



Welcome to the Muon User Meeting

16th - 17th July





- Facility Update
- Development plans
 - SuperMuSR
 - Other news from the facility
 - Early career presentations
 - Science from SuperMuSR
 - Site Calculations



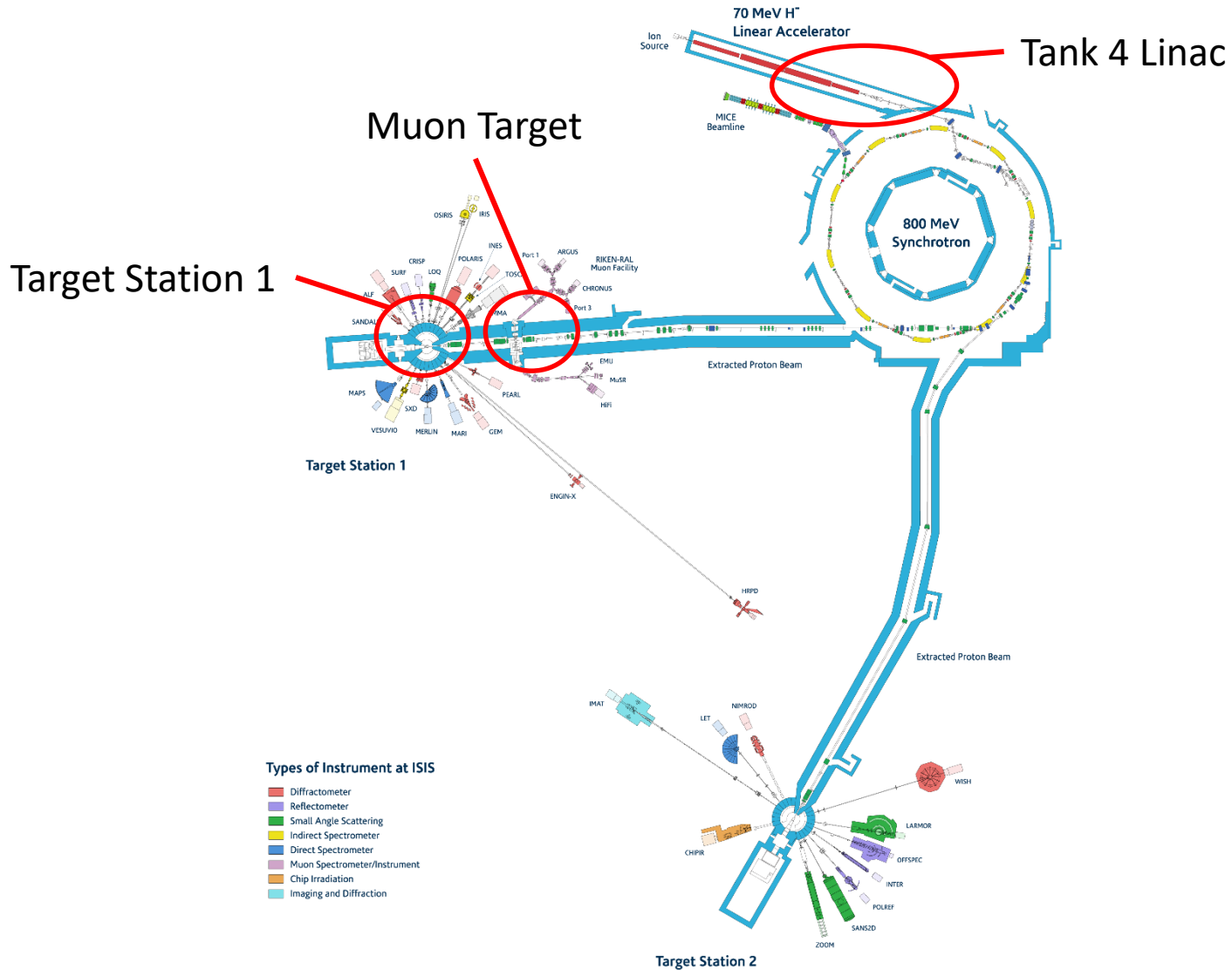
Facility Update

Muon User Meeting 16th - 17th July



- ISIS Update
- Muon Update
- Future Projects

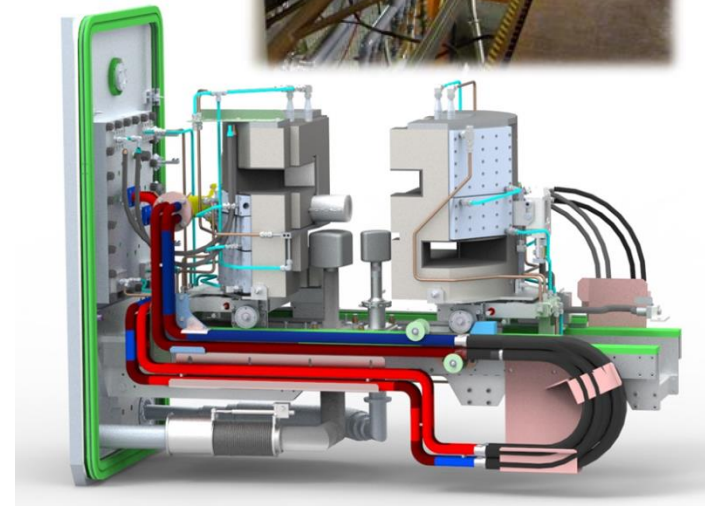
Long Shutdown 2020



Long Shutdown 2020

Why are we having a long shutdown?

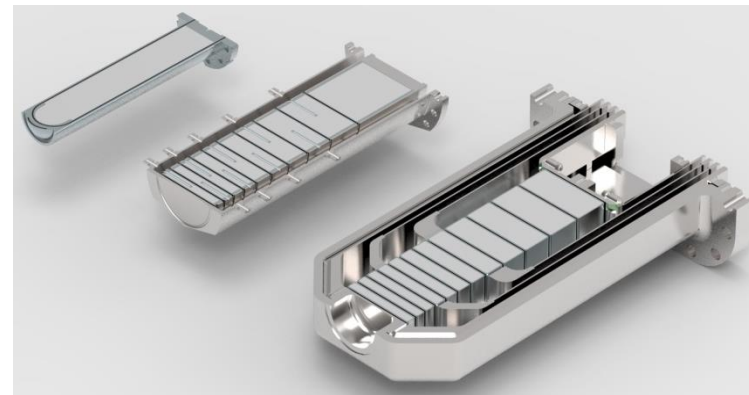
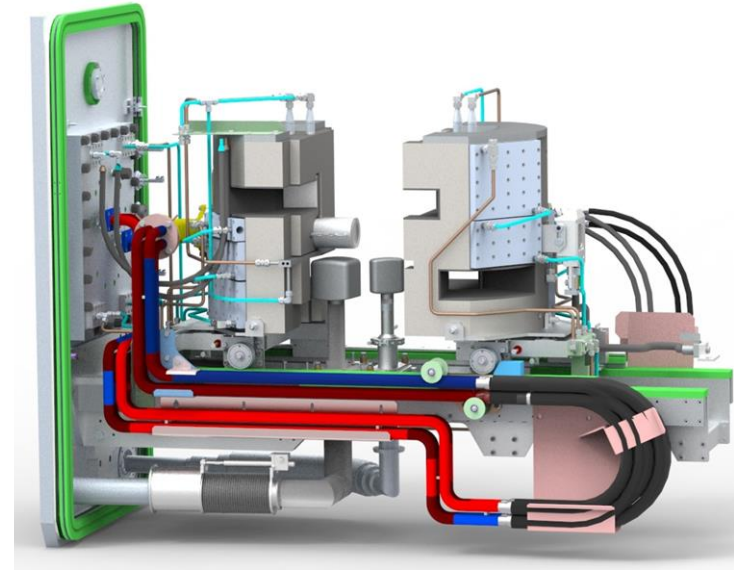
- Long Shutdown for **14 months** most likely to start summer 2020
- Enables us to complete large projects for reliable future running
- Tank 4 upgrade in the linac
- Target Station 1 Upgrade
- Significant work on the RIKEN refurbishment program
- To provide confidence in the ongoing operation of TS1 to enable future instrument upgrades



The ISIS First Target Station Project

Why are we doing the TS1 Project, and why now?

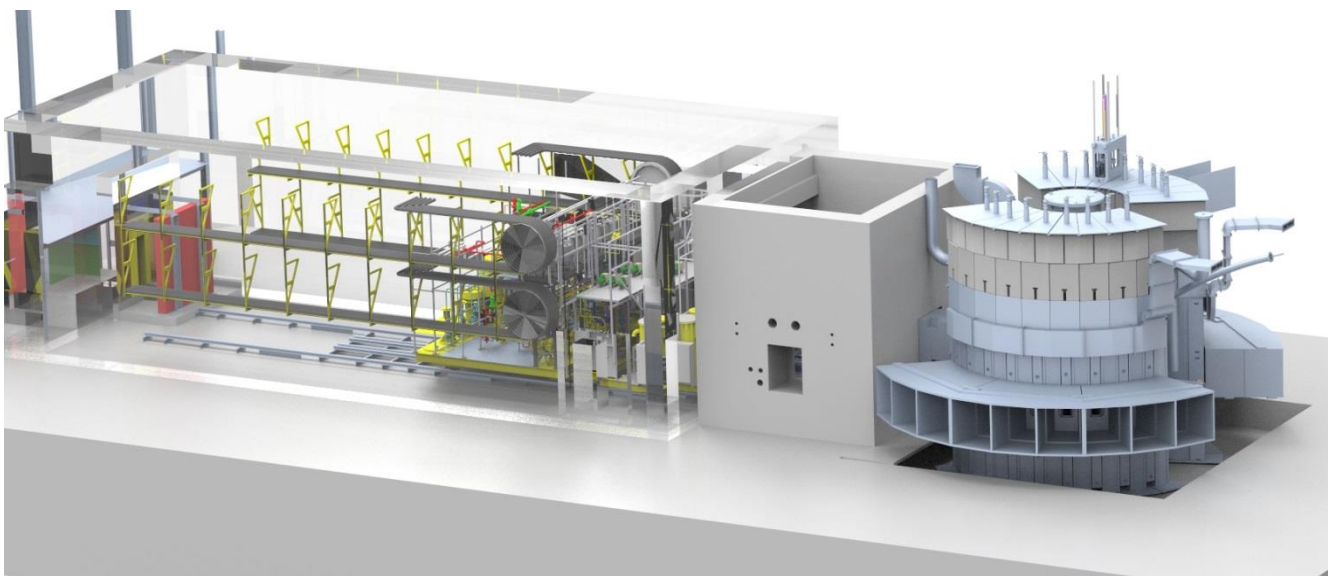
- To secure the future of TS1 and enable it to operate for many more years
- To provide improved flexibility for future target or moderator changes
- To make operation of the target station easier, e.g. improving the time for methane moderator changes
- To provide a neutron performance increase, of up to a factor of 2, on some instruments
- To provide confidence in the ongoing operation of TS1 to enable future instrument upgrades
- Planning for installation in 2020 – 2021.



The ISIS First Target Station Project

What will actually be done during the project

- Complete refurbishment of the internals of the target station, including:
 - Design of the target; target cooling systems
 - Moderators and reflector, and all their cooling systems and services which sit behind the target station
- The project does not include any significant changes to the TS1 neutron or muon instrument suite
- Development of instruments will carry on in parallel to the TS1 project
- Some instruments will see a gain in neutron flux as a result of the project
- The baseline aim is for no instrument's capabilities to be reduced by the project



Linac Tank IV replacement



- Replace 1970's vintage linac tank which has a history of vacuum leaks and inaccessible drift tubes.



- Linac Test Area set up and 2 m test tank built as prototype.

Linac Tank IV replacement

- New tank has six section modular design, access ports to drift tubes and conical ends to drift tubes to reduce demand on RF systems



- Re-establishes UK expertise and manufacturing route for warm linac components.

Program Impact

ISIS will have a shutdown from **Summer 2020 to 2021**

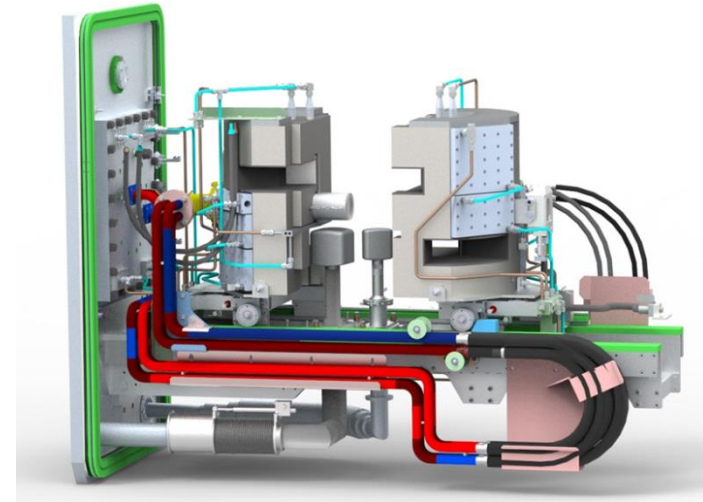
Length will be about **14 months**

Most likely:

No proposal rounds for TS1

April 2020

October 2020



Muon International Review 2017

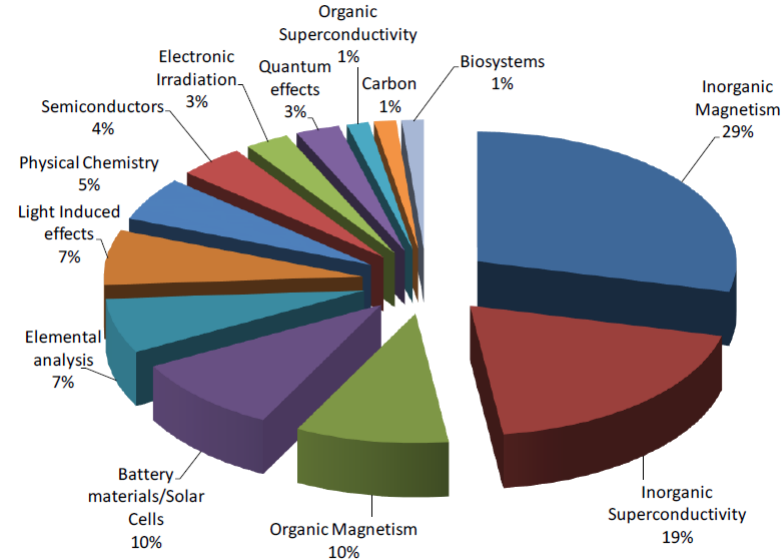
Andrew Fisher (London Centre for Nanotechnology, UCL) - Chair

Laurent Chapon (Diamond Light Source)

Steve Blundell (Department of Physics, University of Oxford)

Alex Amato (Paul Scherrer Institute, Switzerland)

Helena Alberto (Departamento de Física, University of Coimbra, Portugal)



External Review of ISIS μ SR Research, 2017

Review panel members:

- **Andrew Fisher** (London Centre for Nanotechnology, UCL) - Chair
- **Laurent Chapon** (Diamond Light Source)
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Glossary and abbreviations:

- μ SR - muon spin research
 - ALC - avoided level crossing
 - ARGUS, CHRONUS - instruments on the RIKEN beamlines at ISIS
 - EC beamlines - the open-access ISIS beamlines upgraded around 1992 with funding from the (then) European Communities
 - EMU - spectrometer optimised for zero-field and longitudinal-field measurements
 - HiFi - high-field instrument providing longitudinal magnetic fields up to 5T
 - MEOP - metastable exchange optical pumping
 - MuSR - the original general-purpose ISIS muon instrument
 - MuX - elemental analysis project exploiting negative muons on the RIKEN/RAL beamline
 - SAC - Scientific Advisory Committee
- Dates of review panel visit: 12-13 September 2017.

Executive summary

We would like to thank the ISIS management and the muon team for their welcome, support and constructive approach to the review. We formed a very positive view of the current facility. It is the most powerful pulsed muon source worldwide, and is likely to maintain its international scientific relevance for the foreseeable future despite the advent of new sources. We consider there is a high-quality science programme, with a healthy level of over-subscription overall and a peak of demand on the MuSR instrument. The user programme continues to be largely in the traditional areas of magnetism, superconductivity, semiconductors and physical chemistry, but there is growing work in the important area of energy materials. The new EPSRC/Innovate UK/APC 'Faraday Challenge' initiative provides an opportunity to extend this area further. Overall there is a strong breadth of science, and we were pleased to see a large number of non-UK users (about 40%, which we understand is above the ISIS average). There is an expert muon support group, which is internationally recognised and provides an excellent environment for users. Muons are now an integral part of the ISIS facility and any plans for a major upgrade of the machine will need to take the muon activity into account, and should ideally strengthen it. Of the proposed upgrades to the individual instruments, we regard the 'super-MuSR' initiative as the highest priority - this should proceed as soon as possible in order to retain international competitiveness in the context of new sources. Other detector up...

Muon International Review 2017 Highlights

- High Quality and Broad Science Programme with some 230+ publications (2013-2017)
- Growing Science Area in Energy materials (Opportunities to expand with the Faraday Challenge)
- Panel pleased to see a large number of non-UK users
- Muons are an integral part of the ISIS facility and any plans for a major upgrade will need to take muon activity into account
- Given the trends in ISIS proposal numbers and facility oversubscription we are strongly convinced that ISIS will remain a key μ SR player in the future
- Such a position will not come without cost;
 - a strong commitment from the ISIS management
 - continuing efforts to develop cutting-edge technology
 - strong in-house and user-based scientific programmes

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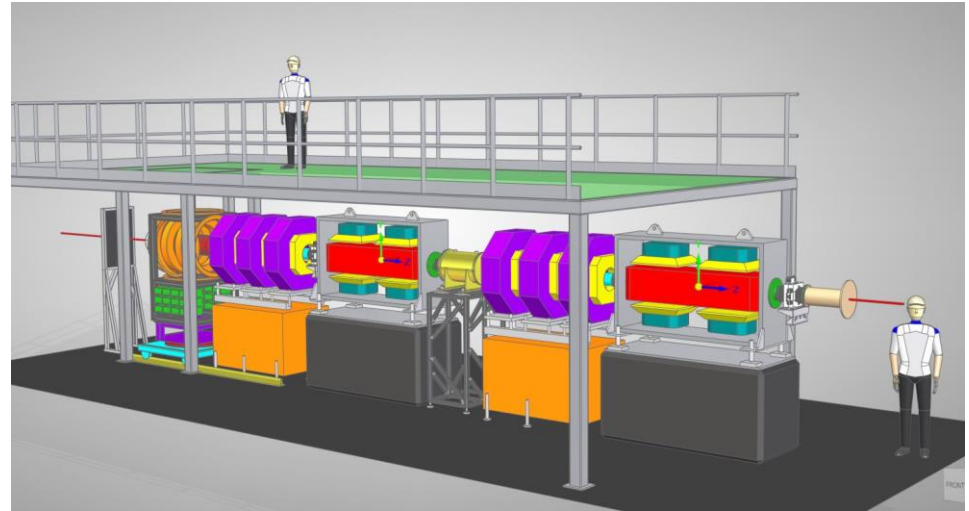
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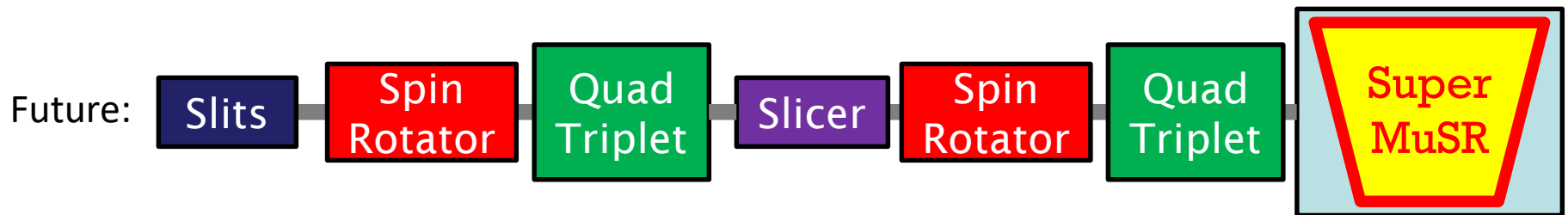
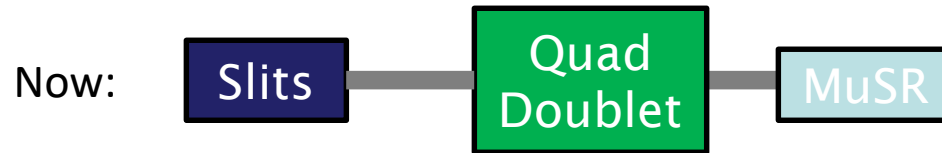
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Instrumentation

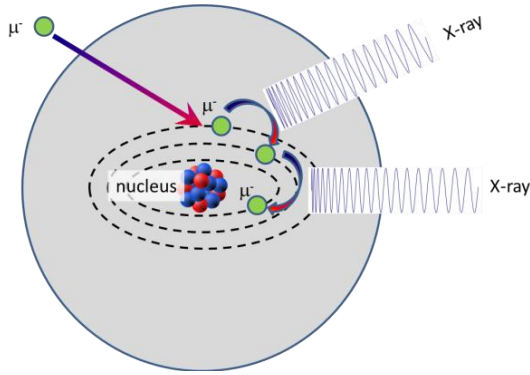
- Super-MuSR is the highest priority. This should proceed as soon as possible
- MuX has great promise
(low risk – high reward)
- Support the continued running of RIKEN-RAL
- Instrument Detector upgrade on the wider suite
- Supportive about the move to Mantid in the long term
- Recent progress in DFT+ μ methods is extremely encouraging



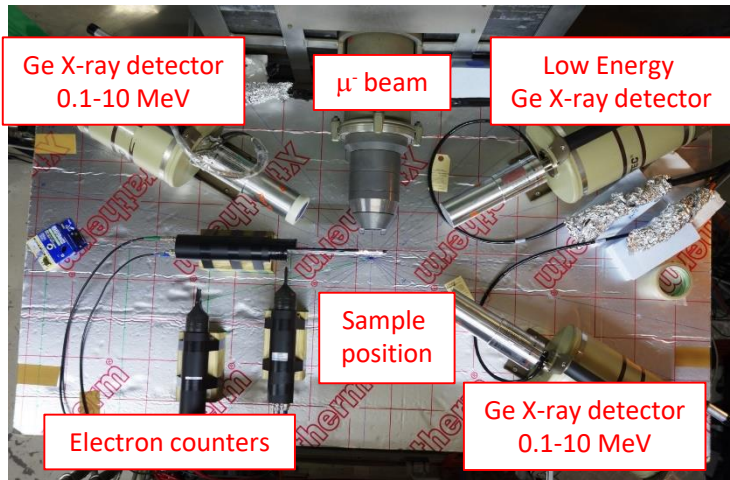
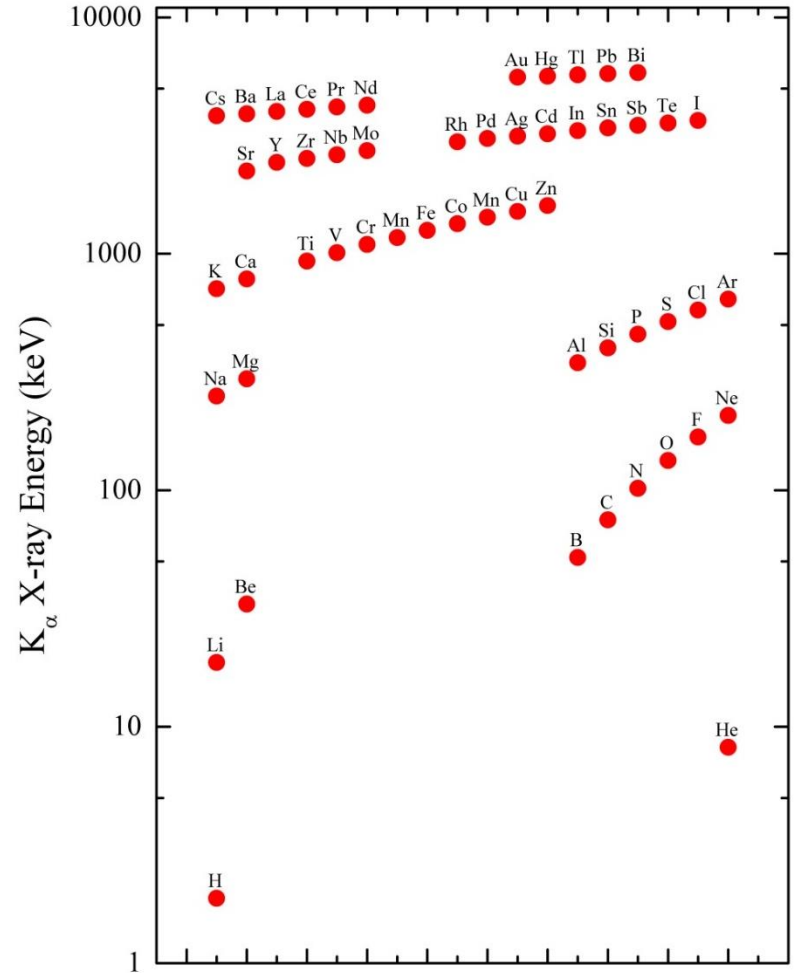
Future Opportunities - MuSR Upgrade



Future Opportunities - Negative muons - MuX



- High Energy X-rays emitted
- Energy dependent of the atom which captures the muon
- 0.01-10MeV - mass of the muon is 200x that of the electron
- Demand continues to rise



New Electronics ordered

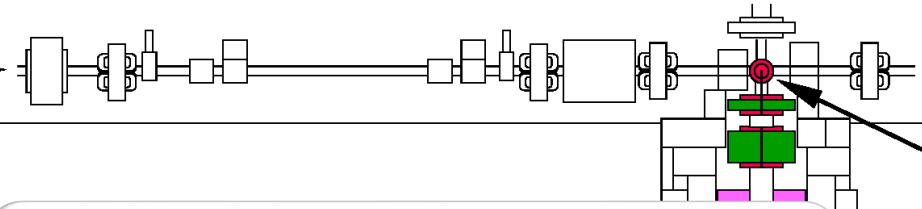


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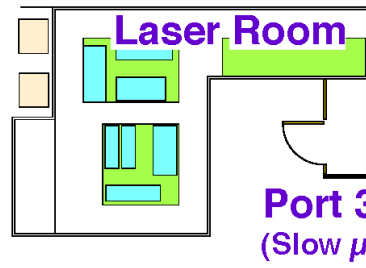
ISIS

RIKEN-RAL Muons at ISIS

800MeV Proton



Production Target



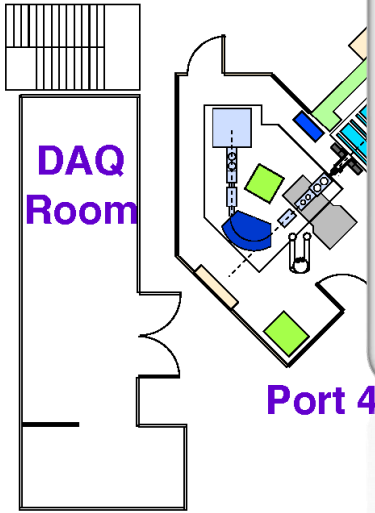
Laser Room

Port 3
(Slow μ)



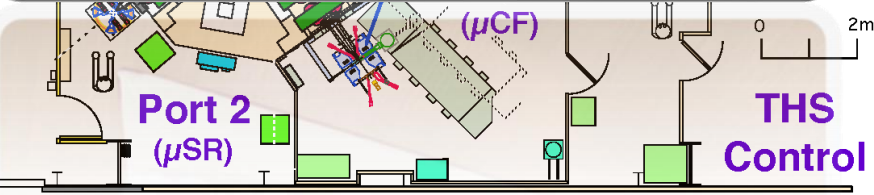
Pion Injector

Superconducting
magnet
System



DAQ Room

Port 4



Port 2
(μ SR)

(μ CF)

THS Control

0 2m



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ISIS

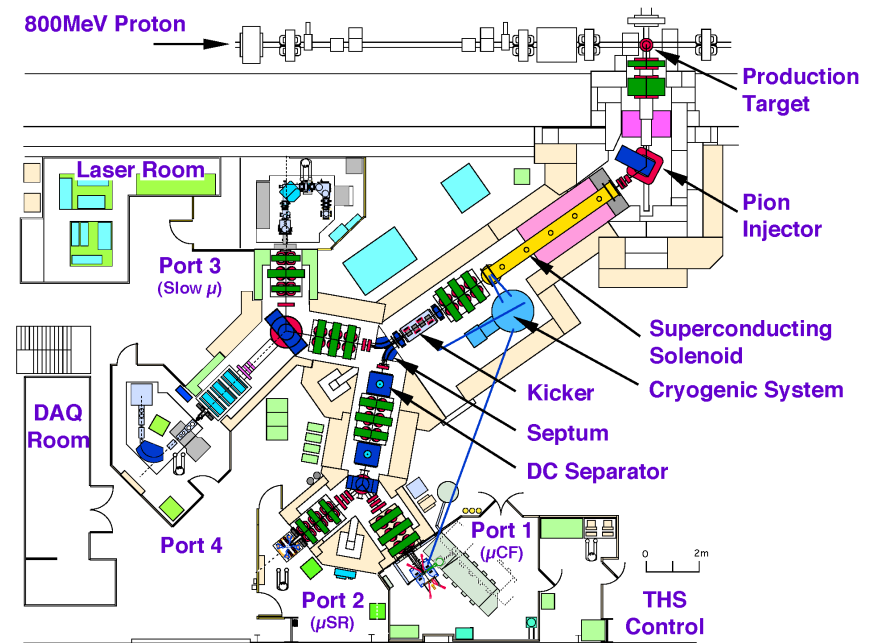


RIKEN

RIKEN-RAL Muons at ISIS

RIKEN-RAL Beamlines are complementary to the EC muon Facility

- Variable Momentum
 - Pressure cells
 - Specialised sample environment
 - Depth profiling
- Negative muons
- Low field Laser excitation
- Experimental area setup whilst still running a program



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ISIS



RIKEN

The New RIKEN-RAL Agreement

AGREEMENT

between
The Science and Technology Facilities Council
of the United Kingdom

and

RIKEN
of Japan

concerning muon science
using the ISIS Facility
at the Rutherford Appleton Laboratory



Signed
Brian Bowsher
Chief Executive
Science and Technology Facilities
Council

Date
30th March 2018

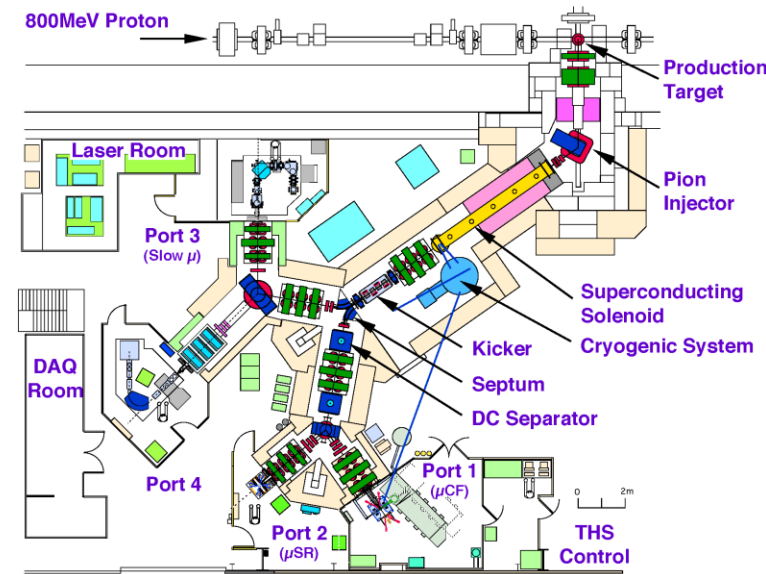
Signed
Hiroshi Matsumoto
President
RIKEN

Date
March 30, 2018

RIKEN-RAL Muons at ISIS the future

New Agreement and contract signed!

- A further agreement 1 April 2018 – 31 March 2023
- Ownership has transferred to ISIS
- ISIS will be responsible for facility operations
- Strong partnership with RIKEN continues
 - Japanese User program
 - Collaboration for refurbishment continues



RIKEN-RAL Muons at ISIS the future

Refurbishment 2018 – 2023 – what might we do?

Work is likely to include:

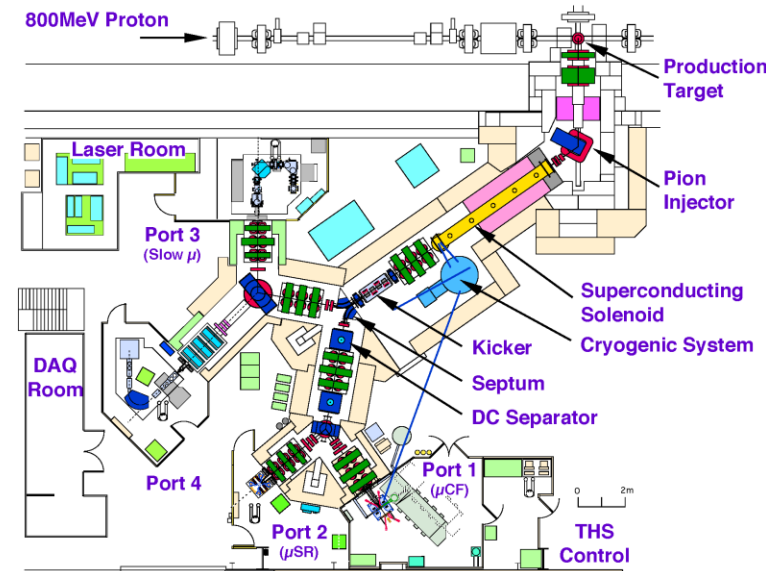
- Replacement of all beamline power supplies, including quadrupoles, kicker, separator
- Recabling of magnets
- Replacement of magnet cooling water circuit
- Replacement of magnet and interlock control systems
- Replacement of vacuum system components
- Refurbishment of Argus and Chronus spectrometers
- Replacement of Argus and Chronus magnet power supplies
- Replacement and refurbishment of sample environment
- Replacement of networking

Currently:

Changing the PLC for an EPICS control system

Sample environment interoperability between EC Muon and RIKEN-RAL instruments

Detailed plan currently being drawn up, and initial purchases being made.



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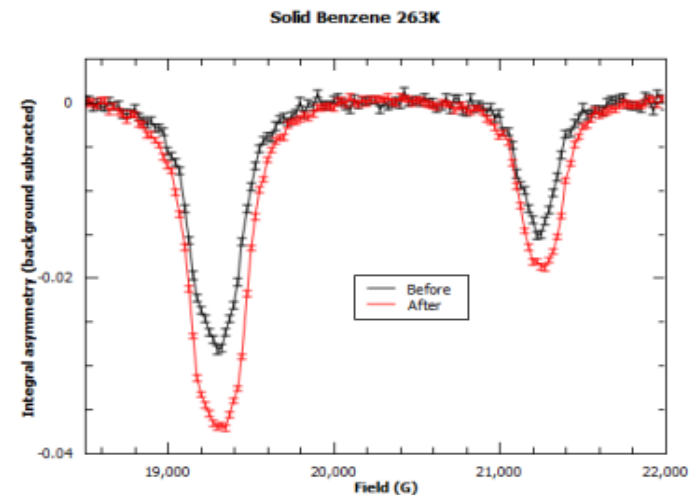
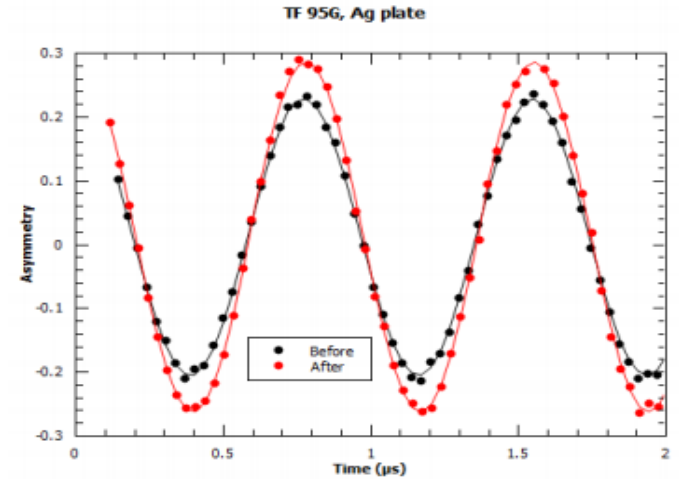
ISIS



RIKEN

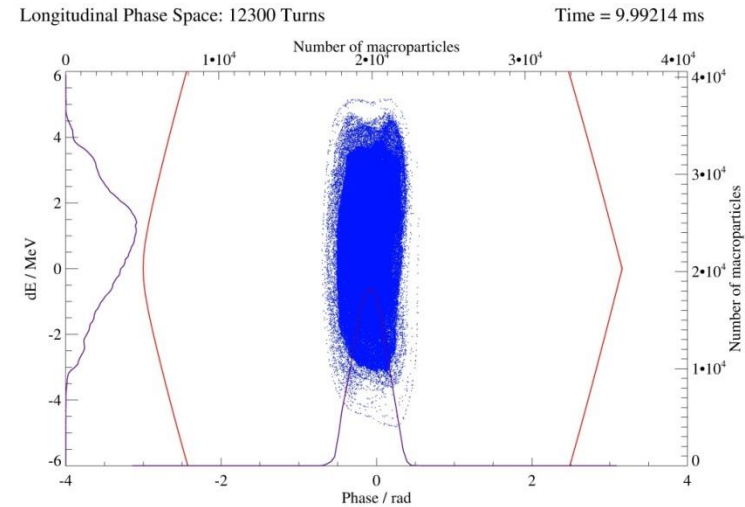
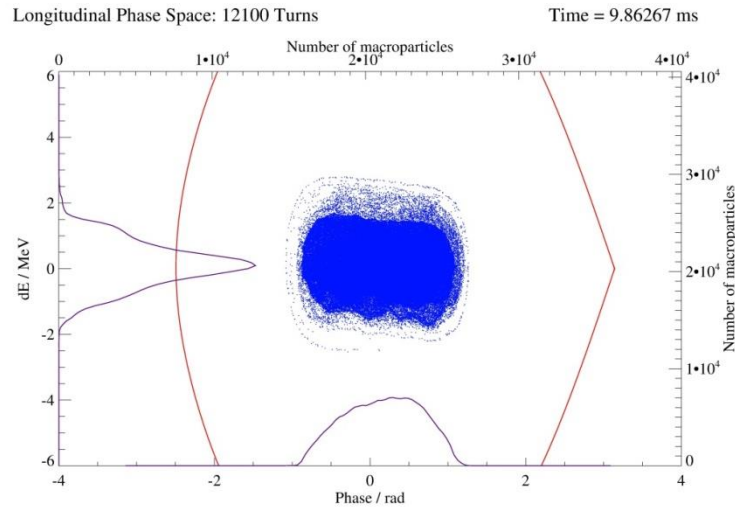
A Degrading Upgrade on HiFi

- Detailed simulation of instrument performance has led to improved data quality
- Over the 2017 summer shutdown positron degraders were fitted to the HiFi detectors to improve the asymmetry and data figure of merit.
- The asymmetry in low field has increased from about 22 to 29% (see top figure) with more modest improvement above 1.5T.
- For most users this means an increase in beam slit width can be tolerated while keeping the rate the same yet improving data quality.



Proton Pulse compression

Improved frequency response with no loss in rate

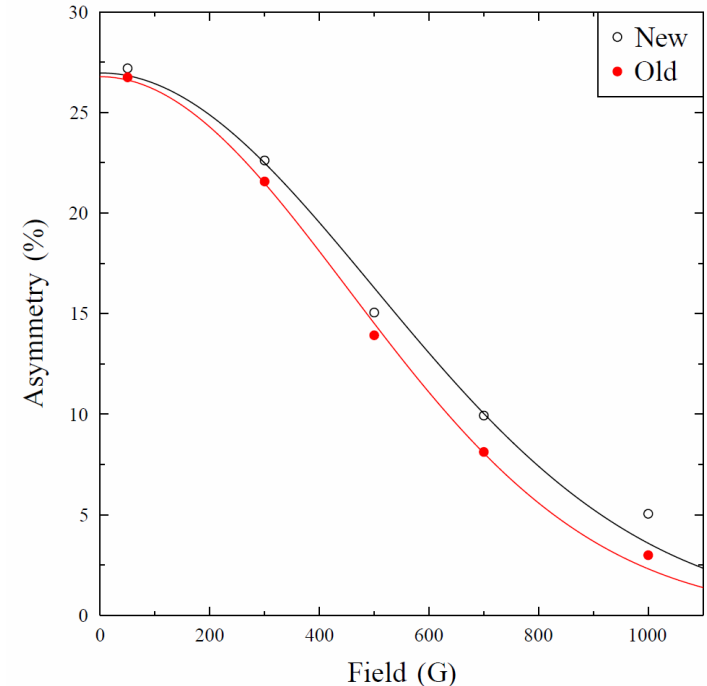
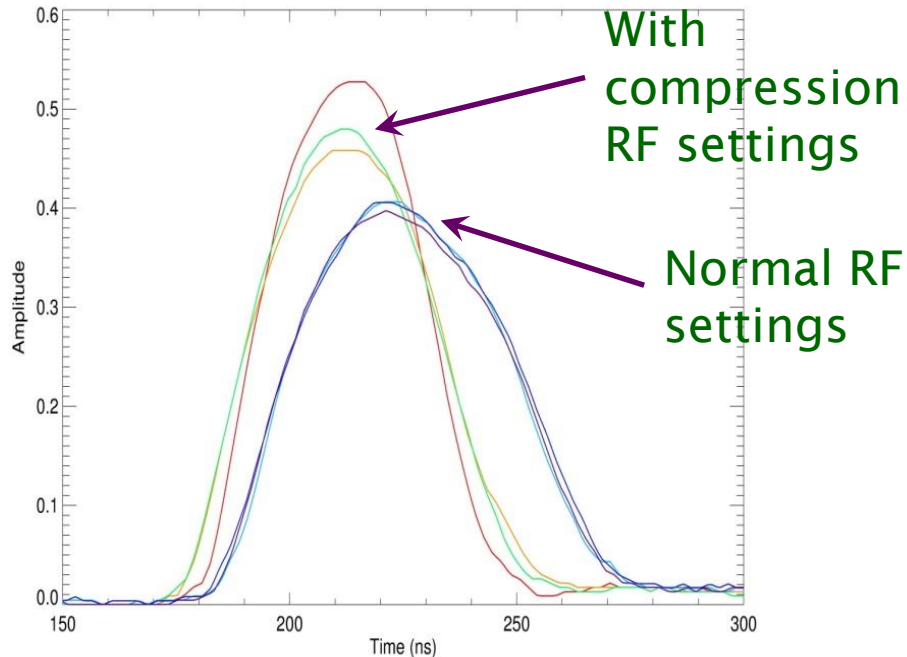


- Developments on-going in the synchrotron
- making full use of the ISIS second harmonic RF system



Proton Pulse compression

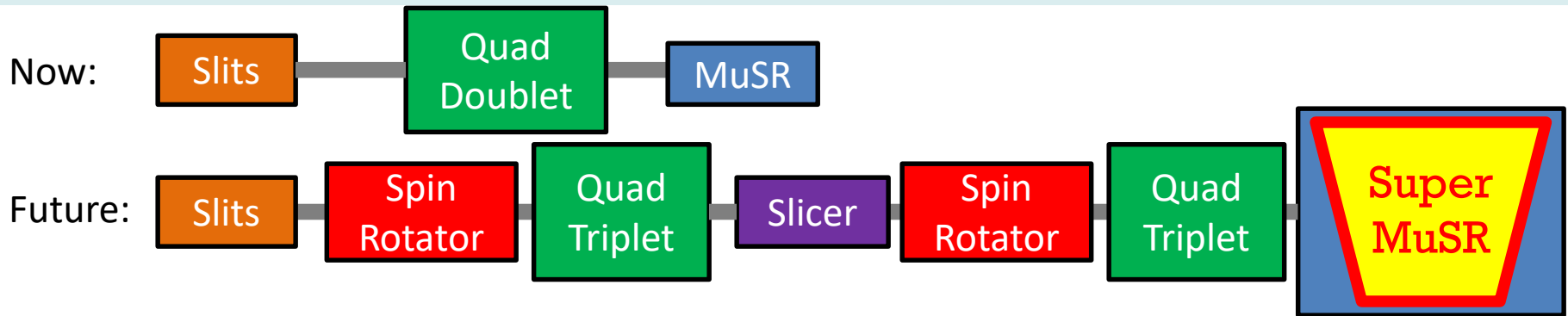
Improved frequency response with no loss in rate



- The pulse length is reduced by an average of 20.75% (FWHM) from 58.8ns to 45.8ns
- Developments on-going in the synchrotron
- making full use of the ISIS second harmonic RF system
- Testing in early Sept. With roll out soon after

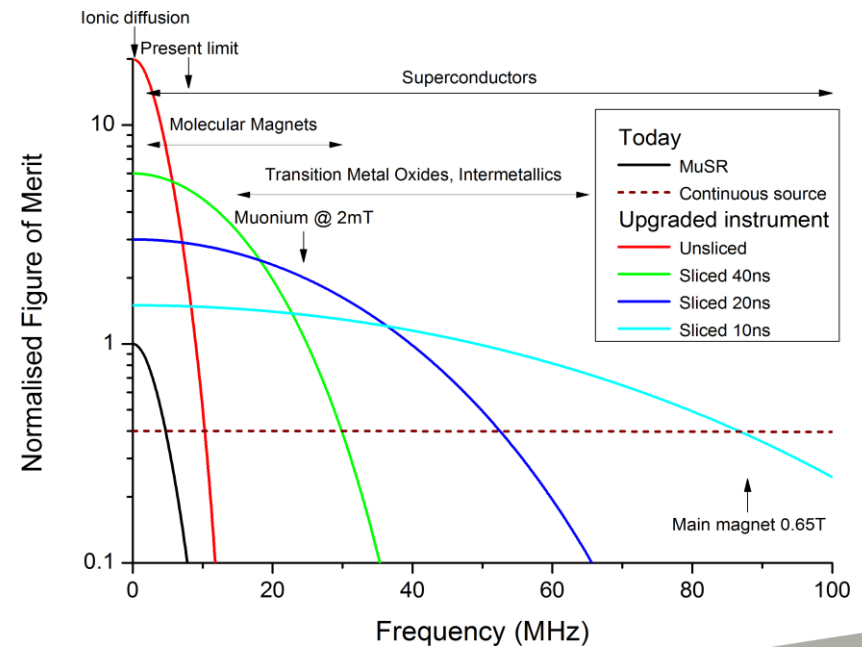


MuSR Upgrade - Increased frequency response

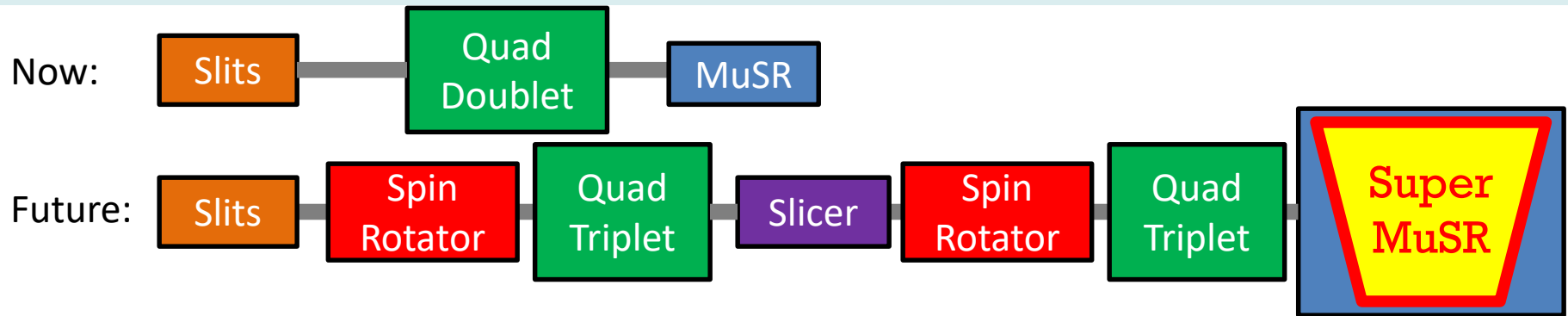


Pulse slicing and Spin Rotation

- Electrostatic slicer like existing kicker (10ns)
- Spin rotation in two stages
- ~10x increase in frequency resolution

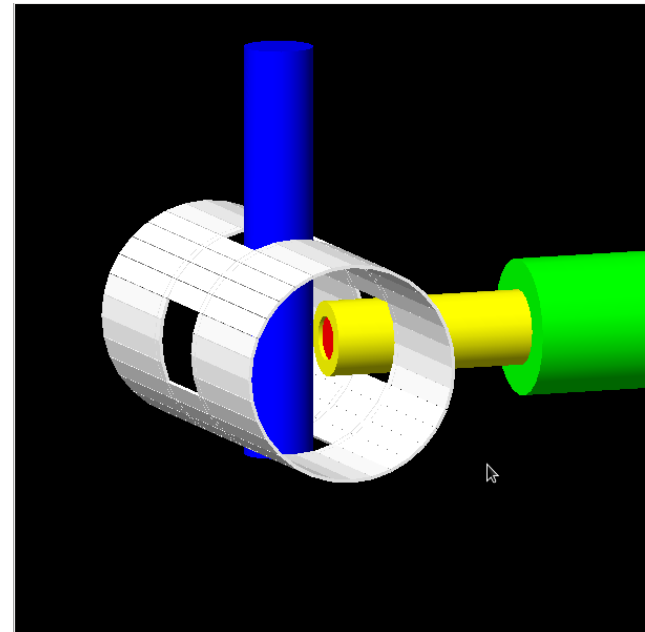


MuSR Upgrade - Increased Data Rates



Solid Angle Coverage

- 2x Solid Angle Coverage
- Segmentation to maintain $E_v/det/fr$
- 15-20x increase in count rate





Pabitra Biswas



Matteo Aramini



Koji Yokoyama



Steve Cottrell



Adrian Hillier

Thanks for your attention



James Lord



Michael Oakley



Francis Pratt



Adam Berlie



Mark Telling



Peter Baker



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ISIS