

WP: MAGIS-UK

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UK Contributions

- The UK as a partner and an early member
- Looking to contribute and help with the experimental effort
- Bring an international element
- Experience of particle physics working in atom interferometry
- Has motivated the AION experiment
- Bring hardware and manpower
 - Staggered contribution – later in 2019
 - See following slides
- Submitted MAGIS-1000 to the Update for the European Strategy for Particle Physics

UK Contributions

Can be broadly split into

- Lasers
- Cameras
- Readout, control, etc
- Mechanical
- Analysis

UK Lasers identified as system capable for interferometer

SOLSTIS

The award-winning SolSTiS is a step-change in continuous-wave Ti:Sapphire laser technology. It's a super-compact system with a completely sealed, alignment-free cavity, offering hands-free operation with an unprecedented tuning range, unrivalled power, and the ultimate narrow linewidth, low noise output.



- Broad tuning range
- Ultra narrow Line widths
- High Power
- Wide continuous scans
- Ultra Low Noise



Interferometry Laser Systems

- Supporting contributions to enhance existing program
- To boost interferometer laser power by coherent combination of additional lasers
- Lead to multiple Wattage at required frequencies
 - Improve LMT base scenarios
- Potential to add other frequencies if required
- Provide control hardware and integration of sequencing into global timing sequence
- Work with North Western to provide capability

CAMERA's

- Need high-contrast low-noise devices
- CCDs - this can be ANDOR or other vendors in the UK
 - EMCCD chips are one possibility also produced in the UK by E2V
 - Other devices are being investigated
- Modifications to the read-out necessary
 - require working directly with the vendor
- work with Fermilab on CCD improvement
 - R&D towards a 1000 meter experiment
- UK Physics community has a large body of knowledge and expertise in semi-conductor devices
- Brings added value and new ideas



Proposed Manpower Contributions

- In addition to Hardware, we are looking towards
- Developing an analysis and framework for the experiment from experience in particle physics, including:
 - data quality
 - and image processing
- A substantial fraction of time is foreseen to be spent at Fermilab to contribute towards the construction, commissioning, as well as operations and data-taking

Other Efforts

- Work with Stanford for AION/MAGIS atom source – and prototyping ruggedization
 - Spend time at Stanford to develop
 - Prototype AION-1 to build experience for AION-10
 - Includes all aspects of the experiment needed for AION that are not covered elsewhere
 - Just needs to be replicated & scaled
 - Engineering Resources for environmental isolation
 - An also help with integration at Fermilab
 - Existing engineering contribution to environmental control around atom source
- Investigating making MAGIS-100 a CERN recognised experiment
 - Allows access to technical knowledge at reduced cost
- Work on integration, commissioning and running,
 - includes data analysis

Contribution to DAQ and Control Systems

- Integrating DAQ and control systems with the Fermilab infrastructure
- complimentary
 - fits well with particle physics experience
- Substantial time and expertise has already been invested by Stanford into developing algorithms and sequences
 - Will need to be integrated with Fermilab infrastructure
 - Camera, interferometry lasers, etc likely to be developed standalone
 - Will need tying together with common timing
 - Read-out storing and data quality will need to be automated and remotely accessible
- Potential to contribute towards hardware and manpower for this task
- Also Ideally placed for timing synchronisation between MAGIS & AION

Summary of Hardware Contributions

- AION-10 as a test-stand for atomic concepts to be used in MAGIS-100
 - As well as a prototype for AION-100
- UK contributions in Hardware and Manpower
- Interferometry Lasers (MSquared as a potential vendor)
- Camera's. e.g. EMCCD as low noise high-contrast device
 - Working with Fermilab to improve technology
- Contributions in hardware for Control and readout
 - Requirements are to integrate with existing sequencing and schemes that have been developed
 - Link with Fermilab infrastructure
 - Ideally linked to do time synchronization
- Work with Stanford for AION atom source – and prototyping ruggedization
- Work on integration, commissioning and running,
 - A substantial fraction of time is foreseen to be spent at Fermilab to contribute towards the construction, commissioning, as well as operations and data-taking.

Current Budget Estimate

- Total Budget Estimate: $\sim 1.8\text{M} [\text{capital}] + 1.2 [\text{FTE}] = \sim 3.0\text{M}$
- Includes:
 - Contribution to Interferometry Laser System – 400K
 - Detection System with associated readout improvements – 150K
 - Atom source development & ruggedization – 500K
 - Camera R&D towards MAGIS-1000 (also for AION) – 550K
 - Data Acquisition, Control and Timing – 200K
- People
 - Integration, commissioning & data analysis -
 - Camera development
 - 3RA (3 years @ 100K each) + Engineering (3 years @ 50K)
- Need to identify overlap with other WP's