence of beam as preferred geometry to minimize depth-of-focus issues in beam images.
  – Scintillators may be used more for ultra-bright electron beams.

• OTR polarization effects need to be elucidated
  – Plan to use linear polarizers with OTR imaging for the perpendicular profile components at ASTA.

• Mitigate microbunching instability effects for profiling of bright beams.
  – Plan to use 400x40 nm band pass filters and LYSO:Ce crystals after bunch compression at ASTA to suppress expected diagnostics complications due to COTR.

• New paradigm for heavy-ion beam imaging with OTR.

• The future remains bright for imaging techniques.
CEBAF/JLAB Upgrade Funded

6 GeV CEBAF

12 GeV CEBAF

Two 0.6 GeV linacs

Two 1.1 GeV linacs
• Injector being installed with First beam expected in 2012.
OTP/ODR Studies Proposed

- Path to test near-field imaging on 10-µm size at 23 GeV.
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   • IBIC12 at Tsukuba, Japan: Oct. 1-4, 2012
   • IBIC14 at San Francisco, CA: Sept. 2014?