2022 UK Instrumentation Lectures

Lies, Damn Lies and Statistics

Daniel Hynds

Many many thanks!

Steering committee members:

- University of Birmingham - *Laura Gonella*
- University of Bristol - *Jaap Velthuis*
- University of Cambridge - *Bart Hommels*
- University of Glasgow - *Kenny Wraight*
- University of Edinburgh - *Andrzej Szelc*
- Imperial College London - *Alex Tapper*
- University of Lancaster - *Lingxin Meng*
- University of Liverpool - *Jon Taylor*
- University of Manchester - *Alexander Oh*
- University of Oxford - *Daniel Hynds (Chair)*
- Queen Mary University of London - *Peter Hobson*
- Rutherford Appleton Laboratory - *Giulio Villani*

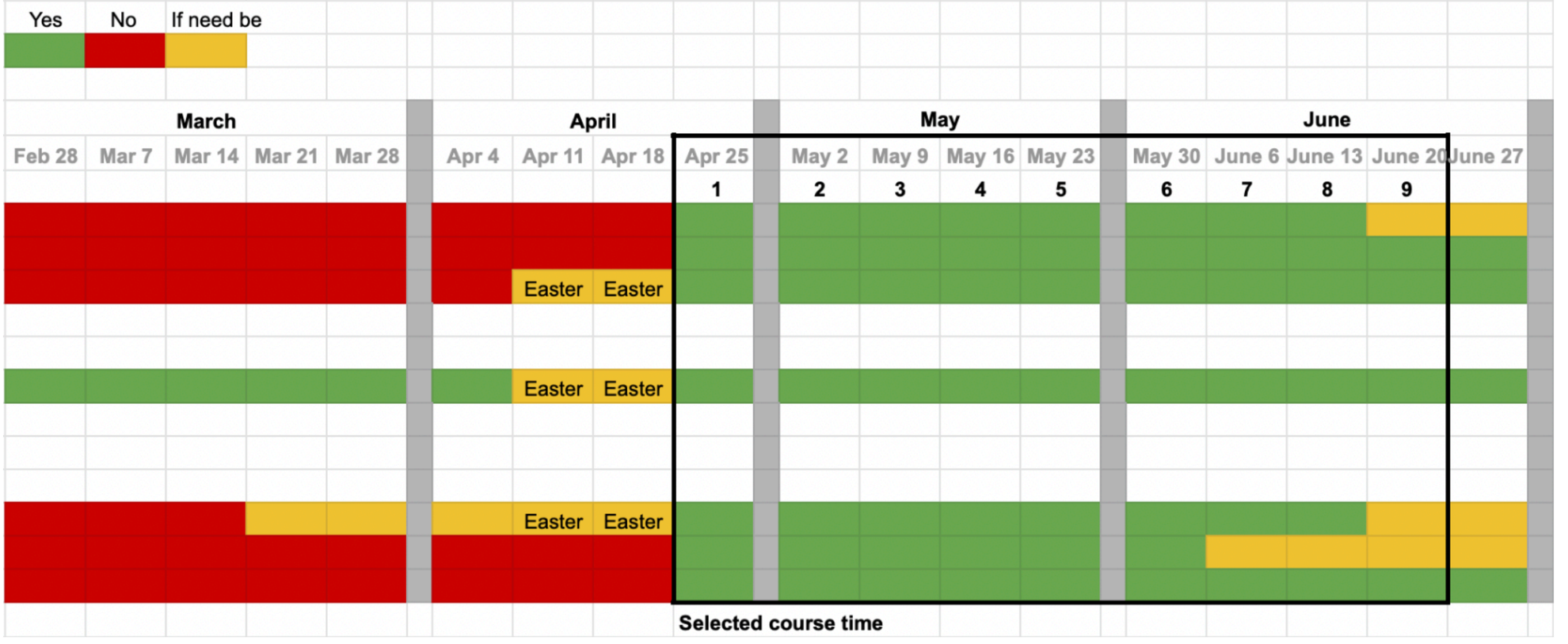
<u>Lecturers</u>

Alex Oh
Andrew Rose
Andy Blue
Bart Hommels
Dan Weatherill
Daniel Hynds
Eva Vilella
Georg Viehhauser
Giulio Villani
Jaap Velthuis
Jon Taylor
Kenny Wraight
Laura Gonella
Mike Booth
Nick Owen
Paki Munoz
Peter Hobson
Phil Allport
Philipp Windischhofer
Sneha Naik
Ulla Blumenschein (A)
Weida Zhang

Course programme

Course									
Semiconductors	Band theory 1	Band theory 2	Layout, guard rings, device calculations 1	Layout, guard rings, device calculations 2	Interaction of particles with matter 1	Interaction of particles with matter 2	Ramo-shockley theory	Radiation damage 1	Radiation damage 2
Electronics and DAQ	General electronics, simple circuit calculations	Circuit theory, common topologies	Circuit design, noise and grounding	Amplifier designs (fast amplifiers, TDC)	[cancelled] Typical ASIC architectures	PCB layout	Trigger + DAQ systems 1	Trigger + DAQ systems 2	FPGA overview
Mechanics and cooling	Mechanical structures 1	Mechanical structures 2	Thermal management 1	Thermal management 2	CAD and technical drawing	FE analysis tools	CAD walkthrough		
Fabrication and structures	Fabrication 1	Fabrication 2	Fabrication 3	Fabrication 4	Device structures: planar and 3D	Device structures: Gain layers (LGAD, SPAD, SiPM)	Device structures: Monolithic	Transistor layout, 250 - 28 nm, FinFETs	
Experimental techniques	Lab techniques: IV, CV, source measurements, x-ray measurements	Lab techniques: IV, CV, source measurements, x-ray measurements	Transient current techniques	Solid state techniques: DLTS, TSC, etc.	Testbeams 1	Testbeams 2	Irradiation 1	Irradiation 2	
TCAD	TCAD introduction, getting started	SProcess planar sensor	SDevice planar sensor	SProcess 3D sensor	SDevice 3D sensor	SProcess monolithic sensor	SDevice monolithic sensor	Advanced features	
Software tools	PCB design 1	PCB design 2	SPICE simulations 1	SPICE simulations 2	MC simulations 1	MC simulations 2	Testbeam reconstruction 1	Testbeam reconstruction 2	
Misc	Photon science applications	Non-silicon semiconductors: Diamond	Non-silicon semiconductors: Diamond II	Other silicon devices: CCDs, Depfets, imaging sensors	Applications: Dosimetry, medical uses				

Schedule


Yes
No
If need be
March
April
May
June
Feb 28
Mar 7
Mar 14
Mar 21
Mar 28
Apr 4
Apr 11
Apr 18
Apr 25
May 2
May 9
May 16
May 23
May 30
June 6
June 13
June 20
June 27
1
2
3
4
5
6
7
8
9
Easter
Easter
Easter
Easter
Easter
Easter
Selected course time

Participation in a few numbers

In total we gave **61 hours** of lectures over 9 weeks

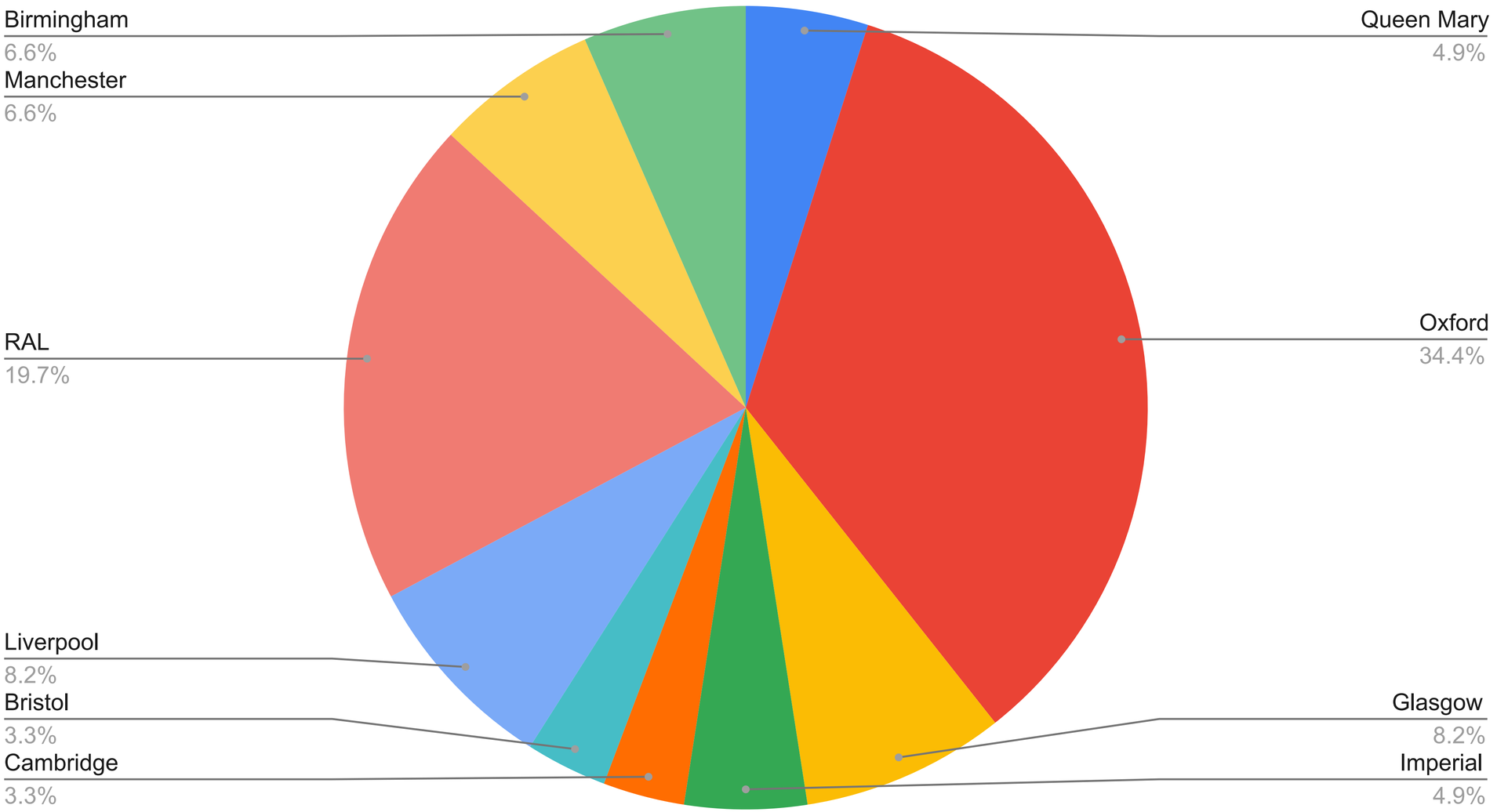
- **22 lecturers** from **10 institutes** volunteered their time

There were **97 registered attendees** from **15 institutes**

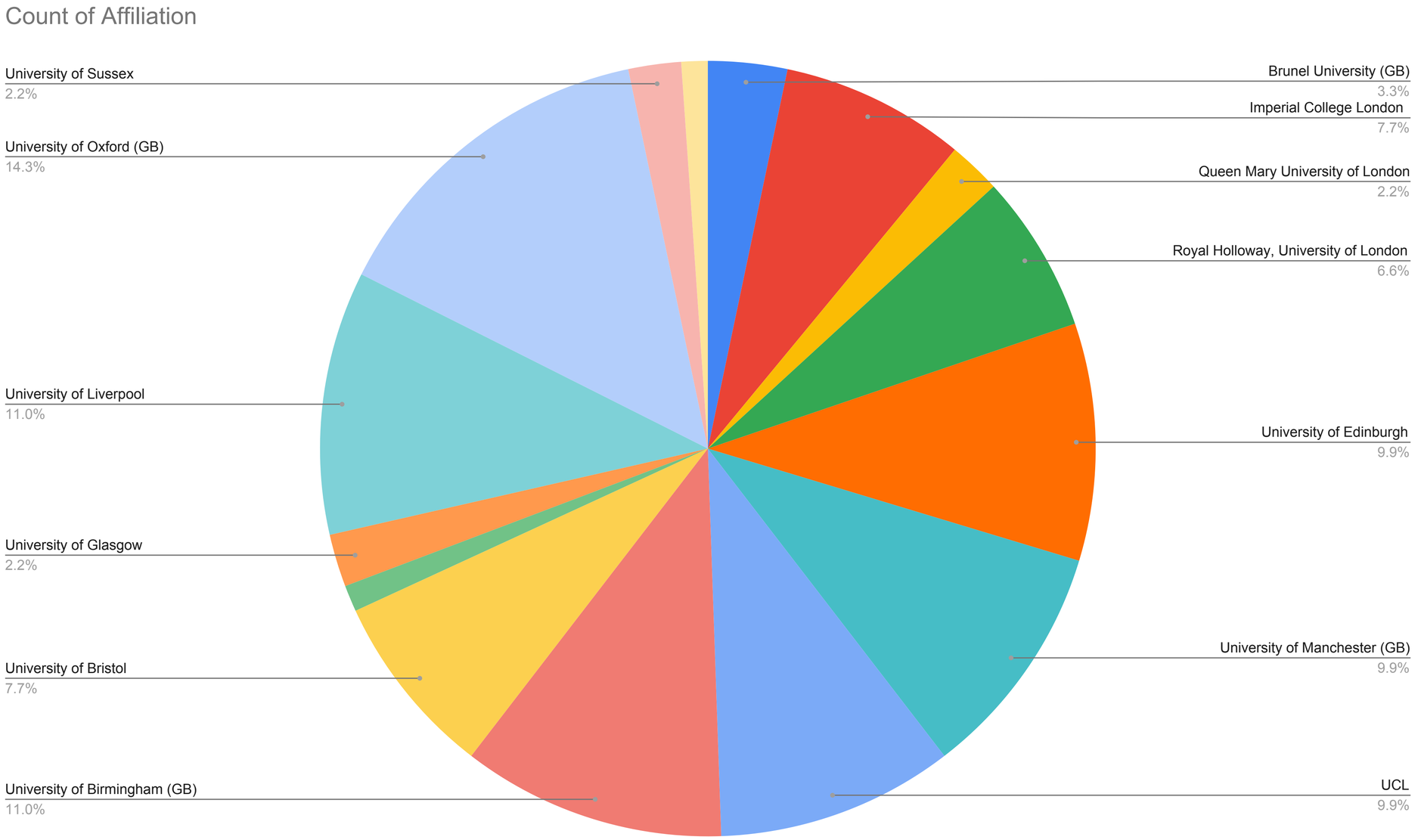
- Participation started strong but tailed off as the courses progressed
- **47 participants** planned to attend all lectures

Only one lecture had to be cancelled due to lack of an available speaker (Typical ASIC architectures), but this was compensated by an additional lecture on FPGAs

Lecturers


Birmingham
6.6%
Manchester
6.6%
RAL
19.7%
Liverpool
8.2%
Bristol
3.3%
Cambridge
3.3%
Queen Mary
4.9%
Oxford
34.4%
Glasgow
8.2%
Imperial
4.9%

Registrants



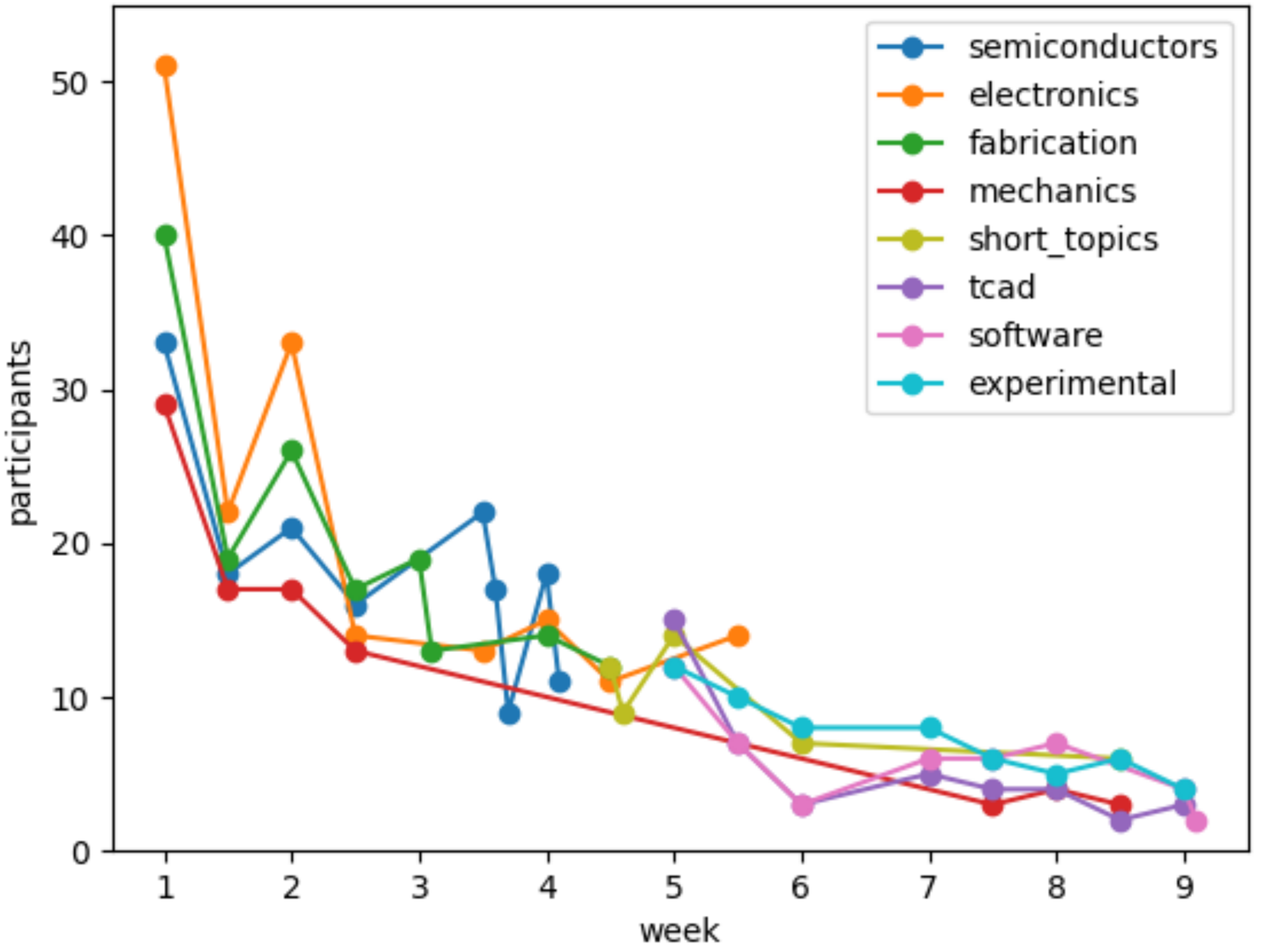
Attendance

Clear drop in participation as the courses progressed

- Perhaps expect inflated numbers at the start due to “novelty”
- Nonetheless, by week 6+ participants generally around 10

After week 2 no significant preference on topics: seem to be generally equally attended

- Does this point to needed changes in format?



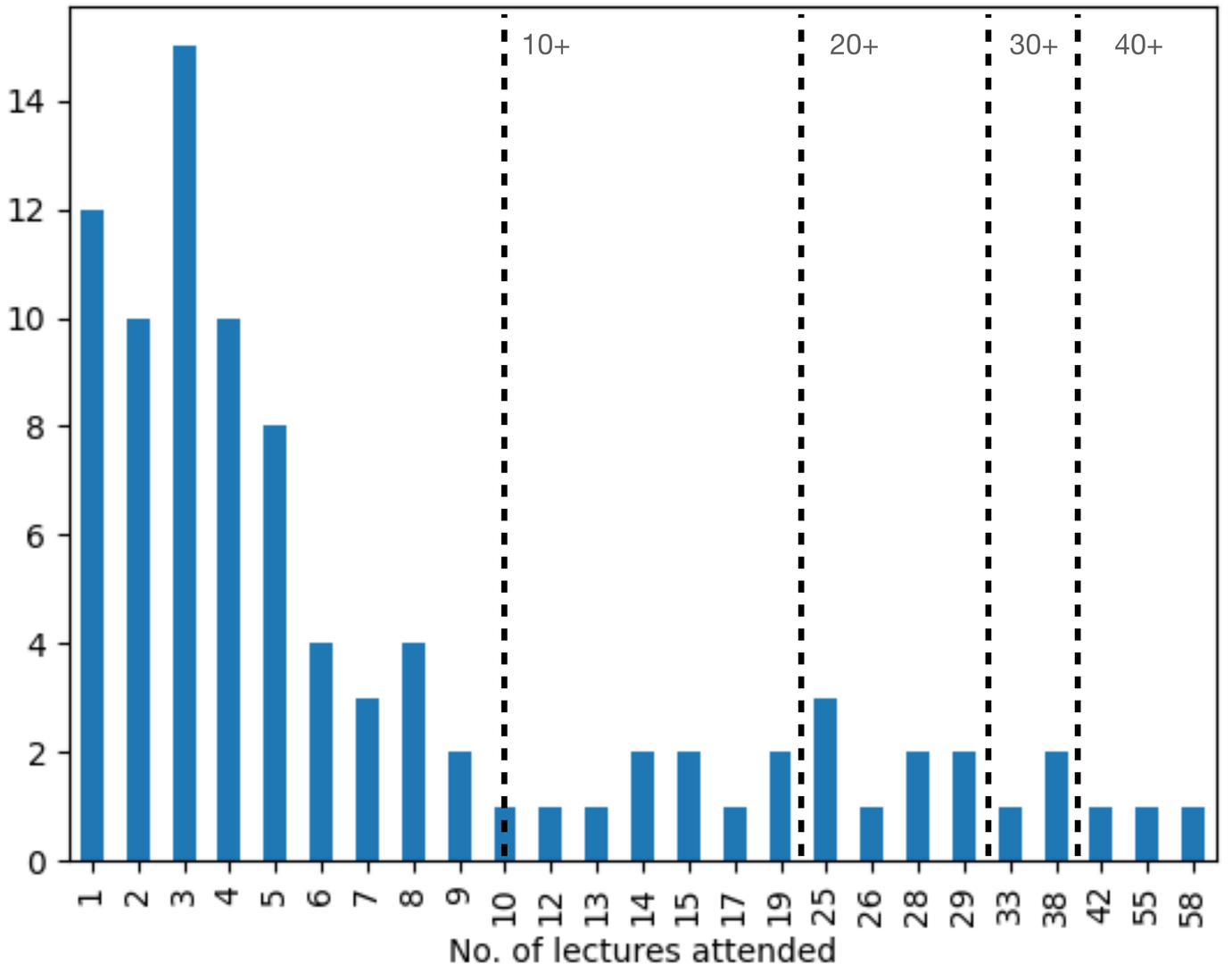
Attendance

Half of all registrants indicated that they did not plan to attend all lectures

- Reasonable that people join for courses which are more relevant

Lecture fatigue a real issue? Of 92 attendees:

- 24 attended 10+ hours
- 14 attended 20+ hours
- 6 attended 30+ hours
- 3 attended 40+ hours

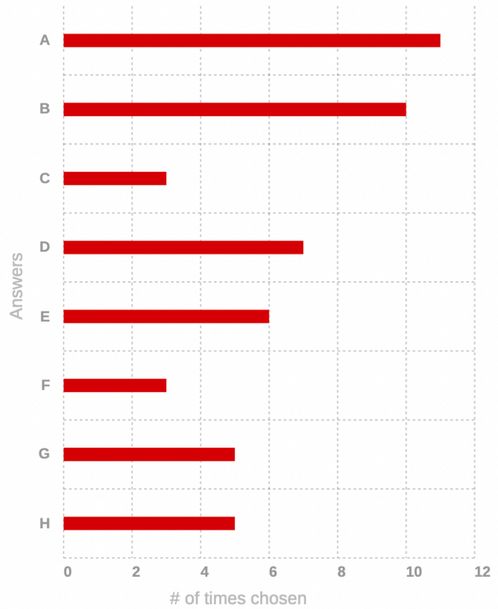


Participant feedback - general questions

Which courses did you attend (fully or partially)?

Answered: *13*

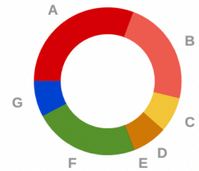
- **A. Semiconductor theory**: 11 (22.00%)
- **B. Electronics and DAQ**: 10 (20.00%)
- **C. Mechanics and cooling**: 3 (6.00%)
- **D. Silicon fabrication and structures**: 7 (14.00%)
- **E. Experimental techniques**: 6 (12.00%)
- **F. TCAD electric field and transport simulations**: 3 (6.00%)
- **G. Software tools**: 5 (10.00%)
- **H. Short topics**: 5 (10.00%)



Roughly how many lectures did you attend?

Answered: *13*

- **A. 1-10**: 4 (30.77%)
- **B. 11-20**: 3 (23.08%)
- **C. 21-30**: 1 (7.69%)
- **D. 31-40**: 1 (7.69%)
- **E. 41-50**: 0 (0.00%)
- **F. 51-60**: 3 (23.08%)
- **G. All**: 1 (7.69%)



Participant feedback - general questions

How would you rate your general opinion of the programme?

Answered: *13*

From 0 (awful) to 10 (amazing)?

- **A. 0**: 0 (0.00%)
- **B. 1**: 0 (0.00%)
- **C. 2**: 0 (0.00%)
- **D. 3**: 0 (0.00%)
- **E. 4**: 0 (0.00%)
- **F. 5**: 1 (7.69%)
- **G. 6**: 0 (0.00%)
- **H. 7**: 3 (23.08%)
- **I. 8**: 2 (15.38%)
- **J. 9**: 6 (46.15%)
- **K. 10**: 1 (7.69%)

Do you have any general comments on the programme?

Answered: *6*

There will be specific questions on the course format and individual course content below

I strongly appreciate all of your efforts. This is really a brilliant programme!

Very useful stuff!

Very nice initiative! Maybe one defect is that some information is repeated multiple times in different lectures, sometimes very fast in all cases. Would be nice if if was presented only once, with more details and time. Would have been easier to provide detailed feedback if the questionnaire was sent at the end of the course :)

Some topic were repeated over different courses, some coordination may help with this issue in the future.

The course was very valuable since it helped improve on my knowledge and also remind me of the contents that I had forgotten having learned about it years ago.

Lectures I attended were good but too much of a commitment to attend regularly - can't take that much time away from other work. Not sure if feasible to poll possible attendees to find what times in the week suit them best but I assume would help attendance. Much easier to attend if there were only 2-4 hours of lectures a week rather than 8. Sometimes other commitments mean that you might miss a morning/afternoon and suddenly you're two lectures behind and wouldn't gain much from going to the subsequent lectures in that course.

Participant feedback - format

Did your attendance drop over the course of the programme?

Answered: *13*

- **A. Yes**: 7 (53.85%)
- **B. No**: 6 (46.15%)

Do you think that there were too many lectures in total?

Answered: *13*

- **A. Yes**: 2 (15.38%)
- **B. No**: 11 (84.62%)

Do you think that there were too many lectures in a single block?

Answered: *13*

Reminder: lectures were scheduled during 2 days per week, with blocks of typically 4 lectures

- **A. Yes**: 2 (15.38%)
- **B. No**: 11 (84.62%)

Would you have preferred:

Answered: *13*

Assuming the same total number of lectures

- **A. More lectures per week over fewer weeks**: 2 (15.38%)
- **B. The same format**: 5 (38.46%)
- **C. Fewer lectures per week over more weeks**: 6 (46.15%)

Would you have preferred:

Answered: *13*

Assuming the same number of lectures per week

- **A. More lectures per block over fewer days**: 1 (7.69%)
- **B. The same format**: 9 (69.23%)
- **C. Fewer lectures per block over more days**: 3 (23.08%)

Participant feedback - format

What would have made you attend more of the lectures?

Answered: *8*

It would be great if we students could get some boards.

The density of lectures was high, that is why sometime lectures can be boring, and I have distraction problem. AS I mentioned above, the number of lectures per day can be decreased from 4 to 2 and the lecture days can be increased from 2 to 3 per week. Therefore, the focus will be increased by students.

Less external requirements occupying my time.

I don't think there is anything wrong with the format. Find lectures very useful and often look at slides for lectures I couldn't attend. My presence is mainly determined by teaching and other meetings.

Not being a senior University manager!

Just do the content over a longer period or less content in general as well. 8 hours a week for 8 weeks is far too much time to take away from your own work. Not to mention if you do miss something you don't really have loads of time to catch up with the content you might have missed so you can attend the next lectures.

8h per week (+ some time to review the material at the end of the lectures) is too much due to other committments as a PostDoc.

Lots of the courses just weren't relevant for me, nothing wrong with them

Participant feedback - going forwards

Would you be keen to see this programme continue in the future?

Answered: *12*

A. Yes: 12 (100.00%)

B. No: 0 (0.00%)

Are there other topics that you would like to see included?

Answered: *1*

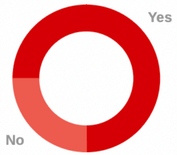
dedicated hands-on training

Would you like to see an intense hands-on in-person school as part of this programme?

Answered: *12*

A. Yes: 9 (75.00%)

B. No: 3 (25.00%)

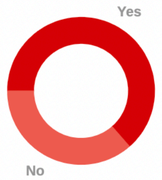


There have been suggestions of extending the UK training programme to include focussed hands-on courses in dedicated topics, such as GPU programming or vibration measurements and analysis. Would you be interested in such focussed training?

Answered: *11*

A. Yes: 7 (63.64%)

B. No: 4 (36.36%)



What kind of topics would you like to see covered there?

Answered: *1*

GPU programming

Do you have any other suggestions for improvements?

Answered: *1*

Record lectures for people that can't attend

(Personal) Thoughts on the future - for discussion - General points

Should we run the programme again this year??

Several lecturers are against recordings of the lectures

- There is also suspicion that this would exacerbate attendance issues
- Nonetheless, several people have raised this: thoughts?

Opening up of the course to non-UK participants

- Last year some colleagues asked about participation for institutions in Europe
- This could be expected to significantly raise number of attendees, and also raise the profile/visibility of the UK community
- Retain UK-only steering committee to make sure that the programme caters to the needs of UK institutes? What about lecturers from outside of the UK?

(Personal) Thoughts on the future - for discussion - Format

I am genuinely torn on this

- On the one hand, of the (limited) responses to the survey, ~half wanted the same layout (2 times 4 hours a week) and ~half wanted fewer lectures/week over more weeks
- On the other, last year ran for 8 weeks total, and extending would end up at 10-11 weeks (at 6 hours/week)
- In addition, there are clear signs that people tail off with time
- Thoughts?

(Personal) Thoughts on the future - for discussion - Extension of the programme

Not for this year (due to limited time), but I would ideally like to see:

- Problem sheets for attendees, possibly with tutorial slots to go through the solutions?
- A hands-on in-person school
  - This could closely follow the lectures: arrive and handed a diode/LGAD, have to make PCB, populate, take lab measurements, simulate in TCAD, Geant4, compare with data…
- Additional hands-on training in more advanced topics (see later)

Thoughts on the future - practicalities

Assuming that we plan to continue the series this year:

- Steering committee should meet soon to sort out a number of things:
  - Dates for this years lectures
  - Assign ‘reviewers’ to each course to go through the slides and highlight repetition of material + provide survey feedback to lecturers?
  - Chase up lecturers to give their lectures again (12 of 22 already confirmed)

A number of other things should be prepared:

- Indico pages
- Announcement to national (+international?) mailing lists

Addendum: TF9

As a follow-up to the ECFA detector R&D roadmapping exercise, the UK will quite likely prepare a funding bid on instrumentation R&D

- This is in parallel to the Detector R&D (DRD) collaborations being formed in the European context
- CF. the silicon town hall meeting in Birmingham last September

It would be good to have training firmly embedded in any UK bid, and (from a silicon standpoint) this could cover:

- Administrative support for this lecture programme
- A hands-on in-person school following the lectures (limited numbers?)
- N-day in-person training courses hosted by institutes across the UK (TPA-TCT in Oxford, GPUs in Bristol, etc.)

Thoughts??

Many thanks again!

To all those who made this possible