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.
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 muo-ions, which are repelled by nuclei, will be used to characterize materials such as high-temperature superconductors.

David Swinbanks

Nature's article reporting surprising RIKEN-RAL funding without "digging hole" efforts.
1990, September 28;
Signing Ceremony between SERC and RIKEN

The first agreement, describing PAC of the experiments belong to outside-accelerat institute, RIKEN.
0-10 years

1994, November;
The first beam!

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

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)
20-25 years

2010, July; Signing ceremony for the Second extension

Signing ceremony of the second extension of Agreement by J. Womelsley (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 Achievements
Significance of Pulsed Muons versus DC Muons
Experiments never possible at PSI, TRIUMF, ---

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

Removal of Coulomb Repulsion

Nuclear Fusion at Short Distance

1000 fm

Coulomb Repulsion

Neutron

t d

Hot Fusion
Climb barrier by thermal motion

t d

Muon Catalyzed Fusion
Coulomb barrier disappears in small neutral atom

Successive Chain Reaction

1st generation

muonic atom

+d,1

muonic molecule

more than 99%

muonic atom

more than 99%

muonic molecule

Fusion in molecule

2nd generation

3rd generation

more than 100 generations

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

RIKEN-RAL Experiment; Phase-sensitive detection of weak $\mu$CF photons

Long-time measurement capability of $\mu$SR
Biological Electron Transfer Studies by $\mu^+$ induced electron (labelled electron)

Need of measurements of delicate change of relaxation after 5 $\mu$s.

Discovery of protein-dependent electron transfer phenomena

Coupling with intense pulsed disturbance, enabling RF, Laser resonances
Currently, this method of low energy $\mu^+$ 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.

Concluding Remarks and Suggestions for Future Developments

1. Long-time measurement capability of $\mu$SR
   *More life-science applications*

2. Coupling with intense pulsed disturbance, enabling RF, Laser resonances
   *More slow-muon production; new ideas? Slow $\mu^-$?

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*