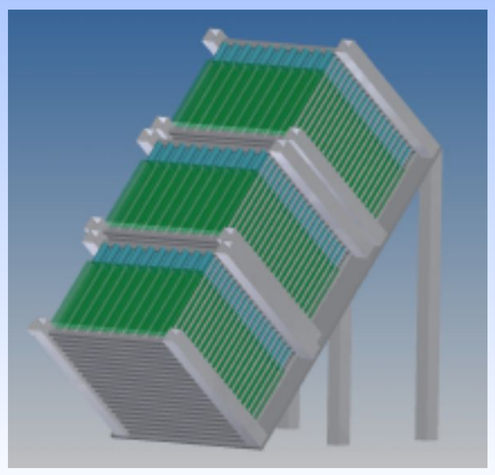

# milliQan

## Searches for milli-charged and S particles at LHC Run3


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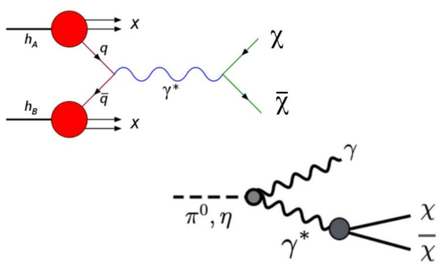
# Introduction

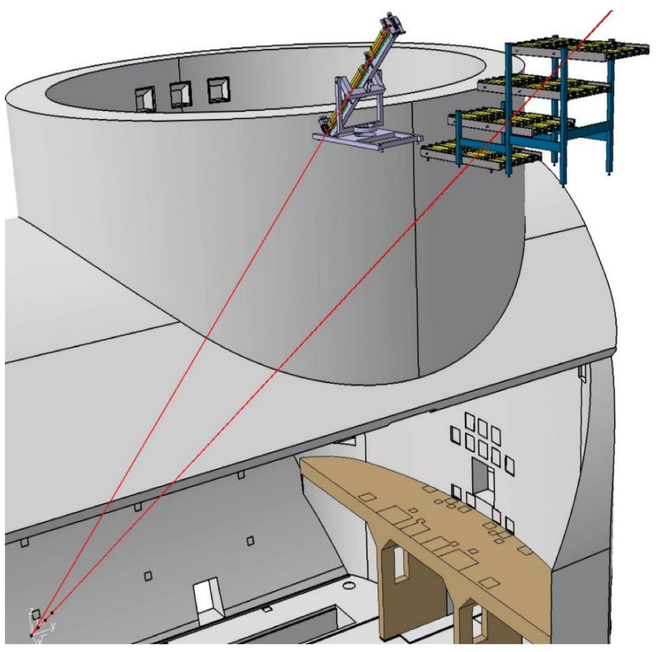
milli-charged particles (mCP) are new stable particles with much less electric charge than the electron and unknown mass.
MilliQan is a new experiment (now a subgroup of CMS) that will search for mCP produced in LHC collisions, from Drell-Yan and meson decays.

With charge of ~1E-3e, the deposited energy is ~1E-6 times that of a MIP.
Long scintillator bars (5x5x60 cm) are used to detect ~1 photo-electron (PE).

An array of 4x4x4 bars and 3x4x4 slabs are placed ~33m from the CMS interaction point in a well-shielded tunnel (17m rock).

An mCP passes through 4 bars or slabs and leaves >1 PE in each within 10ns. Triple-coincidence is used to reduce backgrounds.

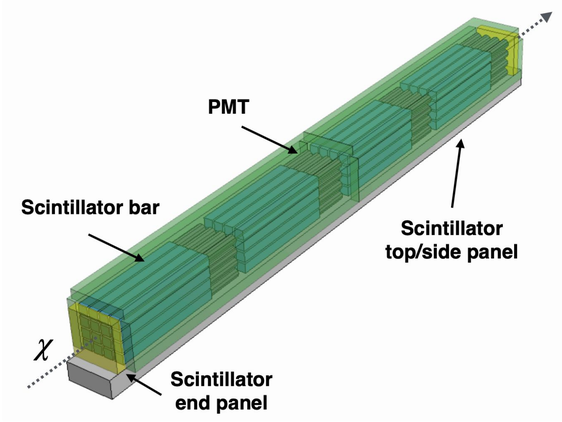


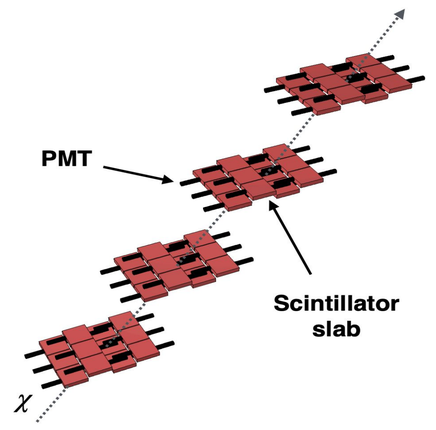
# Run 3 Upgrade

Upgraded bar detector is fully installed in the tunnel and being commissioned.

Completed electrical and safety checks for unsupervised running.



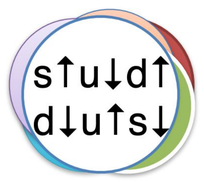

All slabs are completed and in the tunnel, will soon be mounted on a support structure and then commissioned.




S travels like a neutron (with longer interaction length) through rock, then leaves a large energy deposit in a slab from nuclear interaction.

Upgraded trigger system will be able to trigger on large pulses (ToT) as well as combinations of small pulses such as 3 in a row, etc.

Events will be also be recorded by a slow secondary readout to reconstruct energies of large saturated pulses.

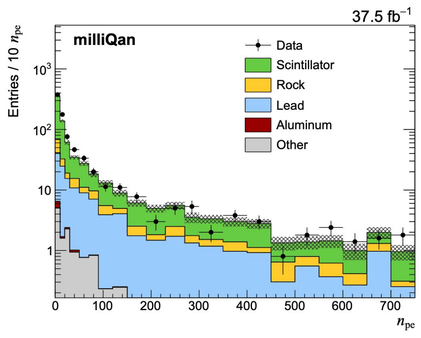


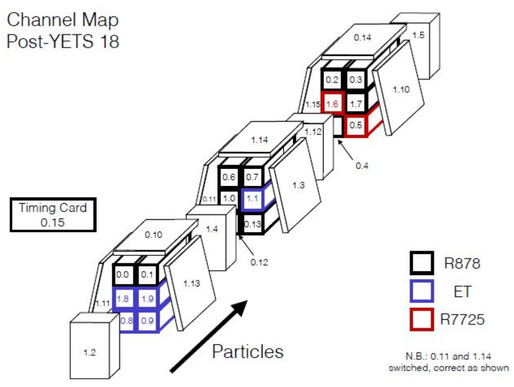

S

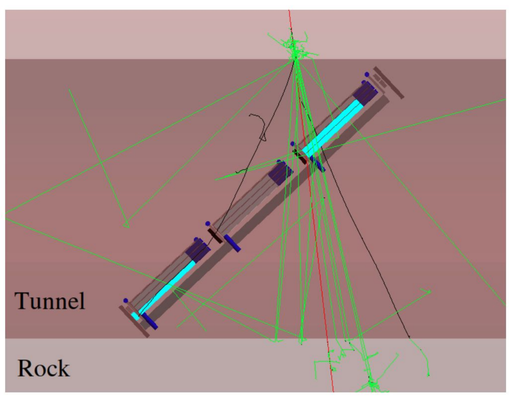
# 1% Demonstrator Test

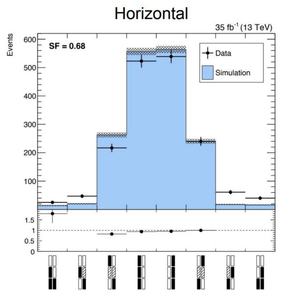
An 18-bar demonstrator (2x3x3 layers) was commissioned in 2017-18, along with 1cm-resolution hodoscopes, slabs between layers, large panels on outside (for cosmic veto), environmental sensors, and a LHC timing card.

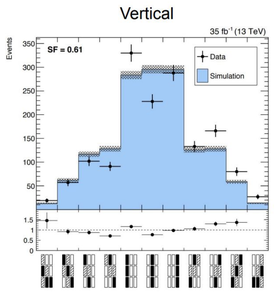
Excellent performance for 37.5/fb of Run2 pp data, and good agreement with backgrounds and simulations. First limits on mCP from the LHC!

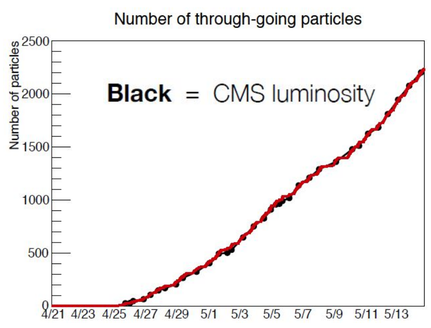



# Expected Sensitivity

milliQan will greatly expand parameter space explored for mCP mass >100 MeV.

Combination of small bar and slab detectors provides better coverage in parameter space than a large bar detector alone, at ~20% of the cost.

Also expect to be sensitive to S production, for attenuation lengths >~15x that of neutrons and production rate in pp collisions >~1E-4 that of neutrons.