Build your own detector: test station

Theme	Explore
Exhibit No.	Exp-E-04a
Exhibit name	Build your own detector: test station
Exhibit description	Before starting, the “Build your own detector” exhibit visitors can use a test station where they can learn more about particles and their interaction with different materials and detectors. This will help them designing their own detector. There is no obligation for the visitor to do the 2 exhibits or to do them in a specific order but the set up should be so that it is logical to first interact with the test station before going to the “Build your own detector” set up..
Learning goal	By comparing what is actually measured in experiments to simulations of what is expected, scientists can check their theories. In the test station, visitors learn how different particles interact with different materials and with different types of detectors. Context ▪ Before one can construct a detector, it is important to know how different particles interact with different detectors and with different materials. ▪ Geant 4, software developed by CERN, simulates how particles interact with different materials. Messages • LHC experiments are built in layers. Each layer is made of detectors measuring a different characteristic of the particles spraying out from the collision in the centre. The choice of materials used for the detectors is key to the experiment's success. • Studying data from particle collisions reveals how the basic ingredients of our universe form and interact.
Type of interactivity	Hands on + multimedia Set up should be so that it lends itself to active open ended exploration
Interaction	Visitors can build different set ups at which they can launch different particles. The interaction of the particles with their set up will be calculated in real time using the Geant 4 software developed at CERN to simulate experiments. Visitors have a box with • Different materials • Different “detectors”, if possible, those look like the real detectors they represent. Preferably each type of detector has a different surface They can put/stick the detectors and materials in front of a particle source on a smart wall/screen/table. Visitors will launch 1 particle at a time. Visitors can put up to 4 materials /detectors in a row. Positions where those can be put are indicated. A screen with instructions: test how different particles interact with different materials and detectors. Visitor put a detector or a material (or up to 4 of them) in the test station, they can then launch particles (to select from a set) at them and see what

happens. The results of their tests will be calculated in real time using Geant 4 software. Visitors have also some materials that they can put in between the particle source and the detector: so that they can see which materials absorb what.
There is no right or wrong in this set up, it is intended for free exploration.

This test station is about free exploration: just observing what happens when different particles encounter different materials and different detectors.
Visitors who first interact with the test station will better understand how to build the detector in the Build your own detector exhibit, it would be nice to encourage them to first do this one, but it should not be an obligation.

The following particles have to be available for the test station

- Protons
- Electrons
- Photons
- Muons
- Neutrinos

The following materials have to be available for the test station

- Paper
- Glass
- Steel
- Lead
- Silicon
- Others?

The following detectors should be present

- Trackers: (Silicon trackers and Scintillating Fibres)
    - tracking devices reveal the paths of electrically charged particles as they pass through and interact with suitable substances. Most tracking devices do not make particle tracks directly visible, but record tiny electrical signals that particles trigger as they move through the device.
- Calorimeters:
    - electromagnetic
        - Measure the energy of electrons and photons as they interact with the electrically charged particles in matter.
    - Hadronic
        - sample the energy of hadrons (particles containing quarks, such as protons and neutrons) as they interact with atomic nuclei
    - (Calorimeters can stop most known particles except muons and neutrinos.)
- Muon detectors
    - The muon interacts very little with matter – it can travel through metres of dense material before it is stopped. For this reason, muon chambers – tracking devices specialized for detecting muons – usually make up the outermost layer of a detector.

Result is shown on the screen:

- Feedback on what is detected: tracks, energy, …

	• Multiple choice can help visitors to draw conclusions from results. • Ask visitor to disassemble for next visitor (or find way to reset automatically).
Exhibit example, picture, sketches, …	For Geant 4: see https://geant4.web.cern.ch/
Number of users	1 user at the test station
Accessibility	Must be accessible to wheelchair users. Detector pieces should contain tactile elements for blind and visually impaired to distinguish the different layers. An audio-description shall also be included.
Consumables on daily basis	NA However, a sufficient number of the different types of “detectors and materials” have to be produced so that visitors can create interesting experiments. Two full duplicate sets to be delivered so that in case of damage or theft parts can be replaced.
Work done or parts delivered by CERN	CERN will deliver and configure the GEANT 4 software for the calculation of the simulated results. All hardware, the software for recognizing the objects and the user interface has to be developed by the supplier. Close collaboration between supplier and CERN team will be necessary.
Safety aspects	
Evaluation and/or prototyping already carried out	
Objects related to this exhibit	
CERN stories related to this exhibit	
Where exhibit is in exhibition/ How exhibit connects to other exhibits and/or objects	Detectors area
Scientist/engineer	John Apostolakis