The X_{17} resonant research at PADME

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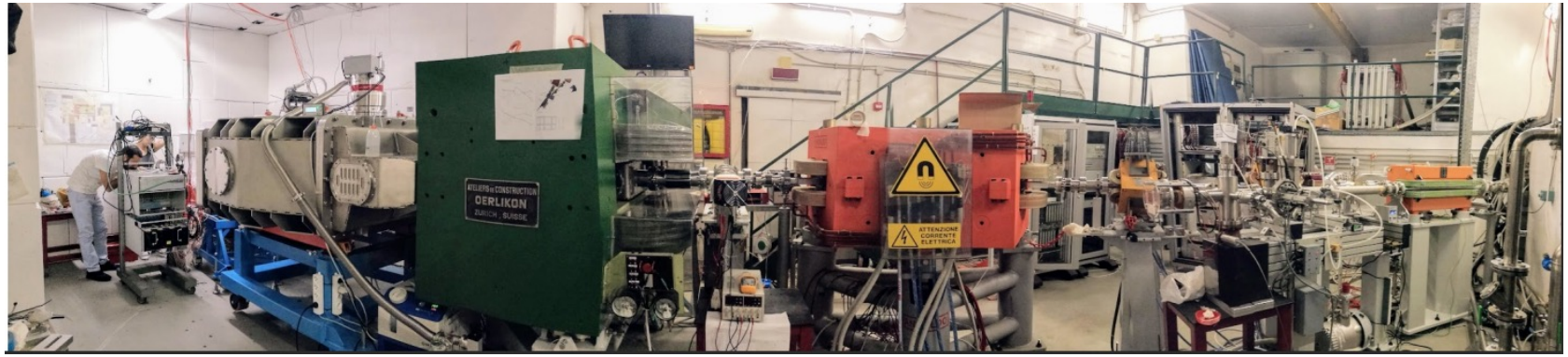

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60th International Winter Meeting on Nuclear Physics,
22-26 January 2024, Bormio – Italy

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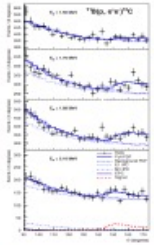
The X_{17} anomaly

Anomaly in the angular correlation of e^+e^- pairs emitted via Internal Pair Creation (ATOMKI anomaly) in ^8Be, ^4He and ^{12}C nuclear transitions [1].
Main properties of the hypothetical new particle:



- $m_{X_{17}} \simeq 17$ MeV
- $\frac{\sigma(e^+e^-\to X_{17})}{\sigma(e^+e^-\to\gamma\gamma)} \simeq 5\times10^{-6}$
- $\Gamma_V \simeq 0.5\left(\frac{g_V}{0.001}\right)^2$ eV for the vector case

$J_* = L \oplus J_0 \oplus J_V$ and $P_* = (-1)^L P_0 P_X$ to identify the nature of the particle [2]

X_*	J^P	Scalar X17	Pseudoscalar X17	Vector X17	Axial Vector X17
^{8}Be(18.15)	1^+	✗	✓	✓	✓
^{12}C(17.23)	1^-	✓	✗	✓	✓
^{8}Be(21.01)	0^+	✗	✓	✗	✓
^{8}Be(21.21)	1^+	✓	✗	✓	✗

^{19}F Last results

PADME experiment

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- e^+-beam ($E < 550$ MeV) on 100μm diamond target
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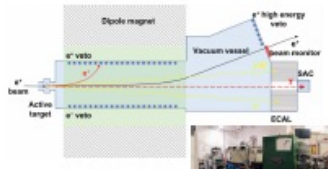


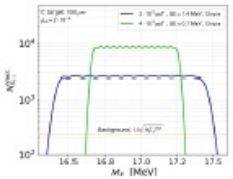
The PADME Run III

Production mechanism

Resonant annihilation: $e^+e^- \to X_{17}$ and search for visible decays into e^+e^-

$$\sigma_{res}(\sqrt{s}) = \frac{12\pi}{m_{X_{17}}^2}\frac{\Gamma_{X_{17}}^2/4}{\left(\sqrt{s}-m_{X_{17}}\right)^2+\Gamma_{X_{17}}^2/4}$$

@PADME $\sqrt{s} = \sqrt{2m_e E_{beam}}$ and $\sigma_{res}(\sqrt{s})$ increases if $\sqrt{s} = m_{X_{17}}$
→ **invariant mass scan procedure [4,5]**



g_{V_e} vector-electron coupling — Gaussian beam spread → σ_E beam energy spread

$$N_{X_{17}}^{perPoT} \simeq \frac{3\varepsilon_{V_e}^2}{2m_e}\ell_{tar}\frac{N_A\rho Z}{A}f\left(\frac{m_{X_{17}}^2}{2m_e}, E_{beam}\right)$$

Main SM background processes: Bhabha scattering & $\gamma\gamma$-production → **Improvements of experimental setup**

Analysis strategy

Fixed target experiment: *s*- and *t*- channel kinematics can be distinguished
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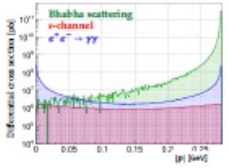

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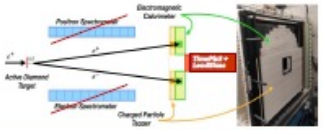

Collected data

Data taking lasted 3 months at the end of 2022

- Acquired luminosity ~ 6×10^{11} PoT:
- 47 points in $260 < E_{beam} < 300$ MeV with $\sigma_E \simeq 0.7$ MeV
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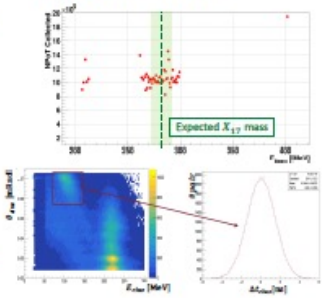

Out-of-resonance points:

- Using kinematic relation between E_γ and θ_γ
  → very good signal to background separation
- Pure SM measurements
- Comparisons with data and PADME full MC [6]

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The data analysis is in progress

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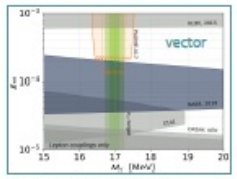

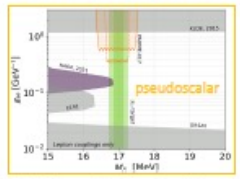

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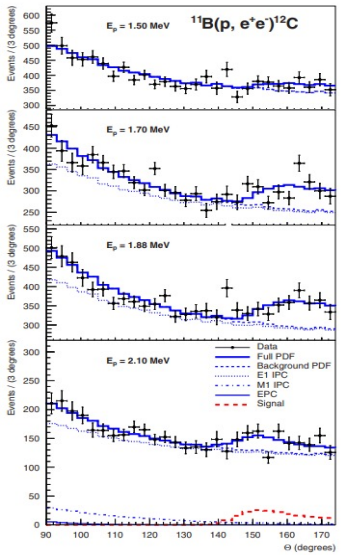

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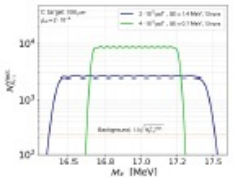

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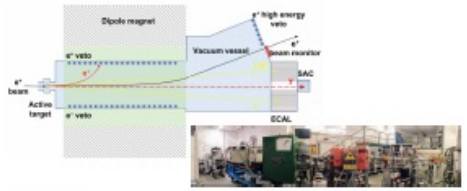

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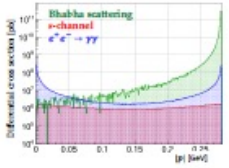

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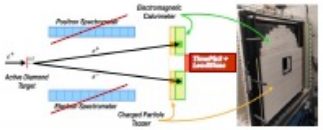

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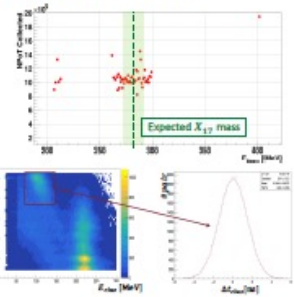

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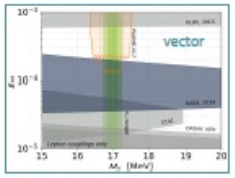

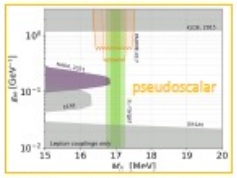

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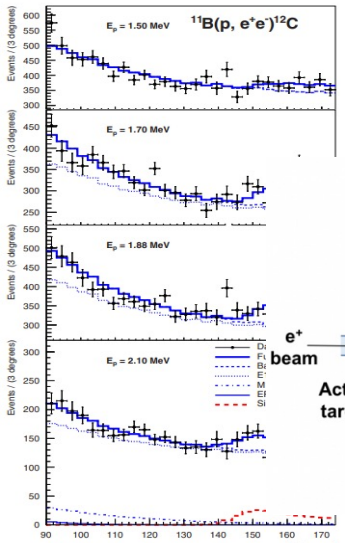

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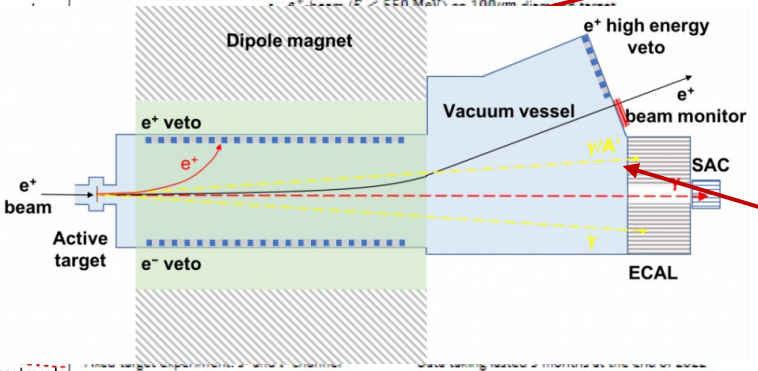

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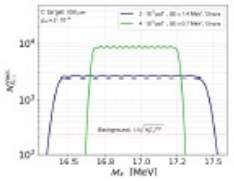

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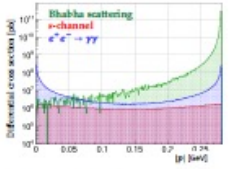

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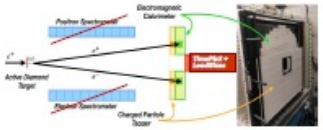

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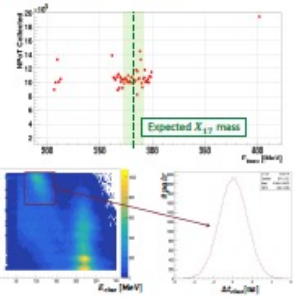

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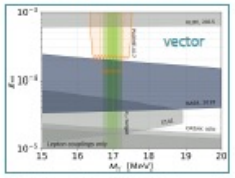

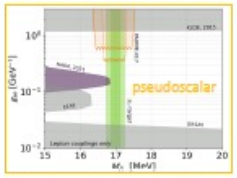

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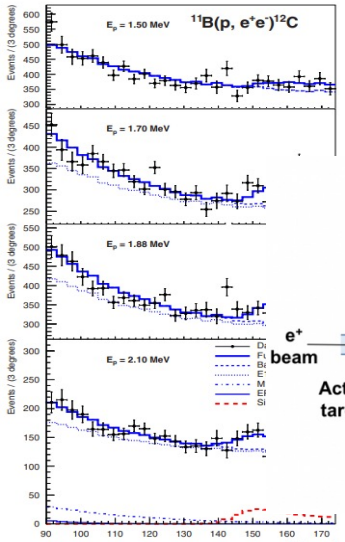

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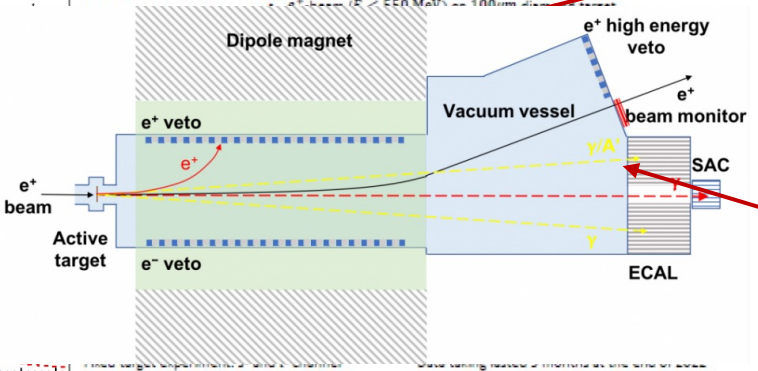

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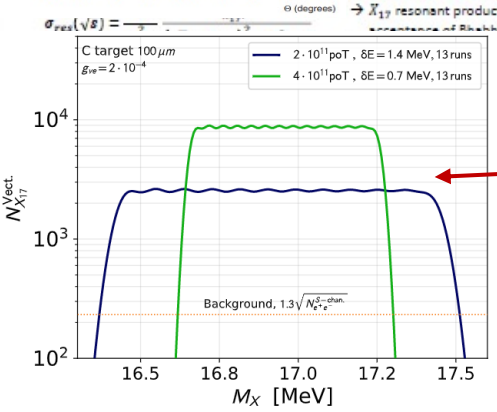

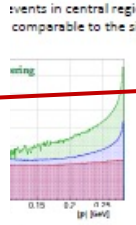

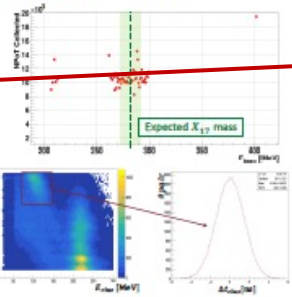

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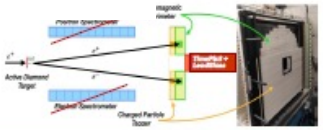

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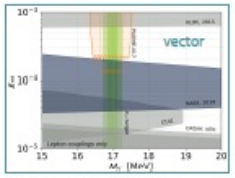

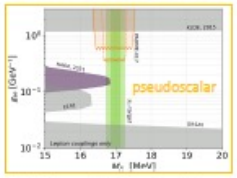

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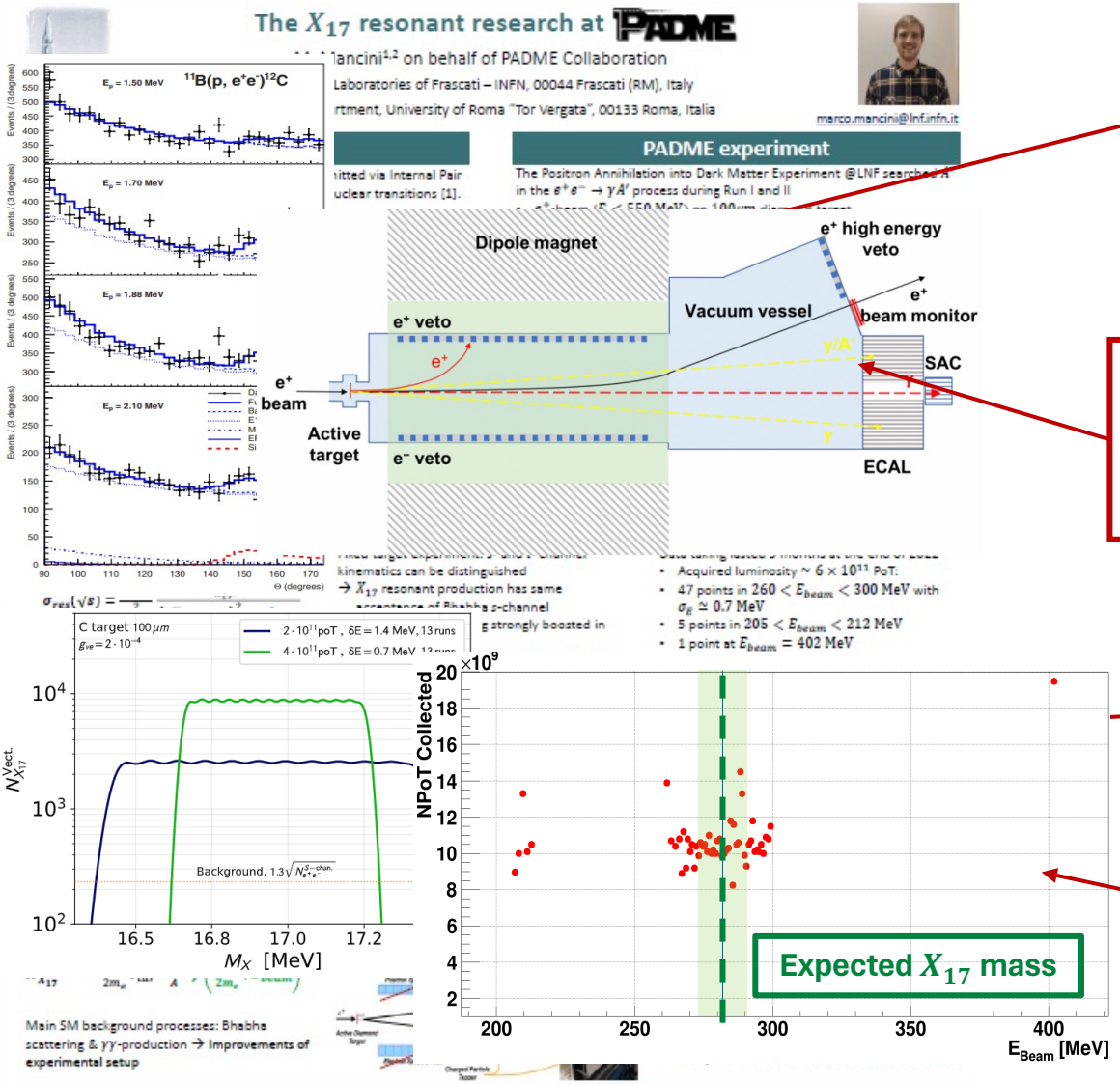
The X_{17} anomaly observed firts by ATOMKI collaboration in nuclear physics experiments

The Positron Annihilation into Dark Matter Experiment – PADME @LNF

Resonant annihilation research



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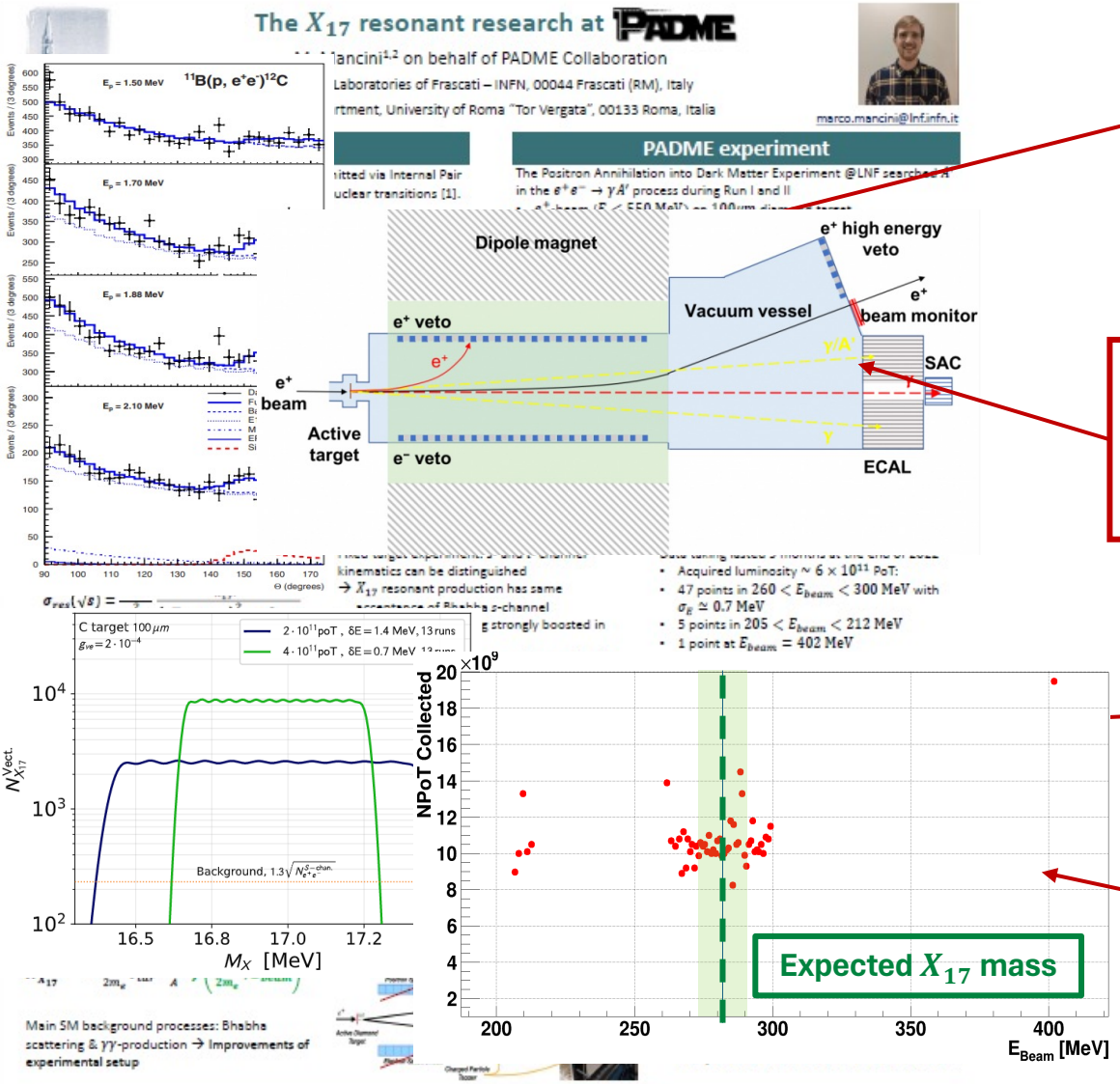
PADME Run III



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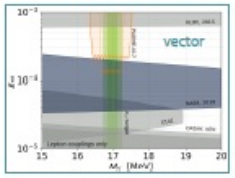
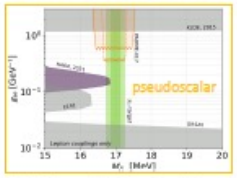
Preliminary results and conclusions

The data analysis is in progress

- PADME will set stringent limits on both vector and pseudoscalar hypotheses [5]
- Measurements of cross sections of involved SM processes below 20 MeV will be performed





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[5] Darmé et al., Phys. Rev. D, 106:L115036(2022)
[6] F. Bossi et al, JHEP, 09:233 (2022)

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See you at the Poster session