

# iDMEu

initiative for Dark Matter in Europe and Beyond

**ECFA-NuPECC-ApPEC**  
**JENAS-Seminar**  
**Madrid, 4 May 2022**

The JENAA iDMEu EOI organizers:

**Marco Cirelli**  
**Caterina Doglioni**  
**Federica Petricca**  
**Gabrijela Zaharijas**

EOI: <https://indico.cern.ch/e/iDMEu>

Indico category: <https://indico.cern.ch/category/12787/>

Current website: <https://idmeu.org>

New website (demo): <https://idmeu.trust-it.it>

# Dark Matter is Everywhere



<https://agenda.infn.it/event/22947/overview>

## “Gravitational Wave Probes of Fundamental Physics” - a cross-cutting initiative

**Fundamental problems in high-energy and gravitational physics.** GWs provide novel portals to explore foundational physics in various flavours. From the particle physics viewpoint, they can provide novel information on the nature and phenomenology of dark matter (e.g., whether it is made of heavy particles, light fields, compact objects, or a mixture thereof), and on the existence of new fundamental fields (e.g. GW searches for axion-like particles and dark-photons which extend beyond the range of ongoing lab searches). From the gravitational viewpoint, violent GW events like mergers will elucidate the nature of black-holes and the fate of spacetime singularities, as well as providing novel probes of possible extensions (classical and quantum) of Einstein's General Relativity. At the same time, the high-accuracy v physics that ha

<https://indico.ph.tum.de/event/4492/>

## JENAS Expression of interest: "Nuclear Physics at the LHC: a unique doorway to investigate the hyperon-puzzle in neutron stars and to enable the search for dark matter in cosmic rays"

Nuclear Physics studies at the LHC have recently demonstrated a wide breadth of possible applications to astrophysics. On the one hand, hyperon-nucleon and hyperon-hyperon interactions can finally be investigated with high precision and these results are fundamental to study the equation of state of neutron stars. On the other hand, the physics of light anti- and hyper-nuclei (e.g. anti-deuteron, anti- $^3\text{He}$  or anti-hyper-triton) have recently sparked a large interest in the communities of astroparticle physics because of its connection to dark matter searches in cosmic rays.

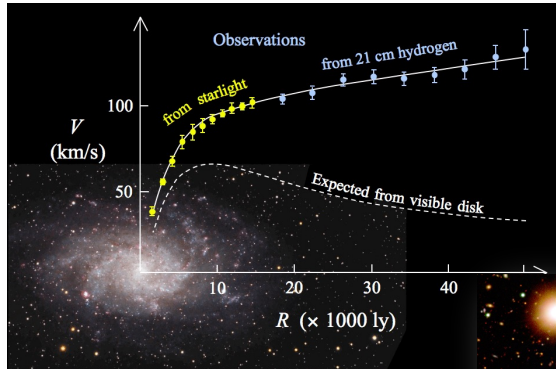
<https://indico.ph.tum.de/event/4482/overview>

## JENAS Expression of Interest: "Storage Rings for the Search of Charged-Particle Electric Dipole Moments (EDM)"

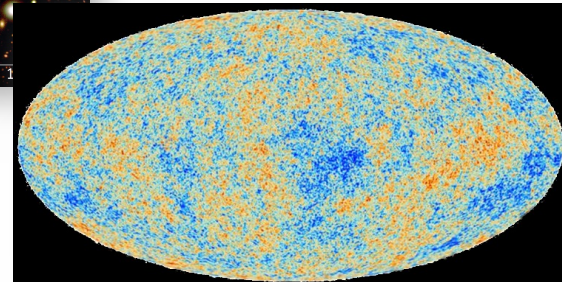
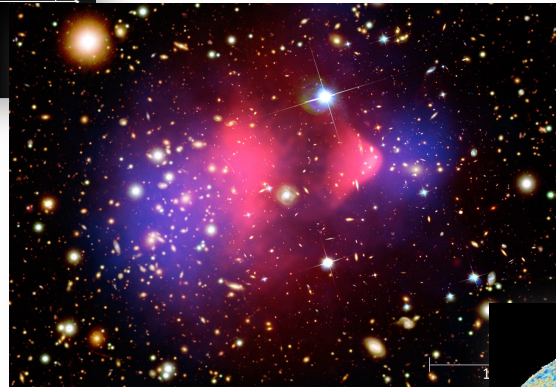
**Abstract:**

We propose a storage ring to search for electric dipole moments of charged particles with unprecedented sensitivity. This requires the design of a new type of accelerator namely an all-electric storage ring capable of simultaneously maintaining clockwise and counter-clockwise polarized beams – a prime task for the accelerator community. The EDM observable is embedded in the time development of the beam polarization, a quantity studied in many nuclear/hadron physics experiments. The scientific case rests upon non-electroweak CP-symmetry violation and the related strong CP-problem; additional CP-violation will elucidate the matter-antimatter asymmetry puzzle of the Universe, which falls into the realm of particle and astroparticle physics. Oscillating EDMs are an additional subject-of-study to search for axion/ALP Dark Matter, one further outstanding question of contemporary subatomic science. This proposal thus constitutes a prime example for a possible cooperation between the JENAS communities.

# The Dark Matter Problem

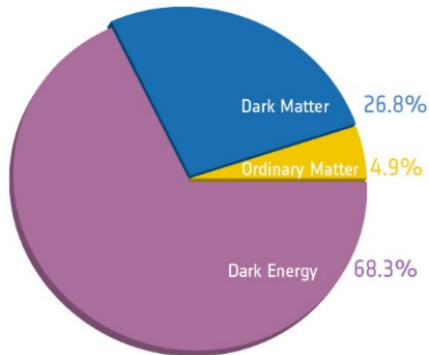


Compelling evidence for dark matter  
on various cosmological scales

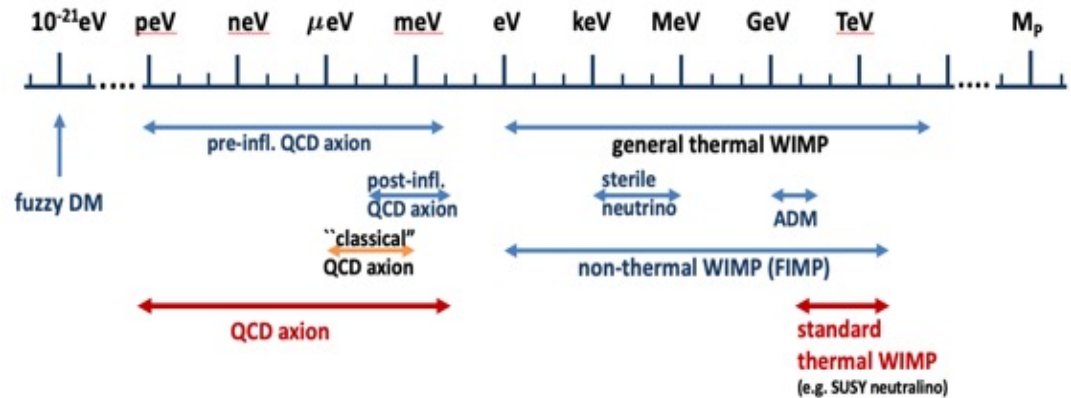


# The Dark Matter Problem

One model fits all  
the observations!



Source: © European Space Agency / Planck

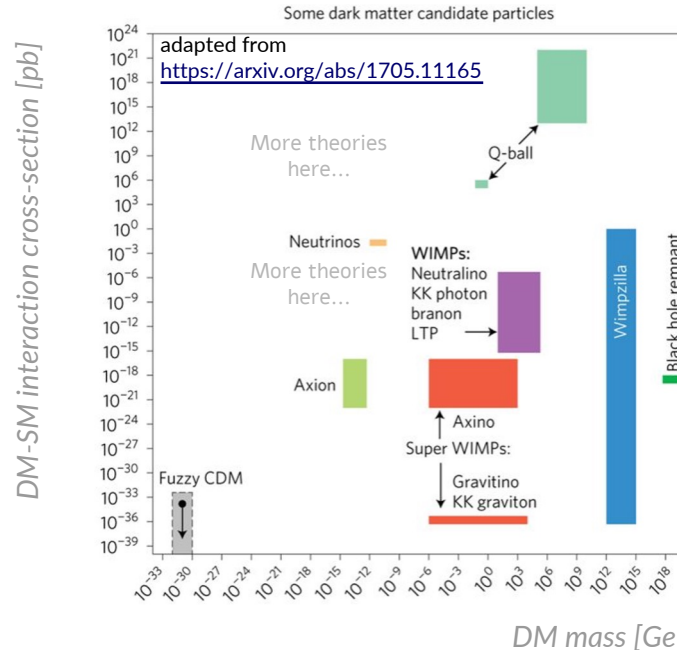


Picture from: Direct Detection of Dark Matter APPEC Committee Report  
<https://arxiv.org/abs/2104.07634>

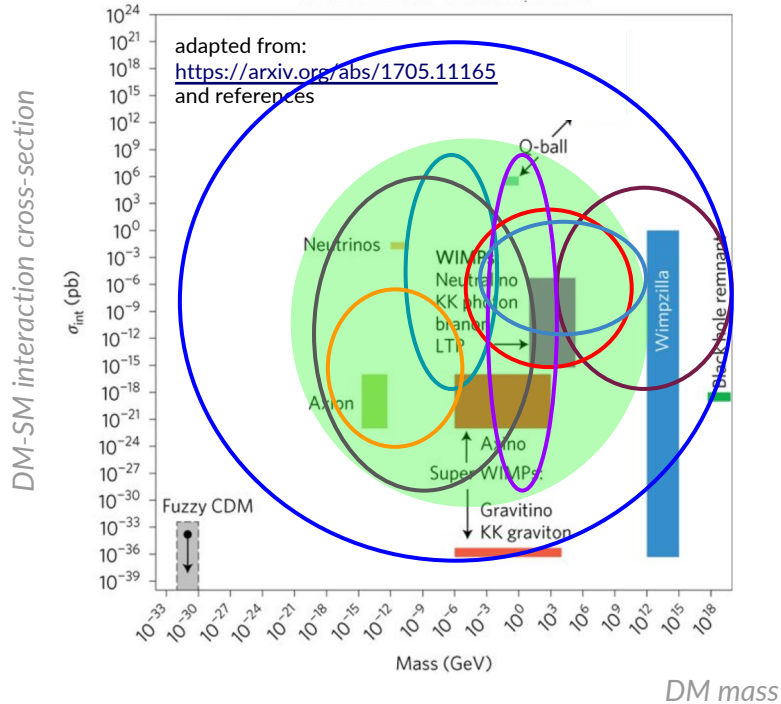
# Why an Initiative for Dark Matter (in Europe and beyond)?

Wide range of mass scales / interaction strengths for DM candidates  
→ wide range of theories and experiments to discover DM

*Looking up: stronger interactions*



# Why an Initiative for Dark Matter (in Europe and beyond)?



- Astrophysics and cosmology
  - High energy collider experiments
  - Axion/ALP experiments
  - Neutrino experiments
  - Indirect detection experiments
  - Direct detection experiments
  - Accelerator (fixed target/beam dump) experiments
  - Gravitational wave experiments
- (Not an inclusive list, and sensitivity contours exclusively for illustration)*

# Why an Initiative for Dark Matter (in Europe and beyond)?

Some DM searches and probes are fairly **mature**:

(e.g. direct and indirect detection, colliders...)

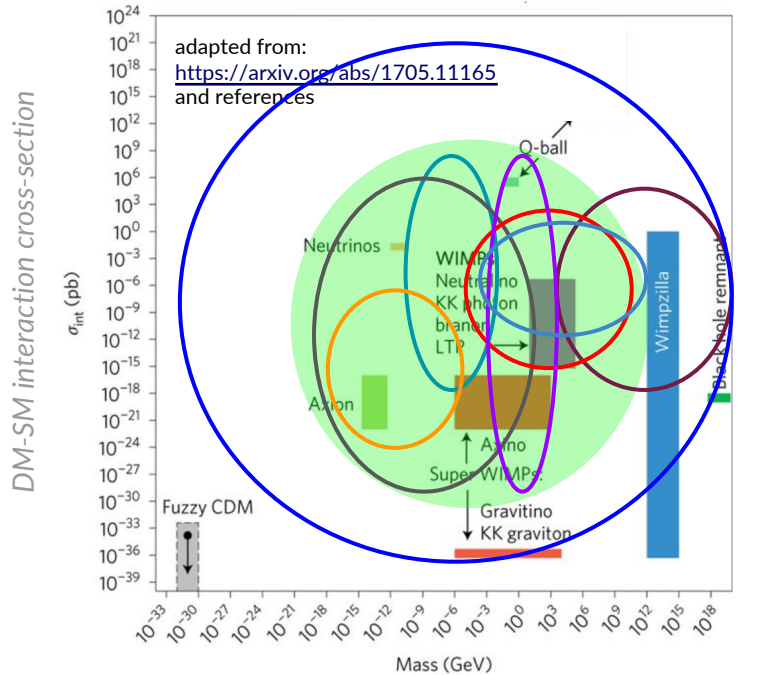
need to develop **mutual understanding** towards  
**common discovery/constraints** on DM

Other DM searches and probes are **more recent**:

(e.g. gravitational waves, quantum sensors...)

need to develop **connections** with other searches & probes  
for a **fully complementary picture**

The best region to find dark matter is the one where  
more techniques and ideas can **discover** and **explore** DM!




# **iDMEu background and development**



# How did iDMEu come to be?



- In October 2019, the proponents participated in the [first JENAS meeting](#) 
- Proponents had a **common shared interest** in dark matter, coming from **different communities**
  - Astroparticle / indirect detection / theory
  - High-energy colliders
  - LHCb and experiments at extracted beam lines
  - Direct detection / experiment
  - Neutrino / theory
  - Gravitational waves community
- In talking to each other, we realised that we all have similar questions:
  - E.g. *“what are your assumptions?” “why do you use this technique?” “how will findings in your DM research impact my DM research?” “where can we meet and discuss this topic in depth after JENAS?”*
- We realized **our scientific worlds weren't communicating enough**
- We decided to submit a [JENAA Expression of Interest](#)

## iDMEu proponents

Elena Cuoco  
Marco Cirelli  
Caterina Doglioni  
Gaia Lanfranchi  
Jocelyn Rebecca Monroe  
Silvia Pascoli  
Federica Petricca  
Florian Reindl

# Why an **I**nitiative for **D**ark **M**atter (in **E**urope and beyond)?



Discovering or constraining dark matter requires **broad discussion**

... but there is to date **no common platform to do so**



aims to be this **common dark matter discussion platform**

where the different communities can **identify cross-fertilization opportunities** for mutual benefits, with an even **broader perspective** of the **complementary** set of experimental searches, astrophysical/cosmological observations and theoretical benchmarks

## 4. Other essential scientific activities for particle physics

- a) The quest for dark matter and the exploration of flavour and fundamental symmetries are crucial components of the search for new physics. This search can be done in many ways, for example through precision measurements of flavour physics and electric or magnetic dipole moments, and searches for axions, dark sector candidates and feebly interacting particles. There are many options to address such

[European Strategy Update  
Deliberation document](#)

**Outlook on synergies:** Focusing on the quest for DM in the coming decades, at the Granada Symposium there was consensus in further developing synergies between the efforts of the high energy physics and astrophysics communities. The discussion highlighted the need for enhanced communication between accelerator/collider-based, direct detection and indirect detection dark sector searches, as well as the potential benefits of common technology platforms (see Chapter 11).

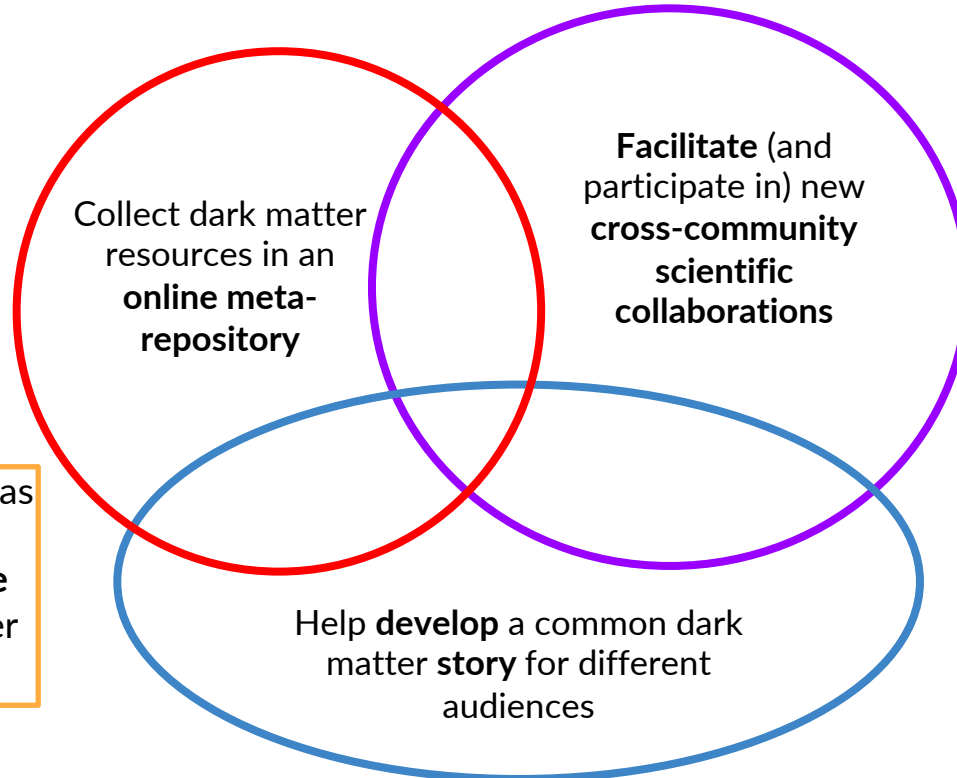
Consensus on common search targets is important for a joint interpretation of results from different searches in different experiments and Physics Theory Centres. The many ex-

b) Astroparticle physics, coordinated by APPEC in Europe, also addresses questions about the fundamental physics of particles and their interactions. The ground-breaking discovery of gravitational waves has occurred since the last Strategy update, and this has contributed to burgeoning multi-messenger observations of the universe. *Synergies between particle and astroparticle physics should be strengthened through scientific exchanges and technological cooperation in areas of common interest and mutual benefit.*

There are multiple synergies between particle and astroparticle physics, at the level of infrastructure, detectors, computing, interaction models and physics goals. These connections are through neutrino physics, dark matter searches, cosmic ray physics and, potentially in the future, gravitational waves. The precision

# Three connected iDMEu objectives

iDMEu enables exploiting **synergies** and highlighting the **complementarity** of different dark matter communities by developing a **common platform** to:



**Note:** iDMEu is intended as a platform that brings together **existing/future** community efforts, rather than a new effort

# Three connected iDMEu objectives



pointers to data, results and relative  
analysis tools, linking to existing  
resources and connecting **technical  
know-how** wherever needed

main **scientific events**  
(workshop, conferences,  
seminars...) are **advertised  
and catalogued**

Collect dark matter  
resources in an  
**online meta-  
repository**

**Facilitate** (and  
participate in) new  
**cross-community  
scientific  
collaborations**

results and underlying  
models, assumptions,  
techniques are  
**discussed and  
compared**

this **facilitates** joint  
data analysis and  
interpretation

**questions from one  
community to another** can  
be answered in an informal  
environment

Help **develop** a common dark  
matter **story** for different  
audiences

material about **dark matter  
outreach** for the general  
public is shared, and  
events are advertised

# How iDMEu intends to reach its objectives



## 1. Kick-off (and subsequent) meetings

May 10-12, 2021 - <https://indico.cern.ch/e/iDMEuKickOff>

## 2. iDMEu online platform & infrastructure

Our focus in the past year

Temporary website at <https://idmeu.org>

New demo at <https://idmeu.trust-it.it>

## 3. Initiating and supporting **cross-collaboration** activities

Current activities mostly with involvement of the organizers soon to include general ideas & contributions from the community

# **The iDMEu kick-off meeting**

# The iDMEu kick-off meeting



## Initiative for Dark Matter in Europe and beyond (iDMEu) kick-off meeting

10–12 May 2021  
Europe/London timezone

Enter your search term

### Overview

Timetable

Contribution List

My Conference

My Contributions

Registration

Participant List

Videoconference

### iDMEu Proponents and Organizers

✉ jenas-eoi-iDMEu-propo...

iDMEu is a recently-created initiative supported by [ECFA/APPEC/NuPECC \(JENAA\)](#) that aims to create a 'public place' where researchers working on the Dark Matter problem from very different communities can talk to each other and identify cross-fertilization opportunities for mutual benefits.

The scope of the initiative is very broad: particle theorists, particle experimentalists, cosmologists and astrophysicists from different sub-communities and different backgrounds will be invited to participate. We do not want to replace existing community efforts but instead help them connect, broaden their view and increase their visibility by other communities.

This is the first kick-off meeting where the different communities meet virtually, get exposed to each other's work, challenges and needs, and begin cross-talk discussions and activities.

Please register if you'd like to attend and be able to access the Zoom information on Indico.

Live captioning for this event has been provided by [AI-Media](#), and it has been funded by the ERC Starting Grant [DARKJETS](#) (GA 679305).

The data privacy notice for this event can be found [at this link](#).

**Starts** 10 May 2021, 13:00  
**Ends** 12 May 2021, 17:00  
Europe/London

**Caterina Doglioni**  
Elena Cuomo  
Federica Petricca  
Florian Reindl  
Gaia Lanfranchi  
Jocelyn Rebecca Monroe  
Marco Cirelli  
Silvia Pascoli

[iDMEu kick-off meeting live notes.pdf](#)  
 Recording\_Day\_1  
 Recording\_Day\_2  
 Recording\_Day3\_ClosingSession.mp4  
 Recording\_Day3\_DMqandA.mp4  
 Recording\_Day3\_Outreach.mp4



Registration

You are registered for this event.

374 / 500

[See details >](#)

A meeting intended to get to know each other's work and main challenges

Live captioning: effort to improve accessibility for online meetings

Live notes including Q&A and items to follow up on

Recordings of each of the sessions



# Kick-off meeting and iDMEu objectives

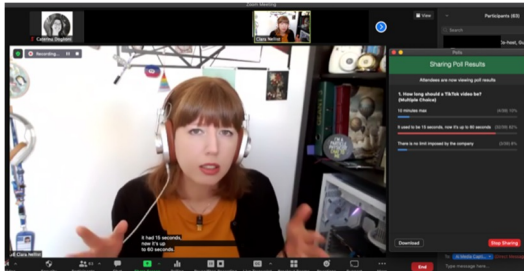
Collect dark matter resources in an **online meta-repository**

**Facilitate** (and participate in) new **cross-community scientific collaborations**

Help **develop** a common dark matter **story** for different audiences

## Day 3: **outreach session**

round table of ongoing efforts & interactive presentation on dark matter outreach



## Day 3: **Q&A session**

Questions contributed on mailing list and short (15') answers by experts

- Example: "Please explain the peaks in the CMB spectrum and why they require that there is matter that interacts gravitationally and is not baryonic (i.e. why they are strong evidence for dark matter)"

## Day 1 and 2: **community talks**

- talks from 12 different DM communities, both experiment & theory
  - Examples: astrophysical probes of DM, direct detection, colliders, accelerators, galaxy simulation
- all speakers were asked to follow the same talk structure:
  - Introduction and outlook
  - Current challenges, cross-community issues
  - Current & future needs of the community

## Day 2: **breakout sessions**

- cross-community points, either from day 1 talks or proposed & led by DM researchers
  - Topics: cosmology of feebly interacting particles, future iDMEu directions, instrumentation for wave-like DM, data sharing in direct detection

# Highlights of some of the breakout sessions #1

Full set of slides: <https://indico.cern.ch/event/1016060/contributions/4352070/>

## A DM virtual forum

- Identified the need for a “Dark Matter Virtual Forum” to share expertise, ask questions, search for collaborations and more.
  - iDMEu proponents thought of adding such functionalities to the website
  - Option that can be discussed:
    - List of ongoing projects that people want to make public and find collaborators for (e.g. [darkmachines.org](http://darkmachines.org))
    - Virtual forum with threads & popularity functionalities (e.g. [Discourse](#), [phpBB](#))
- Points to consider
  - Avoid duplication of work → liaise with EuCAPT/others as they also want to have an “expert webpage”
  - In case of forum: moderation + who is allowed to post
    - Needs to be “safe” (including code of conduct)
    - Needs to be inclusive (avoid one person dominating all conversations)
  - Maintenance
    - Who keeps lists up to date?




Technical infrastructure being developed as part of website, starting point for further iDMEu steps

# Highlights of some of the breakout sessions #2

Full set of slides: <https://indico.cern.ch/event/1016060/contributions/4352070/>

Initiative for Dark Matter in Europe and beyond (iDMEu) kick-off meeting, 10-12 May 2021

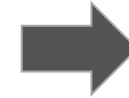
Béla Majorovits 

## Hardware connections across fields:

How to get information about similar technology R&D  
outside the community?

How to share technological advances within community?

- ❖ Dedicated astro-particle hardware conference(s)?
- ❖ R&D based collaborations (like CALICE, Radiation hard semiconductors)
  - ❖ Tool (web based) to share info –  
**Needs pro-active moderation! (iDMEu/APPEC?)**
  - ❖ Make better use of CERN infrastructure?
- ❖ List of failures needed! What has been tested unsuccessfully?



Point of future discussion regarding a potential communication tools (could be set up, once the forum/website is available)  
*[see also I. Shipsey's talk]*

# Conclusions of the kick-off meeting?

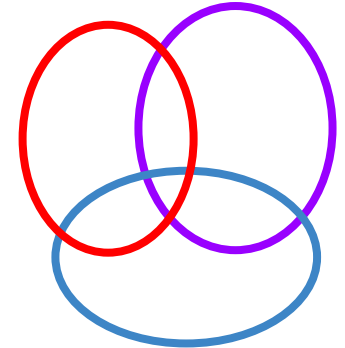
Our vision is to create the conditions for cross-talk and further collaboration

We want to help the community develop a “common DM story” → first focus will be **the website**

- This is relevant in the **communication to different communities**, from the experts to the general public
- A website built upon community contributions will help with this goal as well

After getting to know the rest of the community, iDMEu participants (including ourselves) could **propose ideas to work together**

- Projects will generally be developed within existing groups/communities
- Creation of new sub-projects and collaborations if ideas don't fit in existing groups
- Follow up in subsequent iDMEu meetings (e.g. satellite meetings during existing DM conferences / workshops) to reach different audiences



We also want to develop more links and connections for the future:

- Interactions with **International Training Networks** / COST actions on dark matter (e.g. HIDDEN, S. Pascoli as coordinator)
- Ways to be **synergistic** and of **service** to other current / new EOIs
- Ways to follow up on work done within prioritisation processes (e.g. European Strategy/Snowmass - see last slides)

# The iDMEu website

We thank JENAA for support towards the realization of a professional website for iDMEu. The website has also received funding from the European Union's Horizon 2020 research and innovation programme under [grant agreement No. 679305](#).

# The iDMEu website: content and contributors



Meta-repository idea: don't duplicate what exists already, rather **link to existing resources**

(inspiration: Neutrino Unbound <http://www.nu.to.infn.it>).

JENAA/EU funding used for professional web design (by Trust-IT, already working with ESCAPE)

## Main content includes:

- Experiments and telescopes, with name / homepage / description / timeline / results / contact
- Links to repositories of data, tools and results [see also G. Lamanna's talk]
- Scientific events on dark matter (e.g. workshops and conferences)
- "Dark Matter FAQ" online forum, where experts can answer questions at different levels
- Outreach material, showing the breadth of the DM activities in the communities
  - Events (e.g. Dark Matter day, IPPOG masterclasses...)
  - Resources (e.g. presentations and videos)

## Website content added by curators:

students doing an internship, or a thesis collect info, learn about DM and work on hands-on projects with organizers or members of the community

- **Contact us if you know of interested students!**
- See Gabriella Sabo and Josh Greaves's posters at JENAS 2022

Content will be also submitted to experimental collaborations for cross-checks

## Past iDMEu website curators



Gabriella Szabó  
(Bachelor student, Lund University, Sweden)



Romane Kulesza  
(Bachelor student, PSL University, Paris, France)

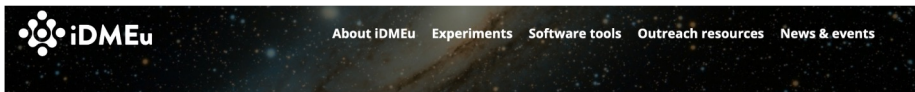


Tom Laclavère  
(Master student, Université de Paris, France)

# Highlights from demo website [work by G. Sabo, see poster]



Searchable tables with information from different kinds of experiments (e.g. here: direct & indirect detection)



Home / Indirect Detection Experiments

## Indirect detection experiments

Displaying 1 - 1 of 1

<b>Title</b> Insert string	<b>Free Search</b>	<b>Energy range</b>
<b>In operation since:</b>	<b>Location</b>	<b>Status</b> - Any -

Title	Home Page	Location	Experiment type	Energy range	In operation since	Status	TDR
H.E.S.S. - High Energy Stereoscopic System	<a href="#">↗</a>	The Khomas Highland, Namibia	Gamma ray experiments	20 GeV - 100 TeV	Summer, 2022	Operational	<a href="#">↗</a> <a href="#">↗</a> <a href="#">↗</a>

To be added:

- Collider experiments
- Accelerator experiments
- Wave-like DM experiments
- Astrophysics experiments
- Other experiments & observations

## Direct detection experiments

Displaying 1 - 9 of 9

<b>Free Search</b>	<b>Commissioning Year</b> Is equal to	<b>End year</b> Is equal to
<b>Unit Mass [g]</b> Is equal to	<b>Total mass [kg]</b> Is equal to	<b>Exposure [kg d]</b> Is equal to
<b>Live time</b> Is equal to	<b>Detection technique</b> - None -	<b>Target material</b> - None -

**Ongoing**

Yes

No

Title	Home Page	Phases / Runs	Location	Commissioning Year	End year	Detection technique	Target material	Unit Mass [g]	Total mass [kg]	Exposure [kg d]	Live time	Sou
AN AIS	<a href="#">↗</a>	AN AIS-112	LSC (Spain)	2017		Scintillation detector	Nal(Tl)		112.50		341.72	<a href="#">↗</a>
AN AIS	<a href="#">↗</a>	AN AIS-112	LSC (Spain)	2017		Scintillation detector	Nal(Tl)		112.50	11766.00		<a href="#">↗</a>
CDEX		CDEX-1	CJPL (China)	2010	2018	Ionisation detector	Ge	1.00		737.10		<a href="#">↗</a>
CDEX		CDEX-10	CJPL (China)	2016		Ionisation detector	Ge	10.00		102.80		<a href="#">↗</a>

# Highlights from curators' work: outreach [by T. Laclavere]



Starting list of outreach material, split by audience and type, will become a searchable table

## General Public

### Conferences & Videos

Outreach Resources - General Public - Conferences & Videos :

Title	Author(s)	Link	Language	Year	Duration	Keywords
What is Dark Matter ?	Minute Physics	<a href="#">Video</a>	English	2011	1 min	Abundance, Evidences
What is Dark Matter ?	PHD Comics	<a href="#">Video</a>	English	2012	6 min	Abundance, Properties, Evidences, Gravitational Lens, Collider Detection
What is Dark Matter ? A Mystery of the Universe	Physics Girl (Dianna Corwen)	<a href="#">Video</a>	English	2014	5 min	Abundance, History, Gravitational Lens, MACHOs, Baryonic Budget, WIMPs
A la recherche de la matière cachée de l'Univers	Marco Cirelli	<a href="#">Conference</a>	French	2015	90 min	
Revealing the Nature of Dark Matter	Dan Hooper	<a href="#">Conference</a>	English	2015	60 min	
Phantom of the Universe	Michael Barnett et al.	<a href="#">Website + Planetarium Video</a>	English	2016	30 min	
The Dark Matter Cake	Katharine Leney	<a href="#">Conference</a>	English	2017	30 min	
Presentation	Wessel Valkenburg	<a href="#">Conference</a>	English	2017	30 min	
La Matière Noire	Science Etonnante (David Louapre)	<a href="#">Video + Article</a>	French	2017	14 min	History, Rotation Curves, Halo, MACHOs, MOND, Baryonic Budget, WIMPs



## Data, tools and results: an opportunity for further connections

A number of data/software repositories for (& beyond) dark matter already exist

Examples:

- [ESCAPE Open-source scientific Software and Service Repository](#) in the context of the [Dark Matter Science Project](#)
- [EuCAPT GitHub repositories for HEP/astrophysics and cosmology tools](#)
- *Data and Software tools collected in the context of the [Dark Matter Data Center](#) in the Origins Cluster in Munich (see later slides)*

The iDMEu website will link to these repositories and show highlights of software packages that change over time for added visibility & recognition of software work

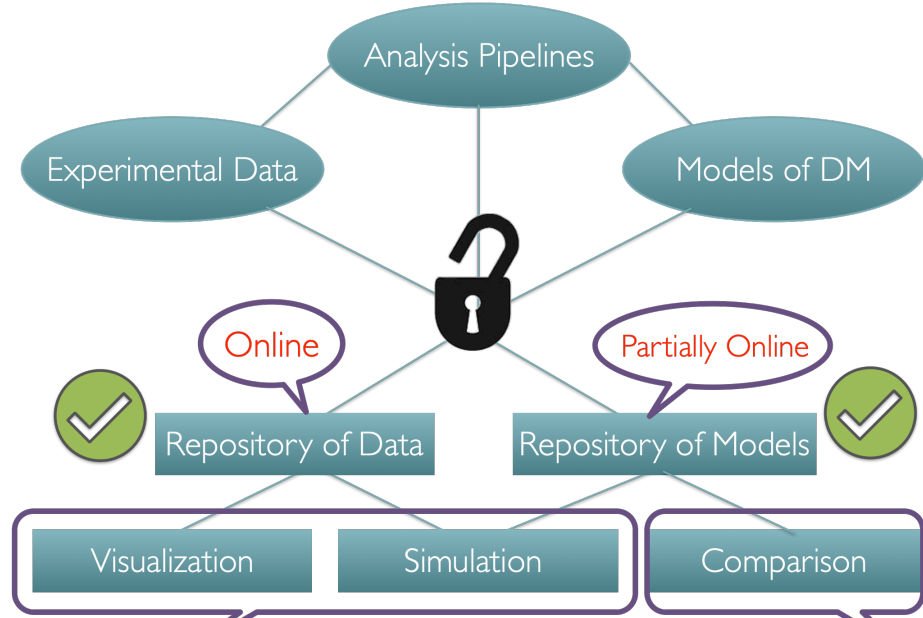
More discussions between the relevant actors above to be expected in the coming months

# Ongoing & connected activities

# Ongoing activity: the Dark Matter Data Center

[work by H. Banerjee and N. Ferreiro, see poster]

Purpose:  
Fostering Data & Information  
Sharing for the DM-DD Community



~2 weeks

Multiple options: Likelihoods, Yellin, Counting stats., etc. (Up to user)



<https://www.origins-cluster.de/en/odsl/dark-matter-data-center>

# Ongoing activity: dark matter complementarity in Snowmass iDMEu

initiative for Dark Matter in Europe and Beyond

**Context:** Snowmass Process (2020-2022), where the US HEP community (and beyond) comes together to identify and document a vision for the future of particle physics in the U.S. and its international partners [iDMEu “Townhall” presentation at the Community Planning Meeting](#)

## Ongoing activities of interest to iDMEu / with iDMEu participation:

- Highlighting strengths and shortcomings of collider assumptions in interpretations of DM searches (<https://arxiv.org/abs/2203.12035> & upcoming whitepaper)
  - This work takes into account feedback from members of direct detection & accelerator community, will eventually improve the plots in the European Strategy update Briefing Book
- Connecting collider and accelerator dark matter benchmarks
  - This work was also suggested/discussed after the colliders community talk at the iDMEu kick-off meeting
  - See J. Greaves’s poster & upcoming whitepaper, also part of ESCAPE Dark Matter Science Case
- Dark matter complementarity effort: showcasing the necessity of multiple approaches to cover different dark matter scenarios (upcoming whitepaper)

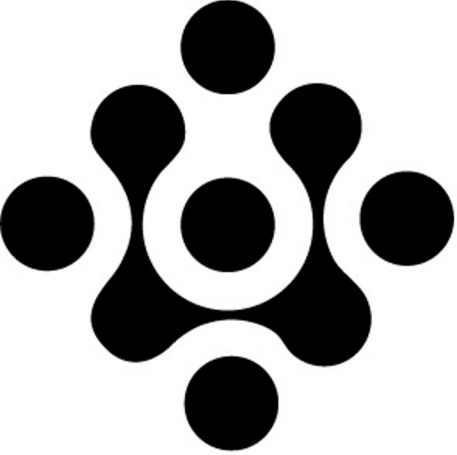
# Conclusions



## iDMEu enables to do **more of the sum of its parts**

- iDMEu is meant to be a **service** to the community
- It aims to provide what we (proponents) felt was missing:
  - A **website** to collect and find information / expertise on dark matter
  - Occasions for **broad community cross-talk** in the shape of meetings / discussion sessions at existing conferences
  - A **platform** where new projects can be initiated, including tools to facilitate communication and common scientific interpretations
  - Resources for developing a common **dark matter story** for different audiences
- iDMEu is still in development shape
  - Also with the help of a [Task Force put in place by JENAA \(APPEC/ECFA/NuPECC\)](#)

iDMEu's success will lie in the **success of the activities it facilitates**



**iDM Eu**

initiative for Dark Matter in Europe and Beyond

**ECFA-NuPECC-ApPEC**

**JENAS-Seminar**

**Madrid, 4 May 2022**

**Backup Slides**

# Composition of our task force [members with (1)]

Thanks for the input!



## JENAS Expressions of Interest

### List of submitted EoI:

1. Dark Matter (<https://indico.cern.ch/event/869195/overview>)
2. Gravitational Waves for fundamental physics (<https://agenda.infn.it/event/22947/overview>)
3. Machine-Learning Optimized Design of Particle Detector Layout for future scientific experiments (PDF version can be found [here](#))
4. Nuclear Physics at the LHC (<https://indico.ph.tum.de/event/4492/>)
5. Storage Rings for the Search of Charged-Particle Electric Dipole Moments (EDM) (<https://indico.ph.tum.de/event/4482/overview>)

EoIs in the form of a brief letter are to be submitted to the chairs of the committees/consortia. In the letter you can elaborate on the synergy topic, the objectives, the initial thoughts and the potential communities involved. This letter is not the end of the process, but potentially the start of further communications on the expressed interest.

### JENAS EoI Task Force representatives

For APPEC:

- Jo van den Brandt (2) ✉
- Jürgen Brunner (3) ✉
- Tomek Bulik (2) ✉
- Francesca Calore (1) ✉
- Fiorenza Donato (4) ✉
- Elena Cuoco (3) ✉
- Uwe Oberlack (1) ✉
- Xin Wu (4) ✉

For ECFA:

- Peter Levai (2) ✉
- Isabell Melzer-Pellmann (1) ✉
- Nick van Remortel (2) ✉
- Mike Seidel (5) ✉
- Marek Tasevsky (3) ✉
- Claude Vallee (1) ✉
- Mikko Voutilainen (3) ✉

For NuPECC:

- Navin Alahari (4) ✉
- Franck Sabatié (3) ✉
- Boris Sharkov (1,2) ✉
- Hans Stroehrer (5) ✉
- Eberhard Widmann (5) ✉
- György Wolf (2,4) ✉

# Example ideas: high-energy collider data



**What we have:** Many different searches that can shed light on the nature of the SM-DM interaction, existing LHC working groups to discuss their (re)interpretations

## What we need:

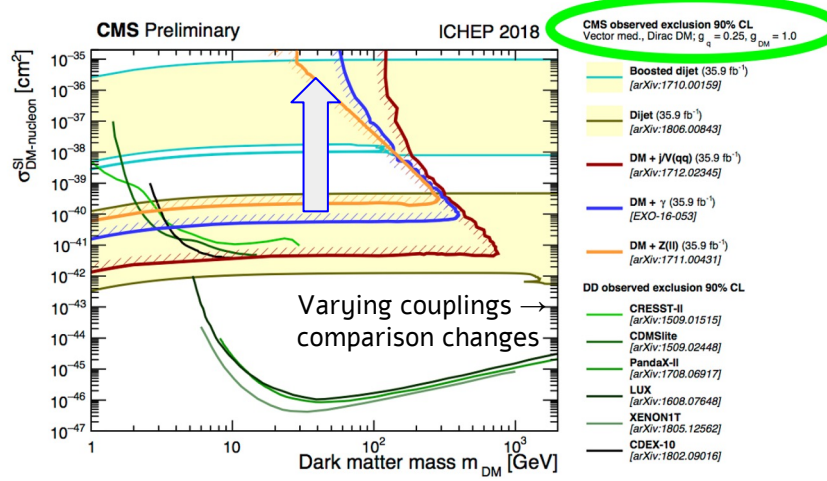
Discussion with other communities about our results and summary plots (e.g. are assumptions reasonable to DD/ID/accelerators?)  
 A “big picture” story and information repository for community members, so they can broaden their view on DM (e.g. when presenting their results at conferences / studying for a dark matter thesis / doing outreach on DM)

**What iDMEu could help facilitating:** Discussion between different communities involving existing WGs if they wish, information meta-repository including outreach, FAQ about dark matter

## Examples of concrete questions for the forum:

- “how should we display model assumptions when comparing with ID/DD”
- “can we safely show collider results for DM particle masses < 1 GeV?”

Example of LHC DM summary plot



Example of [information exchange](#) between DD and colliders during the preparation of [a CERN seminar](#) that could have been solved/made permanent via meta-repository





# Concrete project example: direct detection DM data

**What we have:** Compilation of experimental results in certain scenarios/models

Very broad range of DM masses and couplings probed!

**What we need:** Sharing of (reduced) data sets to:

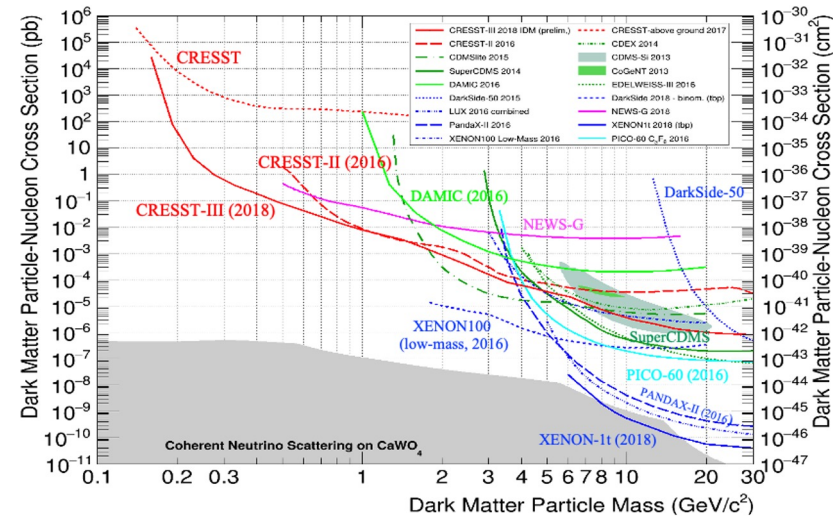
- Interpret for different scenarios/model
- Interpret with common statistical tools
- = Combine results inside direct detection but also beyond (with accelerators and indirect detection)

**What iDMEu could help facilitating:** Creation of data repository + tools for theory interpretation, using and connecting existing tools wherever possible

**Examples of concrete questions:**

- “What is the best way to share not only results, but also data? What is the ‘metadata’ needed?”
- “How do different experiments treat their statistical analysis?”
- “How can we version existing repositories of results?”

F. Reindl @ iDM 2020



# Example ideas: indirect detection DM data

**What we have:** Plethora of excellent experimental results and interpretations.

**What we need:**

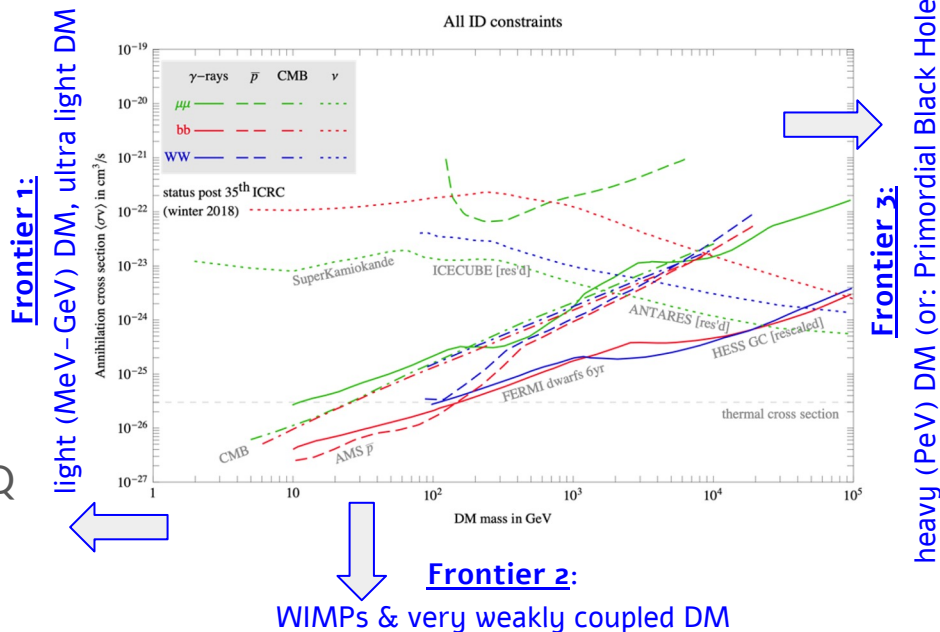
- map the community (tens of experiments w different techniques)
- harmonization (e.g. of astro assumptions)
- improve cross-talk (with DD, Collider, theory & astro/cosmo)

**What iDMEu could help facilitating:** Lists & meta-repositories, shared (evolving?) benchmark lists, FAQ cross-talks

**Examples of concrete questions:**

- “What are the common astrophysical assumptions?”
- “Should we harmonize assumptions/techniques in summary plots?”
- “Can nuclear physics tell us more about ID backgrounds?”  $\Rightarrow$  will be answered by JENAA EOI on nuclear physics @ LHC

M. Cirelli 2018, to appear



# Snowmass 2021 - input to US particle physics prioritization



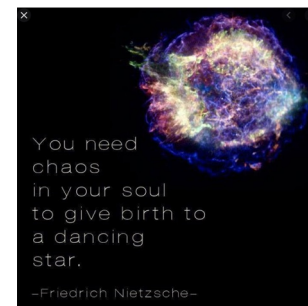
## Goal:

The Snowmass Process is organized by the Division of Particles and Fields (DPF) of the American Physical Society. Snowmass is an opportunity for the entire HEP community to come together to *identify and document a **vision** for the future of particle physics in the U.S. and its international partners, which will eventually drive US funding prioritization.* Timeline: Spring 2020 to Autumn 2022

**Organization:** Many **frontiers** representing communities (Energy Frontier, Cosmic Frontier, Rare and Precision Frontier, Underground Frontier...) and **liaisons** between frontiers

## How is the work proceeding?

(Groups of) community members send in **Letters Of Intent (LOIs)** and **full whitepapers**  
Topical Group conveners follow the work and summarise it into their group's whitepapers  
**Vision** ⇒ one of the Snowmass tasks is to **turn community interests into a coherent big picture**



# How to facilitate interactions, a practical example

- Dark Machines (idea by G. Bertone, led by A. Ruiz et al.):
  - Webpage with a list of names / ongoing projects
  - Participants propose and self-assemble into projects
    - Currently 8 different projects ongoing
    - Each project proceeds independently, and can summarise status/updates at workshops
    - (White)papers published regularly
  - Slack (communication tool) channels, one per project
  - Yearly Dark Machines workshops/hackathons
- Strength of Dark Machines:  
connecting people with different technical / physics expertise

## About Dark Machines

Dark Machines is a research collective of physicists and data scientists. We are curious about the universe and want to answer cutting edge questions about Dark Matter with the most advanced techniques that data science provides us with.

[Visit our indico page](#)