

Development and test of a DRS4-based DAQ system for the PADME experiment at the DAΦNE BTF

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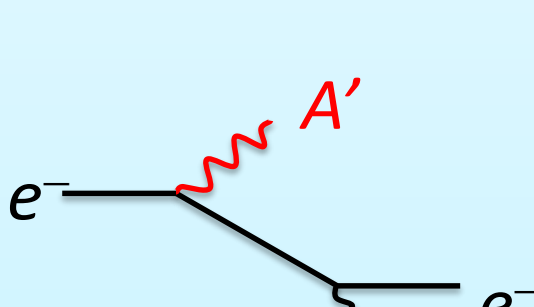


The Dark Photon

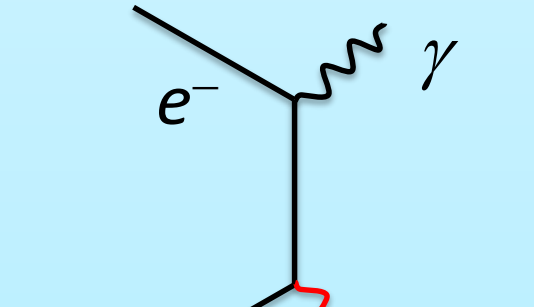
A possible solution to the Dark Matter problem is the hypothesis that it interacts with the SM gauge fields only via “portals” which link our world to the “dark” world. The simplest model postulates the existence of a U(1) symmetry with its corresponding A' vector boson: SM particles are neutral under this symmetry so that this field would couple to the SM only with an effective charge ϵe . As a consequence, A' would behave as a weakly interactive photon and is therefore called «dark photon».

A' production

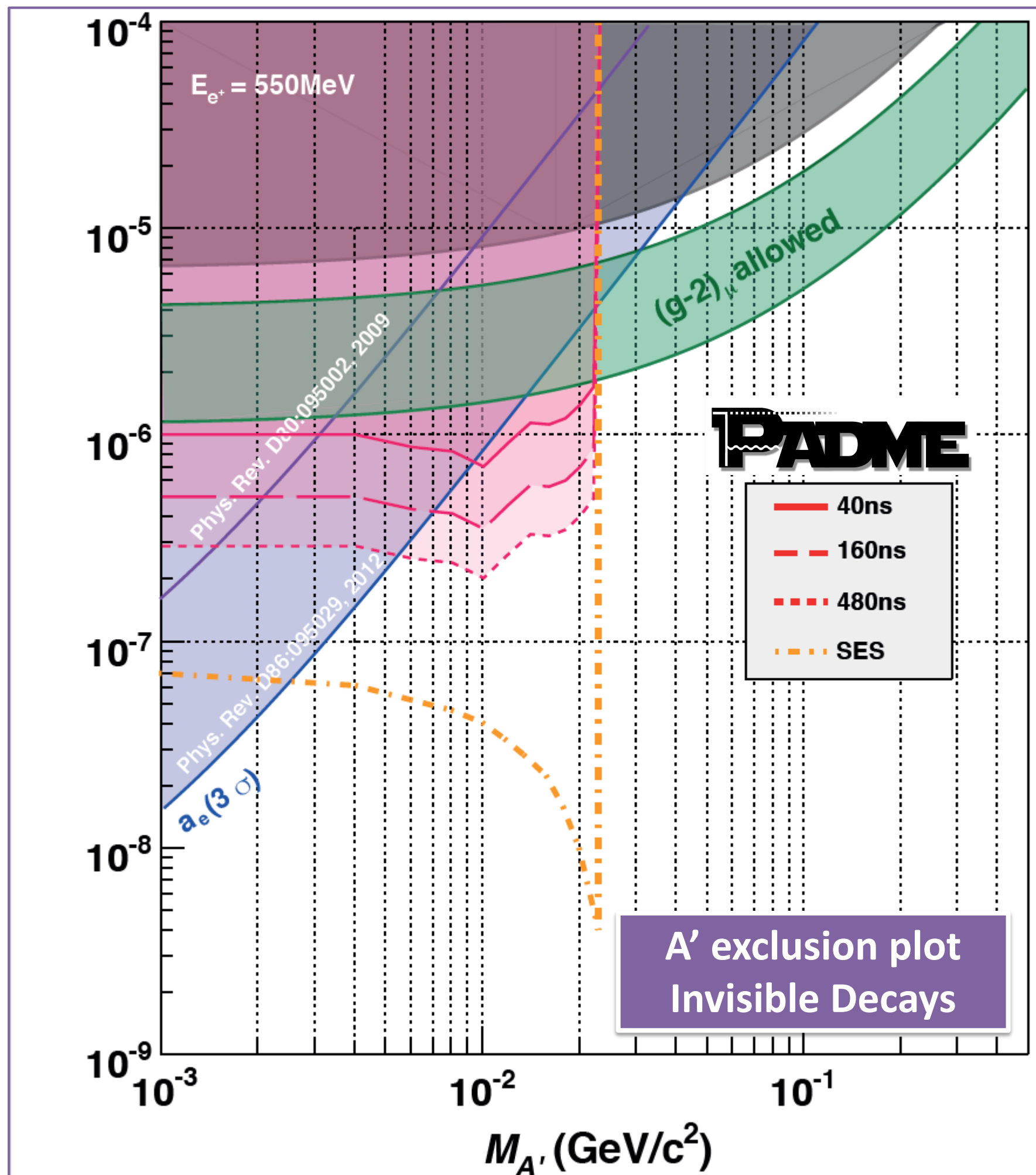
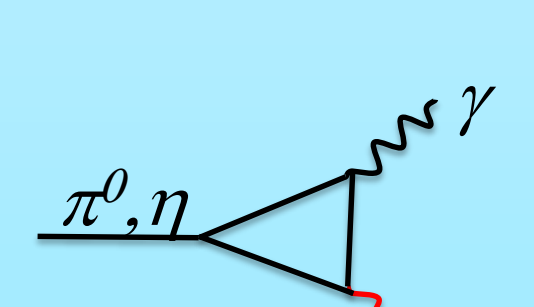
Bremsstrahlung



Annihilation



Meson decay



The PADME Experiment

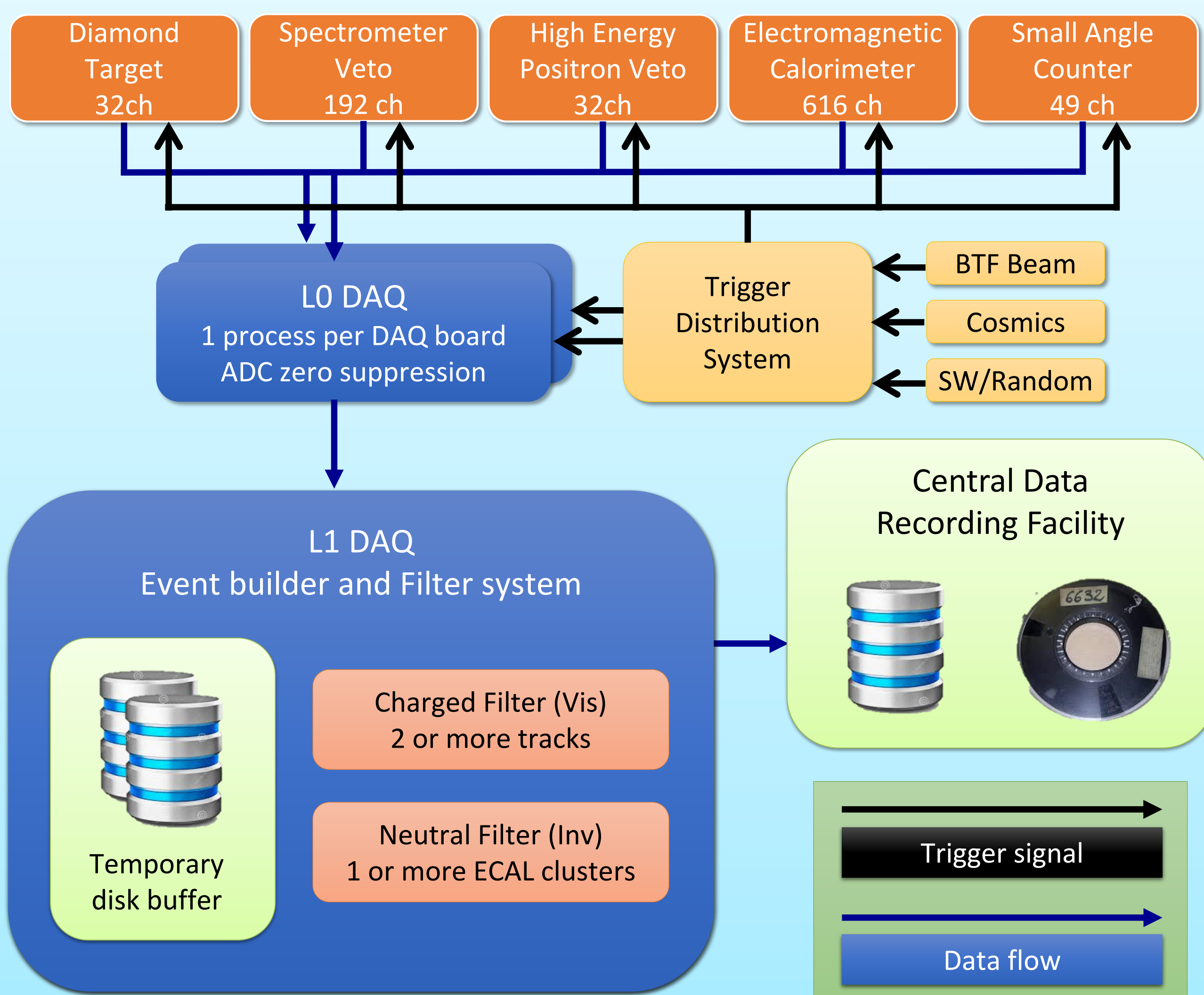
PADME (Positron Annihilation into Dark Mediator Experiment), approved by INFN in 2015, will look for invisible A' decays using the Beam Test Facility (BTF) line of the Linear Accelerator at the INFN Frascati National Laboratory (LNF).

A 550 MeV e^+ beam will impinge on a thin (100 μm) diamond target: the experiment will detect the production of dark photons by measuring the recoil mass of the $e^+e^- \rightarrow A' \gamma$ final state.

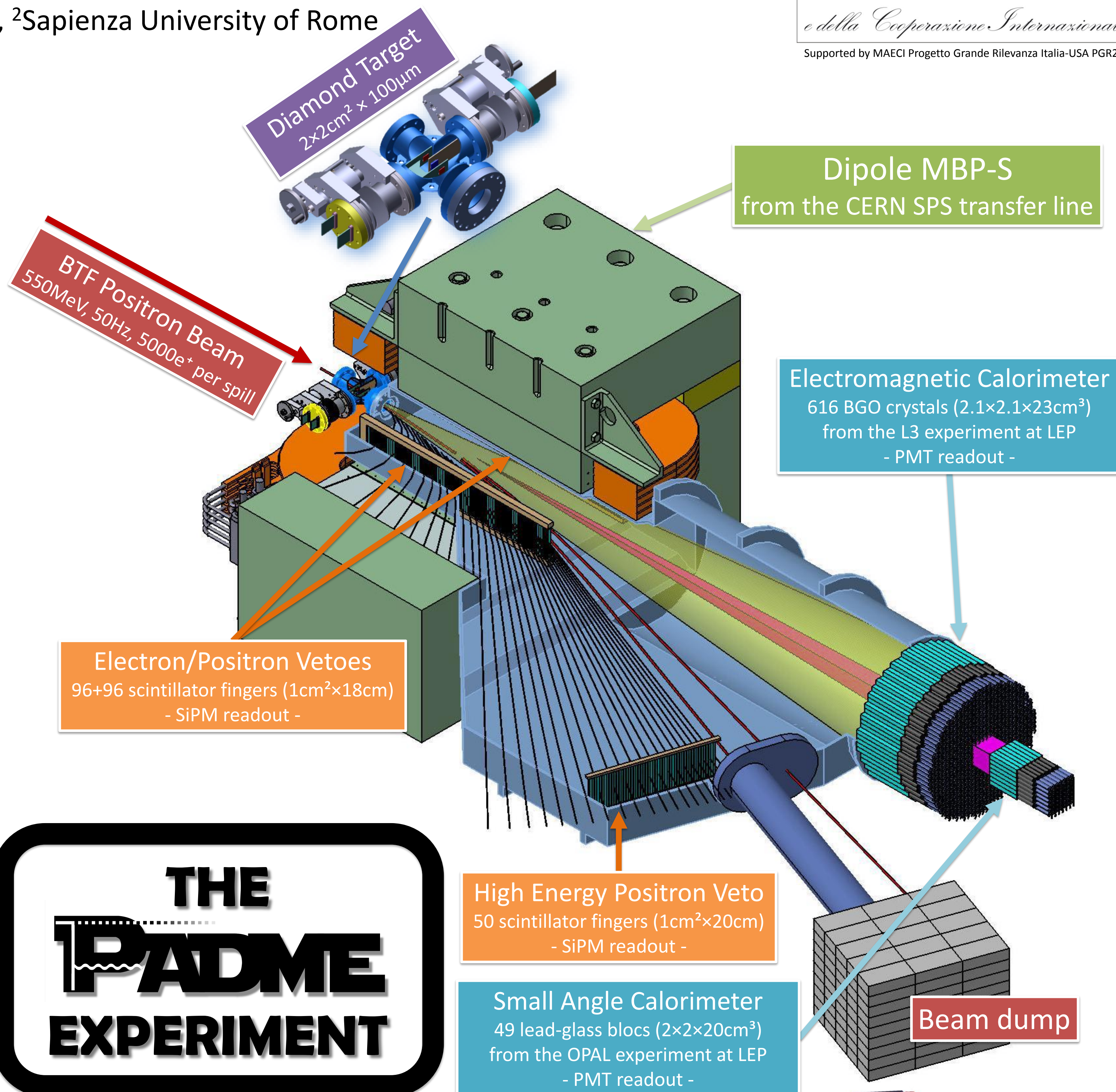
The experiment is currently under construction and will begin data taking in 2018.

The PADME DAQ System

- The PADME DAQ system will handle O(1000) channels, with an expected DAQ rate of 50 Hz, defined by the DAΦNE Linac duty cycle.
- All channels will be read via FADC boards based on the DRS4 chip using a sampling rate varying from 1 GHz (BGO) to 5 GHz (diamond target).
- At L0 data from each FADC board will be read by independent DAQ processes and written to an output file after applying a zero suppression algorithm.
- At L1 the Event builder will collect data from all boards and merge them in the RAW event structure, while the Filter system will tag each event according to its characteristics.



PADME on-line DAQ & computing model



THE
PADME
EXPERIMENT

The DRS4 chip

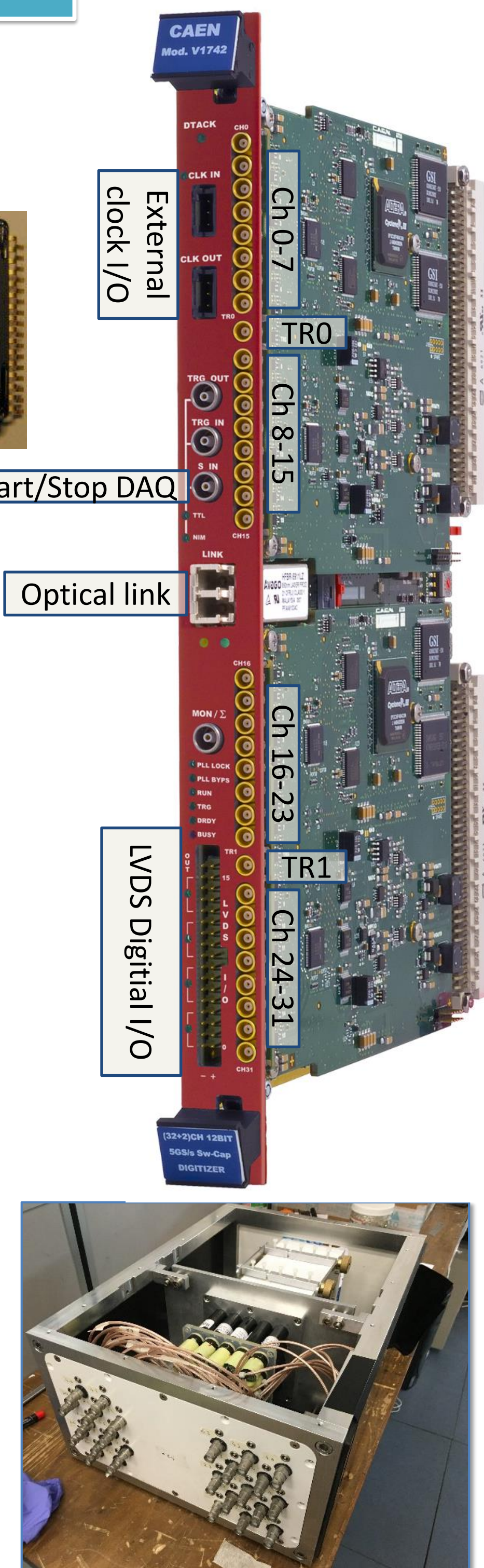
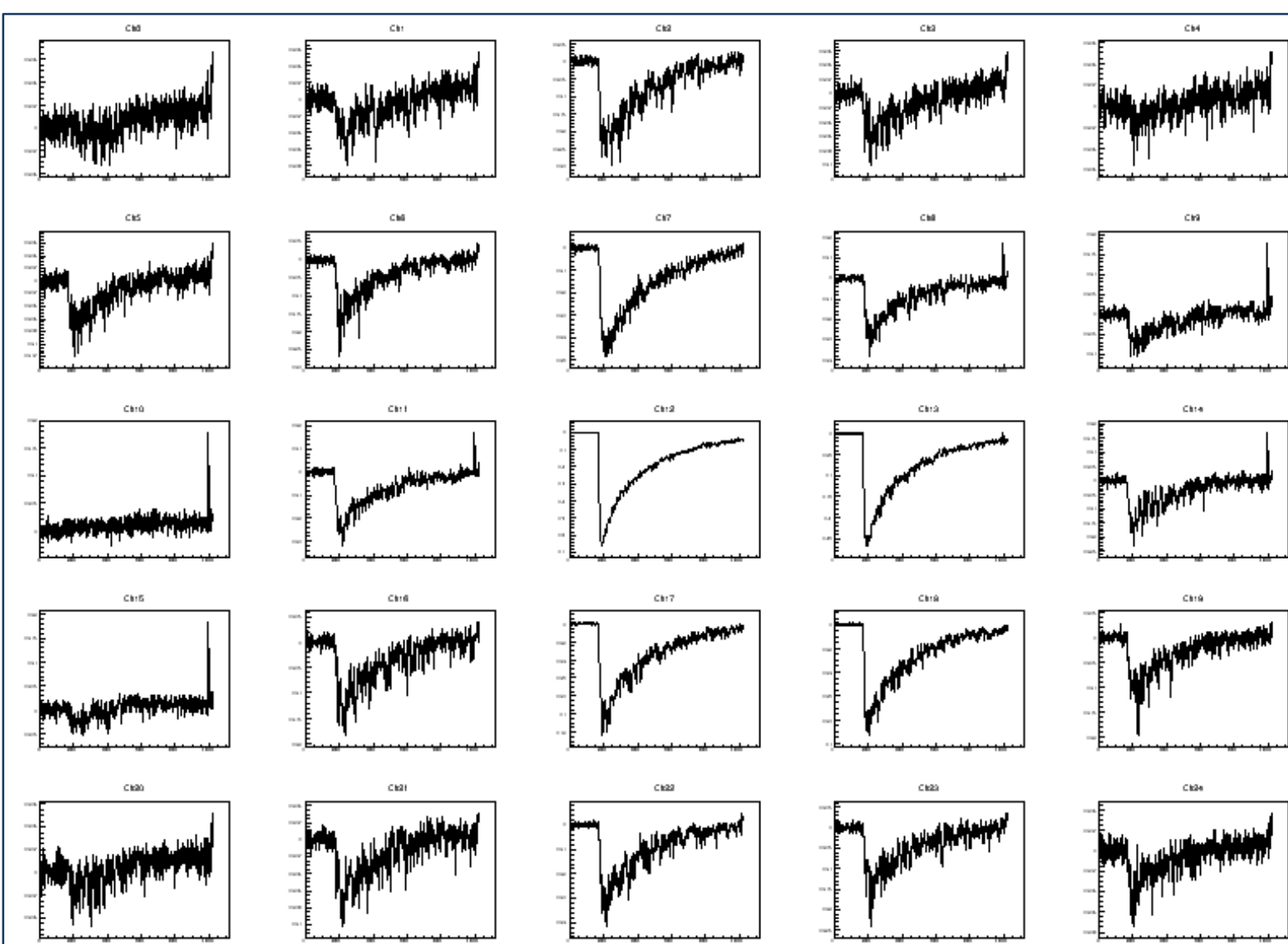
- Developed at PSI (CH) for the MAG experiment
- 1024 cells switched capacitor array (SCA)
- Sampling rate from 0.7 to 5 GSPS
- 8+1 channels

The CAEN V1742 FADC board

- Switched capacitor digitizer based on the DRS4 chip
- Used during 2015 and 2016 testbeams
- 32 channels (+ 2x2 triggers)
- 1 Vpp on 12 bits
- 1024 samples @ 5-2.5-1 GHz
- 181 μs dead time
- 80 MB/s optical link to A2818/A3818 PCI controllers
- Custom modifications by CAEN for PADME:
 - Input dynamics expanded to 2 Vpp
 - Added 750 MHz sampling frequency

DAQ Prototype

- A prototype of the full DAQ system was tested during the 2015 and 2016 testbeams at the DAΦNE BTF.
- Two V1742 boards were used in parallel to acquire data from a 5x5 prototype of the e.m. calorimeter and from the first implementation of the diamond target.
- The full DAQ chain (L0+L1) was active and the merged events were written to ROOT files which were then used for analysis.



Conclusions

- The PADME experiment will look for dark photon production using the DAΦNE BTF beam.
- The DAQ system will handle O(1000) channels using DRS4-based FADC boards.
- A prototype of the DAQ system, based on the CAEN V1742 FADC board, was successfully used during several testbeams in 2015 and 2016.

REFERENCES

- Raggi M, Kozhuharov V. *Results and perspectives in dark photon physics*. Riv. Nuovo Cim. 38 (2015) n.10, 449-505.
- Raggi M, Kozhuharov V, Valente P. *The PADME experiment at LNF*. EPI Web of Conferences 96, 01025 (2015).
- PADME Experiment Home Page: <http://www.lnf.infn.it/acceleratori/padme/>
- DRS Chip Home Page: <https://www.psi.ch/drs/drs-chip>
- CAEN V1742 board: <http://www.caen.it/site/CaenProd.jsp?parent=11&idmod=661>