Pixel Detectors in China: Status and Prospects

XinChou Lou

Experimental Physics Division

IHEP, Beijing

June 1, 2012

Outline

- Interests in Pixel Detectors &
  Institutes and University Groups in China
- Current Activities
- Plans and Prospects

Institutes and Interests

IHEP — Sensors, ASIC, system and operation

Atlas Pixel Upgrade, CMS Pixel upgrades, BESIII upgrade

detector-monitor for synchrotron light sources

University of Science and Technology of China (USTC)

ASIC Atlas

Tsinghua University

LHCb

Central Chinese Normal University (CCNU)

Sensor, system, R&D

No specific HEP experiment association

Shandong University

ASIC design, DAQ

Atlas

Beijing Microelectronics Institute

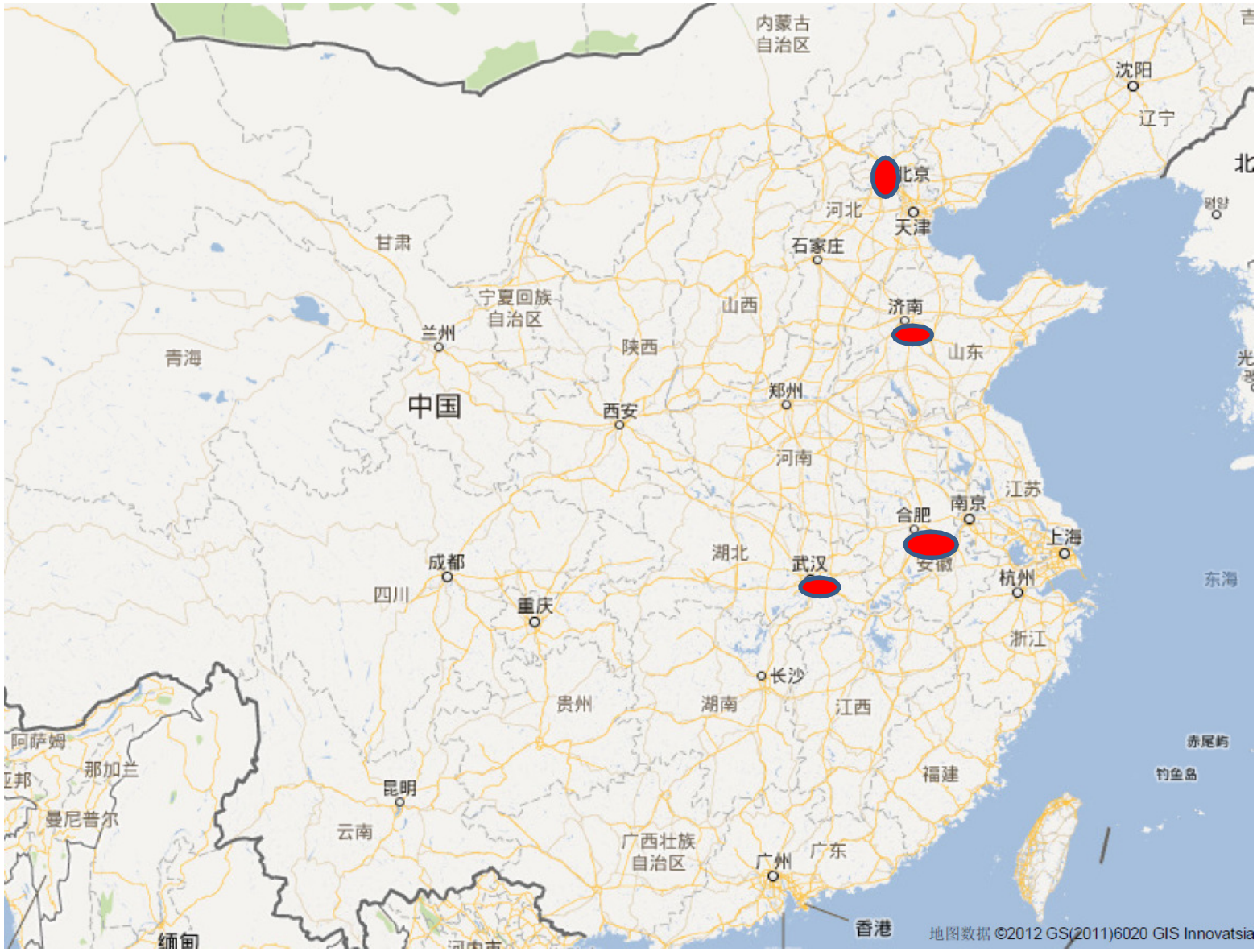
Sensors

"sparse activities"

"uncoordinated"

"need infrastructure"

Institutes and Interests



Informal Meeting on Pixel-Silicon Detectors in China

April 7 – 8, 2012
Meeting Room B410
Institute of High Energy Physics, Beijing

9:00 – 12:00 Current Activities, Plan and Applications with Pixel/silicon Detectors

清华	Dr. Yuanning Gao
山东大学	Dr. Meng Wang
华中师大/LBL	Dr. Xiangming Sun
SMU	Dr. Jingbo Ye
IPHC/IN2P3	Dr. Christine Hu
中科大	Dr. Zhengguo Zhao
高能所	Dr. Qun Ouyang

Session II: Semiconductor Detector Facilities and Infrastructure in China
14:00 – 14:45

高能所	Dr. Yunpeng Lu

14:45 – 15:00 Coffee/Tea Break

Session III: Chip Design and Microelectronics
15:00 – 17:30

中科院微电子研究所	Dr. Huaxiang Yin
华中师大/LBL	Dr. Xiangming Sun
CMOS Pixel Sensors at IPHC & IN2P3/CNRS-ULP	Dr. Christine Hu
ASIC Design at IHEP	Dr. Zheng Wang

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Session IV: Detector and Instrumentation R&D Examples & Discussion
8:30 – 10:00

	CERN RD50, RD51 Collaborations	Dr. Zhengguo Zhao
	Atlas Pixel Detector Upgrade	Dr. Xinchou Lou
	Questions and Anwers	all

10:00 – 10:15 Coffee/Tea Break

Session IV: Open Discussion
10:15 – 12:00

To develop the pixel/silicon detectors in China

- Missing expertise?
- How do we establish a central facility for users in China?
- Test facility – stand along, combined; test beams?
- Do we have a target or real applications?
- Resources
- Other items

Session VI: How Can We Develop Capability with Pixel-silicon Detectors in China?
1:30 – 3:30 pm

Plan and Action Items for Near Future

Institutes and Interests

Pixel-Silicon Detector Survey of Interests

- Simulation
  徐唯唯， 王萌（SDU）， 秦中华（IHEP）， 卢云鹏（IHEP）
- Sensor: design, sensitivity, irradiations and radiation hardness, noise level, timing,
  董明义， 修青磊， 孙向明（CCNU）， 王萌（SDU）， 郭超英，秦中华，王玉光（IME）， 殷华湘（IME），刘剑（SDU），卢云鹏（IHEP）， 欧阳群（IHEP）， 洪才洁
- Flex front-end and off-the-detector readout electronics
  余琳， 盛华义， 叶竞波（SMU），郭超英，蒋小山 Xiaoshan Jiang（IHEP）王铮（IHEP）， 黄光明（CCNU）
- DAQ
  王铮（IHEP），洪才洁，肖亮， 刘震安 TDAQ（IHEP），叶竞波（SMU）
- Cooling, heating
- Service panels (connection for electrical, optical and cooling services)
- Slow control
- Online monitoring
- Offline calibration, alignment
- Standalone test-beam setup: telescope
  秦中华（IHEP）
- Other

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Consensus from this workshop

- Establish the central pixel detector infrastructure at IHEP
  within National Key Lab for Nuclear Detection and Electronics
- Bring in expertize by hiring physicists and engineers with pixel experience
- Bring in expertize by hosting visitors and by collaborating with institutes with strong pixel programs
  CPPM, KEK, LBL, …, FNAL, Univ. of Chicago
- Participation in pixel detector upgrade projects
  Atlas, CMS, LHCb
- Possible BESIII pixel insertable layers

Will meet again end of the year

Current Activities

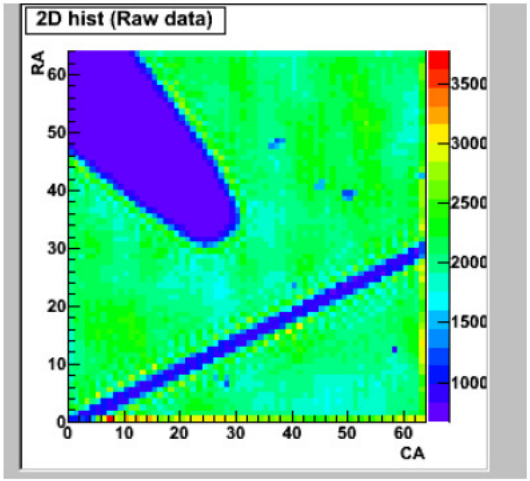
- ASIC design, prototyping for Atlas Pixel Upgrade
  See Wei Wei's presentation
- Sensor design, testing, clean room, apparatus
  Yunpeng Lu has presented
- Simulation
- Atlas pixel detector upgrade in Phase 2; CMS pixel upgrade

Current Activities

SOI Pixel Detector

Red Light Imaging of small objects

- The tip of a pin and 30um golden wire.
- The saw-teeth is a proof of good response to light.
  - 20um*20um pixel.



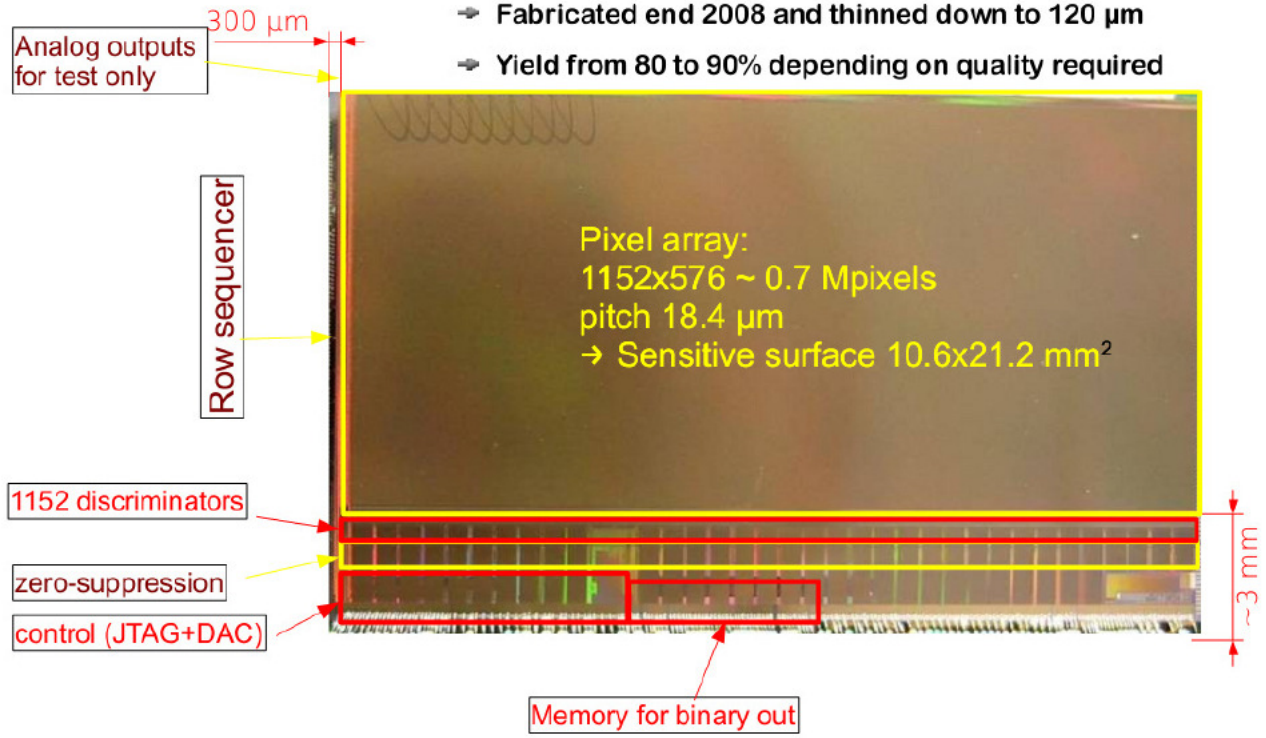
Yunpeng Lu, IHEP

Current Activities

MAPS

Mimosa-26 Sensor Structure

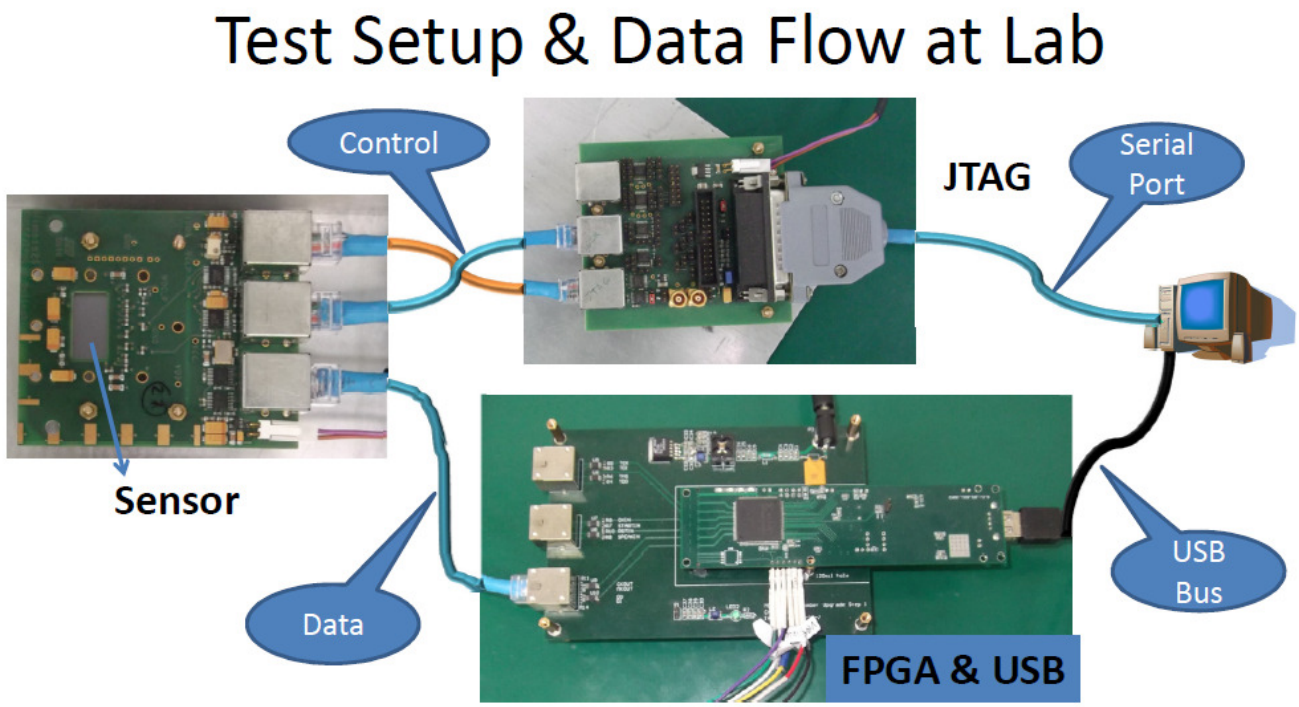
- TC / MIMOSA 26 ~ 10x MIMOSA 22 + 18x SUZE 01
  - Process AMS 0.35 µm OPTO
  - Fabricated end 2008 and thinned down to 120 µm
  - Yield from 80 to 90% depending on quality required



Qin Zhonghua, IHEP

Current Activities

MAPS

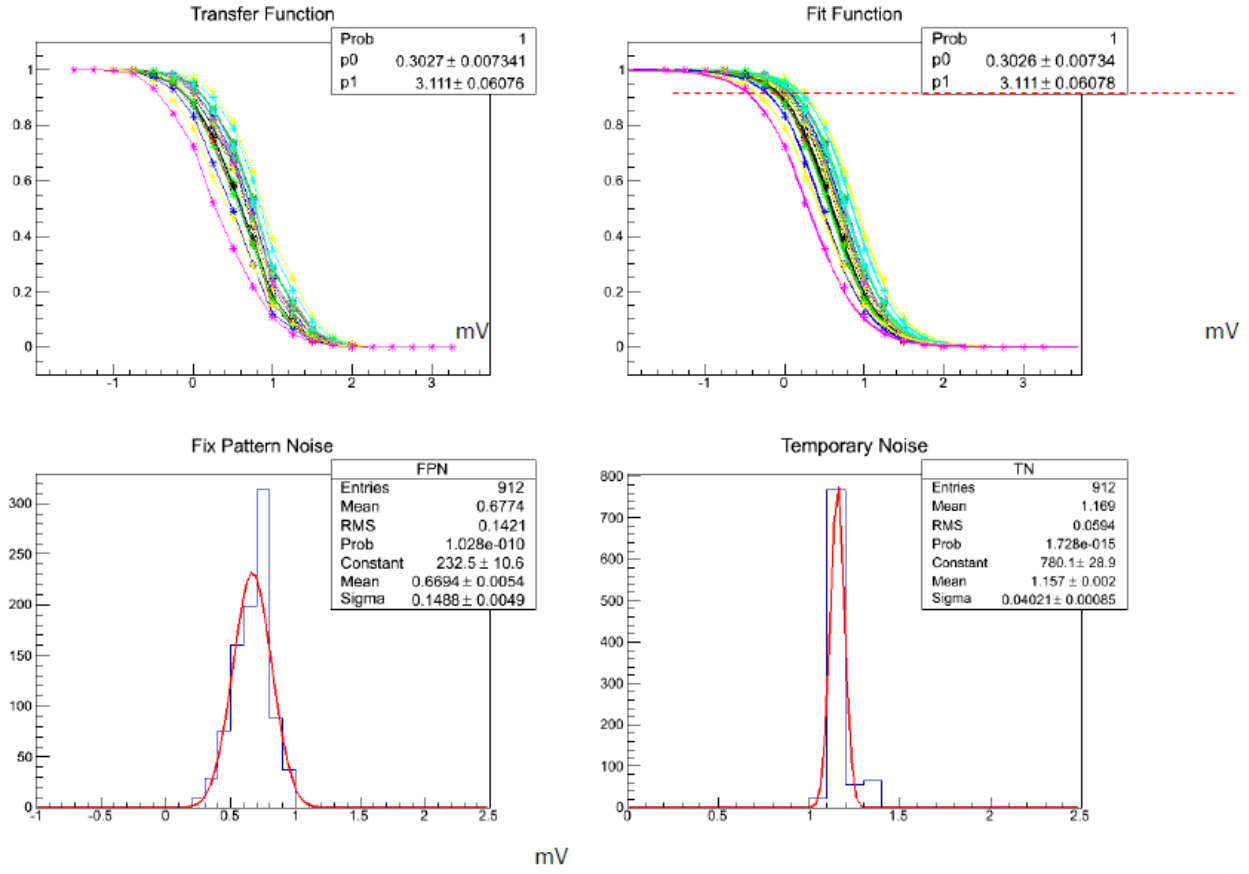


Qin Zhonghua, IHEP

Current Activities

MAPS

Transfer function and noise of the sensor

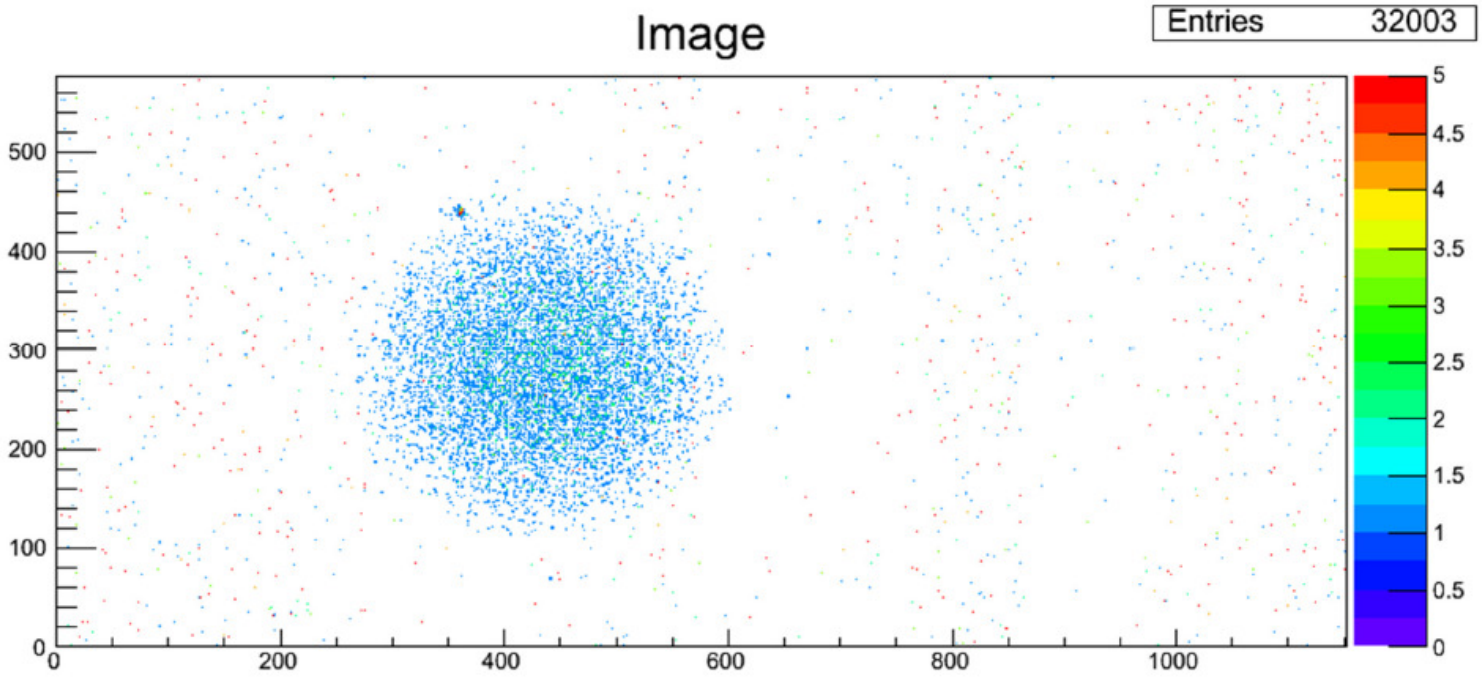


Qin Zhonghua, IHEP

Current Activities

MAPS

Image of a hole with X-Ray (^{55}Fe)



Qin Zhonghua, IHEP

June 1, 2012

Current Activities

MAPS

- “A first try of the silicon pixel sensor and gained a lot.”
- “The sensor works well with our test system”
- “Basic tests of the sensor have been done and some meaningful results are obtained.”
- “The DAQ system is homemade at IHEP”
- “More tests are undergoing.”

Qin Zhonghua, IHEP

Plans and Prospects

Strategy for Chinese participation in the Atlas pixel upgrades – ideas

IBL

- join major players at 1 or more institutes, choose groups based on expertize and applications in the domestic Chinese experiments
- Commission and operation of the Atlas pixel detector at CERN

Pixel Detector Upgrade ~2018 (or 2020)

- Take on a major task which will enable IHEP to gain critical expertize
- Build local infrastructure at IHEP for standalone test and assembly setup
- Build a telescope system for details study of the pixel detector system with sources & test beams
- Establish a team of designers, pixel experts and lab infrastructure
- Delivery on Atlas commitment, and limited other major undertakings

Backup slides

Stage II: High Luminosity LHC Upgrade

ATLAS Shutdown 2018 (or 2020)- Draft Phase-I Shutdown:

It is the topic of a Letter of Intent being prepared by ATLAS to give the scope and anticipated budgetary envelope for the period up to the end of 2018 (or ~2020)

Up to and during the Phase-I shutdown, a number of potential projects have been proposed in ATLAS that could be necessary or beneficial for operation beyond instantaneous luminosities of 1034cm-2s-1. All of these programmes require activities starting rather urgently.

“The non-IBL layers of the pixel system would clearly benefit from employing the technology used for the IBL and from the higher granularity, lower mass and high radiation tolerance. Although the IBL layers are designed to withstand up to Phase-II, the design allows the other layers to be replaced in a way that could be compatible with Phase-II operation and bring the benefits for vertexing already for the majority of data collected before HL-LHC.”

Experience at LBL years ago very relevant to IHEP/China

Comments on LBL and Instrumentation Development

- Development and construction of ATLAS pixel detector involves more than 100 dedicated scientists and engineers from Bonn, Dortmund, Genova, Marseille, Milano, Prague, Siegen, Udine, Wuppertal, as well as New Mexico, Ohio, Oklahoma, and of course LBL.
- After spending more than 10 years on the development of the ATLAS pixel tracker, with LBL playing a leading intellectual role in most areas, offer reflections:
- Development of "beyond state-of-the-art" instrumentation relies on tightly integrated teams of scientists and engineers, something that LBL is uniquely good at.
- Pixel electronics chain required team of several IC designers plus board level designers, over 10 years, constantly following technology developments. After working this long on one problem, much specialized knowledge is developed.
- Major failure of LBL in this respect is to treat instrumentation of this type seriously at the highest levels in the lab, in order to create a strong intellectual center, and build an atmosphere to train and retain the best people in diverse technical areas.
- We achieve sporadic success, but hard to keep momentum and generate synergy across broad areas of instrumentation. Much ATLAS experience already lost.
- Success requires a certain continuity in projects and funding that is very difficult to achieve in highly project-oriented DoE environment. Lab Director can help !!!
- Convinced that this type of sophisticated instrumentation, suitably targeted at many other science communities at LBL/UCB can have a revolutionary impact.