cosmic π

Cosmic Pi

an open source detector for cosmic rays

Scientists

Professionals
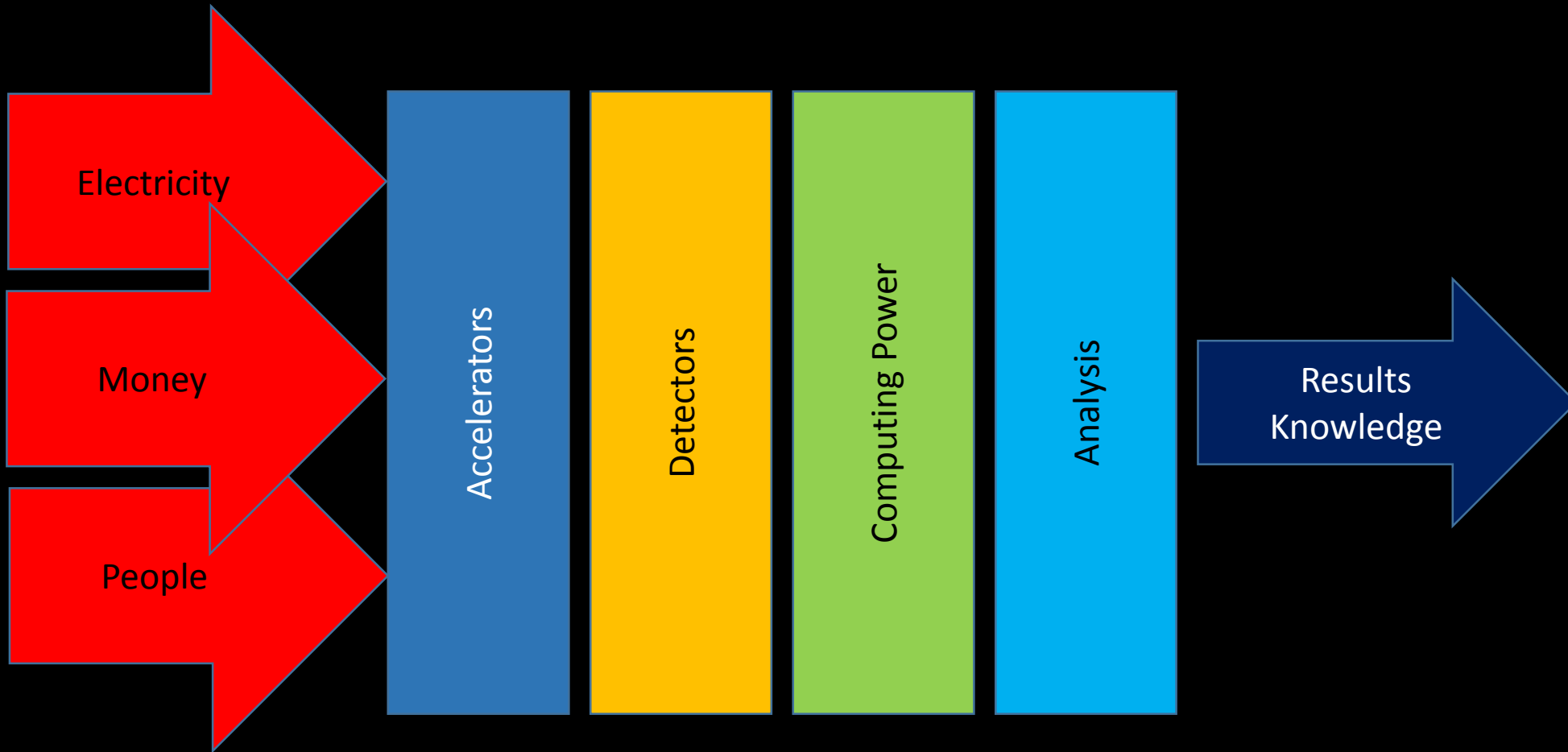

Citizens

The mysteries of the universe

- wouldn't it be great to see the invisible?
- aren't far away galaxies at the edge of the universe exciting?
- why not use the internet to network these detectors?
- what can we do if we all work together on a distributed system?
- CERN is a very exciting place, let's replicate some of it in your pocket…
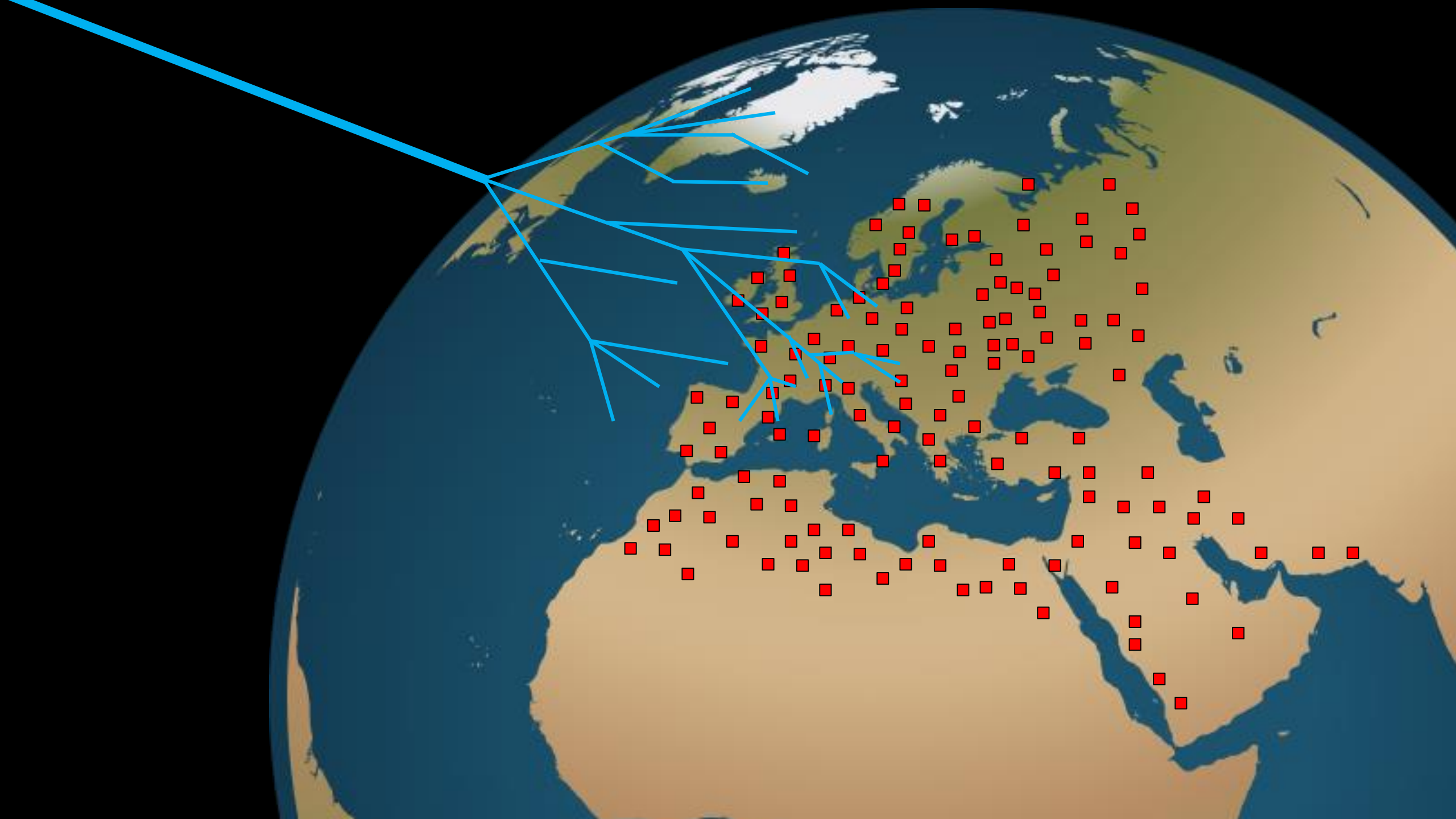
What do we need to do?

- accelerate particles
- convert a particle into something we can detect
- time the arrival of each particle as precisely as possible
- store & share the data
- analyse the results

A way of looking at High Energy Physics

How Cosmic Pi compares

Electricity
Electricity
Electricity
Electricity

Electricity
Money
Time

Cosmic Rays

Detector	Raspberry Pi
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Analysis Framework

Results
Knowledge

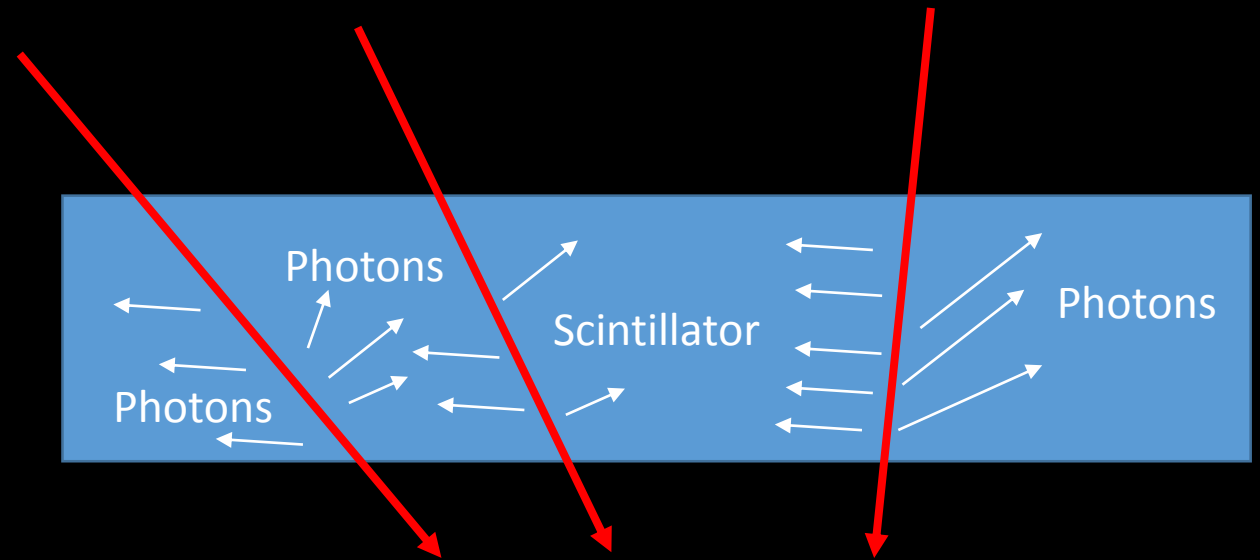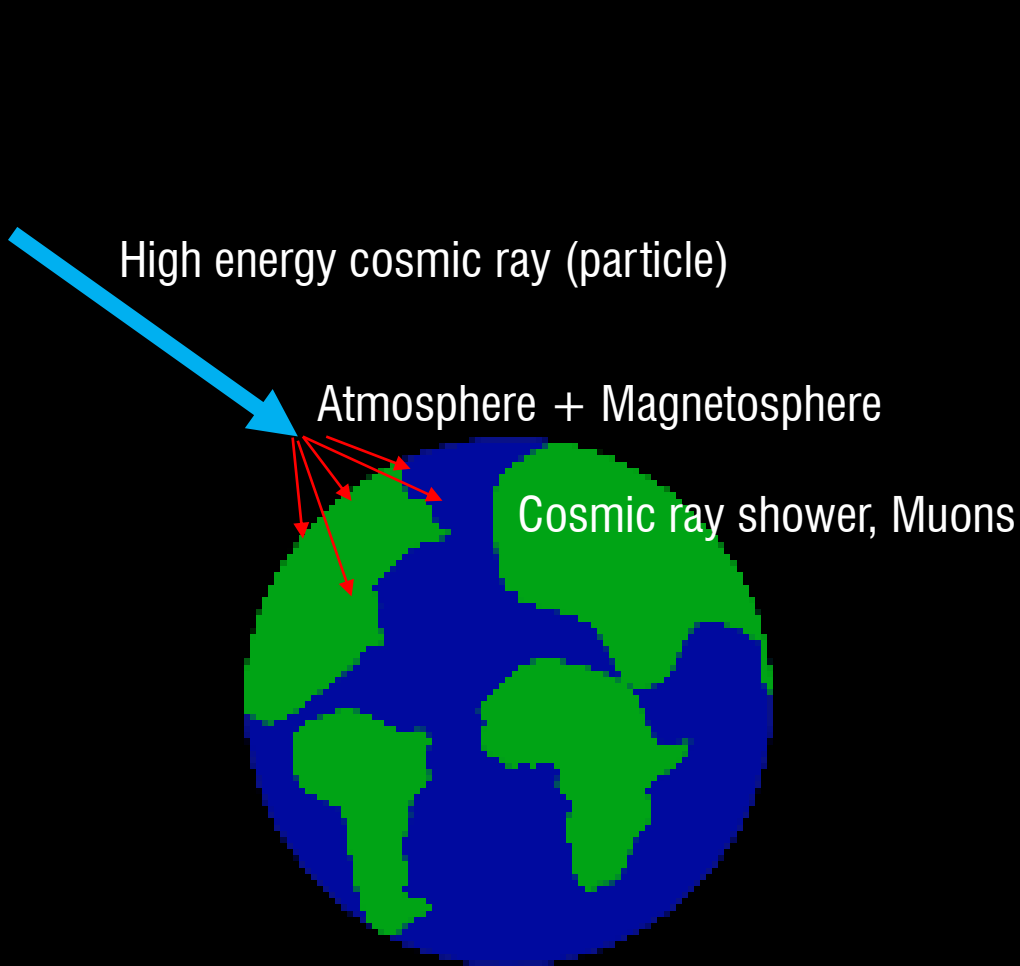# What is important for distributed detection?

- what is happening
- where is it happening
- when did it happen
- what is the detector status

If we know all these things, we can collect useful data.

How to collect this information?

- we need a cosmic ray (muon) detector
- we need to locate the detector in space (GPS)
- we need to mark events in time (GPS + high precision timer)
- we need to monitor the detector status
- additional sensors are probably a good idea:
  - temperature
  - altitude
  - humidity
  - acceleration
  - magnetic field

How do you catch a cosmic ray?

High energy cosmic ray (particle)

Atmosphere + Magnetosphere

Cosmic ray shower, Muons
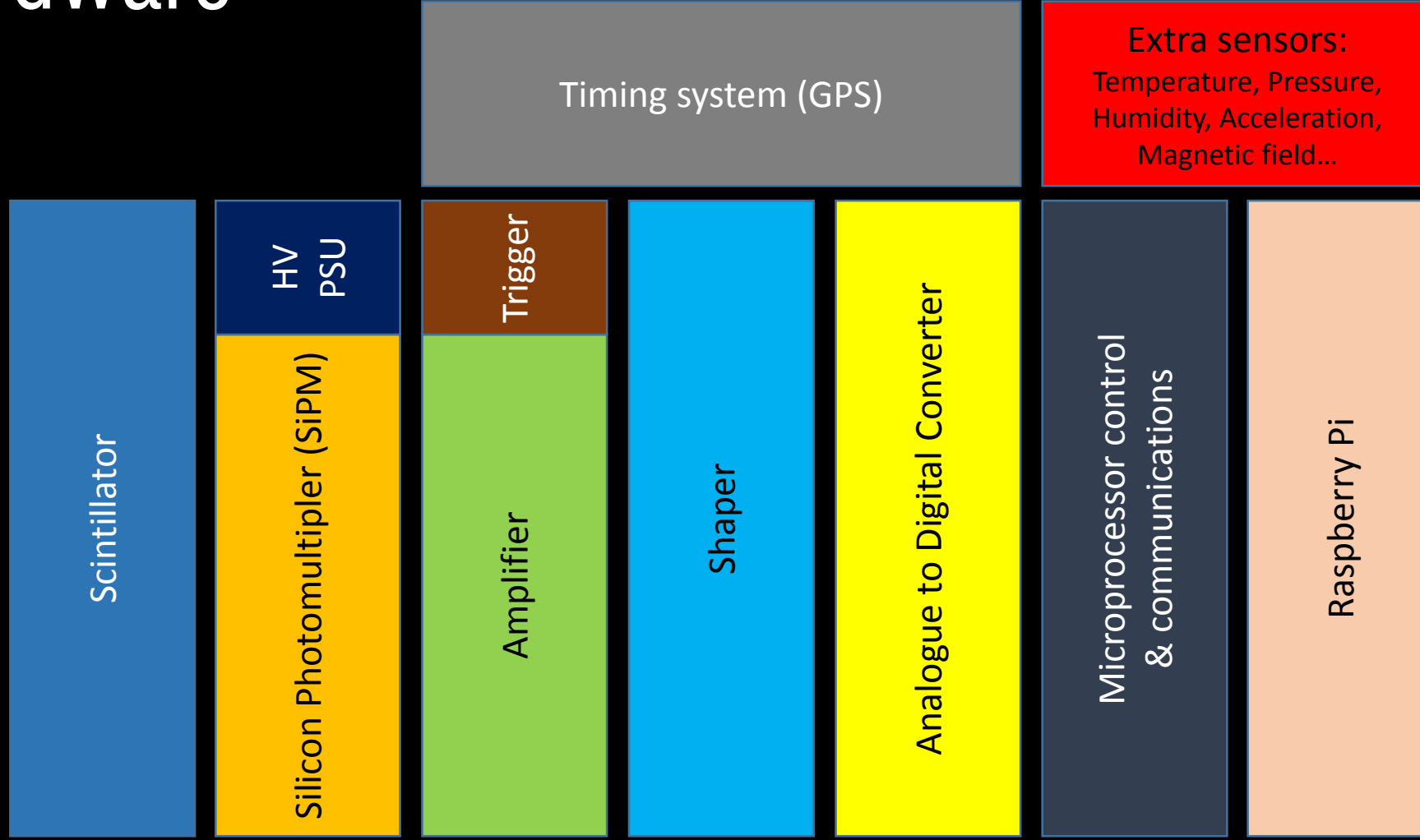
Photons

Scintillator

Photons

Photons

Muons, typically 1 event/cm2/minute at sea level

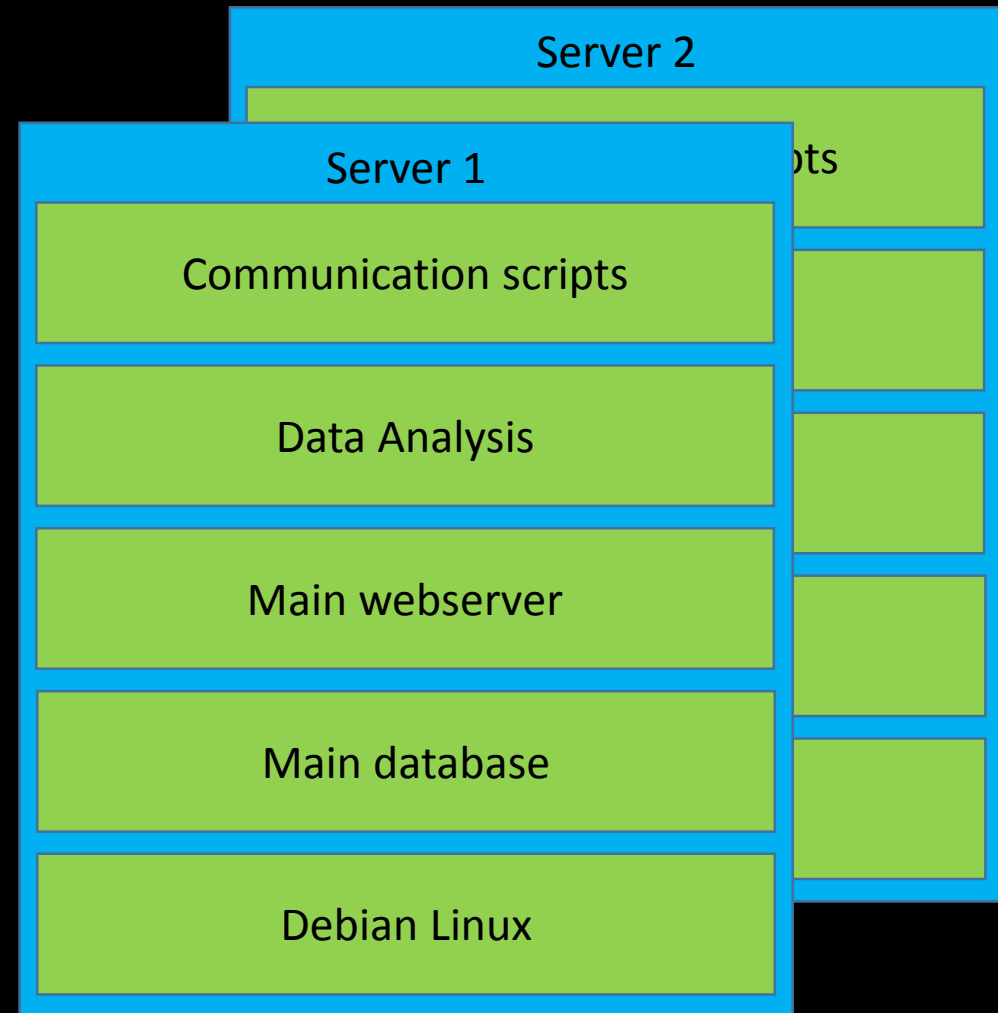We collect the photons with a photon detector, based on the photoelectric effect (A. Einstein)

Our photon detector is called a Silicon Photomultiplier, a highly complex type of diode.

Other methods are possible, this is simply the one we chose!

Hardware

Scintillator

HV PSU

Silicon Photomultipler (SiPM)

Timing system (GPS)

Trigger

Amplifier

Shaper

Analogue to Digital Converter

Extra sensors:
Temperature, Pressure, Humidity, Acceleration, Magnetic field...

Microprocessor control & communications

Raspberry Pi

Software

Client (Cosmic Pi)

Arduino Firmware

Communications scripts

Local webserver

Local database

Raspbian Linux

Server 2

pts

Server 1

Communication scripts

Data Analysis

Main webserver

Main database

Debian Linux

Firmware

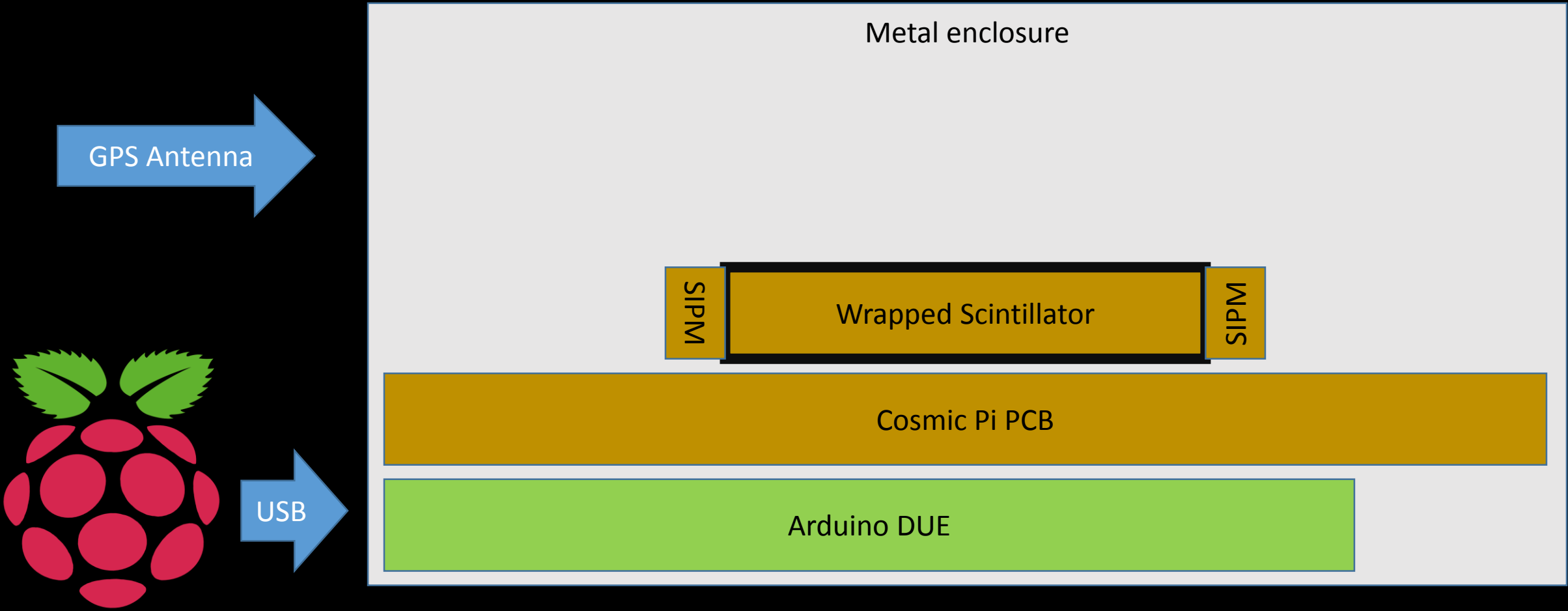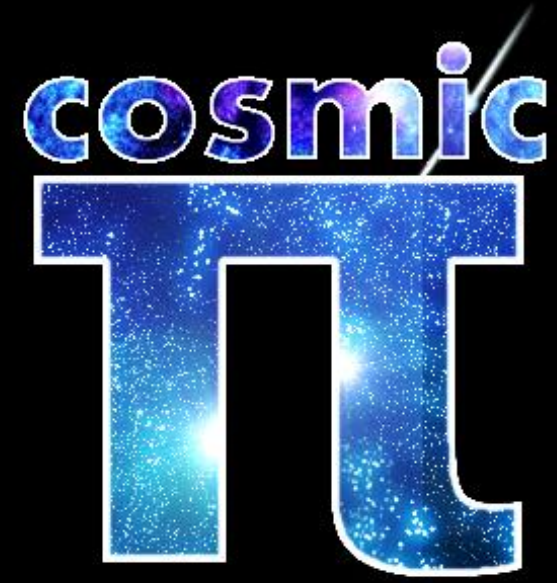|		
Arduino DUE		
Altimeter readout	Analogue to Digital Conversion	Event timing
Temperature & Humidity readout	HV Power Supply Control	GPS input (date + timestamp)
Accelerometer & Magnetometer readout	Detection Threshold Control	Serial Output Routines
Arduino Bootloader		

Assembly

Why is Cosmic Pi different?

- open source (hardware and software)
- distributed system
- scintillator detector
- Cheap (<500 EUR)
- something anyone can build

Cosmicpi.org