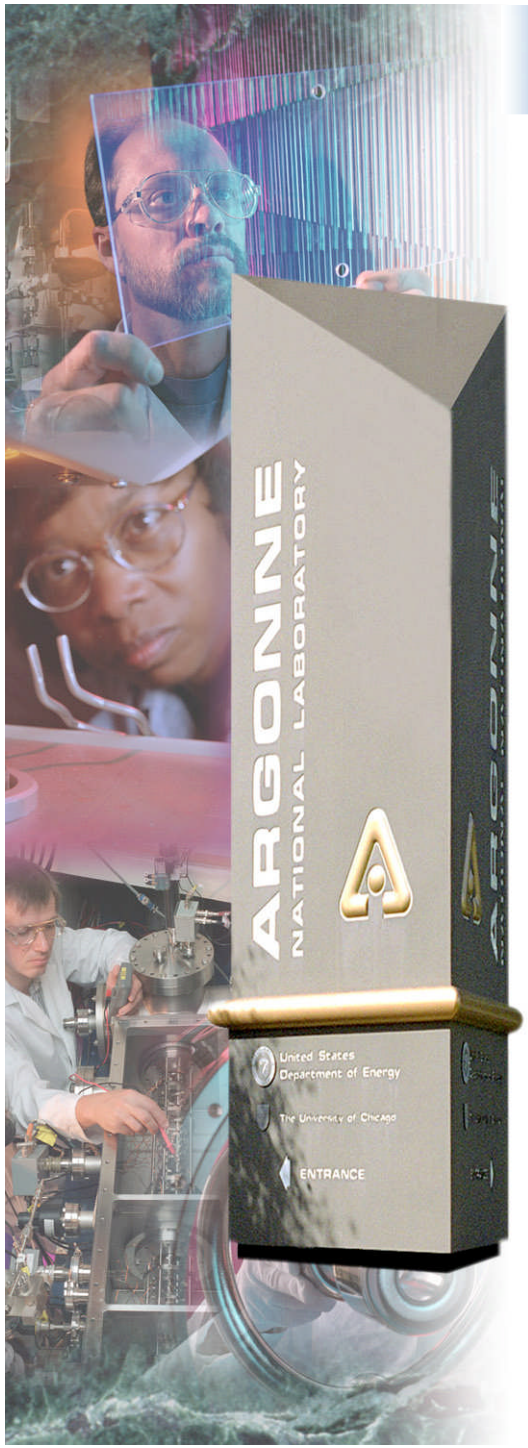

ARGONNE NATIONAL LABORATORY

SRI 2005 Detector Workshop Summary

Patricia Fernandez, AOD-EOS

APS/Users Operations Monthly Meeting

December 14, 2005

THE UNIVERSITY OF CHICAGO

Office of Science
U.S. DEPARTMENT OF ENERGY

Argonne National Laboratory is managed by
The University of Chicago for the U.S. Department of Energy

SRI 2005 Satellite Workshop on Detectors

- Originally scheduled to be held at Baton Rouge on September 19 and 20, 2005. Held at the APS on December 8 and 9, 2005.
- Attended by ~ 70 researchers from the US, Canada, Australia, and Europe. Representatives from industry were also present.

Workshop Objectives

- To assess recent detector developments, both in the U.S. and abroad, in order to identify detector research opportunities that would enhance research capabilities at U.S. synchrotron radiation sources.
- To examine detector technologies, both short-term and long-term, and suggest a strategy to insure that the U.S. researchers are competitive, and remain so, in SR-based science.
- To acquaint young scientists with the present state-of-the-art in detector research and to convey exciting possibilities for the future.
- To document the conclusions of the workshop as an aid to future planning.

Organizing Committee

Chairman

Al Thompson (Lawrence Berkeley Lab)

Workshop Committee Members

Sol M. Gruner (Cornell University)
John Arthur (Stanford)
Dennis M. Mills (APS)
John D. Scott (CAMD)
Edwin Westbrook (LBNL)
Peter Siddons (BNL)
Howard Padmore (LBNL)
Ralf Wehlitz (SRC)

Program – Day 1

Thursday, December 8, 2005

Introduction

8:20 am Welcome and Workshop Logistics – *Dennis Mills, APS*

8:30 am Program Introduction and Goals of Workshop – *Al Thompson, LBNL*

Detector Requirements *(Session Chairman – Al Thompson)*

9:00 am Detector Needs and Plans for X-ray Science – *Heinz Graafsma, ESRF*

9:45 am Detector Needs and Plans for FEL Science – *Jerry Hastings, SSRL*

10:30 am Coffee break

11:00 am Detector Needs and Plans for SoftXR/VUV/IR Science – *Howard Padmore, ALS*

11:45 am Overview of Detector Research for SR Science in Europe – *Gareth Derbyshire, Diamond*

Imaging Detectors *(Session Chairman – Denny Mills)*

1:30 pm Analog Pixel Detectors – *Sol Gruner, CHESS*

2:15 pm Drift Detectors for Imaging – *Lothar Strueder, MPI*

3:00 pm Coffee Break

3:45 pm 3D Active Area Pixel Detectors – *Ed Westbrook, MBC*

4:30 pm Charge Coupled Devices – *Peter Denes, LBNL*

5:15 pm Poster Session (Fifth Floor Gallery)

Program – Day 2

Friday, December 9, 2005

Superconducting Detectors *(Session Chairman – Sol Gruner)*

9:00 am Bolometer Arrays for High Resolution Spectroscopy – *Kent Irwin, NIST*

9:45 am High-resolution Superconducting Tunnel Junction Detectors – *Stephan Friedrich, LLNL*

10:15 am Coffee Break

What we can learn from High Energy Physics

10:45 am ATLAS Detectors – *Maurice Garcia-Sciveres, LBNL*

11:30 am MAPS Detectors – *Grzegorz Deptuch, BNL*

Other Technology *(Session Chairman – Al Thompson)*

1:15 pm Si Arrays for Spectroscopy / Diffraction – *Peter Siddons, NSLS*

1:45 pm Channelplate Based Detectors – *Oswald Siegmund, SSL*

2:15 pm Coffee Break

Roundtable Discussion and Summary

2:45 pm Discussion and Report Writing

4:00 pm Adjourn

Detector Requirements

- H. Graafsma described plans for detector development in Europe: parallel readout CCDs; counting PADs; Active Pixel Sensor detectors; Si drift diode arrays; and APD arrays.
- P. Siddons presented J. Hastings talk on detectors being planned for the LCLS: low noise pixel detectors, 120 frames/sec for 6-12 keV; streak cameras; soft x-ray imaging detectors.
- H. Padmore talked about requirements for VUV and soft x-ray detectors for fluorescence spectroscopy and coherent x-ray diffraction microscopy.
- G. Derbyshire detailed the roadmap for detector development in the UK (www.srs.ac.uk/srs/publications2.html) and the recently established European collaboration on PADs. Commissioning an industrial bump bonder.

Imaging Detectors

- S. Gruner described his work on analog pixel detectors for time-resolved radiography, XFEL applications, and low-contrast imaging.
- L. Strüder, MPI Semiconductor Lab – Work on silicon drift diode arrays and pn-CCD detectors, for astronomy, particle physics, and medical imaging applications.
- E. Westbrook presented his work on 3D pixel detectors for macromolecular crystallography: active edges allow tiling many smaller pixel array modules without dead areas.
- P. Denes – (almost) Parallel readout CCD detectors: extrapolation of well-established CCD technology, capable of 200 frames/sec. Can be used in microdiffraction; can be tiled for PX applications.

Superconducting Detectors

- K. Irwin, NIST – Superconducting bolometer (microcalorimeter) capable of 2.4 eV resolution at 5.9 keV. Currently developing bolometer arrays, including multiplexed semiconductor electronics. Applications in x-ray astronomy and materials analysis. Also developing thin-film refrigerator cooling from 300 mK to 100 mK. (qdev.boulder.nist.gov)
- S. Friedrich, LLNL – STJs operate at T ~ 400 mK, easier to implement than bolometer. Nb-Al STJ x-ray spectrometer in routine use at ALS, well matched for x-ray absorption spectroscopy applications. Presented roadmap for the development of Ta-Al STJ arrays.

Other Technology

- P. Siddons – Multi-channel silicon detectors: Si sensor bonded, via long wires, to a low-noise, 32-channel ASIC. The ASIC controller implements EPICS, allowing straightforward beam line integration. These detectors can be used for spectroscopy and diffraction applications.
- O. Siegmund, Space Sciences Lab, UC Berkeley – MCP detectors, 200 mm by 100 mm with 20 um resolution, for x-ray spectroscopy. Future: GaN and diamond photocathodes for improved QE; use Medipix ASIC for significantly faster readout.

Discussion and Summary

General remarks

- In many instances, cutting-edge science at SR facilities is limited by the available detectors, not by the x-ray flux.
- There is no universal detector. Generic detectors are always a compromise.
- Using only commercially available items is shortsighted.

Funding issues

- Need for a clear detector development roadmap, with strong scientific drivers and facility management support, to present to funding agencies.
- Scientific users of SR facilities have to strongly endorse the roadmap and present the science case to the funding agencies.
- The roadmap should discuss what can be done now, in 5 years, in 10 years, and what are the resources needed and risks assumed in each case.
- Drivers for detector development can also include ease of use, throughput increase, and cost/benefit analysis.
- SR community should set priorities for funding development, not try to do all for all people: agree on a few projects and push them forward through completion.
- Detector development should be facility funded.
- Need streamlined process for sizable funding of demonstration projects (high cost of foundry runs and bump bonding process).

Discussion and Summary – continued

Technical issues

- Move from integrating to counting detectors to improve S/N.
- Push for new materials: CdZnTe, GaAs, diamond.
- Detectors that fully exploit the time resolved domain should be developed ASAP.
- Reliable bump bonding capabilities available to detector scientists would be a big plus. A small facility could be fully utilized by the SR detector development community. High pitch, high density process is required.
- Must do onboard processing to reduce data rate (large imaging arrays at 100-1000 fps).
- Collaboration can overcome technical problems.

Production and commercialization issues

- Commercialization of detector development projects is a laborious process for both sides. Alternative: make resources available for developers to produce units for other facilities.
- Detector development has to be carried through to the end, a final working product that can be easily integrated into the beam lines has to be delivered. Fully characterizing a newly developed detector is not a trivial matter, but it has to be done if the detector is to make a successful transition to production and routine use.

Discussion and Summary – continued

Summary

- Workshop organizers will draft report and will update the white paper produced at the 2000 workshop.
- Workshop presentations will be posted:

www.aps.anl.gov/News/Conferences/2005/Synchrotron_Radiation_Instrumentation/index.htm