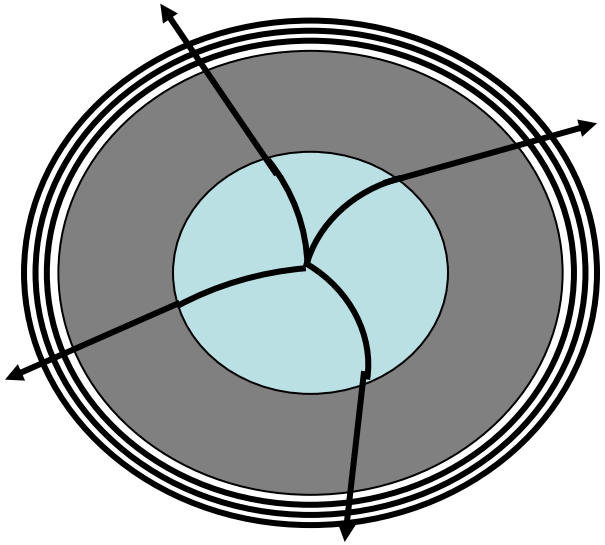
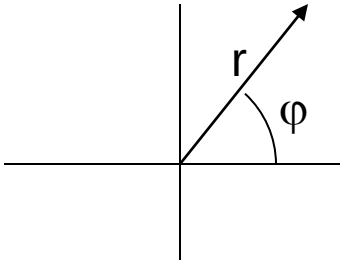
A simple model of an LHC detector

- **The muons all originate from the origin (x,y,z)=(0,0,0).**
- **Assume particles first travel through a a cylindrical volume (R = 1.2m) with a B-field of 4 T pointing along the z-direction.**
- **Outside this volume assume there is no B-field.**
- **Outside the B-field area is a 1m thick layer of iron. (1.2m < R < 2.2m)**
- **At higher radii are 3 detection layers with a resolution in the rφ direction of 250 um (or about 0.1mrad in phi) (R=2.3m, 2.4m,2.5m)**





The sample file

The sample file provided for this project contains several sets of 4 muons produced in (simulated) proton-proton collisions at $E_{c.m.}$= 14 TeV.

Two processes were included in the simulation:

***$H \Rightarrow ZZ \Rightarrow 4$ muons*: one of the decay channels of a Higgs boson that is used to search for (additional) heavy Higgs bosons at the LHC. The hypothetical mass of the Higgs boson candidate, set in the simulation is unknown to you.**

***$ZZ \Rightarrow 4$ muons*: the most important background process in the search for the Higgs having a similar final state with 4 muons.**

Each line in the file correspond to one collisions and has the energy, momentum and charge of 4 muons in the following order:

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E1,Px1,Py1,Pz1,Q1,E2,Px2,Py2,Pz2,Q2,E3,Px3,Py3,Pz3,Q3,E4,Px4,Py4,Pz4,Q4
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The muons are not listed given in any particular order.

The value for the mass of the Z boson used in the simulation was:

m_Z = 91.2 GeV/c^2)

At the origin the muon can be defined in terms of P_X, P_y, P_z and Q or more conveniently in term of φ, $P_\perp$, P_z and Q

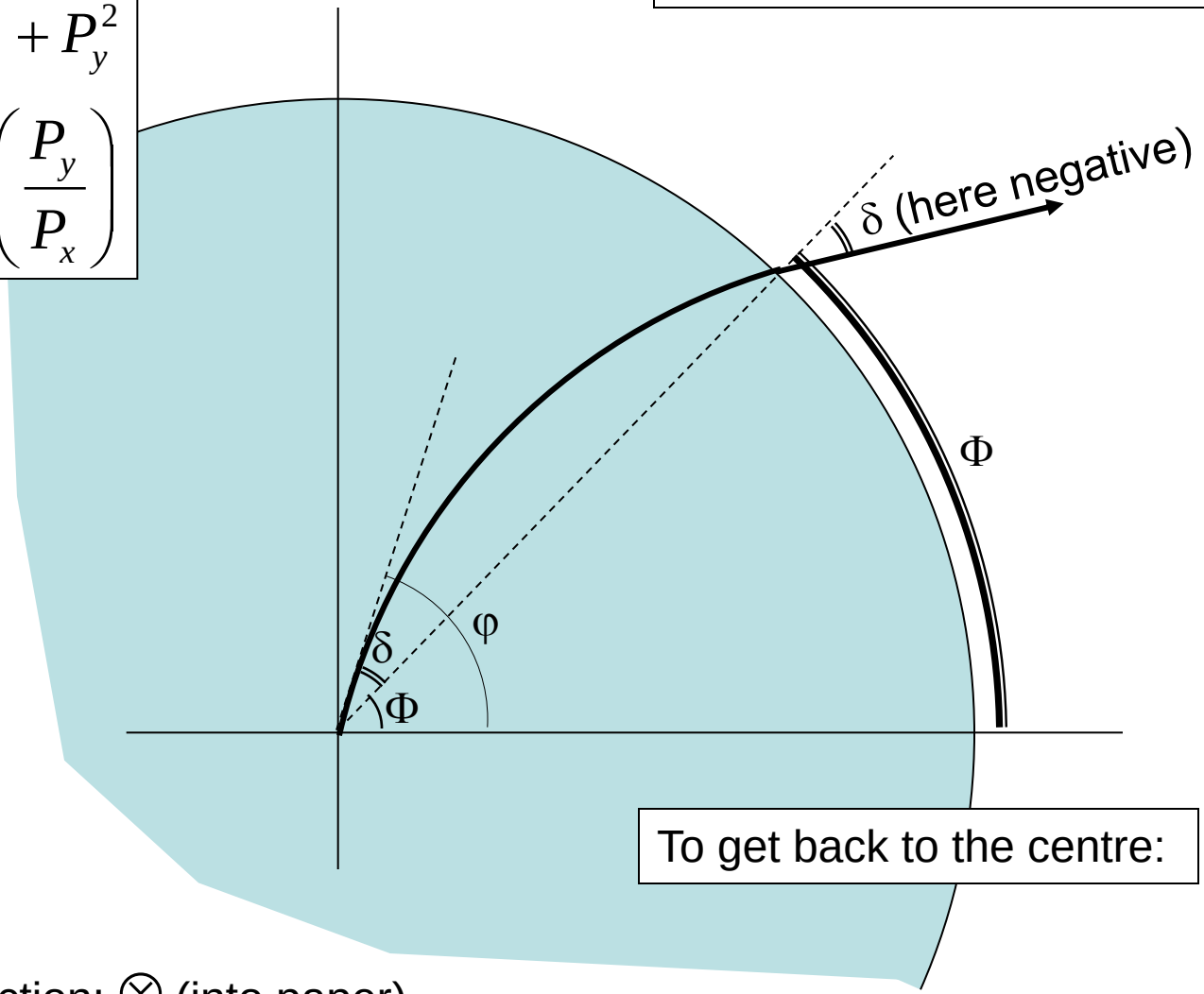
$$P_\perp = \sqrt{P_x^2 + P_y^2}$$

$$\varphi = \tan^{-1}\left(\frac{P_y}{P_x}\right)$$

At the edge of the B-field the muon can be defined in terms of Φ, δ, $P_\perp$ and P_z ($P_\perp$, P_z are unaffected by the B-field)
To get δ and ϕ:

$$\delta \approx \frac{0.3BRQ}{2P_\perp}$$

$$\Phi = \varphi + \delta$$



To get back to the centre:

$$Q = \frac{\delta}{|\delta|}$$

$$\varphi = \Phi - \delta$$

$$P_\perp \approx \frac{0.3BRQ}{2\delta}$$

B-field direction: ⊗ (into paper)