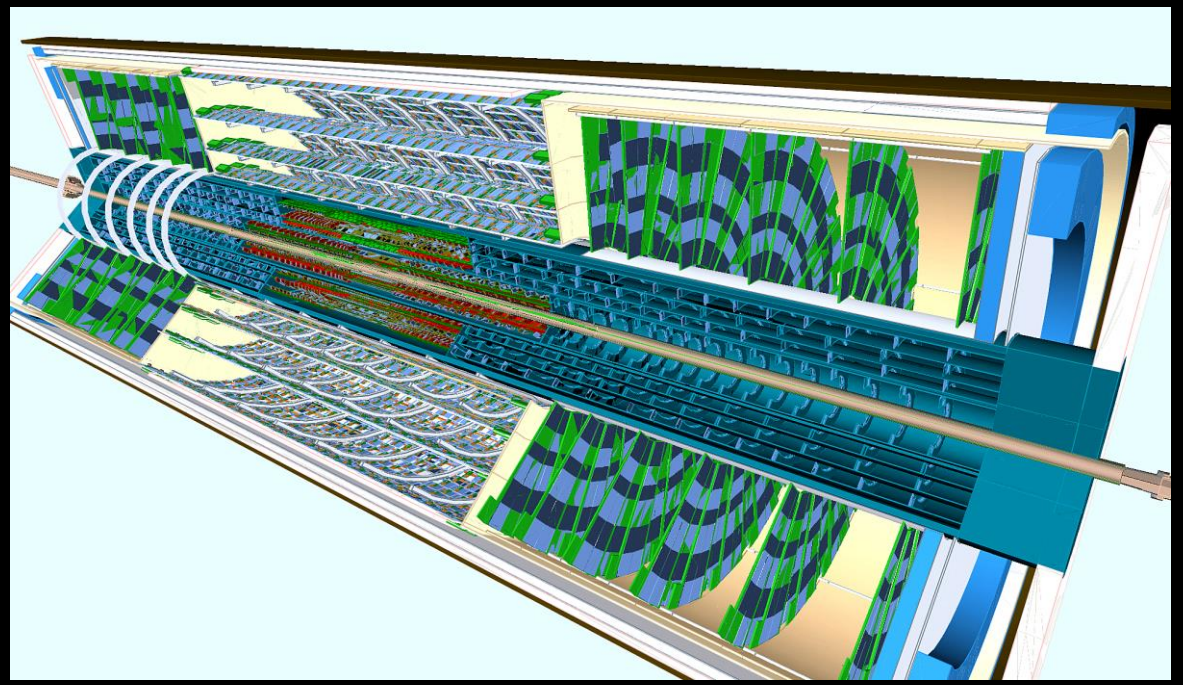
What next ?



D. Bortoletto

University of Oxford

Cosener's House Meeting

March 2016

UK community meeting on C | JHEP04(2016)126.pdf

https://indico.cern.ch/event/477242/overview

Public | Europe/London | D. Bortoletto

UK community meeting on CMOS sensors for particle tracking

10 March 2016
Cosener's House
Europe/London timezone

Search...

- Overview
- Timetable
- Contribution List
- My Conference
  - My Contributions
- Registration
- Participant List
- Travel and Accommodation

The UK has a long involvement in the development of the Silicon sensor technologies for position sensitive charged-particle detection. Devices have been produced for the tracking detectors in a range of previous, existing and future experiments as well as for a possible future application in particle flow calorimetry. CMOS technology, because of the high level of integration it allows and its relative cost-effectiveness compared to other Silicon based technologies, is today widely expected to become the baseline technology for future Silicon detectors. Several groups in the UK now work on the development of CMOS technologies for both future tracking and calorimetry applications.

It is perceived that for the UK to play as significant a role in the development of CMOS sensors for future experiments as it has done for other Silicon technologies, UK groups need to present a joined-up strategy to STFC and persuade it to identify CMOS as a key technology area for the future of our field.

We are organising this one day meeting for the wider particle physics community to discuss its requirements ambitions and to start discussions on how to shape a more joined-up approach. The meeting will also attempt to present an overview of the CMOS technology options and applications that are being pursued.

	HR-CMOS MAPS (15+5) — *Renato Turchetta* — Cosener's House — 09:20 - 09:40	
	HV-CMOS (15+5) — *Eva Vilella Figueras* — Cosener's House — 09:40 - 10:00	
10:00	**Hybrid CMOS strip detectors (15+5)** — *Jens Dopke et al.* — Cosener's House — 10:00 - 10:20	
	Hybrid CMOS pixel detectors (15+5) — *Richard Bates* — Cosener's House — 10:20 - 10:40	
	tea & coffee — Cosener's House — 10:40 - 11:00	
11:00	**CMOS in ALICE/STAR (15+5)** — *Petra Riedler* — Cosener's House — 11:00 - 11:20	
	The Mupix CMOS tracker for Mu3e (15+5) — *Heiko Christian Augustin* — Cosener's House — 11:20 - 11:40	
	CMOS in hh colliders (15+5) — *Philip Patrick Allport* — Cosener's House — 11:40 - 12:00	
12:00	**MAPS for calorimetry in e+e- (15+5)** — *Alasdair Winter et al.* — Cosener's House — 12:00 - 12:20	
	ARIADNE: camera readout for liquid or bi-phase Argon detectors (12+3) — *k Mavrokoridis* — Cosener's House — 12:20 - 12:35	
	• **CMOS for tracking in ILC/CLICdp (15+5)** — *Joel Goldstein* — Cosener's House — 13:30 - 13:50	
14:00	• **RD50 and industrial contacts (15+5)** — *Gianluigi Casse* — Cosener's House — 13:50 - 14:10	
	CMOS applications for charged particle detection (nuclear/mass spectroscopy/medical) (15+5) — *Daniel Muenstermann* — Cosener's House — 14:10 - 14:30	
	CMOS applications for photon detection (x-rays/photon/astronomy) (15+5) — *Andrew Blue* — Cosener's House — 14:30 - 14:50	
15:00	**tea & coffee** — Cosener's House — 14:50 - 15:10	
	Discussion — *Prof. Daniela Bortoletto et al.* — Cosener's House — 15:10 - 16:30	
16:00		

Statement to PPAP

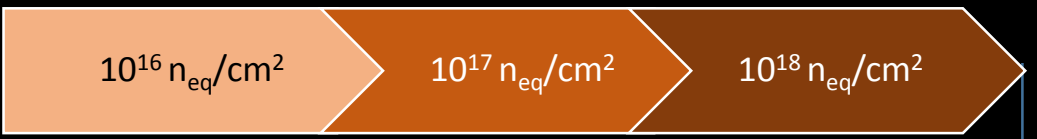
October 2016
11 Universities +
STFC TD and PP

R&D on High Granularity HV/HR-CMOS Detectors for Future Experiments.[1]

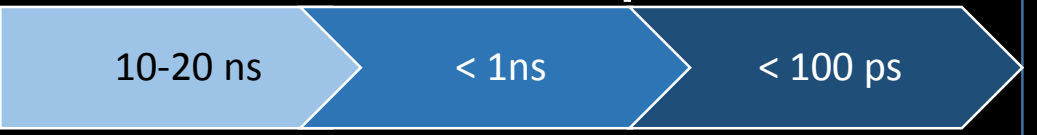
Philip Allport [a], Adrian Bevan [b], Daniela Bortoletto [c], Craig Buttar [d], Neil Geddes [e], Daniel Muenstermann [f], Yvonne Peters [g], Konstantin Stefanov [h], Jaap Velthuis [i], Trevor Vickey [j], Joost Vossebeld [k], Fergus Wilson [l], Akram Khan [m]

a) contact person representing University of Birmingham
b) contact person representing Queen Mary University London
c) contact person representing University of Oxford
d) contact person representing University of Glasgow
e) contact person representing STFC Technology Department
f) contact person representing Lancaster University
g) contact person representing The University of Manchester
h) contact person representing The Open University
i) contact person representing University of Bristol
j) contact person representing The University of Sheffield
k) contact person representing University of Liverpool
l) contact person representing STFC Particle Physics Department
m) contact person representing Brunel University London

Case for enhanced CMOS Technologies



Radiation Tolerance Requirements



Timing Resolution Requirements

Pixel Size Requirements

Device Thickness

Detector array area

Daniela Bortoletto

Technology Driver / Target Application	Pixel Size (Granularity)	Pixel Size (Resolution)	Radiation Hardness	Timing Resolution	Radiation Length	Collection Thinness	Large Area (Cost)
HL-LHC Vertex			Outer radii				
HL-LHC Tracker	Position encoding						
LHCb phase 3 vertex				Vertex timing			
Future hh Vertex							
Future hh Tracker							
Future hh HG ECAL	Count hit pixels	Pre-shower cells smaller				Match to pitch	
Proton EDM							
Future e-h							
Nuclear Physics including HI							
e^+e^- Vertex (ILC/circular)			Higher for Circular	TS (ILC)			
e^+e^- Vertex (CLIC)				Time Stamp (TS)			
e^+e^- Tracker (ILC/circular)				TS (ILC)			
e^+e^- Tracker (CLIC)				Time Stamp (TS)			
e^+e^- HG ECAL						Match to pitch	
cLVF rare muon decays (Mu3e)		Scattering dominated		Vertex timing			
Hadron Therapy	>10^{10} tracks/s	Scattering dominated		>10^{10} tracks/s			

Statement to PPAP

- A long-term, consistent funding is key to a successful development program to:
  - enable regular submissions of prototype designs for evaluation
  - develop lasting relationships with foundries to access their expertise and commercially-restricted information
  - establish a core team of designers exclusively engaged in this technology.
- Funding for training and PhD programmes would be highly desirable as the development of these skills in the youngest members of our community is central to the future.

Statement Of Interest

March 2017
11 Universities +
STFC TD and PP

Statement of Interest in the Development of an STFC Strategic Investment in R&D on Depleted Monolithic Active Pixel Sensor (DMAPS) Technologies

*This SoI follows the document "**R&D on High Granularity HV/HR-CMOS Detectors for Future Experiments**" submitted to the July 2016 meeting of the PPAP and signed by representatives of the Universities of Birmingham, Bristol, Brunel, Glasgow, Lancaster, Liverpool, Manchester, Oxford, Sheffield, Queen Mary University London, The Open University, STFC Particle Physics Department and STFC Technology Department*

SOI

- Create a UK consortium on the Development of HV/HR-CMOS to:
  - Develop strategic and enabling technologies for all STFC's research areas
  - Provide a focus for collaboration with industry to
    - Develop commercial products and applications that would stimulate economic growth
    - Address global challenges
    - Build UK industrial capabilities.
  - Train the next generation of experts
- Requires multi-year funding model, similar to that used successfully to support UK accelerator and distributed computing R&D, at the level about £1.8M/year:
  - £1.5M/year for processing, designers, and device evaluation
  - £0.1M/year for project students
  - £0.06M/year for read-out and equipment
  - £0.1 M/year for travel and conference organization

SOI Organization

- WP1: system integration
  - powering, including bias blocks and regulators
  - common I/O blocks for high bandwidth data transfer
  - common front end board development
- WP2: large areas at low cost
  - Yield improvement, stitching and edge minimization
- WP3: device simulation with development of a common tool-kit.
- WP4: development of sensors optimized for position measurement in high rate/dose environments with high granularity and accurate timing
- WP5: development of large area position and energy measurement with fixed collection depth for uniformity of response with angle and radiation
- WP6: development of sensors with ultra-low noise, high dynamic range.
- WP7: conferences, training, dissemination of expertise, international connections and industrial links

STFC Industrial Strategy Fund Studentships

- Requested 9 PhDs (*Birmingham, Bristol, Lancaster, Liverpool, Oxford, Swansea, UCL, STFC-PPD, STFC-TD)*:
  - Design of new radiation-hard CMOS sensors for precision beam profiling and dosimetry for application at new hadron therapy facilities being built in the UK
  - Simulation and evaluation of HV-CMOS sensors
  - Development of a very accurate, MAPS based dosimetry system for MR-linacs.
  - Dosimetry using MAPS system in MR-linacs
  - Application of high resolution HV-CMOS DMAPS in a 3D water phantom
  - Evaluation of TowerJazz DMAPS and development of large area modules
  - Fast Treatment Verification for Spot scanning Proton Therapy
  - Optimisation by post-processing of CMOS sensors for high radiation environments
  - Application of HV-CMOS sensors in precision mass spectrometry.
- All proposals showed a strong participation of companies and non-academic partners
- Focus on interdisciplinary developments especially with impact on the medical field (instrumentation for radio and hadron therapy for cancer treatment).
- Access to EUROPRACTICE and Training
  - Summer school on “CMOS sensors for particle tracking and imaging”

What next?

- The DMAPS community has cohesively continued pushing the creation of a UK consortium:
  - There is a strong case for enhanced CMOS technologies which have an impact on many STFC research areas
  - We are already important players in the development of DMAPS in RD50 and AIDA2020 but without long term funding itis impossible to keep up with the larger efforts in Germany, Switzerland etc.
  - As demonstrated by the proposed studentships submitted for the industrial challenges we have strong connections with companies and our contributions could have a major impact on the development of new treatments in the medical field
  - We will enable the training of a new generation of technical experts
- What are the steps that we should take to secure the necessary long term support needed?
- How can we engage the STFC?
- Should we implement some of the ideas that have emerged, such as the summer school?