Raspberry Pi

Introduction & motivation

http://www.fnc.co.uk

Raspberry Pi Day
University of Strathclyde
22/04/2017

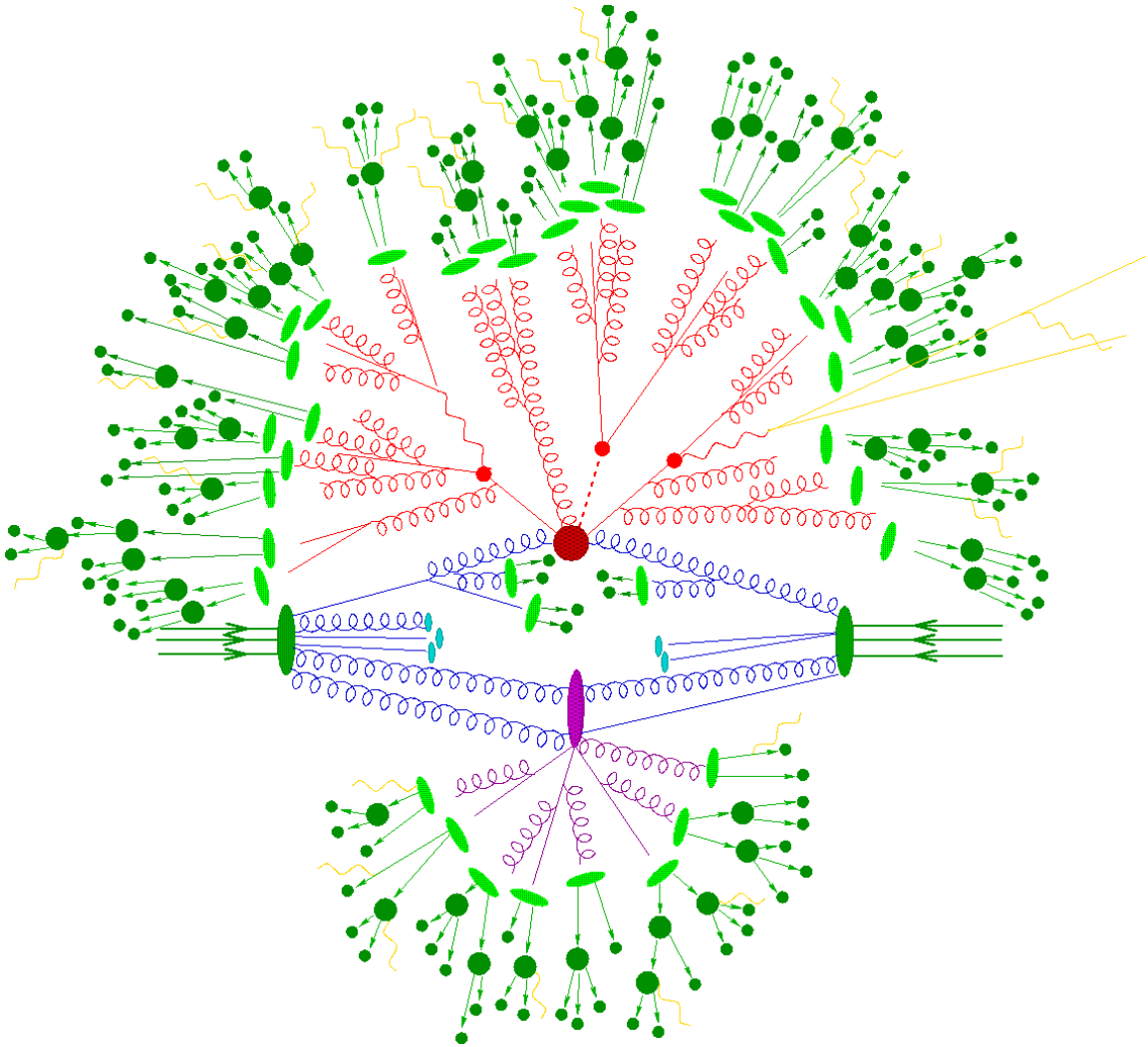
The standard model

A theory of matter and its interactions

$$
\begin{aligned}
\mathcal{L} \;=\; & -\frac{1}{4}B_{\mu\nu}B^{\mu\nu} - \frac{1}{8}tr(\mathbf{W}_{\mu\nu}\mathbf{W}^{\mu\nu}) - \frac{1}{2}tr(\mathbf{G}_{\mu\nu}\mathbf{G}^{\mu\nu}) && \text{(U(1), SU(2) and SU(3) gauge terms)} \\
& + (\bar{\nu}_L, \bar{e}_L)\,\tilde{\sigma}^{\mu} i D_{\mu} \begin{pmatrix} \nu_L \\ e_L \end{pmatrix} + \bar{e}_R \sigma^{\mu} i D_{\mu} e_R + \bar{\nu}_R \sigma^{\mu} i D_{\mu} \nu_R + (\text{h.c.}) && \text{(lepton dynamical term)} \\
& - \frac{\sqrt{2}}{v}\left[(\bar{\nu}_L, \bar{e}_L)\,\phi M^{e} e_R + \bar{e}_R \bar{M}^{e} \bar{\phi} \begin{pmatrix} \nu_L \\ e_L \end{pmatrix} \right] && \text{(electron, muon, tauon mass term)} \\
& - \frac{\sqrt{2}}{v}\left[(-\bar{e}_L, \bar{\nu}_L)\,\phi^{*} M^{\nu} \nu_R + \bar{\nu}_R \bar{M}^{\nu} \phi^{T} \begin{pmatrix} -e_L \\ \nu_L \end{pmatrix} \right] && \text{(neutrino mass term)} \\
& + (\bar{u}_L, \bar{d}_L)\,\tilde{\sigma}^{\mu} i D_{\mu} \begin{pmatrix} u_L \\ d_L \end{pmatrix} + \bar{u}_R \sigma^{\mu} i D_{\mu} u_R + \bar{d}_R \sigma^{\mu} i D_{\mu} d_R + (\text{h.c.}) && \text{(quark dynamical term)} \\
& - \frac{\sqrt{2}}{v}\left[(\bar{u}_L, \bar{d}_L)\,\phi M^{d} d_R + \bar{d}_R \bar{M}^{d} \bar{\phi} \begin{pmatrix} u_L \\ d_L \end{pmatrix} \right] && \text{(down, strange, bottom mass term)} \\
& - \frac{\sqrt{2}}{v}\left[(-\bar{d}_L, \bar{u}_L)\,\phi^{*} M^{u} u_R + \bar{u}_R \bar{M}^{u} \phi^{T} \begin{pmatrix} -d_L \\ u_L \end{pmatrix} \right] && \text{(up, charmed, top mass term)} \\
& + \overline{(D_{\mu}\phi)} D^{\mu}\phi - m_h^2[\bar{\phi}\phi - v^2/2]^2/2v^2. && \text{(Higgs dynamical and mass term)}
\end{aligned}
$$

Difficult to apply without a computer program

The standard model



Computer programming used for scientific calculations

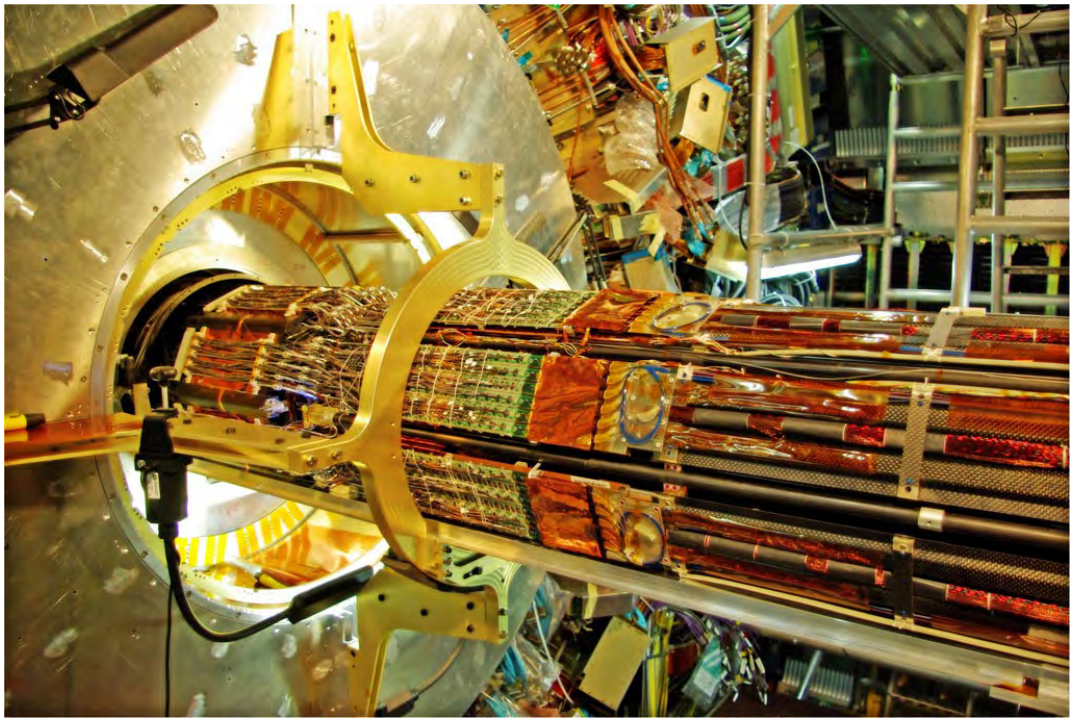
Data acquisition and ATLAS

The trigger system

Readout using bespoke hardware and software.

There are many connections and lots of data.

The ATLAS detector

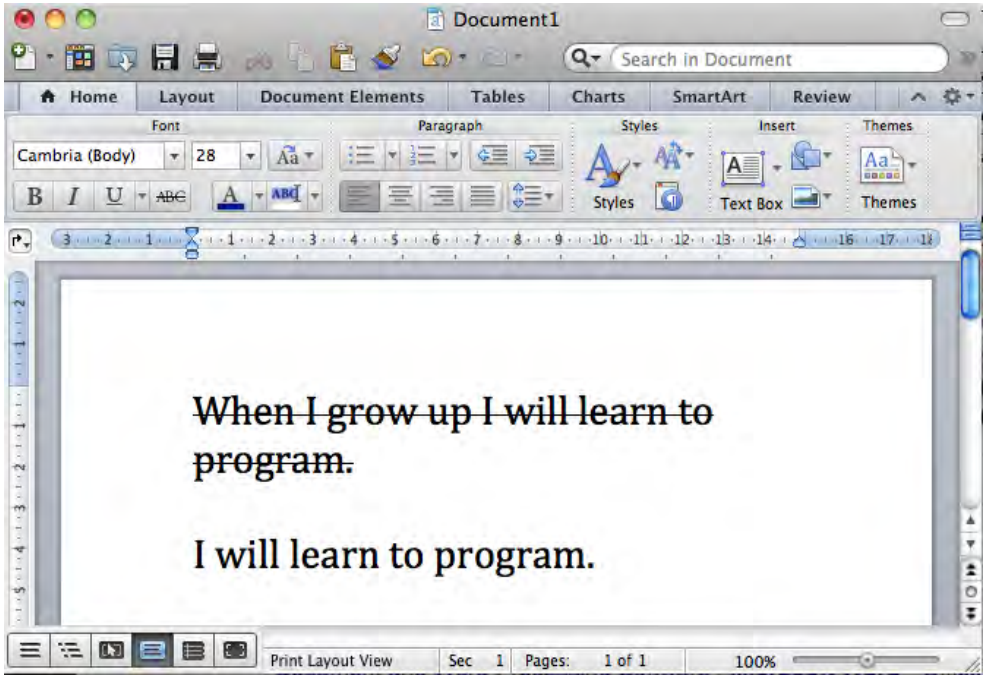


The problem

- Difficult to teach programming at University
  - Students panic, due to lack of experience
- Programming needed for general solutions
  - Stuck when one cannot buy the software needed
  - Students that cannot program miss opportunities

Education

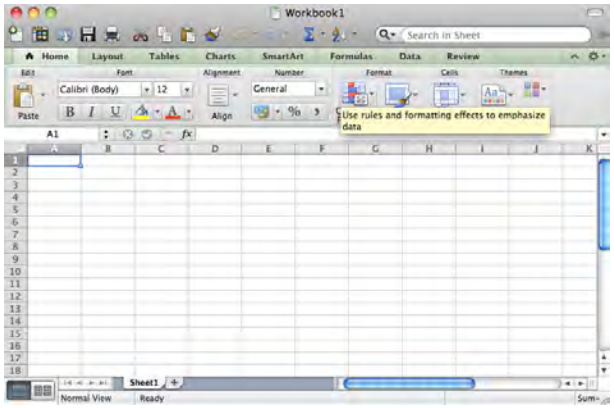
Word processing



Web surfing

Some Scratch programming

Spreadsheet? HTML?



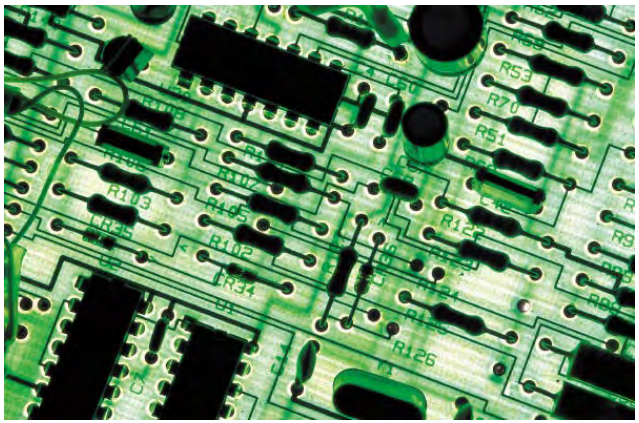
At home

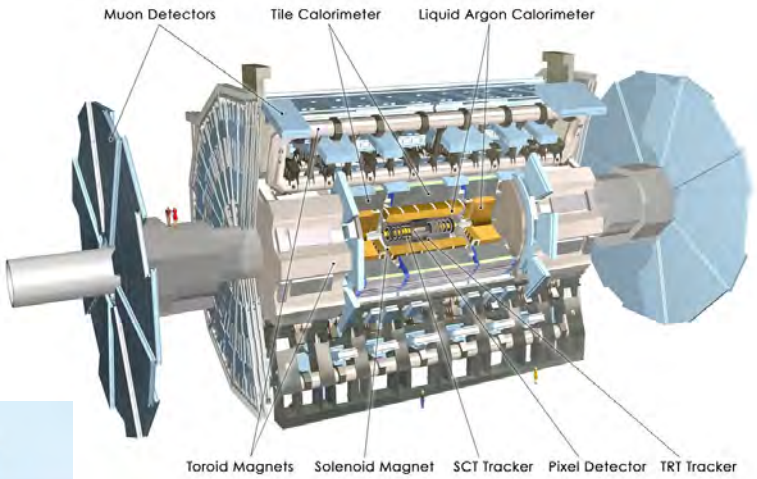
Interesting devices, but locked down.
Cannot compile source code or use for project.

Home PCs used for photo collection, not for experimentation.
Not enough money to buy many standard PCs for many projects.

Programming

Used in many applications





Gaining IT competency

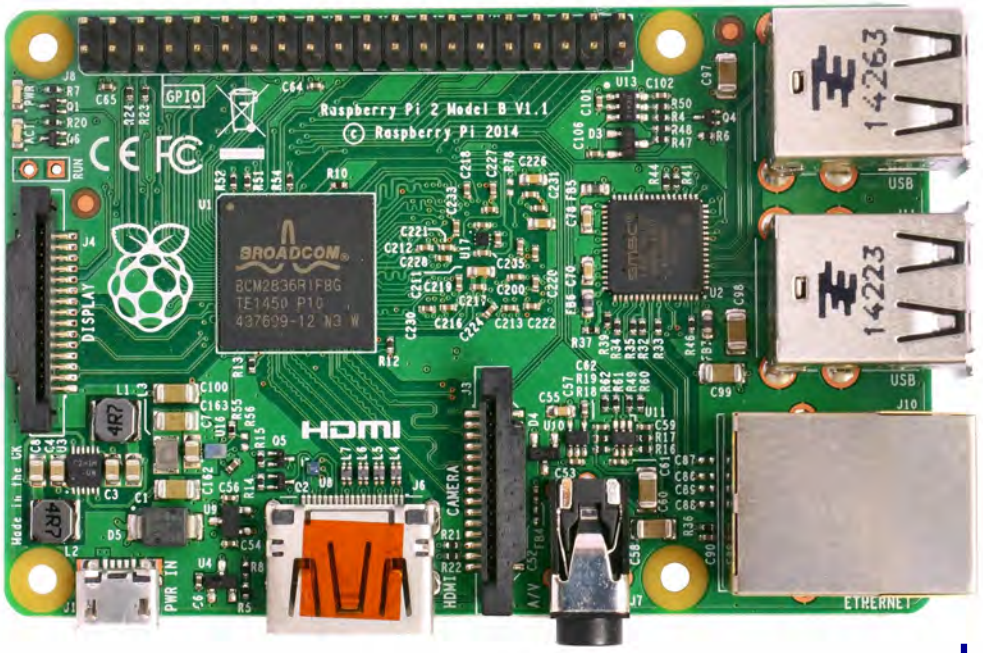
- Need to experiment in a safe environment
  - Need easy I/O connections to connect to other devices.
- Different projects on different computers
  - Deploy computers in remote locations, with battery power or solar cells.
- Experiment with technologies
  - Web servers, file servers, parallel computing, networking, cryptography

Project ideas

Submarine

Oscilloscope

Robotics



Web server

Weather station

WiFi access point

Spacecraft

File server

Home automation

GPIO Header & OS

Raspbian

OSMC

Ubuntu Snappy

Ubuntu Mate

OpenELEC

RiscOS

Windows 10 IoT

Summary

- Need to improve IT competency
  - Programming, interfacing, other skill sets
- Often difficult to experiment with computers at school or at home
  - Can improve at school and at home
- The Raspberry Pi provides a flexible solution
  - Allowing experimentation
  - Open OS & standard programming tools