Initiation and the earliest history of RIKEN-RAL Muon Facility

Muon Spectroscopy User Meeting

The Cosener's House, Abingdon, UK, July 16, 2018

K. Nagamine (KEK & RIKEN)

Initiation

Happenings in 1989 for Successful funding of RIKEN-RAL Muon Facility

Pre-History before 1989

1980, July; The first pulsed muon facility at Meson Science Laboratory, University of Tokyo (UT-MSL) at KEK (5 μA, 500 MeV protons)

1985, October; KN's joinment to RIKEN as a joint appointment

1986, Summer; The first μCF experiment at UT-MSL

1988, Spring; The second μCF experiment at UT-MSL

1988, Fall; visit of P. Williams to UT-MSL/KEK informing EC-RAL Muon Facility and inviting KN to use open area of ISIS

Big Events in 1989

1989, late March; Cold fusion happenings by Fleishmann & Pons, Steve Jones

1989, April 18; KN's Talk on μCF at Liberal Democratic Party head-quarter

1989, June; Submission of funding proposal of RIKEN-RAL Muon Facility, following government suggestion (formal deadline was March 31, 1989)

1989, November; Japanese government announcement of successful funding 23 M$/5 years for RIKEN-RAL muon facility.

Nature's article reporting surprising RIKEN-RAL funding without "digging hole" efforts.

UK–JAPAN COLLABORATION

Cold fusion leaves a legacy

Tokyo

THE fuss over cold fusion in 1989 may not have advanced the frontiers of science very much, but it did help to launch a major collaborative effort between UK and Japanese scientists, according to the Japanese leader of the project. The world's most powerful pulsed muon source, on which construction is scheduled to begin early next year, received funding partly because of the early cold fusion claims.

Scientists from the Rutherford Appleton Laboratory in the United Kingdom last week visited the Institute of Physical and Chemical Research (RIKEN) in Wako city near Tokyo to finalize details of plans to build the muon source at the British laboratory with funds from Japan's Science and Technology Agency. The ¥3,000-million ($23-million) project is one of the first substantial contributions by the Japanese government to British science.

The joint project was first discussed by Japanese and British scientists in late 1988 and it began to move forward a few months later with the support of the British Council in Tokyo. But the key factor that translated an idea into reality was cold fusion, says Kanetada Nagamine of RIKEN, who leads the Japanese side of the project.

In late March 1989, after Stanley Pons and Martin Fleischmann announced their claims of cold fusion, Nagamine was summoned by the science committee of Japan's ruling Liberal Democratic Party to explain what all the fuss was about. His presentation made an impression. Although an earlier request to the Ministry of Education, Science and Culture had been rejected a few weeks earlier, Nagamine's budget request to the Science and Technology Agency — which had been submitted rather late — began to progress rapidly after the meeting with the committee, and the request to the agency was accepted in July.

Nagamine says this is a "world record" by Japanese standards, because in Japan it normally takes years of "root digging" (*nemawashi*) to launch a project of this size. "It's the only good thing to have come out of cold fusion," he says.

Rutherford Appleton Laboratory was chosen because it has the world's most powerful pulsed proton source, which will be used to make the pulsed muon beam. Construction of the facility will begin in January and the first experiments with the muon beam are expected to begin in 1993 or 1994, according to W.G. Williams, head of the muon group at the British laboratory. The facility, which is funded completely by Japan, will be built by British industry, although the superconducting magnets will come from Japan.

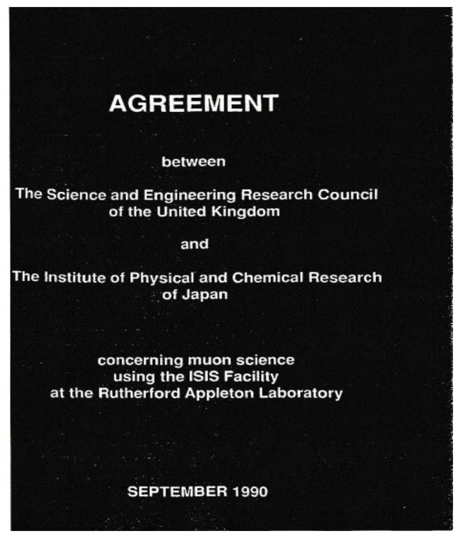
The beam will produce both negatively charged and positively charged high-energy muons. The negatively charged muons, which behave like heavy electrons and are attracted to the positive nuclei of atoms, will be used to investigate muon-catalysed fusion as well as for nondestructive element analysis and for material synthesis through element conversion. The positive muons, which are repelled by nuclei, will be used to characterize materials such as high-temperature superconductors.

David Swinbanks

Time-Zero

1990, September 28;
Signing Ceremony between SERC and RIKEN

Signing ceremony by Minoru Oda (RIKEN president and Bill Mitchel (SERC, chair). Paul Williams, Bob Voss, K. Nagamine are behind



AGREEMENT

between

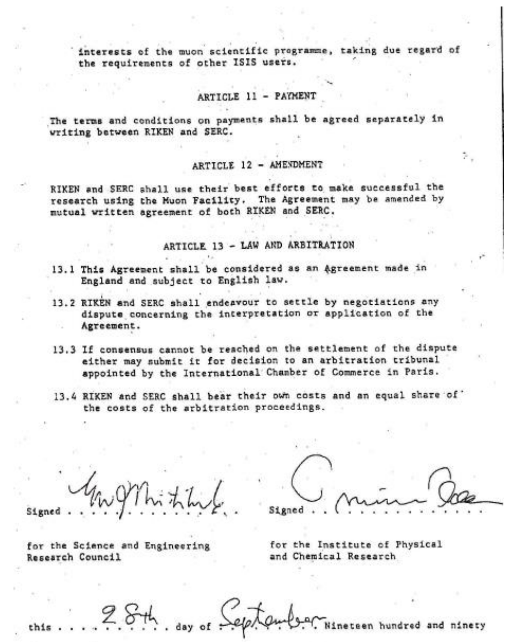
The Science and Engineering Research Council
of the United Kingdom

and

The Institute of Physical and Chemical Research
of Japan

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

SEPTEMBER 1990



interests of the muon scientific programme, taking due regard of the requirements of other ISIS users.

ARTICLE 11 - PAYMENT

The terms and conditions on payments shall be agreed separately in writing between RIKEN and SERC.

ARTICLE 12 - AMENDMENT

RIKEN and SERC shall use their best efforts to make successful the research using the Muon Facility. The Agreement may be amended by mutual written agreement of both RIKEN and SERC.

ARTICLE 13 - LAW AND ARBITRATION

13.1 This Agreement shall be considered as an Agreement made in England and subject to English law.

13.2 RIKEN and SERC shall endeavour to settle by negotiations any dispute concerning the interpretation or application of the Agreement.

13.3 If consensus cannot be reached on the settlement of the dispute either may submit it for decision to an arbitration tribunal appointed by the International Chamber of Commerce in Paris.

13.4 RIKEN and SERC shall bear their own costs and an equal share of the costs of the arbitration proceedings.

Signed . . . . Signed . . . .

for the Science and Engineering Research Council | for the Institute of Physical and Chemical Research

this . . . 28th . . . day of September . . . Nineteen hundred and ninety

The first agreement, describing PAC of the experiments belong to outside-accelerat institute, RIKEN.

0-10 years

1994, November;
The first beam!

Bird-eye view of the RIKEN-RAL in 1994

1995, April;
Opening Ceremony of the RIKEN-RAL Muon Facility

At the time of ceremony, Akito Arima (RIKEN President) and KN.

10-20 years

2000, September; Signing ceremony for the First extension

Signing ceremony of the First extension of the Agreement by Gordon Walker (RAL Director) and T. Ogawa (RIKEN vice-president)

2002, October; Paul Williams received
MEXT Minister Award

20-25 years

2010, July; Signing ceremony for the Second extension

Signing celemony of the second extension of Agreement by J. Womelrsley (STFC CEO) and R. Noyori (RIKEN Director). Paul Williams and KN are behind right.

2015, September;
Informal celebration of 25th anniversary at ISIS

The earliest history of RIKEN-RAL Scientific Acievements

Significance of Pulsed Muons versus DC Muons Experiments never possible at PSI, TRIUMF, ---

Hyperfine Interactions 8 (1981) 787-796

PULSED μSR FACILITY AT THE KEK BOOSTER

K. Nagamine

Meson Science Laboratory, Faculty of Science
University of Tokyo, Bunkyo-ku, Tokyo, Japan

The construction of a new superconducting muon channel has just been completed in our laboratory at the Booster Facility of KEK (National Laboratory for High Energy Physics). The channel takes a sharply pulsed proton beam, and it has been confirmed that an intense pulsed, focussed beam is produced. The instantaneous intensity is at least 10^3 times higher than any other muon channel in a major meson factory. The first μSR spectrum was observed in a time range beyond 10 μS. The beam will be valuable not only for μSR studies of long relaxation, but also for muon spin magnetic resonance experiments.

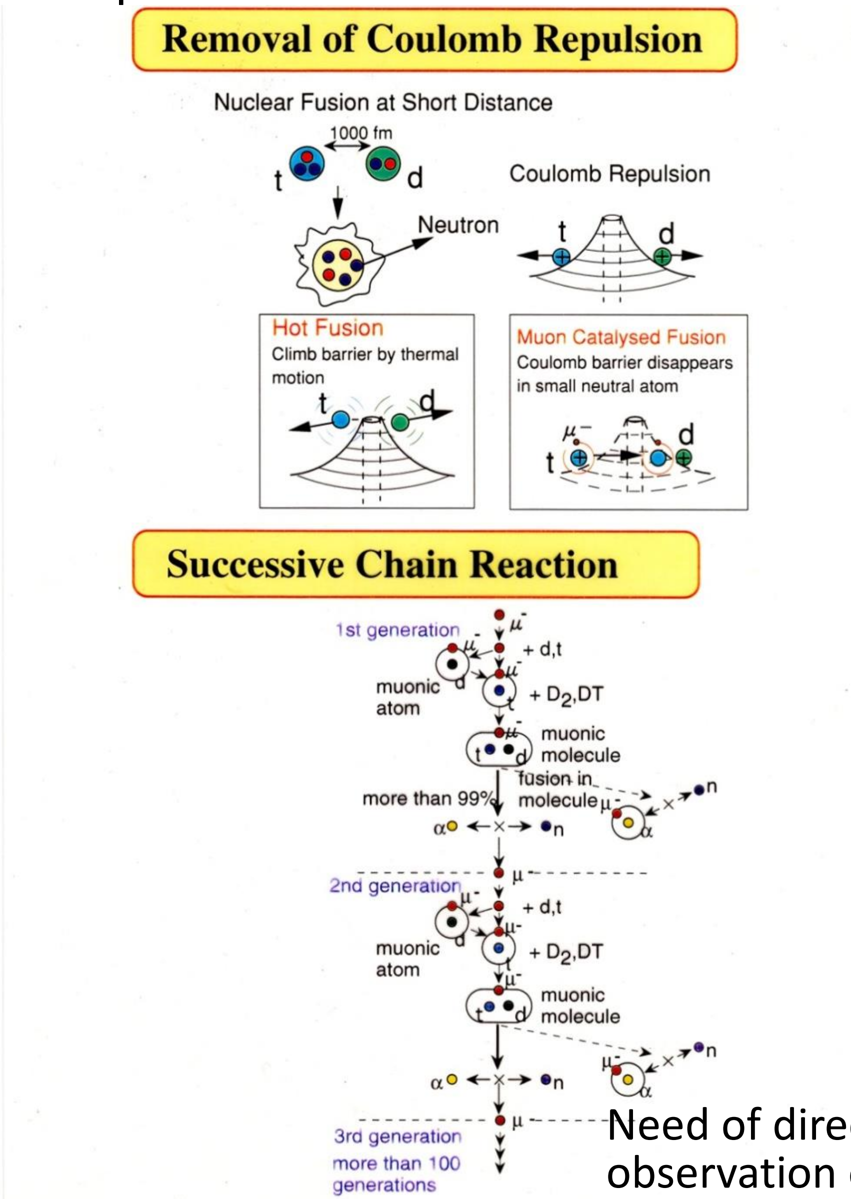
1. Long-time measurement capability of μSR
2. Coupling with intense pulsed disturbance, enabling RF, Laser resonances
3. Phase sensitive detection of weak muon-related signals against huge white noises

Phase sensitive detection of weak muon-related signals against huge white noises

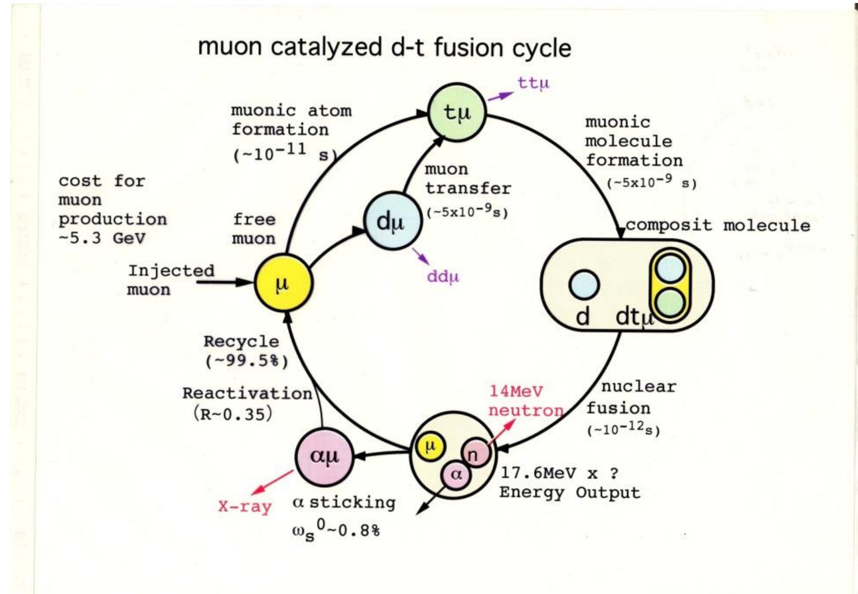
2) Major research results with intense pulsed muons and Future

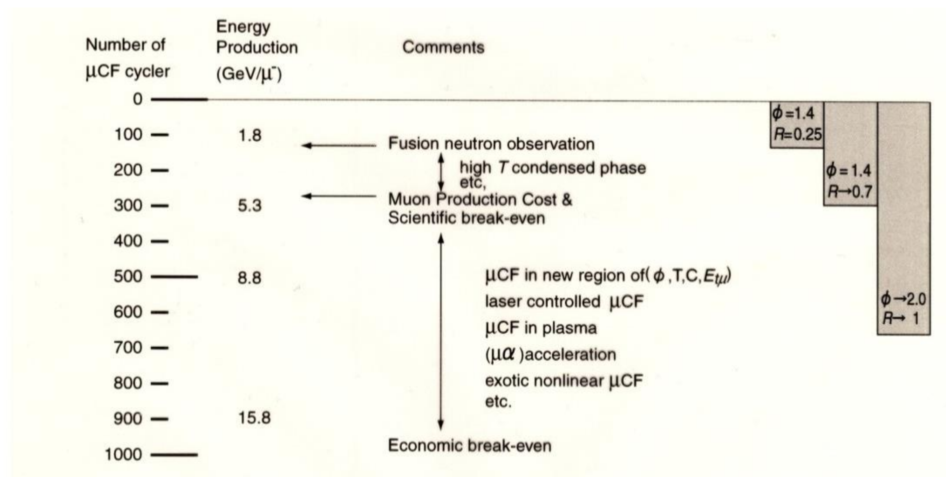
Muon Catalyzed Fusion

Principle



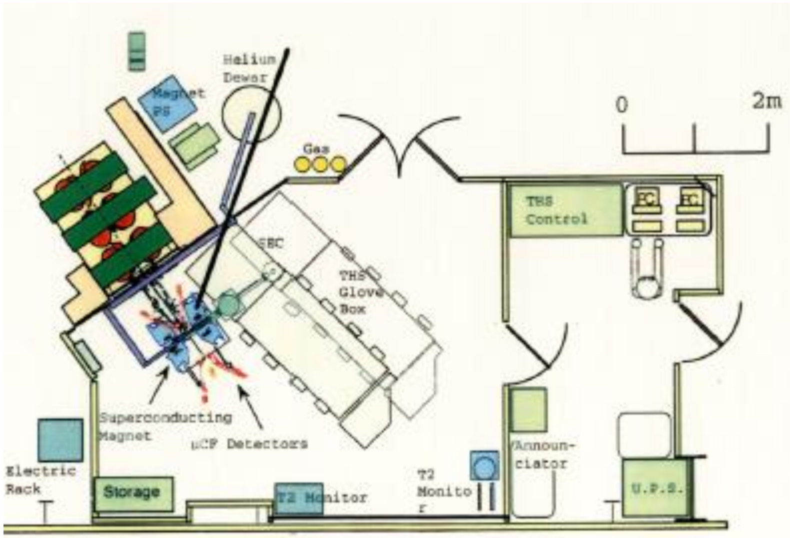
Need of direct observation of $\mu-\alpha$ sticking

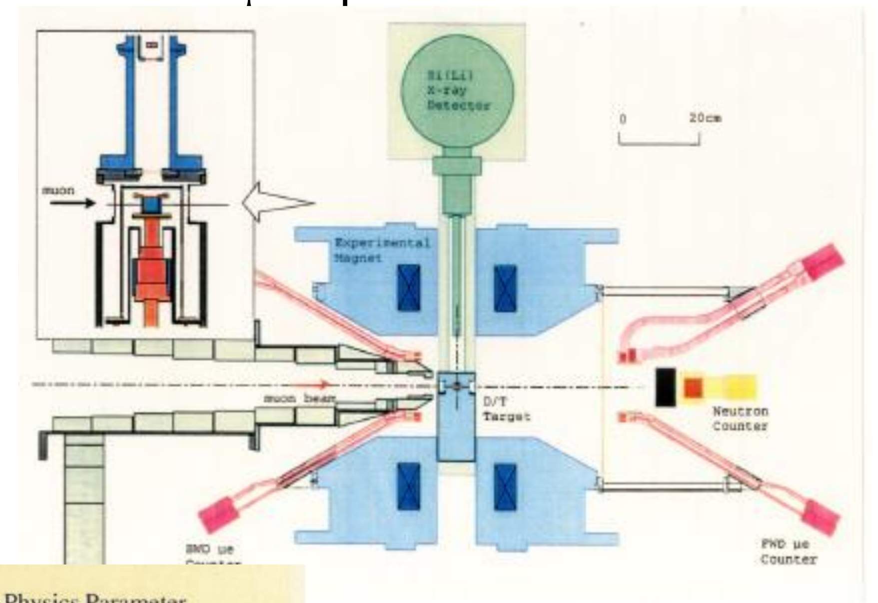


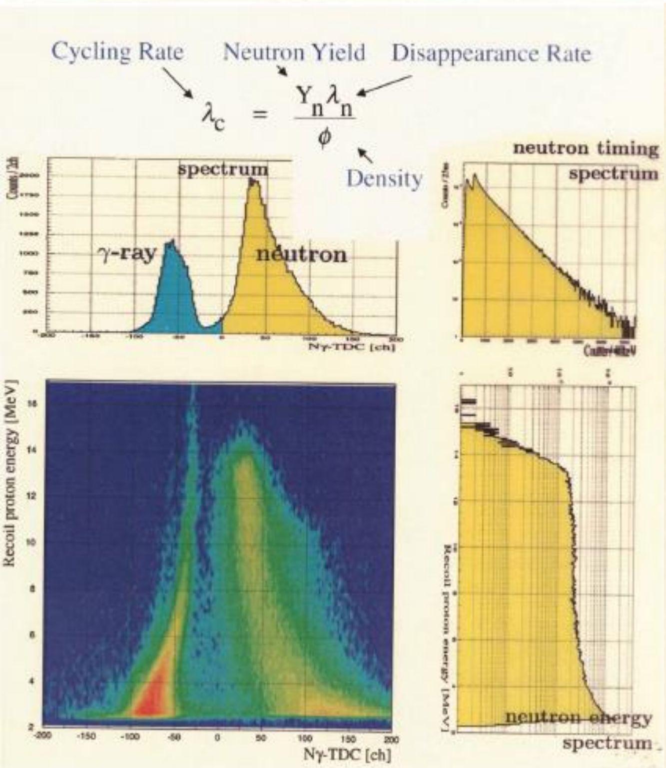


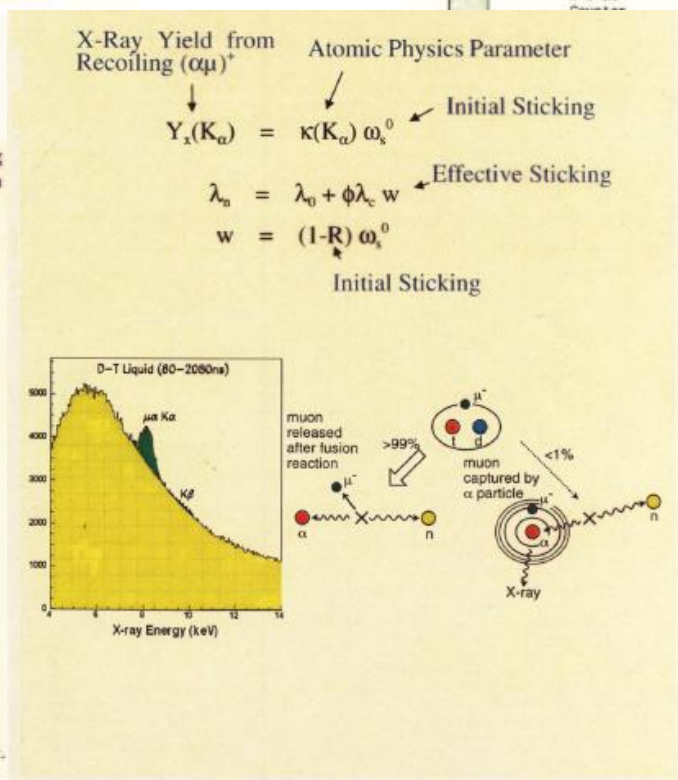
K. Nagamine, (2005) Chapter 11 of Landolt-Börnstein Group VIII/Volume 3, Energy Technologies, (2005) 555

RIKEN-RAL Experiment; Phase-sensitive detection of weak μCF photons





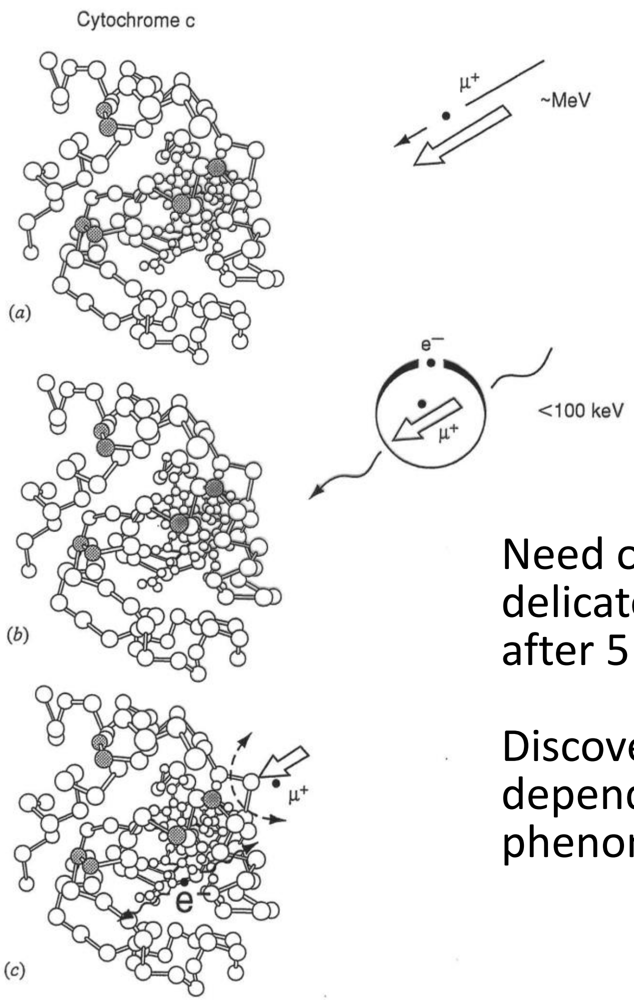


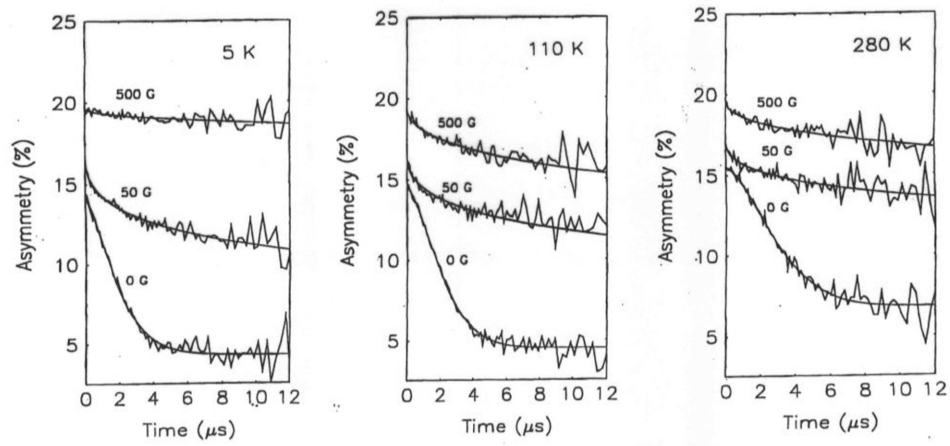


1/10000 reduction of t-decay beta-ray brems B.G.
S.N.Nakamura et al.,Phys. Lett. 473B(2000)226.

Long-time measurement capability of μSR

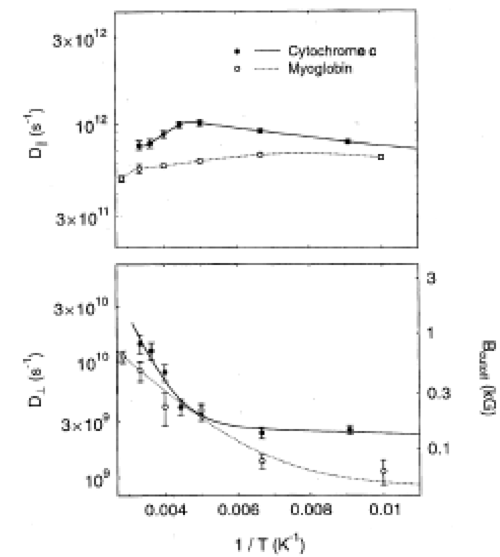
Biological Electron Transfer Studies by μ^+ induced electron (labelled electron)





Need of measurements of delicate change of relaxation after 5 μs.

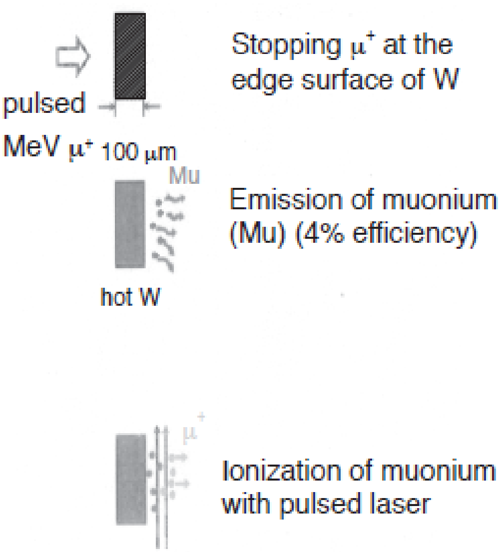
Discovery of protein-dependent electron transfer phenomena

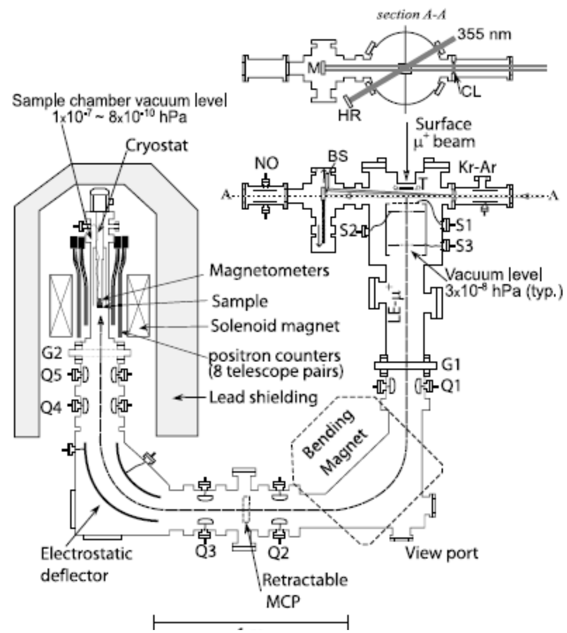


K.Nagamine and E.Torikai, JOP Cond. Matt. 16 (2004) S4797.

Coupling with intense pulsed disturbance, enabling RF, Laser resonances

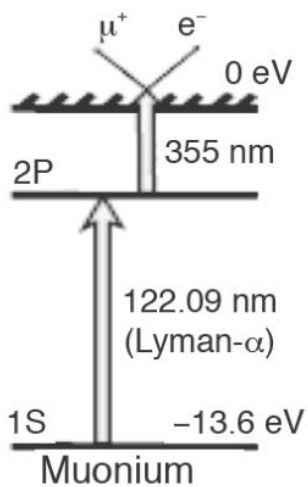
Production and Use of Ultra-Slow μ^+ Exporfting to J-PARC with advanced thermal Mu production & lasers

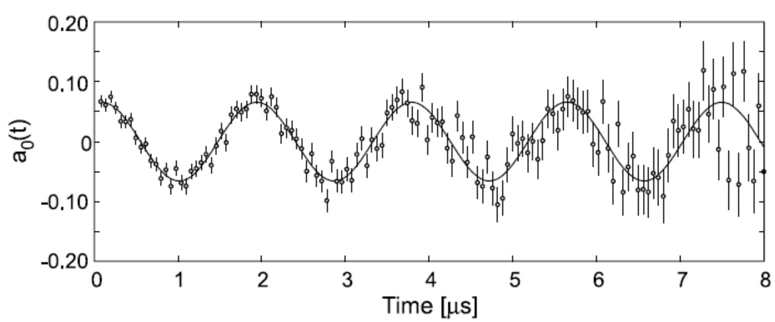




Currently, this method of low energy μ^+ production (laser resonant ionization of thermal muonium) is under full development at J-PARC MUSE (more than 1000/s today).

There should be a new approach which should be investigated at ISIS.





P.Bakule et al., Nucl.Instr. B226 (2008) 335.

Concluding Remarks and Suggestions for Future Developments

1. Long-time measurement capability of μSR
   More life-science applications

2. Coupling with intense pulsed disturbance, enabling RF, Laser resonances
   More slow-muon production; new ideas ? Slow μ^{-} ?

3. Phase sensitive detection of weak muon-related signals against huge white noises
   More spectroscopy for white-noise backgrounds; e.g. muonic X-ray element analysis of radioactive materials