Detecting Neutrinos from Nuclear Reactors Using the New LiquidO Technology

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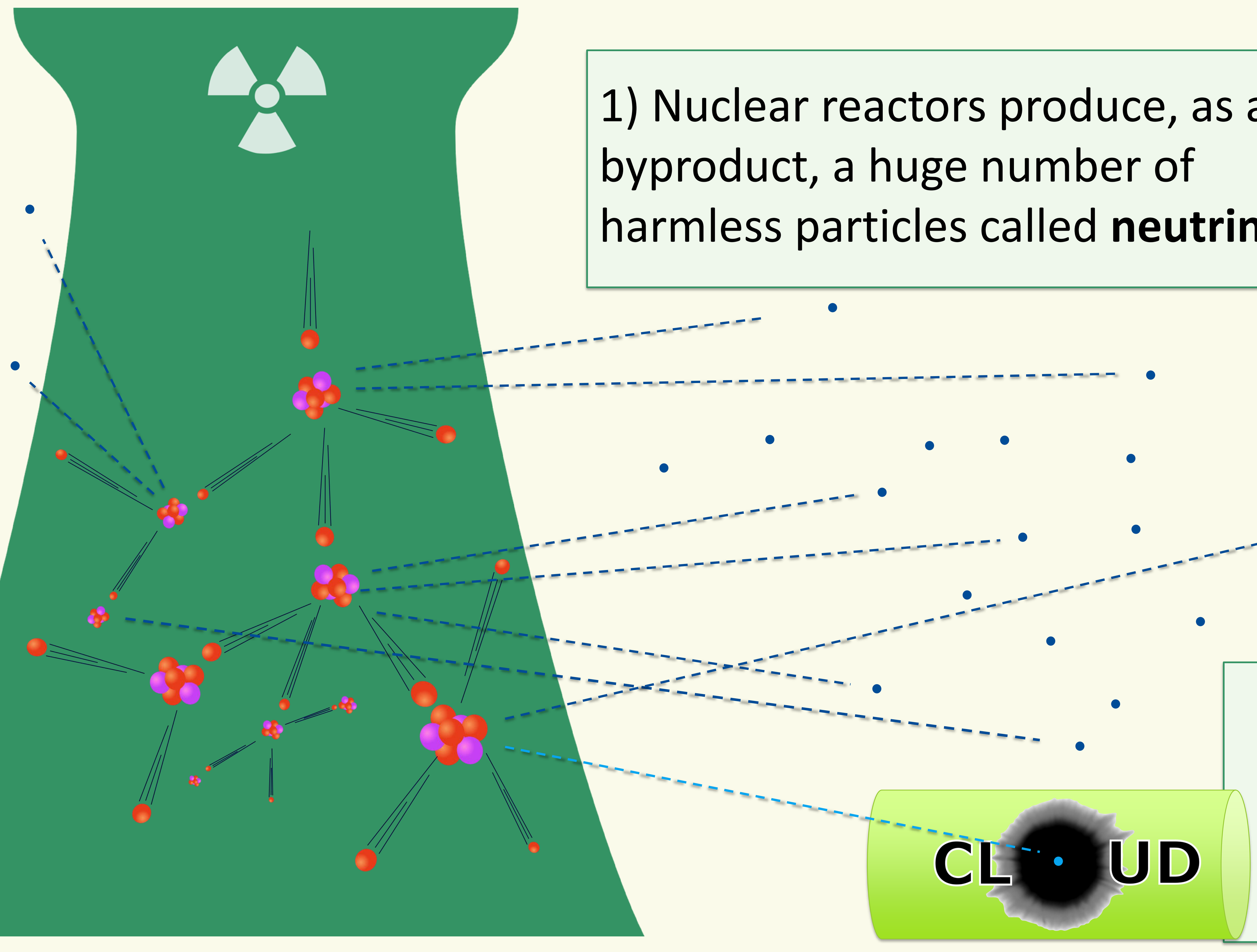


1) Nuclear reactors produce, as a byproduct, a huge number of harmless particles called **neutrinos**.

2) Neutrinos **interact very rarely**. This means, they can easily escape the reactor building.

3) Detecting reactor neutrinos allows us to study both the **nuclear processes** in the reactor and the **nature of neutrinos**.

4) Because neutrinos interact so rarely, their **signal is very small relative to background**.

5) A new technology called **LiquidO** uses **particle identification** to separate signal from background.

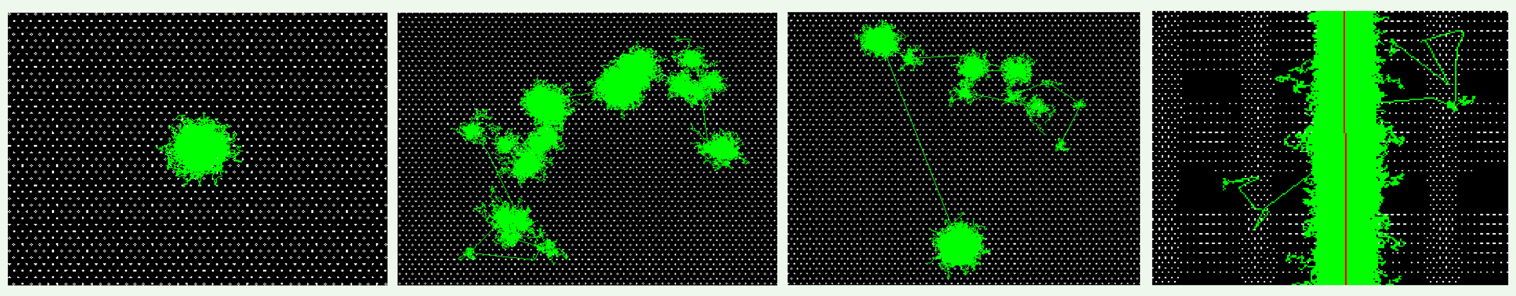
6) The **CLOUD experiment** will be a neutrino detector that uses the LiquidO technology to monitor reactor neutrinos.

LiquidO Scintillator Technology

Scintillator: A material that **produces light** when a charged particle travels through it.

LiquidO: Opaque liquid scintillator; the **light is confined** close to its creation point. This is a **new technology**.

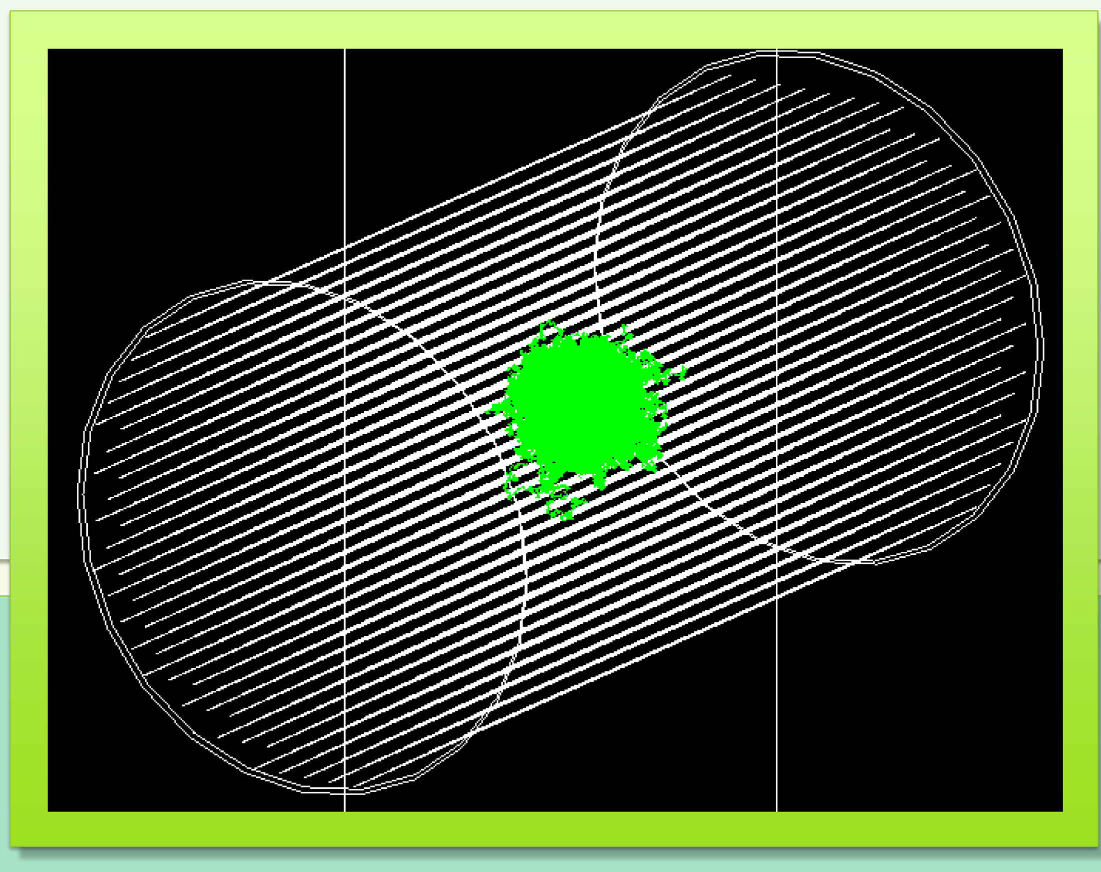
Different particles produce different patterns of light deposits. Therefore, particles can be identified by analysing the signal.



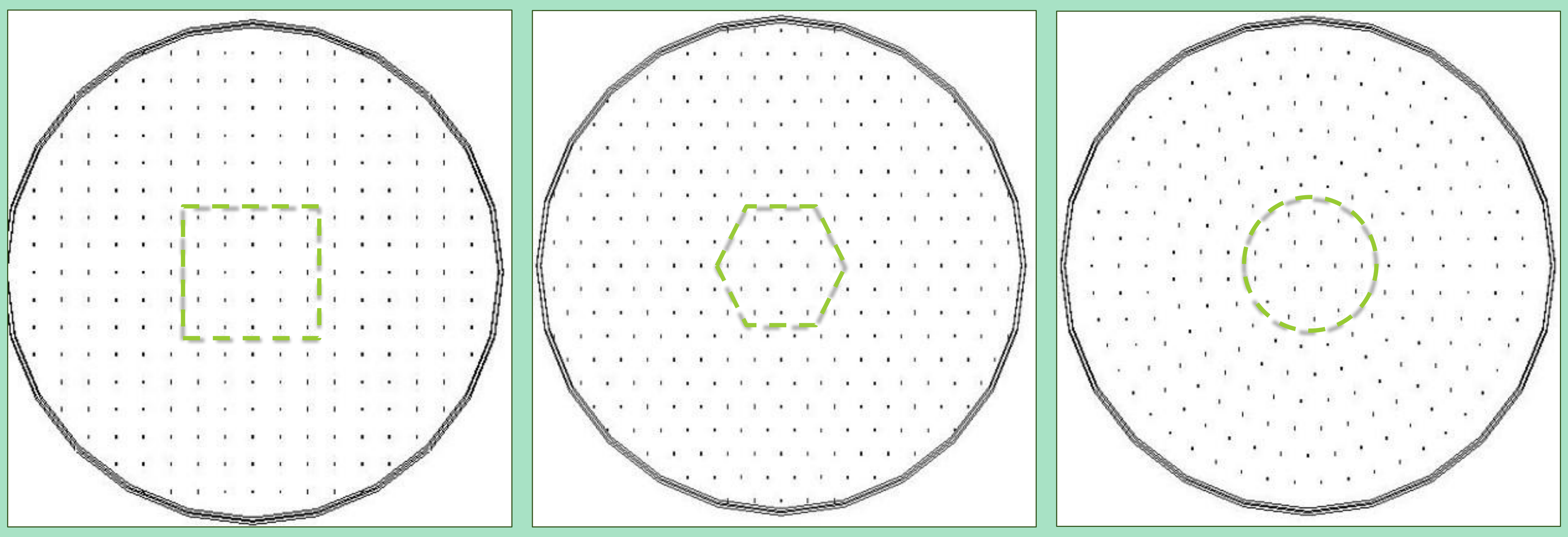
Electron Positron Gamma Muon

Basic Detector Design

- Big tank of LiquidO scintillator (produces light)
- **Array of optical fibres** (collects and transports light)
- SiPMs at ends of fibres (light detection)



How to arrange the fibres – z-parallel options



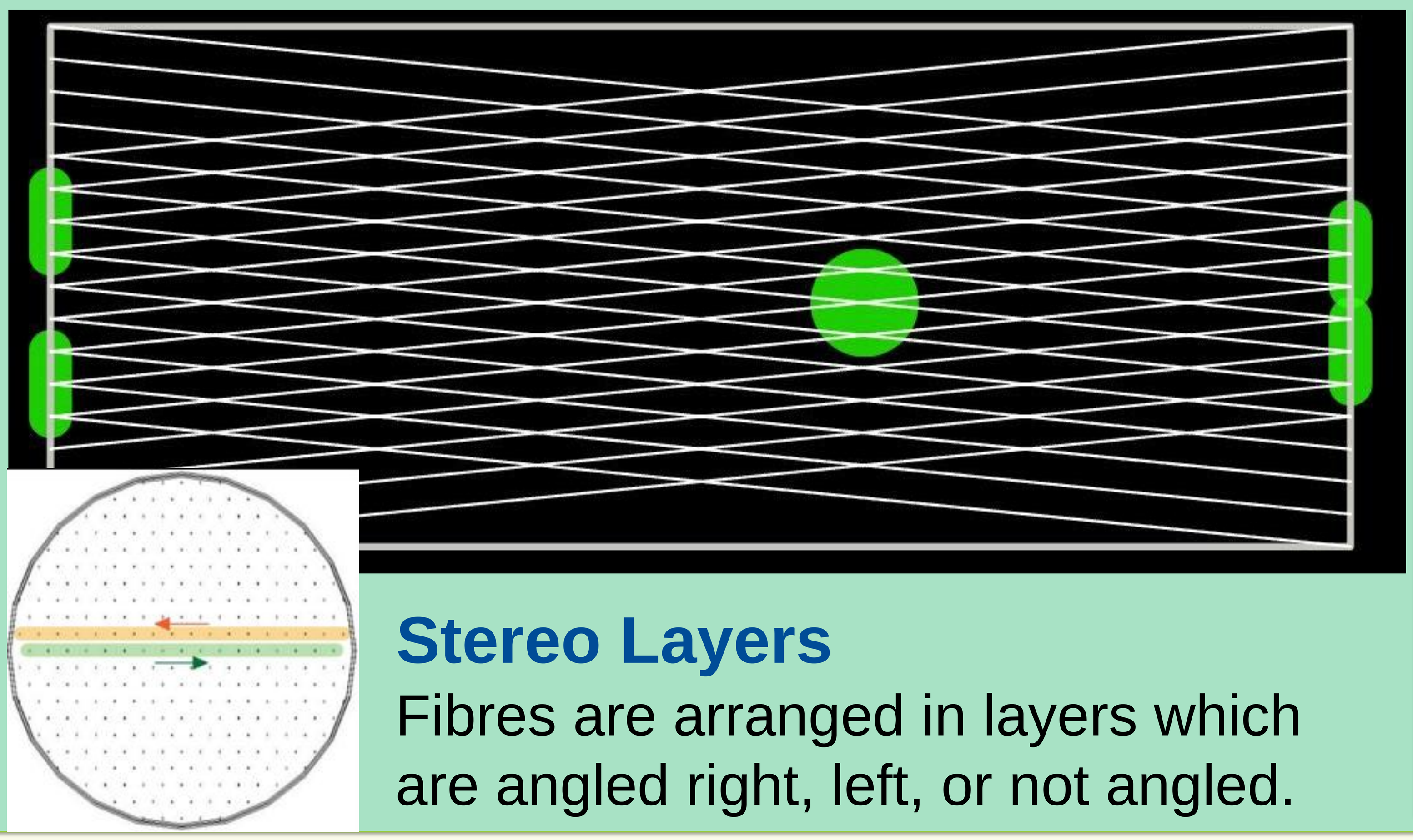
Square Array Shape Hexagon Array Shape Circle Array Shape

Simplest case - parallel fibres are arranged in a 2D array shape.

Position reconstruction:

- **x & y resolution ~ few mm (very good),** determined from the fibre hit pattern (ie. which fibres see signal);
- **z resolution ~ few cm (worse)** determined from the time difference in readout at the two ends of the fibre.

How to arrange the fibres – stereo options

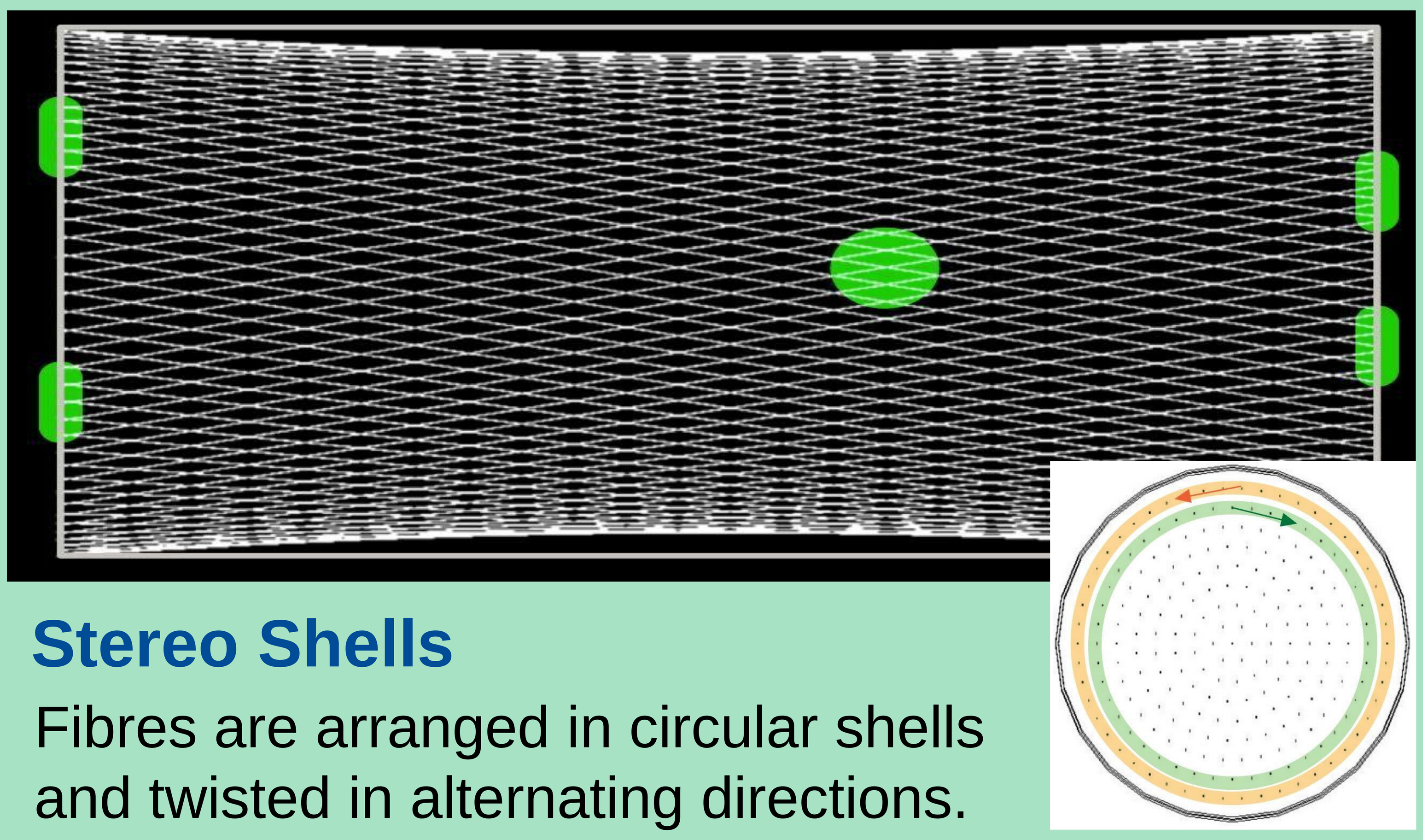


Stereo Layers

Fibres are arranged in layers which are angled right, left, or not angled.

Z-resolution can be improved if the **fibres are angled** relative to each other.

Stereo arrays are **more difficult**, so simulations are being used to study their effect. **Are they worth it?**



Stereo Shells

Fibres are arranged in circular shells and twisted in alternating directions.

CLOUD Collaboration

A fundamental physics extension of the AntiMatter-OTech innovation project detector

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