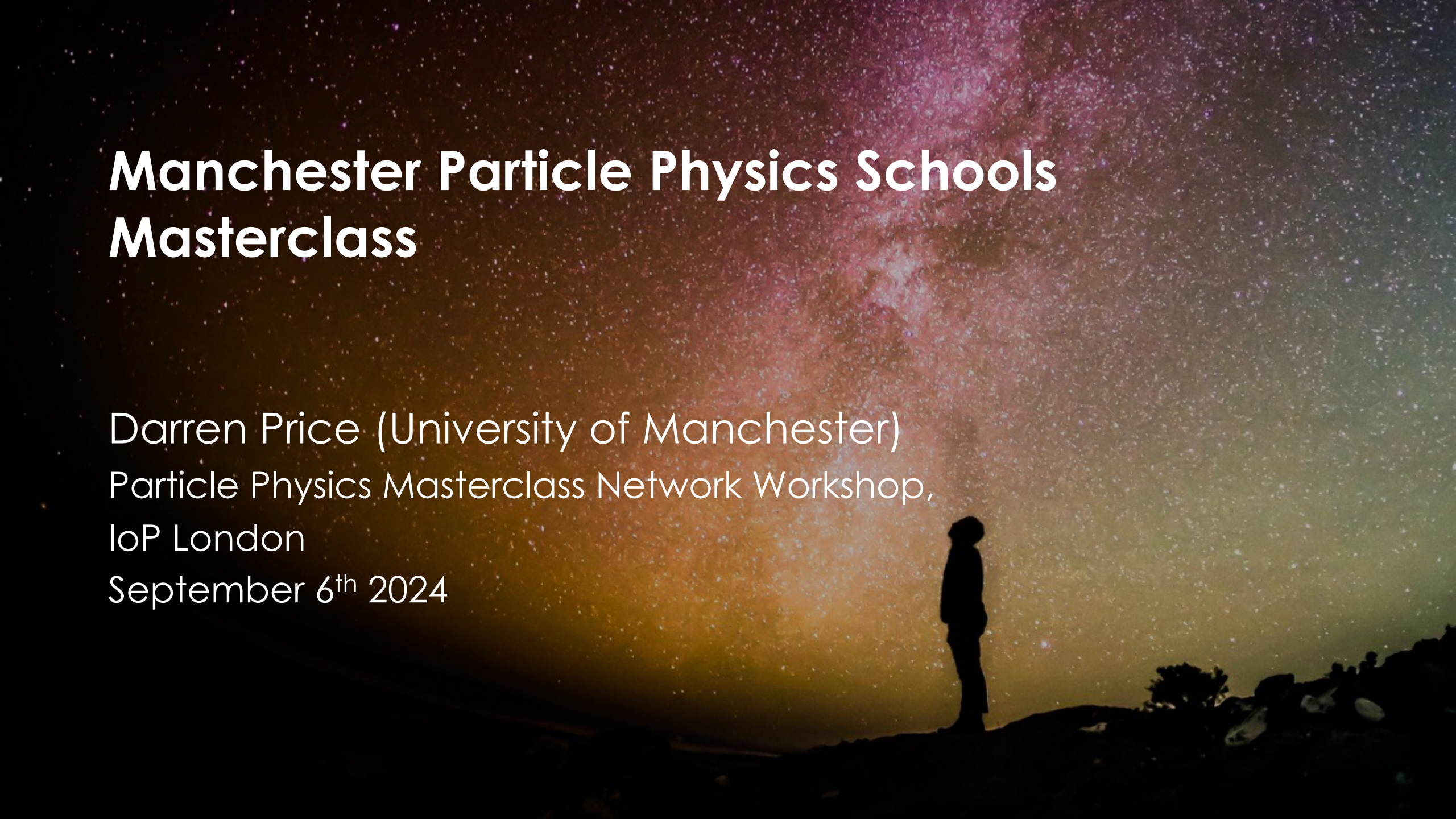

Manchester Particle Physics Schools Masterclass

Darren Price (University of Manchester)

Particle Physics Masterclass Network Workshop,
IoP London
September 6th 2024

Current masterclass a continuation of an evolving long-standingprogramme at Manchester

In close to its current form since 2015

- Runs once (sometimes twice) per year
- Increasing scale/reach with experience:
  - 300 students per day (aged 16-18) + teachers
  - Some widening participation schools, but not exclusively-targeted
  - Reach registration capacity within ~12 hours of opening
- Deep engagement model: (relatively) low numbers, unique opportunities/experiences:
  - Limited by logistical capacity only: expect to expand to ~500/day next year
  - Model scales nicely beyond baseline (see later: ~3 hrs extra FTE per 30 students

What's coming next?

- Expanding scale following smooth running
- Expanding evaluation capabilities/goals
  - Sharing best practice and common model would be ideal
- Focused masterclasses at targeted audiences
  - WP-specific; younger age groups; low science capital / disengaged schools
  - Interest in developing new resources to support this

Masterclass in its current form may be a useful model for groups kick-starting / refreshing their own offering?

What does a Masterclass look like?

Masterclass a full day activity, with parallel streams (to manage group size)

Timetable								
930	Reception [Schuster Foyer]							
1000	Welcome							
1010	Particle Physics + collider intro							
1105	Neutrino talk							
	Gluon	**Photon**	**Z boson**	**W boson**	**Neutrino**	**Electron**	**Up quark**	**Down quark**
1300	Setting up groups [Schuster Foyer]							
1315	Computing	Computing	Computing	Computing	Nuclear (2nd floo	Particle lab (5th	Virtual Visit	Virtual Visit
1330	Computing	Computing	Computing	Computing	Particle lab (5th	Nuclear (2nd floo	Virtual Visit	Virtual Visit
1345	Computing	Computing	Computing	Computing	Virtual Visit	Virtual Visit	Nuclear (2nd floo	Particle lab (5th
1400	Computing	Computing	Computing	Computing	Virtual Visit	Virtual Visit	Particle lab (5th	Nuclear (2nd floo
1415	Virtual Visit	Virtual Visit	Nuclear (2nd floo	Particle lab (5th	Computing	Computing	Computing	Computing
1430	Virtual Visit	Virtual Visit	Particle lab (5th	Nuclear (4th floo	Computing	Computing	Computing	Computing
1445	Nuclear (2nd floor tea	Particle lab (5th	Virtual Visit	Virtual Visit	Computing	Computing	Computing	Computing
1500	Particle lab (5th floor	Nuclear (2nd floo	Virtual Visit	Virtual Visit	Computing	Computing	Computing	Computing
1515								
1530	Summing up [Rutherford booked until 1630]							

Masterclass a full day activity, with parallel streams (to manage group size)

- Morning session based around combination of talks + Q&A sessions (after initial orientation, H&S etc.)

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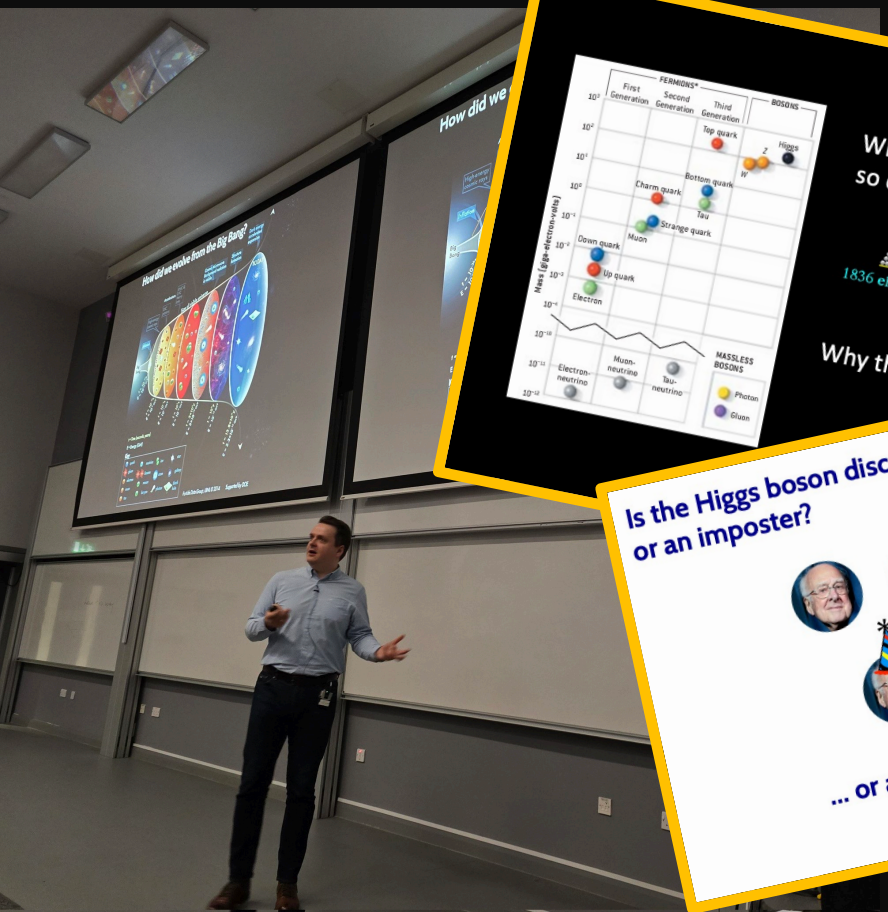
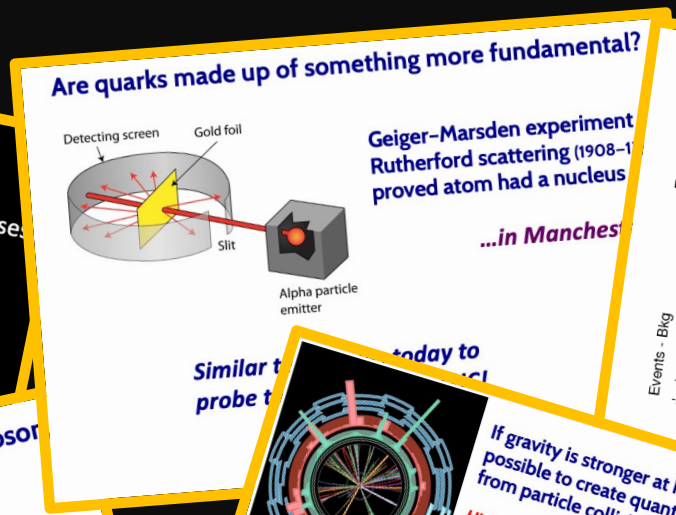
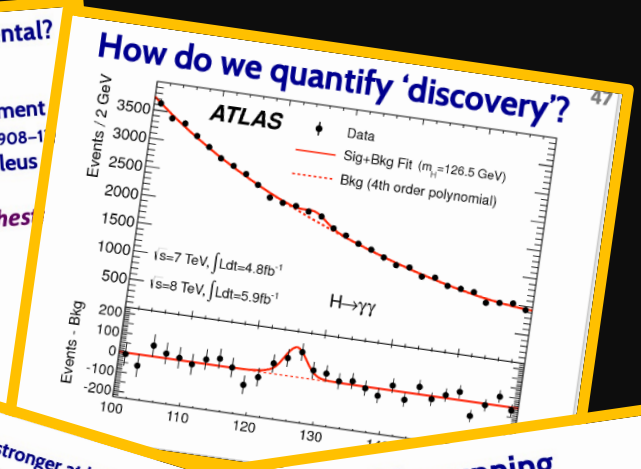
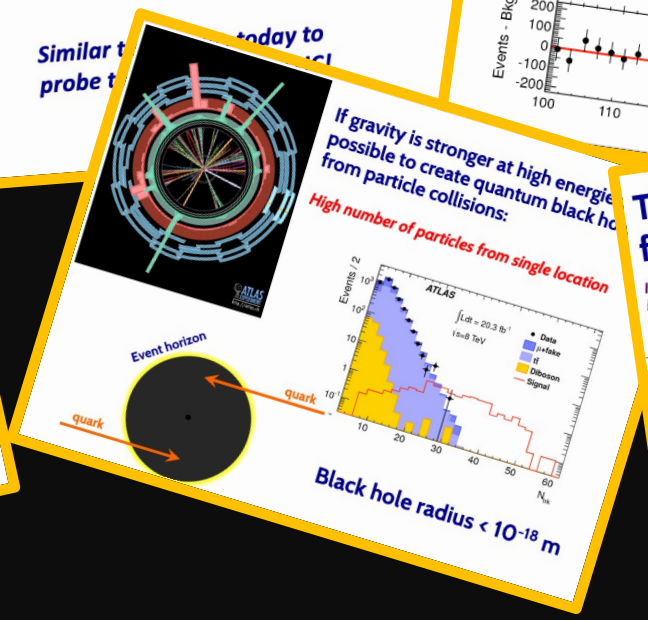
Initial overview of particle physics + collider focus (45 min) + Q&A (15 min)

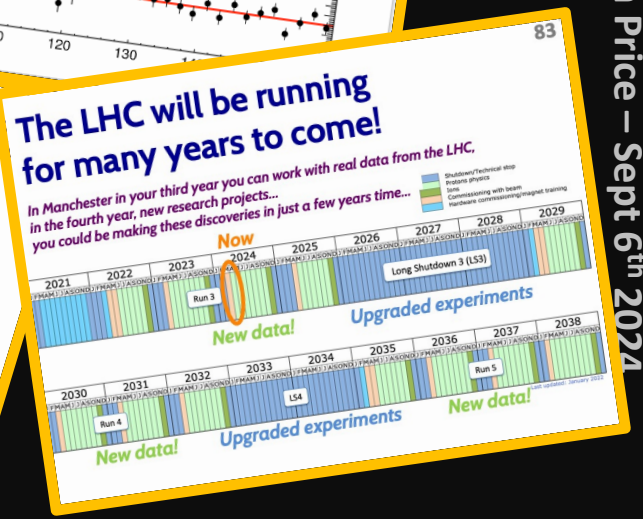
Talk typically focuses on the premise of discovery – what are open questions; why collide particles; how do we search for the unknown; what are tools/techniques + examples of cutting-edge science + link to curriculum





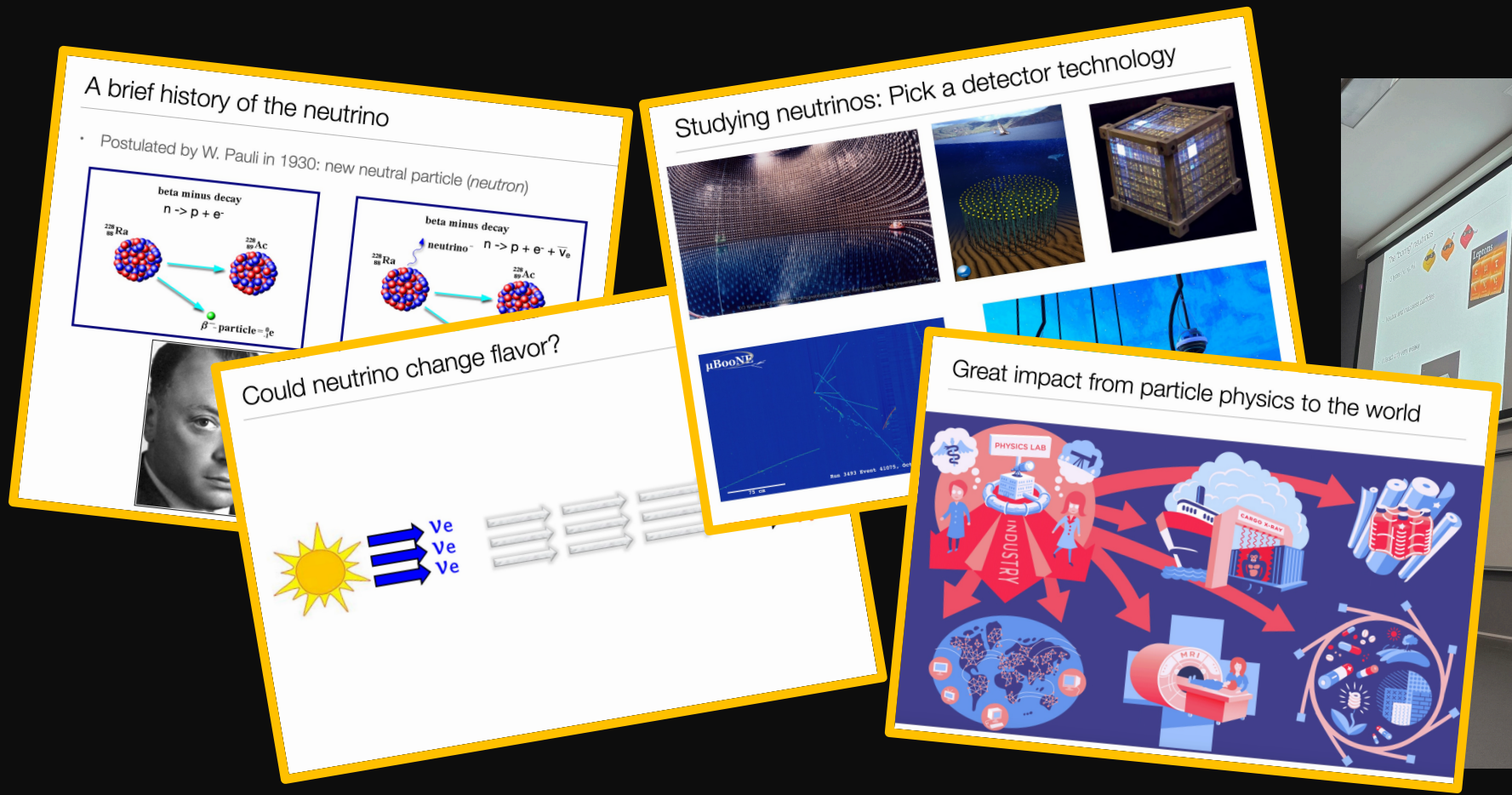






Second talk introduces different topic (currently neutrino physics)

Demonstrates different technologies, different approaches to the same fundamental questions.
While first talk focuses on collaboration, international involvement, and future participation of audience, this talk also tackles career opportunities and trajectories too.



Afternoon is highly parallelised (for logistics)

Four activities: hands on computing, nuclear lab, particle physics lab, virtual visit, before reconvening in one location for a sum-up and close

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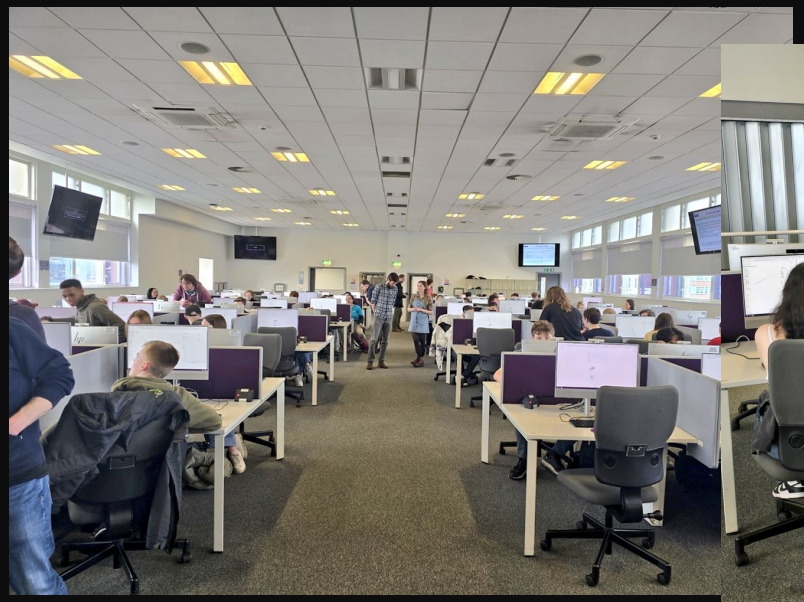
1530	Summing up [Rutherford booke ntil 1630]							

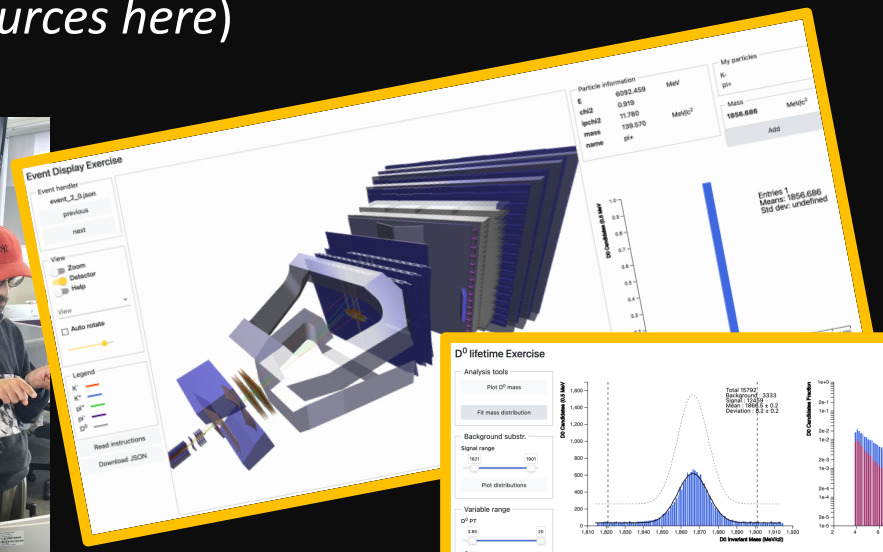
A group of ~30 students + 1—2 teachers + 1 Manchester rep follows the path through activities vertically

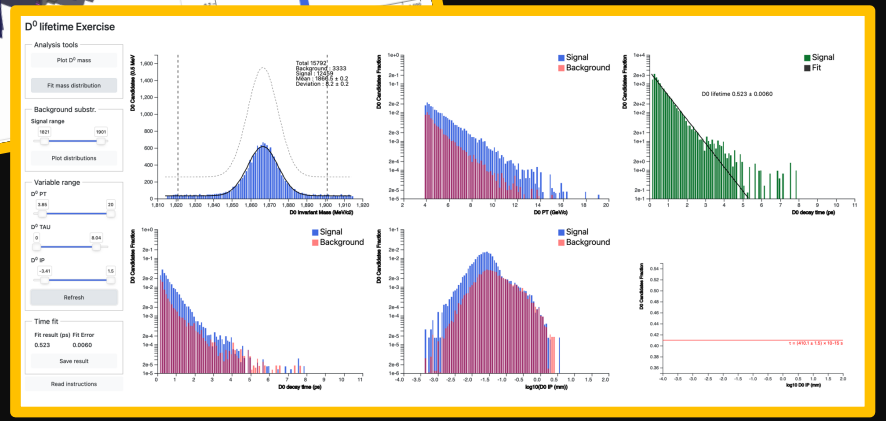
Hands-on computing session - 1 hour

Brief intro talk, then per-event event display / reconstruction activity; computer automated reconstruction; particle distributions; cut selections (signal/background); … systematics!

- Need ACTIVE staff/student support team asking good questions, providing technical advice, encouraging
- Used LEP activity in the past, currently use LHCb tool (lhcb-d0-preprod.web.cern.ch/), exploring ATLAS Open Data opportunity *(+keen to expand resources here*)

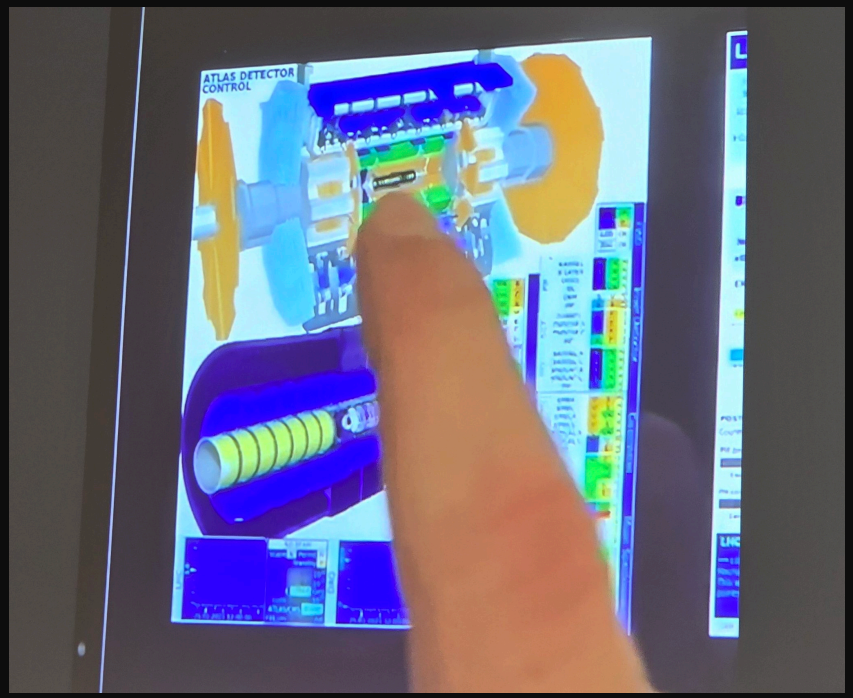






Two-way connection, tour + discussion with CERN - 30 mins

- Currently based around virtual visit to ATLAS: students keen to engage
  https://atlas.cern/Discover/Visit/Virtual-Visit



Nuclear lab (hands on demos) – 15 mins

- Opportunity for hands on live demos (using undergraduate lab equipment): explore radioactivity, characterisation, measurement apparatus
- In the past have also used outreach resources in this interval (accelerator demos etc.)
  - *Opportunity for common resource development/sharing?*

Particle physics labs / detector development – 15 mins

- Detector development, cutting edge labs, what are the tools/equipment/techniques
- Starts with brief intro, show-and-tell with detector spares, quick tour of lab facilities

Thoughts on running an event

Logistics

- Rooms: large lecture theatre, computer suite, conference rooms for virtual visits, demos – think about transfer logistics!
- Would suggest to start small (not parallelised) and then build up capacity when operating smoothly!!

Talks

- Talks need to be at appropriate level, make some connections to syllabus and what students are familiar with. Good to link to sense of place – what is role of THIS university/city?
- Highlight international/collaborative nature AND role of University staff/students – neither are obvious!
- I highlight timescales, and how students now can be working on projects like this in only a few years (UG projects, PhD, tech/engineering + routes to this)

Resource commitment

- Often but not always provided refreshments mid morning (not had any feedback to suggest this is necessary/valued + £££
- Always allowed students to bring own lunch or buy nearby (reduces costs) – check practicalities
- Think about what giveaways you want, if any: any brochures/resources you want to give out?
  Not necessarily impactful, and £££.

This is a resource-intensive activity, but gets deep engagement (a tradeoff): *40+5n/30 hrs*

1. Lead person for overall organisation, recruitment, design and planning
2. Admin contact person to help with room bookings, registration queries, liaison with schools, advertising (a lifesaver! didn't have this in the early days and really takes the load off the lead)
3. Two keynote speakers *[Load: ~ 1 hr each plus prep time]*
4. Lead person for running computing session (needs to be very engaged, present intro slides to activity, give clear instructions/expectations and mentor staff/students helping with the session) *[Load: pre-familiarity with material/exercise, 1 hour of pre-support/dry-run for support team, 12—3pm on the day]*
5. 1 staff/PhD student per 30 school student for computing activity *[Load: pre-familiarity with material/exercise, 1 hour of pre-support/dry-run for support team,3 hours on the day]*
6. 1—2 local hosts (+1/2 remote ATLAS hosts) to run 4x30 min Virtual Visits *[Load: 3 hours on day]*
7. 2 staff/PhD students per particle lab and nuclear lab activity *[Load: 3 hours on the day, plus pre-plan]*
8. Eight students (UG/MSc/PhD) to guide student groups around afternoon activities, opportunity to chat about uni life, research, etc. *[Load: 3 hours on the day]*

Put aside a couple of people who can fill in if needed on the day (esp. group guiding) – train more computing session people than you need to, and then can pull from that team if needed too to fill in elsewhere (e.g. someone who works on particle detection could fill in in lab tours)

Timeline for planning your event

-6 months: **contact key schools to find out best dates**, and secure room availability (+develop base programme, If needed!)

-4 months: **identify key staff** (two speakers, lead for computing activity) + confirm computing logistics (accounts, software running)

-3 months: send out save-the-date email to school distribution lists

-2 months: get student/staff commitment to various roles (particle/nuclear lab guides, virtual visit booking and hosts (local/remote))

-1 month: registration opens for event; advertise; finalise remaining roles (helpers, leads for parallel groups)

-2 weeks: dry run of computing activity and nuclear/particle demos – do all helpers know what they are meant to do, and how to mentor students / actively engage them?

-1 week: confirm everyone's attendance and set expectations

-1 day: remind about attendance + importance to success

Running a successful, smoothly running modularised full-day masterclass in Manchester at-scale for a decade+ … but constantly evolving!

This is admittedly a resource intensive activity (time, not £) and only works due to the commitment of staff and students in the Particle Physics group!

Future plans (+wishes for co-development in WGs):

★ Capacity: Expanding capacity (students per day, and sessions per year)

★ **Custom content for diverse audiences**: developing modified content + timetable for underserved/low science capital groups with teacher support (connection to learning/skills) – through WGs?

★ **Expand/enhance modular hands-on activities** (computing and other) – through WGs?

★ **Develop best-practice pre-/post-event evaluation** to better update offering – year-on-year, tailor content, and demonstrate impact – through WGs?