# Current Group

- Simone

- Nigel (also small % ILC)

- Cristina (also NA62)

- Sasha (also ATLAS)

- Tonino (also NA62)

- Mark S. (also everything)

- Students
    - Jimmy McCarthy – started teaching job 1-Sep-2015
    - Luca Pescatore, Pete Griffith
    - Nathanael Farley
    - Tim Williams
    - Kristian Zarebski, Georgios Chatzikonstantinidis

Wide interest in LHCb - rare decays

- Using heavy flavour measurements, two routes to finding physics beyond the SM

- CP violation
  - Clearly must exist
- Rare decays
  - FCNC
  - Only via loop, box diagrams as forbidden at tree level
  - Br typically ~10^{-6} or less

- New physics participant may enter in loops as virtual particles

- Indirect probe accesses higher energy scale than direct searches
  - Convenient detection mechanism
  - Not so straightforward to identify the origin - modelling

SM

>SM
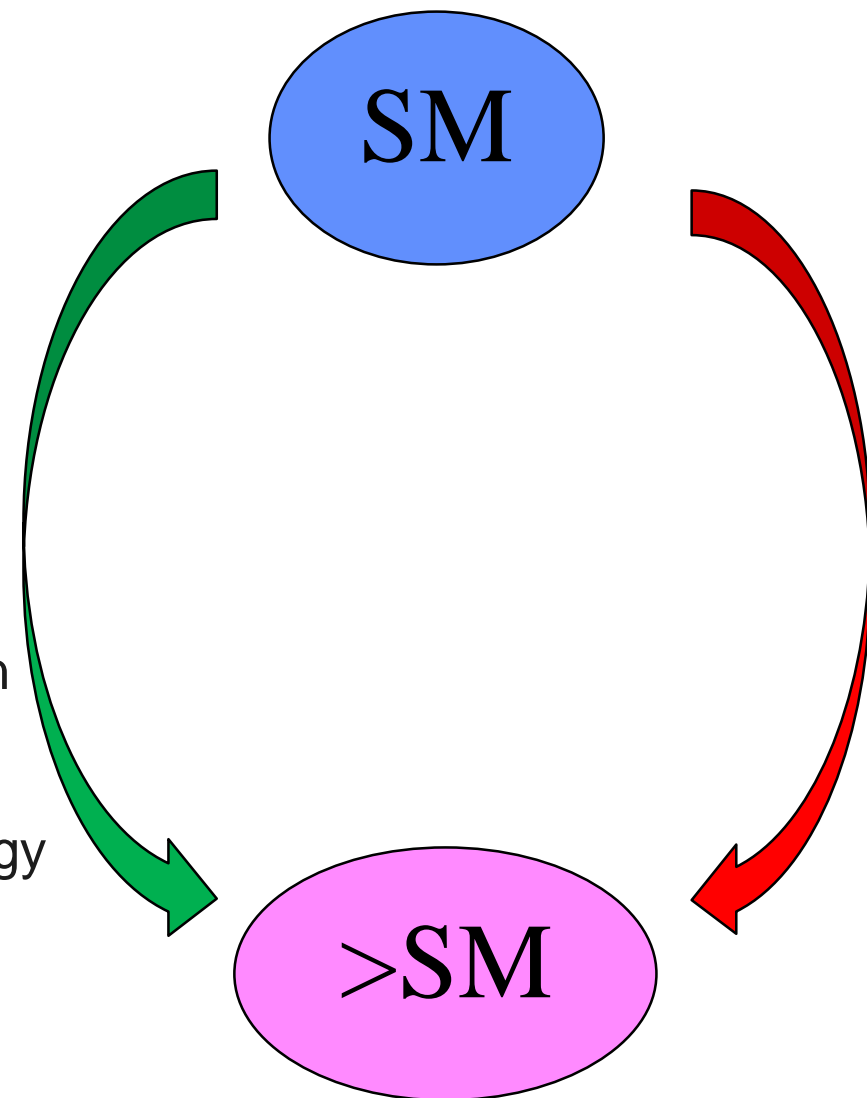
# $b \to s\ell^+\ell^-$ processes

- FCNC themselves are highly attractive for experiments
    - Wide variety of angular observables accessible in 4 particle final states
    - Experimental signatures
        - Clean
        - Low backgrounds
- New physics may be apparent via
    - Rate
    - Angular distributions
    - Asymmetries
    - Often as f(dilepton invariant mass), q^2
- Predictions well-established
    - Varying degrees of theoretical uncertainty
   - Hadronic form factors
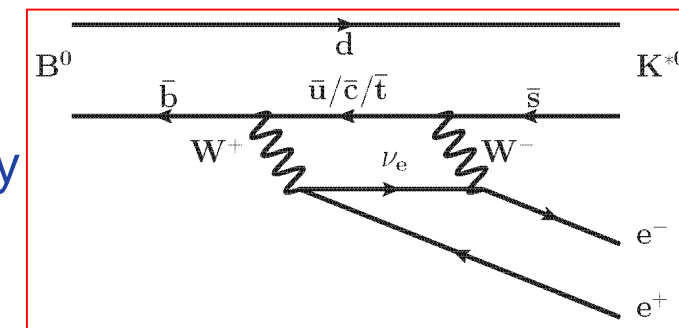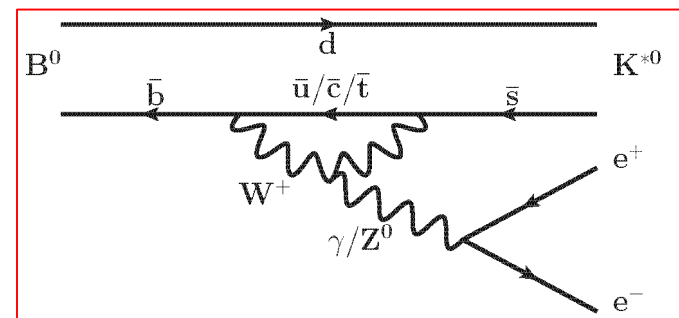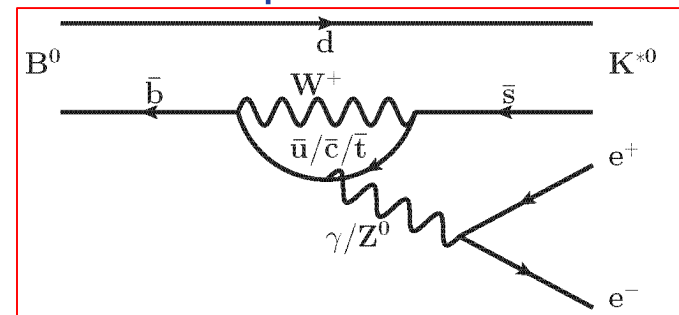
Recent Physics Analyses

- Electroweak, rare decays, charmless B decays
  - Measurement of the forward W boson cross-section in pp collisions at $\sqrt{s}=7$ TeV
    - JHEP12(2014)079 Simone Bifani et al.

  - Search for the $\Lambda_b^0 \rightarrow \Lambda\eta'$ and $\Lambda_b^0 \rightarrow \Lambda\eta$ decays with the LHCb detector
    - JHEP09(2015)006 (Jimmy McCarthy et al. – PhD approved 25/9/2015)

  - Differential branching fraction and angular analysis of $\Lambda_b^0 \rightarrow \Lambda\mu^+\mu^-$ decays
    - JHEP06(2015)115 (Luca Pescatore et al. – writing up), *see e.g. following slides*

  - In review…
    - Measurement of W and Z production cross sections at 8 TeV – Simone et al.
    - W and Z boson cross-section at 13 TeV using muon final states – Simone et al.

  - To enter review…
    - Search for $\Lambda_b^0 \rightarrow pK\mu^+\mu^-$ (Pete Griffith, to enter review ~1 month)
    - R_{K^*} ($B^0 \rightarrow K^{*0} \mu\mu / B^0 \rightarrow K^{*0}$ ee) (Luca, Simone, …)
  - In progress
  - B^+_c decays (Nathanael Farley)
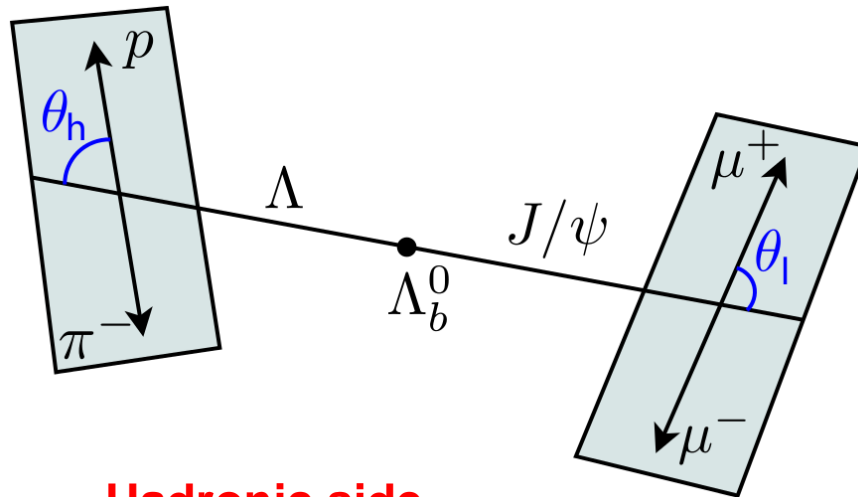 - Search for $\Lambda_b^0 \rightarrow pK\eta'$ (Tim Williams)

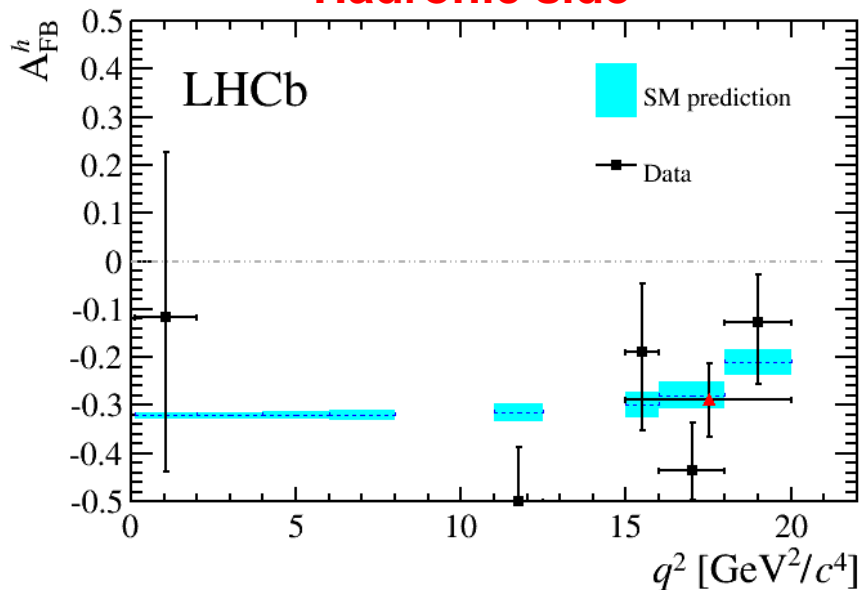# $\Lambda_b^0 \to \Lambda\mu^+\mu^-$ differential branching fraction
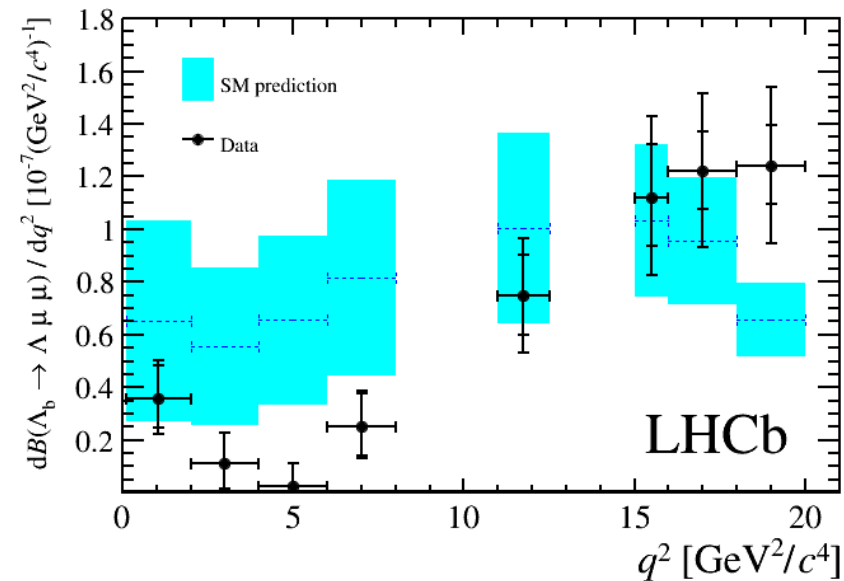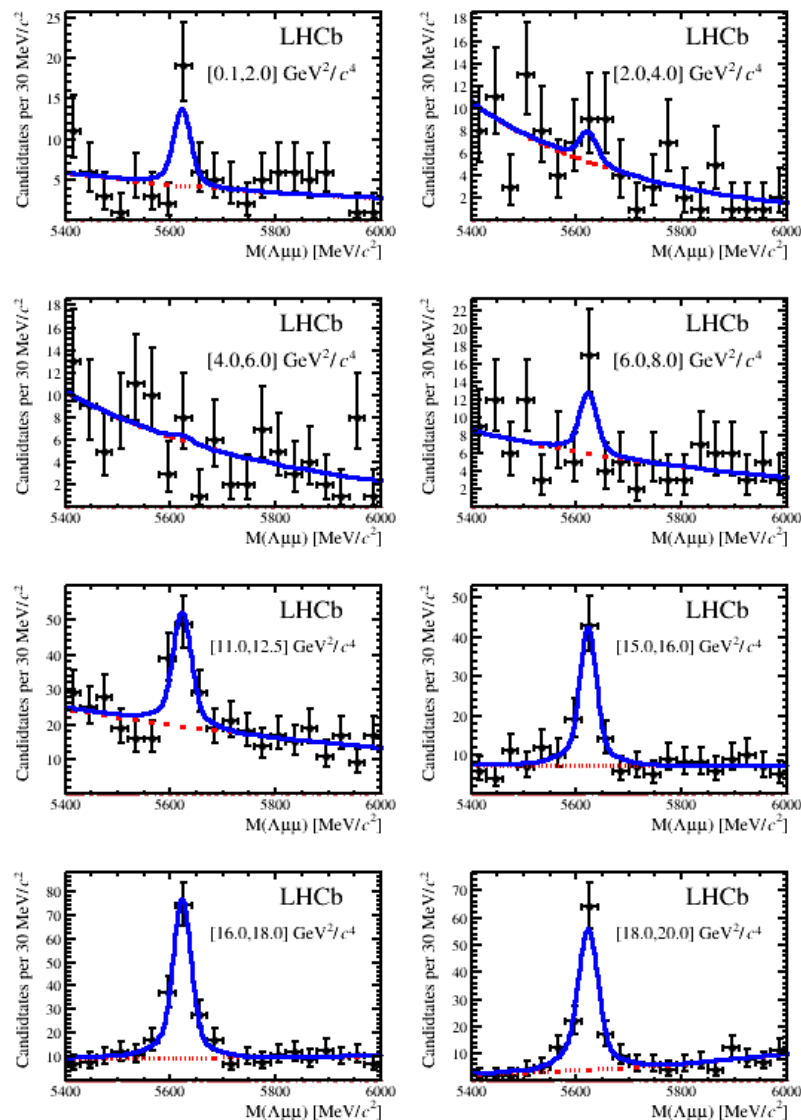
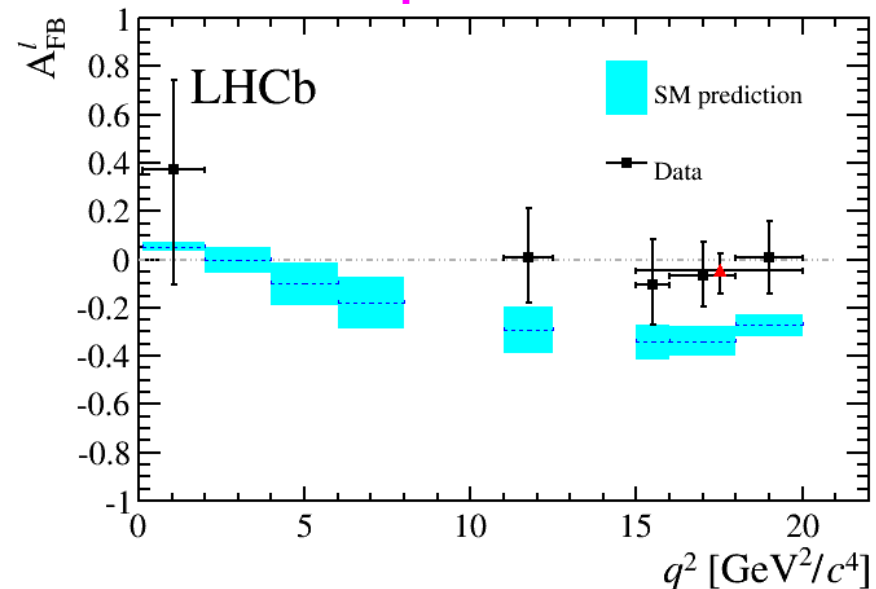# $\Lambda_b^0 \to \Lambda\mu^+\mu^-$ angular analysis

- Compare angular asymmetries for hadronic and leptonic sides of decay vs. q^2
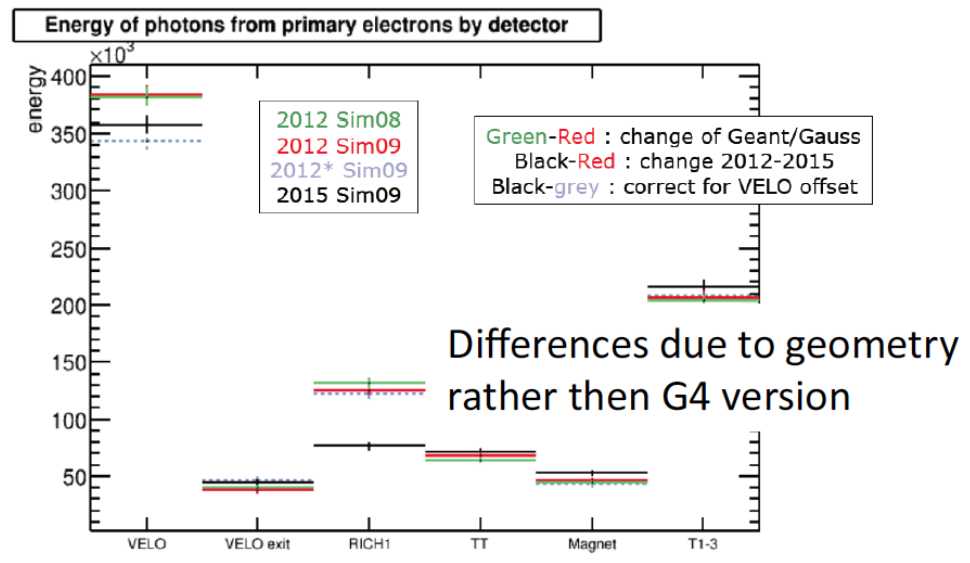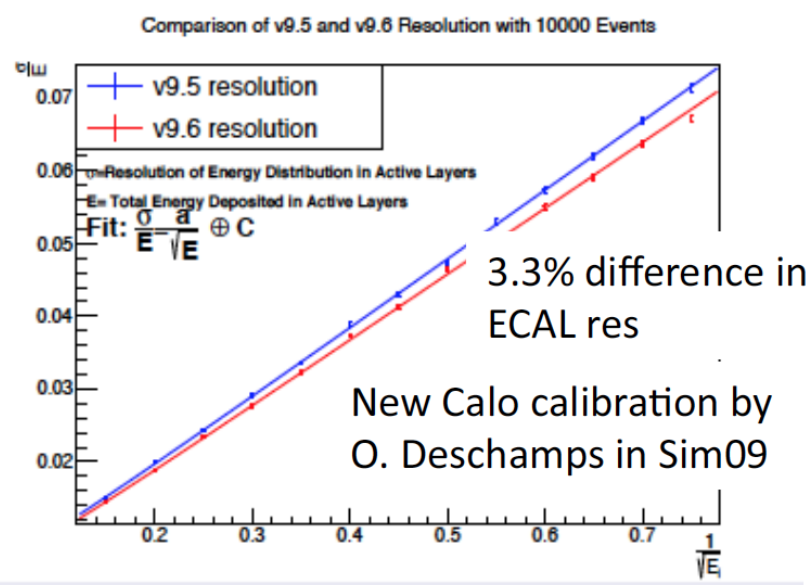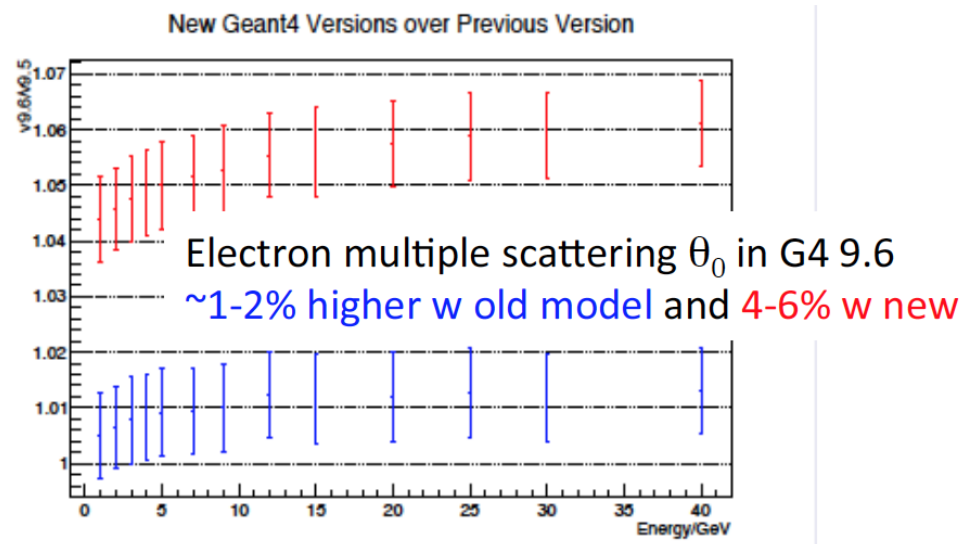
Hadronic side

Leptonic side

Technical

- Geant4 (in LHCb) release management, responsible - NKW
  - Verifications/validations of Geant4 physics, *see e.g. following slides*
  - Likewise in LHCb simulation application ('Gauss')
  - New G4 v10…
  - Fast sim. – Delphes or Geant4?
- Validation testing framework ('LHCbPR') - Sasha
  - Tests for Geant4, Gauss
  - Framework itself
- Geometry restructuring within Geant4/LHCb – t.b.d.
- Grid Expert on Call and Distributed Analysis Support - Mark (+Ganga development for LHCb and core Ganga)
- Physics WG liaisons (e.g. Luca – MC liaison for Rare Decays; Jimmy – trigger liaison for Charmless B decays)
- Paper reviewing, shift leaders, Editorial Board (NKW just ended sentence as deputy chairperson)

Checks on Geant4 electromagnetic physics

dE/dx MPV in 300μm silicon stable between G4 9.6/9.5

Electron multiple scattering θ_0 in G4 9.6
~1-2% higher w old model and 4-6% w new

New Geant4 Versions over Previous Version

Comparison of v9.5 and v9.6 Resolution with 10000 Events

v9.5 resolution
v9.6 resolution

Resolution of Energy Distribution in Active Layers
E= Total Energy Deposited in Active Layers
Fit: $\frac{\sigma}{E} = \frac{a}{\sqrt{E}} \oplus C$

3.3% difference in ECAL res

New Calo calibration by O. Deschamps in Sim09

Energy of photons from primary electrons by detector

2012 Sim08
2012 Sim09
2012* Sim09
2015 Sim09

Green-Red : change of Geant/Gauss
Black-Red : change 2012-2015
Black-grey : correct for VELO offset

Differences due to geometry rather then G4 version

© Tim Williams & Pete Griffith, SimPP & Dave Ward, QEE

Checks on Geant4 hadronic physics
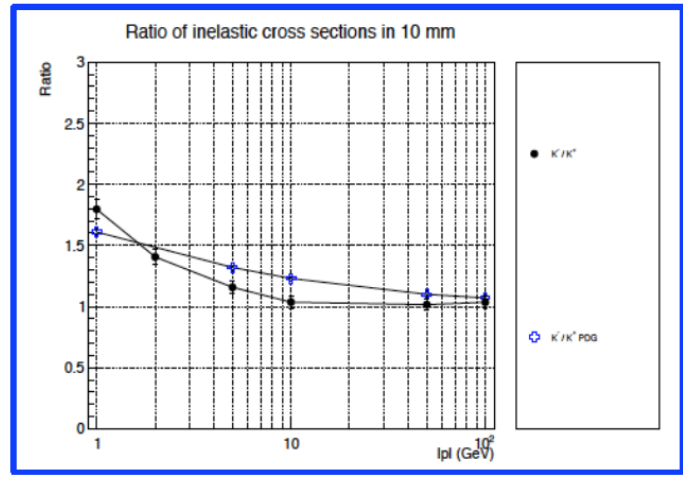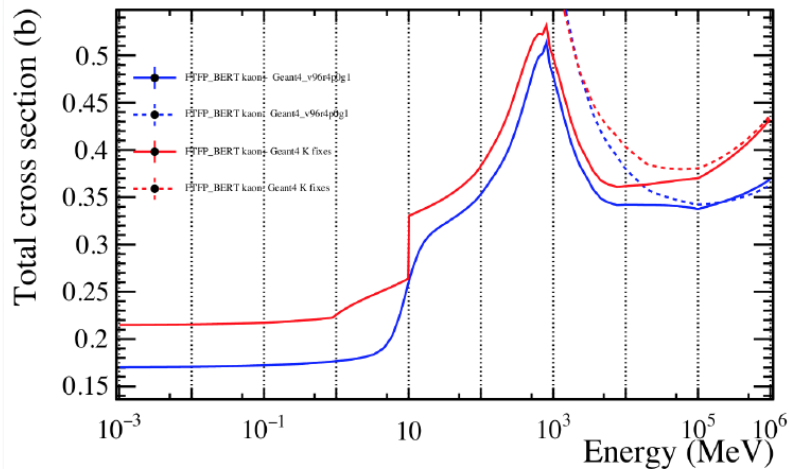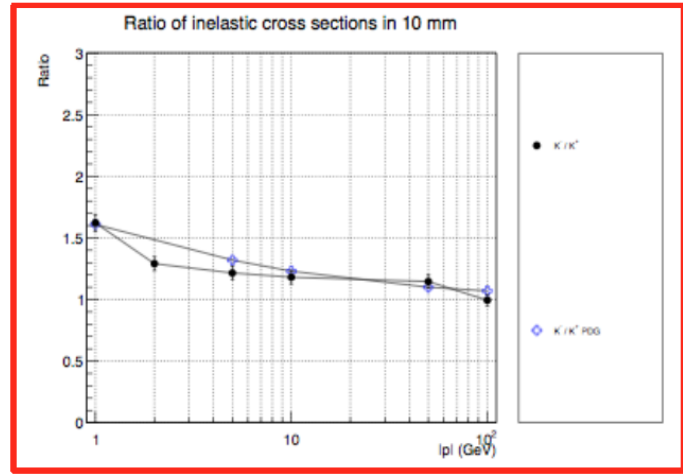
Geant4 as-is vs w-kaons-changes

And looking at ratio of cross sections in Gauss vs PDG →

© Luca Pescatore, SimPP

• Ratio a little closer to PDG prediction

What we do

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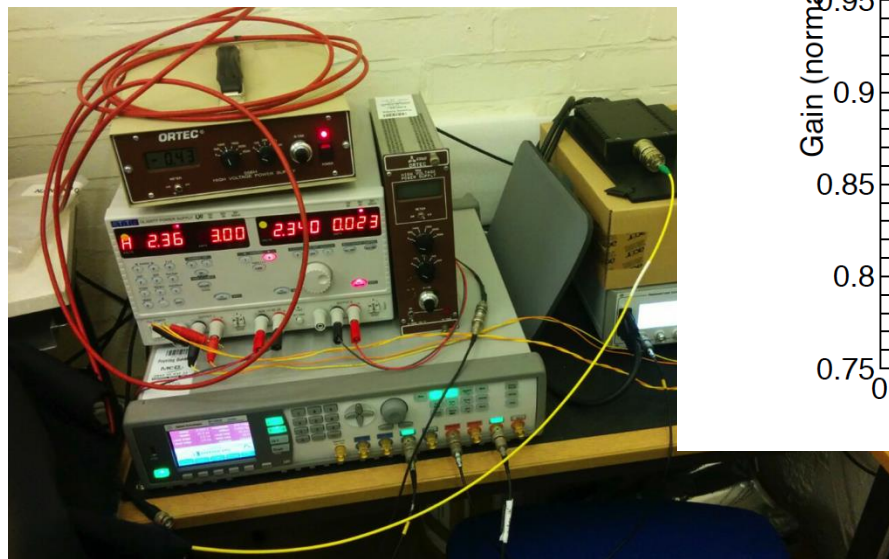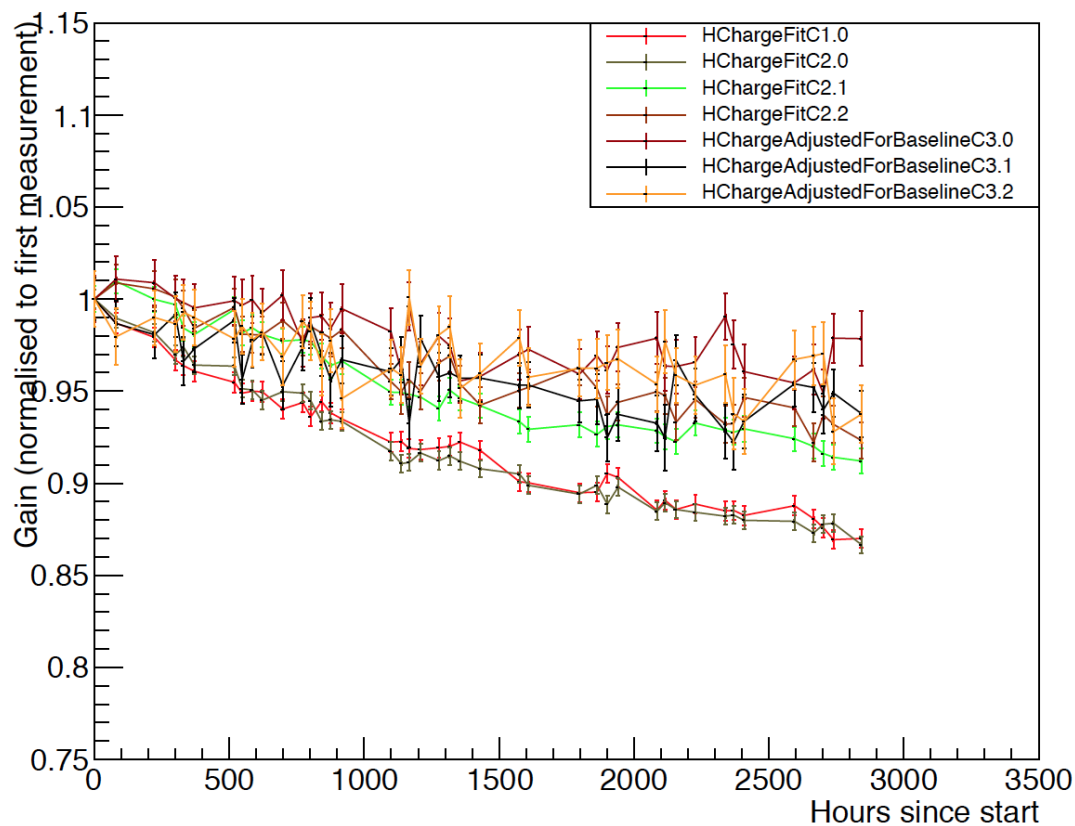
Upgrade and future

- Funded by STFC now

- UK projects are RICH and VELO

- Although we are not really in either detector group, we do

  - Ageing tests for new PMTs

  - Firmware for RICH

    - Benefit hugely from the overlap with NA62 expertise!

  - Component testing for radiation hardness at cyclotron

  - Especially for VELO, for upgrade need 8e15 n/cm^2

    - Benefit hugely from the overlap with ATLAS expertise!

- All groups joined since 2011 are being reviewed by LHCb…

  - Includes us but we don't anticipate any problems!

PMT Gain Tests

Gain % change over time

All graphs

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