Plans to measure the beam halo and Compton electron recoil spectrum after the IP of ATF2

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TB at 13th ATF2 project meeting, KEK

12 September 2012

ATF2 activities at LAL from 2011

1. General effort for goal 1

- Supporting / discussing / reviewing beam tuning and IP-BSM activities and scheduling…
- “Mitigating the effects of higher order multipole fields in the magnets of ATF2”, S. Bai (IHEP) et al., accepted for publication in Chinese Phys. C, also discussions with E. Marin (CERN)

2. New beam pipe for low-Q IP-BPM triplet for goal 2

➔ talk in “goal 2 session”, 13-01-2012

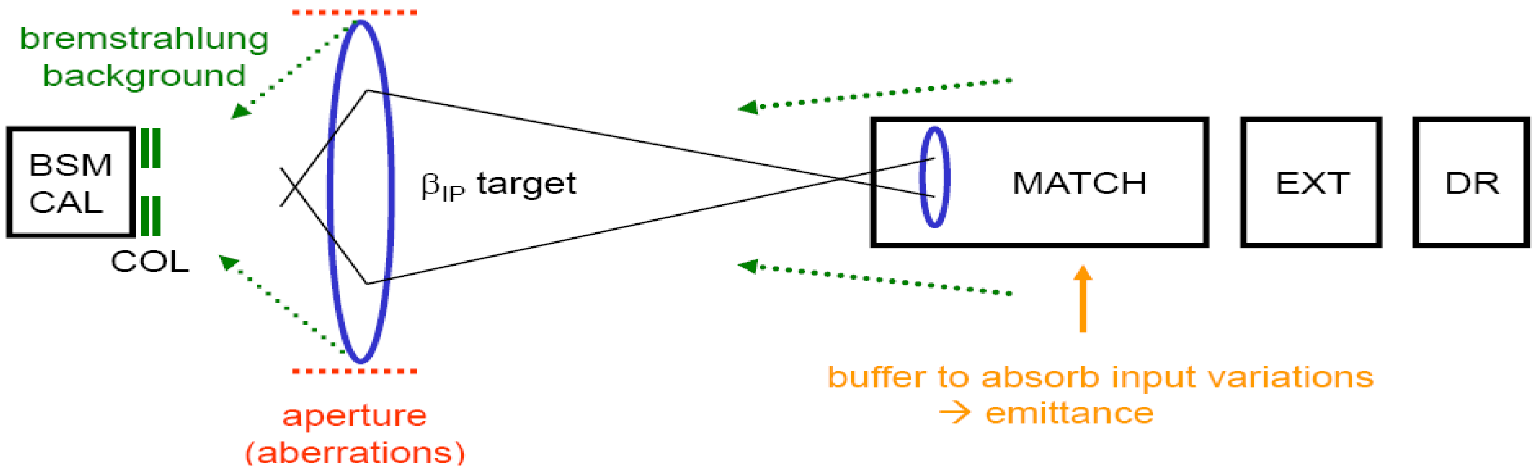
- Design with internal / external alignment capabilities and remote 2D adjustments for 3rd BPM
- Fabrication, BPM pre-installation / alignment, vacuum test and 3D measurement at LAL
- FJPPL “T.Yuasa” / FKPPL workshop 19-20 March at LAL (with also other topics / colleagues)
- IN2P3 support; also part of new application to ANR with LAPP & CERN, possible contribution by new PhD on the CLIC final focus to experimentation with IP-BPMs and related data analyses

3. Information on plans to measure beam halo and Compton electron recoil spectrum with semi-conductor sensors

➔ this talk

Issue of beam halo in HEP colliders and ATF2

1. Beam halo ➔ major issue for IR backgrounds at many colliders, e.g. future linear colliders, B factories – also an important problem at ATF2 !
2. Control of halo via collimation / optics essential to enable the most aggressive optics configurations for luminosity performance



3. Halo population poorly known, involves various mechanisms :
   "dark current", wake-fields, non-linearity, multiple intra-beam Coulomb scattering, scattering off residual beam gas and thermal photons, very low Pt t-channel physics processes,…

Motivation for measurements at ATF2

1. Previous measurements in 2007 (T. Suehara et al.) in old EXT line

arXiv:0810.5467

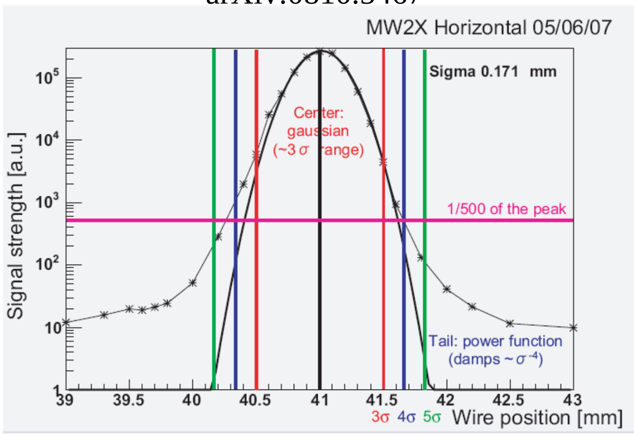


Fig. 25. Measured result of charge distribution using an ATF extraction line wire scanner.

$$\rho_{h1} = 2.2 \times 10^9 \times x^{-3.5} \quad \text{(horizontal and vertical until 6 } \sigma\text{)}$$
$$\rho_{h2} = 3.7 \times 10^8 \times x^{-2.5} \quad \text{(vertical outside 6 } \sigma\text{)}$$

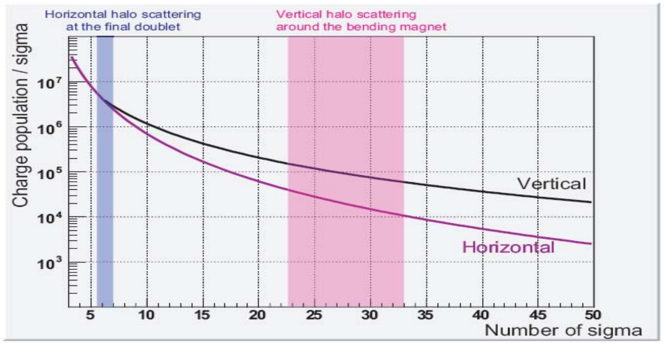
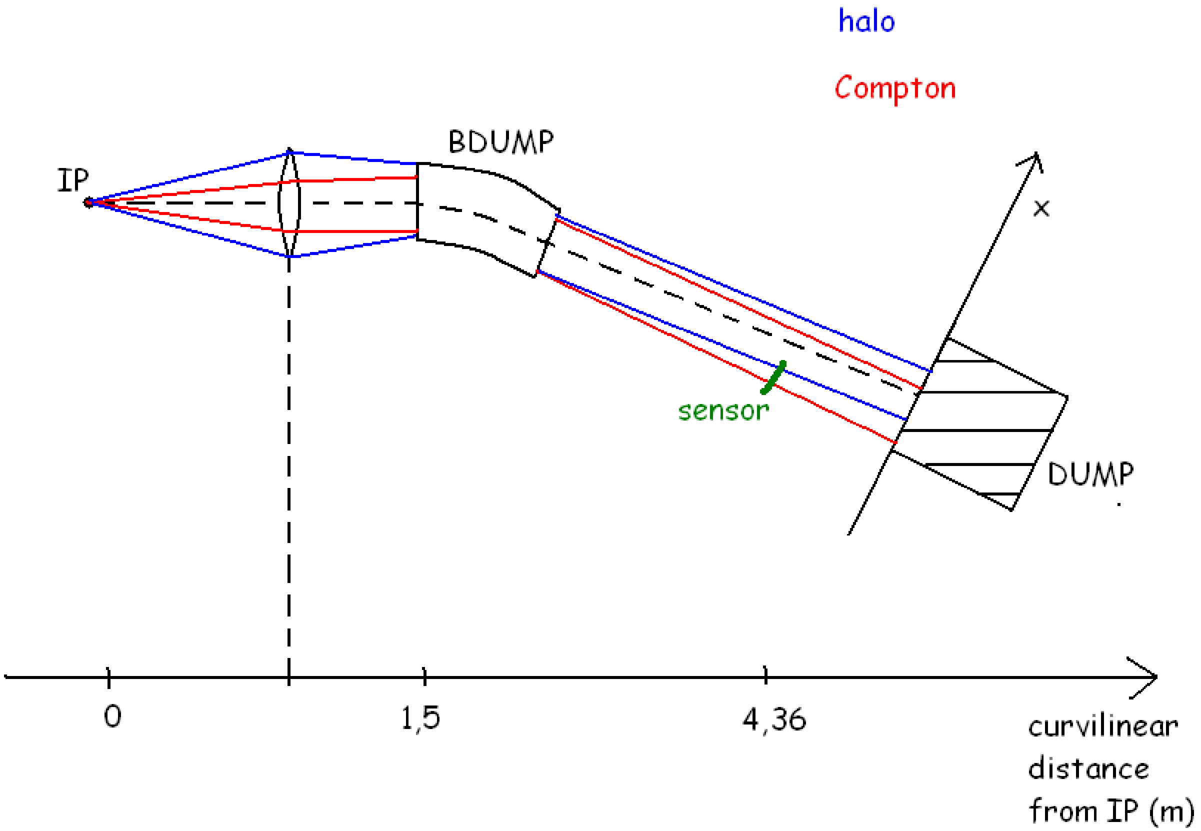


Fig. 27. Maximum charge density of the beam halo estimated by the halo measurement. Blue and purple area shows the concerned region, discussed in Section 6.2.4.

2. Halo transport in ATF2 and direct probe of tails in IP angular spread
3. Investigation of halo modeling / comparing with measurements
4. Check possibility to probe Compton electron recoil distribution during IP-BSM operation (additional observable, also prepares future non-linear QED measurements with very high power laser at “ATF3”)

Initial visibility study behind BDUMP magnet

C. Chao, Université de Cergy-Pontoise

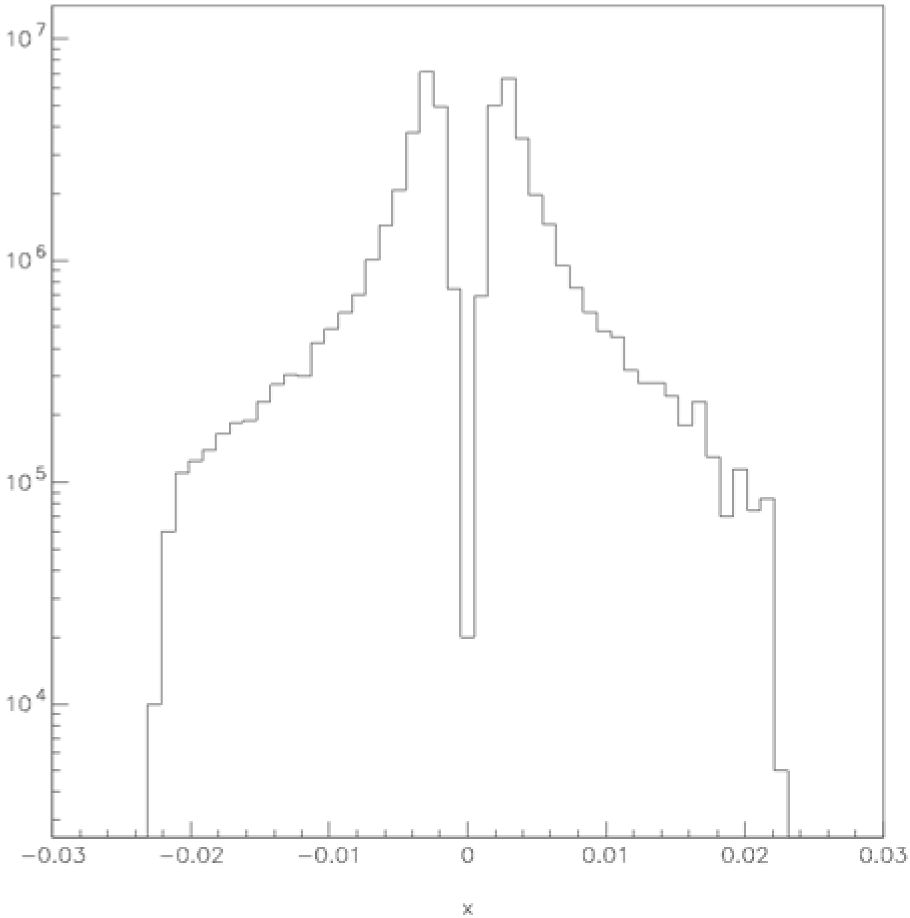


Halo generator → used parameterization in arXiv:0810.5467 with cut corresponding to 2.5 cm FD aperture

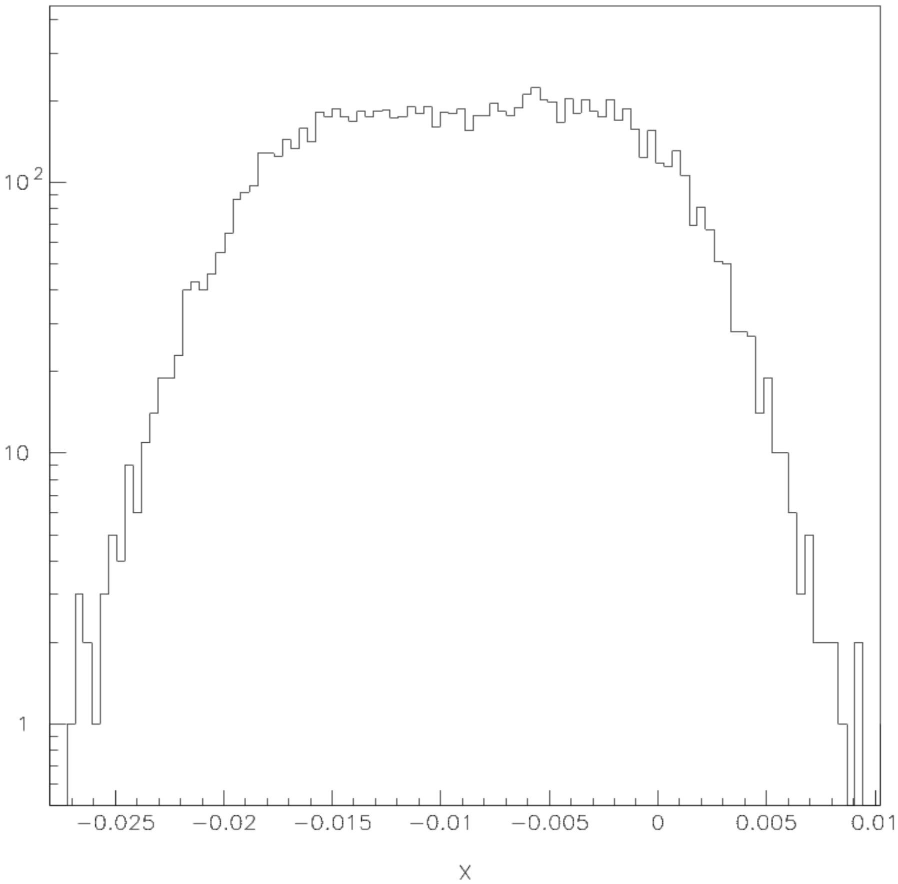
Compton generator → model only spectrum shape, maximum energy loss = 2.23% ~ 30 MeV

Illustrative layout

Without quad

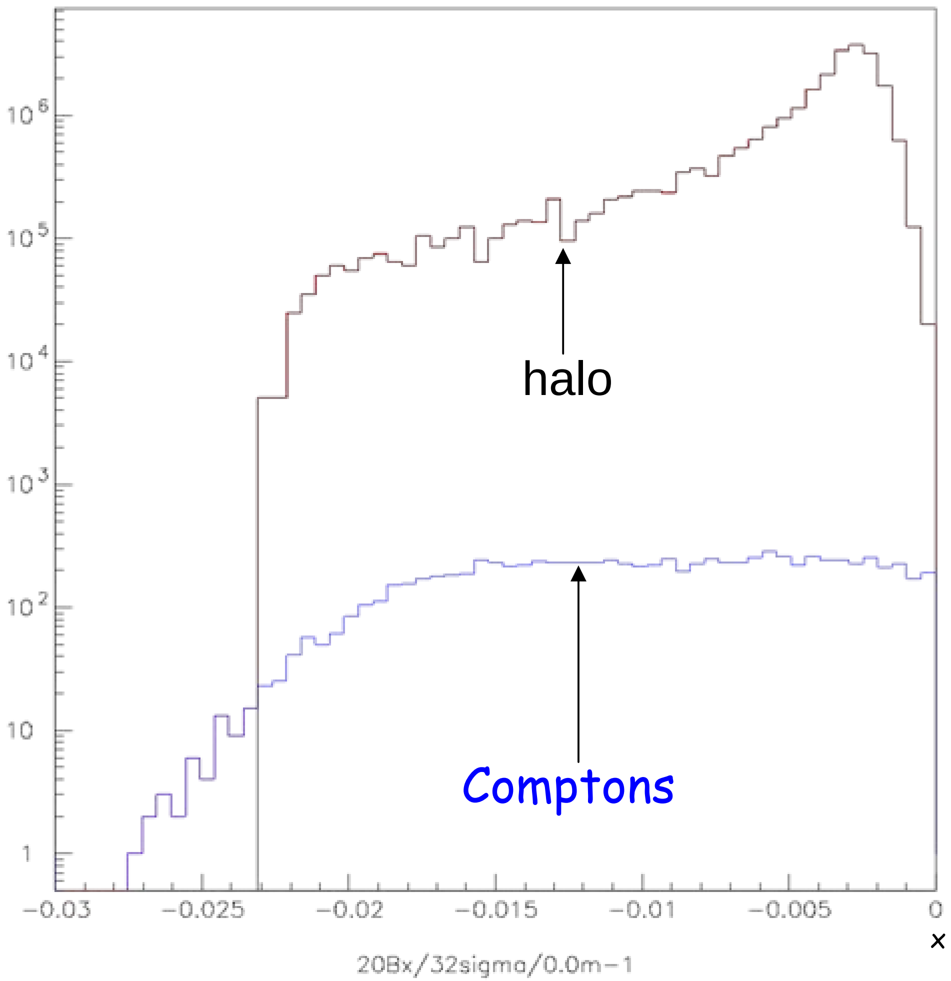


X distribution for the halo [m]



X distribution for Comptons [m]

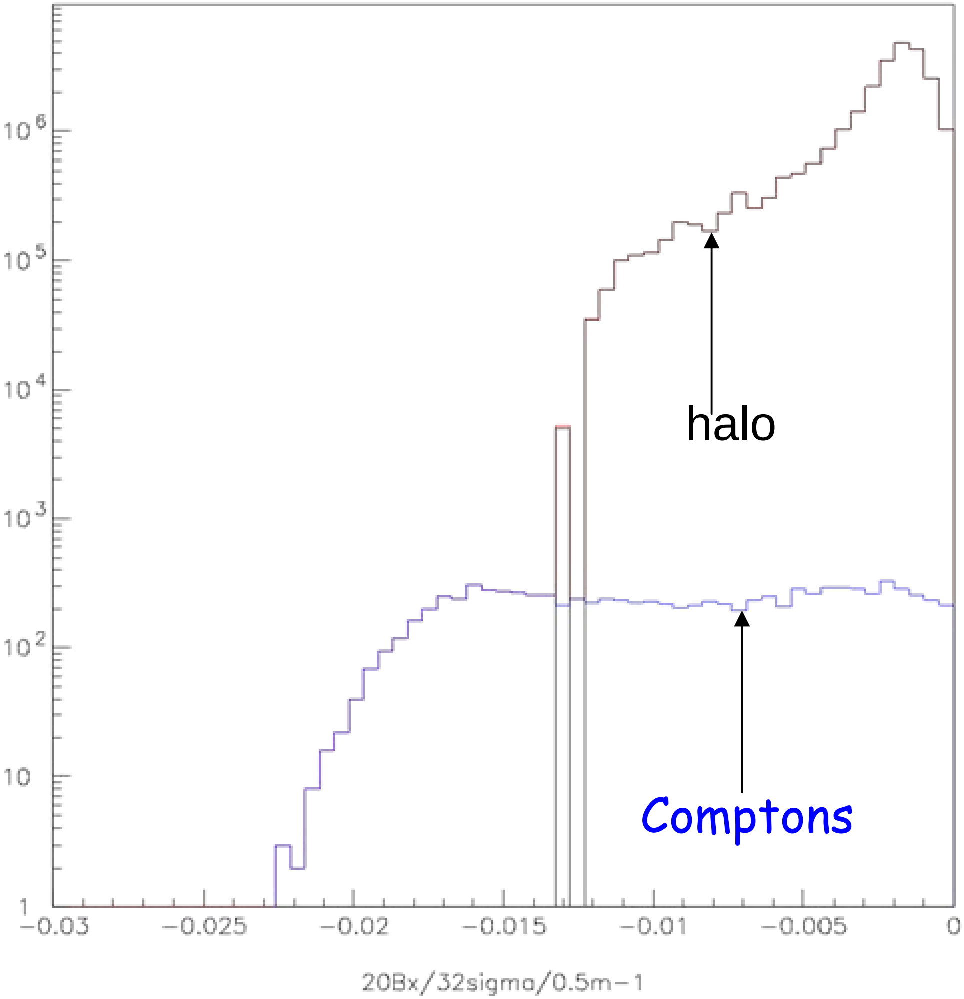
Without quad



X distribution [m]

Comptons are difficult to dectect without quad (unless tighter collimation is used)

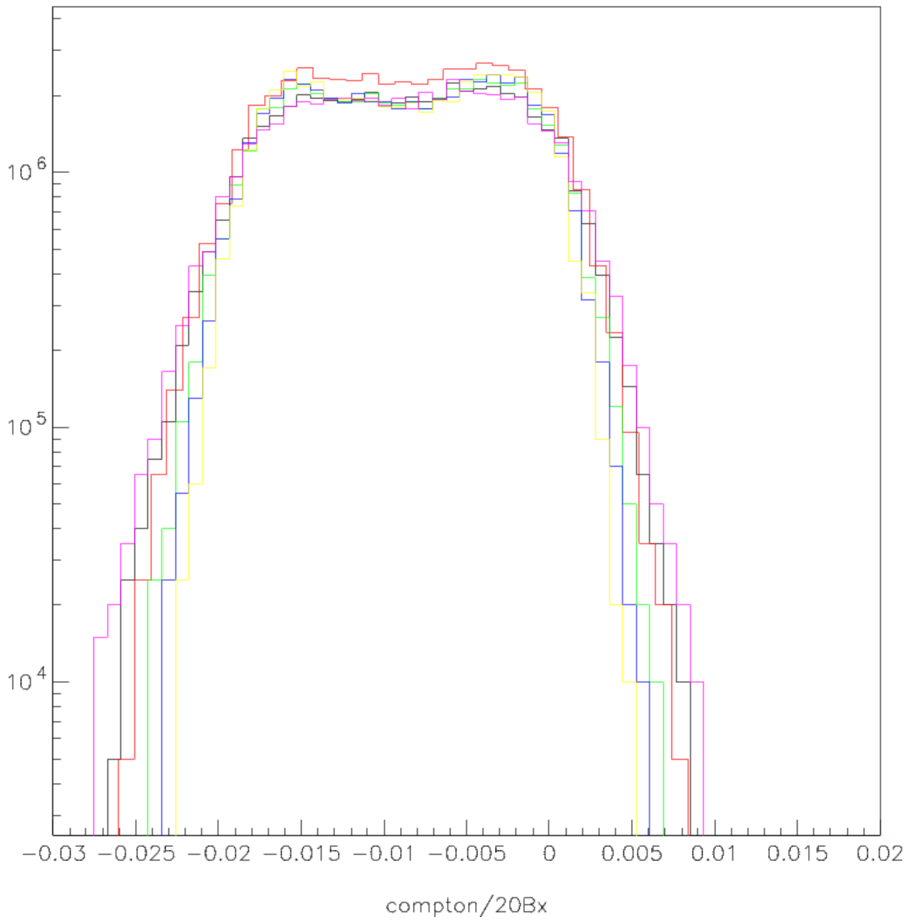
With quad (QM7R-like)



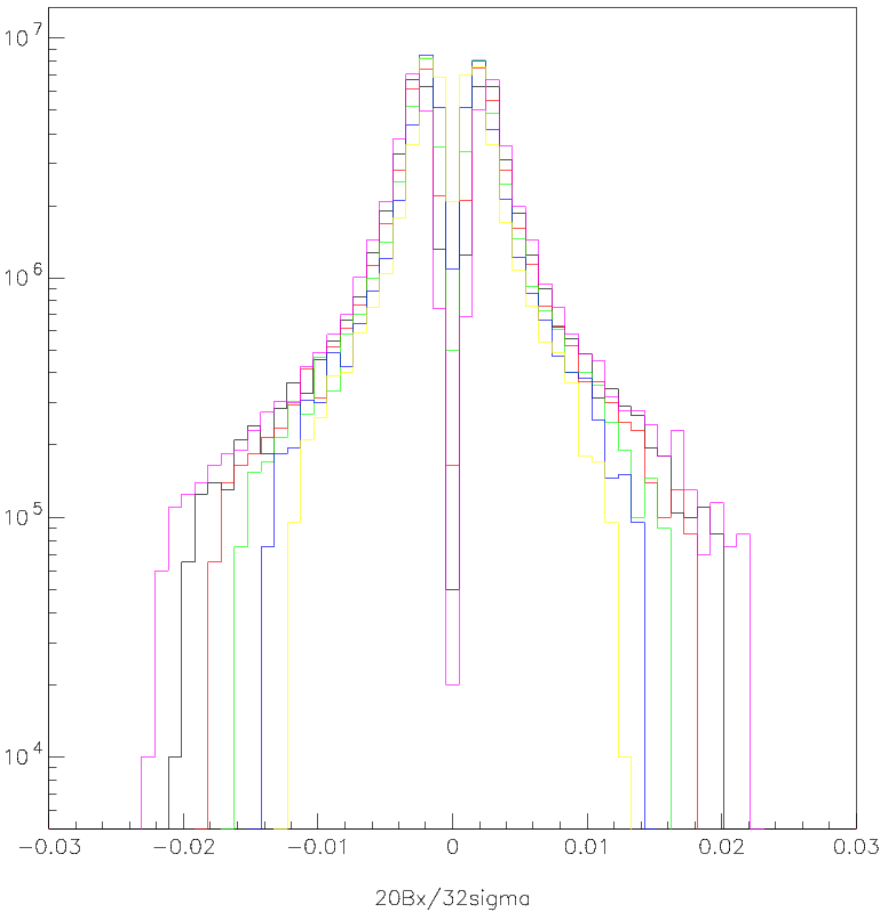
X distribution [m]

For quad strength of 0,5m^{-1}, we could detect Comptons

Evolution of X-distributions



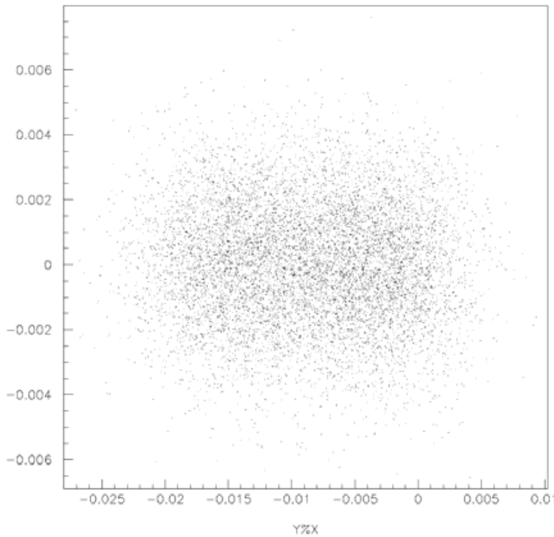
For Comptons [m]



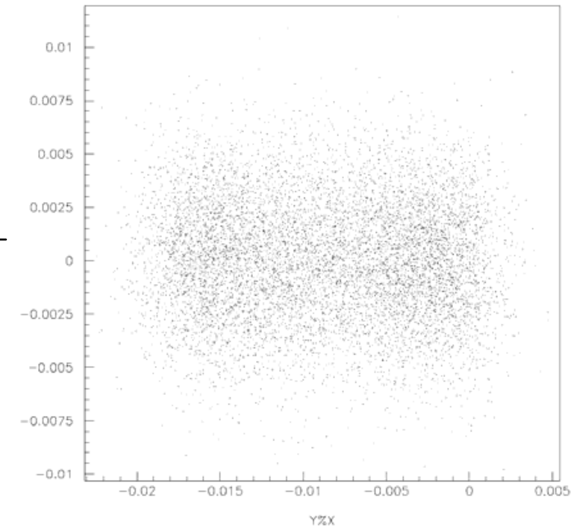
For the halo [m]

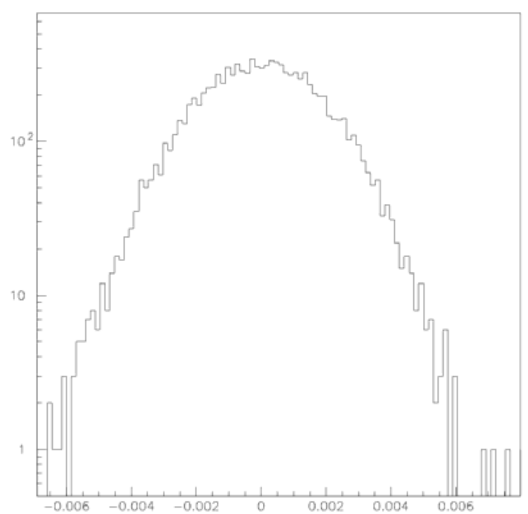
<u>Quad strength:</u> $0.0m^{-1}$, $0.1m^{-1}$, $0.2m^{-1}$, $0.3m^{-1}$, $0.4m^{-1}$, $0.5m^{-1}$

2D plot of Comptons and Y distribution

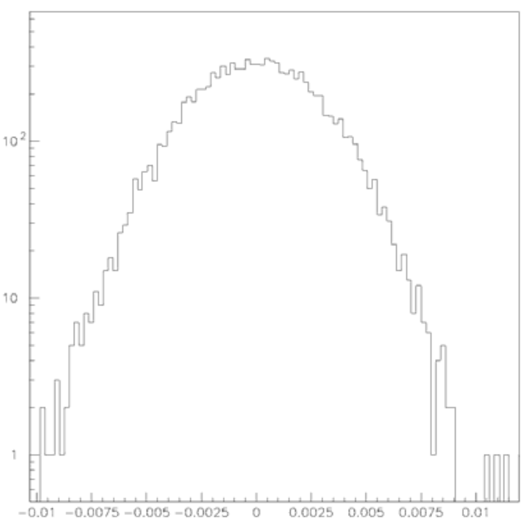


2D plot





Y-distribution

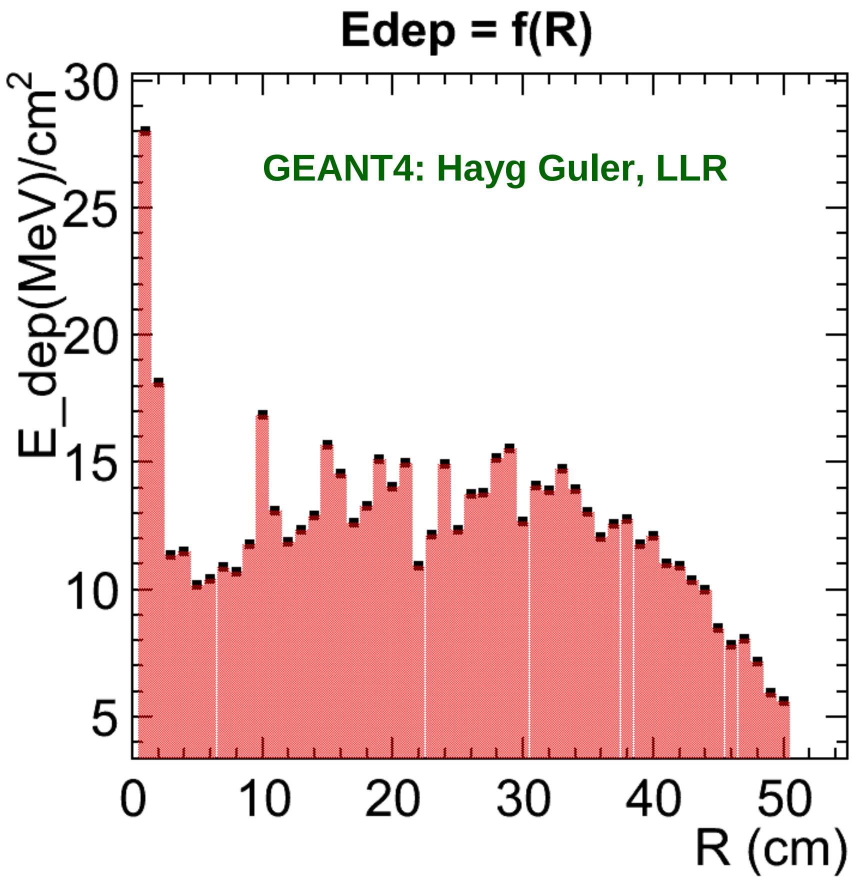


Without quadrupole

For a quad strength of 0.5m^{-1}

Expected radiation dose near beam dump

- preliminary -



- 500 μm thick Si sensor 2 m from dump
- (for 10^7 beam electrons incident on dump)
- deposition from neutron backscattering

➔0.25 10^-4 Gy / pulse or 300 Gy / year

- deposition from 10^7 halo electrons

➔ 0.3 10^-2 Gy pulse or 25 kGy / year

tolerance for diamond CVD > 1 MGy

Radiation hard diamond sensors for high flux particle detection, using fast remote read out

IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 57, NO. 6, DECEMBER 2010

used / planned at JET / ITER tokamaks

Neutron Spectroscopy by Means of Artificial Diamond Detectors Using a Remote Read Out Scheme

Maurizio Angelone, Giulio Aielli, Salvatore Almaviva, Roberto Cardarelli, Daniele Lattanzi, Marco Marinelli, Enrico Milani, Mario Pillon, Giuseppe Prestopino, Rinaldo Santonico, Claudio Verona, and Gianluca Verona Rinati

Halo monitoring near Atlas and CMS

Diamond pixel modules and the ATLAS beam conditions monitor

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On behalf of the RD42, the ATLAS Diamond Pixel Upgrade and the ATLAS Beam Conditions Monitor Collaborations

A R T I C L E I N F O

Available online 4 July 2010

Keywords:
CVD diamond
Beam conditions monitor
Pixel detector
LHC
ATLAS experiment

A B S T R A C T

Chemical vapor deposition diamonds are considered among possible sensor materials for the next pixel upgrade in ATLAS. Full size diamond pixel modules have been constructed to the specification of the ATLAS Pixel Detector using poly-crystalline CVD diamond sensors to develop the production techniques required for industrial production. Those modules were tested in the lab and testbeam. Additionally we will present results of diamond pixel modules using single-crystal diamonds and results of proton irradiations up to 1.8×10^{16} protons/cm^2. The ATLAS Beam Conditions Monitors (BCM) main purpose is to protect the experiments silicon tracker from beam incidents. In total 16 1×1 cm^2 500 μm thick diamond pCVD sensors are used in eight positions around the LHC interaction point. They perform time difference measurements with sub nanosecond resolution to distinguish between particles from a collision and spray particles from a beam incident; an abundance of the latter can lead the BCM to provoke an abort of LHC beam. The BCM diamond detector modules, their readout system and the algorithms used to detect beam incidents are described. Results of the BCM operation with circulating LHC beams and its commissioning with first LHC collisions are reported.

Performance of the Fast Beam Conditions Monitor BCM1F of CMS in the first running periods of LHC

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ABSTRACT: The Beam Conditions and Radiation Monitoring System, BRM, is implemented in CMS to protect the detector and provide an interface to the LHC. Seven sub-systems monitor beam conditions and the radiation level inside the detector on different time scales. They detect adverse beam conditions, facilitate beam tuning close to CMS, and measure the doses accumulated in different detector components. Data are taken and analysed independently of the CMS data acquisition, displayed in the control room, and provide inputs to the trigger system and the LHC operators. In case of beam conditions dangerous to the CMS detector, a beam abort is induced.
The Fast Beam Conditions Monitor, BCM1F, is a flux counter close to the beam pipe inside the tracker volume. It uses single-crystal CVD diamond sensors, radiation-hard FE electronics, and optical signal transmission to measure the beam halo as well as collision products bunch by bunch. The system has been operational during the initiatory runs of LHC in September 2008. It works reliably since the restart in 2009 and is invaluable to CMS for everyday LHC operation. A characterisation of the system on the basis of data collected during LHC operation is presented.

Further prospects

1. - Receiving some limited IN2P3 support in 2012
   - Successful application for “initial R&D” grant covering 2012-2014
   (from new “Labex P2IO: Physique des 2 infinis et des origines” fund)
   - 1 post-doc and 1 PhD applications pending (two good candidates…)
2. Design / lab test at LAL, mechanics and more detailed simulations
3. Aim to first do beam tests in ATF diagnostic area → end 2012 / early 2013 ?

tentative schedule, can hopefully be confirmed in June meeting

	2012-S1	2012-S2	2013-S1	2013-S2	2014-S1	2014-S2
Conception (capteur, readout)	■	□				
Test proto au LAL Conception méca.	□	■	□			
Fabrication (méca., readout)		□	■			
Pré-instal. 1^{er} test instal. finale KEK		□	□	■	□	
Expérimentation en faisceau		□	□	□	■	■
Simulations (géné/tracking/G4)	□	□	□	□	□	□
Évaluation autres appl.			□	□	□	□