Innovate UK

Results of Competition: SBRI GNSS Antenna - Phase 1
Competition Code: 1410_SBRI2_Ant

Total available funding for this competition was £467,735 from Innovate UK and the MOD

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
BAE Systems Applied Intelligence Ltd	Compact GNSS Antenna Phase 2	£190,144	£190,144

Project description - provided by applicants
Global Navigation Satellite Systems (GNSS) are well established and applications are expected to increase in the foreseeable future. Applications include navigation and positioning for a very wide variety of vehicles, people and high-value commercial goods. However, systems such as GPS and Galileo operate at microwave frequencies around 1GHz where the wavelength of signals is about 30cm. An antenna is an essential component in any GNSS system. The antenna size should be comparable with the wavelength to work efficiently. Typically, a conventional GNSS receive antenna might measure around half a wavelength (15cm) which is too large for many applications such as man-worn or electronic tagging systems. Smaller GPS antennas are available, but have reduced sensitivity. Also, as alternative GNSS systems such as Galileo become available there is a need to work with services operating on multiple frequencies from a single antenna. The challenge is to make an affordable antenna with a small physical size and high sensitivity. This proposal is for a project to demonstrate a highly compact antenna for GNSS applications covering the 1176MHz (GPS L5/ Galileo E5a) to 1575MHz (L1/E1) frequency range. The project will be led by BAE Systems Applied Intelligence Laboratories (AI Labs) who have over 50 years experience in antenna design, navigation techniques and electromagnetic (EM) simulation. AI Labs develops technologies for BAE Systems product units (Military Air, Maritime and Land Systems) and so is well placed to bring a military systems perspective, environmental qualification and exploitation route to the GNSS solution. MoD is currently funding AI Labs to design both wideband antennas and body-worn antennas manufactured using conducting textiles. AI Labs will be supported by Liverpool University (LU) who are one of the leading Universities in the UK for innovative research into novel antennas, electronics and measurement techniques. This proposal is for a follow-on to the Phase 1 study in which we developed a highly-compact crossed dipole antenna design which receives circularly polarised waves across the required frequency bands (1176, 1227 and 1575MHz). The design is compatible with the target size of 50mm and may be used both for body-worn and vehicle mounted applications. The aim of Phase 2 is to demonstrate a prototype antenna. The work will comprise 3 phases: Optimise existing design, manufacture prototype units and evaluate the RF performance characteristics. The RF performance characteristics will be evaluated with the antenna isolated in free space, above a ground plane and installed on the DSTL "phantom" (a manikin representative of the human body). Measurements will be carried out in the AI Labs anechoic chamber and the LU reverberation chamber and techniques for manufacture. Recent research at LU has demonstrated a compact (50mm x 50mm x 2mm) antenna design which receives circular polarisation over the desired three frequency bands (1176, 1227 and 1575MHz) with low rejected power (VSWR<1.5). This design, which is described in this proposal and is subject to a patent application, achieves a performance close to that required by SBRI. However, Phase 1 will investigate further size reduction, use of alternative materials and sensitivity of the design to near by materials. Following Phase 1, a prototype antenna will be built and demonstrated in Phase 2 which is outlined in this proposal.

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Surrey Satellite Technology Ltd	Slotted Circular Broadband GNSS Antenna - Phase 2	£75,248	£75,248

Project description - provided by applicants

This Phase 2 study continues the development and test of new GNSS antenna technologies put forward by SSTL in the Phase 1 study. Two different prototype antenna designs were produced by SSTL applying the technique of Composite Left and Right-handed Transmission Lines (CRL-TL), often referred to as meta-materials. Using CRL-TL allows the reduction in size of antenna features below the normal 1/4 wavelength limit. One antenna developed was a multi-resonant interdigital antenna, the other a circular slotted ground-plane broadband antenna. During this Phase 2 study, the main focus will be on the development of the most promising slotted circular broadband antenna for practical applications. The design of the antenna will be refined, packaging options will be developed with a view to manufacture, 10 units will be produced and will undergo testing in collaboration with DSTL laboratories. At the end of the study, a report will be issued detailing the path to commercial exploitation. .

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Arralis Technologies Ltd	Phase 2 Prototype Development of a GNSS Antenna Using a Meandered Spiral and High Impedance Surface	£97,600	£97,600

Project description - provided by applicants

The Arralis design is a low space, weight and power, wearable (e.g. in a MTP helmet cover for an MK6 helmet) or mountable, spiral antenna which uses a High Impedance Surface (HIS) to reduce the thickness (to < 8 mm). By using a meandered spiral type antenna on a HIS, the surface area is kept within 96 mm x 86 mm, and by incorporating a ground plane, the mounting, or 'contact' interactions are removed, meaning that the antenna can be positioned easily on equipment or clothing. The work from Phase 1 shows that the single connection component is well matched to 50 ohms from GPS L5 to GPS L1 frequency bands using a stripline Marchand Balun, and operates using Right-Hand Circularly Polarised (RHCP) waves with an in-band axial ratio < 3 dB. By using a multi-resonant HIS to introduce multiple in-band, in-phase waves from the antenna reflector, the antenna gain and radiation efficiency are increased over a wider bandwidth than conventional antennas and with the added advantage that the thickness and weight are kept to a minimum. This highly repeatable design will be manufactured using existing PCB manufacturing processes to ensure high yields on a technology that is resilient for battlefield conditions, and to keep the costs to a minimum. Furthermore, flexible or woven materials will be implemented to render the device suitable for on-body applications. Simulation results performed in Phase 1 show good performance with the antenna having passive gain in all bands at the larger antenna size. Simulations also show that the antenna can operate, with low dc consumption using active gain, at a lower size and profile.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Selex ES Ltd	GNSS Antenna Phase II	£86,256	£86,256
Project description - provided by applicants			
Selex ES are proposing an antenna concept that employs novel microstrip printed element technology to obtain multi-frequency, GNSS operation from a single, composite output, low profile patch-ring antenna. The fundamental design is a quad-band circular patch antenna with parasitic concentric ring resonator and an innovative coupled line feed structure. This technology uses established printed circuit fabrication techniques and can therefore be easily manufactured, at low cost, to suit a wide range of applications where size and weight is a key parameter, for example, the dismounted soldier or small vehicle deployment. A critical design feature for this concept is performance stability and reliability of the antenna when deployed on the platform itself in a typically harsh military environment. The principle of this antenna element design is modular and scalable making it applicable to a variety of applications, including use within controlled radiation pattern arrays (CRPAs) as used in anti-jam networks.			

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