Dark Boson as a New Force Carrier

(New JEDI : New Judicious Experiments for Dark Sectors Investigations)

Beyhan BASTIN
Grand Accélérateur National d'Ions lourds (Caen, France)

- Scientific scope of the project
- New JEDI collaboration and implication of their members in the project
- Description of the New JEDI scientific project
- Timeline, human and financial resources and calls for funding

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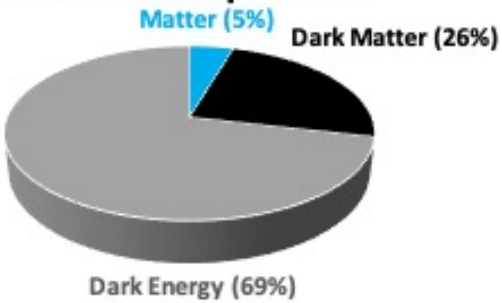
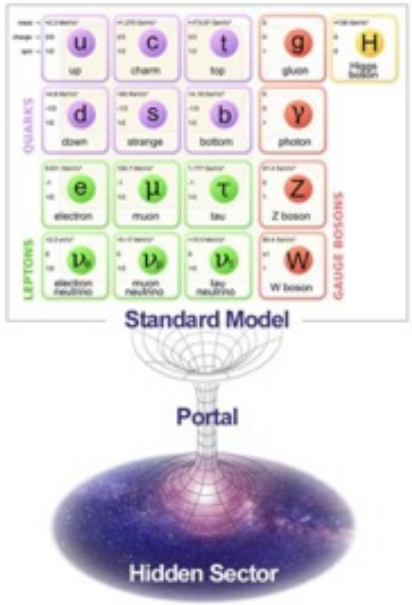
Dark sectors theory as a new alternative scenario to the standard direct Dark Matter detection approach

Universe composition



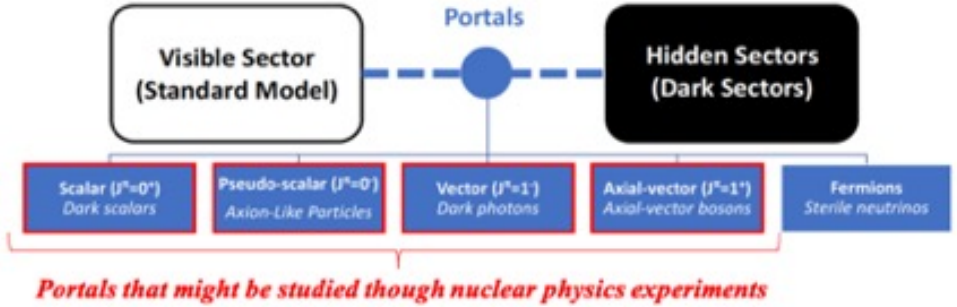


The Standard Model (SM) of particle physics fails to describe hidden sectors of our universe.

Dark Sectors (DS) = hypothetical sets of relatively light particles with interaction orders of magnitude lower than the electromagnetic interactions. DS are composed of one or more particles, that couple to SM through portals.

Introduced by [1] C. Boehm *et al.*, NPB 683 (04) 219. M. Pospelov *et al.* PLB 662 (08) 53. [3] N. Arkani-Hame *et al.* PRD 79 (09) 015014

...but poorly tested.



New JEDI lecture series

- 2022 edition : lectures of Pierre Fayet : https://indico.ijclab.in2p3.fr/event/8277/

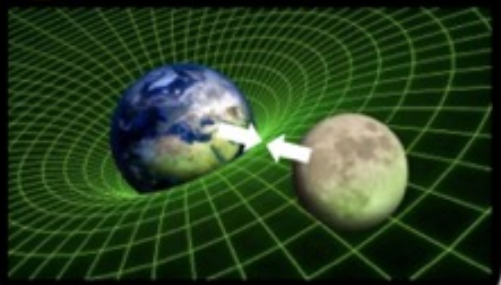
"The U boson as a generalized dark photon (possibly behaving as an axionlike particle)"

- 2023 edition : lectures of Maxim Pospelov

Well-known four forces of nature?

NEW JEDI

1 Gravity



10^{-39}

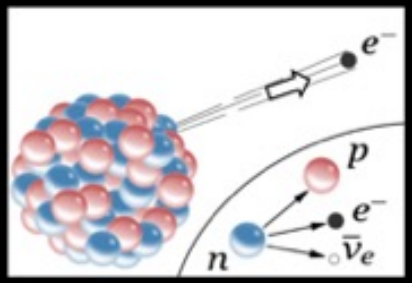
Graviton

2 Electromagnetic force

10^{-2}

Photon

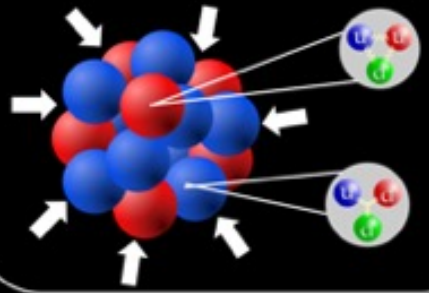
3 Weak force



10^{-7}

W and Z bosons

4 Strong force



1

Gluon

Boson : messenger of the force

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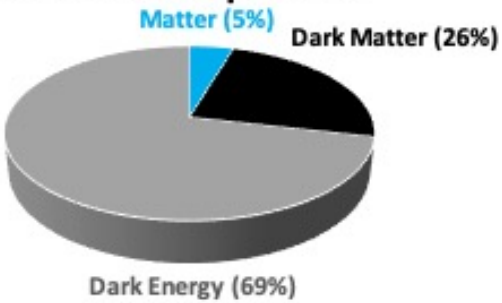

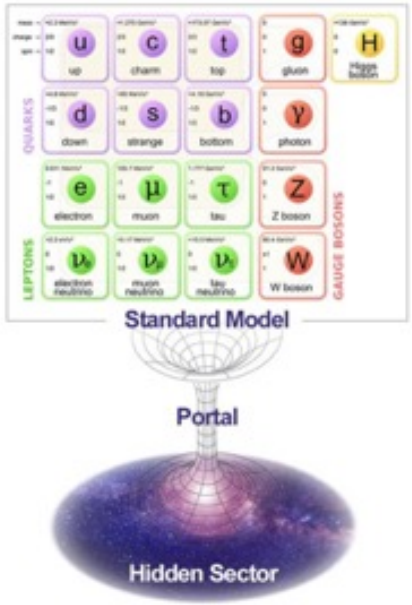

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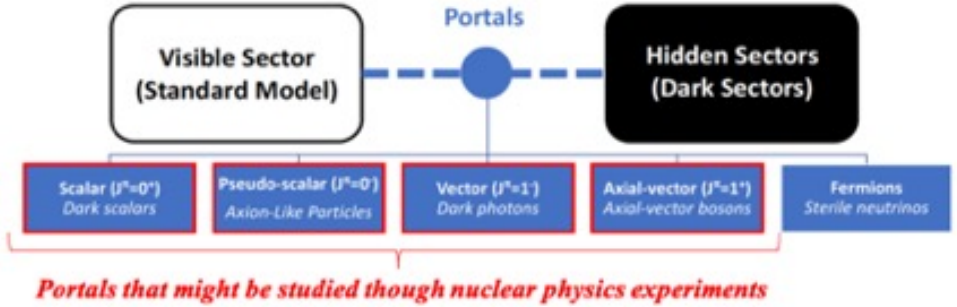

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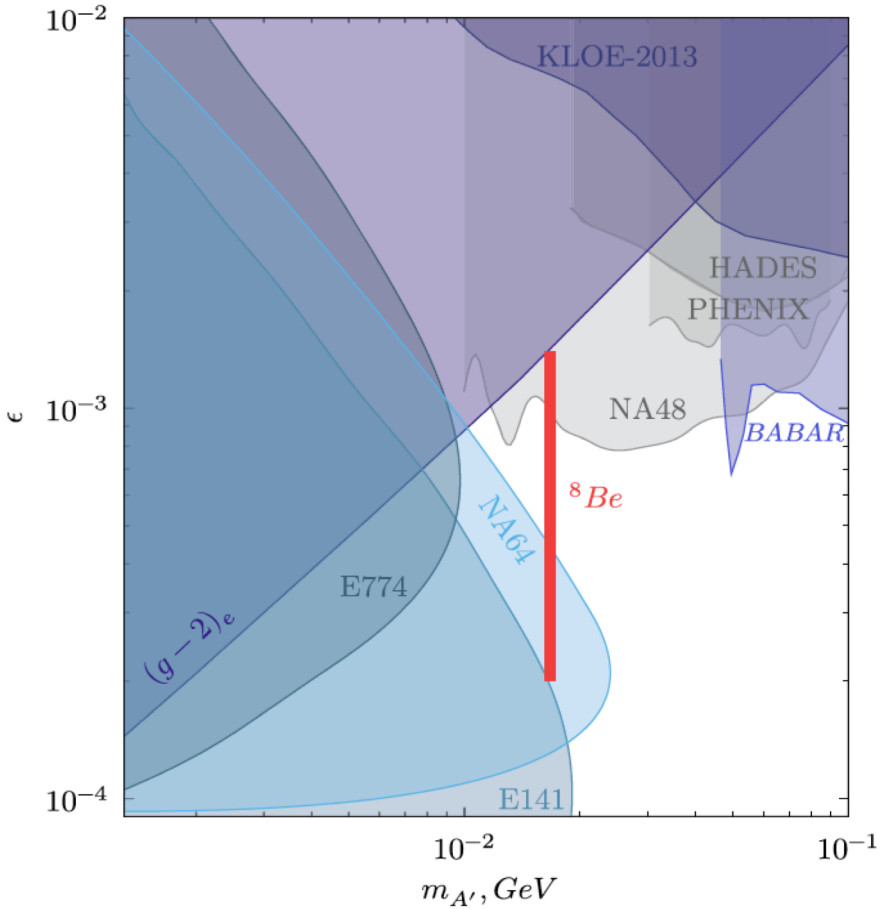
Focus on dark photons



- The main constraint on $m_{A'}$ comes from the ^{8}Be Anomaly [Kra16]:
  $\mathbf{m_{A'} = m_X = 16.70 \pm 0.35\ (stat) \pm 0.5\ (syst)\ MeV/c^2}$

Note : from this experiment, $\boldsymbol{|\varepsilon_e| \gtrsim 1.3 \times 10^{-5}}$

$$\Gamma(X \rightarrow e^+e^-) = \boldsymbol{\varepsilon_e^2}\alpha \frac{\boldsymbol{m_X^2} + 2m_e^2}{3\,\boldsymbol{m_X}} \sqrt{1 - 4m_e^2/\boldsymbol{m_X^2}}$$

- **The limits on the figure are from [Fen16][Fen17]** :
- $\boldsymbol{|\varepsilon_e| < 1.4 \times 10^{-3}}$ $\boldsymbol{(3\sigma)}$ anomalous magnetic moment of the electron
- $\boldsymbol{|\varepsilon_e| > 2 \times 10^{-4}}$ from the E141 SLAC experiment (search for dark photons bremsstrahlung)

- Recently NA64 : $\mathbf{1.3 \times 10^{-4} \lesssim \varepsilon_e \lesssim 4.2 \times 10^{-4}}$
  (bremsstrahlung reaction $e^- + Z \rightarrow e^- + Z + X$)

Not really compatible with the NA48 experiment (CERN)

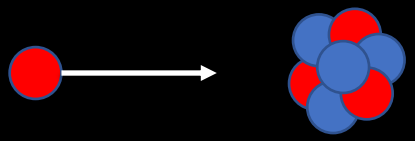
$\pi^0 \longrightarrow X\,\gamma$

=> Protophobic boson

^{8}Be Anomaly

^{7}Li

(3p + 4n)



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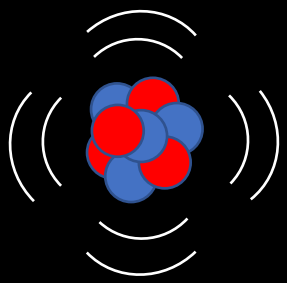
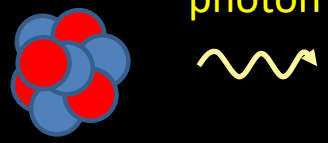


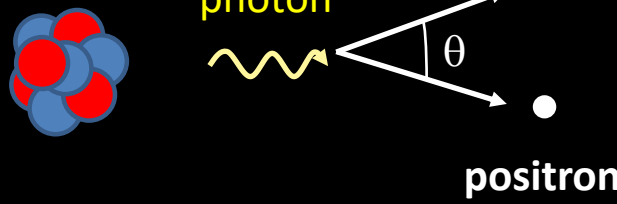
Case N°1 : emission of a photon

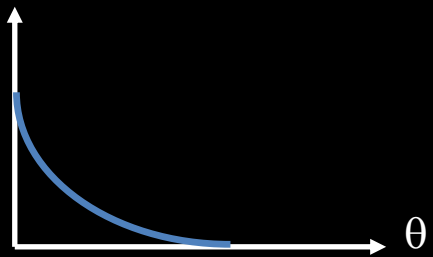
^{8}Be
(4p + 4n)



Case N°2 : emission of a photon + e-/e+ pair creaction

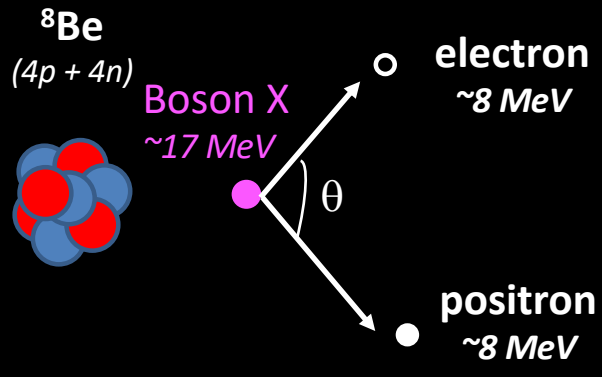
^{8}Be
(4p + 4n)

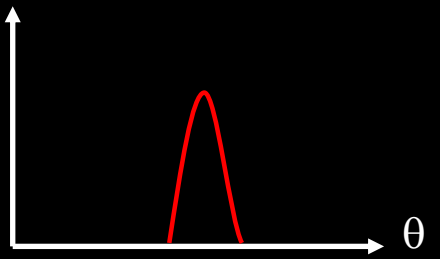




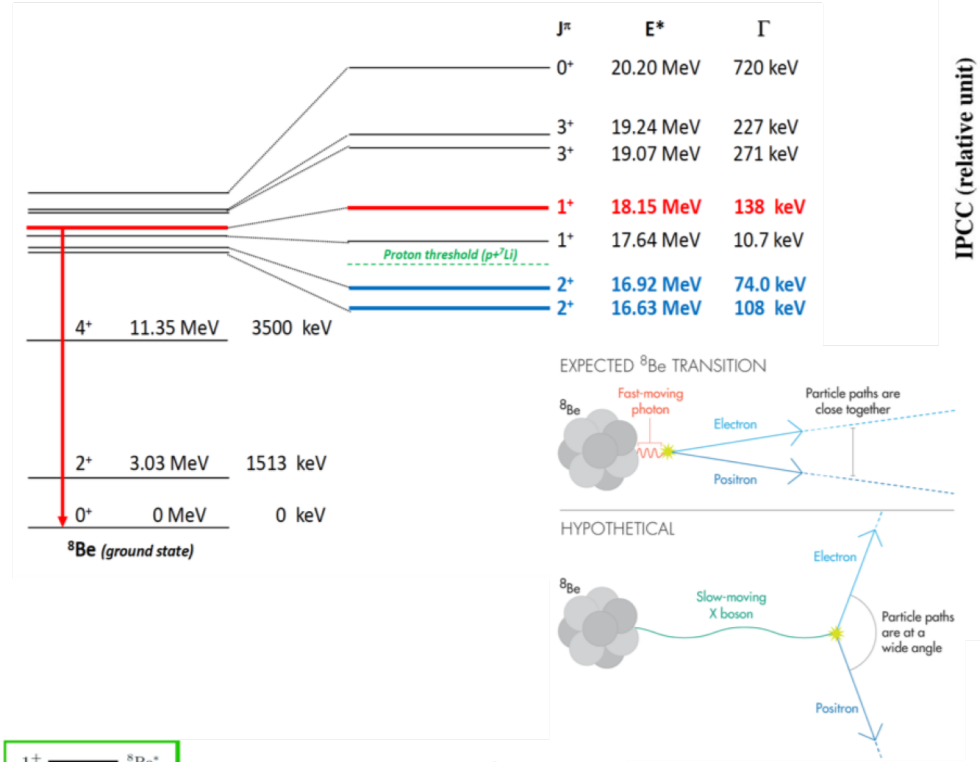
Case N°3 : émission of a boson (X17) and an e-/e+ pair

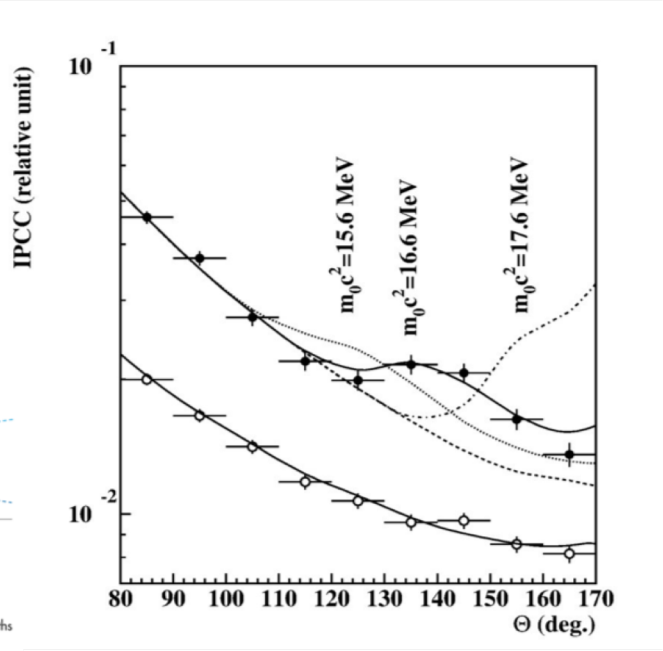
^{8}Be
(4p + 4n)

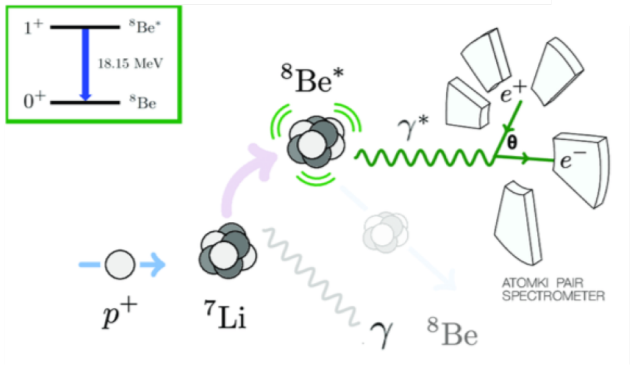




The ^{8}Be anomaly: experimental results and interpretations







From this experiment, the following branching ratios were also extracted (assuming Br(X⟶e-e+)=1):

1) **Proton decay**: Br(p + ^{7}Li) ≈ 100%
2) **γ- decay**: Br(^{8}Be + γ) ≈ 1.5 x 10^{-5}
3) **Internal pair creation**: Br(^{8}Be + e-e+) ≈ 5.5 x 10^{-8}
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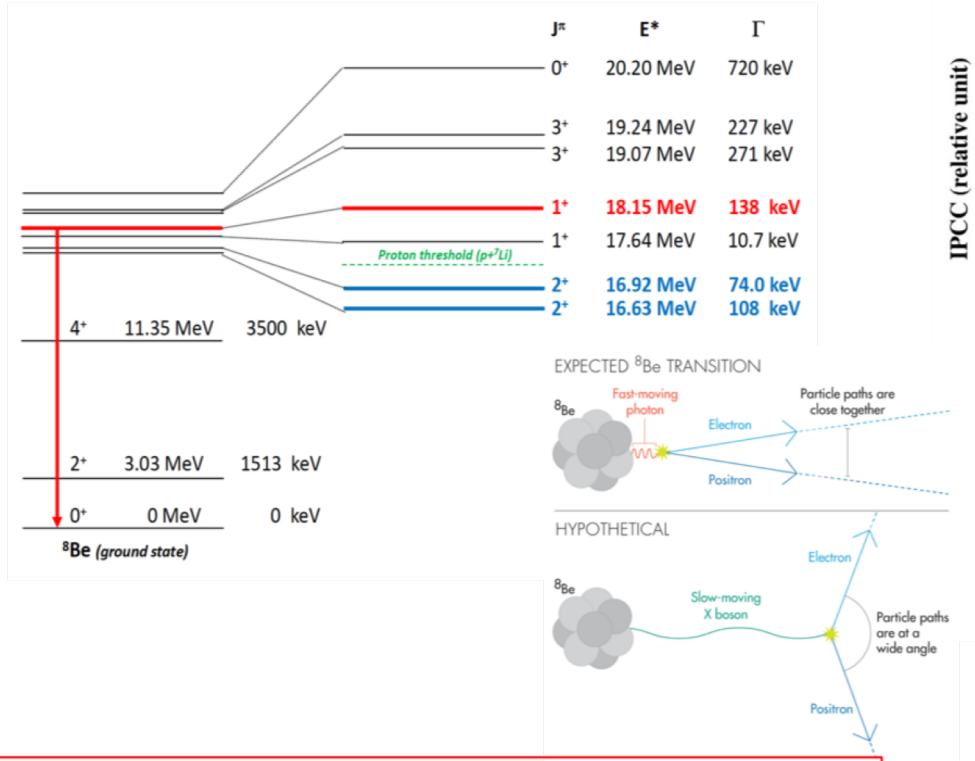

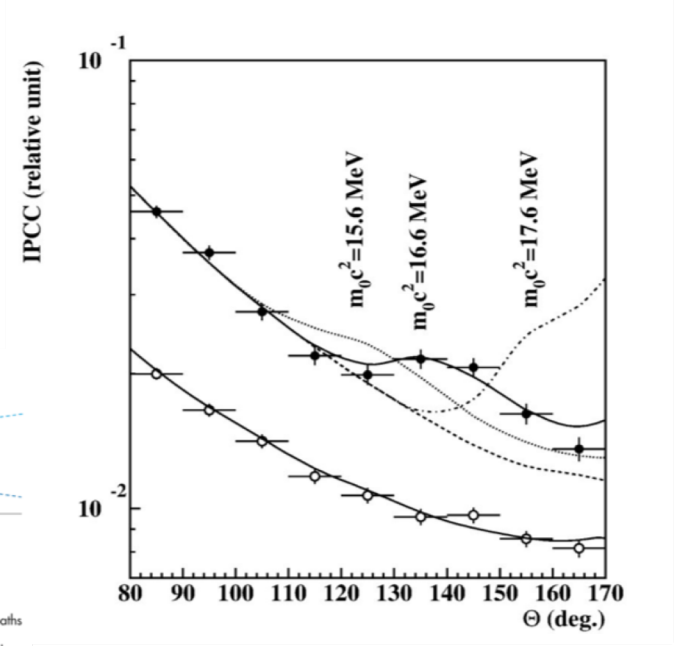

Depending on its spin-parity, the observed 17 MeV boson can be:

- vector if $J^\pi=1^-$ J. L. Feng *et al.* Phys. Rev. D 95 (2017) 035017
- pseudo-vector if $J^\pi=1^+$ J. Kozaczuk *et al.* Phys. Rev. D 95 (2017) 115024
- pseudo-scalar if $J^\pi=0^-$ U. Ellwanger and S. Moretti 2016, arXiv:1609.01669 [hep-ph].

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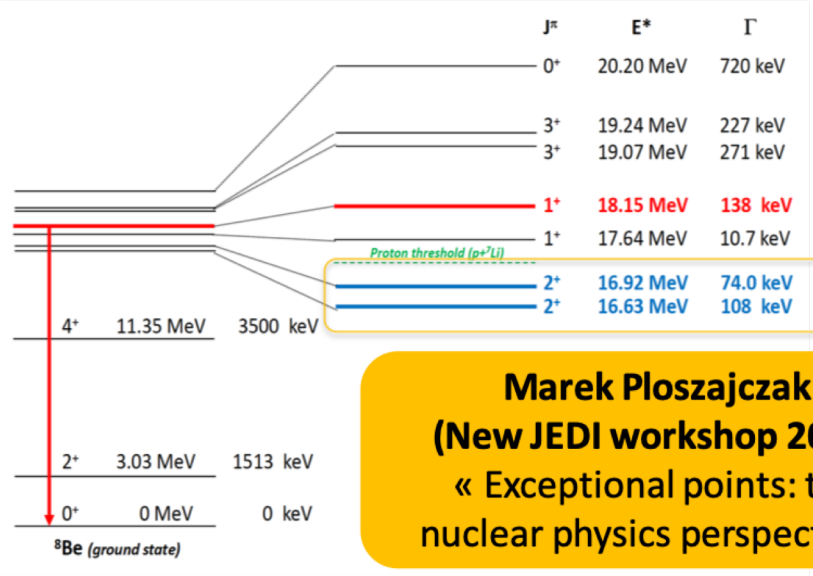
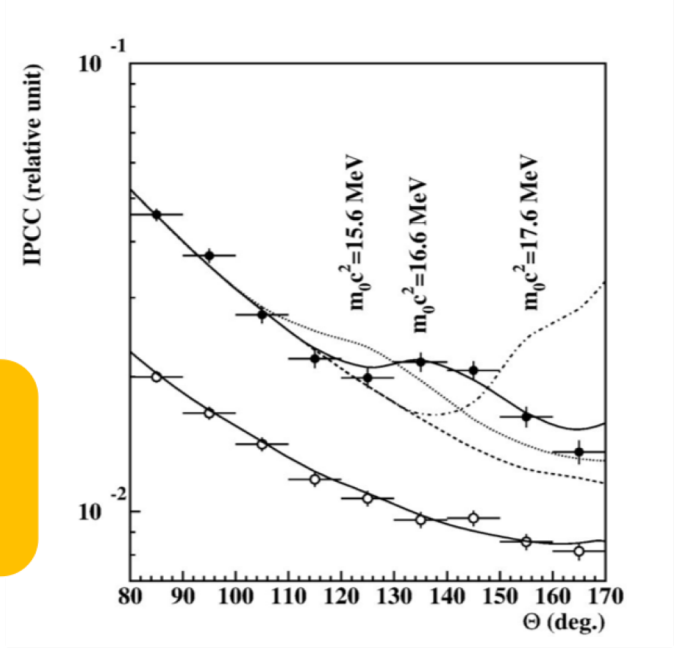


Marek Ploszajczak
(New JEDI workshop 2021)
« Exceptional points: the nuclear physics perspective»



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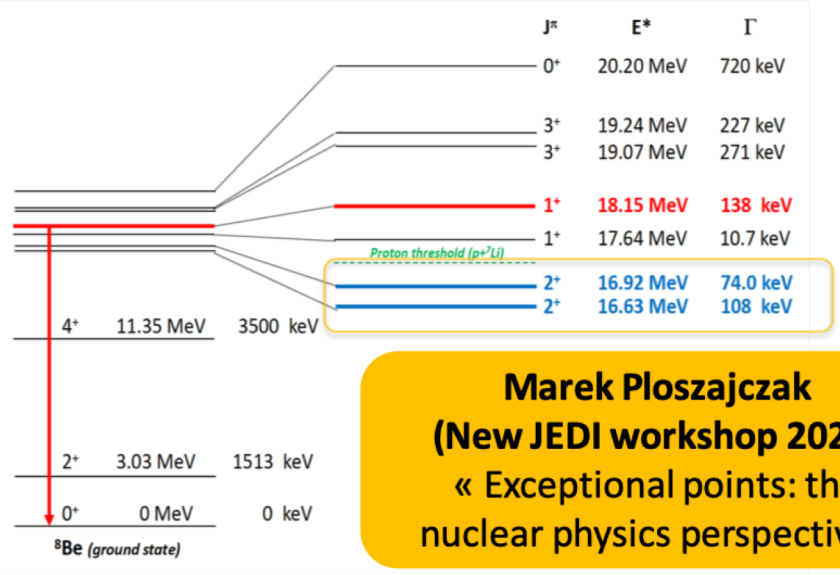

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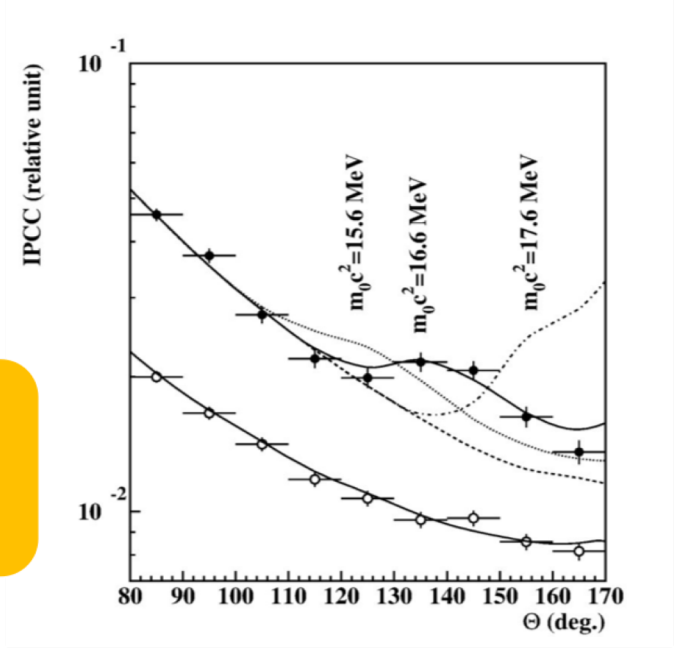

Philip Adsley, Jurgen Kiener and Marco La Cognata
Study of ^{8}Be anomaly @ iThembaLABS (2023) :
angular distribution and hard γ-γ process

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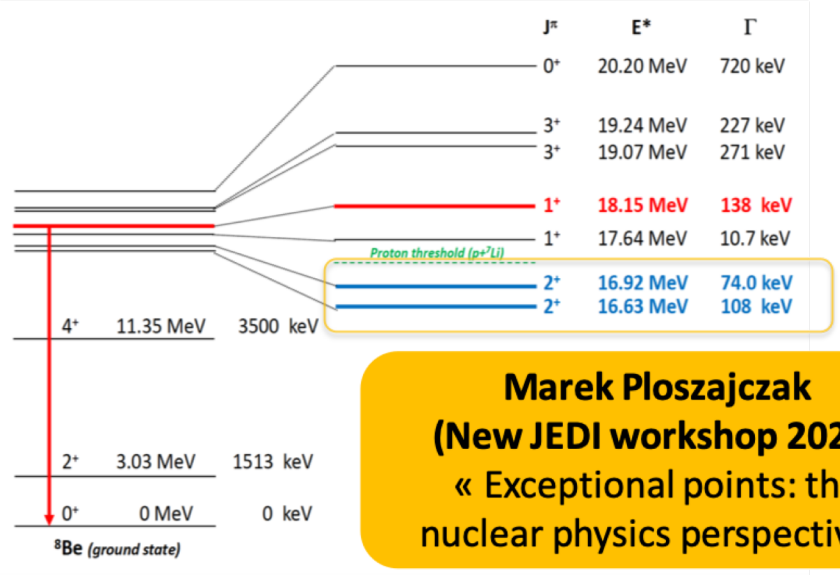

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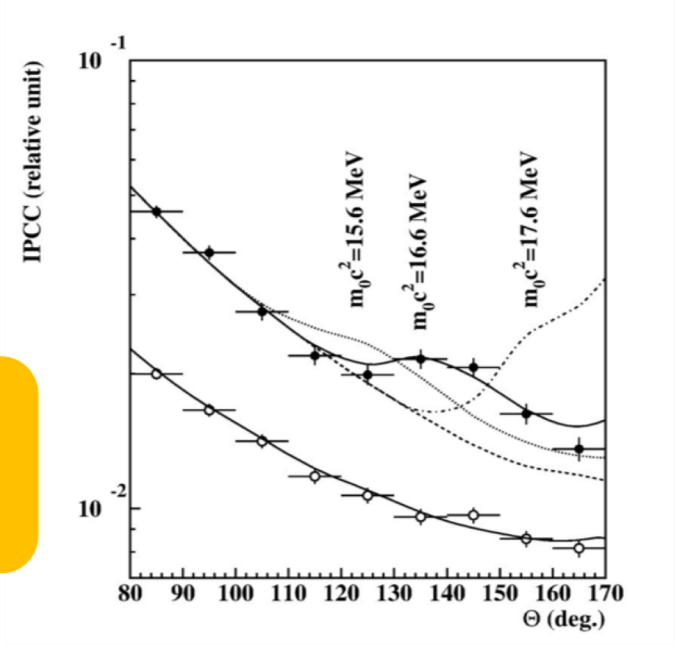

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Petr Navratil
« Ab initio investigations…»

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J.L. Feng *et al.*, Phys. Rev. D 102 (2021) 036016.

TABLE III. Nuclear excited states N_*, their spin-parity $J^{P_*}_*$, and the possibilities for X (scalar, pseudoscalar, vector, axial vector) allowed by angular momentum and parity conservation, along with the operators that mediate the decay and references to the equation numbers where these operators are defined. The operator subscripts label the operator's dimension and the partial wave of the decay, and the superscript labels the X spin. For example, $\mathcal{O}^{(0)}_{4P}$ is a dimension-4 operator that mediates a P-wave decay to a spin-0 X boson.

N_*	$J^{P_*}_*$	Scalar X	Pseudoscalar X	Vector X	Axial Vector X
^{8}Be(18.15)	1^+	—	$\mathcal{O}^{(0)}_{4P}$ (27)	$\mathcal{O}^{(1)}_{5P}$ (37)	$\mathcal{O}^{(1)}_{3S}$ (29), $\mathcal{O}^{(1)}_{5D}$ (34)
^{12}C(17.23)	1^-	$\mathcal{O}^{(0)}_{4P}$ (27)	—	$\mathcal{O}^{(1)}_{3S}$ (29), $\mathcal{O}^{(1)}_{5D}$ (34)	$\mathcal{O}^{(1)}_{5P}$ (37)
^{4}He(21.01)	0^-	—	$\mathcal{O}^{(0)}_{3S}$ (39)	—	$\mathcal{O}^{(1)}_{4P}$ (40)
^{4}He(20.21)	0^+	$\mathcal{O}^{(0)}_{3S}$ (39)	—	$\mathcal{O}^{(1)}_{4P}$ (40)	—

A. J. Krasznahorkay et al., Phys. Rev. C 104 (2021) 044003

Conclusion : « This anomalous excess of e+e− pairs can be described by the creation and subsequent decay of a light particle during the direct capture process »
Following somehow idea of Zhang and Miller Phys. Lett. B 813, 136061(2021), protopho-bic vector boson model :
X17 production is dominated by direct capture transitions both in ^{8}Be and ^{4}He without going through any nuclear resonance).

An independant measurement is needed…

Aims and objectives of the New JEDI project

- **Goal #1 (exp. ^{8}Be @ ANDROMEDE done): confirm or reject the X boson experimental signature observed in ^{8}Be through an independent measurement.**
- **Goal #2 (exp. ^{8}Be @ iThemba LABS 2023): check the existence and the impact of additional nuclear physics effects in the ^{8}Be quantum system and to see to what extent it impacts the result concerning the X boson.**
- **Goal #3 (exp. next SPIRAL2 / ANDROMEDE >2023): check the existence of a light gauge boson in much simpler quantum systems, for which uncertainties linked to nuclear structure are greatly reduced**

+ Bring additional constraints on the boson characteristics (mass, coupling strength with ordinary matter) and **clarify its nature, if it exists.**

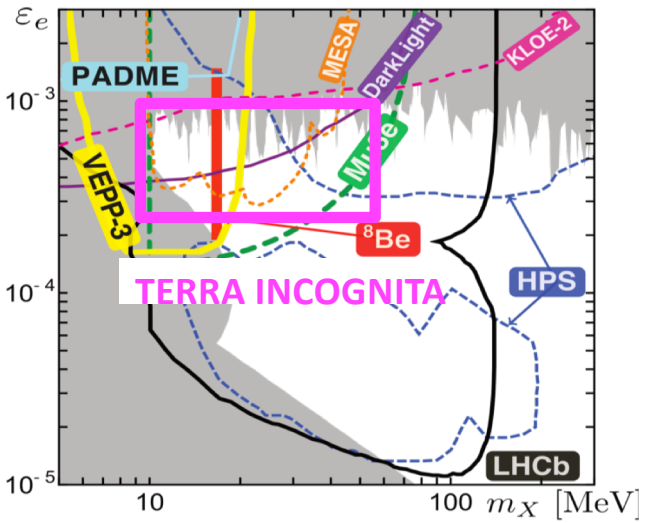

Figure: *(left) projected sensitivities of future experiments on the kinetic mixing parameter ϵ_e and a possible dark photon mass m_X, taken from [Fen17]. Current experimental constraints (grey) and constraint from 8Be (red), established from [Kra16][Fen16][Fen17], are also reminded. In pink the Terra Incognita area that the New JEDI BiRTh project can investigate (Right) details concerning these experiments: foreseen reaction and timeline (see [Fen17] for references about these projects). In addition, new emerging NP experimental programs are indicated within the red frame, including New JEDI [Bro17][Lan17][Hug20][Mit20][Gus21].*

Experiment			2018	2019	2020	2021	2022	2023	2024
LHCb	[8]	Charm meson decay $D^*(2007)^0 \rightarrow D^0 A'$ $A' \rightarrow e^-e^+$				⟷			
Mu3e	[8]	Muon decay channel $\mu^+ \rightarrow e^+ \nu_e \overline{\nu_\mu}$ ($A' \rightarrow e^-e^+$)	⟷	⟷	⟷	⟷	⟷	⟷	⟷
VEPP-3	[8]	$e^-e^+ \rightarrow A'\gamma$	proposed						
KLOE-2	[8]	$e^-e^+ \rightarrow \gamma(X \rightarrow e^-e^+)$	⟷	⟷					
MESA	[8]	e- beam on gaseous target, to produce A'			⟷	commissioning			
Darklight	[8]	e- scattering of H gas target, to produce A'	⟷	⟷	⟷	⟷			
HPS	[8]	e- beam on W to study $A' \rightarrow e^-e^+$ and $A' \rightarrow \mu^-\mu^+$	⟷	⟷	⟷				
PADME	[8]	e+ beam on diamond target $e^-e^+ \rightarrow X\gamma$			⟷	⟷	⟷	⟷	⟷
NA64		$eZ \rightarrow eZ + X17$							
NSL	[Bro17]	^{8}Be ($A' \rightarrow e$-e+)	Proposal (Funding Requested)						
8BeP	[Lan17]	^{8}Be ($A' \rightarrow e$-e+)	Proposal (Funding Requested)						
New JEDI		^{8}Be/^{3}He/d... ($A' \rightarrow e$-e+)	First experiment : September 2021						
Montréal Uni.		^{8}Be ($A' \rightarrow e$-e+)	Proposal						
NSCL	[Mit20]	^{8}Be ($A' \rightarrow e$-e+)	First experiment : June 2021						
IUAP CTU	[Hug20]	^{8}Be and ^{4}He ($A' \rightarrow e$-e+)	Proposal (Funding Requested)						
INFN Roma	[Gus21]	^{8}Be and ^{4}He($A' \rightarrow e$-e+)	Proposal (Funding Requested)/1rst exp. : end 2021						
Zürick (MAG2)		^{8}Be							

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(New JEDI : New Judicious Experiments for Dark Sectors Investigations)

Beyhan BASTIN
Grand Accélérateur National d'Ions lourds (Caen, France)

- Scientific scope of the project
- **New JEDI collaboration and implication of their members in the project**
- Description of the New JEDI scientific project
- Timeline, human and financial resources and calls for funding

New JEDI

Beyhan BASTIN (scientific coordinator)

Co-spokespersons : Jurgen Kiener*, Isabelle Deloncle, Alain Coc*, Maxim Pospelov, Jaromir Mrazek and Livio Lamia

*retirement

GANIL-SPIRAL2 experiments (^{3}He,D)
Beyhan BASTIN

IJCLab experiments (^{8}Be)
Jurgen Kiener
Isabelle Deloncle

NPI experiments (commissioning)
Jaromir Mrazek

iThemba LABS experiments (^{8}Be structure)
Lindsay Donaldson
Philip Adsley

TARGETs
Livio Lamia
Christelle Stodel

FASERED (Protea 2021*)

Dark Sector theory
Maxim Pospelov
Pierre Fayet

Big Bang Nucleosynthesis theory
Cyril Pitrou
Alain Coc

Nuclear Structure theories
Marek Ploszajczak
Petr Navratil
Guillaume Hupin
Pierre Descouvement

GANIL (France): Beyhan Bastin, François de Oliveira, Marek Lewitowicz, Jean-Eric Ducret, Olivier Sorlin, Dieter Ackermann, Christelle Stodel, Abdelouahad Chbihi, Jean-Charles Thomas, Gilles De France, Marek Ploszajczak ; **IJCLab (France):** Jürgen Kiener, Alain Coc, Isabelle Deloncle, Charles-Olivier Bacri, Clarisse Hamadache, Adrien Laviron, Jérôme Bourçois, Vincent Tatischeff, Fairouz Hammache, Nicolas de Séréville and Brigitte Roussière ; **IAP (France):** Cyril Pitrou ; **IP2I (France):** Bernadette Rebeiro and Yasmine Demane ; **Minnesota University (USA):** Maxim Pospelov **;** **NPI (Czech Republic):** Jaromir Mrazek**,** Anastasia Cassisa, Eva Simeckova and Vaclav Burjan **;** **ULB (Belgium):** Pierre Descouvemont ; **INFN LNS (Italy):** Livio Lamia, Marco La Cognata, Gianluca Pizzone, Guiseppe D'Agata, Alessia Di Pietro, Aurora Tumino, Maria Letizia Sergi, Dominico Santonocito, Giovanni Luca Guardo and Guiseppe Rapisarda; **iThemba LABS (South Africa) :** Lindsay Donaldson, Philip Adsley, Pete Jones, Kgashane Malatji, Ignasio Wakudyanaye, Elena Lawrie and Johann Wiggert Brummer.

*French Ministry of Foreign Affairs and the Ministry of Higher Education and Research from the French side, and the Department of Science and Innovation (DSI) and the National Research Foundation (NRF)

Implication of the New JEDI members in the project

(very active and interactive : 57 collaboration meetings up to now)

GANIL:

Mainly SC, in collaboration with some technical staff: coordination, reporting, mechanical assembly, tests of detectors, electronics development and characterization of the New JEDI prototype, as well as the online and the offline data analysis programs.

+ Only few others researchers (4) contributed to the ^{8}Be experiment at ANDROMEDE.

IJCLab:

Mainly Isabelle Deloncle, Jurgen Kiener*: optimization and the new design of the Plastic detectors, in collaboration with the IJCLab mechanical design department + GEANT 3 simulations needed for the project.

+ **IJCLab Nuclear Physics researchers' community provided an active contribution during the ^{8}Be experiment @ ANDROMEDE**, ensuring to a large extend its success.

INFN LNS:

All the group involved with Livio Lamia as representative. In charge of all the **targets production and characterization** + **Active contribution during meetings and experiments (2 persons/week during all the experimental process).**

NPI:

Mainly Jaromir Mrazek with post-doc and Phd student as well as some technical staff : co-leading commissioning (assembling and realization) , material support for the beam current monitoring and network system.

+ Very strong contribution during meetings and the ^{8}Be experiment at ANDROMEDE.

+ Active and recurrent interactions with theoreticians (annual collaboration meetings, Academic lectures…)

Dark Boson as a New Force Carrier

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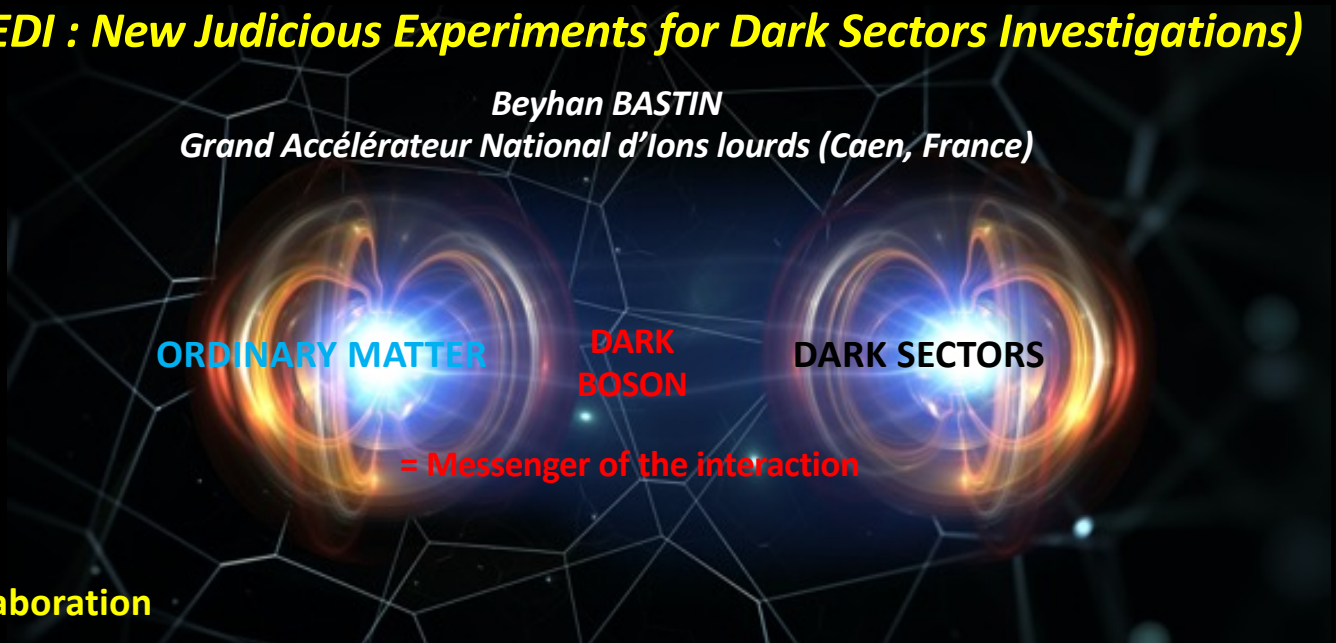

(Core + Extended) collaboration

GANIL (France): Beyhan Bastin, François de Oliveira, Marek Lewitowicz, Jean-Eric Ducret, Olivier Sorlin, Dieter Ackerman, Christelle Stodel, Abdelouahad Chbihi, Jean-Charles Thomas, Gilles De France, Marek Ploszajczak, Marius Lejoubioux; **IJCLab (France):** Jürgen Kiener, Alain Coc, Isabelle Deloncle, Charles-Olivier Bacri, Clarisse Hamadache, Adrien Laviron, Jérôme Bourçois, Vincent Tatischeff, Fairouz Hammache, Nicolas de Séréville, Brigitte Roussière, Serge Della Negra, Isabelle Ribaud, Sarah harrouz, Alessandro de Lara, Louis Hardouin, Julien Guillot, Matthieu Lebois, Massyl Kaci, Ioland Matea, Mathieu Ehrhart, Radomira Lozeva, Corentin Hiver; **IAP (France):** Cyril Pitrou ; **IP2I (France):** Bernadette Rebeiro and Yasmine Demane ; **Minnesota University (USA):** Maxim Pospelov **; NPI (Czech Republic):** Jaromir Mrazek**,** Anastasia Cassisa, Eva Simeckova and Vaclav Burjan **; ULB (Belgium):** Pierre Descouvemont ; **INFN LNS (Italy):** Livio Lamia, Marco La Cognata, Gianluca Pizzone, Guiseppe D'Agata, Alessia Di Pietro, Aurora Tumino, Maria Letizia Sergi, Dominico Santonocito, Giovanni Luca Guardo, Guiseppe Rapisarda, Dario Lattuato; **University of Perugia (Italy) :** Sara Palmerini ; **IThemba LABS (South Africa) :** Lindsay Donaldson, Philip Adsley, Pete Jones, Kgashane Malatji, Ignasio Wakudyanaye, Elena Lawrie and Johann Wiggert Brummer ; **BioMAPS (France):** Jean-Michel Daugas, Marie Poirier-Quinot, Sina Marhabaie, Angéline Nemeth, Anthony Novell; **IPHC (France) :** François Didierjean, Marcel Heine; **INFN LNL (Italy) :** Giacomo de Angelis ; **ENS (France) :** Jérôme Delacotte, **McGill University (Canada) :** Bernadette Rebeiro, **C2N (France) :** Jean-Paul Adam; **University of Texas (US) :** Philip Adsley, Diana P Carrasco-Rojas; **IJS (Slovenia) :** Jelena Vesic.

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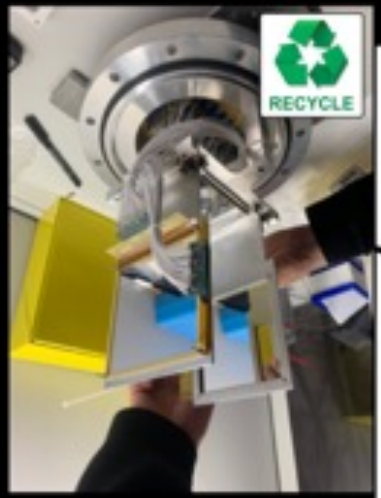
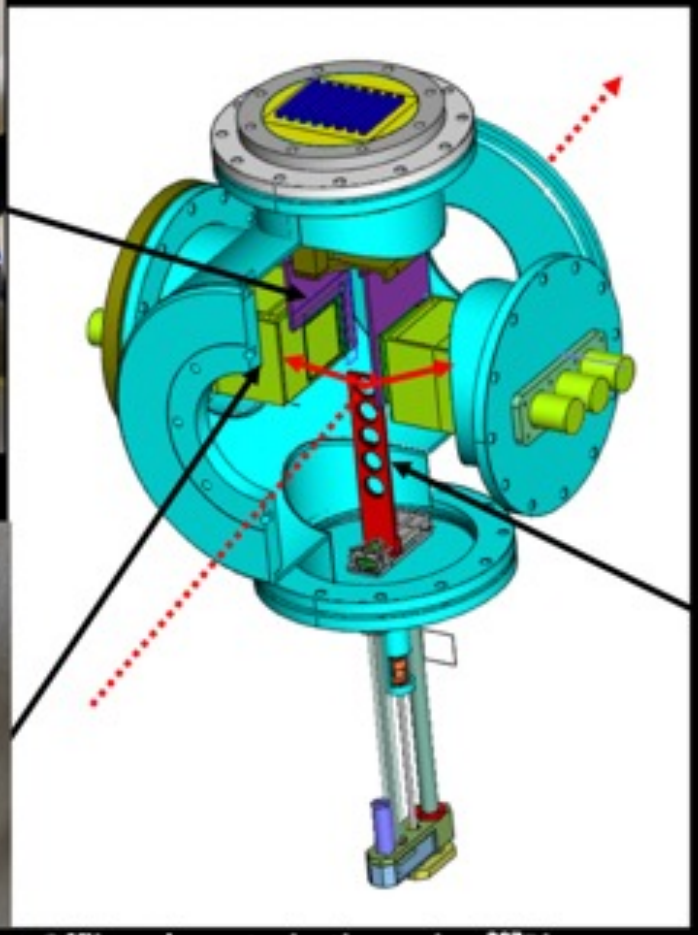
New JEDI 2021 setup (offline tests @ GANIL and commissioning @ NPI)

Based on results from test runs carried out in 2018 and 2019 @ ARAMIS-SCALP (IJCLAB) + GEANT3 simulations

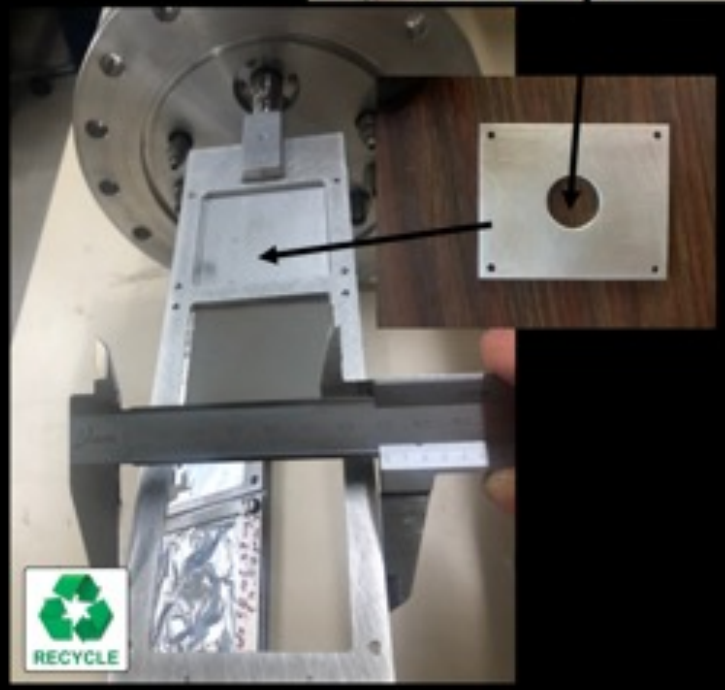
DSSSDs from Microns **(only new elements! B-grades!! 2 x 6000 € + 600 € maintenance)**



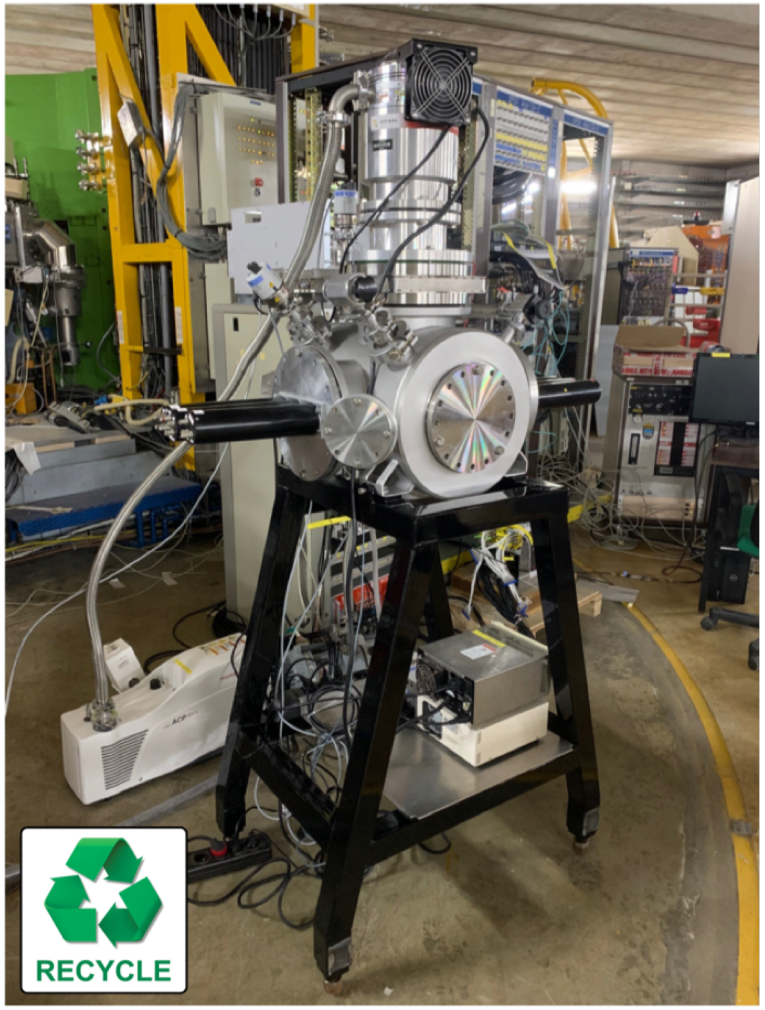
Plastic detectors



Offline characterisation using ^{207}Bi source

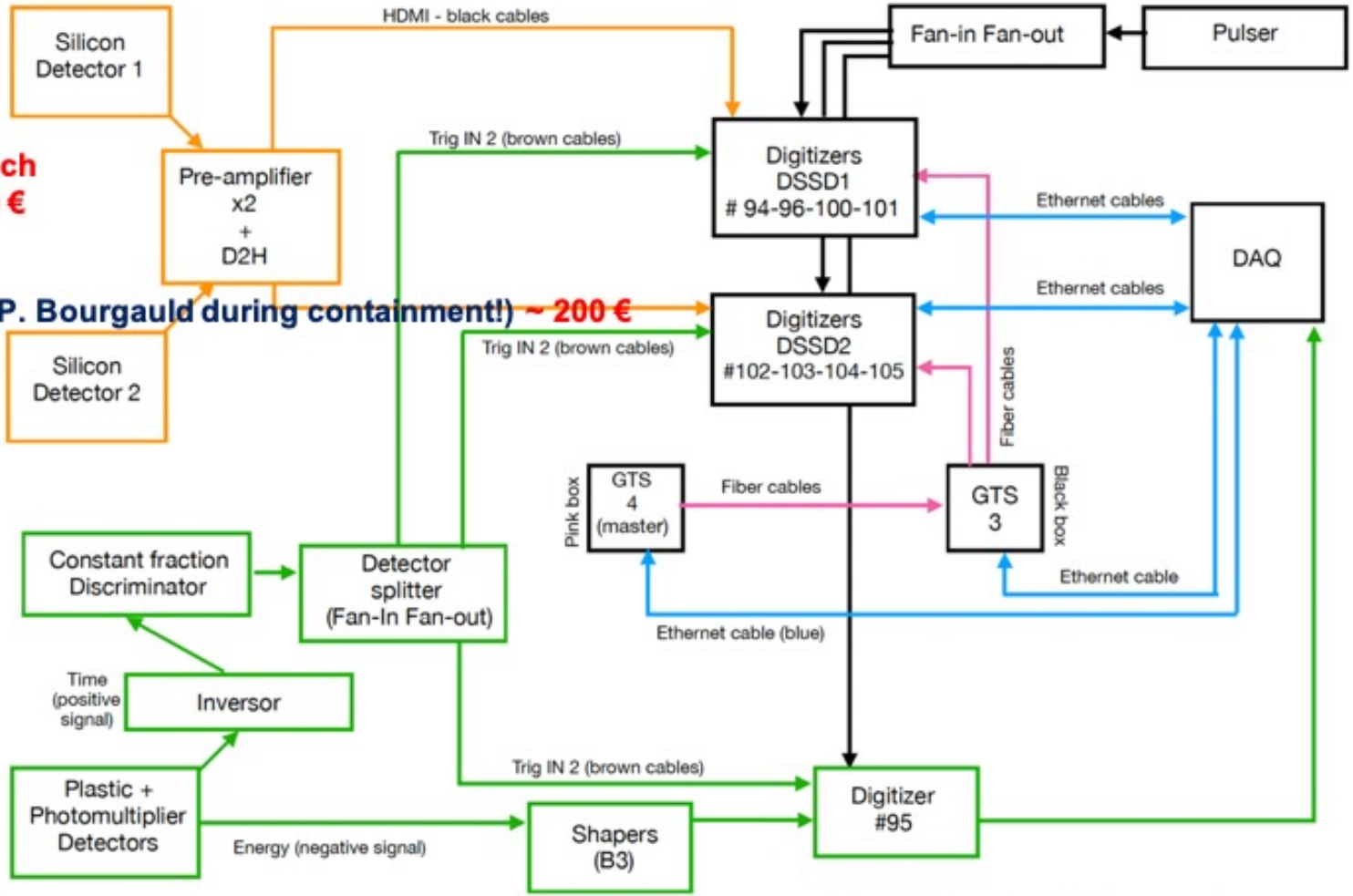


With some home staging…



Target chamber and frame from CIMAP garbage (17/06/2020)

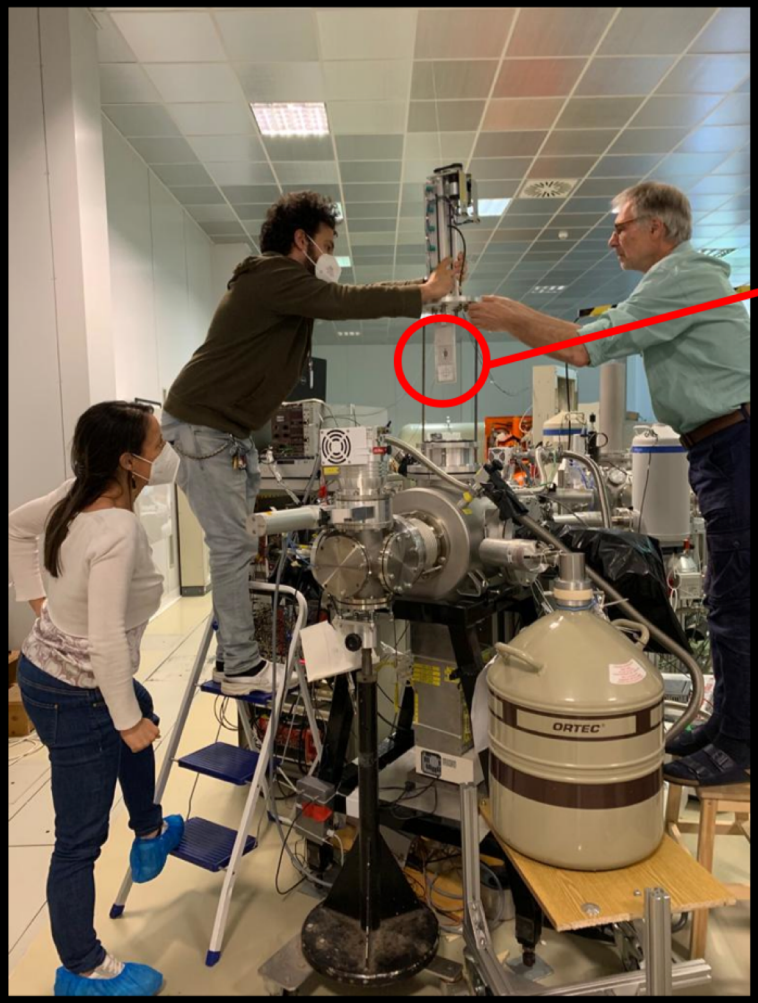
(acid bath : 500 €)



Used also for the LISE zero degree detection!!!

QDC + Fusion mode (~3 weeks C. Houarner during calm working periods)

New JEDI commissioning at Rez 3MV tandetron facility (May-June 2021)



Before

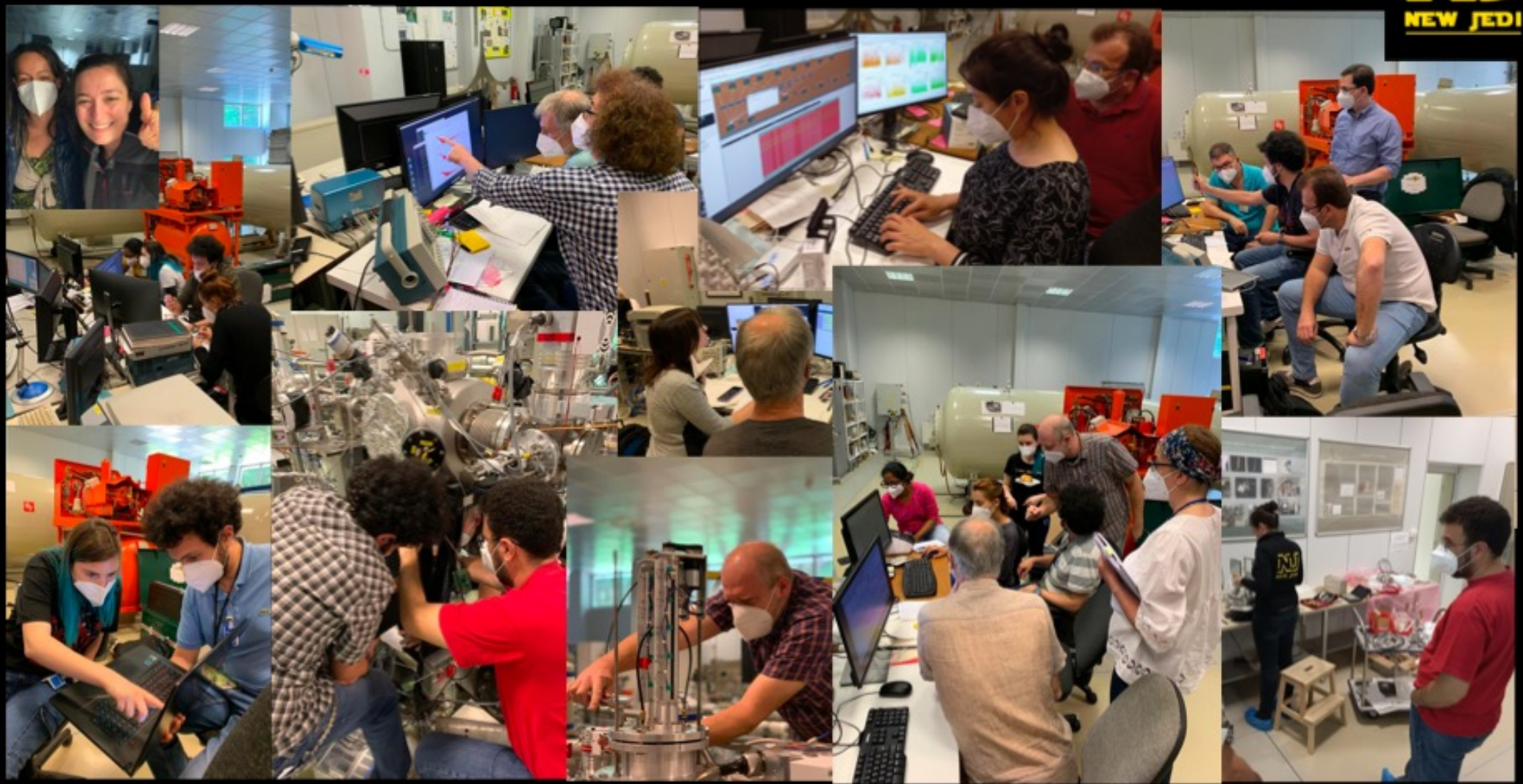
After

ONLINE

TARGETS :
Made in Catania
INFN-LNS

New JEDI commissioning at Rez 3MV tandetron facility (May-June 2021)

New physics + New detection system + New Facility => no data taking but rather trying to understand and to fix issues!



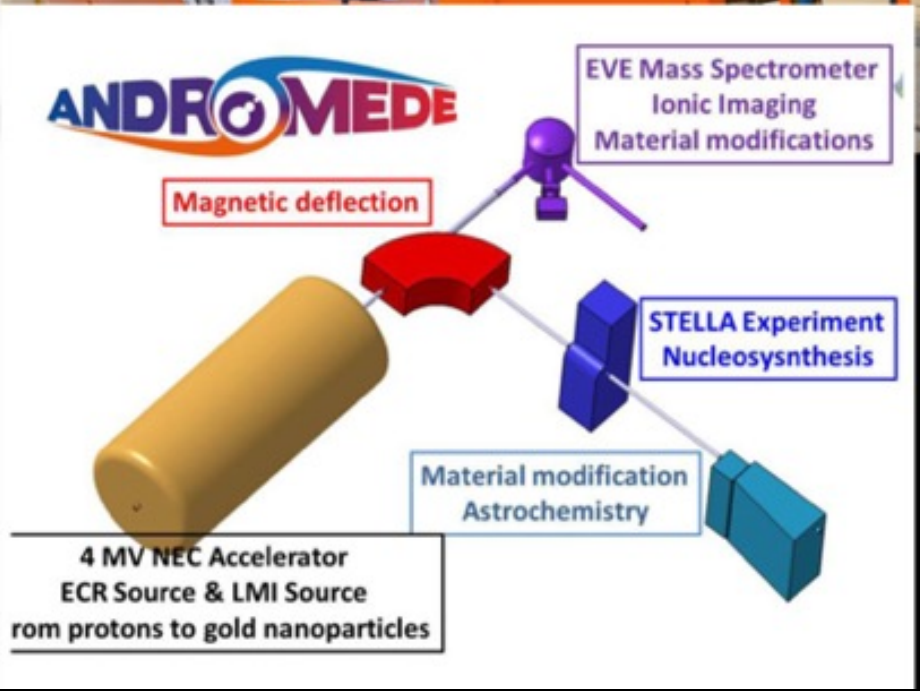
New JEDI commissioning at Rez 3MV tandetron facility (May-June 2021)

- **Major contribution of the $^{19}F(p,a)^{16}O$ reaction** in the DSSSDs
- **The Lithium target emits also a lot of electrons**
- **Observed clearly lot of multi-scattering processes that needs to be investigated more in details (GEANT simulations)**.
- **The methods developed to measure and to check the proper coincidences between the different detectors seems to work properly.**
- **XXX and XXX targets developed by the INFN-LNS laboratory (disentangle the contribution of reaction from F in the spectra) showed online very promising characteristics**.
- **The detection efficiency and observed count rates are very similar to those expected from the simulations. We estimate about a reasonable efficiency of 10% for the X boson electron-positron pair decay, if it exists.**
- We also **observed interesting geometrical effects**

Major difficulties for on/off-line analysis (use of new Digitizers):

- **the merging process of data was not possible online due to very asymmetric flux => need to develop specific offline programs.**
- **the data conversion speed : we record 4 Gb every 6 minutes. This requires 45 minutes conversion process!**

Nov. 2021 : moved to the ANDROMEDE facility to prepare the first exp. (8Be)



First long experimental run (May to July 2022 = 7 weeks of beam)

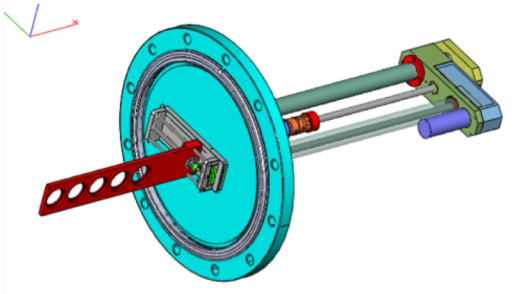
Hundreds of targets (LNS)

Developments for the ^{8}Be experiment at ANDROMEDE & ^{3}He @ GANIL-SPIRAL2

At GANIL

1) 2 DSSSDs A-grade : **2 x 8 000 €**

2) New target holder (allow H&V movements) **(G. Frémont)** :
- Design 02/09/2020
- Construction 05/2022



3) Target holder command & control **(C. Gouyet et *al.* ~2-3 weeks)** : mandatory for the SP2-NFS experiment

4) HV with an interlock for DSSSDs (**6 000 €**)

At IJCLab

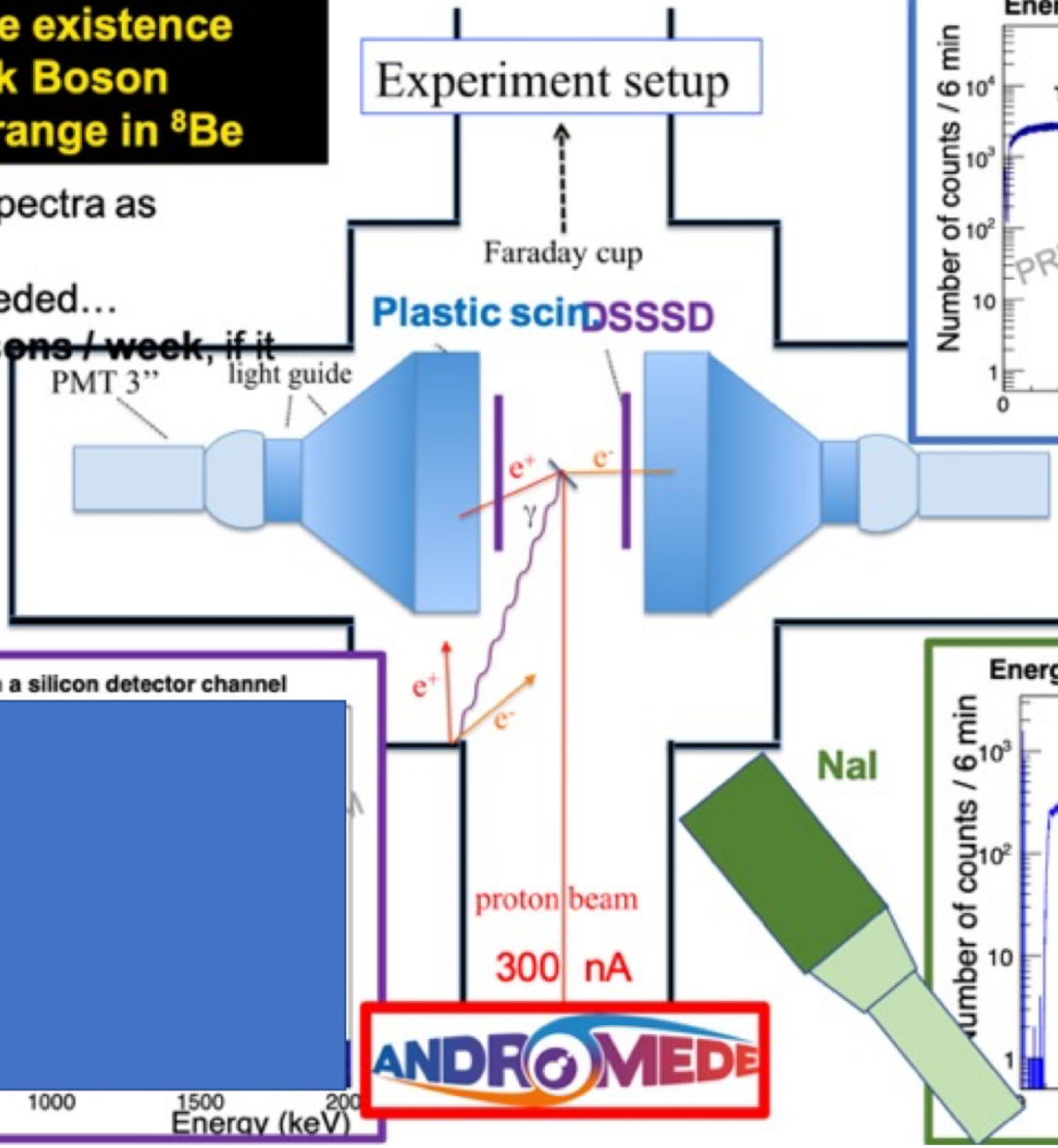
5) New Plastics design construction @ IJCLab ; 2 units (**7000 €**)

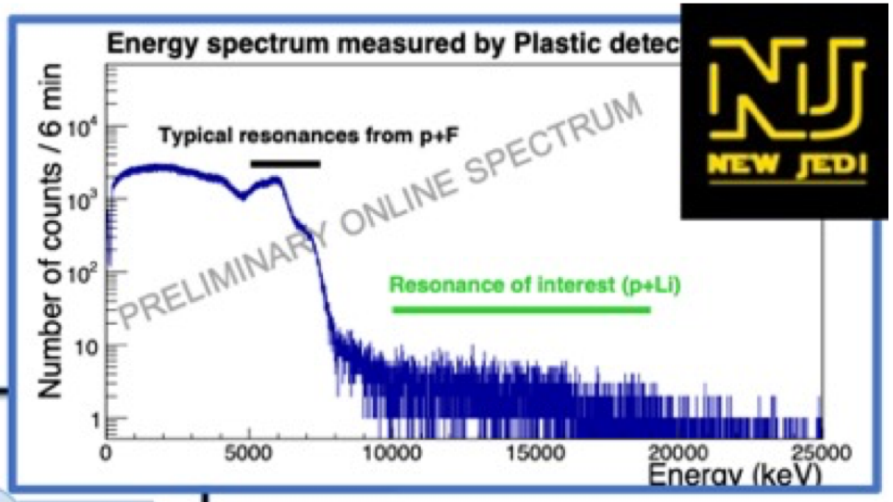
6) Additional equipment :
- 4 PMs (1 broke already) : **4 x 1 500 €**
- Electronics crane : **~4 000 €**
- Pumping system : **~4 000 €**

Study of the existence of a Dark Boson in the MeV range in ^{8}Be

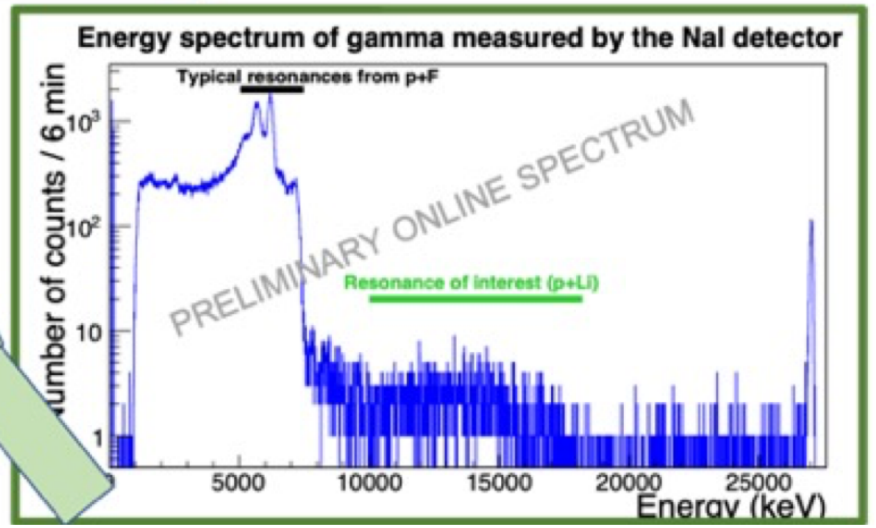
- Count rates on spectra as expected
- Fine analysis needed…

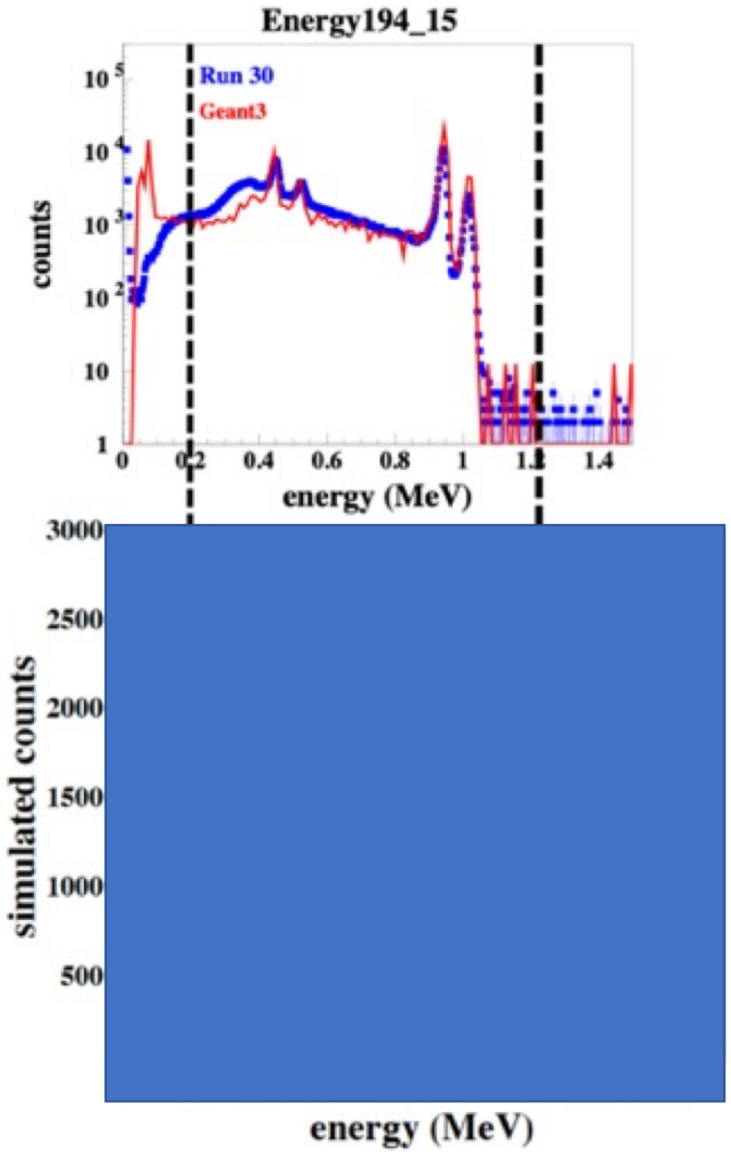
(expect ~ **500 bosons / week**, if it exists)





Target : 300 μgr/cm² LiF
on 30 μgr/cm² C backing





Optimizing thresholds of detectors

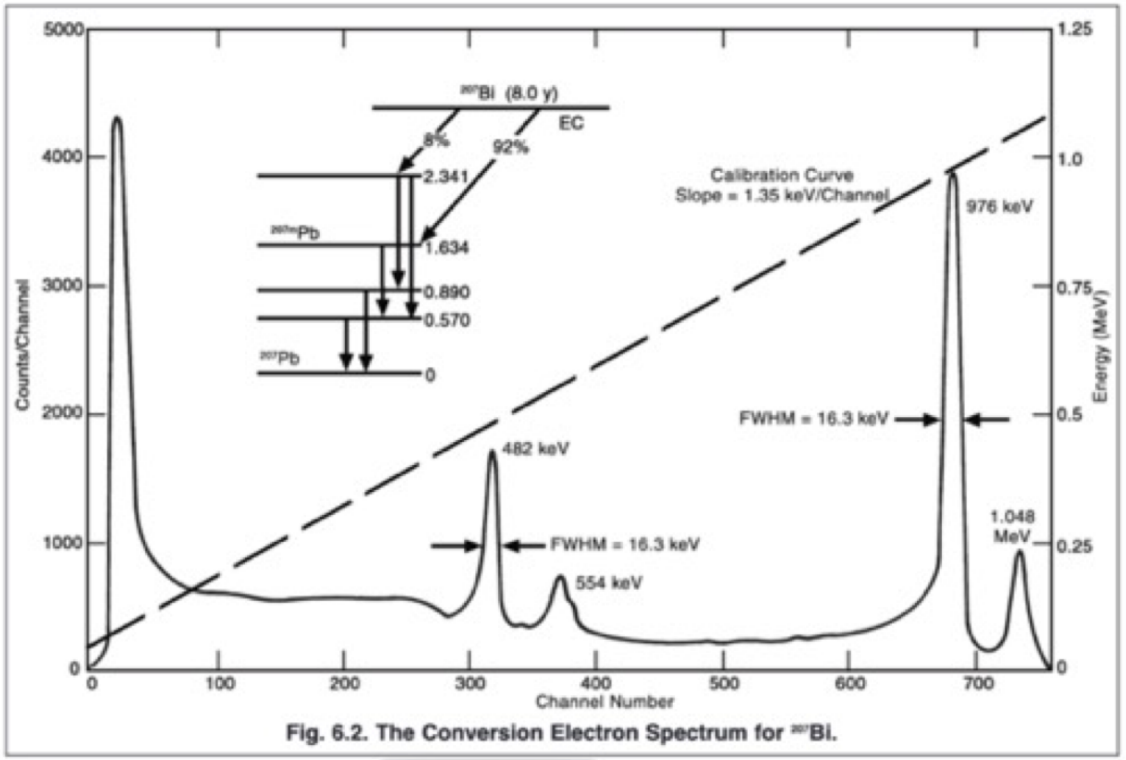


Fig. 6.2. The Conversion Electron Spectrum for ^{207}Bi.

Note : Atomki is using a 500 μm thick DSSSD and claim to have a 50 keV threshold

Fine analysis of New JEDI data on ^{8}Be : Ignasio WAKUDYANAYE Phd Thesis

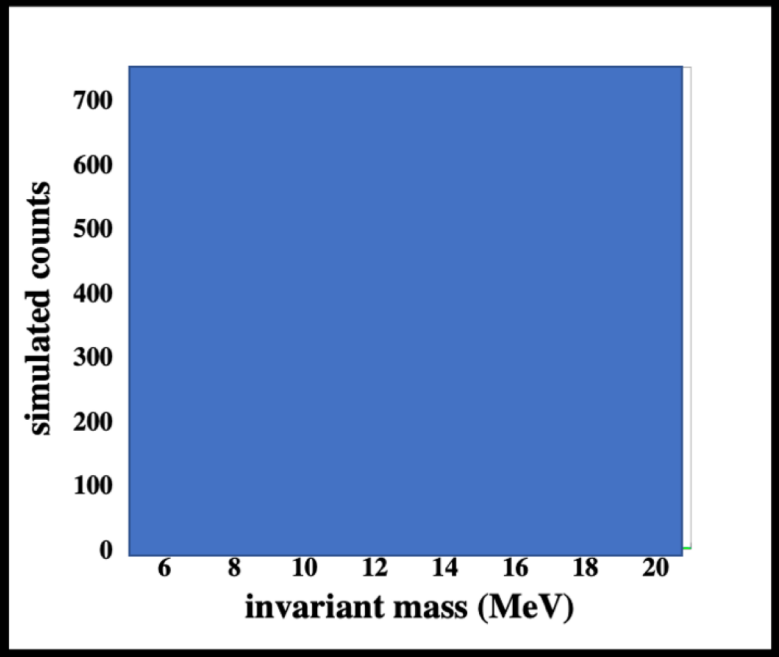
What do simulations say?

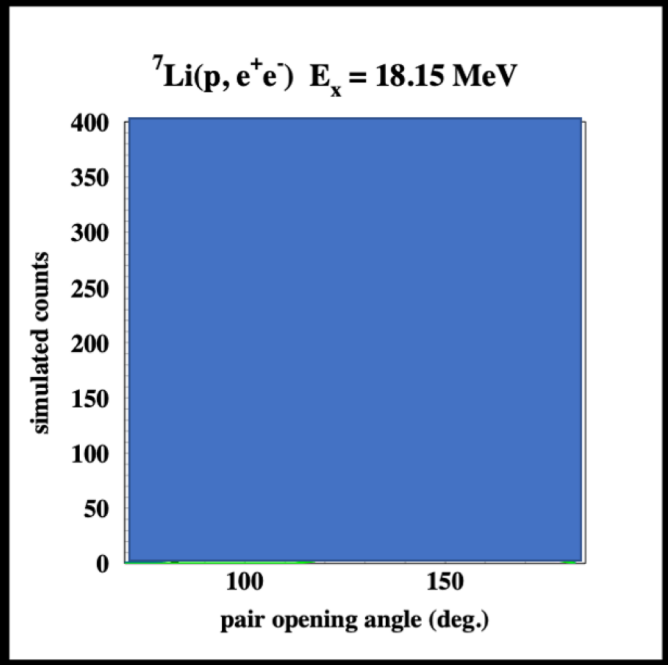
For the simulation

- the diameter of the **beam spot was set to 4 mm and 1 μA**
- spatial resolution of the DSSSD considered was **Δx=2.0 mm**
- energy resolution of the DSSSD and the plastic scintillator used were typically **ΔE=20 keV at 1 MeV** and **ΔE=240 keV at 5 MeV**

If Energy sum between 16 to 20 MeV + selection on the e-e+ symmetry energy (selection of symmetric pairs), the X signal is much more improve with respect to IPC contribution.

The detection efficiency for **X boson e-e+ pair decay is still reasonable ε_{coinc}=18.0%.**





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New JEDI PROJECT timeline

Letter of Intent @GANIL PAC : commissioning supported

10 days commissioning (Be)
@ Rez tandetron scheduled

1rst experiment (Be)
@ Andromede (IJCLab)

Experiment @ iThemba LABS on ^{8}Be
(decay studies using GAMKA)

2020 2021 2022 2023

Sept Dec Jan Mar May June Aug Autumn June Jan

1rst experiment (He) @ GANIL-SPIRAL2

2nd experiment (Be) @ Andromede (IJCLab)

Prototype ready

Targets (INFN LNS) : prepared, characterized and delivered

New JEDI workshop 2022 @ IJCLab
+ lectures on DB related theories

GANIL Scientific Council

New JEDI workshop 2023 @ iThemba LABS
+ lectures

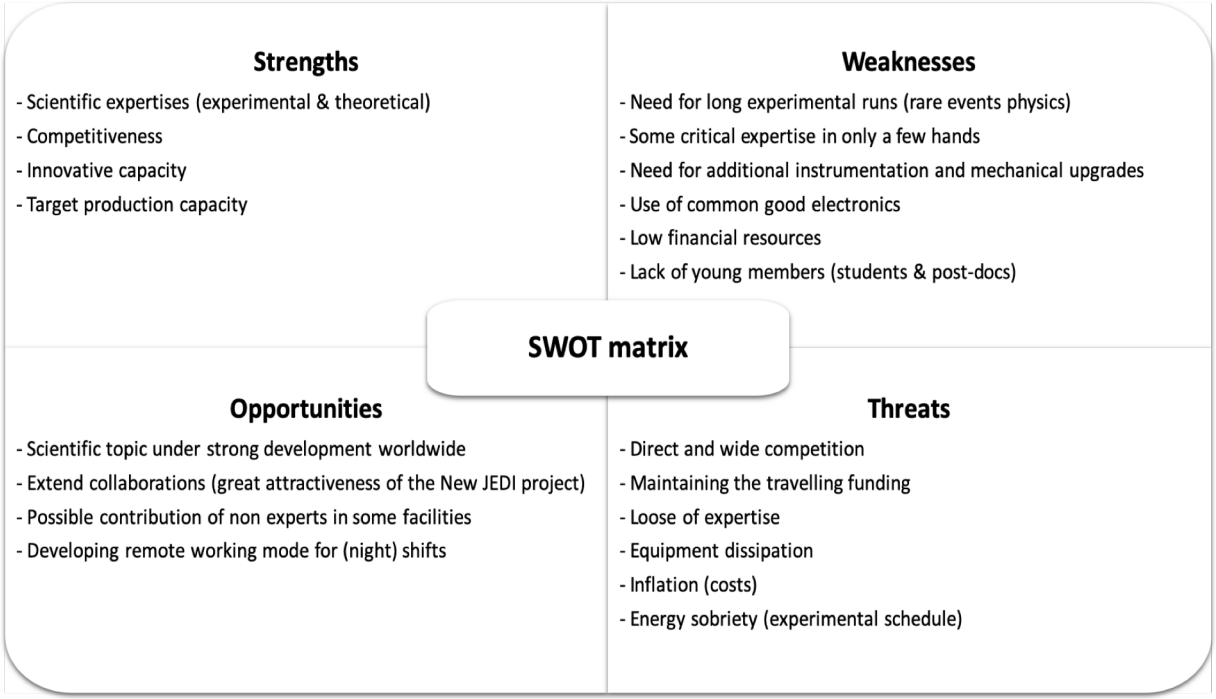
New JEDI workshop 2021 (theory related)
@IJCLab Via GDR RESANET

New JEDI videos (IDEAAL)
(project presentation + pedagogical on Dark Sectors)

New JEDI students

- Ignasio Wakudyanaye (PhD) (12/22-11/25)
- Sabiha Tasneem (M2) (09/22-01/23)
- Damiano Stramaccioni (M2) (09/22-01/23)
- Ernest Granollers Colom (L3) (03/23-07/23)

Critical analysis of the situation and identification of required resources



4 week of optimal data taking per experiment is needed!

Caution #1 : if the experimental activity of frozen for a too long time (last exp. 07/22):
- Lose of expertise
- Lose of recurrent funding (travelling)

Caution #2 : every exp. need to buy materiel 1 year before => If we want to carry out an exp. in 2024, we need to buy now!
- Delivery delay (6 months for microns)
- + additional time for tests and characterization

- There should be **a core-team of experts nuclear (astro)physicists in situ** (support 24/ 7/7) :

Need of an experienced post-doc (backup of the SC) + some manpower (Master/PhD students) for (i) **simulations** (efficiency corrections, define optimal New JEDI setup for a long term program including BGO and magnetic field), (ii) measurements for **systematics studies** and (iii) to **solve remaining issues**.

- Better organisation of the shift schedule :
  - Mainly senior researchers! Need of **more students** for night shifts.
  - Develop **remote shifts**
- Use of common use electronics and DAQ => **need for dedicated material**

Budget over 5 years (2017-2022)

Material	price
- 2 DSSSDs B-grade	12000
- 2 DSSSDs A-grade	16000
- 2 preampliers Mesytech	9400
- 1 DSSSD maintenance	600
- 1 HV with interlock	6000
- D2H cards	200
- Acid bath	500
- Others (tools, boxes…)	1200
TOTAL GANIL	**45900**

Material	price
- 2 set of new plastics with mechanics	7000
- 4 PMs	6000
- 1 electronics crane	4000
- 1 pumping	4000
TOTAL IJC Lab	**21000**

ERC 2019, ANR 2019, ERC 2021 : rejected (need of some results)
Personal note : if we have the results, we don't need means!
PROTEA-FASERED **2022 & 2023 : 20 000 €/year (mobility FR-SA)**

Financial resources needed for the New JEDI future scientific program

Assuming 4 weeks of pure data taking runs per experiment:

- 4 DSSSDs for each experiment : 32 000 €
- 2 PMs for each experiment : 3 000 € (depending on test results)
- Data storage : 3 000 €

Materiel needed for the next experiment:

- A Mesytech MSCF-16 amplifier and shaper : NEAM
- Linear Gate Stretchers (5 units) : NEAM

For identified future developments:

- BGO detectors : NEAM
- Magnetic field (e-/e+ discrimination) : NEAM
- A dedicated DAQ system : 120 000 €

To release progressively common use material :

- 3 electronic units / year : 20 000 €

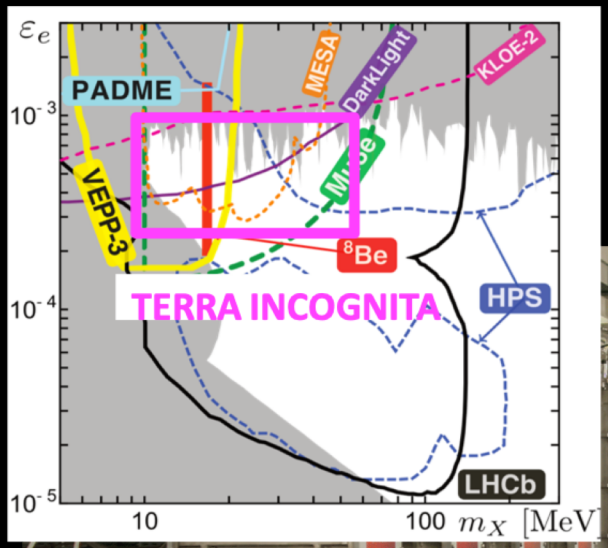
=> from 60 000€ to 80 000€ annual budget is needed

+ 1 post-doc / year and **1 PhD student / experiment**

For example STELLA project : 2 CR + 1 DR + (1 PR) + 1 post-doc + 3 PhD students…

NEAM : not estimated at the moment

New JEDI @ GANIL-SPIRAL2 facility : existence of dark boson in other nuclei



If adequate resources are allocated to ensure the sustainability of the project, the New JEDI collaboration plans to **investigate the existence of a Dark Boson in the MeV range in other light quantum systems** where nuclear structure uncertainties are much reduced. This wider study will be carried out mainly at the GANIL-SPIRAL2 facility. **If this boson exists, it would open up an entire new field in Particle Physics Beyond the Standard Model.**

Most intense stable beams in Europe

Low Risk, High Gain