WP15.2 – Improvements of test beam infrastructure for high precision tracking

Jan Dreyling-Eschweiler (DESY) for the telescope and test beam team

AIDA-2020 WP15 satellite meeting during 7th BTTB Workshop
WP15: Upgrade of beam and irradiation test infrastructure
CERN, 14th January 2019

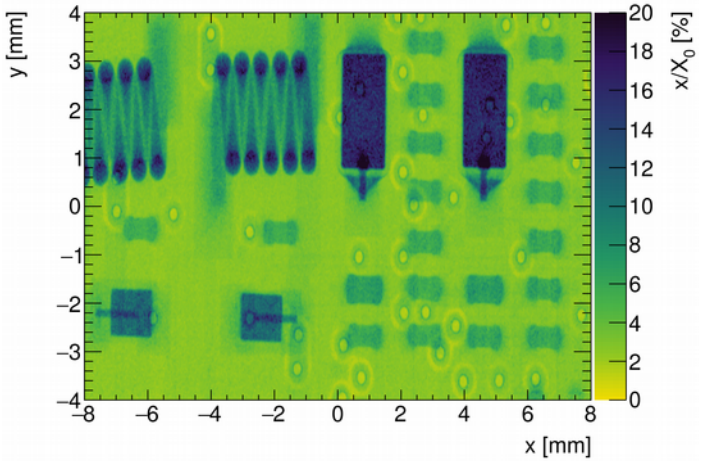
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

AIDA 2020

DESY TEST BEAM.

DESY.

Contents



Scientific/Technical Note

Checklists for using and maintaining EUDET beam telescopes

Dreyling-Eschweiler, Jan (DESY) *et al*

06 March 2017

Test beams* in the world, status September 2017

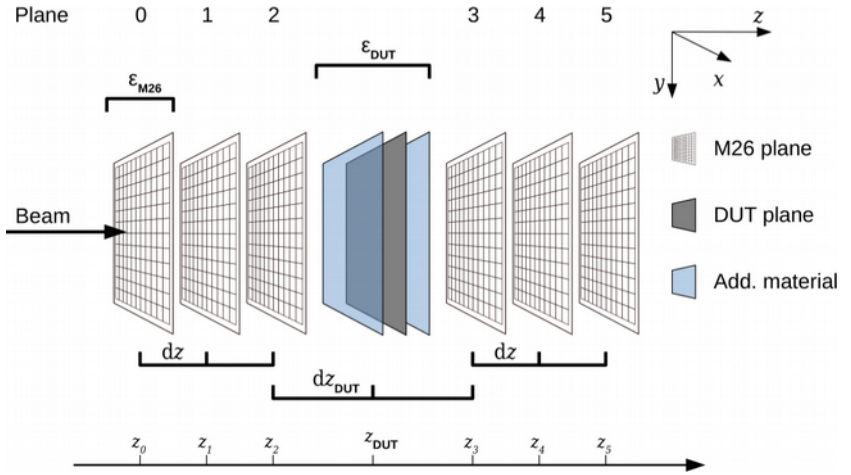
Laboratory	Number of beam lines	Particles	Energy range	Diagnostics etc.	Availability	Information, contacts & comments
CERN / PS (CH)	2	e, h, μ (sec.)	0.5 - 10 GeV/c	Threshold Cherencov, scintillators, MWPCs, delay wire chambers, scintillators, magnet, movable platform	9 months per year, continous except winter shutdown Duty cycle depends on PS / SPS / LHC operation mode and is typical * PS ~1-3% * SPS: 20-40% No PS and SPS test beams in 2019 and 2020	Contact beam time request and scheduling: Sps.Coordinator@cern.ch http://sps-schedule.web.cern.ch/sps-schedule/ contact beam lines: sba-physicists@cern.ch http://sba.web.cern.ch/sba/
CERN / SPS (CH)	4	p (prim.) e, h, μ (sec.) e, h (tert.) Pb ions (prim) other ion species (out of fragmented primary Pb ions)	400 GeV/c 10 - <400 GeV/c 10 - 200 GeV/c 20 - 400 GeV/c proton equivalent (z=1)	Delay wire chambers, filament scanners, XEMC calorimeters, Threshold & CEDAR, hodoscopes, magnet, movable platform		
CERN / CLEAR (CH)	1	e-	50-250 MeV/c		8 -9 months per year	Contact: CLEAR-Info@cern.ch https://clear.web.cern.ch
DAFNE BTF Frascati, (IT)	1	e+/e- both primaries and secondaries	25-750 MeV/c Rep Rate 50Hz 1-40 ns 1 to 10^{10} p/pulse	Calorimeter, silicon pixel, remote trolley, gas system, HV, trigger	depending on DAFNE schedule, from 25 to 35 weeks/year Not available in the first half of 2018	Contact: btf@lnf.infn.it, paolo.valente@lnf.infn.it info at: http://www.lnf.infn.it/acceleratori/btf http://www.lnf.infn.it/acceleratori/padme
DESY (D)	3	e+, e- (sec.) e- (prim., planned for 2017)	1 - 6 GeV/c 6.3 GeV/c	Trigger systems and beam telescopes, magnet (~1T)	10 months per year, Duty cycle ~ 50%	Contact: Testbeam-Coor@desy.de http:// testbeam.desy.de
ELPH (Sendai)	2	photons (tagged) e+, e- (conv.)	0.7-1.2 GeV/c 0.1-1.0 GeV/c		2 months/year	contact: Toshimi Suda (suda@lns.tohoku.ac.jp)

01 Introduction: Beam Telescopes

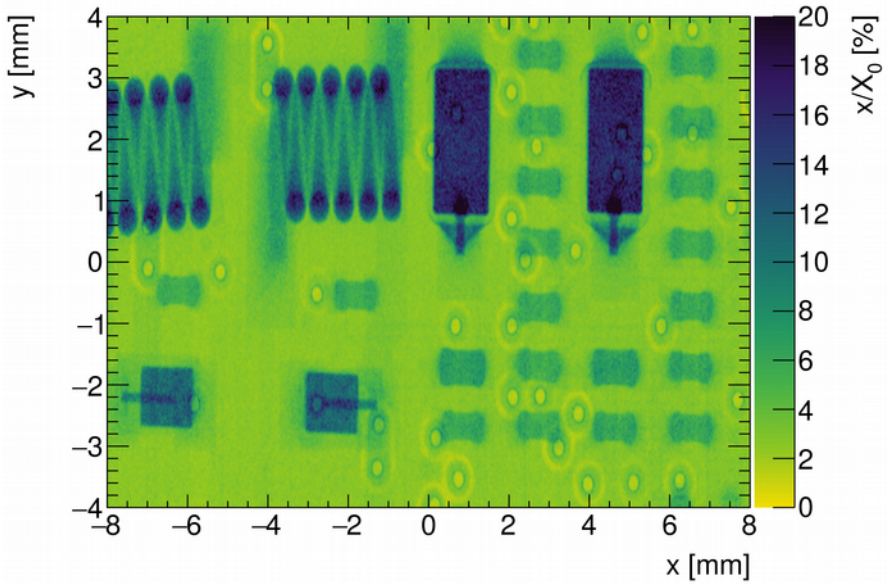
High precision reference tracker

EUDET-type telescopes in a nutshell

- Mimosa26 based 6-plane telescope
  → Device Under Test (DUT) in between (or behind)
  → Response studies, efficiency, Lorentz angle, etc.
- Pointing resolution (> 1.8 µm) or
  angular resolution (> 0.03 mrad) @ 1-6 GeV/c
  → Material Budget (X0) imaging
- Whole infrastructure: Trigger and DAQ user interfaces and track reconstruction software
- In the las decade a workhorse for various (HEP) test beams: 7 copies at 5 different test beam facilities



H. Jansen et al https://doi.org/10.1140/epjti/s40485-016-0033-2



Electronic Board for ATLAS ITk strip upgrade (J.-H. Arling, C. David, M. Queitsch-Maitland)

02 WP15.2 Status

Deliverables achieved

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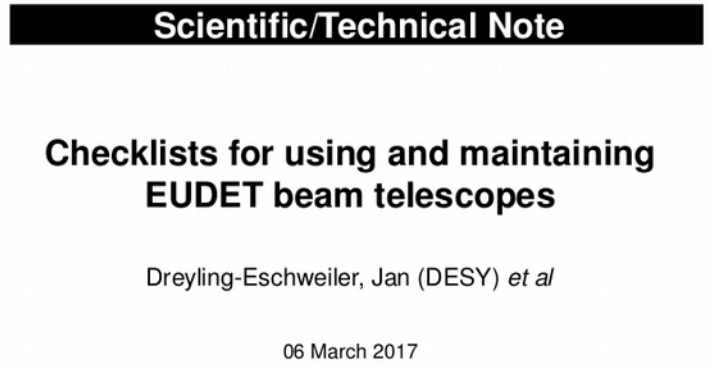
AIDA2020 – WP15.2 – Improvements of test beam infrastructure for high precision tracking

- **7th EUDET-type telescope AZALEA** was installed at PS T10, CERN, in September 2016
- Milestone and Delivery achieved, Documentation updated

MS32	Pixel telescope hardware assembled	15	M18	31/10/2016	Achieved	Report
D15.1	CERN pixel beam telescope for the PS	WP15	M24	27/03/2017	Achieved	Report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Starting point of documentation

- *telescopes.desy.de*

03 Results of improving the infrastructure

Main purpose here: Higher time resolution

@BTTB Tuesday 11:50
Overview and status talk

EUDET-type hardware ⟷ **EUDAQ** DAQ software → **EUTelescope** Track Reconstruction SW

- Integration of new AIDA TLU (WP5)

  @BTTB Thursday 12:30 session talk

- Exploring MMC3 board as new Mimosa DAQ (Univ. Bonn)
- Exploring new sensor canditates

  @BTTB Thursday 19:00 discussion in the Forum

- CI for version 1
- Optimizing version 2 for telescope usage with new TLU and new data-taking modes (IEEE18 talk)
  - Trigger rate now limited by busy time for clocking out trigger ID, for example using a FEI4: 8.8 µs = 115 kHz (**factor ~30 of improvement**)
  - Timestamped tracks (with FEI4) all tracks with high time resolution **factor 5.5 of improvement** at 2 GeV/c at DESY TB

@BTTB Thursday 14:00 hands-on (EUDAQ2 and AIDA TLU)

- Updated GBL Processor
- Updated user examples
  - Only telescope
  - Passive DUT (SUT)

@BTTB Tuesday 14:00 hands-on

  - DUT

@BTTB Tuesday 16:30 hands-on

@BTTB: And many more user talks, see https://indico.cern.ch/event/731649/timetable/#all.detailed

04 Request for “Test Beam Database”?

Copying the success story of the irradiation facility database

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Considerations:

- Technical part as for the irrads
- Manpower for coordination/reviewing contents
- Starting point: Table from Christoph Rembser (CERN)
- Add-ons: particle rate (peak and avg.), available tools, ...

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05 Summary & Outlook

Summary

- EUDET, AIDA, AIDA2020 were and are booster for success story of common beam telescopes
- WP15.2 supported 7th telescope and maintenance
- DESY reviewed the last decade and asked the community for future needs
  - Better time resolution: Ongoing integrations and documentations
    → **The AIDA2020 extension will be helpful!**
  - Test beam database
- **Link:** telescopes.desy.de

Outlook

- BTTB sessions
- Continuing support & continuous integration
- 4 reference publications in pipeline: Hardware upgrade, EUDAQ1, EUDAQ2, EUTelescope
- Long LHC shutdown 2019/2020
  → Moving one telescope from CERN to DESY
  → Three telescopes at DESY