The ATLAS Beam Conditions Monitor

- Design/Goal of BCM
- The Collaboration
- The detector system hardware
- Testbeam results
- Performance Simulations
- Canadian contributions

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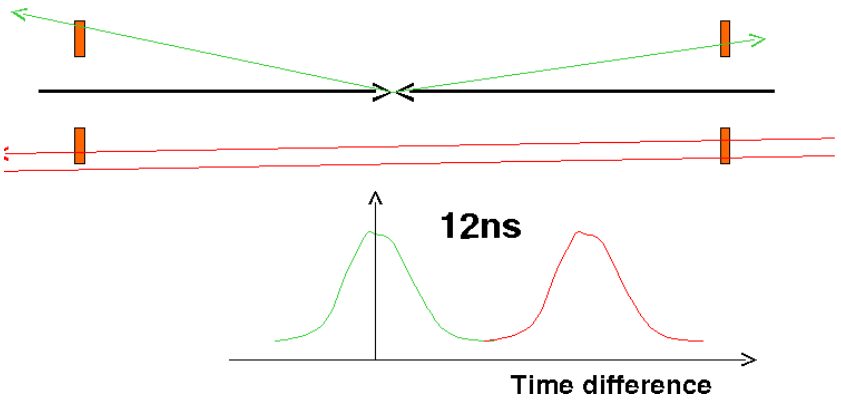
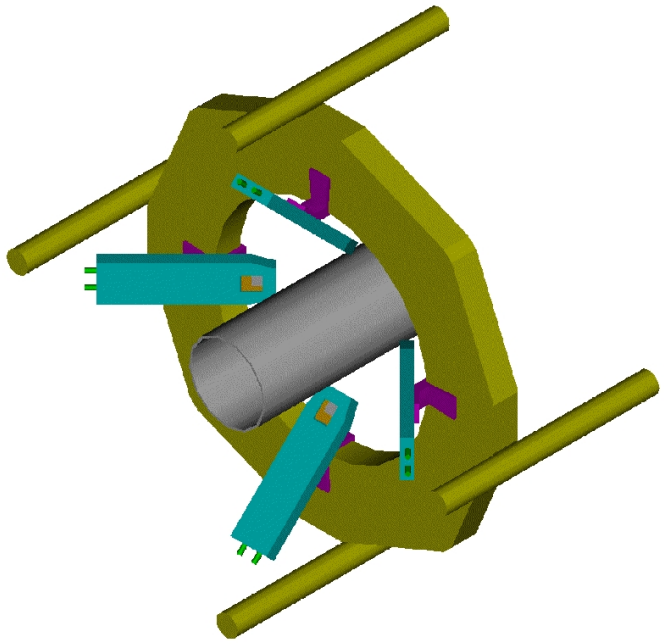
University of Toronto
December 13, 2007

ATLAS Beam Conditions Monitor

- ATLAS plans to use time of flight to distinguish beam collisions from background



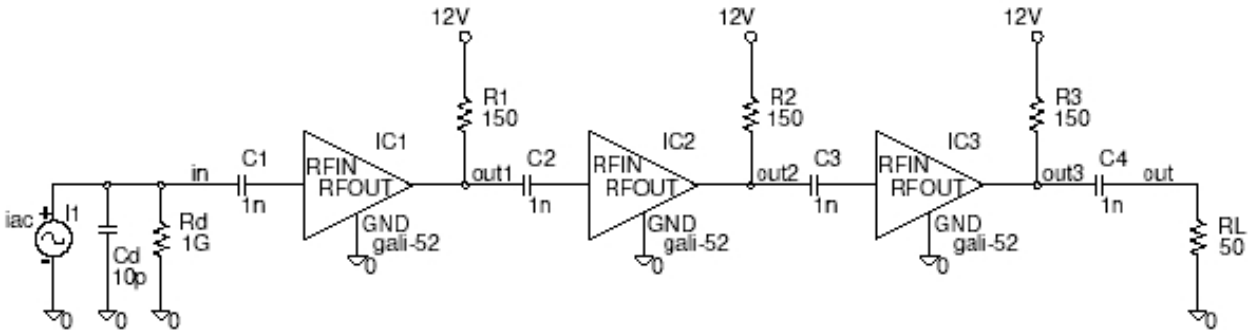
- Optimal separation is 4.1m
- Ideal support in pixel space-frame 3.8m apart



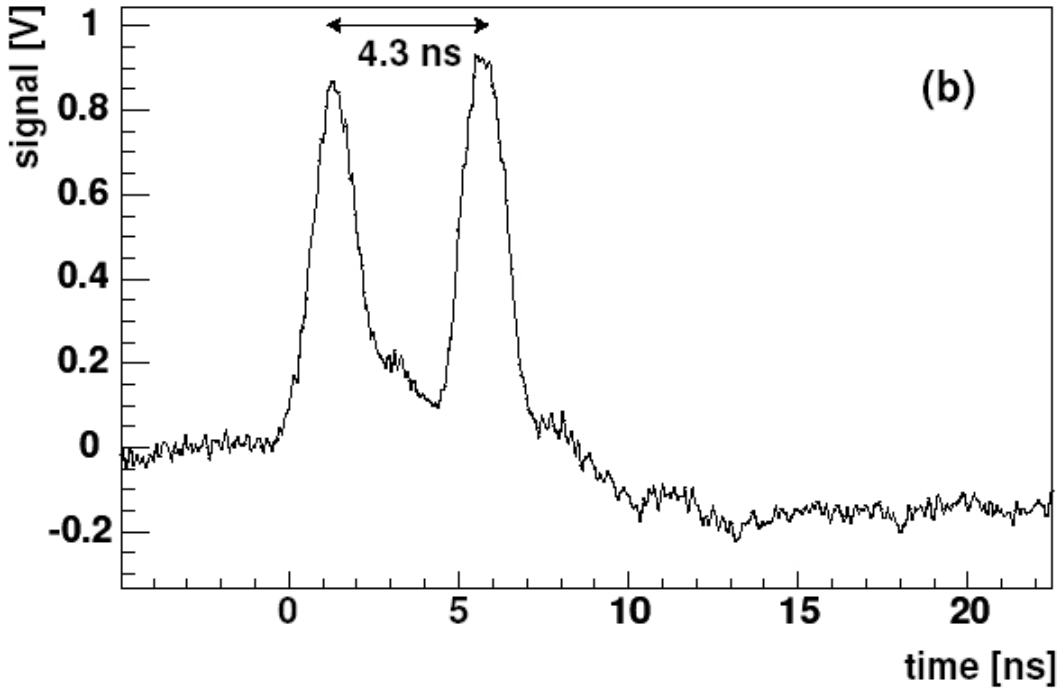
- Use CVD diamond sensors
  - 10x faster and 10x more radiation hard than silicon
- Very fast, rad hard GaAs front end amplifier

Front-End Readout Electronics

- Designed and developed by the Vienna group
- Peaking time of less than 3 ns



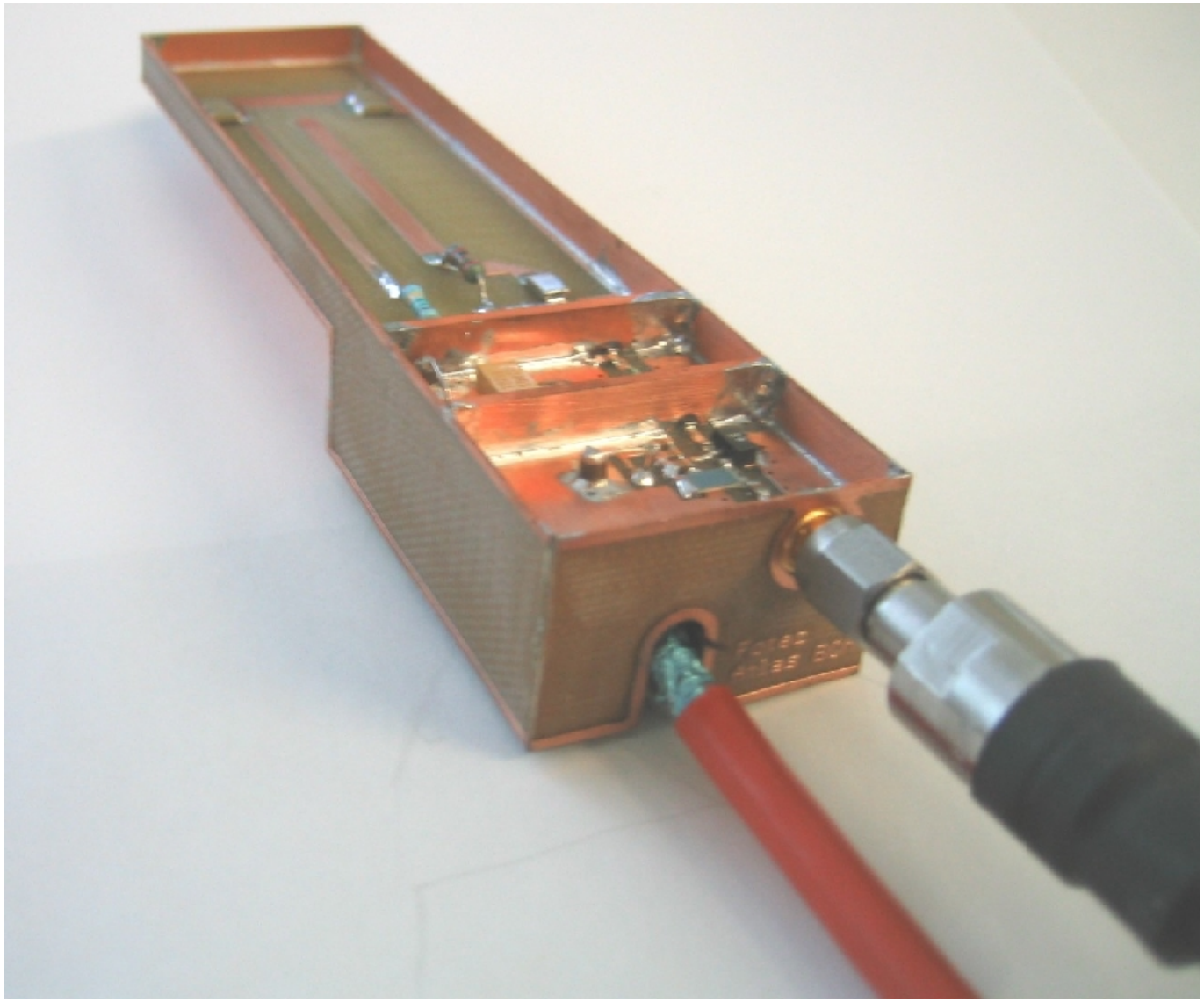
- Response to test-pulses 5 ns apart



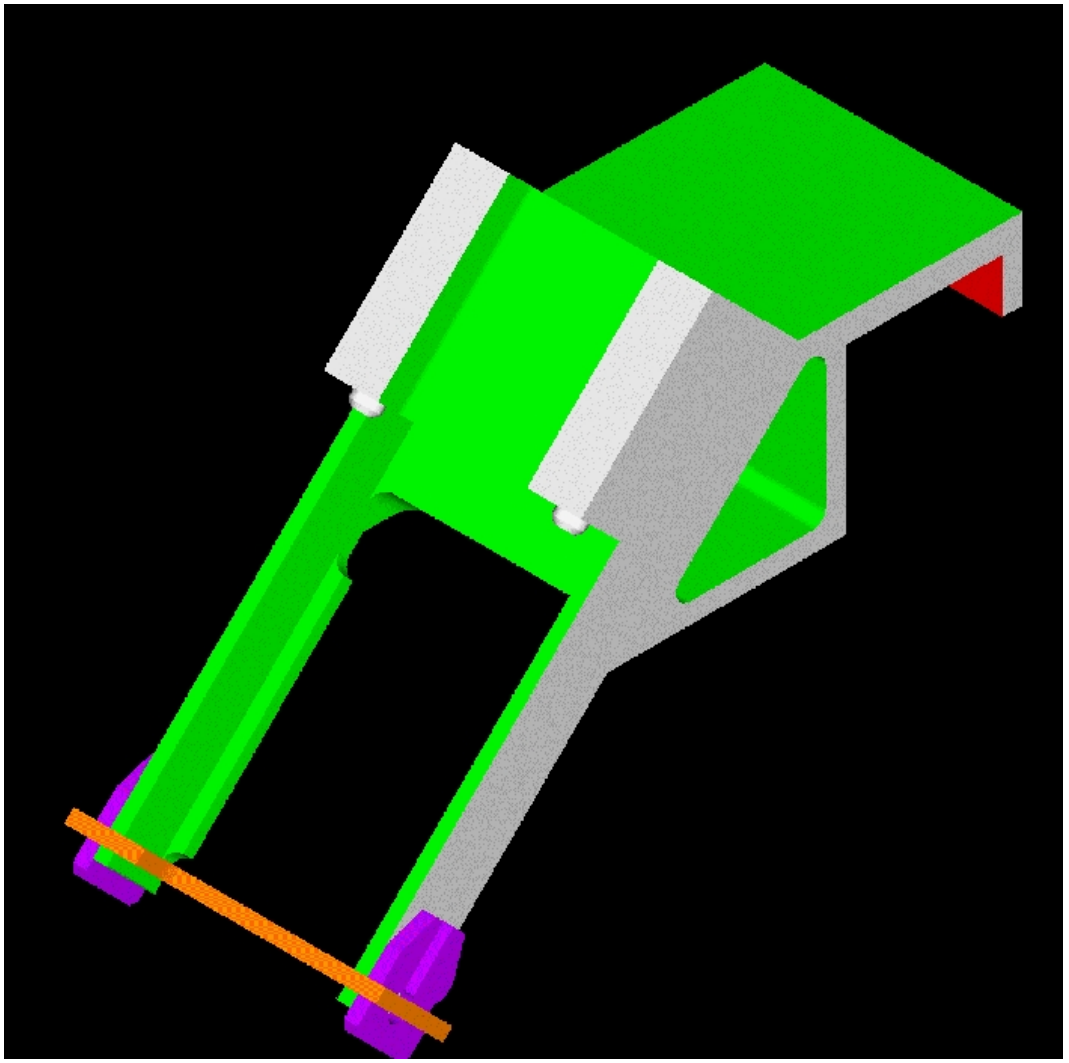
Who is Working on the ATLAS BCM

- Toronto
  - Diamonds, mechanical integration, simulation and testbeam
- Ohio State
  - Diamond characterisation, sensor preparation, packaging
- CERN
  - Module assembly and back-end readout
- Vienna
  - Front-end amplifier design/production
- Ljubliana
  - Testbeam analysis, radiation hardness, integration, cabling

Module with Cable

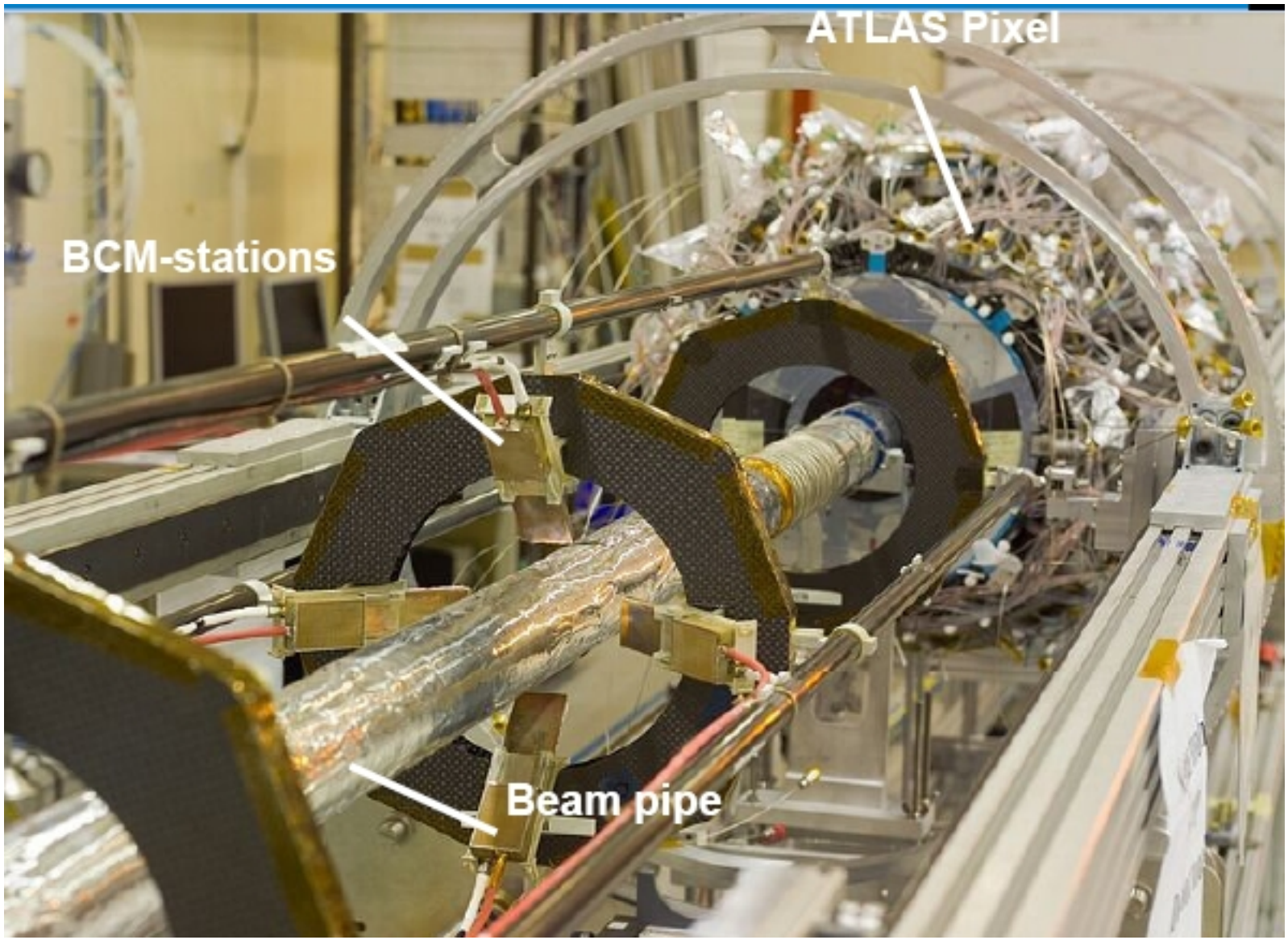


Module Support Bracket

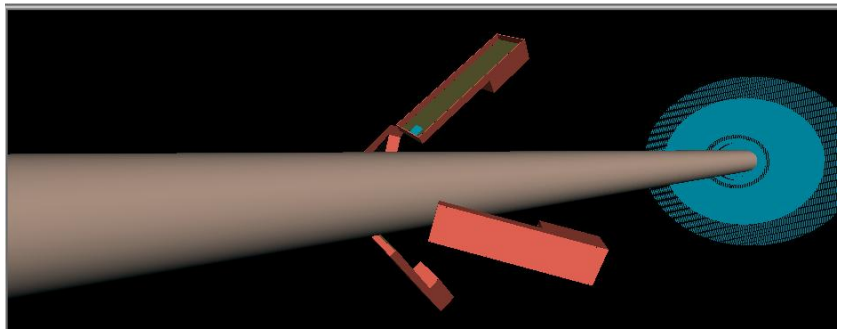


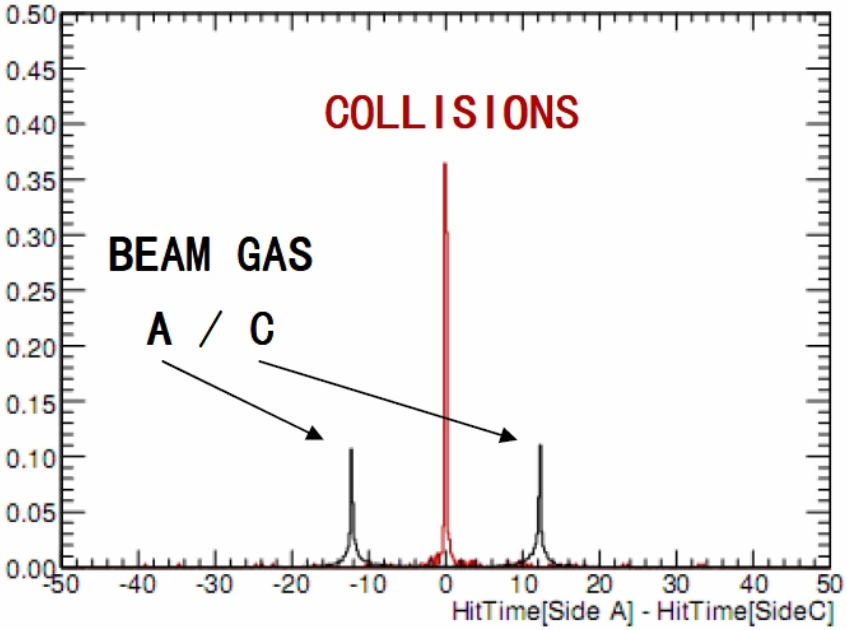
- Designed in Toronto
- SLA manufactured by Pixel group
- Small parts + QA done in Canada
- Now all at CERN

Mechanical Installation (January 2007)



BCM Geometry in Simulation

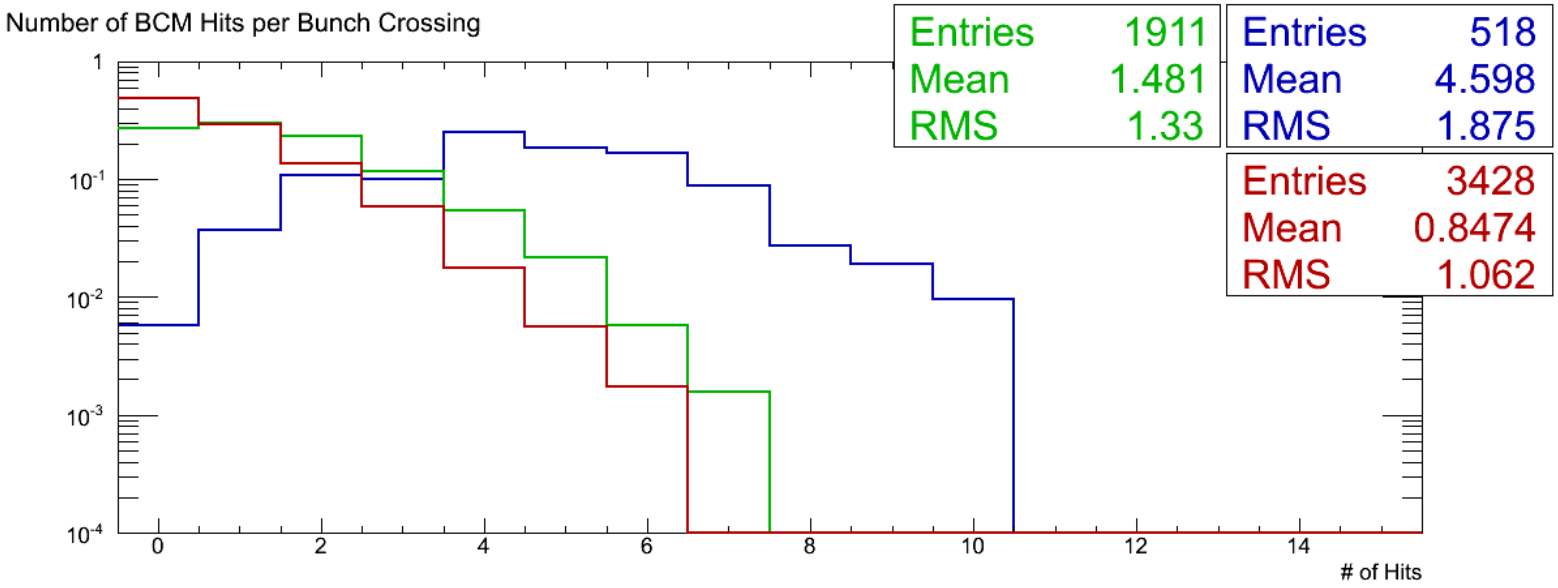


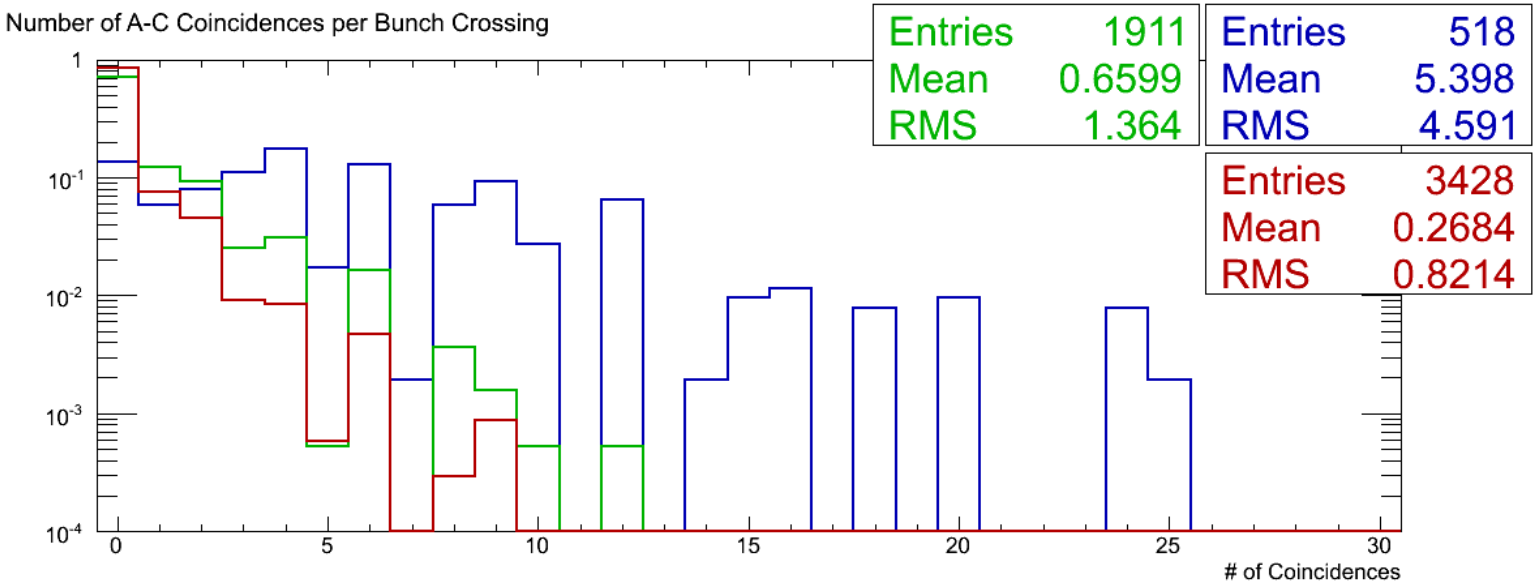


- Full GEANT model of BCM module boxes and support brackets
  - In ATLAS ID simulation

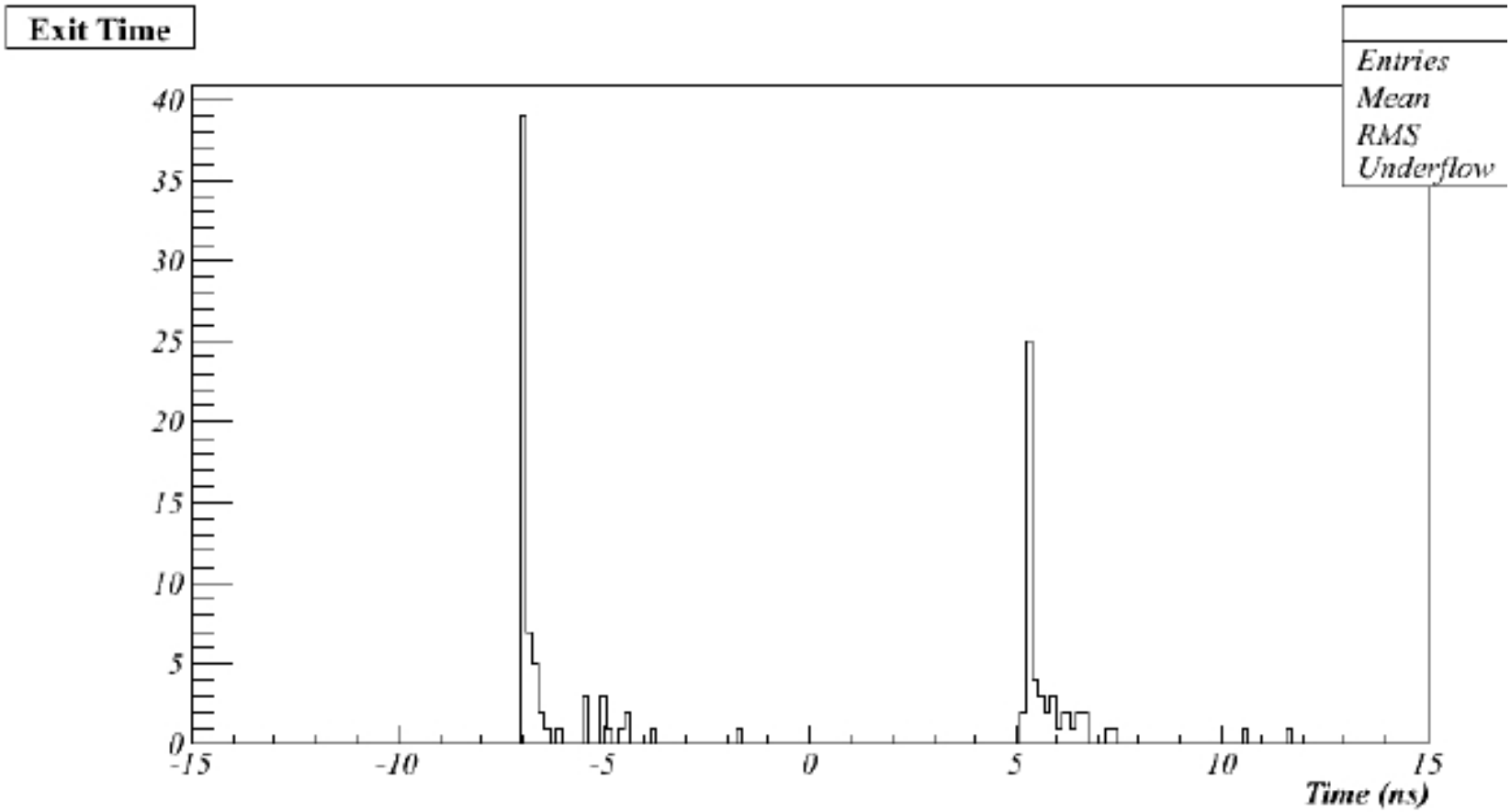
- Study occupancies and arrival times in minbias collisions
- First look at showers of lost particles

Minimum Bias Collisions

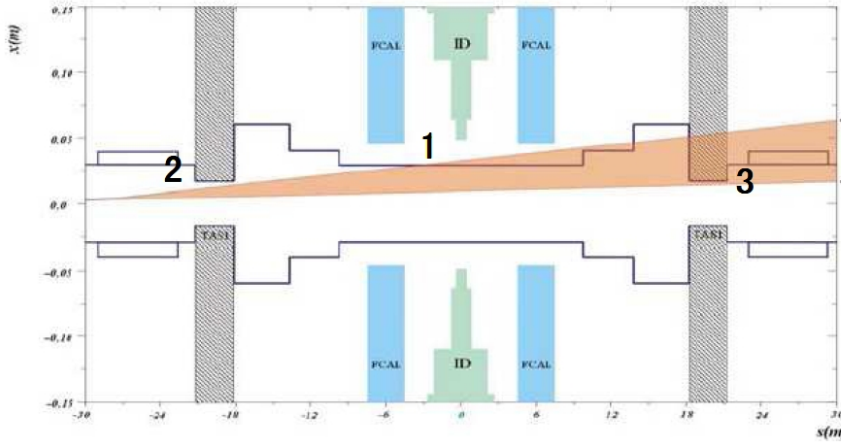


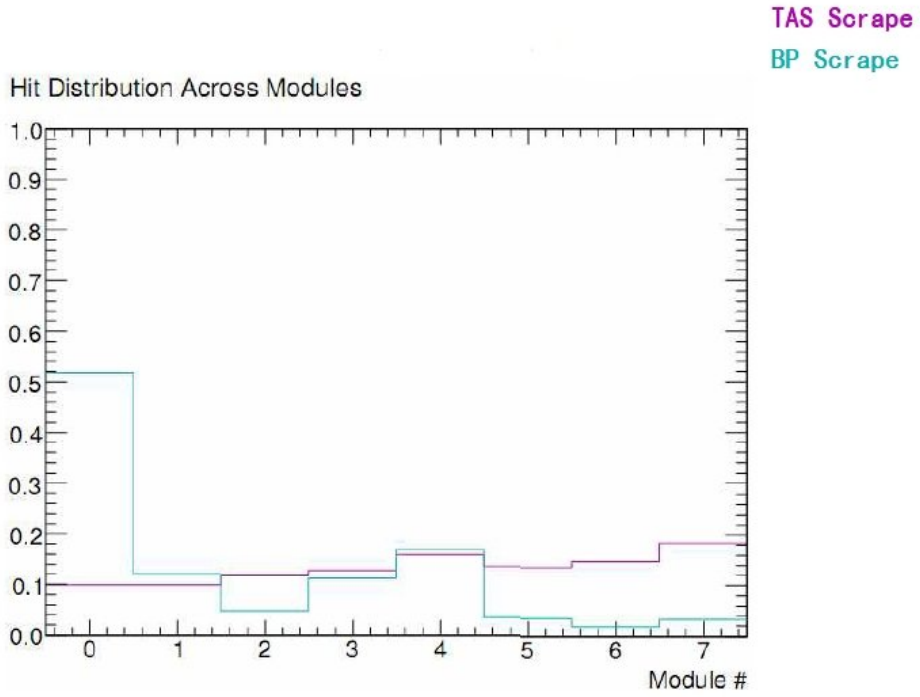


Simulated 7 TeV Lost Proton



Beam Scraping Simulations



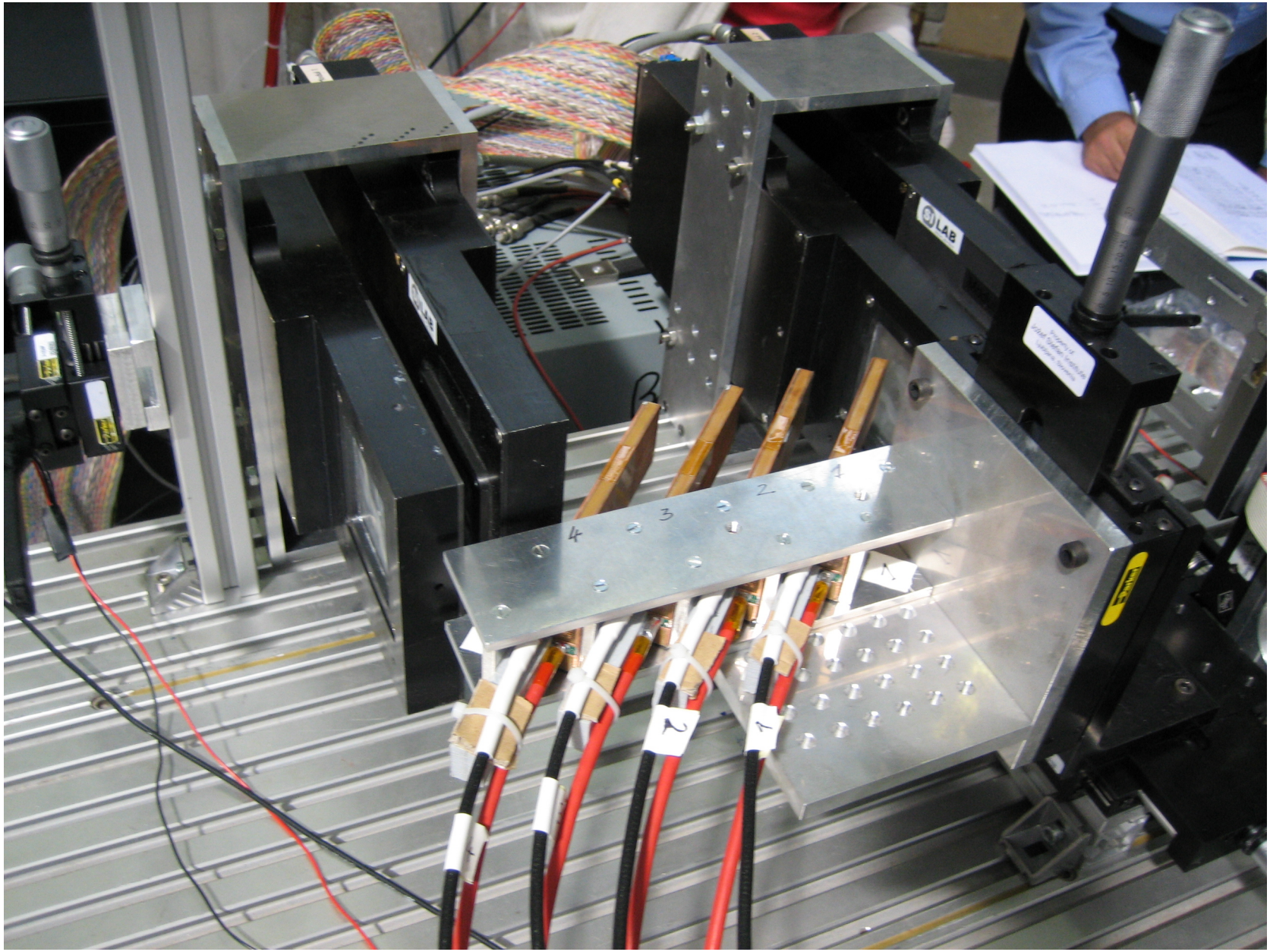


- Three injection loss scenarios

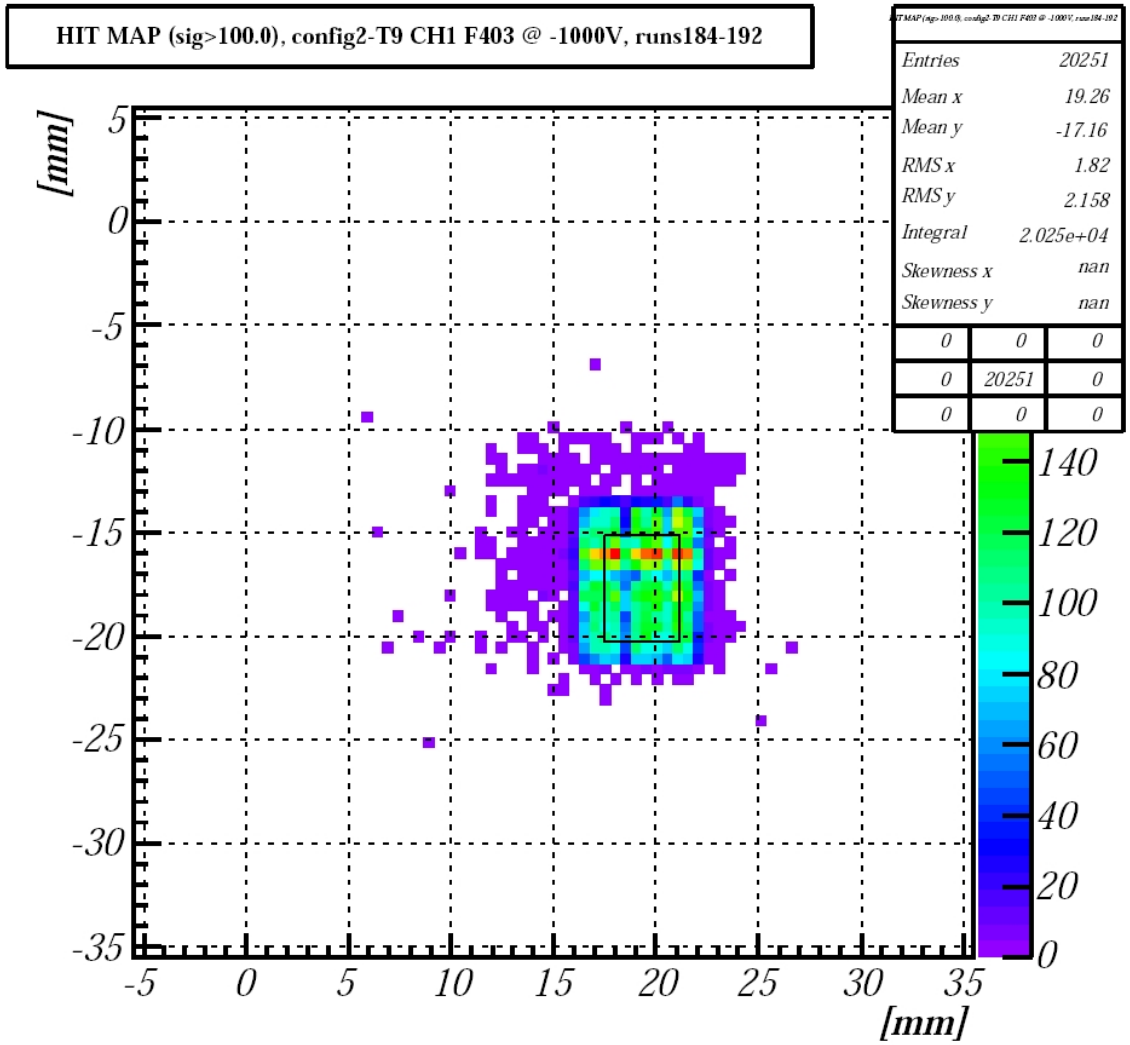
1. Scraping on ATLAS pipe
2. Scraping on incoming TAS
3. Scraping on outgoing TAS

- Angular distribution of BCM hits

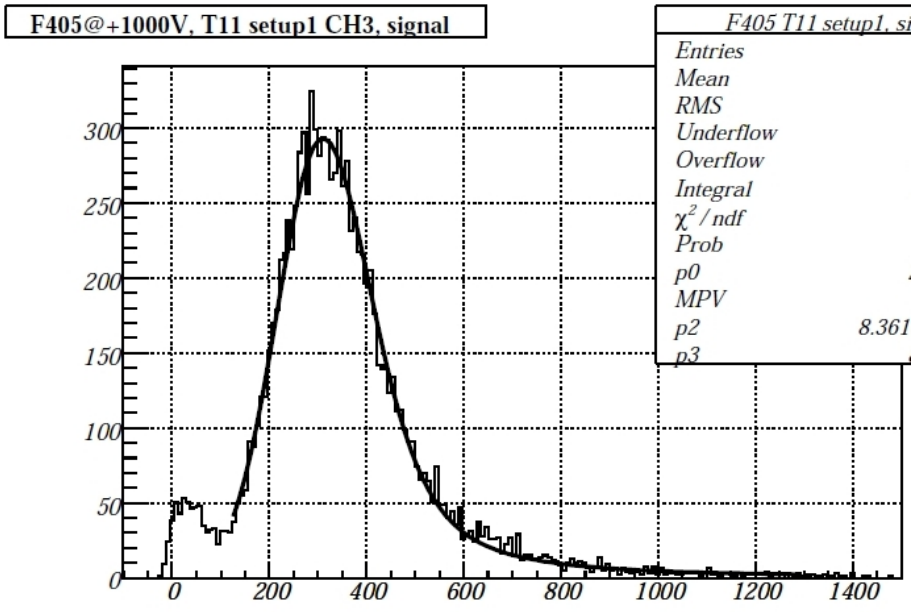
Testbeam Setup at CERN

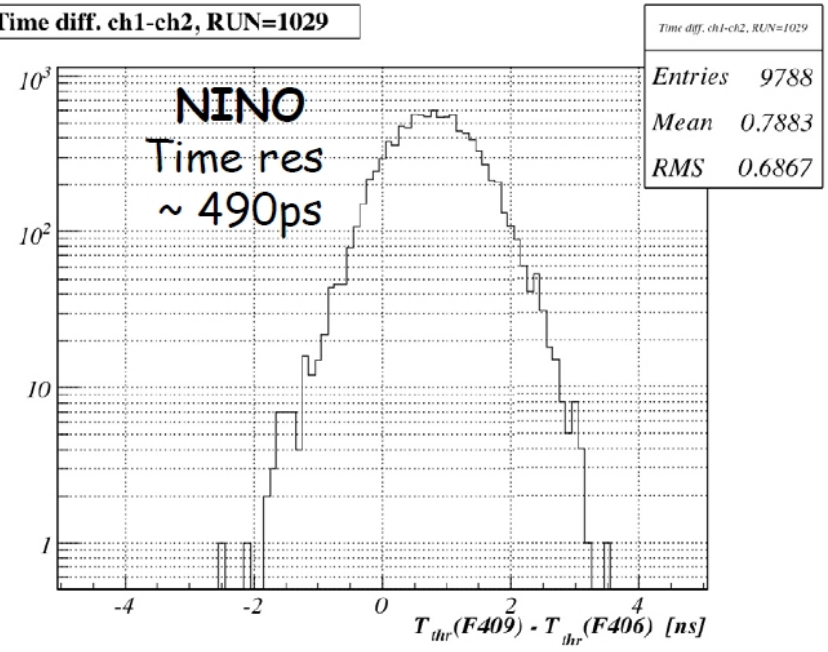


Beam Profile and BCM Hit Efficiency



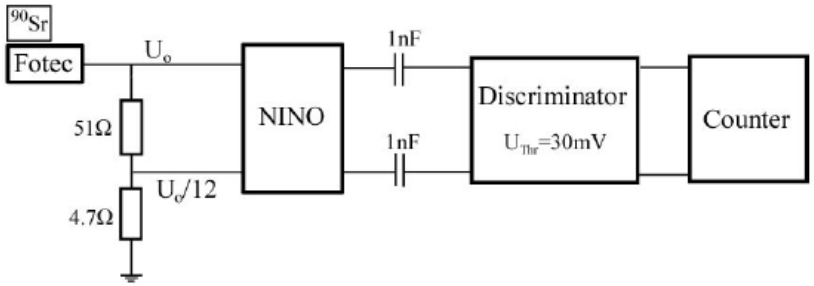
Testbeam Signal Distributions

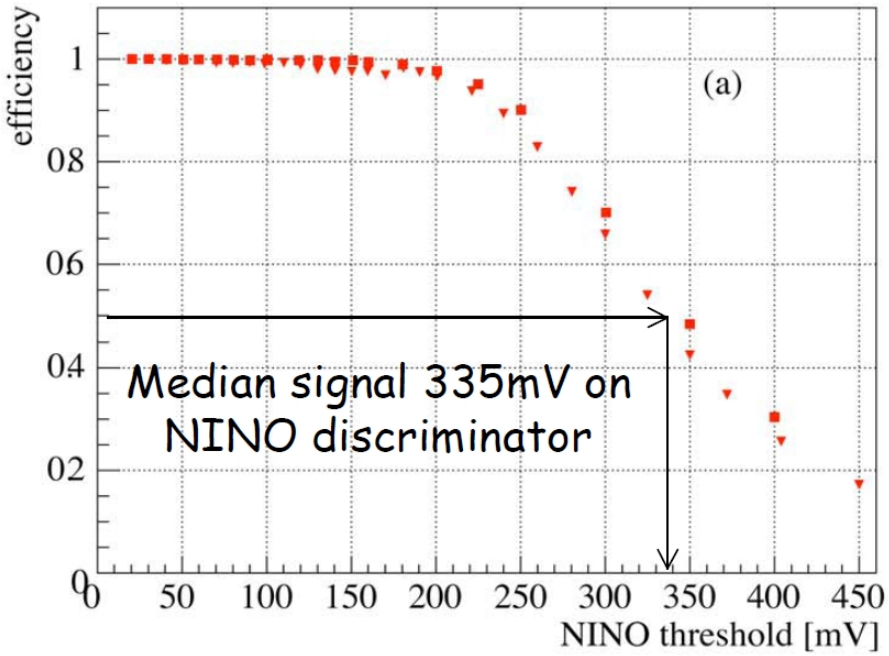


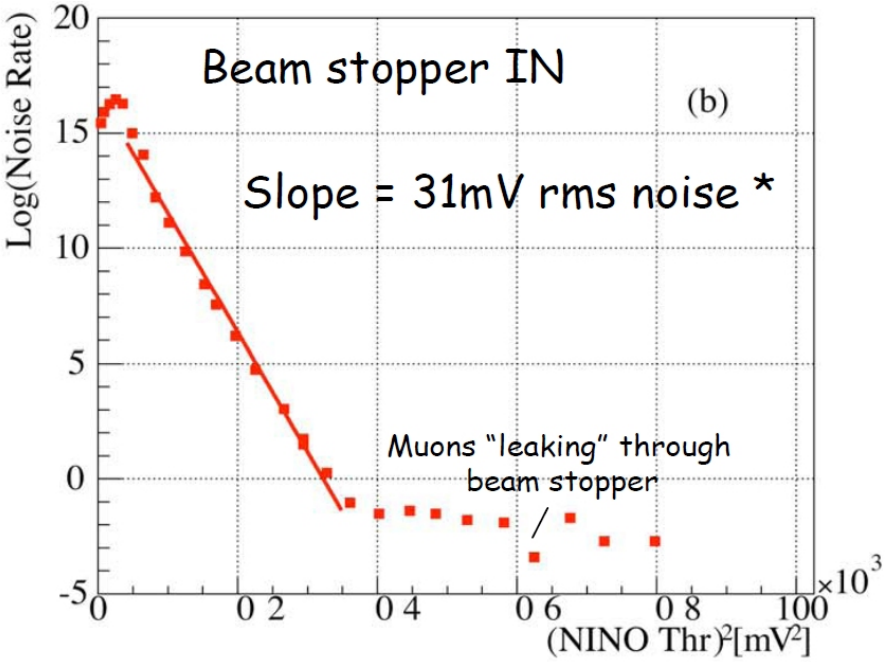


Digitisation Performance

- Using ALICE-TPC standard ADC (NINO) digitiser

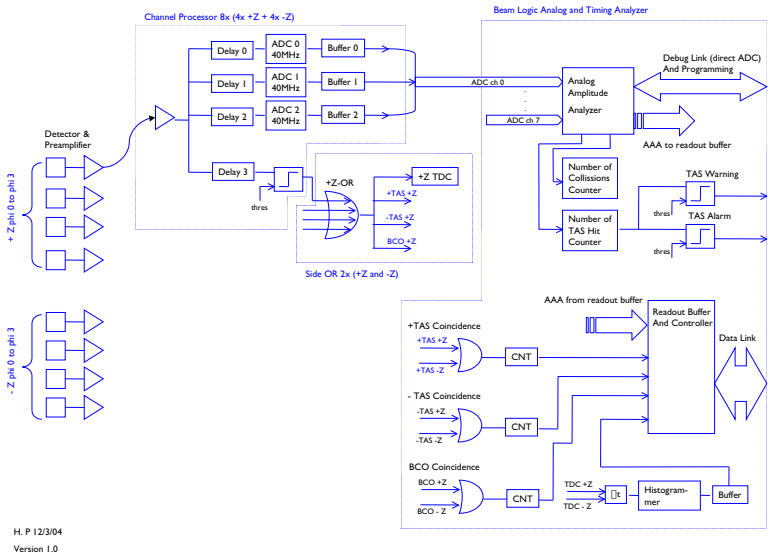


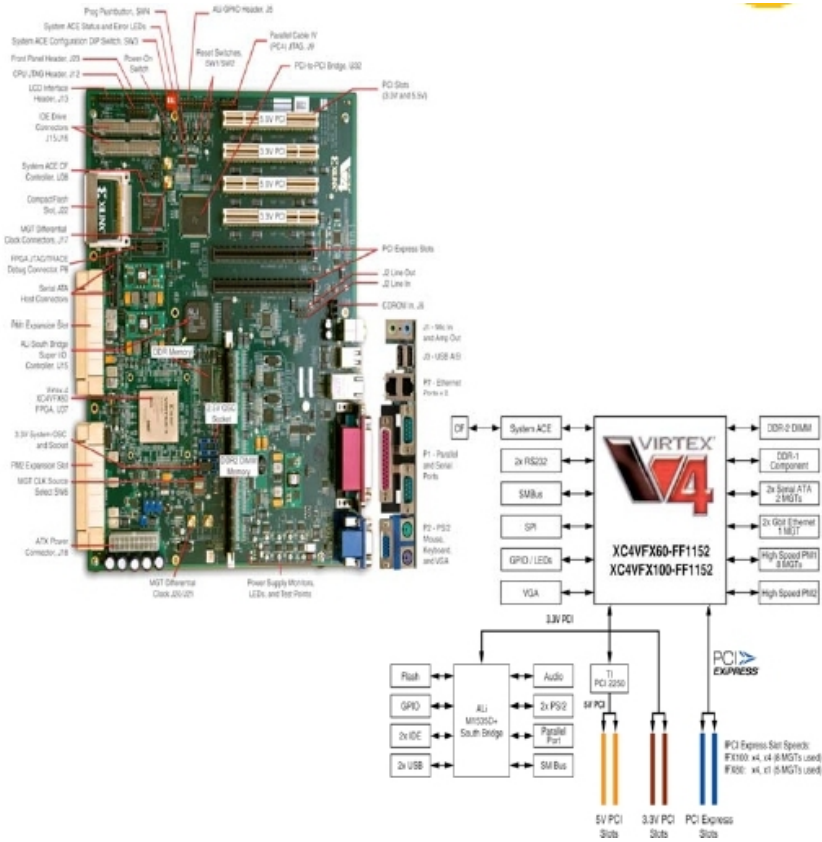




- Results from 2007 testbeam
  - Median signal: 335 mV
  - Inferred noise: 31 mV
  - System S/N = 11:1

FPGA Back-End Beam Loss/Abort Logic





- Implemented/tested in 2007 testbeam runs with spare BCM modules

J-Inst Paper

Document JINST_004P_1207

Preprint number:	JINST_004P_1207
arXiv preprint number:	Not available
Title:	The ATLAS Beam Conditions Monitor
All authors:	V. Cindro, I. Dolenc, H. Frais-Kolbl, A. Gorisek, E. Griesmayer, H. Kagan, G. Kramberger, I. Mandic, M. Mikuz, M. Niegl, H. Pernegger, D. Tardif, W. Trischuk, P. Weilhammer, M. Zavrtanik
Corresponding author:	William Trischuk (william@physics.utoronto.ca)
Abstract:	pop-up
Key words:	Beam-line instrumentation (beam position and profile monitors; beam-intensity monitors; bunch length monitors) [100] Solid state detectors [50] Timing detectors [25] Instrumentation and methods for time-of-flight (TOF) spectroscopy [25]

Canadian Contributions to BCM

- Acquisition of 20 diamond sensors ($26k)
- Acquisition and integration of iSEG HV supplies ($10k)
- Source'd and acquired module power connectors ($3k)
- Design and QA for BCM module brackets (Cadabeschi)
  (SLA + PEEK parts $2k)
- Acquisition of Gore air-core signal cables ($7k)
- Implemented BCM geometry in ATLAS simulation (Bendavid, Mazini)
- `GEANT` simulations of lost beam and commissioning (Tan, Tardif)

Full partners in BCM – contributing 1/3 of effort and equipment

Summary

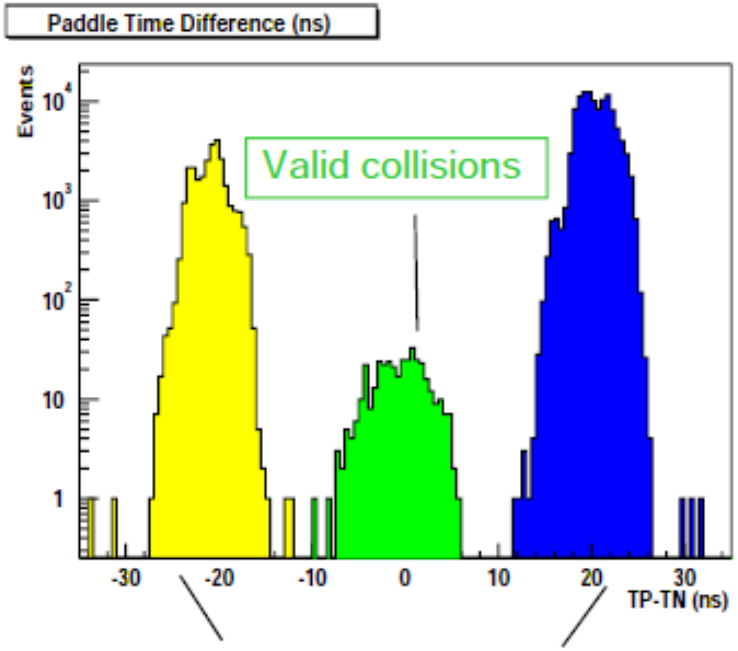
- Eight BCM modules installed in ATLAS June 2007
- First readout in pit early 2008
- Now working on beam accident simulations
- Use simulations to guide design of trigger logic
- Prepare and deploy final beam loss signals in spring 2008
- Fully integrate into LHC machine commissioning

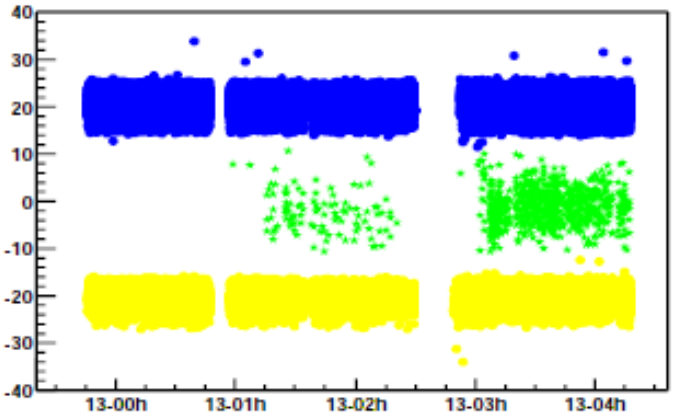
Possibly the first detector to observer LHC collisions

Example from Phobos (RHIC)

On June 13th, 2000 at RHIC in Phobos

- Monitor "in-time" & "out of time" coincidences vs time to give feedback to LHC operator for conditions in Atlas center ?





+/- TOF distance = upstream background

This was used during RHIC beam tuning and gave us collisions on the first day