Welcome and Workshop Overview

G. Venanzoni

μCF Workshop, Liverpool, 2/7/26

LEVERHULME TRUST

The Muon Physics: A Worldwide frontier research

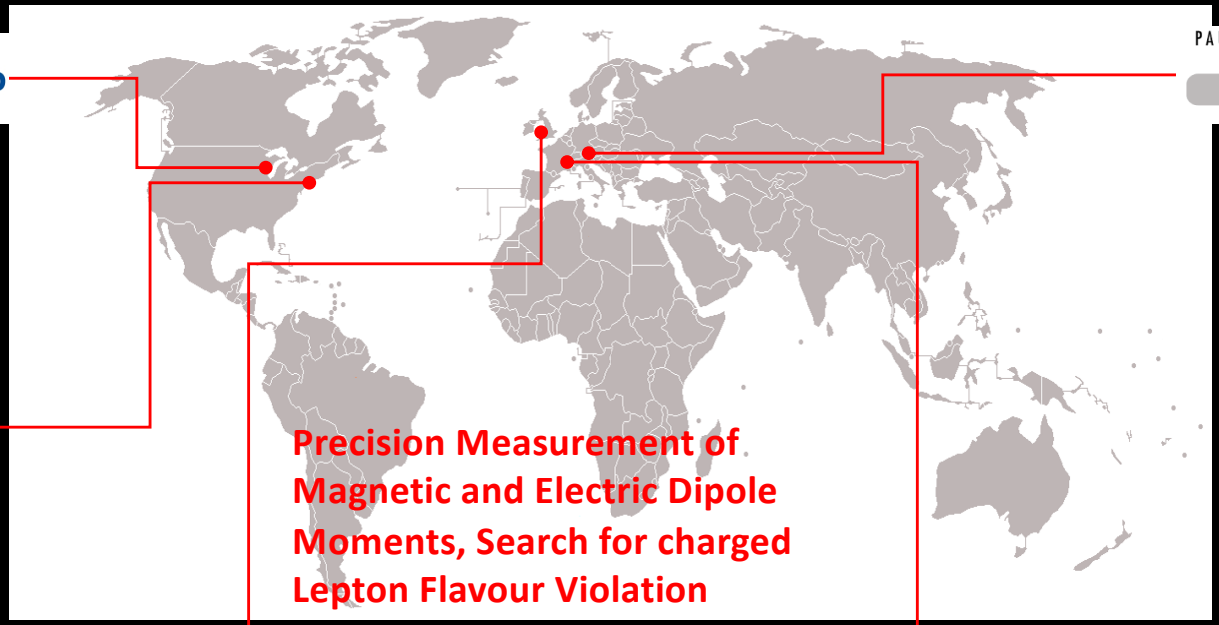
Fermilab

g-2 experiment

Mu2e experiment

Brookhaven National Laboratory

Proton EDM proposed experiment



Precision Measurement of Magnetic and Electric Dipole Moments, Search for charged Lepton Flavour Violation

PAUL SCHERRER INSTITUT PSI

Mu3e experiment

Muon EDM proposed experiment

CERN

MUonE proposed experiment

LSDC (Semiconductor Centre)
- Pixel detector construction Mu3e
- Straw tracker assembly g-2

PP/NS collaboration on
- High Purity Germanium for Mu2e

DFF (workshop)
- g-2 tracking stations
- Mu3e tracker mechanics and tooling
- MUonE tracking supports
- Proton EDM electro-static deflectors

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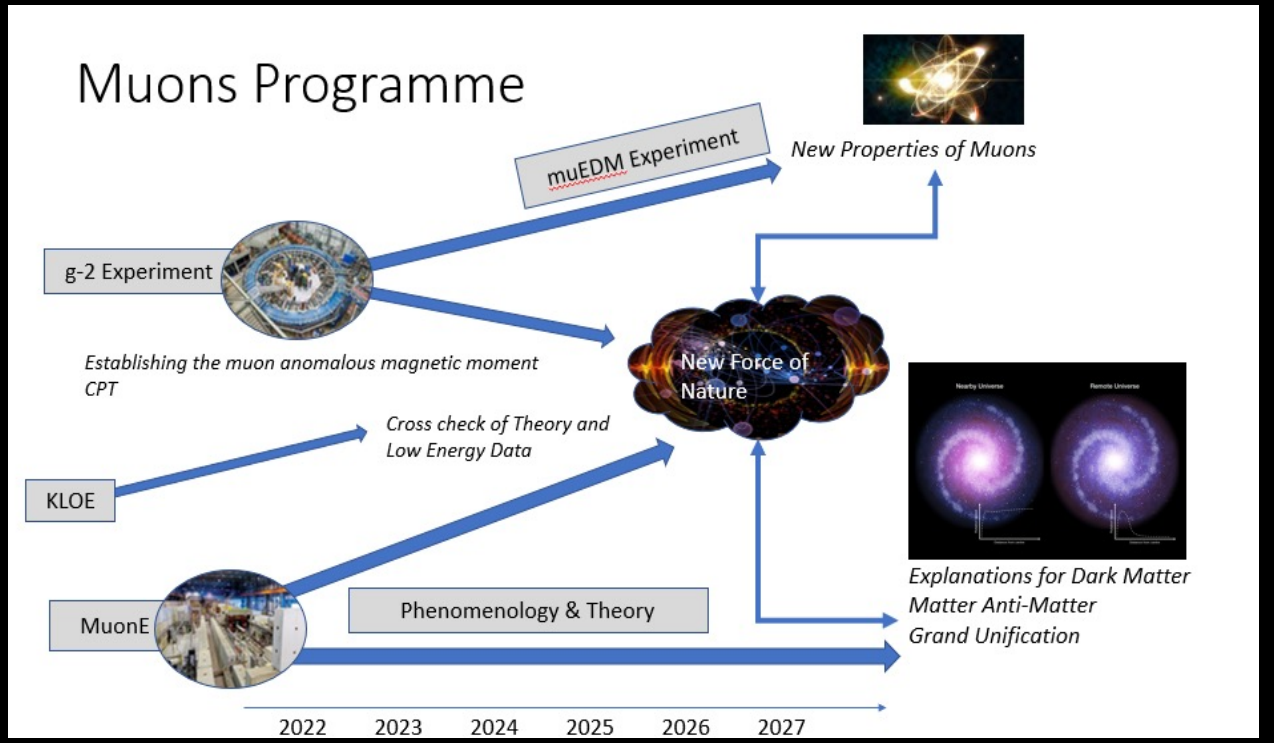
The “Muon Precision Physics Program” in Liverpool

LEVERHULME TRUST

- 5 years grant funded by the **Leverhulme Trust** (£4.3M Leverhulme International Professorship award). Started in Oct 22
- Rich Experimental and Theory program
- Strong collaboration between Liverpool and National/International groups
- Advance on technological aspects
- Mentoring and training of students and early-career researchers
- A unique opportunity to advance this exciting field!



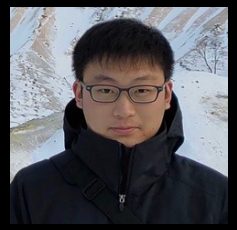
The Fermilab g-2 Experiment

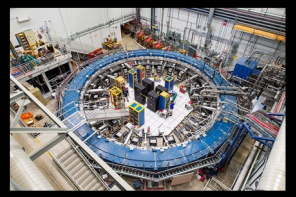
World record precision Measurement of the muon anomalous magnetic moment at 127 ppb(!)

Liverpool is the largest group in the g-2 collaboration

Built **straw tracking detectors** to measure the muon beam → crucial to reach uncertainty goal

Leadership in several areas including: **magnetic field**, **beam dynamics**, **EDM**; **spin precession**. Spokesperson, analysis coordinators, run coordinators, committee membership.

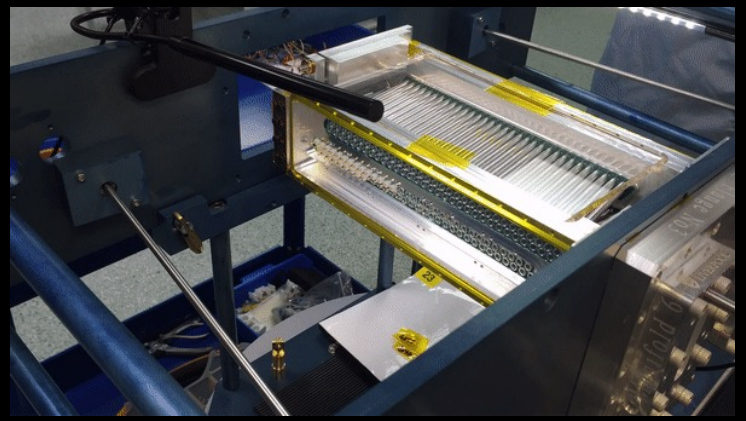










Straw tracker construction in Liverpool clean rooms / workshop

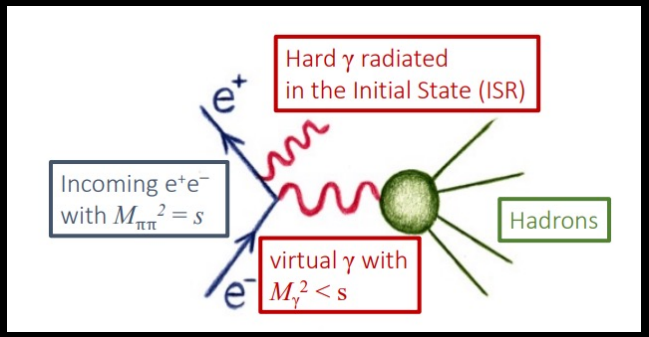
The KLOE Experiment

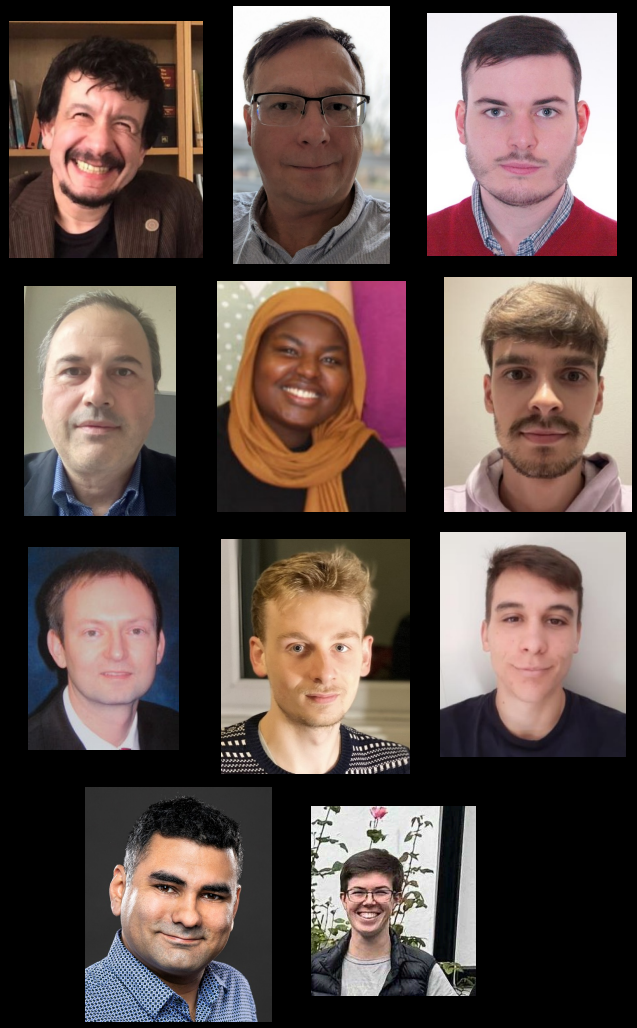
2. Confirm the SM prediction by analysing KLOE data

Liverpool is leading a novel analysis of data from the KLOE experiment

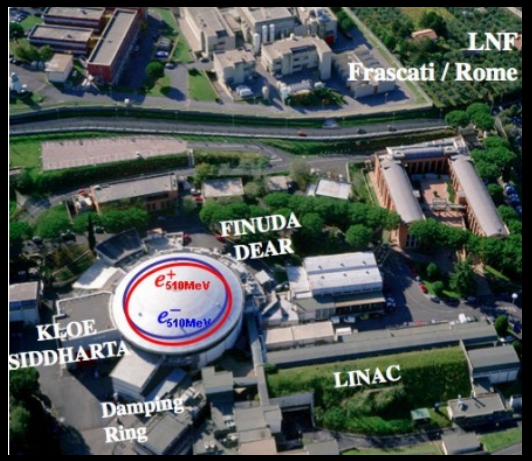
KLOE data is one of the most significant inputs to the data-driven calculation

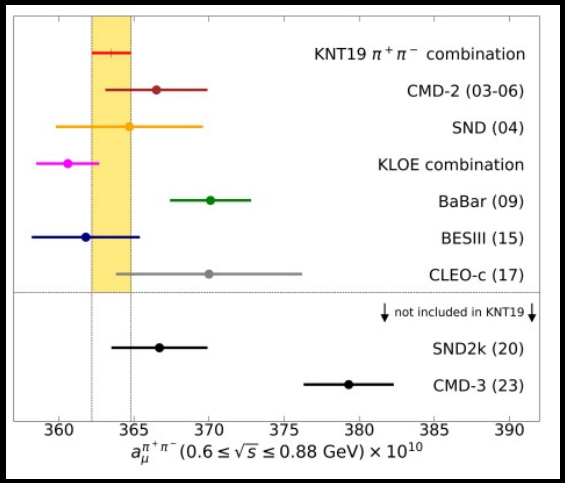
Joint initiative between experimental (Physics department) and theory group (Maths department)





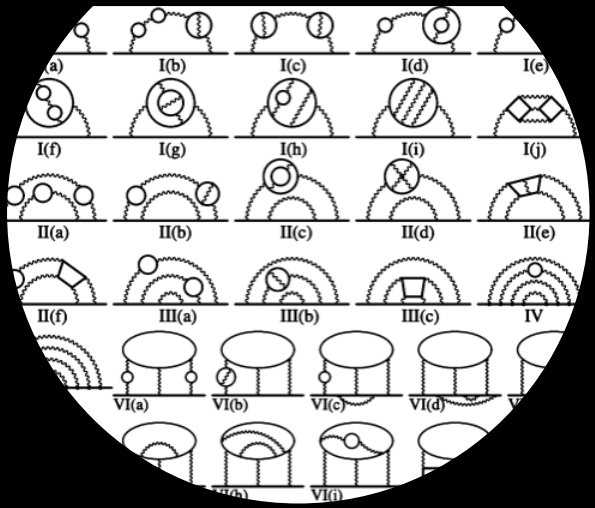
Frascati (near Rome, Italy)





Collaboration between Experiment and Theory

- A > 20 years **common** activity on the evaluation of the Muon g-2
- Development of theoretical tools (MC, RC) for interpretation of data
- Participation to common Working Groups



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Physics Reports

Volume 887, 3 December 2020, Pages 1-166

The anomalous magnetic moment of the muon in the Standard Model

T. Aoyama [1, 2, 3], N. Asmussen [4], M. Benayoun [5], J. Bijnens [6], T. Blum [7, 8], M. Bruno [9], I. Caprini [10], C.M. Carloni Calame [11], M. Cè [9, 12, 13], G. Colangelo [14], F. Curciarello [15, 16], H. Czyż [17], I. Danilkin [12], M. Davier [18], C.T.H. Davies [19], M. Della Morte [20], S.I. Eidelman [21, 22], A.X. El-Khadra [23, 24] ... A.S. Zhevlakov [78]

Show more

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Physics Letters B

Volume 848, January 2024, 138344

Letter

An alternative evaluation of the leading-order hadronic contribution to the muon $g-2$ with MUonE

Fedor Ignatov [a], Riccardo Nunzio Pilato [a], Thomas Teubner [a], Graziano Venanzoni [a b]

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[b] INFN Sezione di Pisa, Largo Bruno Pontecorvo 3, 56127, Pisa, Italy

STRONG 2020

RADIO MONTECARLOW

Review | Published: 23 February 2010

Quest for precision in hadronic cross sections at low energy: Monte Carlo tools vs. experimental data

Working Group on Radiative Corrections and Monte Carlo Generators for Low Energies, S. Actis, A. Arbuzov, G. Balossini, P. Beltrame, C. Bignamini, R. Bonciani, C. M. Carloni Calame, V. Cherepanov, M. Czakon, H. Czyż, A. Denig, S. Eidelman, G. V. Fedotovich, A. Ferroglia, J. Gluza, A. Grzelińska, M. Gunia, A. Hafner, F. Ignatov, S. Jadach, F. Jegerlehner, A. Kalinowski, W. Kluge, ... C. Z. Yuan

+ Show authors

The European Physical Journal C **66**, 585–686 (2010) | Cite this article

Springer Link

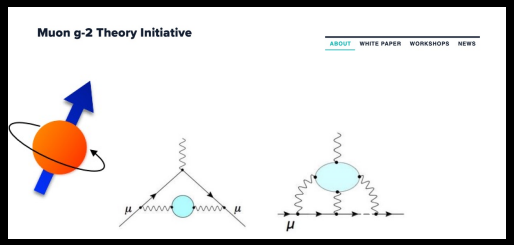
Regular Article - Experimental Physics | Open Access | Published: 28 March 2018

Combination of KLOE $\sigma(e^+e^- \to \pi^+\pi^-\gamma(\gamma))$ measurements and determination of $a_\mu^{\pi^+\pi^-}$ in the energy range $0.10 < s < 0.95$ GeV^2

The KLOE-2 collaboration, A. Anastasi, D. Babusci, M. Berlowski, C. Bloise, F. Bossi, P. Branchini, A. Budano, L. Caldeira Balkeståhl, B. Cao, F. Ceradini, P. Ciambrone, F. Curciarello, E. Czerwinski, G. D'Agostini, E. Danè, V. De Leo, E. De Lucia, A. De Santis, P. De Simone, A. Di Cicco, A. Di Domenico, D. Domenici, A. D'Uffizi, ... T. Teubner

+ Show authors

Journal of High Energy Physics **2018**, Article number: 173 (2018) | Cite this article



The MUonE Experiment at CERN

$$a_\mu^{HLO} = \frac{\alpha_0}{\pi} \int_0^1 dx(1-x)\Delta\alpha_{had}[t(x)]$$

3. Cross-check the SM prediction with a direct, completely different measurement → MUonE experiment at CERN

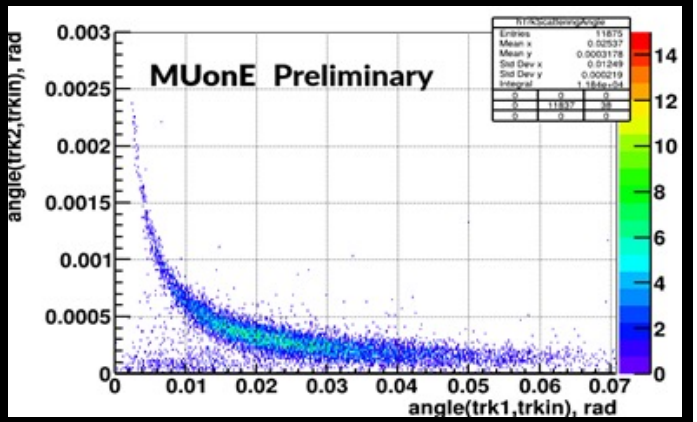
MUonE experiment proposed at CERN.
Phase-I 2025, Phase-II >2028 (after LS3)

Direct measurement of the leading term in the theory prediction

Liverpool group at the forefront of the Physics analysis and instrumentation

Joint effort between experiment and theory colleagues

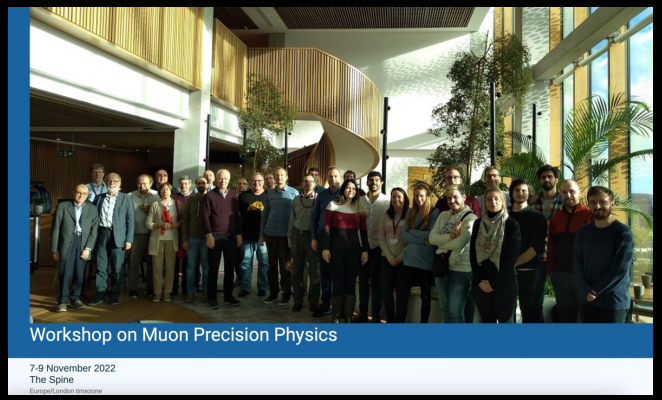
Instrumentation: Beam Spectrometer (BMS) detector, CF support for tracking detectors, …



Muon precision physics at Liverpool

- Liverpool has hosted 4 workshops for Muon Precision Physics (Nov 2022-2025), well-attended by experts from the experiment and theory communities worldwide. We plan to have a workshop also this November!

November 2022



November 2023

November 2024

November 2025

Recent interest: muon Catalyzed Fusion (μCF)

- 2025:Initial studies of the experimental and theory landscape
- June 2025: seminar at Liverpool by Fedor https://indico.ph.liv.ac.uk/event/2009/contributions/9639/attachments/4465/6245/mucf.pdf
- November 2025: Start of the collaboration with the Japan μFC group
- February 2026: Meeting with Japan and US groups at PSI
- July 2026: μCF Workshop in Liverpool

Few more details on the Workshop

- The workshop will take place in room 337
- Coffee breaks will be served on site
- Lunches and dinners will be held at local restaurants (to be decided day by day)
- Support to the workshop from JST Moonshot Goal 10 (Japan), the Leverhulme Trust, and the University of Liverpool (UK).

The workshop is intended as an informal forum for discussing physics and exploring future opportunities.

Many thanks to everyone who contributed to the organisation of the workshop, especially our Japanese colleagues (in particular Okada-san), C. Beck (IAA funding), D. Joss, K. McKay, K. Whittle, F. Ignatov, C. Zhang, J. Clark, and A. Reid.

Have a nice workshop!!!

Today, Thu 2 July

Welcome and Workshop Overview	*Graziano Venanzoni et al.*	
Oliver Lodge 337, Liverpool Physics	10:00 - 10:10	
Introduction to Research Activities at the University of Liverpool	*Joost Vossebeld*	
Oliver Lodge 337, Liverpool Physics	10:10 - 10:30	
μCF Studies in Japan and Moonshot Activities	*Shinji Okada*	
Oliver Lodge 337, Liverpool Physics	10:30 - 11:00	
Current Status of μCF Theory	*Yasushi Kino*	
Oliver Lodge 337, Liverpool Physics	11:00 - 11:30	
Clean room visit		
Oliver Lodge 337, Liverpool Physics	11:30 - 12:00	
Lunch		
Summary of Previous μCF Experiments and Lessons Learned	*Akihisa Toyoda*	
Oliver Lodge 337, Liverpool Physics	13:30 - 14:00	
Current Status of μCF Experiments at PSI	*Ara Knaian*	
Oliver Lodge 337, Liverpool Physics	14:00 - 14:30	
Recent Tritium Activities in μCF	*Walter Shmayda*	
Oliver Lodge 337, Liverpool Physics	14:30 - 15:00	
Exotic Atom Spectroscopy and High-Resolution X-Ray Measurements	*Yuichi Toyama*	
Oliver Lodge 337, Liverpool Physics	15:00 - 15:25	
Future Plans at PSI and J-PARC and International Coordination	*Satoshi Mihara*	
Oliver Lodge 337, Liverpool Physics	15:25 - 15:50	
Coffee break		
Oliver Lodge 337, Liverpool Physics	15:50 - 16:20	
Funding Opportunities and Future International Programs	*Joost Vossebeld*	
Oliver Lodge 337, Liverpool Physics	16:20 - 16:40	
Open Discussion on Future International Collaboration		
Oliver Lodge 337, Liverpool Physics	16:40 - 17:00	

Tomorrow, Fri 3 July

Detector Concepts and Key Measurements in Future μCF Experiments	*Akihisa Toyoda*	
Oliver Lodge 337, Liverpool Physics	10:00 - 10:30	
Neutron Detector Options for Future μCF Experiments	*Kazuki Ueno*	
Oliver Lodge 337, Liverpool Physics	10:30 - 10:40	
Preliminary Studies of Liquid Scintillator-Based Neutron Detection for μCF Experiments	*Saki ARAMAKI*	
Oliver Lodge 337, Liverpool Physics	10:40 - 10:50	
Coffee break		
Oliver Lodge 337, Liverpool Physics	10:50 - 11:20	
TES Detectors and High-Resolution X-Ray Detection for μCF and Exotic Atom Studies	*Shinji Okada et al.*	
Oliver Lodge 337, Liverpool Physics	11:20 - 11:40	
Simulation and Beam Optimization Studies: Current Results and Future Challenges	*Ce Zhang*	
Oliver Lodge 337, Liverpool Physics	11:40 - 12:00	
General Discussion		
Oliver Lodge 337, Liverpool Physics	12:00 - 12:20	
Lunch		
Fusion Research Overview in Japan	*Kenich Nagaoka*	
Oliver Lodge 337, Liverpool Physics	14:00 - 14:30	
Negative Muon Cooling and Potential Applications of μCF	*Patrick Strasser*	
Oliver Lodge 337, Liverpool Physics	14:30 - 14:50	
Fusion-Related Industrial Perspectives and Technology Development	*Masaru Oka*	
Oliver Lodge 337, Liverpool Physics	14:50 - 15:20	
Future Perspectives of μCF Studies in Relation to COMET	*Satoshi Mihara*	
Oliver Lodge 337, Liverpool Physics	15:20 - 15:40	
Coffee break		
Oliver Lodge 337, Liverpool Physics	15:40 - 16:10	
Future Roadmap toward PSI, J-PARC, and Next-Generation μCF Experiments		
Oliver Lodge 337, Liverpool Physics	16:10 - 16:30	
Closing Discussion		
Oliver Lodge 337, Liverpool Physics	16:30 - 17:00	

Meteo Liverpool

Thursday 2 July

	00:00	03:00	06:00	09:00	12:00	15:00	18:00	21:00
Temperature	16°C	17°C	15°C	14°C	17°C	18°C	17°C	15°C
Weather	Partly cloudy	Patchy rain possible	Patchy rain possible	Patchy rain possible	Patchy rain possible	Sunny	Sunny	Sunny
Chance of rain	16%	37%	21%	21%	13%	3%	4%	8%

Friday 3 July

	00:00	03:00	06:00	09:00	12:00	15:00	18:00	21:00
Temperature	13° C	12° C	12° C	18° C	21° C	23° C	22° C	19° C
Weather	Clear	Partly cloudy	Sunny	Partly cloudy	Partly cloudy	Sunny	Sunny	Sunny
Chance of rain	12%	18%	10%	7%	4%	1%	3%	7%


ONE THING IS FOR SURE: THE HUNT IS ON, AND NEW DISCOVERIES ARE ON THE HORIZON.
Stay tuned!

END