

ESPERIMENTO PADME

RICERCA DI DARK PHOTON A FRASCATI



PADME kickoff meeting

20-21 April 2015 *Laboratori Nazionali di Frascati*
Europe/Rome timezone

Active target

Aula Touschek, Laboratori Nazionali di Frascati

CHIODINI, Gabriele

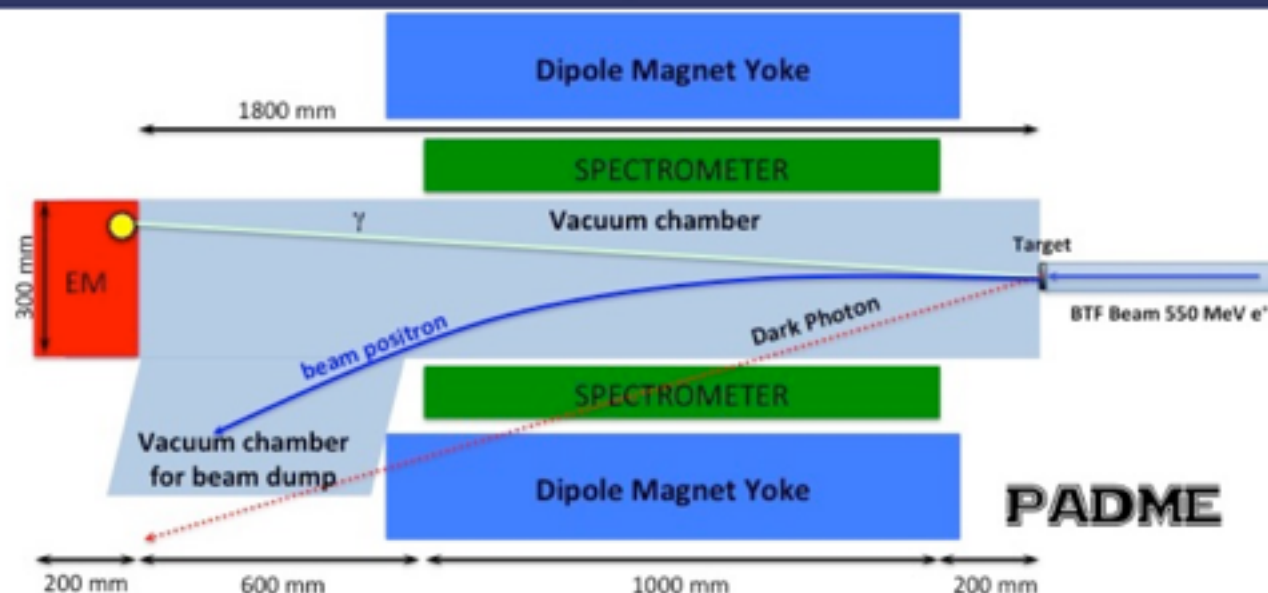
17:10 - 17:30

G. Chiodini and S. Spagnolo

Overview

- 1. PADME**
- 2. Status and Plans**
- 3. Anagrafica provvisoria**
- 4. Prospetto finanziario**
- 5. Back-up:**
 - 1. Physics**
 - 2. Main Backgrounds**

The PADME experiment



- Beam: 10^3 - 10^4 e^+ on target per bunch, at 50 bunch/s (10^{13} - 10^{14} e^+ /year)
- Detector components:
 - Active target, thin: 50-100 μm diamond (Time, Ne-, beam position and spot)
 - Magnetic spectrometer/ scintillating veto $\sim 1\text{m}$ length
 - Conventional magnet, $B \approx 0.6\text{T}$ but large gap for gaining acceptance
 - Cylindrical crystal (BGO or LYSO) EM calorimeter $R=15\text{ cm}$ (with $1 \times 1 \times 20\text{ cm}^3$ crystals)
 - Measures: time, energy and direction of photons
- Compute the $M_{\text{miss}}^2 = (P_{e^-}^4 + P_{\text{beam}}^4 - P_{\gamma}^4)^2$
 - $P_{e^-}^4 = (0,0,0,m_e)$ and $P_{\text{beam}}^4 = (0,0,550,\text{sqrt}(550^2 + m_e^2))$

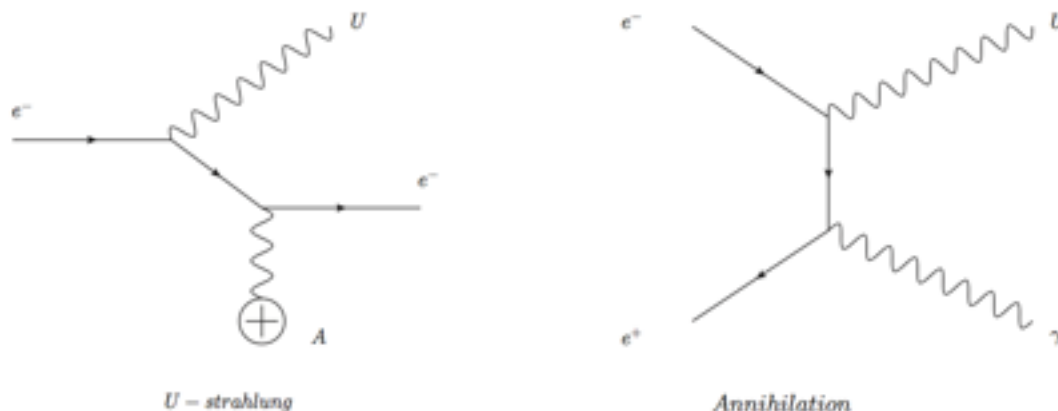
M. Raggi CSN1 june 2015

Roma 4/06/15

Proposto a WHAT NEXT

“ Proposal to Search for a Dark Photon in Positron on Target Collisions at DAPHNE Linac”
M.Raggi and V. Kozhuharov. Advances in High Energy Physics, 2014 ID 959802 (2014).

1.5 mb= γ -bremsStrahlung $\sim 435 \times$ (γ -annihilation)



LECCE proposal:
“Full carbon” thin diamond active target

STATUS and PLANS

4 giugno presentazione di PADME in commissione 1:

- RN (Mauro Raggi):

<https://agenda.infn.it/getFile.py/access?contribId=6&resId=0&materialId=slides&confId=9694>

- Referees:

<https://agenda.infn.it/getFile.py/access?contribId=7&resId=0&materialId=slides&confId=9694>

Accoglienza molto positiva, con alcune osservazioni e suggerimenti:

- coinvolgimento soddisfacente, per un esperimento di quest scala, ma coinvolgere gruppi non italiani e avere senior che segnalino un impegno forte con FTE $\geq 50\%$
- Recupero del calorimetro (per esempio i cristalli di L3) potrebbe fare la differenza tra poter o non poter finanziare PADME

2015:

- Documento tecnico per Settembre
- Tesbeam a Ottobre con prototipo di target a diamante

2016:

- Apertura sigla P-PADME
- Misurare e capire background alla BTF con TARGET+ piccola porzione di EM-CALO
- R&D fascio BTF a 20 ns 2016:

2017

- Apertura sigla P-PADME
- Costruzione PADME INVISIBLE
- 2 mesi di press dati alls BTF

PADME anagrafica provvisoria

Personale di ricerca

INFN Lecce

G. Chiodini (Gr. 1) 30%

INFN Lecce and Università Salento

A. Caricato (Gr. 5) 20%

B. M. Martino (Professore, Gr. 5) 20%

M. De Feudis (Dott. Gr. 5) 100%

S. Spagnolo (Gr. 1) 20%

CNR-NANO and Università Salento

G. Maruccio (Professore, Gr. 5) 20%

A. Monteduro (Dott. Gr. 5) 20%

INFN LNF (Divisione Ricerca)

R. Bedogni 20%

F. Bossi 30%

M. Palutan 20%

G. Piperno (A.d.R.) 100%

M. Raggi 30%

B. Sciascia 10%

V. Kozhuharov (Università Sofia) 50%

G. Georgiev (Università Sofia) 50%

INFN LNF (Divisione Acceleratori)

B. Buonomo (20%)

L. Foggetta (20%)

A. Ghigo (10%)

INFN Roma

F. Ferrarotto 60%

E. Leonardi 40%

M. Serra 20%

P. Valente 30%

S. Fiore (ENEA) 20%

INFN Roma and Università Sapienza

G. Organtini (Professore) 30%

Molti **confermati**, altri da confermare nell'entità numeri finali per Luglio

M. Raggi CSN1 june 2015

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Piano finanziario 2015-2017

PADME-invisible	2015	2016	2017	2018	Totale
Magnete+positron veto	3	20+30	50		103
Diamond target	2	70	30		102
Front charged veto		50	100		150
Calorimetro BGO/ <i>LYSO</i>	15	135/520			150/520
APD+FEE	10	85	120		215
DAQ			280		280
Small Angle Veto		20	30		50
Large Angle Veto		20	80		100
Vuoto+servizi		50			50
Computing and storage			60	20	80
Totale	20+10	480/865	750	20	1280/1665

Uncertainties 20% better cost estimate in the Technical proposal ;
Tracking spectrometer not included

Detailed breakdown in PADME kickoff meeting
<http://agenda.infn.it/event/padme-kickoff>

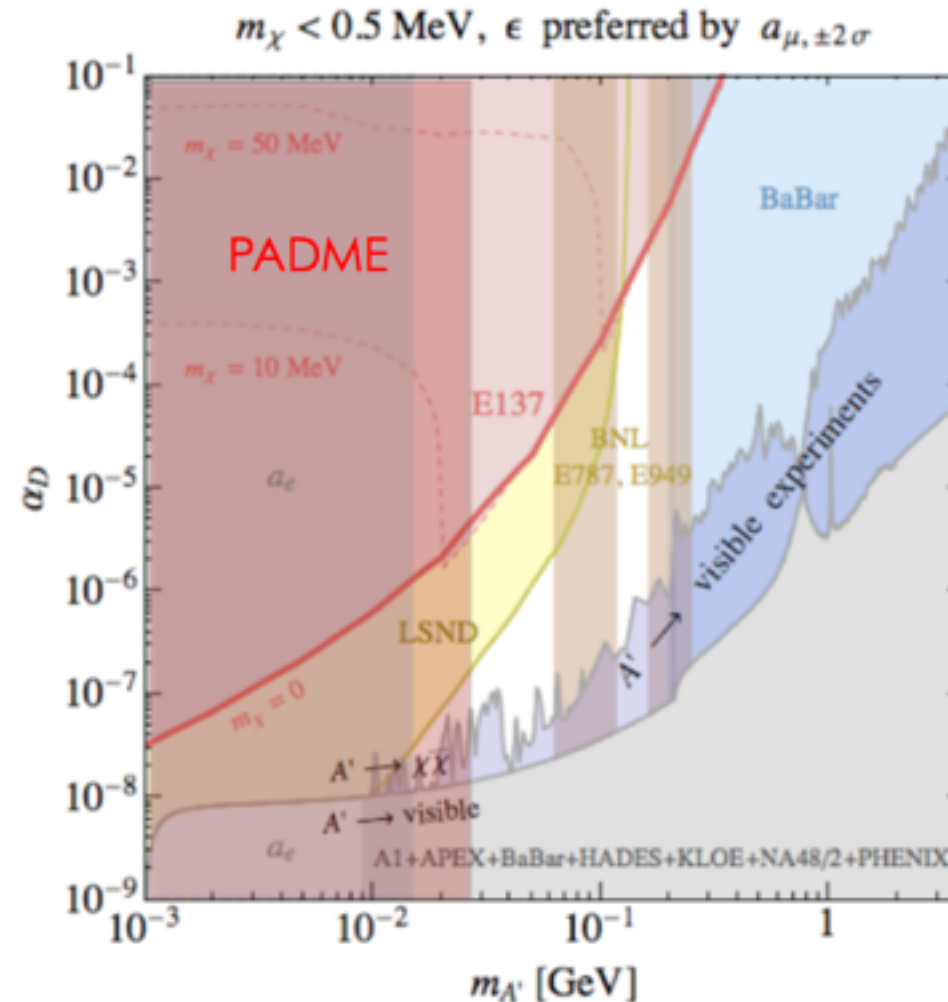
Back-up

1. Physics

2. Main Backgrounds

Combining visible and invisible

N.B. This kind of exclusion plot fixes ϵ with $(g-2)_\mu$ and shows α_D vs $m_{A'}$.



PADME can access the plot independently of α_D up to 20-30 MeV

The exclusion by PADME is independent from the value of m_χ as well

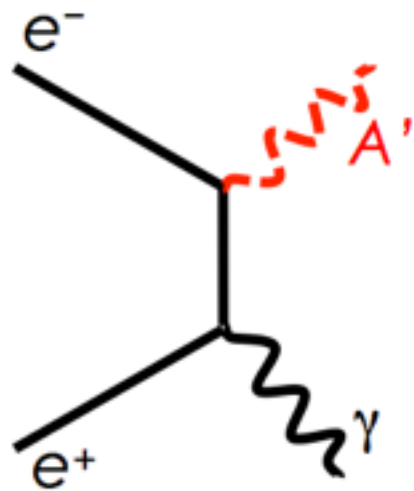
M. Raggi CSN1 june 2015

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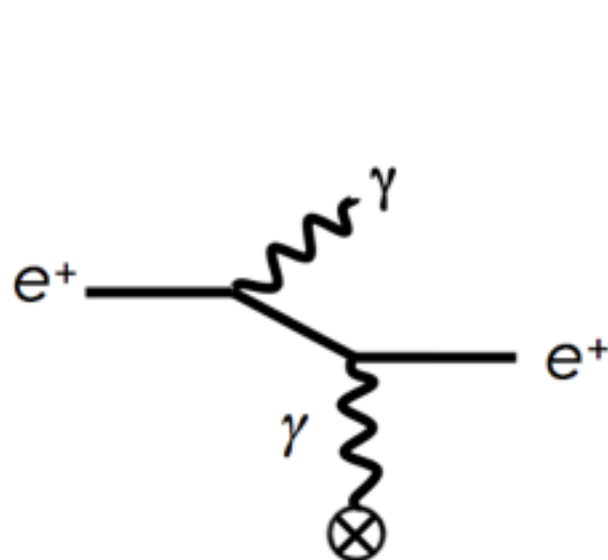
- PADME aims at detecting A' produced in e^+e^- annihilation and decaying into any final state by searching for missing mass in $e^+e^- \rightarrow \gamma A'$, $A' \rightarrow \chi\chi$
 - No assumption on the A' decays products and coupling to quarks
 - Only minimal assumption: A' bosons couples to leptons
 - PADME will limit the coupling of any new light particle produced in e^+e^- collisions: scalars (H_d), vectors (A' and Z_d)

Main background sources

- Geant4 simulation accounts for:
 - Bremsstrahlung, 2 photon annihilation, ionization processes, Bhabha and Moller scattering, and production of δ -rays.
 - Custom treatment of $e^+e^- \rightarrow \gamma\gamma(\gamma)$ using CalcHep generator.

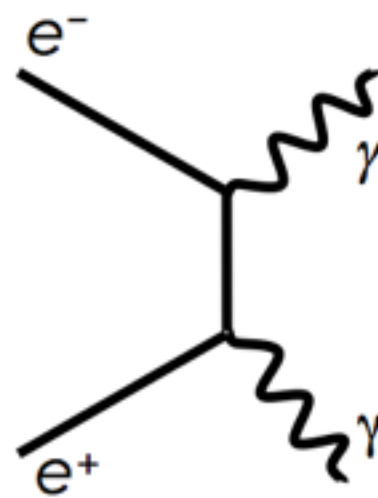


Signal: $e^+e^- \rightarrow \gamma + \text{missing mass (A')}$

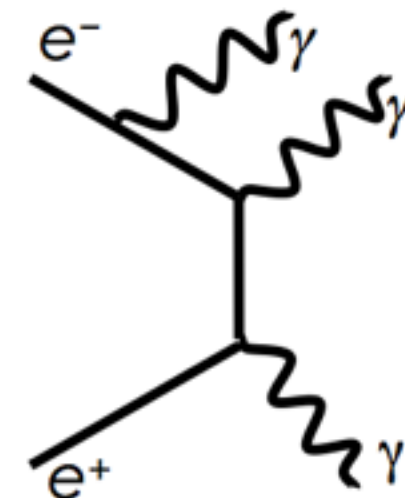


+1 electron

Backgrounds



+1 γ



+2 γ