

DIPAC2011; May 16 -18 – Hamburg Summary

Matthias Gross

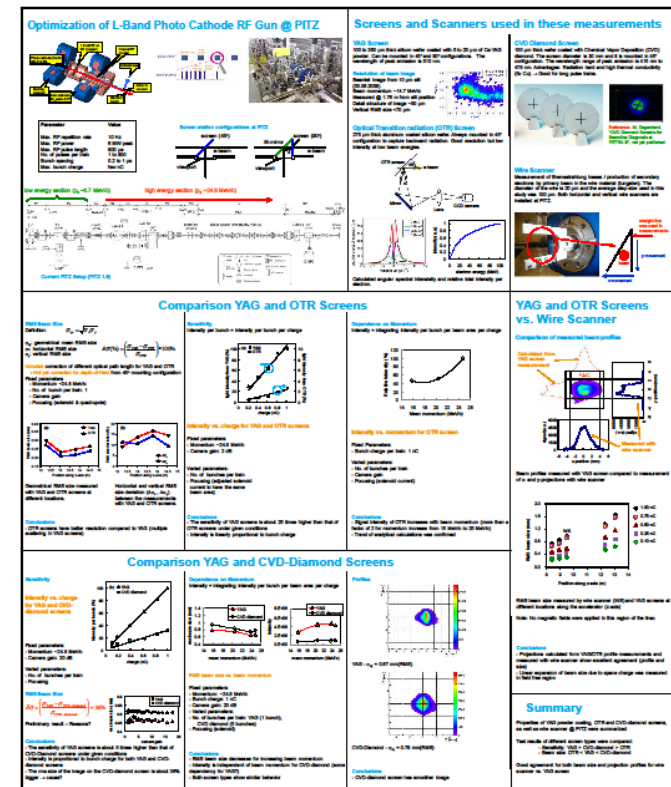
Igor Isaev

Dmitriy Malyutin

- Web site (includes preliminary proceedings)
 - <http://dipac2011.desy.de/>
- 300 participants
- PITZ: Poster presented
 - S. Rimjaem et al. „Comparison of Different Radiators used to Measure the Transverse Characteristics of Low Energy Electron Beams at PITZ“

Comparison of Different Radiators Used to Measure the Transverse Characteristics of Low Energy Electron Beams at PITZ

S. Rimjaem, J. Bähr, H.J. Grabosch, M. Gross et al., DESY, 15738 Zeuthen




Highlights: Overviews

- BPMs: Manfred Wendt (Fermilab) MOOC01*
- DAQs: Andrea Boccardi (CERN) TUOB01*
- Electronics in Radiation Environments: Christos Zamantzas (CERN) TUOB02* „Electronics failure due to radiation has become commonplace“
- COTR: Stephan Wesch (DESY) WEOA01*
- Screen Monitors: Beata Walasek-Höhne (GSI) WEOB01
- Beam Charge Measurements: David Belohrad (CERN) WEOC01
- Beam Induced Fluorescence Monitors: Frank Becker (GSI) WEOD01

Poster: MOPD53

- Peter Forck et al: Scintillation Screen Investigations at GSI
- Comparison of many scintillators for Carbon and Uranium beams
- All linear but orders of magnitude difference in signal strength



Scintillation Screen Investigations for High Energy Ion Beams at GSI

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Abstract

Various scintillation screens were irradiated with high energy ion beams as extracted from the GSI synchrotron SIS18. Their imaging properties were studied with the goal to determine a precise transverse profile determination. Scintillation images were characterized with respect to the light yield and detection efficiency. To study the scintillation properties over a wide range of intensities a 290 MeV Uranium ion beam with 10⁴ to 10⁷ particles per pulse was applied as well as a 290 MeV Carbon beam. Sensitive scintillators, namely CaF₂, YAG:Ce, P43 and Ce-doped glass were investigated for lower beam currents. Ceramics like Al₂O₃, Al₂O₃:Cr, ZrO₂:Y and ZrO₂:Mg as well as Heralds-glass were studied. For the various screens remarkable differences have been observed, e.g. the recorded profile width varies by about 100 %.

Standard Screen Realization

Advantage:

- > Cheap device
- > Direct 2-Dim Image
- > Suited for all beams
- > Single pulse operation

Requirement:

- > Undistorted image
- > Precise for saturation
- > Precise light scattering
- > Very large dynamic range

High detailed target investigations required

Foreseen at FAIR: #1-40 locations

Dedicated workshop: www.gsi.de/ahab/rd/index.html

Investigated Materials

Type	Material	Supplier
Single Crystal	YAG:Ce, CaF ₂	Sumitomo Crystal
Powder (on Al ₂ O ₃)	P43 (SiO ₂ :Pb:Ti), Phosphor	Phosphor
Ceramics	Al ₂ O ₃ , Al ₂ O ₃ :Cr (Chroma), ZrO ₂ :Y (ZSRO 20 A), ZrO ₂ :Mg (ZSRO)	BCI Special Ceramics
Quartz-glass	Pure (Heraul 102), Ce-doped (HAGC)	Heraul

Images at different Uranium currents: YAG:Ce, Heral, Quartz:Ce, P43

Experimental Setup

Adjusting motor driven target located 1.20 m length for 10 screens of up to 630 mm → Observation without longer interrupts to ensure the same beam properties for all materials.

Camera: AVT Merlin F035B, VGA variable gain, FireWire interface
Lens: Pentax S214ER, remote controlled via for dynamic range
DAQ: RT-LabVIEW
GPU: C++, individual image storage

Spectral stability of monochrome CCD

Planar arrangement → depth of focus
Investigation in air → cheaper realization
Normalization to beam current → Ionization chamber
Secondary Electron Em. Monitor

Timing, Raw Data and Evaluation

Timing of experiment:

- > Beam delivery typically 0.4 s
- > 2 Images recorded → background subtraction done

Single Image:

- > Fixed region-of-interest
- > Projection on axis
- > Background subtraction on projection
- > Integration → light yield
- > Gaussian fit
- > Statistical moments
- > Variance of $\hat{\mu}$ formula: $\sigma_{\hat{\mu}}^2 = \frac{\sigma^2}{N}$

Result: Light Yield for Uranium Impact

4 orders of magnitude different light yield:

- > Most sensitive: CaF₂, YAG:Ce, P43, Al₂O₃:Cr
- > Very linear behavior for CaF₂, YAG:Ce, P43, Al₂O₃:Cr, Al₂O₃
- > Insensitive: Heral, ZrO₂:Y
- > Non-linear behavior for ZrO₂:Y and ZrO₂:Mg

Evaluation done by image integration → within CCD spectral range

Boundary for the range of number of particles:

- > Lower current border: given by camera threshold level
- > Upper current border: given by camera saturation

Beam: Uranium 290 MeV, 10⁴ to 10⁷ pp, 300 ms spill
290 MeV Uranium after bremsstrahlung & detectors, 300 MeV Uranium accelerated
Energy loss per ion: YAG:Ce: 10 GeV, P43: 0.7 GeV, Al₂O₃: 7.9 GeV, Heral: 6.7 GeV

Light Yield for Carbon Impact

Beam: C⁶⁺ 290 MeV/u, 10⁴ to 10⁷ pp, 400 ms spill
Energy loss: YAG:Ce: 4.6 GeV, P43: 2.9 GeV, Al₂O₃: 3.0 GeV

Result: YAG:Ce most sensitive
Same relative behavior between materials
Linearity of light yield of 3 orders of mag.

Result: Image width for Uranium Impact

Quite different distributions measured:

- > Significant overestimation for CaF₂ and YAG:Ce
- > Same profile reading for P43, Al₂O₃:Cr and Al₂O₃
- > Underestimation for Heral, ZrO₂:Mg and possibly Quartz:Ce
- > Wrong reading for ZrO₂:Y
- > Same tendency for other methods of width determination

Conclusion:

- > P43, Al₂O₃:Cr (Chroma) and Al₂O₃ are good candidates
- > More investigations required for CaF₂ and YAG:Ce
- > e.g. concerning neutron background or absorption - re-emission
- > Heral not useful (confirmed by previous investigations)
- > BUT: not all materials reproduce a Gaussian shape!

Image width for Carbon Impact

Result: YAG:Ce overestimate beam width
Same profile reading for P43, Al₂O₃:Cr and Al₂O₃ on entire range

2nd meas. for Uranium Impact

Beam: Uranium 290 MeV, different CCD setting

Comparable results: Light yield, beam size, large range

Variation in Image Shape

Features:

- > CaF₂ and YAG:Ce produce shoulders
- > P43, Al₂O₃:Cr, Al₂O₃ have same distribution
- > Heral produces too small images
- > Typical behavior, but Physical reason not understood

Relative Light Yield

Y_{rel} yield relative to YAG:Ce

Result: Same high score for U and C

Scintillator	Y _{rel} (U)	Y _{rel} (C)
CaF ₂	100	100
YAG:Ce	100	100
P43	54	58
Al ₂ O ₃ :Cr	45	45
Al ₂ O ₃	4	1.7
Quartz:Ce	0.3	0.3
ZrO ₂ :Mg	0.04	0.04
ZrO ₂ :Y	0.00	0.00
Heral	0.00	0.00

Remark: Heral, with different line

Summary and Outlook

- > Light yield of various materials investigated
- > Different values of the profile width for various materials, even for "well known" scintillators
- > The described behavior is reproducible
- > Ongoing data analysis with statistical moments to distinguish saturation ↔ self-absorption
- > More ion-beam test with different ions and energies foreseen for characterization
- > Quantitative understand of behavior in preparation
- > Spectroscopic investigation foreseen
- > Determination of absolute light yield foreseen
- > Test of radiation hardware required

Poster: MOPD59

- Stephane Burger et al: A new fast profile monitor for the LHC and the SPS
- Goal: turn-by-turn readout of beam profile: 44kHz! → need extremely fast camera
- Solution: linear CCD (Hamamatsu) with specially designed optics (2 cylinder lenses)

Announcements

- This was the last DIPAC – regional workshops will be replaced by international conference series with 3-year rotation
- Upcoming
 - The last BIW: April 16-19 2012 in Newport News, VA
 - IBIC12: the first International Beam Instrumentation Conference – October 1-4 2012 in Tsukuba, Japan