Expression of Interest for participating in the H2020 Innovation Pilot on detector technologies at accelerators

Title: Study of e*co-friendly gas mixtures for Resistive Plate Chamber detectors*
(keywords: Gaseous detectors; Resistive Plate Chambers; Eco-gas)

Participants (max. 6): *list the participating institutes, laboratories and industrial partners*

Name of the legal entity	Type (university, institute, laboratory, company)	Country
INFN (BA, BO, LNF, RTV, TO)	Institute	Italy
CERN	Laboratory	Switzerland
Universiteit Gent	University	Belgium

Contacts: *One name + e-mail per participant*

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Description of the project:
In High Energy Particle Physics (HEP) a large number of gaseous detectors devoted to charged particles detection, tracking and triggering, are currently designed to be operated with F-based gas mixtures, especially where excellent time resolution and avalanche operation are necessary.
However, fluorinated gases have been recently indicated as GreenHouse Gases (GHG) by European Union (EU) due to their high Global Warming Potential (GWP) and their use has been limited or banned in new types of equipment where alternatives are available.
In the HEP community, EU regulations kicked off investigations into new eco-friendly gas mixtures aiming at identifying efficient candidates to replace the F-gas components while keeping high detector performance or even improving them, both in the case of detectors that are open mode systems or make use of gas recirculation systems. As a byproduct, the exponential cost increase for F-gases will

not be an issue for devices employing environmental friendly mixtures.
Eco-gas studies are therefore of great relevance in view of future accelerator-based HEP projects and upgrade of existing detectors at LHC where the use of gaseous detectors still operated with fluorinated-gases is foreseen.
First efforts in developing high-rate and fine space resolution RPCs operated with eco-gases were funded in AIDA-2020 or pursued by single Collaborations. The investigation on RPC detector performances with eco-gas has identified 1,3,3,3-tetrafluoropropene (HFO-1234ze), chemical formula C3H2F4, as a valid alternative to partially replace high GWP gases as the Tetrafluoroethane (C2H2F4) and SF6. HFO-1234ze has a very low GWP (1-6) and a zero Ozone Depletion Potential (ODP).
In this task we propose to systematically assess the performance of RPC detectors operated in LHC conditions with eco-gas mixtures free from high GWP components, both for open mode systems or recirculating ones. This will be done in full synergy with the effort that CERN is expending on gas systems' R&D with the aim of reducing the environmental impact of particle detection at the LHC experiments. Space and time resolution studies for eco-friendly RPCs will be based on cosmic rays and test-beam data. The design of the detector will be eventually optimized and tested in the laboratories with cosmic muons and validated with high-intensity backgrounds at CERN Gamma Irradiation Facility GIF++. The impact of impurities formation under different levels of irradiation will be investigated as well.
Laboratory test will be performed at Ghent and INFN laboratories.
The irradiation tests will be performed at GIF++ under the supervision of all participants.
The analysis of impurities in the gas mixture will be performed under CERN group supervision.

Common interests for the Community and relevance for future HEP projects
The results of these studies will be of great relevance for the full RPC community as any future application of these detectors to a possible experiment and in particular to the future upgrades of LHC experiments will have to face the problem of ecological impact.

Deliverables (max. 3): list the expected deliverable(s) of the proposed activities
Deliverable 1. Report on performance studies of a wide range of ecological gas mixtures for RPC detectors under different background conditions.

Budget estimate

Total number of PMs	EC contribution (in kEUR) (a)	Matching funds (in kEUR) (b)	Full costs (in kEUR) (a) + (b)
48	150	300	450