Cosmic-ray tracker improvements & augmented reality event-display for GIF++

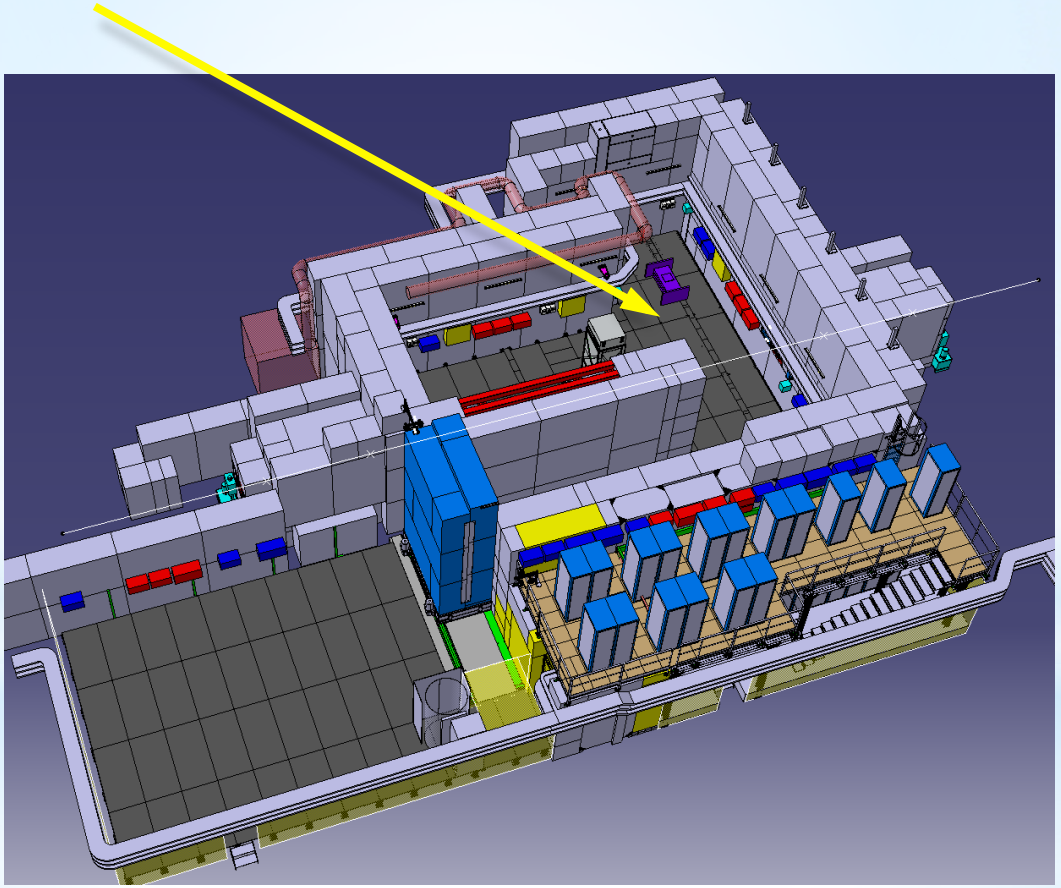
Davide Boscherini (INFN-Bologna)

WP 15.5.4

AIDA-2020 Kick-off Meeting - CERN, 3-5 June 2015

Improvement of the GIF++ cosmic-ray tracker

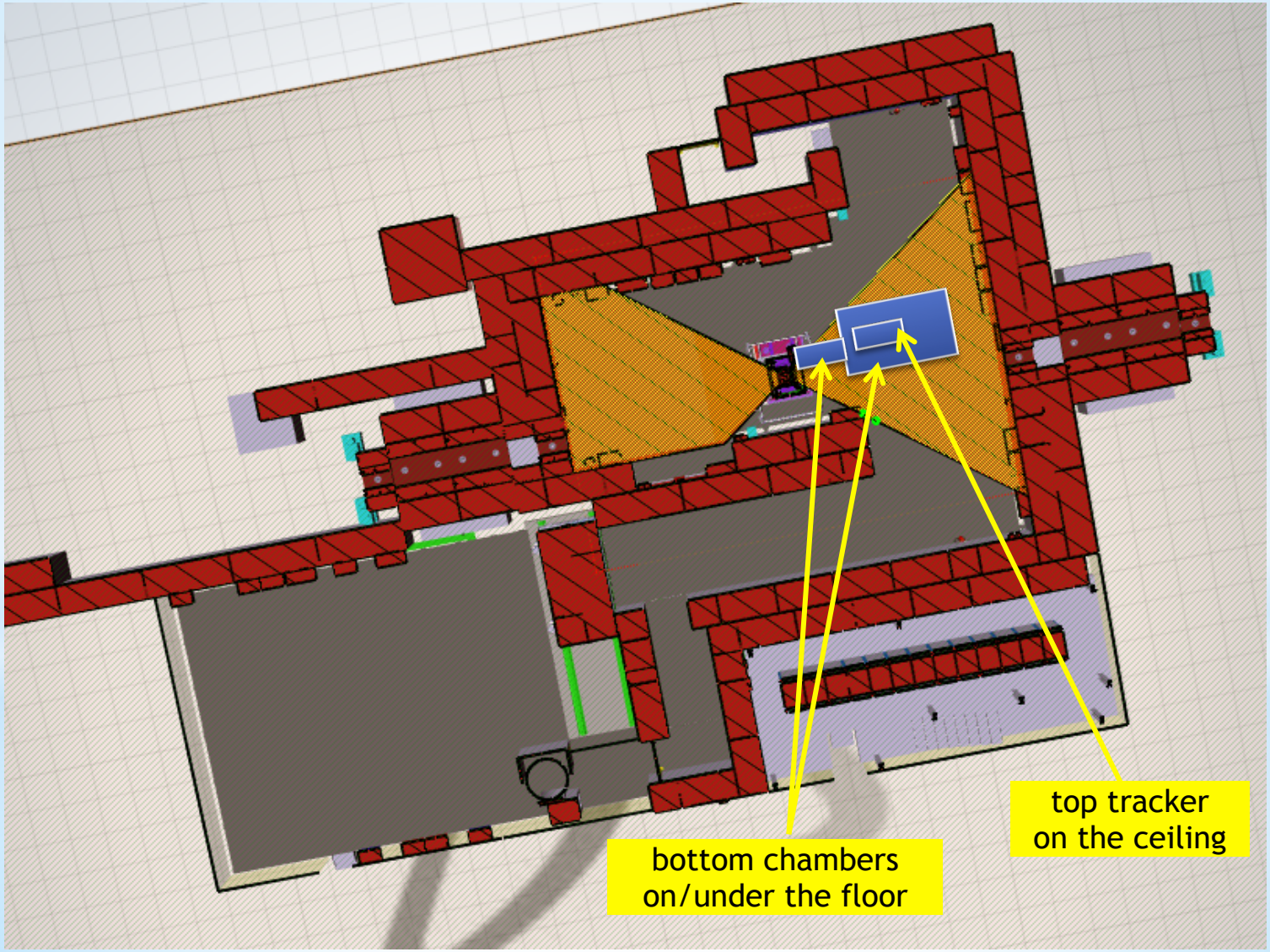
Muon beam at GIF++ available ~6-8 weeks/year as main users
(+ similar time as parasitic users)
Therefore, GIF++ is (going to be) equipped with a cosmic-ray tracker covering one side (wrt the irradiation source) of the bunker



GIF++ surface is ~2x the old-GIF, but it is going to be pretty crowded!

Current cosmic tracker setup

Based on **Resistive Plate Chamber** technology

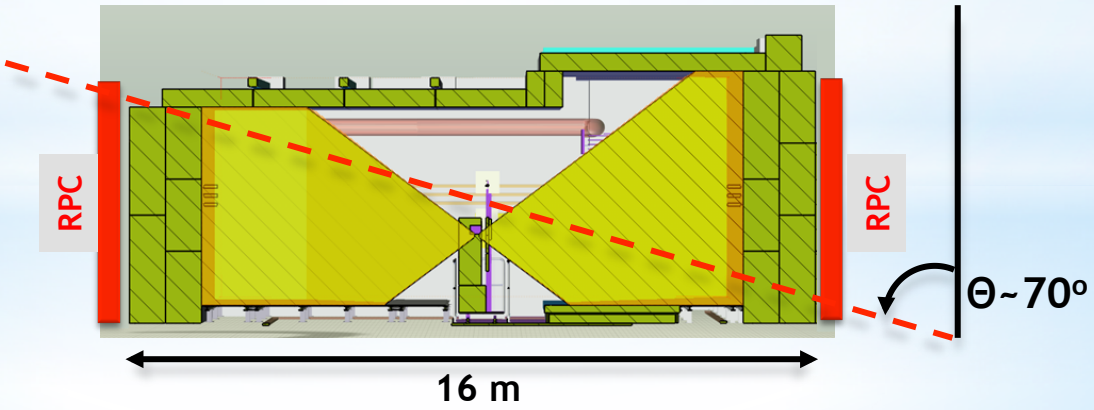


Motivations and proposal for improvement

Two main requests have been raised:

- Instrument a larger area of the facility
- Select higher momentum muons

Installing large area RPCs on the vertical walls of the facility
both requirements can be fulfilled (see next slide)
… at the price of a reduced flux



Furthermore, using large angle cosmic muons, no need to change orientation of the detectors under test wrt the setup for beam muons

Spectrum of cosmic muons at sea level

θ = 0°

θ = 75°

from PDG

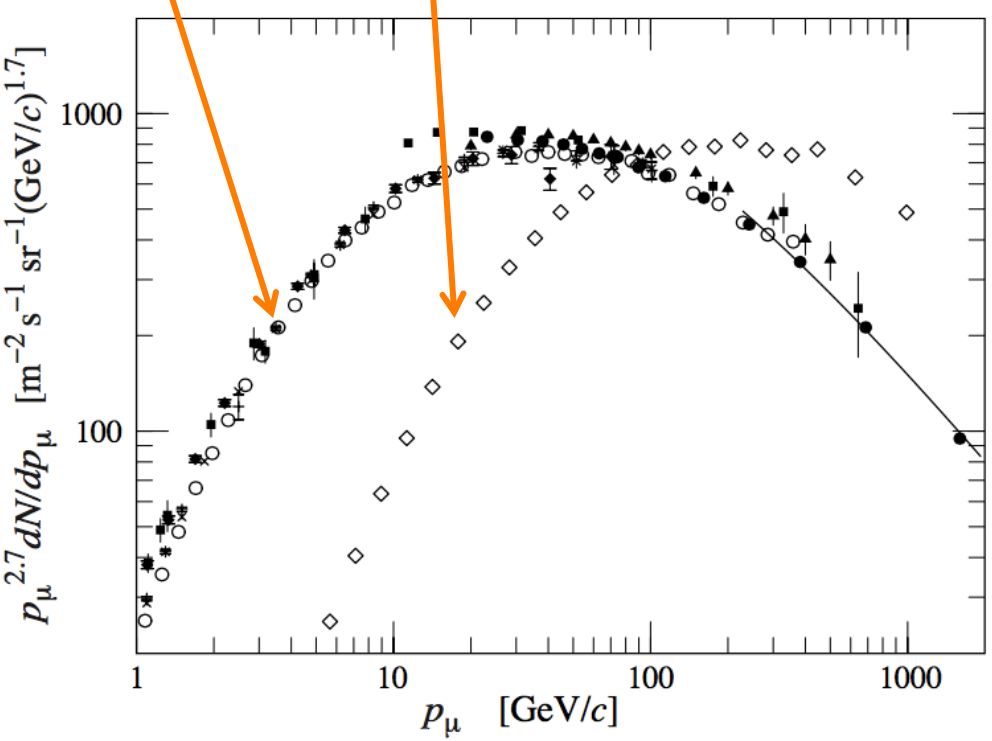


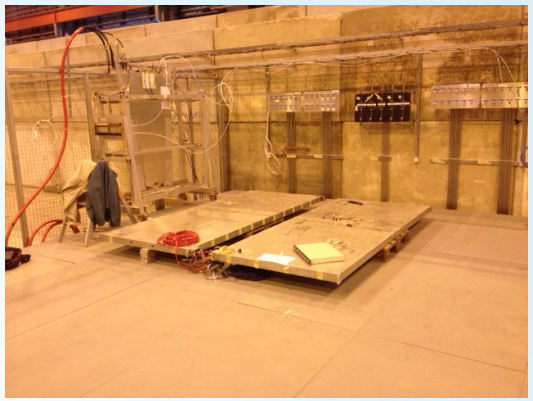
Figure 26.4: Spectrum of muons at $\theta = 0°$ (♦ [41], ■ [46], ▼ [47], ▲ [48], ×, + [43], ○ [44], and • [45] and $\theta = 75°$ ◇ [49]) . The line plots the result from Eq. (26.4) for vertical showers.

Harder spectrum at larger incidence angles

Project description

Build RPC chambers to be placed at both ends of the bunker (see pictures in next slide) with a total surface of 15-20 m^2

Chamber dimensions similar to the confirm plane of the current cosmic tracker (2.8 x 1.2 m^2)



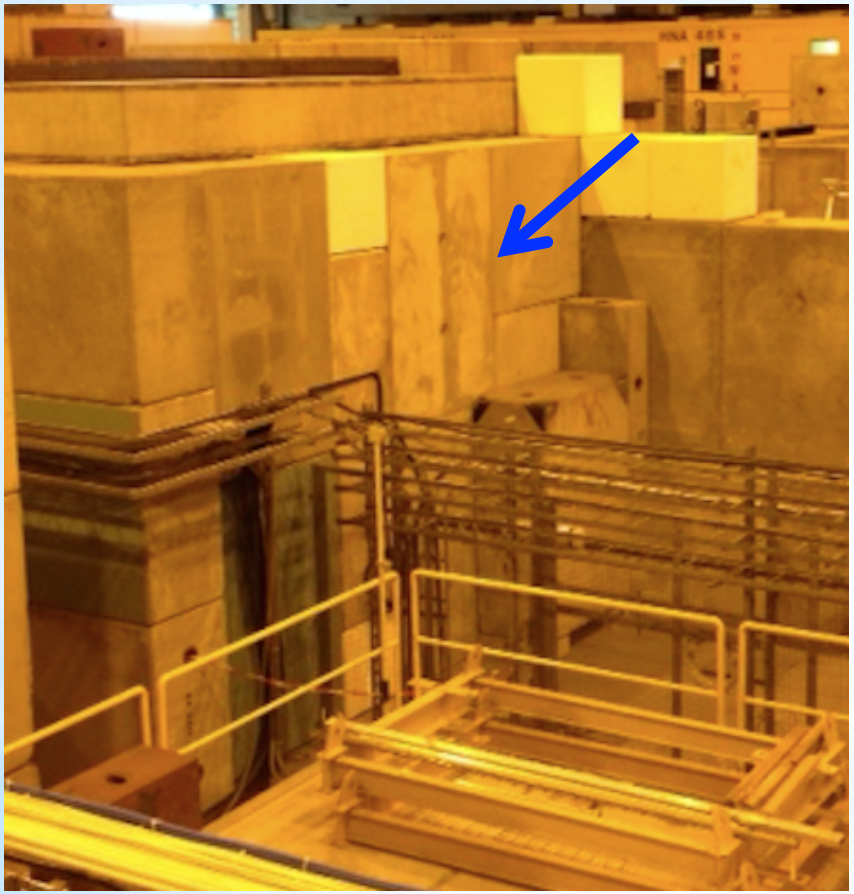
Spatial resolution ~1 cm

Exploit the already existing infrastructure of the cosmic tracker:

- gas system
- power supplies
- DCS
- DAQ
- …

Views of GIF++ end-walls

Upstream view



Downstream view

Involved institutes/people

Beneficiary is **INFN**
Allocated EU funding is **90 kEuro**

AIDA (0.25 FTE)

Bologna (0.5 FTE):
INFN: Davide Boscherini (0.2), Cristiano Gessi (0.2), Alessandro Polini (0.1)

Roma "Tor Vergata" (0.2 FTE + university FTE):
INFN: Roberto Cardarelli (0.1), Enrico Pastori (0.1)
UNIVERSITY: Giulio Aielli, Paolo Camarri, Anna Di Ciaccio, Rinaldo Santonico

Project deadlines

Milestone:

Design of chambers

18 months

Deliverable:

Cosmic tracker installed and commissioned

44 months

Timeline

2015-2016
Design chambers

2016-2017
Produce chambers:
- gas volumes
- readout panels
- front-end electronics
- mechanics

2017-2018
Chamber installation and integration into the existing system

Summary for cosmic-rays tracker

Design and build 4-6 large area RPC chambers

Groups involved with great experience in RPC construction and operation
Adequate person-power available

First deadline:
    design chambers for milestone at M18

The Muon Room

Augmented Reality cosmic-rays event display

G. Aielli (University of Roma Tor Vergata)

The Muon Room scenario: Augmented Reality event display infrastructure

* **What:** is the combination of particle detectors, real time data acquisition and Augmented Reality (AR) to provide users with a First Person View (FPV) interactive event display and detector status. We propose to develop this infrastructure as an enhancement of the GIF++ within the AIDA 2020 proposal

* **Why:** experimental particle physics and AR are advanced and established techniques but they have never been combined before. The result is the direct and interactive experience of CRs for an operator in a given detector setup

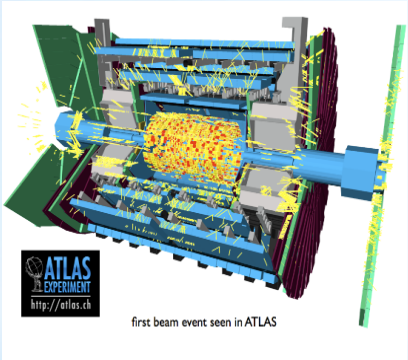
* **Why GIF++:** the HW infrastructure to support such system is almost all there in the GIF++. We need only to add the necessary software for AR and user interface

* **Direct benefits:** the GIF++ will be a pilot project for a new generation of tools for commissioning and long term maintenance of complex experimental apparatus, reducing the time for finding and fixing detector problems and enhance the operator safety. In facts the system can also be interfaced with the DCS showing the power status (HV, LV, etc.) of any detector component the operator is looking at

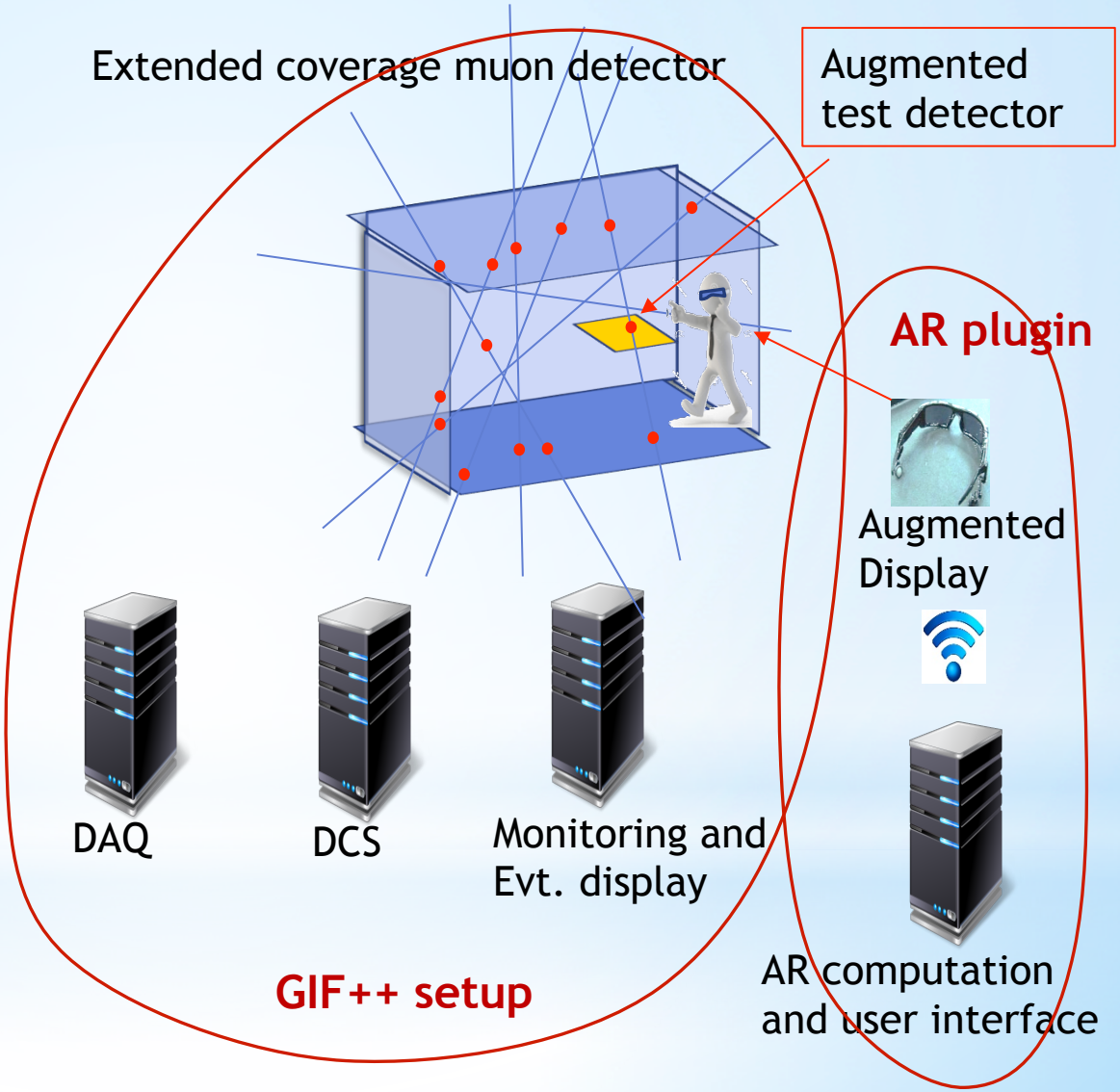
* **Scenario:** the ability to visualize the CR in the natural environment. Thanks to good timing detectors (RPCs), a CR shower event can be replayed, stopped, observed in slow motion, as well as the consequences of the impact on a test detector

Relation between the GIF++ and the Muon Room

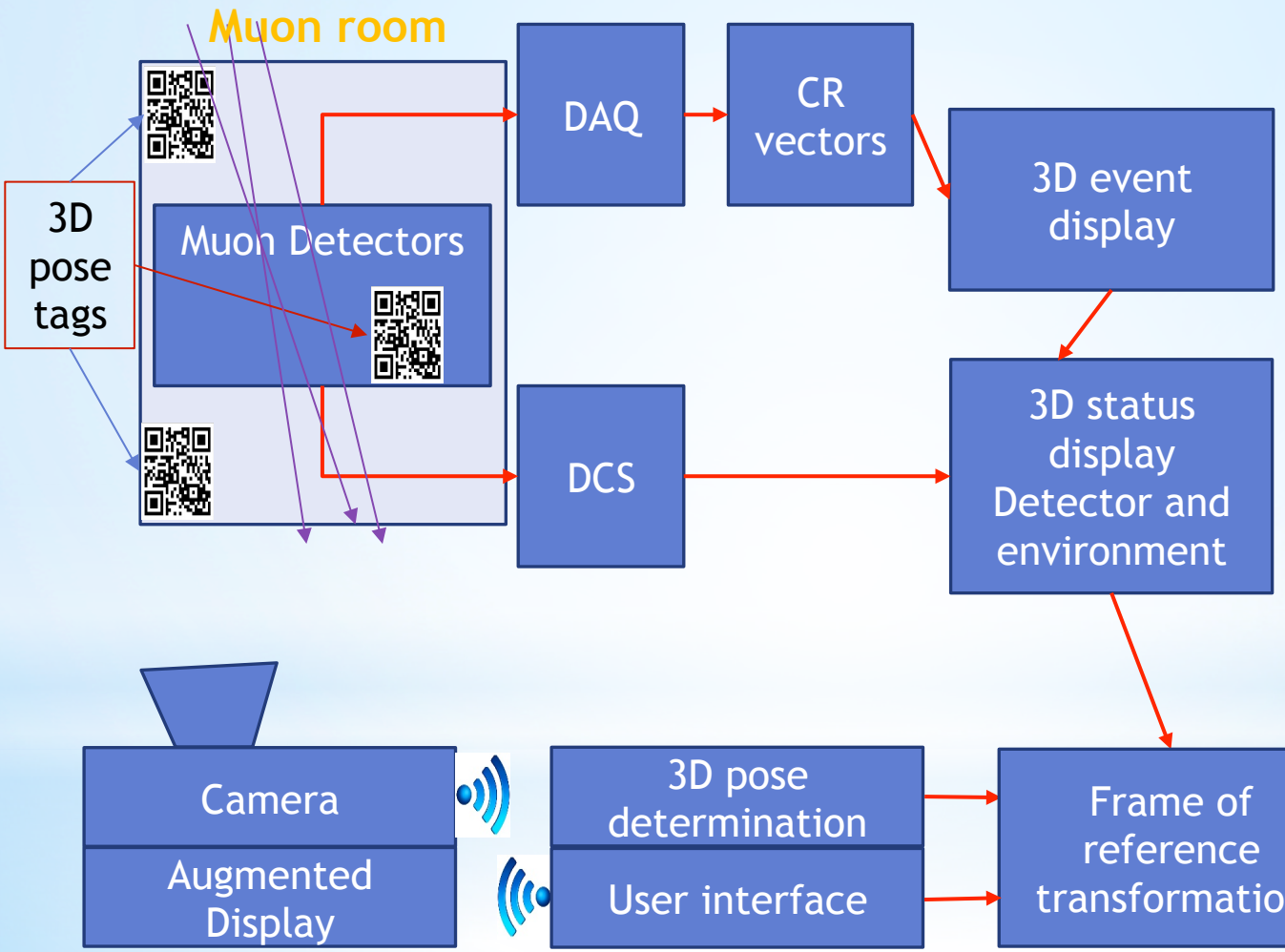
* The diagram below shows that most of the HW is already enclosed in the GIF++, especially if the CR detector coverage will be extended and we will add the 3D event display features to the online monitoring system



* The cost of this task is very limited with respect to the yield and consists in the person months equivalent for the AR software and user interface and the augmented display hardware



Functional description of the AR display in the GIF++



* Muon detectors data to construct the event display
* Camera reconstruct its pose through local tags
* The event display is transformed in the reference frame of the operator
* 3D event is sent to the augmented display through the user interface

Conclusions for the augmented reality event-display

* **Potential repercussions on the society:** interfacing real time DAQ/ control system (HEP field of expertise…) and AR have in general a huge potential in several applications such as future **industrial control**, **production** and **safety**. The special case of cosmic-rays visualization can be largely used for education and outreach, for Universities, exhibitions, museum, etc. This concept can be extended in principle to any source of invisible field of radiation by replacing the type of sensors, e.g. Radio Frequency, Infrared, UV…

* **Benefits for the project approval:** For what above this proposal **fully matches the addresses and recommendations of the EC for the project applications**, enhancing the overall chances of approval of the AIDA 2020 project.

* **Estimation of cost (strictly AR additional function): very preliminary**
  * augmented display (5000 CHF)
  * camera pose calculation (software development) → 6 month FTE
  * user interface → 12 month FTE