



UNIVERSITY OF

LIVERPOOL

LCUK Silicon work status update

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Outline

Brief update status of UK Tracker R&D plans.

Status update on:

- Layout, mechanics and alignment (work, plans & ideas)
- Sensor work: CMOS/MAPS, hybrid HV-CMOS and HV-MAPS

Focussed on most recent activities.

(Thanks to Aidan Robson and Georg Viehhauser for useful inputs)

LC detector related activities in the UK

Longstanding involvement UK groups with different aspects of worldwide LC programme (detectors, physics, simulation, ..).

We secured 2 years of (travel) funding to (re)build a stronger involvement with detector R&D for a linear collider.

Most of actual work is still unfunded and done with very small effort or in some cases by benefitting from the work done for other projects.

Institutes have recently submitted 3-4 year grant proposals to STFC, asking for a few FTE (across institutes) dedicated to LC work.

Add to this with studentships, academic effort, etc...

LC Tracking related activities in the UK

UK groups identified a common interest in pursuing a CMOS pixel tracker.

We have started regular meetings in the UK (chaired by Joel Goldstein).

Focus for now mostly on

- Simulation (Glasgow)
- (HV-)CMOS sensor R&D (RAL, OU, Liverpool, Glasgow, Oxford, ..)
- Interest in mechanics, cooling, .. (Oxford, Liverpool, Bristol) and alignment requirements (Oxford)

The groups involved jointly bring strong expertise / infrastructure from

- *major build programmes for LHC and HL-LHC on both strips and pixels (sensors, hybrids, mechanics, alignment,..)*
- *active R&D programmes in planar silicon, MAPS devices and more recently HV-CMOS (hybrid and standalone)*

A pixel tracker for the ILC

SPT proposal: UK proposed already in 2008 a “Gigapixel” silicon tracker (layout similar to SiD).

- ~70 m² silicon area
- with separate tracking and timing layers
- SiC foam support ladders

Physics case:

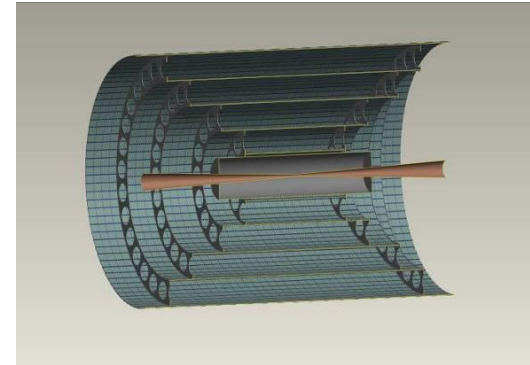
Obvious advantages in resolution and pattern recognition (compared to strips), which need to be balanced with implications in terms of timing, material, cooling, etc..

Dependent on the chosen technology and solution for cooling, mechanics etc

Extensive simulation work needed to guide choice between proposed layout, mechanics and technology solution.

Effort dedicated to this in Glasgow starting from SiD model.

Rest of slides on sensor R&D and some mechanics



CMOS programme UK

Long involvement MAPS (RAL, OU, Oxford, Glasgow)

Continued development MAPS sensors including use of HR substrates (submission soon)

TCAD work TowerJazz HR-CMOS sensors (Glasgow, ..)

AIDA202 Support for TCAD work (Glasgow, RAL)

Broad R&D started in HV-CMOS (both hybrid and standalone sensors)

Sensor design work (Liverpool, KIT, Geneva)

- Next few weeks submission of AMS350 pixel demonstrator, including standalone (HV-MAPS) pixels
- Further submission plans this year with AMS350, Lfoundry(?), AMS180
- hybrid macro-pixel devices with routing in metal layers (e.g. 50x1000 um pixel)
- AMS180 ATLAS pixels (interested to contribute to design CLIC device if this were included, talk Ivan Peric tomorrow)
- Pursue HV-MAPS devices with improved timing (in collaboration with Ivan Peric)

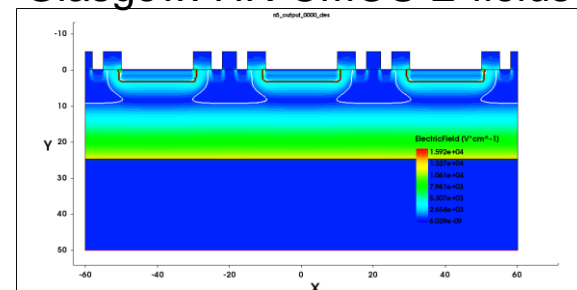
Extensive TCAD effort towards device optimization

(Liverpool, CERN, Geneva, Paris, Bonn)

- AMS350(180) Pixel demonstrator (talk Matthew Buckland)

Support for HV/HR-CMOS prototyping through AIDA2020 (Liverpool, Glasgow, RAL)

Glasgow: HR-CMOS E-fields



HV-CMOS 50x150 um pixel (AMS350)



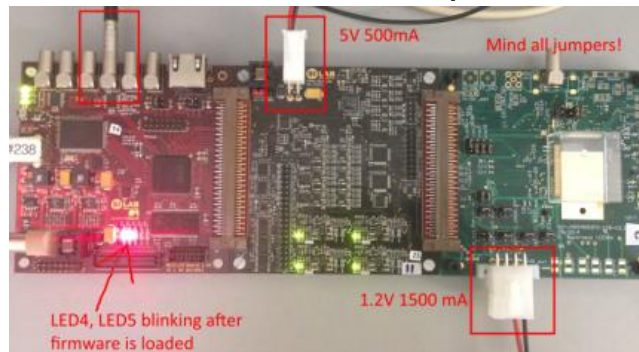
CMOS programme UK (continued)

Active participation in ATLAS-wide HV-CMOS strip (Glasgow, Oxford) and pixel (Glasgow, Liverpool) programmes, focussed on characterisation and hybridisation.

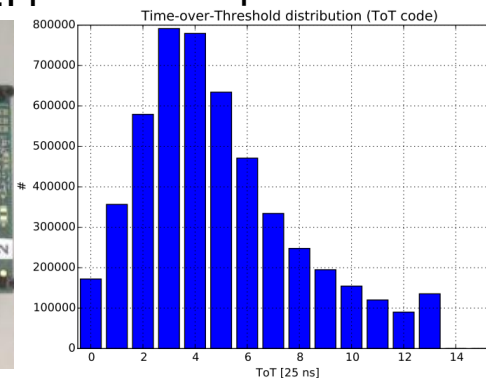
Characterisation: in laboratory, with source, x-ray and testbeams (Glasgow, Liverpool, Oxford)

- pixel devices based on FEI4 and CLICPix
- strip devices

Readout CCPD AC coupled to FEI4



Sr90 spectrum



Hybridisation

- AIDA2020 “WP6: HV-CMOS hybridisation” sub-project led by Liverpool to explore AC coupled die bonding techniques. (Details to be decided this week)
- Work on devices with TSV’s (Glasgow)

Mechanics

Lot of work done in UK on ladders for ATLAS ITK strip upgrade. Particular focus has been on integration of cooling and services with mechanical supports to minimise mass of final structure.

- CF/honeycomb structures with carbon foam (Allcomp) cooling channels with embedded thin-wall Ti tubes
- Kapton/Cu flex circuits co-cured with CF skin

Keen Interest in studying solutions for LC tracker mechanics and cooling (Oxford, Liverpool, Bristol)

AIDA2020 support for development micro-channel cooling (Oxford participates)

AIDA2020 “WP9: support structures” sub-project led by Oxford/CSIC-IFIC (co-participants Liverpool) Aimed at developing and making available various tools for qualification of the thermo-mechanical performance and metrology of low mass support structures. (More details this week.)

Big challenge for LC tracker is stability of large mechanical structure with very low mass vis-à-vis the alignment requirements. (Oxford)

cu/kapton tapes
co-cured with CF
skin (Oxford)



Summary

UK groups have started to (re)build a LC R&D

Modest STFC funding, but it means IC work is on the future roadmap and help to coordinate our efforts.

We try to add funding and effort through other routes (generic R&D, AIDA2020, studentships,..)

Interest in work on CMOS pixel tracker

- Simulation work for layout studies
- Sensor R&D pursuing MAPS and HV-CMOS.
- Strong interest in Mechanics and alignment of such a tracker.