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Why Collaboration?

Prof Jim Hough

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University of Glasgow

14th June 2016

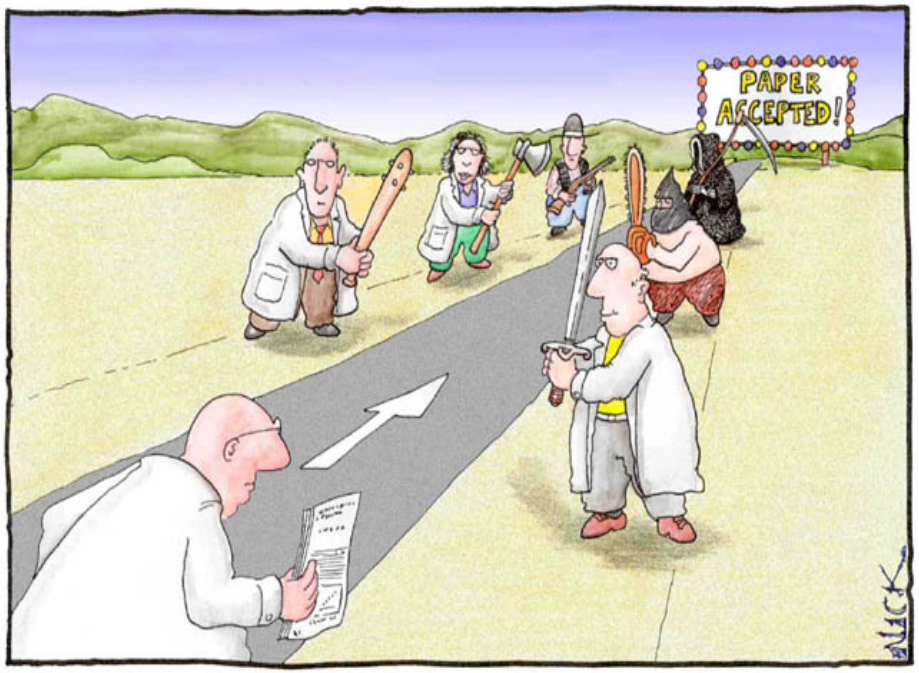
My Background

- 1971 Ph.D. in Nuclear Instrumentation (Glasgow)
- 1972 Lectureship in Natural Philosophy at Glasgow University
- 1983 Visiting Fellow JILA, Boulder Colorado
- 1986 Professor of Physics (Glasgow)
- 1984 – 2009 PI of Gravitational Wave Group and then Director of the Institute for Gravitational Research at Glasgow
- 2009 ongoing – Associate Director, Institute for Gravitational Research at Glasgow

- 1993 FInstP
- 2001 FRSE and FAPS
- 2003 FRS
- 2012 FRSA
- 2013 OBE for Services to Science
- Major Grants typically share of > £2M/annum

Life as it sometimes seems

And even more



Most scientists regarded the new streamlined peer-review process as 'quite an improvement.'

"I'm sorry, he left for his annual holiday this morning and won't be back until this afternoon."

Collaboration can be the answer

Historically as parts of physics have grown to require large facilities they have become collaborative in nature
Very well illustrated by

- **the discovery of the Higgs boson at the LHC, CERN**
- **The nuclear physics and neutron facilities round the world**
- **The development of the large gravitational wave detectors LIGO, Virgo and GEO 600**
- **The growth of physics 'pools' like SUPA and SEPNET in the UK**

My field

‘Gravitational wave astronomy’

Highlighted by our discovery of gravitational waves from a coalescing black hole system in September 2015

- In the last ~20 years has turned from laboratory based research into ‘big science’ on the international stage *
- The UK (led by Glasgow) along with our German colleagues (Albert Einstein Institute, Hannover) are recognised as world leading (where the players include Caltech, MIT, Stanford, ANU, ICRR Univ Tokyo, Univ Rome, Pisa..others)
- Many of these organisations were once our competitors
- How did it get to be that way?

*I know that you come from a variety of fields, some very different in nature, but I think that there can still be interesting common features of progress in research

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Answer in one slide

- In the UK we explicitly could not compete with financial investment in the field in the USA and Europe
- We (repeatedly) found a niche activity that was critical in the field (either in experimental ideas or techniques for the analysis of data)
- Became experts in those niches
- Our competitors then needed our expertise to make progress and we became highly desirable collaborators

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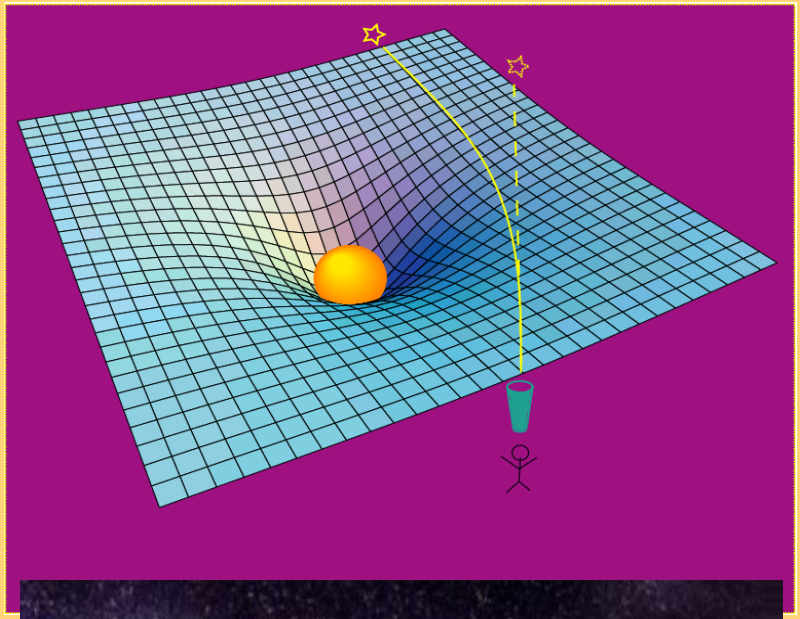
In practice how did this work?

- Need a slight digression into context, science and history...

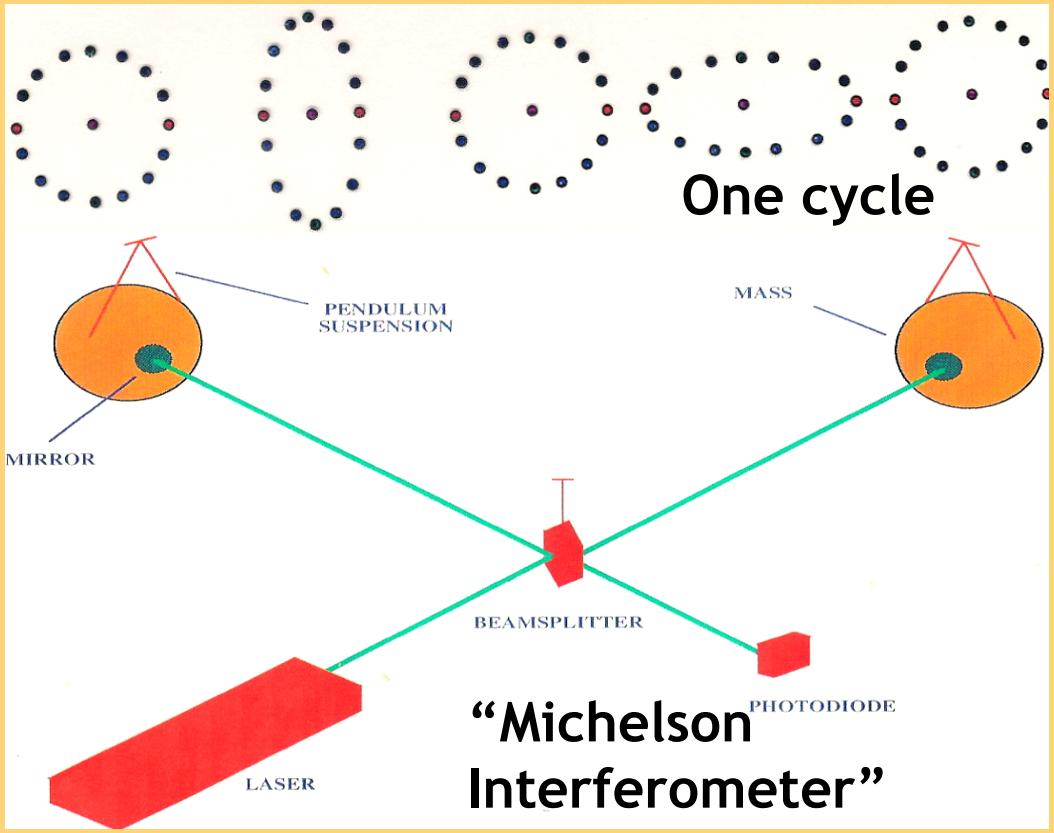
Gravitational Wave Astronomy

'ripples in the curvature of spacetime' that carry information about changing gravitational fields



Binary stars or black holes colliding

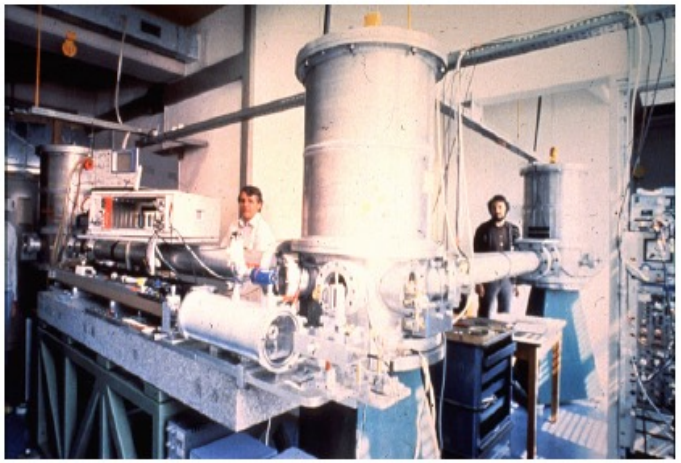
Consider the effect of a wave on a ring of particles :

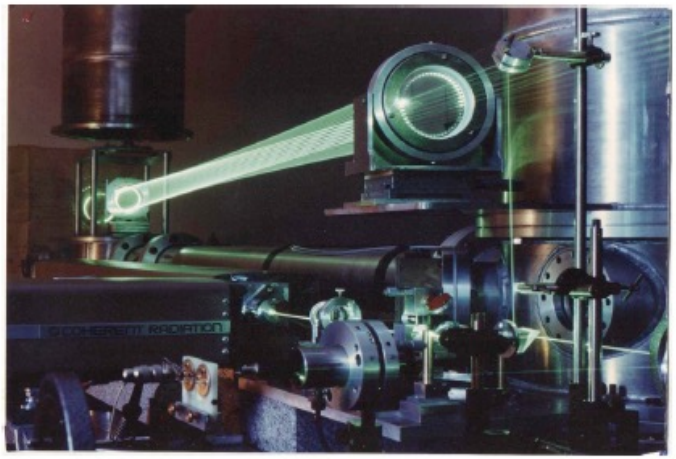


"Michelson Interferometer"

Years of competition in the lab ('70s and 80s)

Garching MPA/MPQ





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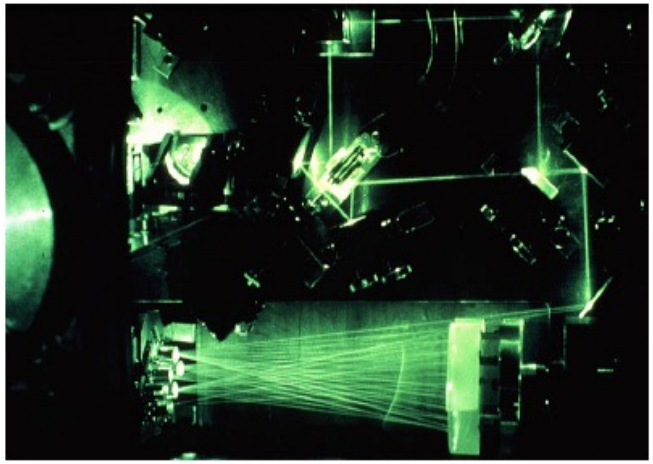

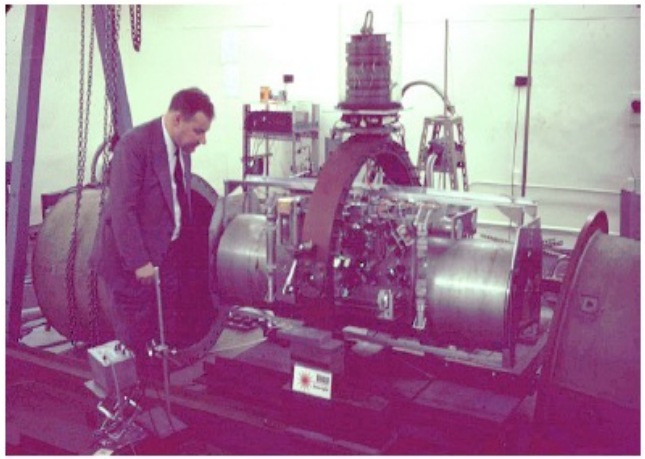

Plus at MIT (and Caltech) – also researchers in France, Italy

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In the USA

1983 Little and Stone Design study for Long baseline GW detector (Weiss MIT)
1984 First Design Study Proposal to NSF for LIGO (Drever, Thorne and Weiss)
1985 Revised LIGO Design Study Proposal to NSF
1989 LIGO Construction proposal to NSF

German detector proposal 1985-1987

MAX-PLANCK-INSTITUT FÜR QUANTENOPTIK

Plans for a large gravitational wave antenna in Germany

Walter Winkler, Karl Maischberger, Albrecht Rüdiger
Roland Schilling, Lise Schnupp, David Shoemaker

M P Q 101 August 1985

'Plan for a large gravitational wave antenna in Germany'

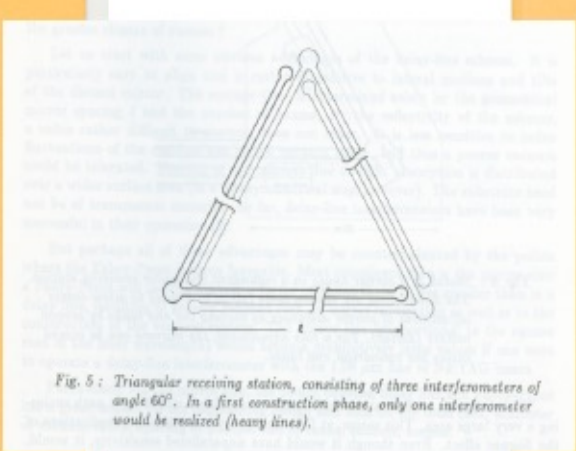


Fig. 5: Triangular receiving station, consisting of three interferometers of angle 60°. In a first construction phase, only one interferometer would be realized (heavy lines).

MAX-PLANCK-INSTITUT FÜR QUANTENOPTIK

Proposal for the Construction of a Large Laser Interferometer for the Measurement of Gravitational Waves

Translation of Summaries of the Report M P Q 129

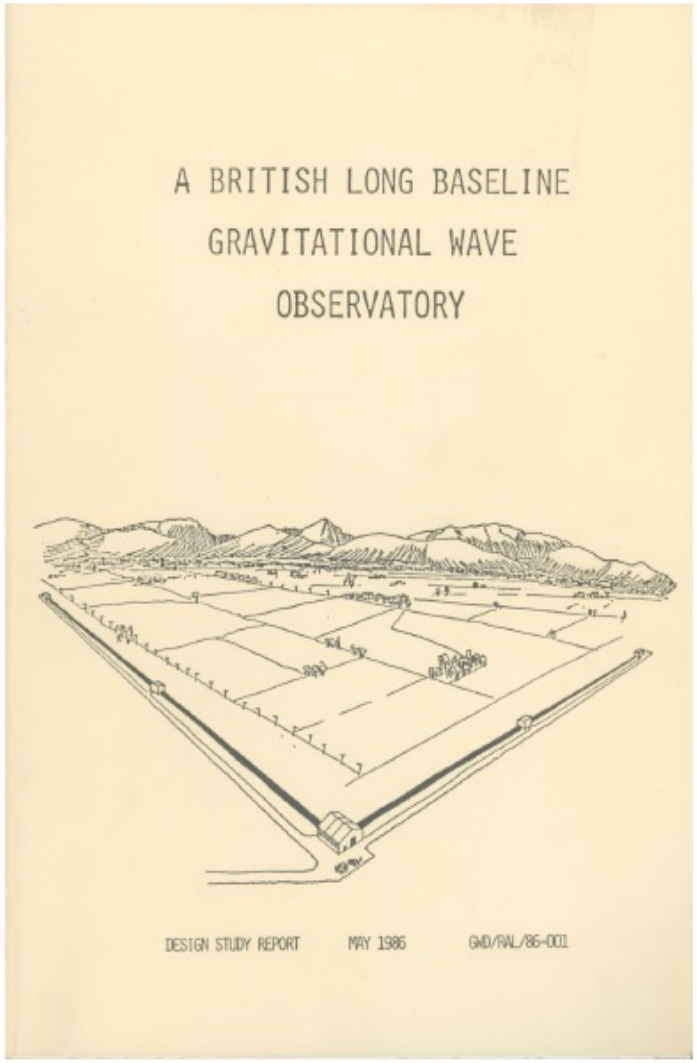
Vorschlag zum Bau eines großen Laser-Interferometers zur Messung von Gravitationswellen
– Erweiterte Fassung –

Gerd Leuchs, Karl Maischberger, Albrecht Rüdiger
Roland Schilling, Lise Schnupp, Walter Winkler

M P Q 131 June 1987

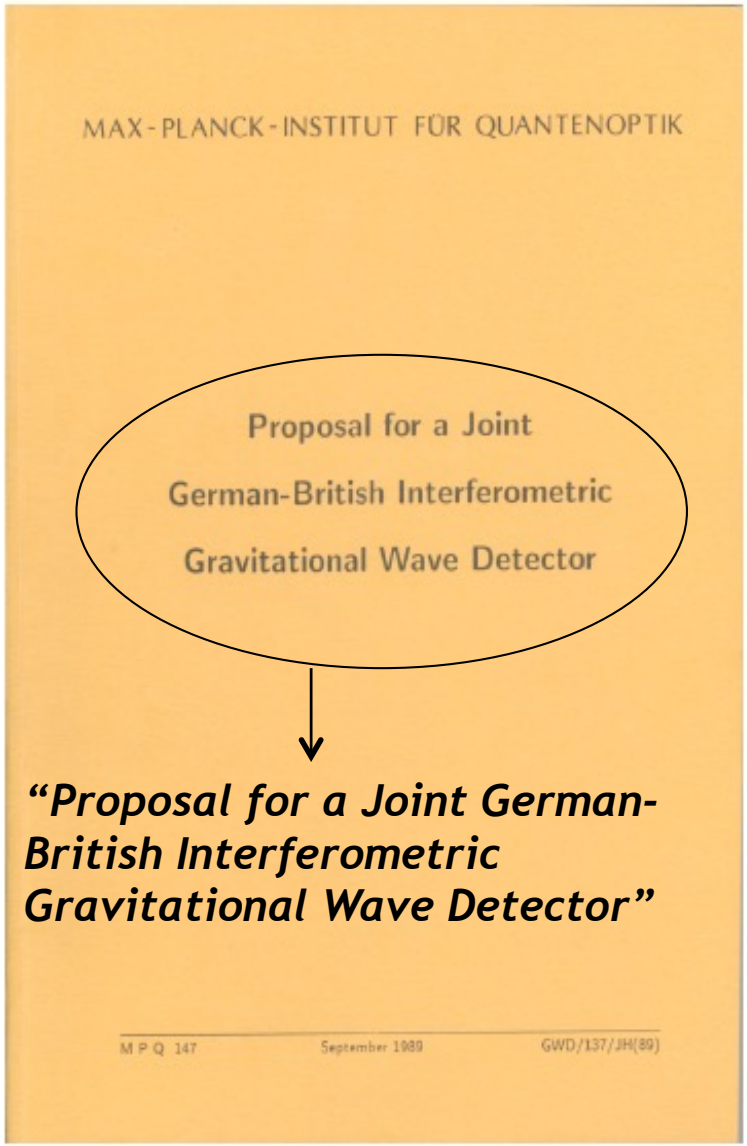
'Proposal for the Construction of a large laser interferometer for the measurement of gravitational waves'

UK detector project 1986



Tentsmuir Forest

German-UK proposal 1989



"Proposal for a Joint German-British Interferometric Gravitational Wave Detector"

UK money promised

But SERC program in UK overheated

And Reunification began in Germany

↓

No funding available

Meanwhile big detectors in USA, Italy, being proposed and funding becoming available

New German/UK project – "GEO600", 1994

Workshop in Bad Honnef between the UK and German groups.

Led to concept of a smaller, cheaper, technically advanced 'niche' detector.

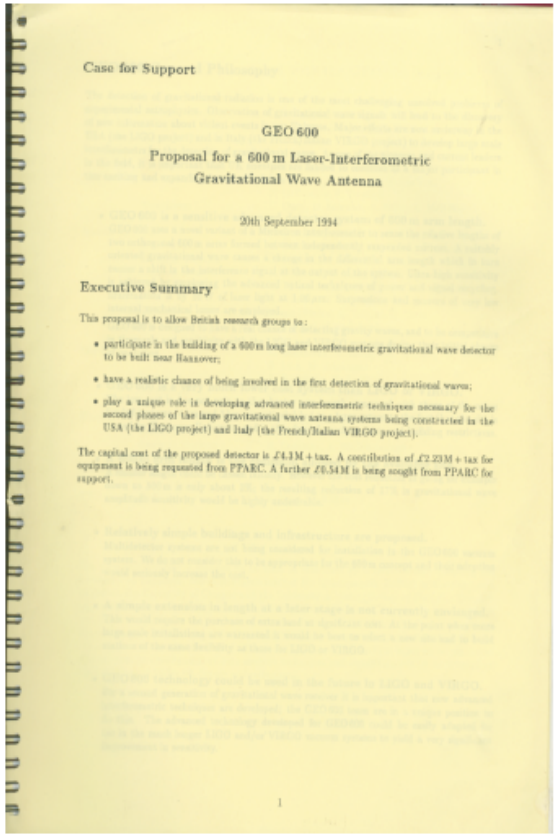
Low cost/ high risk compared to other projects

Novel, 'advanced' technologies

↓

Funding of smaller scale project in Hannover

Niedersachsen, VW and PPARC



Case for Support

GEO 600

Proposal for a 600 m Laser-Interferometric Gravitational Wave Antenna

20th September 1994

Executive Summary

This proposal is to allow British research groups to :

- participate in the building of a 600 m long laser interferometric gravitational wave detector to be built near Hannover;
- have a realistic chance of being involved in the first detection of gravitational waves;
- play a unique role in developing advanced interferometric techniques necessary for the second phases of the large gravitational wave antenna systems being constructed in the USA (the LIGO project) and Italy (the French/Italian VIRGO project).

The capital cost of the proposed detector is £4.1M + tax. A contribution of £2.23M + tax for equipment is being requested from PPARC. A further £0.54M is being sought from PPARC for support.

1

(now STFC)

20 years of joint research since then..

The bigger picture

- The larger projects (100s of $M led by Caltech and MIT) were too big to take risks – led to conservative technology
- When time for ‘next steps’ came, they were behind in R&D.. they were not in a position to compete. They had to collaborate.
- The UK/German collaboration became key to the next stages in the big global projects
- 2003 - UK (led by Glasgow) committed £8M to supply technology to the US (in parallel Germany agreed slightly more.....)
- 2008 – US National Science Foundation agreed to fund ‘next generation’ of US detectors (a further $200M investment) with the UK and Germany as partners – seats on Oversight committee/executive committee etc

Answer in one slide

- In the UK we explicitly could not compete on investment compared with USA and Europe
- We (repeatedly) found a niche activity that was critical in the field (either in experimental ideas or techniques for the analysis of data)
- Became experts in those niches
- Our competitors then needed our expertise to make progress and we became highly desirable collaborators
- *Whilst working on collaborative projects ...time to move into the next niche area....*

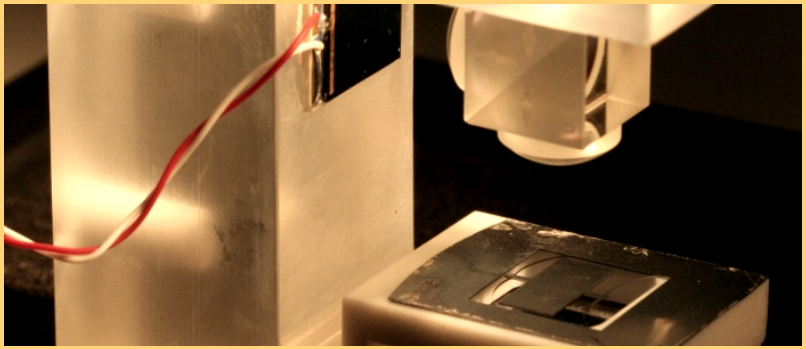
So, meanwhile..

- In the UK and Germany for the past 5-10 years in parallel with supporting our US collaborators we've been working in the lab on technology for new detectors and the _next_ stage of upgrades.....

(Aside - in 2013 we incorporated that R&D with other related technologies (including Miles Padgett's work) into the first 'International Max Planck Partnership' on 'Measurement and Observation at the Quantum limit'.

Precursor to the recent 'Quantum Hub QuantiC' – led by Miles/Steve Beaumont - and possible further collaborations...

Indeed Giles Hammond and colleagues collaborating inside Quantic have designed and built a highly sensitive MEMS gravimeter resently featured in Nature



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Now

- In 2016 the US is again looking to its future and the next stage of upgrades...again they are behind in technology R&D cf the UK/ Germany (but efforts are ramping up..)

So while we continue our work with our US collaborators, it's probably time to start thinking of a new niche.....we're working closely with our European colleagues..

Summary

- Biggest isn't always best if your aim is to stay at the forefront – you need to (be able to) take risks
- Good collaborators are invaluable – don't compete when you don't have to
- Recognise one's weakness and play to one's strengths

Whatever your field - what is the niche area that you can be expert in that others will need?.

- *Always* be looking for the next niche whilst others catch up

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Today: The Global Network of Gravitational Wave Interferometers