ROUNTABLE WG4

Claudio Gatti

Marin Karuza

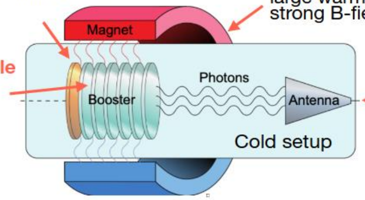
Deniz Aybas

WG4 ACTIVITIES
172 MEMBERS

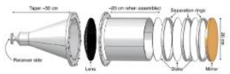
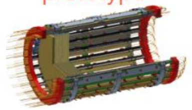
- Working Group Meeting – Feb Heidelberg
- WG4 meeting – May --> The RES-NOVA neutrino observatory
- Bainstorming meeting – April
- General Meeting
- Training School – hands on, CERN visit
- White paper – finishing line (Claudio)

PARALLEL SESSION

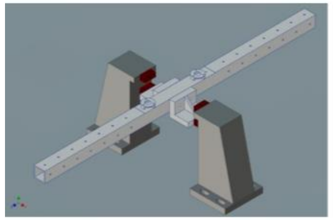
On the path to full-scale MADMAX



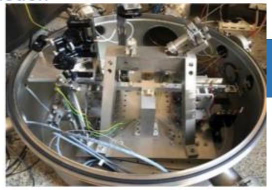
→ Prototyping phase since 2020 with physics runs @CERN (MORPURGO 1.6 T magnet)

⌀200 mm closed prototype	⌀100 mm closed prototype	⌀300 mm open prototype
		
17-day run @18.5, 19.2 GHz with peak $\lvert g_{a\gamma}\rvert \approx O(3\times10^{-11})$ GeV^{-1}	20-hour cold run @ ≈19 GHz and T < 10 K under B field (Analysis ongoing)	(2026) 3 discs $\lvert g_{a\gamma}\rvert \approx O(10^{-12})$ GeV^{-1} (2027-2029) 20 discs $\lvert g_{a\gamma}\rvert \approx O(10^{-13})$ GeV^{-1}

The balance prototype



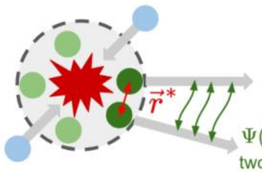
- 50 cm long arm with low momentum of inertia
- suspended through thin flexible joints (Cu-Be, 100 μm x 500 μm), similar to LIGO tiltmeters (Venkateswara et al. 2014)
- Balance center of mass positioned as close as possible to bending point (~10 μm) to minimize the coupling with ground motion



- Resonance frequency ~20-30 mHz
- Installed at the Sar-Grav surface laboratories in Lula (NU) – Sos-Enattos mine

Femtoscopy

Koonin-Pratt equation



$$C(k^*) = \frac{N_{SE}(k^*)}{N_{ME}(k^*)} = \int S(r^*)\left|\Psi(\vec{k}^*, \vec{r}^*)\right|^2 d^3r^* \xrightarrow{k^*\to\infty} 1$$

Lisa et al. Ann.Rev.Nucl.Part.Sci.55:357-402, 2005

Relative distance and ½ relative momentum evaluated in the pair rest frame

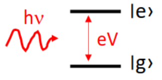
- Measure C(k*), fix S(r*), study the interaction.
- Detailed studies of the source in pp:
  ALICE Coll. Phys.Lett.B 811 (2020) 135849
  Mihaylov and Gonzalez Gonzalez, EPJC 83 (2023) 7, 590
- CATS framework to evaluate the above integral Mihaylov et al. EPJC 78 (2018) 5, 394

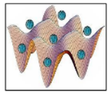
Atomic Clocks & Gravimeters

TIME

Optical atomic clocks

internal d.o.f., electronic states



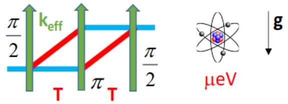


relative precision <10^{-20}

GRAVITY

Atom interferometers (gravimeters/gradiometers)

external d.o.f., momentum states



relative precision < 10^{-11} g

ultralight DM search

Table-top, low-energy experiments, high precision

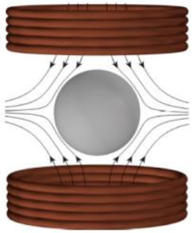
High sensitivity to: ***accelerations***, ***spin precession***, ***variation of fundamental constants***

Towards a Hunt for ALPs Sourced by Pulsars

Jackson Fowler
Magnetic Levitation Group

CA21106 General Meeting
Sofia, Bulgaria
10.09.2025

MBI Marietta Blau Institute for Particle Physics ÖAW Austrian Academy of Sciences



PLENARY SESSION

Preliminary ALPs sensitivity projections for the RES-NOVA Observatory

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Università degli Studi di Milano-Bicocca & INFN-MiB

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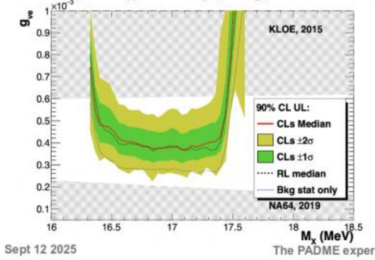
Istituto de Astrofisica de Canarias

PADME Expected sensitivity

- Evaluate expected 90% CL UL in absence of signal
- Modified frequentist approach, LEP-style test statistic
- **Likelihood fits** performed for the separate assumptions of **signal + background vs background only,** define Q statistic based on Likelihood ratio: Q = LS + B(g_{ve}, M_X)/ LB. The likelihood includes terms for each nuisance parameter pdf
- For a given M_X, CLs = P_S/ (1 –P_B) is used to define the UL on g_{ve}



Source	Uncertainty [%]
N_2	0.6
B	0.35
N_{PoT}	0.55
TOTAL on g_R	**0.88**
TOTAL on K(s)	**2.1**

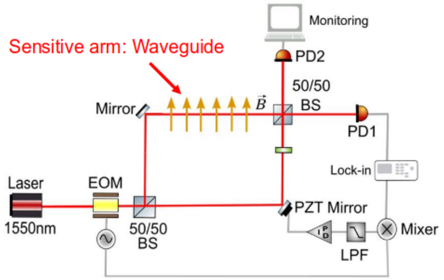
Pseudo data (SM background) is generated accounting for the expected uncertainties of nuisance parameters + statistical fluctuations

Universität Hamburg — CLUSTER OF EXCELLENCE QUANTUM UNIVERSE — DESY.

WISPFI (WISP searches on a Fiber Interferometer)

- γ→a conversion inside a **waveguide** measuring **photon disappearance** in the presence of B_{ext} [4].
- Axion conversion probability scales with [5]:
  For $P_{\gamma\to a} \ll 1$: $P_{\gamma\to a} \propto g_{a\gamma\gamma}^2 (BL)^2$
- **Mach-Zehnder interferometer** (MZI) with the sensing arm inside the magnetic field.
- Light guiding & **resonant detection.**
- Signal: **amplitude reduction** & **phase shift.**

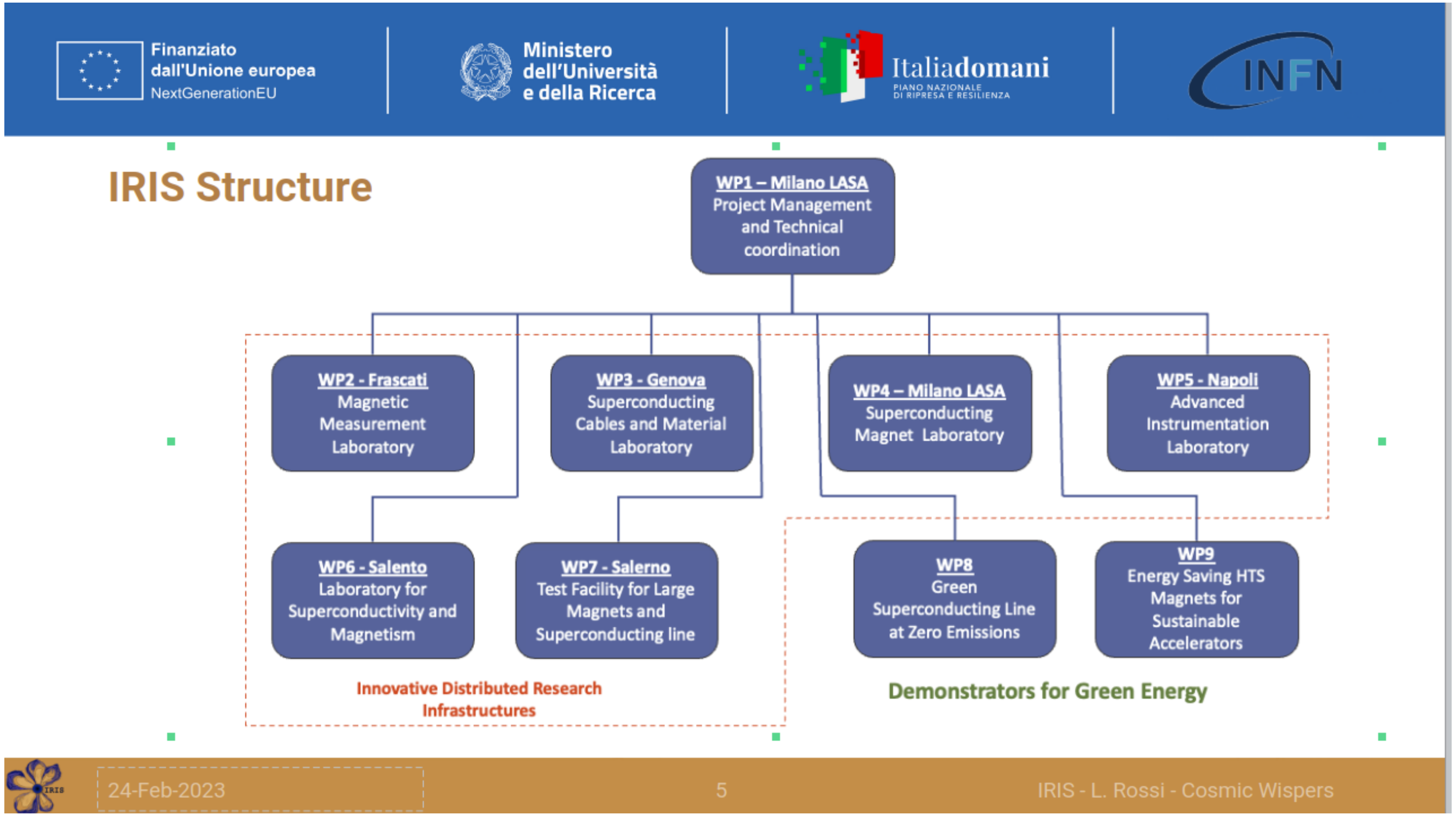
➢ No ρ_{DM} dependence.
➢ Room temperature operation



TECHNOLOGY FORUM: HIGH MAGNETIC FIELDS FOR WISPS SEARCHES
23–24 FEB 2023
LABORATORI NAZIONALI DI FRASCATI (ROME), ITALY

Introduction		*Aula Touschek, Laboratori Nazionali di Frascati (Rome), Italy*	14:30 - 14:40
The Babylaxo Magnet	*Matthias Mentink*	*Aula Touschek, Laboratori Nazionali di Frascati (Rome), Italy*	14:45 - 15:15
The MADMAX Magnet	*Walid Abdel Maksoud*	*Aula Touschek, Laboratori Nazionali di Frascati (Rome), Italy*	15:20 - 15:50
The GrAHal project within the context of the Grenoble high magnetic field facility	*Pierre Pugnat*	*Aula Touschek, Laboratori Nazionali di Frascati (Rome), Italy*	15:55 - 16:25
IRIS	*Lucio Rossi*	*Aula Touschek, Laboratori Nazionali di Frascati (Rome), Italy*	16:30 - 17:00

HIGH MAGNETIC FIELDS

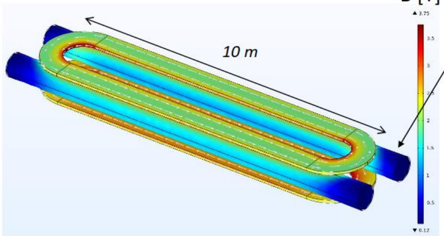


HIGH MAGNETIC FIELD - EXPERIMENTS

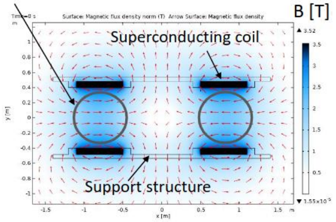
CERN

Winding layout

IAXO DESY.



warm bores



Common-coil dipole, with counter-flowing current in two superconducting race-track coils

Cross-section of magnet cold mass with magnetic field

Proposed winding layout:

- Common-coil superconducting dipole with a coil length of 10 meters
- Two race-track coils with counter-flowing currents
- Produces a transverse magnetic field over the two 11-meter-long bores with a free diameter of 0.7 m
- To be operated at T ≤ 5 K featuring Nb-Ti-based superconducting coils with about 2 T in the bore

CA21106 Kick-off meeting Feb 2023 4

cea

General specification of the magnet

MADMAX

Design
Magnetic design
Mechanical design
Conductor design

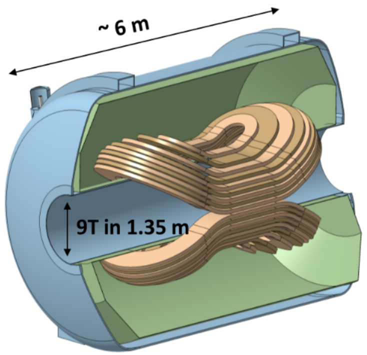
Manufacturing aspects
Winding issues
Casing issues

Conductor R&D
Copper profile shape
Cold work

Quench propagation R&D
Design
Manufacturing & integration
Test results

Physics specification	Value
"Ideal" FoM	~ 100 T²m²
Booster length 'L_b'	1.3 m
Bore diameter	1.35 m
Dipole Field	~ 9 T
Homogeneity (z=0)	± 10%
Maximum overall length	6.9 m
Maximum overall weight	200 t

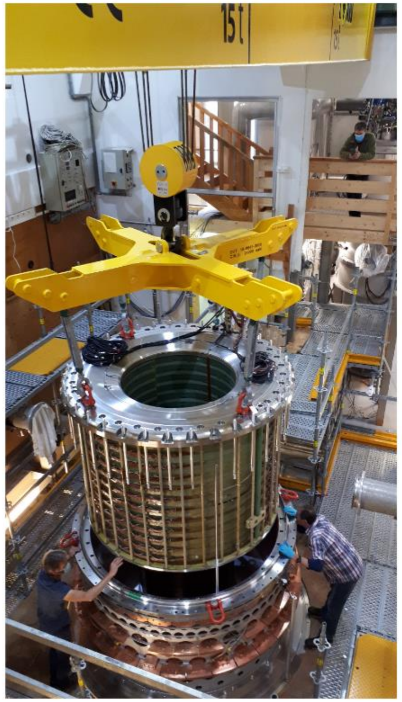
Magnet specification	Value
Superconductor	NbTi
Operating temperature	1.8 K
Load Line margin	10 %
Temperature margin	1 K
Allowable VM stress	180 MPa
Hot spot	100 K
Discharge voltage	± 1 kV
Maximum current	30 kA



Commissariat à l'énergie atomique et aux énergies alternatives Walid ABDEL MAKSOUD 7 septembre 2025

Outline

- Focus on high field facilities & magnets
  - International context
  - Highest DC field magnets worldwide
  - 43+T Hybrid Magnet
  - Presentation of LNCMI
- GrAHal-QUAX-CAPP
  - Scientific Motivations
  - Principle of the Experiment (Sikivie Haloscope)
  - Current Status of GrAHal & First Results
    - Cu and dielectric RF cavity 4-7 GHz (ANR French funding agency, 2022-2026)
  - Objectives and plans
    - GrAHal-QUAX for 7-10 GHz (dielectric RF cavity)
    - GrAHal-CAPP for 200-600 MHz (thin Cu RF cavity)
  - Upgrade phases under study
    - Within a 40 T all superconducting magnet under construction
    - Toward a 60 T Hybrid magnet (?)



Pierre.Pugnat@lncmi.cnrs.fr 2

TECHNOLOGY FORUM ON QUANTUM TECHNOLOGIES FOR WISPS

FEB 1 – 2, 2024

DESY HAMBURG

SQUIDs and their applications	*Michael Mueck*	
Main Auditorium, DESY Hamburg	15:00 - 15:25	
Development of superconducting circuits in Italy	*Federica Mantegazzini*	
Main Auditorium, DESY Hamburg	15:25 - 15:50	
Quantum Sensing and the Dark Quantum project	*Takis Kontos*	
Main Auditorium, DESY Hamburg	15:50 - 16:15	

QUANTUM TECHNOLOGIES FOR WISPS

SQUIDs and Their Applications

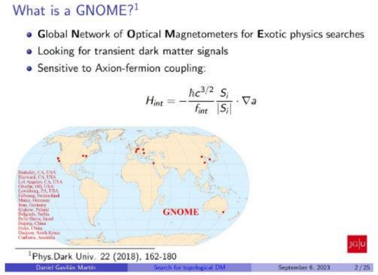
Michael Mück,ez SQUID Mess- und Analysegeraete

1. Introduction
2. The dc SQUID
3. 'Traditional' Applications of SQUIDs (Medical Diagnostics, Nondestructive Testing of Material)
4. Using a dc SQUID as a high-frequency amplifier
5. A SQUID amplifier with microstrip input coupling (MSA)
6. Gain and Noise Temperature of Microstrip SQUID Amplifiers
7. Some Recent Applications of MSAs

From Istanbul talk →

Networks

1. Help extending existing networks
2. Create links for new networks
3. Create opportunities for joint proposal for axion experiments with multi detectors



See talk by Daniel Gavilán

https://www.pi.uni-bonn.de/gravnet/en

TECHNOLOGY FORUM: ITC CONTRIBUTIONS
SOFIA 8 – 12 SEP 2025

Advances in optomechanics	*Nenad Kralj*	
Aula, Sofia University		15:30 - 16:00
Satellites & Space Missions	*Lubomir Toshev et al.*	
Aula, Sofia University		16:00 - 16:30
Magnetometry: from single measurements to network of magnetometers	*Boyan Benev*	
Aula, Sofia University		16:30 - 17:00

ITC CONTRIBUTION