

Physics: Setting the Scene

Physics is discipline taught in 49 departments across the country (only ~20 have more than 100ug's per year) and overwhelmingly to students with at least A grades in both mathematics and physics. There is no "downmarket" in physics. Either you attract these well-qualified students, or you don't attract students at all.

We have been quite successful in growing our intake to 250+ and hope to continue this growth. Our numbers split roughly 67% on Physics or Physics with Astrophysics and 33% on Mathematics and Physics.

Interdisciplinary

Of the main departments in STEMGC (CH, ES and PX), we are the only one running what we call the Zeeman approach which is widely used across mathematical sciences. We allow anyone to take our modules and encourage our students to study outside the department. Each year about 25% of the teaching to our students is delivered by outside departments, while we teach students from other departments (principally Maths) in our modules.

Mathematics and Physics

About one third of our intake is on the interdisciplinary course, Mathematics and Physics. This course is roughly 50% taught by Mathematics and 50% by Physics. These students do not take laboratory modules. They expect to be considered genuine double-discipline students. It is hard to deliver on this, but any new building must take these students' interests into account.

Laboratories

Most experiments involve recording electrical or electromagnetic signals and discussing what they mean. In the first and second years, students work in pairs and in the third year lab in groups of three. To the right is a photo from the main physics first year lab. The photo below is of the electronics lab.

Equipment is largely fixed to the stations and cannot be easily moved into or out of the lab.



Protection from harm involves safe handling of equipment and safe behaviour, not the wearing of white coats and safety specs! For students, who have been inducted into the lab, they are safe places and are often used for catch-up and seminars at times when teaching labs are not scheduled.

Lectures

Lectures in physics (and mathematical sciences) are about telling stories and working through arguments in front of students.

Lectures are not about projecting information onto walls or screens. In fact, students complain bitterly at people who overuse technology. The students have agreed a [policy](#) with us that powerpoint should almost never be used. Students want the arguments developed in front of them on the blackboard or visualiser and not dumped onto powerpoint slides.



The picture above shows a fourth year/MSc option class. The picture below shows a first year core class (the same lecturer appears twice).



The lecture is one part of the learning process. Lectures are where students meet new concepts. Students need to work through the arguments many times by themselves and attempt problems to appreciate the beauty and value of the underlying ideas. In the first two years when the classes are large, there are support classes (~25 students), tutorials with academics (~5) and supervisions with pg students (~5 for maths).

Tutorials

Tutorials are as important to us as lectures or labs. They are academic tutorials in which students study physics with an academic. This is a widely used procedure across mathematical sciences and physics (but less so across the rest of the University). It is important that these can run at the same time each week and need to run in academic offices.



Physicists talk physics in their offices with staff, postgraduates as well as undergraduates. They are an important resource for all aspects of the department's activities.

The Concourse

The concourse is used daily by students as a study space. The part shown on the right leads only to a small building occupied by Physics staff so that there is little traffic. When walking through, most staff recognise a few students and say hello. It helps develop students' and the staff's sense of identity: "we are at ease here and people know us".

At other times, the concourse is used for large events such as admissions open days, conference meetings, or (as shown below) the final year students' poster presentations.



Workrooms

Students need workspaces to look at problems together, discuss laboratory write-ups and to socialise. In our experience, students like to be together with students on the same (or a similar course). We put facilities, for example computers, textbooks and printers, in these rooms. There also need to be enough sockets for students devices. The photo shows the current general physics student workroom.



Physics learn by studying and discussing as much as by doing. The workrooms, the concourse and our offices are as important as the formal lectures.

PHYSICS TEACHING SPACE REQUIREMENTS

ACADEMIC OFFICES

Every Physics Academic who works full time needs their own office, with the space to hold small group tutorials and confidential meetings with undergraduates, postgraduates, other staff and external visitors for research too. The minimum size of the office should be 14 m² to be fit for purpose.

What teaching activities are supported in offices now?

- Timetabled tutorials with 5 to 6 UG students (1st, 2nd years) for 3 terms, 2 hours per week.
- Non-timetabled (depends on availability of staff and students), monitoring meetings with 3rd and 4th year tutees individually, minimum 12 hours every Term.
- Non-timetabled (depends on availability of staff and students), supervision meetings with final year project students (2 groups of 2 students per academic), Terms 1-2 typically 2-6 hours per week on an ad-hoc basis, Term 3 typically 4-6 hours total.
- Weekly meetings with PG students (individually and in groups) for progress meetings and regular dialogue regarding day to progress – typically 1-6 hours per week on an ad-hoc basis throughout the year.
- Preparation, marking and storage of confidential paperwork and electronic documents.

Also need to consider teaching needs that affect many staff:

- Pre-arranged as well as ad-hoc confidential meetings with UG and PG students requiring help/advice re: teaching/pastoral matters.
- Meetings with UG students (1st, 2nd and 3rd years) to provide feedback on lab reports, once a Term, for up to 10-12 students individually.
- UG student vivas for the final year projects.
- PhD vivas and postgraduate student interviews, supervision and review meetings.

And non-teaching needs that should also be considered (often confidential):

- Meetings (private) with colleagues to discuss teaching related matters.
- Meeting with postdoctoral researchers and support staff (typically up to 6 hours per week throughout the year)
- Meetings with external people.

Summary:

Term time requirements for each full time academic – typically up to 9 hours per week predictable requirement, most of which cannot be easily timetabled in advance as they are arranged based on need and around student timetables. Number of people in the office can be up to 7 at once for at least 20 hours per term, which requires a minimum size office space.

Any growth in UG, PG and PDRA numbers will see a proportional increase in the requirement of office space. A small increase in UG numbers could see a doubling in

the number of tutorial hours if we wish to maintain our well received small tutorial groups.

Note that the points here apply to both Physics and Math/Physics UGs. Maths/Physics is an example of a successful UK-leading, truly interdisciplinary course that is an extremely well-regarded degree, attracting some of the UKs brightest students who wish to study mathematics & physics.

Opportunities and justification of the need for individual offices of a suitable minimum size for tutorials:

Physics currently sits between 6-10 in the UK Physics rankings. One key theme common to our peers (in normal times) is the provision of face-to-face, small-group teaching through a tutorial system. Our system of tutorials in groups of around 5 students is the most important component of the pedagogy used by Physics in years 1 and 2. This system must be retained.

Undergraduates greatly appreciate the face-to-face engagement with academics through tutorials and other teaching activities (as evidenced through feedback and in recent meetings with students in STEM GC), and it is one of the features that attracts good candidates to come to Warwick to study Physics.

The tutorial system needs the availability of tutorial spaces at well-defined points in the timetable. Currently these are academics' offices. The idea that other teaching spaces can be found to accommodate around 50 first year and 50 second year tutorials at suitable times each week is unworkable. On the other hand, the increase in space in a modern office to accommodate 6-7 people as compared to one person is fairly modest. It would also reduce the costs of building and maintaining large numbers of tutorial rooms with low occupancy outside of term times.

Our final year projects are another key strength of our courses, and essential part of our accreditation with the IOP – the supervision of these projects also take place in staff offices. With improved IT in suitable staff offices, we could enhance this learning experience further.

Like many of our peer Physics Departments, we use an 'open door' policy, making it difficult to book ad-hoc spaces, which costs staff time (academic & clerical). We must not lose this feature as it will be viewed negatively by current and prospective students and very likely be reflected in NSS scores and University rankings. It is extremely beneficial to have a fixed location where students know they can reach you – many of whom may not be tutees or project students.

TEACHING LABORATORIES FOR PHYSICS UG

Physics UG students currently have a dedicated lab space of 854m² that was able to accommodate 120 students in each of the first two years, and with a planned expansion in the current cohort to 175 student in each of the 1st and 2nd Year and 90 3rd Year MPhys and MMathPhys students, this space is already too small. It is impacting our ability to deliver lab teaching and will need to expand significantly. Students work as individuals or in pairs or as a team of three at dedicated stations, and most of the equipment requires a dedicated computer and other electrical hardware, much of which is not easy or safe to move. This equipment is required to teach the Physics required for IOP accreditation.

What teaching activities are supported in Physics Labs ?

- Timetabled 1st Year labs run on Thursdays and Fridays in all 3 terms.
- Timetabled 2nd Year labs run on Monday and Tuesday afternoons in terms 1-2.
- Timetabled 2nd and 3rd Year MPhys labs using more complex, non-portable hardware.
- Ad-hoc access for students in the day during Term time and vacations (subject to availability) to undertake additional work to support their work in timetabled sessions, or to take catch-up sessions that may have been missed due to illness etc.
- Ad-hoc access for students in daytime (subject to availability) to support their final year projects or a computational resource for other modules.
- Teaching labs are used for some outreach and widening participation activities in vacation time, with space managed by the head lab technician. This can involve bringing cohorts into the labs or using the lab as a “maker space”.
- UG summer research project type activities and additional student space.
- Maintenance of hardware is undertaken in the vacations as is the design and construction of new teaching lab experiments.
- Observatory for astrophysics.
- Where pragmatic and safe to do so, some spaces are already used to provide workstations for different UG experiments, which are sometimes if different year cohorts too.

Summary:

The bullet points above describe what is currently done, and whilst we do not have to organise things in exactly the same way in the future, we need the space and time resources to deliver the same amount of lab-based teaching and learning – and more as we expand.

Any growth in UG, numbers will see a proportional increase in the requirement of teaching space. A dedicated, new Physics teaching lab space presents us with what is needed to maintain current student numbers through increases in the UG cohort and the development of a new Physics taught Masters course.

Opportunities and justification of the need for dedicated UG Physics Teaching Labs:

The current Physics teaching labs were a major investment a decade ago, helping to secure UG numbers, providing them with exciting practical opportunities. A new, well-equipped teaching lab space with a distinct Physics and Physics with Astrophysics identities will be instrumental in growing the number of UGs with high entry scores.

The flexibility to develop new teaching lab experiments over the next 20-30 years will be essential and will strengthen Warwick's offering. The ability to adapt teaching lab experiments and reconfigurable spaces to complement developing research strengths in areas such as fabrication or optics will be very attractive.

Certain spaces will need to be dedicated to particular activities – such as dark rooms for particular experiments. These need to be designed in from the start through consultation.

Opportunity with potential growth in a taught 1 year MSc course – this will help to attract high quality graduates from other universities and will mitigate risks if students tend to move to BSc from MPhys courses (often driven by student fees). To ensure efficient delivery of high-quality lab support, these labs will need to be dedicated spaces for postgrad teaching delivery, and continuous with UG teaching labs.

A dedicated Physics laboratory provide improved safety of people and equipment, providing work areas fit for purpose is paramount. Having an area that was shared with other disciplines will present unnecessary risks and excessive extra work for support staff. For example, an increased likelihood of liquid spills would cause serious issues for H&S and equipment.

Specialist and experienced technicians would be able to provide quality of support for both the equipment, students and staff working in the teaching labs. Most of our support staff working in the teaching labs have highly specialised physics-based skills, education and training, which greatly enhances the operational efficiency of the labs and the student learning experience.

Shared, cross-subject lab spaces will generally result in significant inefficiency, and increased staff time and costs associated with managing a complex timetabling and arrangement of equipment and consumables, which are fairly disparate across the different STEM disciplines. Specialist lab technicians are also key in delivering a high-quality learning experience and environment.

There are some teaching laboratory facilities that could be sensible to use as a shared space, such as some relating to computation (discussed elsewhere in this document) or perhaps shared spaces for electronics experiments. These need to be informed by where a strong synergy and similarity of requirement already exists though – and it's essential that these are established through dialogue with the staff who deliver the teaching.

DEDICATED LEARNING AND STUDENT SPACES FOR MATHS PHYSICS UG

Maths/Physics UG students are a significant and important sub-set of our UG cohort (~90 students enter per year), and we need to ensure that they have a dedicated space for them, which provides them with a sense of identity and a feeling that they are valued. Maths/Physics is an example of a very successful UK-leading interdisciplinary course, that is extremely well-regarded degree, attracting some of the UKs brightest students. Their space requirements are modest and can easily be co-located within a Physics building.

What teaching activities for Maths Physics UG are supported in existing spaces ?

- Tutorials (section on tutorial and office spaces apply here)
- Timetabled 3rd Year Maths Physics MPhys labs using more complex, non-portable hardware.
- Supervision and meetings for final year project students in offices and labs.
- Timetabled lectures in the Maths Dept in classic lecture theatre arrangements.
- Timetabled lectures in centrally timetabled locations around campus.
- Timetabled problems classes in centrally timetabled locations around campus.

Summary:

If Maths/Physics students are to feel valued, we must ensure that these students have a space that is identifiably theirs. This course cannot continue to work if the students are expected to fit into the interstices between departments. Maths/Physics students do not have access to student workspaces in the Maths Department, although many of them study more maths than physics. This creates resentments. Failure to provide Maths/Physics space, will damage the reputation of the course and its ability to attract good numbers of good students.

Opportunities and justification of the need for dedicated Maths Physics UG spaces:

Warwick can grow its current lead in offering this well-established, interdisciplinary course, where there is a strong and clear academic benefit to linking Mathematics and Physics, without significant implications on lab space.

It is unlikely that we could run courses jointly with Chemistry or Engineering. Related to this, there may be potential to grow other interdisciplinary courses within mathematical sciences where there is a strong and natural synergy with what we already deliver and are well-known for.

COMPUTER ROOMS FOR PHYSICS UNDERGRADUATES

Access to a centrally timetabled computer teaching room with access to up to 150 terminals will be needed going forward. Physics also requires dedicated computer rooms that can be used for Physics UG teaching: some terminals are located in teaching laboratories and others are located in Physics UG Workrooms, with typically 50 terminals provide the students with a learning experience is greatly enhanced through peer-peer interactions that can also be across year groups

What teaching activities are supported by Physics?

Our UG workroom P521 with computers is very popular and constantly in use by UGs. It would benefit from more machines/desks for students to study.

Students have access to software required to undertake data analysis and preparation of their results through University managed machines.

Computing modules are currently undertaken in the following locations:

- Library R0.39 and R0.41: A total of around 70 machines normally
- Maths A0.02: around 40 machines.
- Physics labs, level 3: again around 40 machines

It is an expectation from all UK undergraduates and accreditation bodies that, at any highly ranked academic department, UG students have easy access to general computing facilities at multiple access points across campus.

For most teaching in workshop format for modules [PX159](#), [PX281](#), [PX390](#) and [PX457](#), the number of workstations is sufficient in these rooms except at the start of modules when the rooms above tend to overflow. Most students revert quickly to using private machines, although not all the software they require will run on Mac IOS.

Summary:

There is scope for Physics students to use some shared spaces for computer access, but they will require protected spaces that only they can access to ensure that we are able to provide them with the learning spaces that they require when they require it. Some of this can be co-located in Physics student workrooms and teaching labs (which are not open all the time due to H&S).

Access to computers is required as an integral part of many of the taught modules and teaching laboratories, in addition to modules that specifically focus on computation. We need to ensure that there is adequate future proofing for an evolution and expansion in Physics related computationally intensive modules, some of which may not be able to run on students' personal computers.

Additional comments on requirements for computing space for teaching in new building

Flexibility is the key with spaces used for Physics UG teaching or workrooms, if the new building is going to be fit for purpose for the next 20-40 years.

The provision of a central computing facility with up to 200 machines would help permit regular teaching in a workshop format. If such a shared space could easily be partitioned into 2 spaces, it would provide greater flexibility. Carefully designed computing facilities could also be used for the benefit of cluster based HPC, when not in demand for teaching.

Teaching this year without access to shared facilities did not result in any insurmountable problems with computing equipment access, but did cause a number of issues that required significant amounts of staff time to resolve. There were for example some issues with students who used IOS based systems not being able to access some of the data analysis software that they would usually use, and issues with the rollout of Labview software was also problematic.

A strong provision of computing facilities for teaching will greatly enhance the learning experience for our UGs in the future and will support our ambitions and flexibility to run new computationally intensive modules, or even new joint degree programmes.

There is always a core of students who much prefer a shared facility with face-to-face assistance. They would often sit in the workroom at a PC but still use their own computer.

We need to maintain smaller Physics student workrooms equipped with approximately 50 terminals, where students could access licensed software and HPC. Students could also choose to use their own laptops in these spaces in some circumstances.

LECTURE AND CLASS ROOMS FOR PHYSICS UNDERGRADUATES

There is a wide range of Physics modules that require lecture theatre style teaching for a cohort that would typically vary in size from 50 – 400 UG students, with the higher numbers more likely in some 1st Year modules. The current arrangement of centrally timetabled lecture and workrooms generally seems to work well, although it is very desirable for Physics to continue to have one large lecture theatre (~ 400 seats) within the Department for high profile visiting speakers, events and UG and PG admissions.

What teaching activities are supported in class rooms now?

- Timetabled lectures of 235, 330 , 320 and 330 hours in the 1st, 2nd, 3rd and 4th year UG courses with class sizes between 450 - 40.
- Problems classes – 11 per week with groups of 25 students for years 1-2.

Summary:

The current arrangement of centrally timetabled lecture theatres and workrooms works well and is an efficient use of space. It is a tried and tested approach that staff and students are familiar with and one that is adopted by most of our peers.

A 400 seat, well equipped lecture theatre located in Physics similar to the new lecture theatre in the IBRB building, where Physics would have priority bookings will be an essential and attractive feature that helps with current and expanded student recruitment, in addition to raising the profile of the department for externally facing events.

An aside on the design of lecture theatres

Successful lectures within mathematical sciences and physics are almost always those that take students through challenging arguments. They need good blackboards and/or visualisers.

A common misconception is that lectures are about projecting information onto a teaching wall. In fact, we go as close as we can to dissuade our staff from using Powerpoint presentations. Staff are expected to “tell a story” and use visualisers and blackboards to help students make their own notes. This approach also forces staff to engage with their class, and eliminates the possibility of hiding behind pre-prepared slides or provide a running commentary on such slides.

It is rare for students to want to discuss the ideas as they meet them. They are simply too difficult. Students need to concentrate in the lectures on understanding the arguments and derivations. Discussion takes place elsewhere - in small groups such as tutorials, examples classes, discussions with project supervisors or lab demonstrators, and in discussions between students after lectures.

We are not in favour of building large “cabaret-style” spaces for lectures.

Opportunities and justification of the need for Physics class rooms and lecture spaces :

Ability to run larger open and admission days, to support expansion of student numbers in an attractive environment that is the main showcase for potential students and their parents.

The appearance of a Physics based lecture theatre is one of the most important first impressions that we can make to potential new students.

Raise the profile of Physics to external visitors from other academic institutions or industry.

Physics has always had a lecture theatre in the Department, but it is not large enough to accommodate the existing student cohort on many modules, before we even consider any growth in student numbers.

Being able to locate larger conferences with excellent facilities has wider benefits for Physics and the University.

The classroom and lecture-based teaching delivery methods have been an important feature in very positive student feedback. Many of our students are highly motivated, self-driven learners, but a significant number of the cohort benefit significantly from the structured learning that timetabled face-to-face lectures provide: confidence building, motivation, social skills and interactions and an enhanced sense of identity and belonging. To remove our capacity to offer face-to-face lectures will be very detrimental to learning for a significant number of our students.

STUDENT LED STUDY SPACES

UG students make extensive use of the existing study spaces that they have exclusive use of within the Physics Department. It is a feature that gives them a guaranteed space to study and opportunities for peer-to-peer support, even between different years. It also gives a valuable focal point for the UG cohort and a location that academics can enter to easily engage with UGs on an informal basis, and a place where UGs can work whilst waiting for meetings with academics or before the start of teaching laboratories that often require some preparatory work.

What study spaces are required?

The current offering of a Physics UG workroom (50 desks) and a smaller quiet Physics UG workroom (20 desks) needs to be at least maintained and ideally enhanced. It needs to be equipped with computer terminals, large display screens and white boards. This room could be partitioned to provide one larger workroom for some activities outside term times.

Many of our students work collaboratively and learn through peer-peer support. Having facilities that they can access and feel some sense of ownership of will be extremely beneficial – not just desks and computers, but also the provision of basic facilities to prepare food and drink, and a small space that could be used for social interaction, relaxing and eating.

Summary:

Other departments that have not had dedicated study spaces for their students have found that students from other departments will occupy what spaces they have, even when they are significant distances away from their own department.

There are already many shared study spaces that Physics students can use if they wish to. The normal high usage of the Physics-based study space highlights the requirement and the benefit that the students get from the spaces within Physics, and so these spaces must be maintained and/or enhanced.