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MUonE experiment - investigation of the fake signal background events

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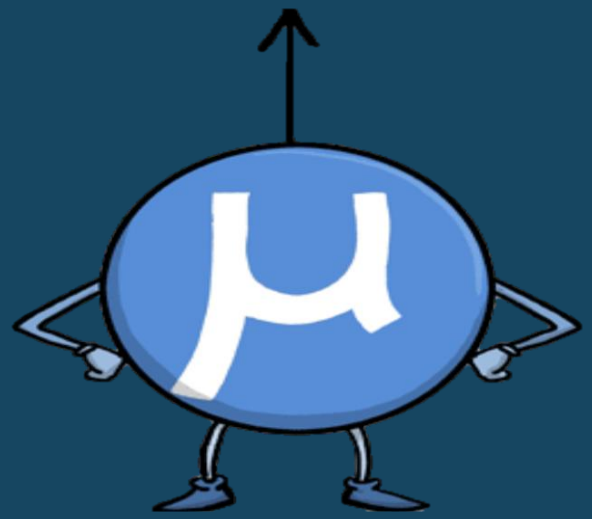
What are we investigating?

The g-factor quantifies the intrinsic magnetism of a muon.

It relates the magnetic dipole moment (MDM) of a particle to its spin.

$$\mathrm{MDM} = g\frac{\mathrm{e}}{2m}\vec{S}$$



Muon anomaly, $a_\mu = \frac{\mathrm{g}-2}{2}$

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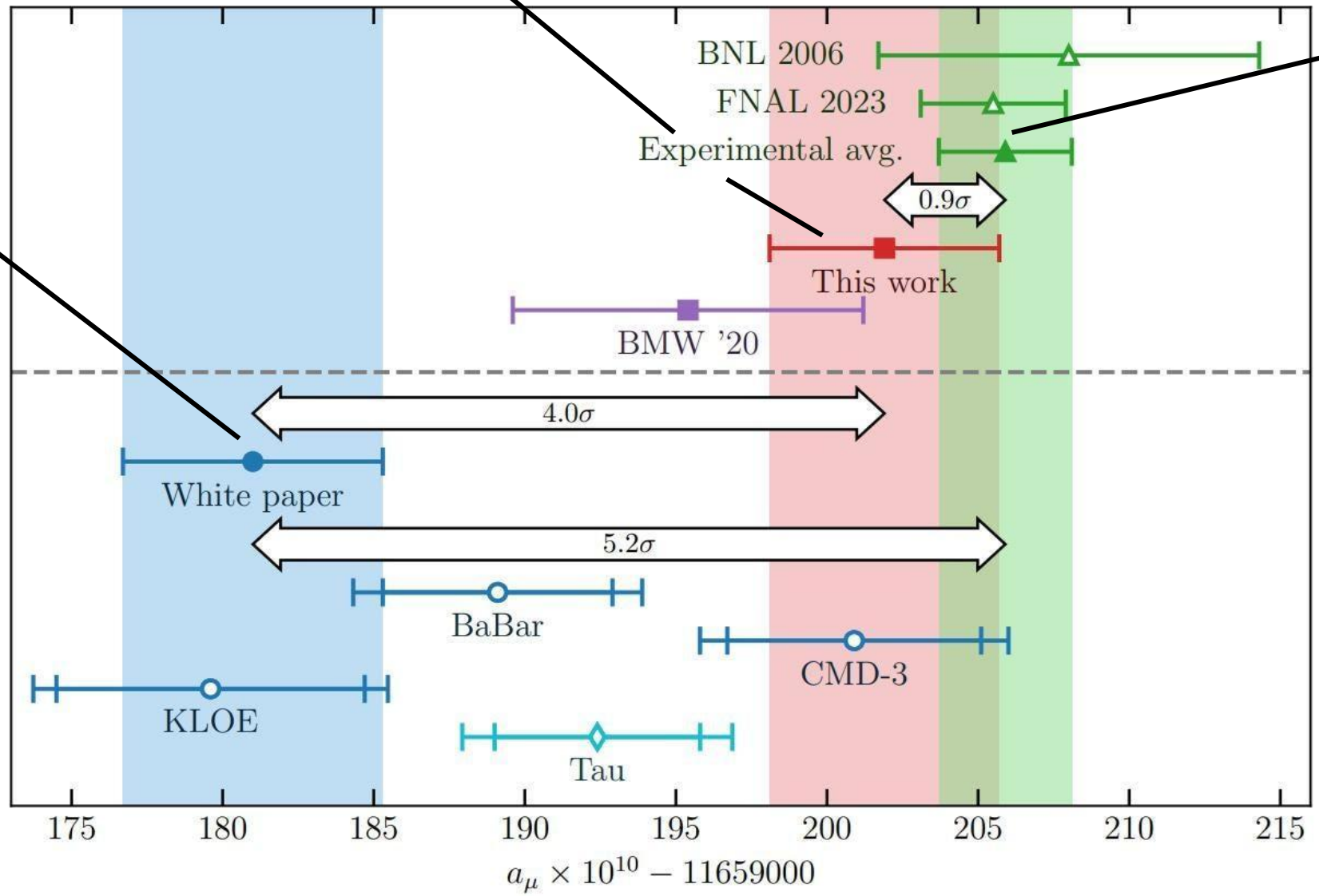
The problem

Lattice QCD theory

Experimental data

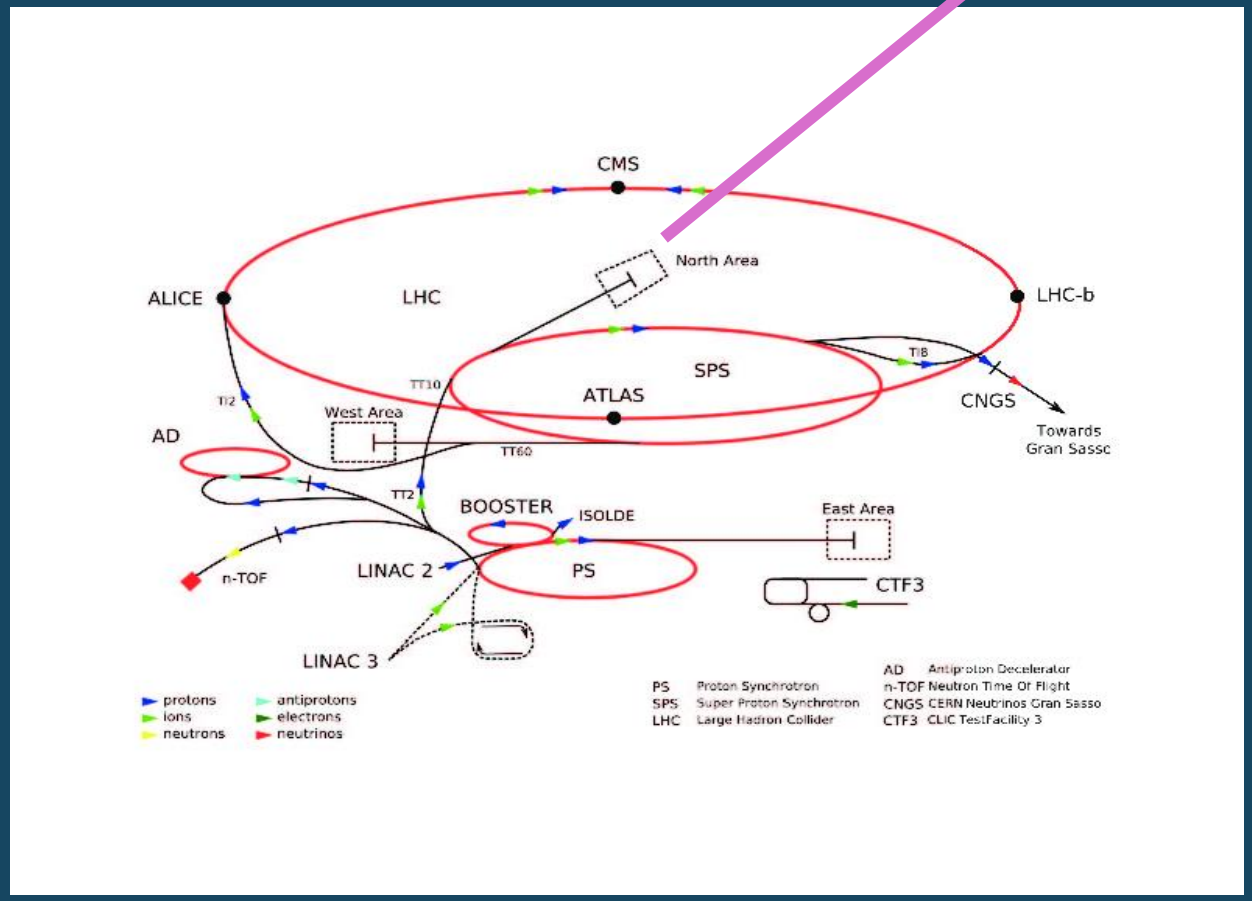
Theory calculated using experimental data



0.9σ?
4.0σ?
5.2σ?

MUonE

MUonE is here!



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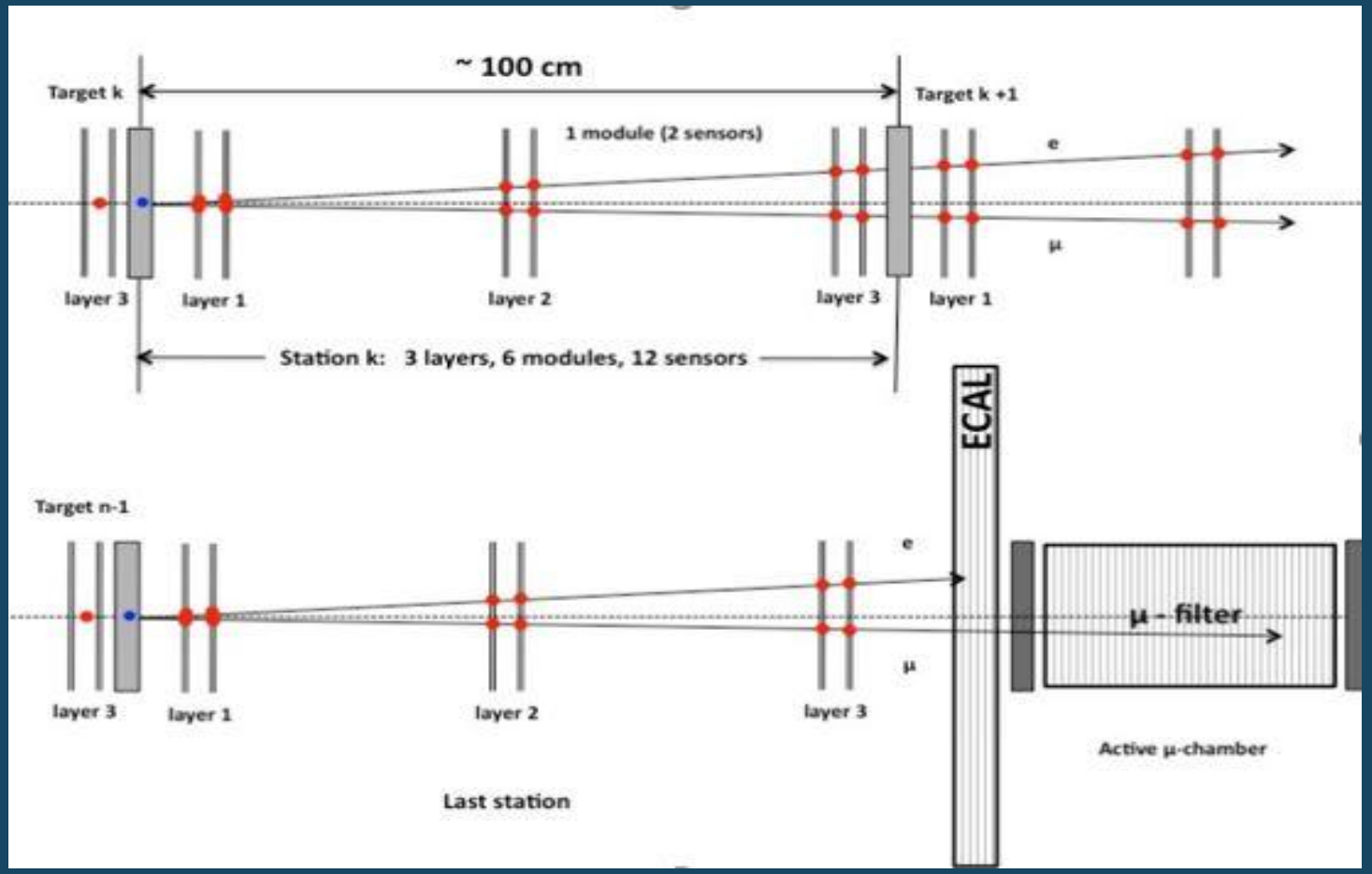
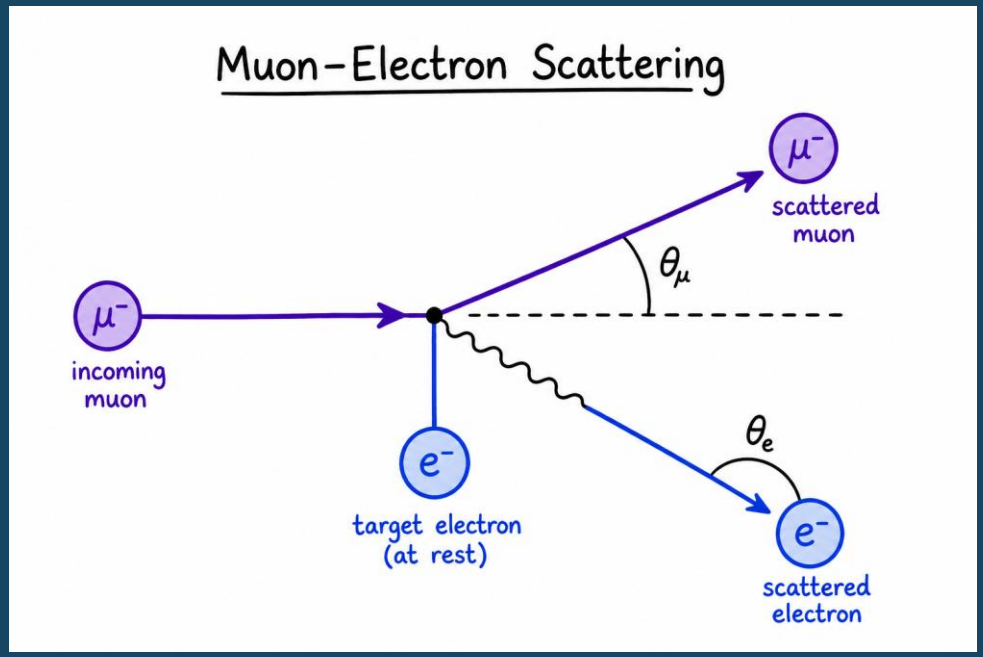
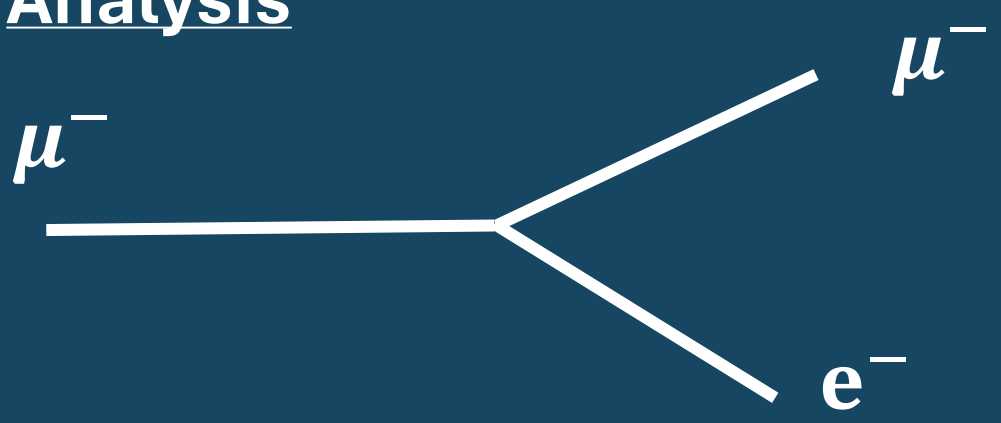
MUonE detector set-up



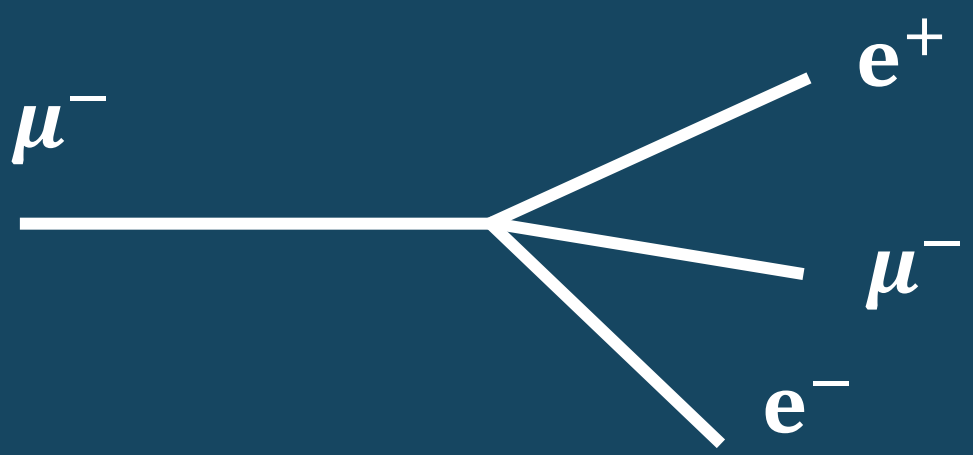


x 40 detector stations

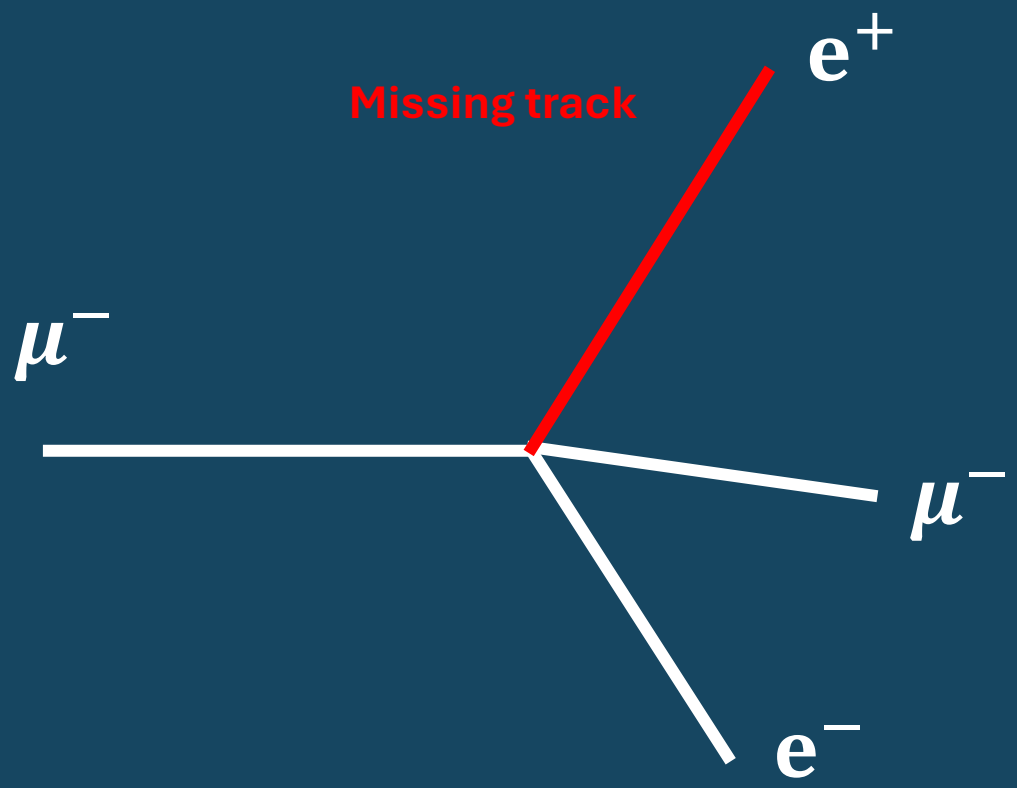
Analysis



Electron-muon scattering - 2 outgoing tracks (**signal**)



Pair production - 3 outgoing tracks (**background**)

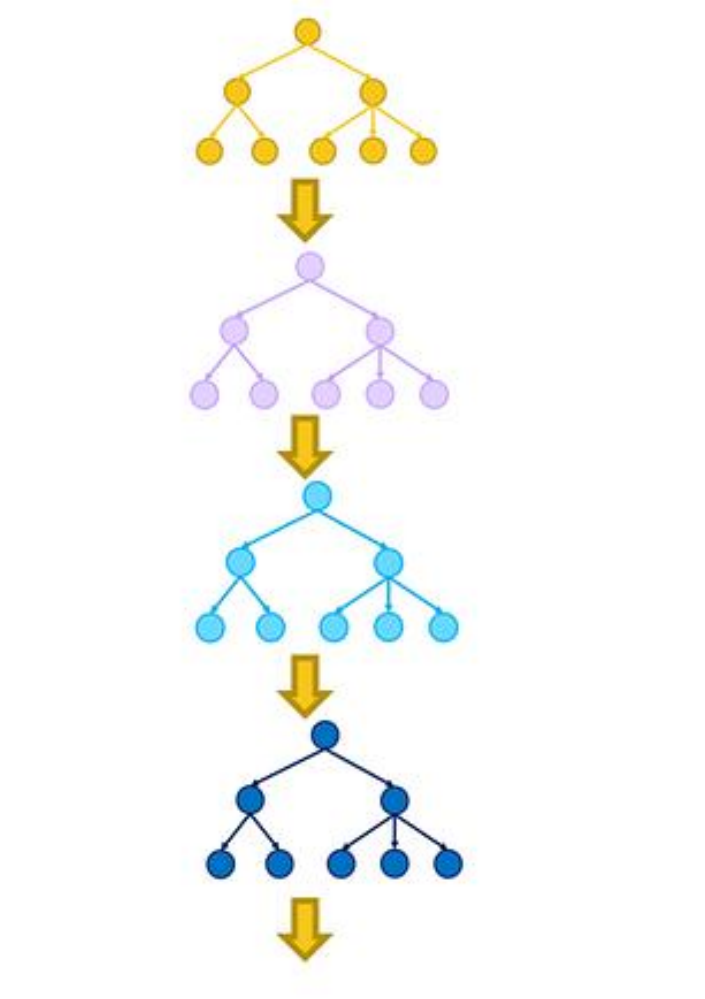


Fake signal background event

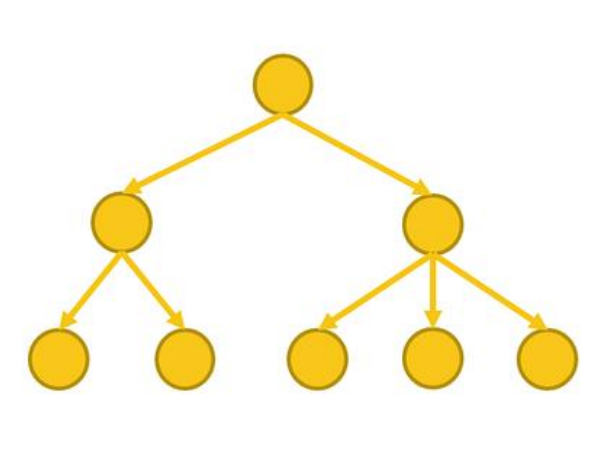
- 1 outgoing track is missing
- Looks like a signal event
- Misidentified

Analysis

Boosted Decision Tree (BDT)



Decision Tree (DT)



8 different BDTs are trialled for this analysis.

Input dataset

Trial 1

No additional conditions

Try 1

9 typical variables related to the reconstructed vertices

Trial 2

Split into vertices made with an outgoing muon and electron and vertices made with an outgoing muon and positron

Try 2

13 other, less typical variables related to the reconstructed vertices

Trial 3

Apply a set of elastic cuts

Try 3

12 calculated variables related to the reconstructed variables and the number of unused hits an event

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Results

3 trys x 3 trials x 8 BDTs = 72 analyses

$$Background - signal\ ratio, R = \frac{background \rightarrow Integral()}{signal \rightarrow Integral()}$$

Current background-signal ratio: $R = (13.1 \pm 2.4)10^{-5}$

Best BDT (with elasticity cut) ratio: $R = (67.0 \pm 6.4)10^{-5}$

Making particle physics more sustainable

- The electrical supply for the LHC at CERN comes from France where only 10% of electricity is produced by fossil fuels
- Waste heat from LHC cooling is ready to heat 8000 homes in France and plans are being made to heat more homes in Switzerland
- SESAME light source facility have pioneered using renewable energy to power accelerators
- Funding for European labs now include criteria involving the energy efficiency and carbon footprint of project proposals – energy consumption must be shown to be estimated and minimised
- European labs should also limit frequent travel and move many of their activities online

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Thank you!

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References:

[1] DOI:10.48550/arXiv.2503.03364

[2] DOI: https://doi.org/10.7494/csci.2019.20.4.3376

[3] DOI:10.47679/ijasca.v2i2.30