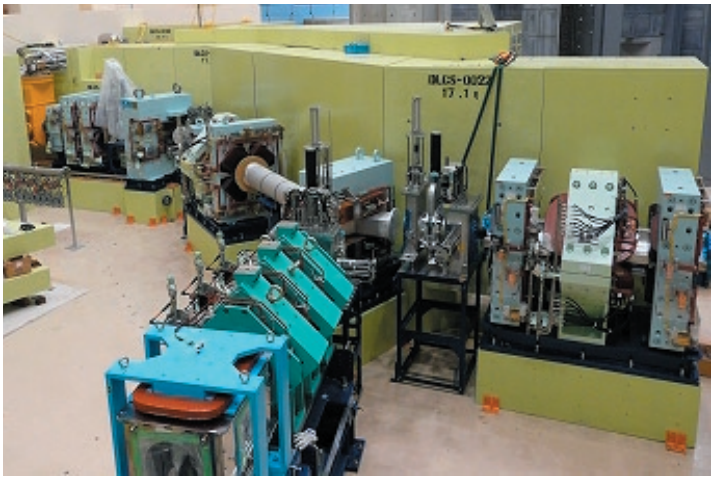
International Society for μSR Spectroscopy

Newsletter No. 8 - April 2009

Greetings from the President of ISMS, Jeff Sonier

Your new ISMS Executive Committee is currently working on an agenda to further strengthen the worldwide standing and appeal of μSR. Despite the tough economic challenges being faced around the globe, there are many exciting developments taking place within our community. Some of these are highlighted in the current e-Newsletter, which we hope you take time out to thoroughly read.

A new era for muon science was ushered in on September 26, 2008 with the delivery of the first pulsed surface muon beam at J-PARC. While still in its infancy, the J-PARC facility will soon provide greater accessibility to pulsed-μSR techniques. Our community should do all that it can to stimulate rapid development of the J-PARC muon beams by initiating experiments and participating in collaborative work. Such efforts will go a long way to ensuring the long-term success of the facility. Maintaining μSR facilities around the globe is crucial for justifying the financing of any single muon facility and for sustaining a healthy international community of muon beam users.



J-PARC muon beamlines.

Another exciting development is the building of new state-of-the art muon beam lines at TRIUMF. Fortunately the funding for these was secured prior to the economic meltdown, and hence there is no foreseen halt to construction. While attaining adequate operational funding will certainly be a challenge, the mere existence of these new muon beam lines provides security for the immediate future of μSR in North America.

With these new facilities comes a natural desire to expand applications beyond traditional research areas. But with the current financial and energy crises, this may well be a requirement for survival. I strongly urge all ISMS members to think outside the realm of their traditional research and to establish collaborations with others working in vital areas of global importance. For example, using the positive muon or muonium as proton and hydrogen analogues, there is the real potential for μSR to play an increased role in the emerging alternative energy and environmental science sectors.

Finally, I would like to commend and congratulate our Japanese colleagues on the tremendous job they did in hosting our 11th International μSR conference this past July in Tsukuba. There were many highlights of the meeting, including the tour of J-PARC, talk of magnetic polarons, and a late-evening shake from Mother Nature. Memories of these events will be with us for years to come. Planning is now underway for the next international conference, to be held in Cancun, Mexico in 2011. At the moment the local organizing committee faces steep financial challenges with governments and industries cutting costs. Consequently, your support by means of attendance in 2011 will be relied upon more than ever.

Jeff Sonier

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μSR2008 Tsukuba

Last year's muon conference might seem a little way off now - but here are some photos of the event to remind us - you can find more at http://msr08.riken.jp/

1. Elvezio Morenzoni receives the Yamazaki prize from ISMS President Jochen Litterst. 2. Poster prize presentations. 3. Bob Heffner and Alex Amato in discussion during a poster session. 4. Roger Lichti discusses hydrogen energy levels in semiconductors with Chris Van de Walle. 5. The conference photo. 6. Conference attendees visiting the new J-PARC muon facility. 7. Prof Kenya Kubo, Dr Akihiro Koda, Prof Yasuhiro Miyake, Prof Shoji Nagamiya and Dr Kichiro Shimomura raising a glass of sake to muon science at the conference banquet.

News from the VP - Americas

It has been a year of change in both Canada and US. Obama's presidency is expected to have significant implications for the science in the US - through his appointment of distinguished scientists as his science advisors and his proposed initiatives for investment in research and development, and education and training, and promises of extended research funding. In Canada's recently approved budget there are initiatives for environmentally friendly projects, quantum computing, Arctic research facilities, maintenance of federal laboratories and for research facilities financed through the Canada Foundation for Innovation.

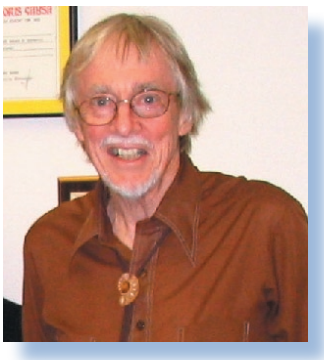
Such funding is very important for research in Canada, e.g. the new M20 beam line, to be installed in 1010/11, is funded through Canada Foundation for Innovation, British Columbia Knowledge Development Fund and TRIUMF. Also, the Centre for Molecular and Materials science (CMMS) at TRIUMF is seeing extensive development including the new M9A beamline ($3M funding by TRIUMF), and construction of a 3.5 GP pressure cell. Also in 2008 Canadian μSR scientists applied for a Major Resources Support funding for the next 5 years. CMMS was visited by Natural Sciences and Engineering Research Council of Canada reviewers as part of the grant application process.

Awards for Canadian μSR scientists

Professor Jess Brewer from University of British Columbia physics department has won the Brockhouse Medal. The Brockhouse medal is sponsored jointly by the Division of Condensed Matter and Materials Physics (DCMMP) and the Canadian Association of Physicists (CAP). It is named in honour of Bertram Brockhouse, whose outstanding contributions to research in condensed matter physics in Canada were recognized by the 1994 Nobel Prize for Physics. Jess has received this award particularly for "pioneering work in developing muon spin relaxation and related techniques, leading to the creation of an important new field in materials physics". Jess has been a major developer and promoter of μSR with an active interest in fundamental aspects of muon science as well as the practical aspects of muon beam technology. He is currently involved in close to 20 experiments at TRIUMF!

Prof Jess Brewer (UBC), winner of the Brockhouse Medal.

Another major award won by TRIUMF user ***Professor Robert West*** from the chemistry department of University of Wisconsin is the Honorary Membership of Japan Chemical Society (2008). This is a recognition given to chemists of great international statue including Nobel prize winners.



Prof Robert West (University of Wisconsin).

Also two undergraduate students, whose research is based at TRIUMF and Mount Allison University, were the recipients of two presentation awards at two different international conferences:

Becky Anne Taylor received best poster presentation for the chemistry session at the 11th international μSR conference held in Japan last year. Becky's research was on ionic liquids and how these solvents interact with free radicals at different temperatures. Becky says: "Working at the TRIUMF facility benefited not only my research but also my growth as a researcher. The hands on experience and the support in place contributed to a good understanding of the chemistry taking place, which were key to my successful presentation".

Becky Anne Taylor receiving her poster prize.

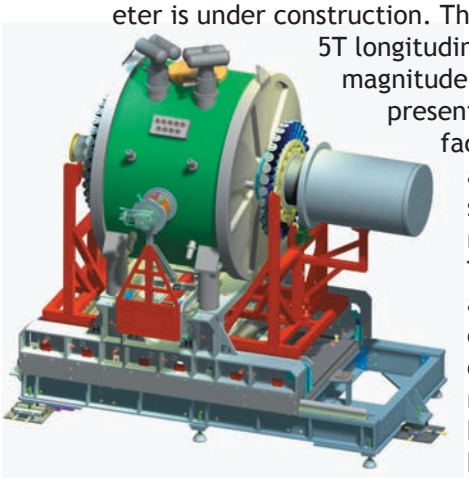
Alasdair Dunlap-Smith was the recipient of best poster presentation award at the 6th Congress of the International Society for Theoretical Chemical Physics held in Canada. Alasdair is examining ionic liquid crystals with muons. Alasdair says: "My time at TRIUMF has provided me with a unique opportunity to learn and conduct research at a world-class facility. The contribution TRIUMF has made to my growth as a student and a researcher is immeasurable. I sincerely thank the personnel of CMMS for allowing this irreplaceable facility to function."

Alasdair Dunlap Smith (Mount Allison University).

News from the VP - Europe and Africa

News from ISIS

A variety of larger instrument developments are taking place at ISIS. The new high-field spectrometer is under construction. This will provide up to 5T longitudinal field, an order of magnitude greater than that presently available at the facility - opening up a variety of new science areas for muon studies at ISIS. The detector array and electronics is complete; a variety of sample environment equipment has been purchased or built, and we are presently awaiting arrival of the main magnet. The EMU instrument will also be refurbished later this year, including a new detector array, to treble data rates and provide greater sample environment access.



European muon funding

ISIS and PSI muons have received funding over recent years from the European Union by being a part of a big neutron and muon collaboration called the Neutron and Muon Integrated Infrastructure Initiative (NMI3). This funding has included money to allow European researchers to come and use ISIS and PSI muon faicilities, funds for a muon technology development network, and support for meetings and workshops. A new round of European funding has just begun. Whilst both facilities can still provide support for EC researchers, the amount of money for this has been cut very significantly (as it has for all the neutron facilities too). There is still a technology development network which includes both facilities plus university partners. And It is possible to apply for funds for muon-related workshops. The NMI3 website can be found at http://www.muon-eu.net.

Students at the ISIS muon training course loading a cryostat with Iain McKenzie and Sean Giblin of the ISIS Muon Group. The training course is held roughly every two years, and provides an opportunity for students and post-docs to learn about the muon technique.

New accelerators for new muon sources

Recent developments in accelerator science and technology, notably in the resurrection of the Fixed Field Alternating Gradient (FFAG) accelerator concept (see for example *Science*, 315, (2007) 933) have been attracting the attention of a number of European μSR scientists. They have been considering the possibility of designing and constructing the world's first fully optimised, high intensity, stand alone muon facility. The new generation of non-scaling FFAGs, currently being developed by the British Accelerator Science and Radiation Oncology Consortium (BASROC) as part of the £8.5M CONFORM project, opens the door to cheaper and more compact high energy, high current proton drivers which could be tailored specifically for muon beam production. An NMI3-funded European Foresight meeting was recently held at the Cockcroft Institute, at Daresbury Laboratory (UK) to explore this possibility.
The Foresight workshop concluded that the concept of a stand-alone, 0.5MW FFAG-driven intense muon source is most certainly worth pursuing: significant gains in intensity (ie one to two orders of magnitude) over all existing muon sources could be achieved particularly with pulsed mode operation. The workshop established that three modes of operation are both desirable and feasible: a pure pulsed mode (ideally >10kHz) with an integrated count rate of at least x100 ISIS and with better frequency response than ISIS (30ns pulse width), an electrostatically-tailored pulse mode (~5ns, 25KHz) with an order of magnitude higher count rate than ISIS but with significantly improved frequency response and a quasi-CW mode – which at least matches the experimental count rate at PSI.

A particular advantage of a stand-alone source is that a dedicated proton driver unconstrained by additional symbiotic or parasitic uses of the proton beam will enable precise tailoring of beam/target assemblies, allowing smaller proton/muon beams, and more efficient pion/muon collection and will also facilitate the implementation of *multiple* muon production targets, with each sequential target dedicated to specific instrumental/experimental geometries. These possibilities are now being explored within BASROC, through simulation of pion/muon collection efficiency, and proton beam focusing and target geometries using ISIS as a benchmark. These design studies, in conjunction with the outcome of operational tests on the world's first ns-FFAG ,EMMA, currently under construction by CONFORM, will, over the next eighteen months, establish whether a cost effective high intensity, stand alone, ns-FFAG-driven muon source can be realised. Watch this space!

News from the VP - Japan

First muon beam production at J-PARC MUSE

Last year, 2008, was a memorial year for muon science. At the J-PARC Muon facility (MUon Source Extension, MUSE), a pulsed muon beam was, for the first time, successfully produced, extracted, and delivered into the experimental area which is located downstream of decay / surface muon line at 12:10pm on September 26th, 2008.

The MUSE facility is located upstream of the neutron facility in the J-PARC Materials and Life Science facility (MLF), as is shown in Fig.1. On September, 19th, the 20 mm thick edge-cooled non-rotating graphite target, which is surrounded by a copper frame, was, for the first time, placed into the 3GeV proton beam obtained from the rapid cycling synchrotron (RCS). The nuclear reaction between the 3 GeV proton beam and the carbon target produces both positively and negatively charged pions. During first beam we extracted "surface muons" which are obtained from the decay of π^+ near the surface of the pion production target in the proton beam line. We commissioned the secondary muon beam line optics by tuning the superconducting magnet, the quadrupole and bending magnets, and the DC separator in order to optimize the transportation of the surface muon beam and to eliminate the positron contamination. Fig 2 shows a picture of the secondary muon line, which was installed in the MLF experimental hall No.2.

After commissioning the secondary muon beam line optics, we finally succeeded in delivering the surface muon beam to the D1 muon experimental port at 12:10p.m. on September 26th, 2008. In front of a live audience, we demonstrated a μSR asymmetry measurement under a weak transverse magnetic field with an aluminum plate as a sample, using the 128 x 2 channel DAI-Omega μSR spectrometer. Afterwards, together with the audience, we celebrated the extraction of the first muon beam. The profile of the muon beam was also measured by a profile monitor and an imaging plate (IP). Fig. 3 shows a picture celebrating the first Muon beam production with about one hundred people at J-PARC MUSE.

Following this, beam commissioning is continuing. At the same time, the user experiments were started from January 2009 and several scientific results have already been obtained by the general users at J-PARC MUSE.

J-PARC MUSE is open for researchers from around the world. We are waiting for your visit to J-PARC MUSE.

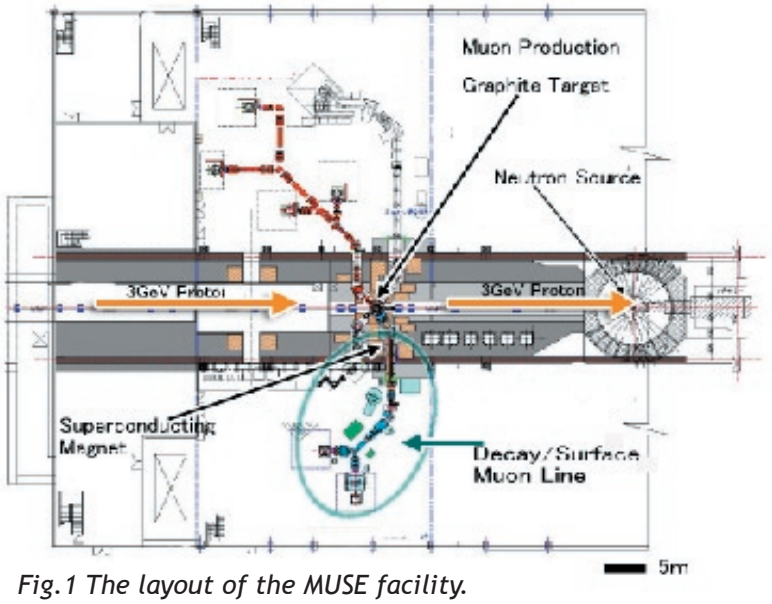


Fig.1 The layout of the MUSE facility.

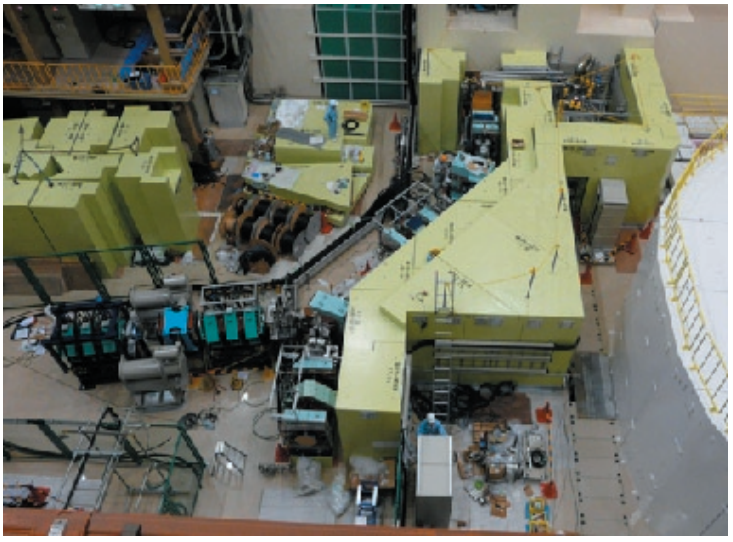


Fig. 2 Photograph of the muon secondary channel(decay / surface muon line).

Fig. 3. A picture celebrating the first muon beam production at J-PARC MUSE witnessed by about 100 people.

Dr Brian Webster MA PhD MRSC (1939 - 2008)

Brian Webster was born in Bournemouth 20 June 1939. After an education at Bournemouth Grammar School he went up to Oxford to read Chemistry where he began his research career with a fourth year research project with Professor Coulson in Applied Mathematics. In 1961 once he had completed his degrees, Brian married Mary, and between 1964 and 1970 they had four children.

Brian studied for a PhD under the supervision of Professor Cruickshank at Glasgow University where he later became a full member of academic staff. Between 1967 and 1978 he worked alongside David Walker with the "structure of the hydrated electron" as a central research interest: David's group worked on the experimental side of the project (laser-photoexcitation) and Brian carrying out the theoretical work.

Brian' involvement with muons began at this time through his collaborations with David Walker and Don Fleming. By 1980 Brian was involved with the SIN group and wrote a Review for Chemistry in Britain in 1983 and the Annual Report of the RSC on MuSR in 1984.

Brian retired in Autumn 2000 and was appointed as an Honorary Research Fellow at Glasgow. He continued pursuing his own research from home including academic writing. He also spent much of his time pursuing his other interests: increasing his extensive knowledge of painting and sculpture, playing the piano and the clarsach harp, and of course walking and hiking in the Scottish Highlands.

Brian will be fondly remembered by many. Both undergraduate and postgraduate students found him to be a talented and inspirational lecturer. He was internationally respected, attended many conferences, and he was held in high regard by his peers at Glasgow and beyond.

Brian died in hospital on 17 October 2008 after contracting pneumonia. He is survived by wife, 4 children and 5 grandchildren.

Sue Kilcoyne and Steve Cox

Isotope effects beyond the Born-Oppenheimer approximation

Brian Webster published relatively few papers, but those he did are of lasting importance, not least those on isotope effects in muonium-substituted molecules. We now understand these effects to be largely due to the different zero-point energies of muon and proton in the potential that binds them to the rest of the molecule. But the assumption of a unique potential surface controlling the molecular dynamics of different isotopomers is only strictly true within the Born-Oppenheimer (1927) approximation: the usual separation of nuclear and electronic wavefunctions and solution of the electronic Schrödinger equation then leads to a potential energy surface that is a function of nuclear positions but not of nuclear masses. In tribute to Brian's work, we mention that the validity of the Born-Oppenheimer approximation for muonium-substituted molecules has often been questioned, but that he was the first to test it quantitatively. His accurate calculations for small model systems imply subtle differences between the potential energy curves binding muons and protons in analogous species (Webster 1984, McKenna and Webster 1984, 1985). These are effects that go beyond the usual Born-Oppenheimer approximation but they are largely covered by the so-called diagonal Born-Oppenheimer correction. Inversely proportional to the nuclear mass, this is a term in the nuclear equation that is usually neglected altogether, although it is not entirely negligible, even for the proton or deuteron. It translates as an increase in force constant confining the muon of not more than a few percent. The effect on observable properties, varying with average bond length as $(k/m)^{1/2}$ or with rms excursion $(mk)^{-1/4}$, are likely to be unmeasurably small. Importantly, the diagonal term is included in the more complete *adiabatic* approximation, so that the potential energy that binds the nuclei is still only a function of nuclear position, not of nuclear kinetic energy. Genuinely non-adiabatic effects involve couplings or level crossings to excited electronic states. The most familiar examples are in the quantum diffusion of muons in metals, but another is spin relaxation in rapidly rotating small molecules — the electron cloud cannot quite keep up in either case. The term is often used for muonium moving through non-metallic lattices too, and for various other differences in H and Mu behaviour in silicon, but here it refers rather to the inability of heavy nuclei to respond to the muon or proton motion, i.e. to sluggish lattice relaxation, rather than the separation of electronic and nuclear wavefunctions.

Steve Cox, Rod Macrae, Nikitas Gidopoulos
November 2008

Muon and Muonium Chemistry

David Walker's book with the above title has recently been republished by Cambridge University Press in paperback form to celebrate its 25th anniversary, and so is now available again after having been out of print. It provides a valuable historical perspective on muonium chemistry, together with a collection of primary data in the study of muonium as an isotope of H.

To go along with the book, there is an up-to-date web page of muonium atom reactions, with tables of 200 muonium reactions in solution, which can be found at
http://mbaza.mm.com.pl/data_base2.asp.

Attendees at the Foresight meeting which considered the possibility of using a non-scaling Fixed Field Alternating Gradient accelerator as the basis for a new muon facility.

μSR 2011

As discussed at the 2008 international muon conference, the 12th International Conference on Muon Spin Rotation, Relaxation and Resonance will take place in 2011 in Cancun, Mexico. It is being organised by Jeff Sonier, Graeme Luke and their team in Canada. More details to follow!

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ISMS Executive Committee

Following the election results announced at the MuSR08 Conference, the present ISMS Executive committee is:
President:
Prof. Jeff Sonier, Simon Fraser University, Canada
President-elect:
Prof. Stephen Blundell, University of Oxford, UK
Vice-president, Americas:
Prof. Khashayar Ghandi, Mount Alison University, Canada
Vice-president, Asia:
Dr. Wataru Higemoto, JAEA, Japan
Vice-president, Europe, Africa:
Prof. Bob Cywinski, Huddersfield University, UK
Treasurer:
Dr. Hubertus Luetkens, PSI, Switzerland
Secretary:
Dr. Philip King, ISIS, UK

If you have comments on any aspect of the ISMS, please contact a committee member.

Comments on this newsletter?

The ISMS newsletter will be distributed periodically to inform the μSR community of ISMS activities, and to provide other information and news of interest to community members. We would welcome comments and thoughts on the content and distribution method - please email the Secretary, Philip King, at isms@rl.ac.uk if you have suggestions.