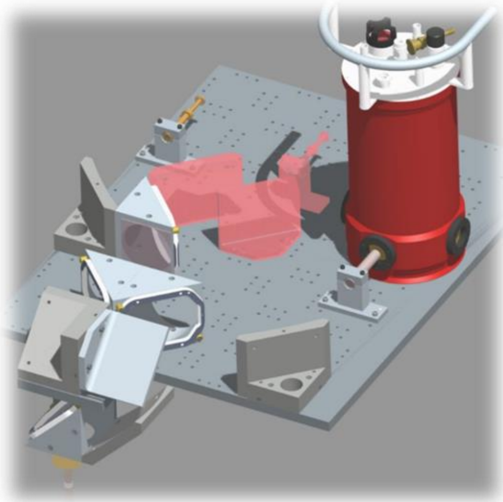
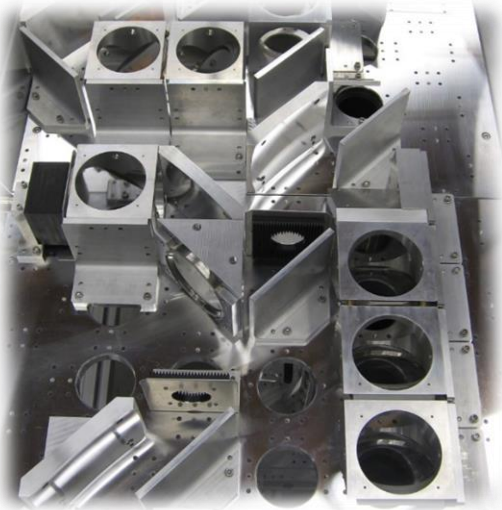
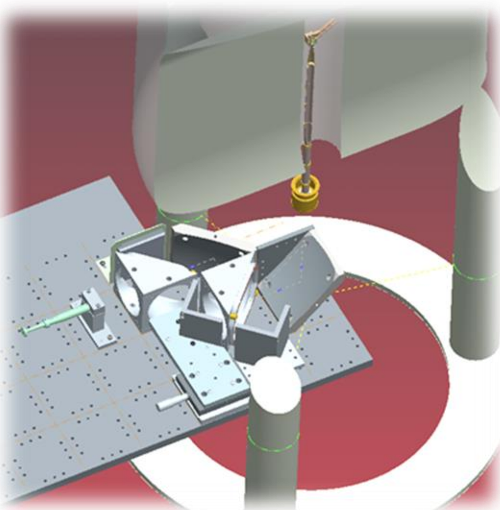
TK INSTRUMENTS



High Field Electron Spin Resonance

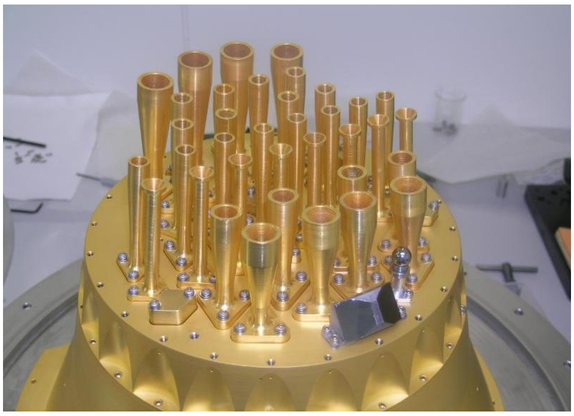




About Us

Thomas Keating Ltd. (TK) and its sister company QMC Instruments develop, design and manufacture quasi-optic (QO) components and systems for ESR and DNP-NMR.

TK's offices and factory in Billingshurst, West Sussex, UK



The feed-horn cluster for the Planck High Frequency Instrument, now parked near Lagrangian point L2

Other applications of our feed horns, mirrors, polarising wire grids, isolators, dichroic filters and absorbers include plasma fusion diagnostics, material characterisation, cosmology, astronomy, and atmospheric remote sensing.

The commercial origins of Thomas Keating Ltd. stretch back to the 18th Century. The scientific instruments side of the business, developed over the last thirty years, draws on our existing tool-making skills. We design and develop quasi-optical systems and subsystems operating in the millimetre and submillimetre wave regime.

The two companies employ about 50 people and are unique in the generation, manipulation and detection of millimetre and far infra-red radiation. In 2012 Thomas Keating Ltd. received a Queen's Award for Enterprise, a very rare distinction.

For more information please contact us by e-mail or using the details at the bottom of this page.

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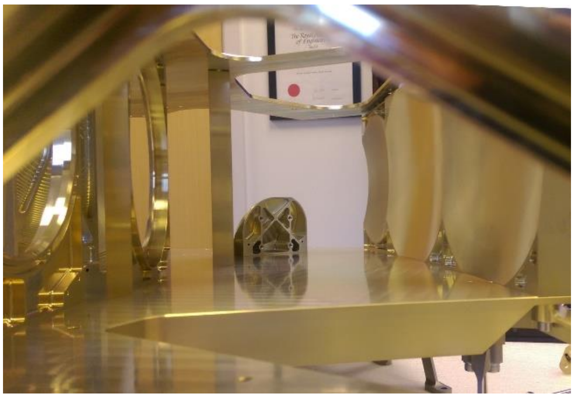

Inside the Quasi Optic Network (QON) Engineering Qualification Model for the MetOp-SG satellite MWS instrument

Thomas Keating Ltd

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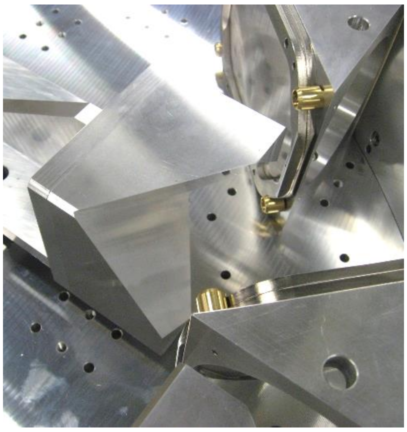
THE QUEEN'S AWARDS FOR ENTERPRISE: INTERNATIONAL TRADE 2012

TK Expertise in High Field ESR and DNP



Diagonal roof mirror – part of a Martin-Puplett interferometer for NIH (USA)

For over 20 years TK has been working with leading experimental scientists to design and build high field EPR and DNP bridges.

Predominately working at W-band and above, and drawing upon expertise in the Millimetre-Wave and EPR Group at the University of St Andrews, we have installations in universities and national labs around the world.

Examples of our low loss quasi-optics and HE11 probes, and cooled broad-band detector technologies are shown below. Other customers in Europe include groups at CNRS Grenoble, EPFL Lausanne, Heidelberg, Pisa, Saclay, Nottingham, Warwick, Mulheim, Berlin and Frankfurt, and in the USA include groups at MIT, NHMFL, Cornell, Yale, UF Gainesville, Northeastern, Northwestern, John Hopkins, PNNL and UCSB.

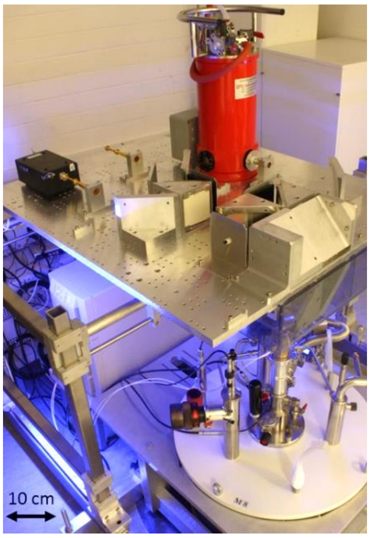
We regularly collaborate with Virginia Diodes Inc. (http://vadiodes.com/) – and recommend the use of their source multiplier chains and room temperature Schottky diode detectors.

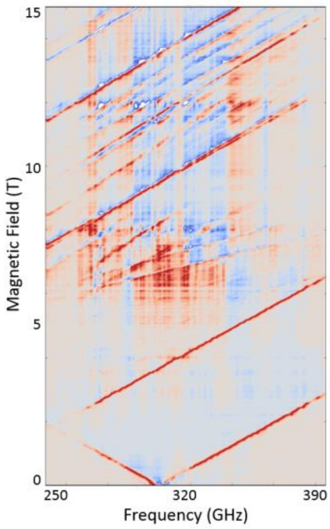
We would be happy to discuss any plans and programmes to bring our skills to your measurement challenges.

University of Stuttgart

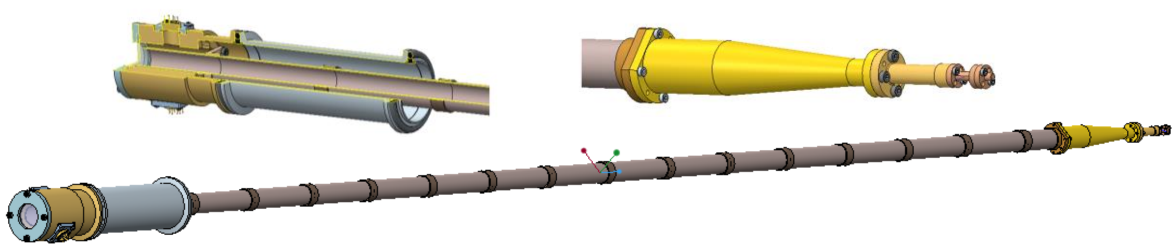
TK have supplied the quasi-optic bench and ESR probes for a very broadband spectrometer, with bands centred at 210, 320, 430 and 630 GHz.

A QO bench (near right, with example data) provides co-polar and cross-polar ESR detection capabilities and isolation using ferrite tiles. A QMC-I Ltd. hot electron bolometer type QFI/XBI is included.





The QO bench provides the feed to an ESR probe (CAD images shown below) through an impedance matched vacuum window. A circular corrugated waveguide connects the input beam waist above the cryostat aperture to a corrugated taper near the magnet centre, which reduces the beam to the sample size.



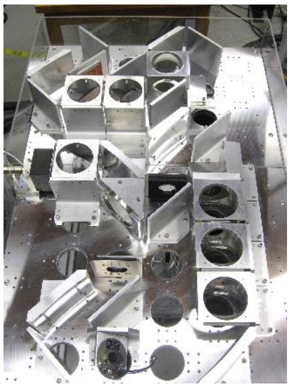
University of St Andrews

TK collaborated with the Millimetre Wave & EPR group on the HiPER project, a 94 GHz kilowatt pulsed ESR spectrometer. It has the ability to perform ESR and certain DNP-NMR experiments. The quasi optics in this spectrometer help to give it a very short dead time by reducing standing waves. HiPER spectrometers have now also been supplied to PNNL (USA) and FSU for NHMFL (USA).

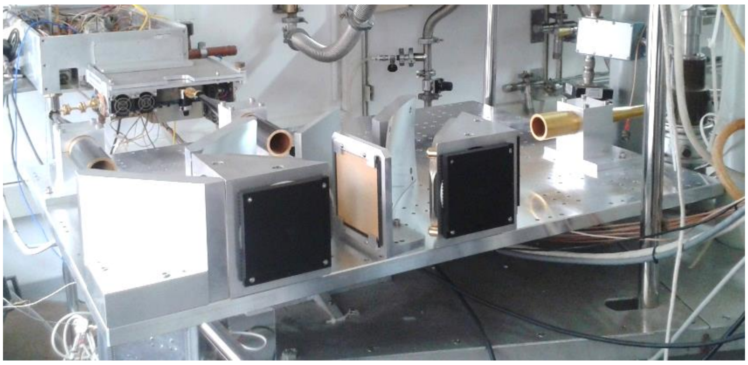
Florida State University (NHMFL)

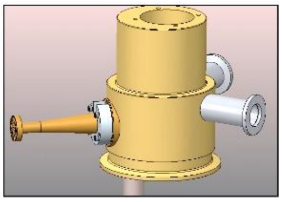
DNP-NMR QO benches, with Thierry Dubroca (FSU), Richard Wylde (TK) and Kevin Pike (TK).

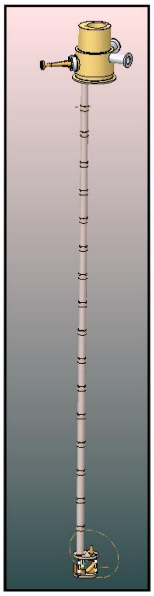
TK has supplied ESR and DNP-NMR equipment to the FSU labs at NHMFL, including a HiPER spectrometer, a QO bridge for a multi-frequency high-frequency pulsed ESR/ENDOR spectrometer and QO for processing a 395 GHz gyrotron beam and feeding it to 2 DNP-NMR spectrometers.

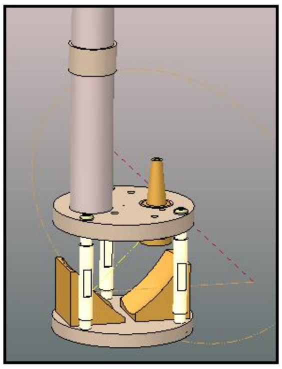


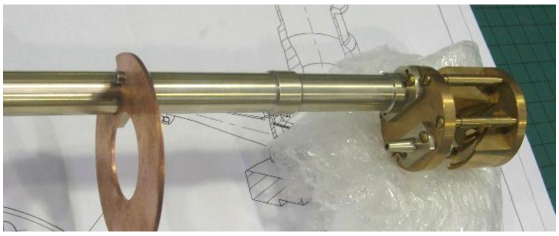
Weizmann Institute of Science











TK has manufactured two 94 GHz probes for ESR and DNP-NMR, using two refocussing mirrors to feed the beam to the sample holder from below, allowing a sample changer mechanism to extract the sample from above.

We have also provided a circulator-like QO bench that provides isolation and cross-polar ESR signal detection (shown top right, above).

Quasi-Optical Components

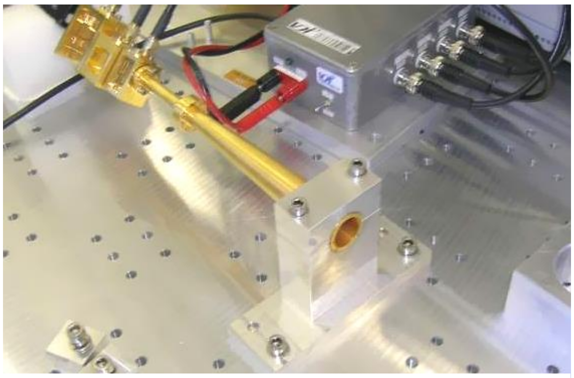
HE11 corrugated circular waveguides

18 mm ID 263 GHz corrugated waveguides with precision mitre bends, rotatable flanges and tapers. Larger and smaller IDs and a larger range of frequencies are available.

These waveguide are used by TK to provide efficient transmission of microwaves and mm waves along magnet bores and through cryostats. These are manufactured from German/nickel silver, as standard, which is not ferromagnetic.

TK produces these waveguides with a range of internal diameters and frequencies (< 10 to > 20 mm; 94 GHz to > 500 GHz, see Figure 2.4).

Corrugated horns and tapers

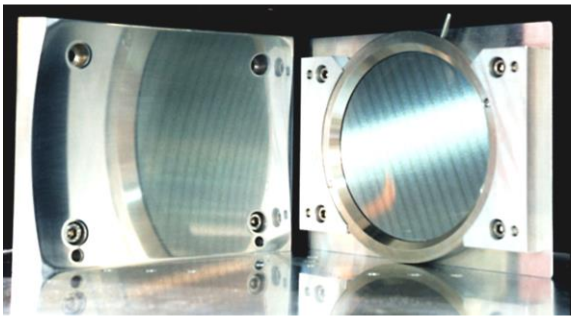


TK Ultra-Gaussian gold-plated copper feed horn with VDI waveguide-based multipliers

TK manufactures corrugated horns and tapers for frequencies between 40 and >1000 GHz by electroforming copper. It has its own gold-plating facilities.

We develop designs for horns, tapers and other components with academic and commercial collaborators: Ultra-Gaussian horns were developed that improve the Gaussian profile of beams and thus simplify the design of efficient QO systems.

Wire-grid polarisers (WGPs)

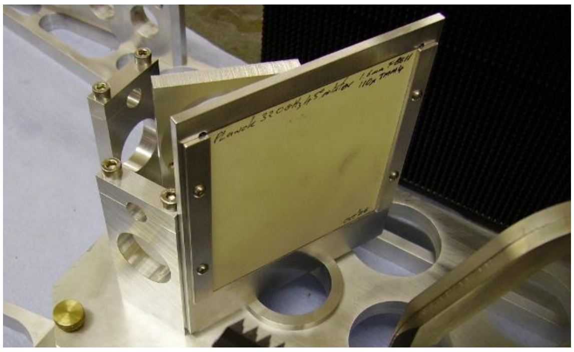


A curved refocusing mirror (left) and a rotatable wire-grid polarizer (right)

We manufacture high-performance grids for frequencies well above 500 GHz. These can be used to purify linear polarisations in beams, to split beams and to attenuate beam power.

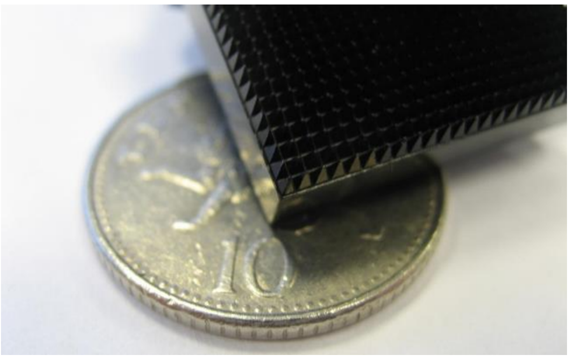
Our WGPs form important parts of our free-space isolator and Martin-Puplett interferometer subsystems.

Free-space isolation



ESTEC used a 310 GHz isolator supplied for the calibration of the ESA Planck CMB mission

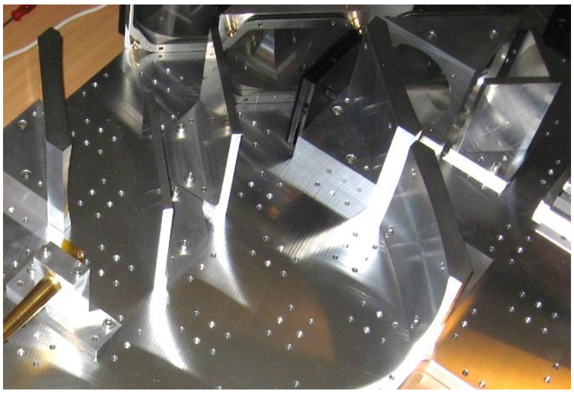
Our free space isolators utilise the Faraday rotation of polarisation caused by transmission through or refection by a ferrite-based tile of material. The tile causes the polarisation to be rotated by 45°. The tile is used together with a system of WGPs to dump reflected power into a high performance load.



TK RAM tile with sharp pyramidal array: 25 mm square for higher frequencies

Tessellating Terahertz RAM tiles

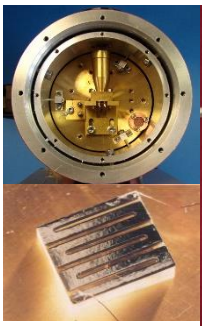
These tiles of radar-absorbing material (RAM) are used as beam dumps. They can be locked together to form larger sheets. Two versions are available: a small tile, 25 mm square with good operation down to 100 GHz, and a larger tile 100 mm square, operating to below 50 GHz. Our ‘witches hat’ horns developed for HiPER provide higher performance, when it is needed.



Refocusing and flat mirrors on a standard TK 125 mm grid bench plate

Mirrors, lenses and bench plates

TK manufacturers a wide range of mirrors for its QO networks but we can supply standard parts that can easily be reconfigurable, including mirrors and lenses, as well as the other components described here. Standard parts are for bench plates with either 125 mm or 62 mm grids of mounting points. At each point, there are tapped holes for fixing components and holes for dowels for accurate positioning (our systems are accurate: they do not need adjusting).



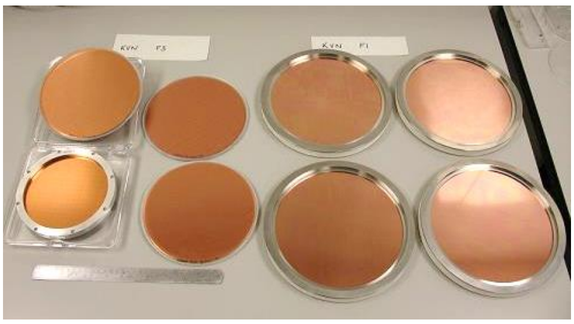
Bolometer and Winston cone in cryostat (top). Indium antimonide hot electron bolometer (above).

Liquid helium and dry detector systems (right).

Detector systems

We offer a range of high-sensitivity detectors that operate at 4 K and below, including systems packaged with our own cryostats, optics, filters and amplifiers. ‘High sensitivity’ means 1 pW/Hz^{½}.

- Superconducting bolometer (high sensitivity above 100 GHz)
- InSb HEB (hot electron bolometer) (high sensitivity up to 500 GHz and fast response)
- Magnetically enhanced InSb HEB (high sensitivity above 500 GHz and fast response)
- Doped germanium photoconductor (high sensitivity above 1.5 THz)



Free-space multi-mesh filters with a 30 cmm rule for scale.

Free-space filters

We offer a unique multi-mesh filter technology that allows extremely precise wavelength selection. Low-pass, high-pass, band-pass and band-stop (notch) types are available in standard and non-standard specifications. These can be used from 1 K to above room temperature and can be cut to size.

Anti-reflection coatings are also available.