Plan Overview

A Data Management Plan created using DMPonline

Title: SFI Frontiers for the Future

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Project abstract:

Constant improvement of photon detectors is crucial for astronomy, and has far-reaching applications and societal impacts beyond astronomy. Next-generation detectors will use the huge advantages offered by superconductors, with MKIDs being the most promising superconducting-detector technology. Every MKID pixel can not only detect and count single photons without dark counts, but can also measure individual photon energies and arrival times. We propose to design, fabricate, characterise, and optimise energy-resolving MKIDs through a collaboration led by Maynooth University with cooperation from DIAS, TCD, and Tyndall, toward a European hub for MKID development and fabrication. We plan to build-upon existing international collaborations toward incorporating MKIDs into novel instruments, concentrating on extreme adaptive optics and high contrast imaging of exoplanets with ESO observatories. Adaptive optics relies on fast wave-front sensors to for wavefront correction, and MKIDs offer readout speeds up to 104 times faster than CCDs. Direct high contrast imaging of exoplanets profits significantly from MKID's unique combination of intrinsic energy resolution, fast readout speed and lack of dark counts, allowing increased contrast between exoplanet and host star by up to two orders of magnitude. MKIDs should therefore enable direct-detection of habitable-zone planets around nearby M-dwarfs using extremely large telescopes, currently under construction.

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SFI Frontiers for the Future

Data description and collection or re-use of existing data

How will new data be collected or produced and/or how will existing data be re-used?

There are three main categories of data for the SFI-FFP project.

1) Data collected from 'critical temperature (Tc)' measurements.
These measurements and corresponding data will result from iterating through the parameter space of layer thickness in the novel materials being developed for the project.
The data from each iteration serve to guide the design in the subsequent iteration.
The data is initially acquired on a PC connect to the measurement set-up in the DIAS cryogenic laboratory.
The data will be backed-up on a Google-Drive account, accessible by team members while at DIAS and while at Maynooth University.
The data will be further backed-up on the "Stokes" network at Maynooth University.
Care must be taken when archiving the Tc measurement data, with particular care required to track the relevant data and the specific chip sample it is linked to.
A well-designed electronic filing system is being created for this purpose.

2) Data collected from "dark" resonant frequency and quality factor measurements of the detector arrays will be stored on the DIAS acquisition computer, as well as on the Cloud on Google-Drive.
The data will be further backed-up on the "Stokes" network at Maynooth University.
Archiving the data from the optical tests will be important for use as training data for machine-learning tools, later-on in the project (years 3 and 4).

3) Data collected from "light" optical measurements on prototype resonator arrays will be compiled in a statistical approach, where the phase response of the resonators to illumination under monochromatic (laser) light of different wavelengths will be acquired.

What data (for example the kinds, formats, and volumes) will be collected or produced?

Type-1 data which relates to critical temperature (Tc) measurements from the materials science iterations will be of modest size, requiring no more than 2 to 5 GigaBytes of storage space.
This data will be of a format that measures resistance as a function of decreasing temperature, with temperature ranging from roughly 4K down to 0.1K.
Each data file for a given Tc test sample must contain information about the particular sample used for the test, the time and date of the test, and the date of fabrication of the sample.
The data for critical temperature (Tc) measurements will be of a permanent format, and should be archived carefully and robustly for future reference.

Type-2 data will be of modest size, requiring no more than 2 to 5 Giga-Bytes of storage space. The date and time of measurements relating to this data will be documented, as there is typically variability observed with these measurements due to a number of factors (primarily due to the trapping of magnetic fields during cool-down).

Type-3 data will be of a much larger volume, and large quantities of the data will be of a temporary format. For example, the data acquired while attenuation of the photon sources (lasers) is being tuned will be temporary, and can be overwritten continually.
Photon event and phase response data for each prototype resonator/pixel will be saved in the same manner described for Type 1 and 2 (above).
Since it is expected that multiple Tera-Bytes of storage space will be required for time-series resonator

statistics, there will likely be a requirement to purchase additional storage space on Google-Drive.

Documentation and data quality

What metadata and documentation (for example the methodology of data collection and way of organising data) will accompany data?

There are a number of pieces of important metadata for the effective management of data for this project.
For Type-1 data, the sample parameters/information should be documented on each data set, specifying:
a) Sample ID code.
b) Thickness of each layer of the material.
c) Fabrication steps employed for the sample.
d) Date of fabrication at Tyndall.
e) Date measurements were performed.

For Type-2 data, the following should be documented on each data set:
a) Sample ID code.
b) Resonator number on the array under study.
c) Coupling Q-factor, Internal Q-factor, Resonant Frequency
d) Date measurements were performed.
e) VNA settings during frequency sweep.

For Type-3 data, the following should be documented on each data set:
a) Sample ID code.
b) Resonator number on the array under study.
c) Frequency of source (or source number).
d) Power/attenuation of source.
e) Value for noise floor in time-series data.
f) Date measurements were performed.

What data quality control measures will be used?

Regular calibration of the measurement and test systems will be important for robust data.
Characterisation of noise contributions from each component in the sampe and readout system will be paramount to good data quality.
Regular checks will be performed to ensure that all team member are adhering to data and metadata formats and archiving procedures.
Handwritten hardback notebooks will be maintained in the laboratory as a hard copy backup for significant activities including each cryogenic cycle and the samples tested during each cycle.

Storage and backup during the research process

How will data and metadata be stored and backed up during the research process?

1) Data collected from 'critical temperature (Tc)' measurements.
The data is initially acquired on a DAQ PC connect to the measurement set-up in the DIAS cryogenic laboratory.
The data will be backed-up on a Google-Drive account, accessible by team members while at DIAS and while at Maynooth University.
The data will be further backed-up on the "Stokes" network at Maynooth University.

2) Data collected from "dark" resonant frequency and quality factor measurements of the detector arrays will be stored on the DIAS acquisition computer, as well as on the Cloud on Google-Drive.
The data will be further backed-up on the "Stokes" network at Maynooth University.

3) Data collected from "light" optical measurements on prototype resonator arrays will be stored on the DIAS acquisition computer, as well as on the Cloud on Google-Drive.
The data will be further backed-up on the "Stokes" network at Maynooth University.

How will data security and protection of sensitive data be taken care of during the research?

All data will be handled and stored according to the university’s Policy on Categorising and Protecting University Information Assets. Note that there is no sensitive personal data as defined by the General Data Protection Regulation act.
All data that will be produced during the research relates to photon detection devices that is not considered sensitive.

Legal and ethical requirements, codes of conduct

If personal data are processed, how will compliance with legislation on personal data and on data security be ensured?

Not applicable to the research to be undertaken during this project.
Note that there is no sensitive personal data as defined by the General Data Protection Regulation act.

How will other legal issues, such as intellectual property rights and ownership, be managed? What legislation is applicable?

In the spirit of open-access, we plan to make all data available upon reasonable request to any University or Research Institution that inquires.
There is no private intellectual property rights involved with the research, and no associated legislation.

How will possible ethical issues be taken into account, and codes of conduct followed?

If necessary, data collection protocols will be assessed by appropriate Ethics committee of Maynooth University. However, it is not expected that any ethical issues will arise during data collection for this research.

Data sharing and long-term preservation

How and when will data be shared? Are there possible restrictions to data sharing or embargo reasons?

In the spirit of open-access, we plan to make all data available upon reasonable request to any University or Research Institution that inquires.
There are no known restrictions to data sharing or embargo issues.

How will data for preservation be selected, and where will data be preserved long-term (for example a data repository or archive)?

1) The data will be backed-up on the "Stokes" network at Maynooth University for long-term preservation.
The data will be further backed-up on a Google-Drive account which.

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For all three data types, in order to ensure public and permanent open data access, we plan to use a third-party data repository such as the Open Science Framework or Zenodo (CERN’s data archive, supported by the ERC).
A web browser and an internet connection should be sufficient for accessing deposited data via a third-party repository, with no requirement for specialist software or systems.

What methods or software tools will be needed to access and use the data?

There are no specialised software or tools required to view or access the measurement and test data.

For optical modeling software, and firmware design files, Github will be used to store and allow access to the code. Python (which is open-access) will be used where possible.

Xilinx design tools will be required to view or edit the firmware design files.

How will the application of a unique and persistent identifier (such as a Digital Object Identifier (DOI)) to each data set be ensured?

DOIs are automatically added to individual project components as part of the service offered by the third-party repositories (e.g., Zenodo). Where this is not possible, DOIs will be manually assigned to components as they are made available.

Data management responsibilities and resources

Who (for example role, position, and institution) will be responsible for data management (i.e. the data steward)?

The PI will be responsible for data management, since the PI is a permanent member of staff at Maynooth University, as as such can ensure long-term preservation of data.

What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

There are no specific financial resources assigned for data management, but time is assigned in the project plans to allow for FAIR curation and appropriate documentation of deposited data and project outputs.