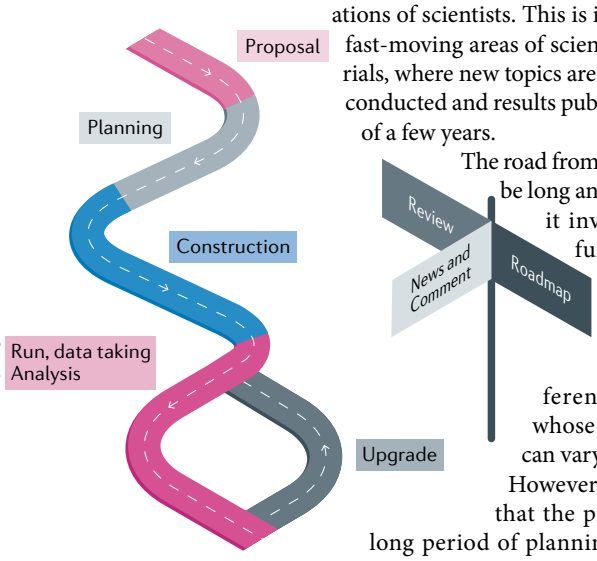
The long and winding road

In this issue we look back at the debut of two unique experiments a decade ago and forward to the future of gravitational wave astronomy. We ponder on how journals can follow such long-term projects reporting every step of the way.

May 2011 – on the last flight of the space shuttle Endeavour the Alpha Magnetic Spectrometer 2 (AMS-02) is transported to the International Space Station (ISS) where it will be operating for the next decade. 2011 saw the end of NASA's Space Shuttle program, but also new beginnings. In the US the Advanced LIGO installation was underway, while at the South Pole the construction of the IceCube neutrino observatory had just been completed. Few people would have then predicted, or even dared hope, that in a few years LIGO would detect gravitational waves and IceCube would spot ultrahigh-energy neutrinos from a blazar. New discoveries occur unexpectedly, but the concepts for the instruments that make them possible precede them by decades.

The idea of a space-based spectrometer to detect antimatter, like AMS, was proposed in 1994. The IceCube proposal was made in 1999 and its construction began in 2004. As for LIGO, its roots can be traced back to the 1970s. The first proposal for LIGO was made in the early 1980s and construction was approved in 1990 and completed in 1999. Similar or even longer timescales are common for big projects in particle physics, space missions and astronomy. Big science requires lengthy planning, extensive R&D and the involvement of generations of scientists. This is in stark contrast with fast-moving areas of science, such as 2D materials, where new topics are funded, experiments conducted and results published in a timeframe of a few years.



Credit: Charlotte Gurr/Springer Nature Ltd

The road from idea to discovery can be long and even more so when it involves the planning, funding, construction and operation of a big instrument. A project follows a path through different stages (pictured) whose nature and duration can vary between disciplines. However, it is always the case that the project begins with a long period of planning and construction where relatively few publications are produced. After the original proposal, which can be a white paper or a report, scientists develop more detailed plans described in a technical paper or a technical design report. Throughout planning and construction, there is intensive R&D documented by instrumentation papers. When the instrument is completed and starts running, there may be periods of intensive data taking, followed by breaks for upgrades and maintenance. The cycle operation run–commissioning break can be repeated several times before the instrument is retired or is upgraded to a new generation. Data analysis can be long and laborious, the periods marked by the publication of exciting new results are short compared to entire lifespan of a big project.

Due to the size and complexity of upcoming instruments, the timescales in big science will only lengthen. But in publishing, timeframes are often aligned with the pace of fast-moving research. How can then scientific publishing better report on the progress in fields characterized by long research cycles with uneven publication output? In primary research, there is an increased awareness of the needs of big projects which led to dedicated new journals such as Computing and Software for Big Science. There is more news coverage of the technical breakthroughs and more recognition in high profile journals for the intermediate results leading to a big discovery. Still there's more to be done to cover the entire research cycle.

Reviews of the results of an individual experiment (such as this Review of the BESIII physics programme) are becoming more common. In this issue, two short pieces celebrate the past decade of discoveries from AMS-02 and IceCube. Also in this issue a Roadmap on gravitational-wave research in the 2020s and 2030s provides a beautiful example of how review articles can also look into the future, state the most important questions and map out research directions. Roadmaps outline the timeframes for achieving certain milestones and help newcomers find their feet in the field. By looking back at past achievements, providing context for the latest discoveries, and looking forward with anticipation at what is to come, *Nature Reviews Physics* aims to document the life of present and future big projects following them closely on their path.