



PLUME detector for BEAST 2

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- Historical perspective on French cont'
- Physics goal
- Sensors
- mechanics
- DAQ
- Questions

[Previous talk
at 19th B2GM](#)

Historical perspective



- First contacts
 - Informal discussion with Belle-II in Spring 2013 for a French participation
 - France-Japan Particle Physics Lab. June 2013
 - Agreement for investigation on French contribution
 - potential domains for IPHC: physics analysis, tracking, BEAST

 - Discussion with KEK colleagues
 - October 2013 at IPHC & LAL
 - Output: PLUME contribution to BEAST-2 interesting

 - Presentation at 16th B2GM (Nov. 2013)
 - Description of PLUME project

 - Final agreement of French IN2P3, Summer 2014
 - Green light ONLY for participation to BEAST

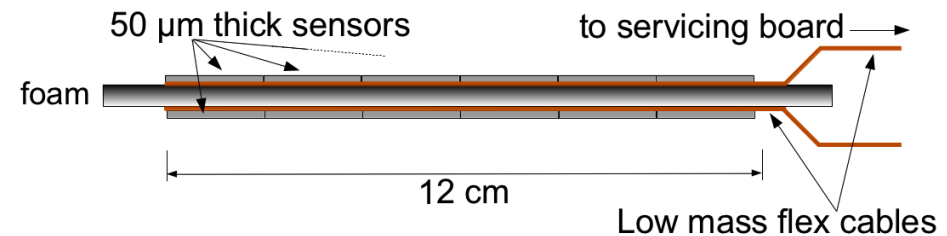
 - Presentation at 19th B2GM (Nov. 2014)
 - First detailed proposition for PLUME in Beast-2
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PLUME



■ Concept

- Double-sided layer of pixelated sensors
- Designed driven by ILC-VXD
- Air cooled
- Collab: Bristol, DESY, IPHC

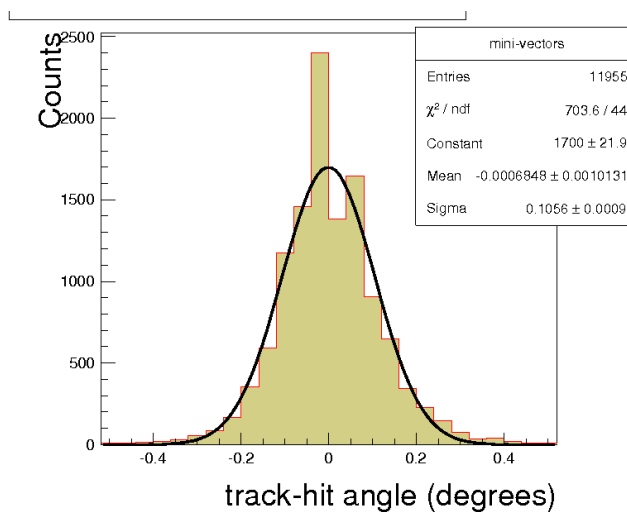


■ Production

- PLUME-1:
 - MIMOSA-26 sensors
 - Material budget 0.6% X₀
 - 2 functional ladders
- PLUME-2
 - MIMOSA-26 sensors
 - Material budget 0.35% X₀
 - ≲10 ladders in production
- PLUME-3 (dedicated to BEAST-2)
 - MISTRAL sensors
 - Material budget guess ≲ 0.5 % X₀
 - Few ladders goal

■ Beam test @ SPS (2011)

- Incident angle resolution:
0.2 degrees at 40 degrees



Physics goals with PLUME



■ Main goals

- Insure PXD operation
- Validation of background simulation

Analysis of cluster shape
(simulation)

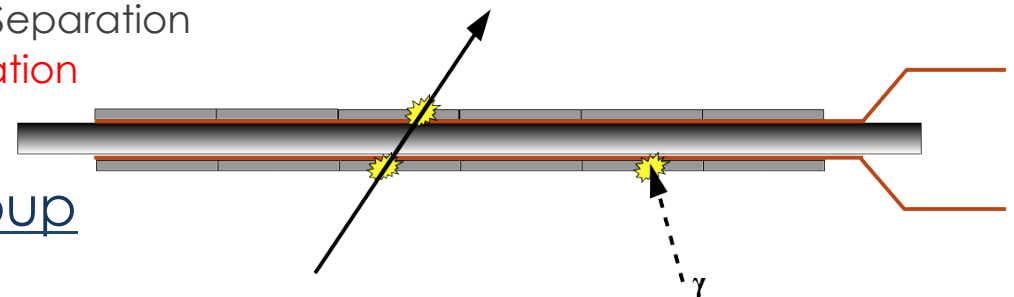
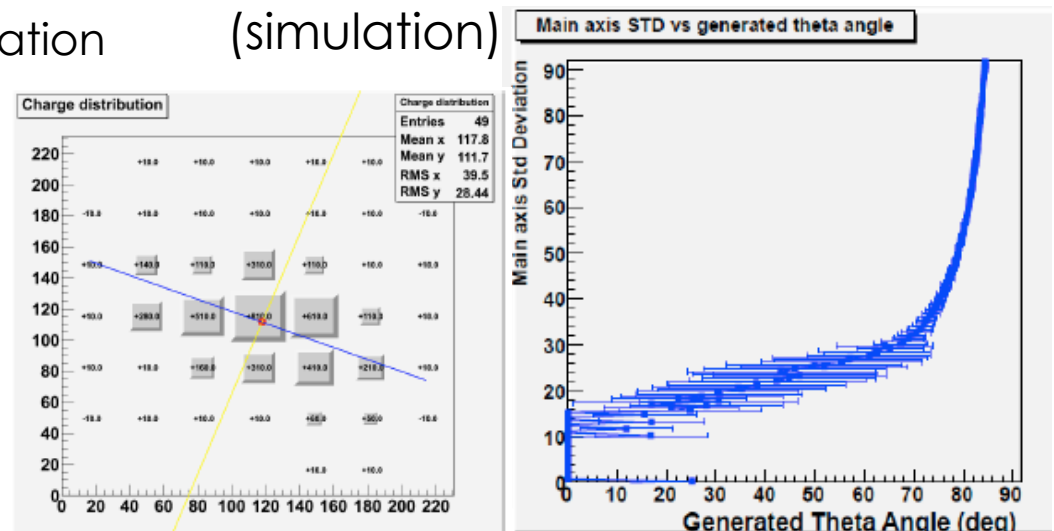
■ Measurements

- Hit rate (few 10^6 hits/cm²/s)
- Injection noise damping time
 - with continuous integration
 - with 2 μ s time precision
- Separate background types
 - Cluster shape
 - Incident angle estimation
 - Photon (4-8 keV) / charged part. Separation

➔ all to be demonstrated with simulation

■ Additional interest for IPHC group

- Understand inner tracking region
- In view of future Belle-II participation to physics analysis
- Matches IPHC expertise



MIMOSA Sensors (binary out)



■ PLUME-1/2 with MIMOSA-26

- Existing ladder (more in production)
- Small pixel → good for incident angle estimation
- Continuous rolling shutter read-out mode
 - Counting rate: $\leq 10^6$ hits/cm²/s
- Ionizing radiation tolerance ~ 0.3 MRad
- BUT injection noise issue / 100 μ s integration
 - Only viable if injection noise damping time < 20 ms
- Sensitive length: 10x120 mm²



■ PLUME-3 with MISTRAL (ALICE-ITS chip)

- Sensor back from foundry in Q3-2015
 - Beam test (single sensor) CERN-SPS Nov.2015
 - PLUME ladder to be produced in Q1/2-2016
- Integration time (continuous rolling-shutter)
 - Nominal 20 μ s
 - Special mode ~2 μ s (see next slide)
- Ionizing radiation tolerance ~ 1 MRad
- Large pixel (36x62.5 μ m²) → not optimal for incident angle
- Sensitive length: 13x90 mm² (nominal mode) 0.08x90 mm²

Remark 1:

- if inject. noise damping time < integration time
- Injection noise appearance time known at 200 ns precision

Remark 2:

- discriminator threshold tuning

MISTRAL integration time

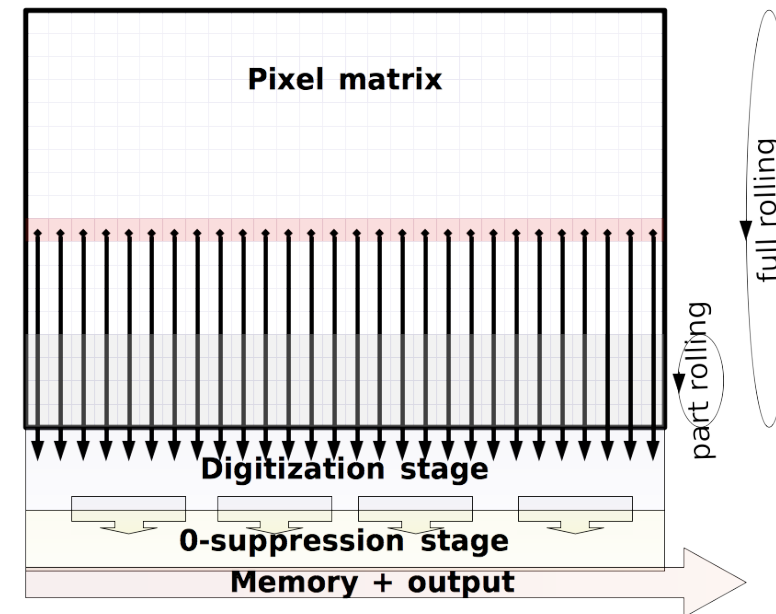


■ Nominal mode

- 208 rows
- Row read-out time 160 to 200 ns
- Integration time = 16.6 to 20.8 μs
- 0-suppression logic treats 208 rows synchronously with integration time
- Output memory (100 hits) read once after 208 rows treated

■ Specific BEAST-2 mode

- Select $208/16 = 13$ rows (0.8 mm)
 - partial rolling-shutter
- Row read-out time unchanged
- Effective integration time = 2.1-2.6 μs **without dead-time**
- 0-suppression logic sees 16 times the same 13 rows
- Output memory delivers 16 times the 13 rows content after 208 rows
- 100 hits/208 rows $\rightarrow \sim 10^8$ hits/s/cm²



Mechanics



■ Current proposition

- Two supporting pieces
- Installation (+ shipment) requires additional rod

■ Cabling

- 2 flat cables in VXD volume
- 16 mm wide, 50 cm long
- Contin'd with 1m50 kind of twisted pairs

■ Room needed for fixtures

- ~ 10 mm on support to 20 mm on ladder

■ Radius?

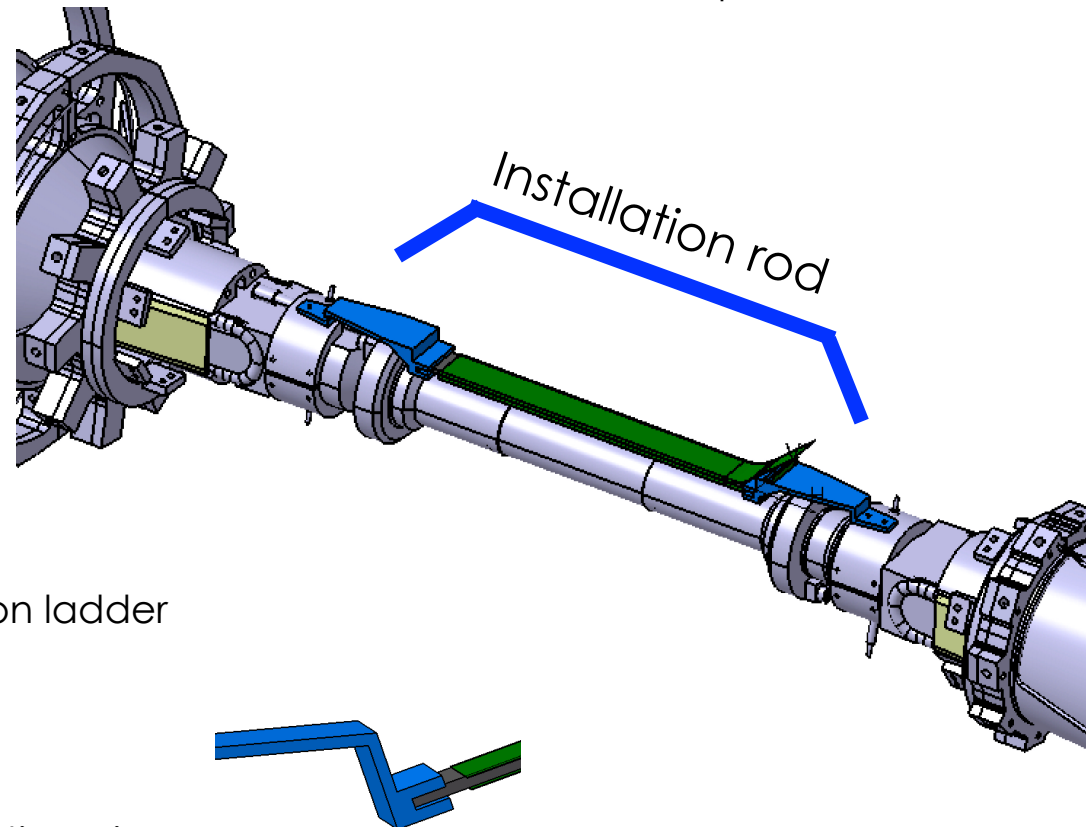
- Currently 20 mm
- Adjustable by changing supporting piece

■ Material budget

- 0.3 to 0.6 % X_0 within 12 cm

■ Cooling

- PLUME-1/2/3: power diss. < 9 W

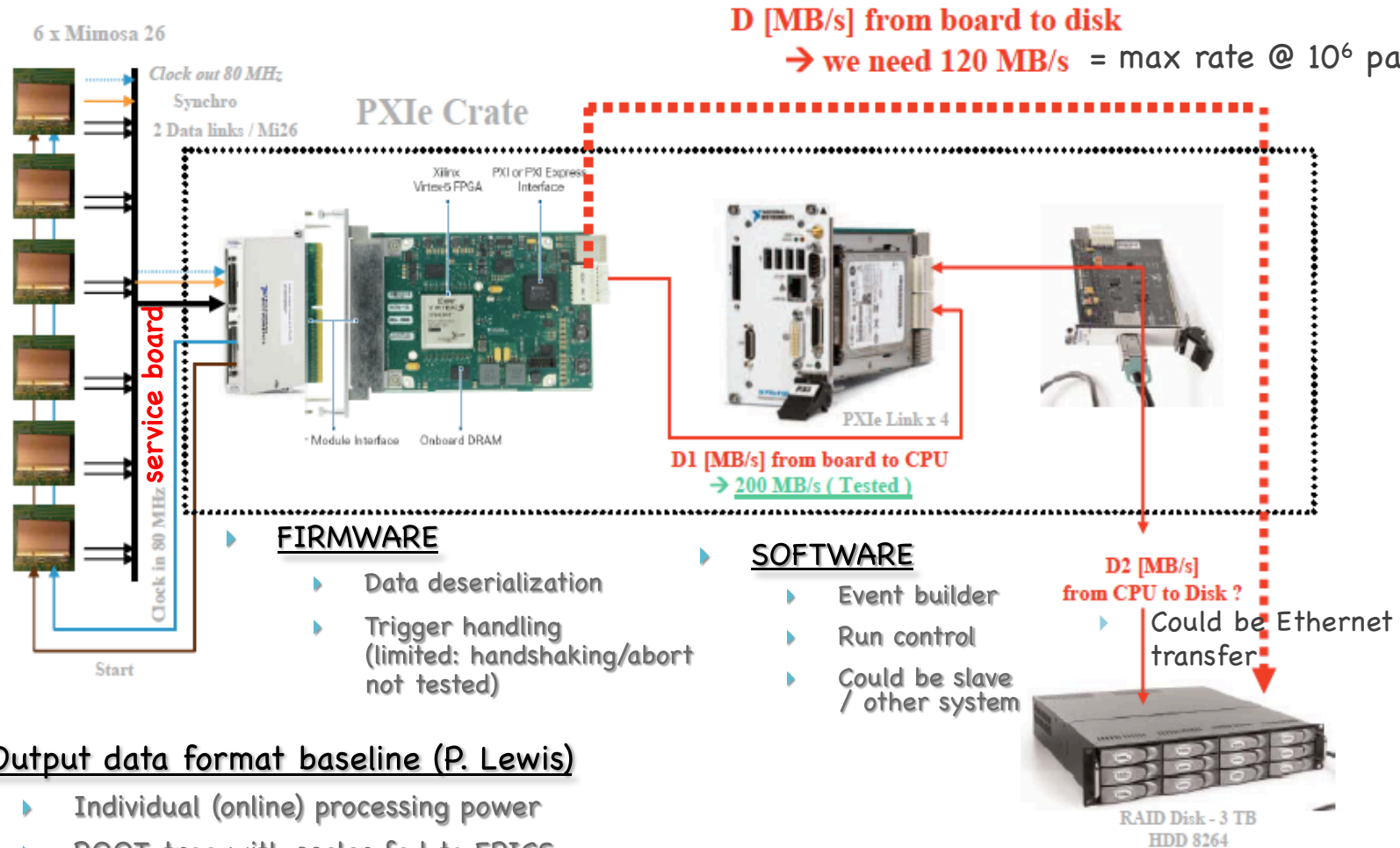


[3D models links](#)

DAQ



- ▶ IPHC system based on NI crate
- ▶ Operated in many beam tests since 2008



- ▶ Output data format baseline (P. Lewis)
 - ▶ Individual (online) processing power
 - ▶ ROOT-tree with scalar fed to EPICS
 - ▶ Higher integration with VXD preferred? → To be discussed

Schedule



■ PLUME-2 option

- Mechanical support demonstrator for June 2015 B2GM
- Full system ready by Q1-2016
 - Includes DAQ but not online monitoring

■ PLUME-3 option

- Sensor validation: Q4-2015
- Identical aspects / PLUME-2
 - Mechanical support
 - Cooling requirement
 - Cabling
 - DAQ
- Ladder(s) production: Q1-2016
 - Re-use of PLUME-2 robot
- Intermediate boards adaptation: Q2-2016
 - Probably include validation beam-test
- Full system ready by Q3-2016

■ Online monitoring / analysis

- Needs organization here for common effort & goals
- Work during 2015-16

Questions



- Radiation level in Belle II
 - Is it taking into account injection noise?

 - Cooling in VXD volume
 - Still nitrogen at -10°C with moderate speed ~ 1 m/s ?

 - Added value for PLUME-DAQ to be integrated in Belle-II-DAQ?

 - Charged particle momentum to track
 - Background concentrated at $p_T \lesssim \text{few MeV}/c \rightarrow$ un-trackable?

 - Synchrotron background
 - Impact of direct photons VS secondaries
 - Difference in BEAST-2 and Belle-II?
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