Physics Reach Study with Cluster Counting

a project outline

Jean-François Caron

First SuperB Collaboration Meeting

Queen Mary University, London

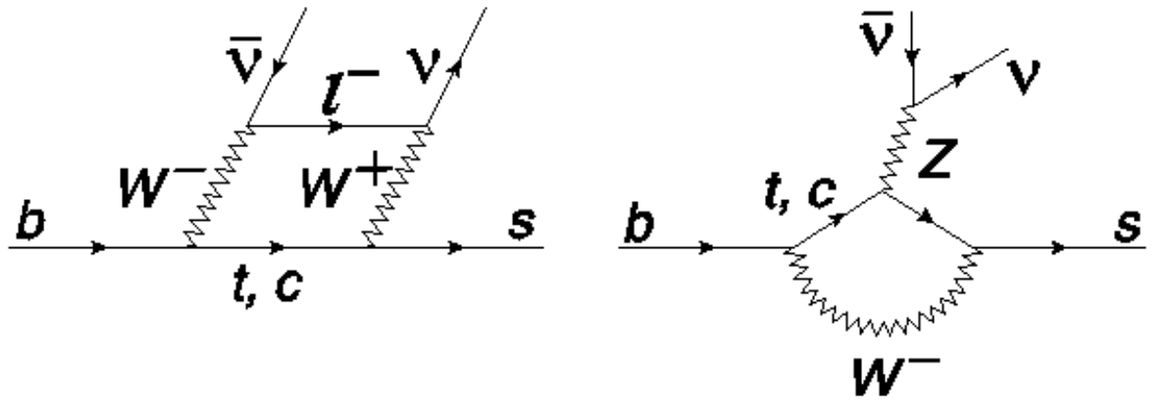
Outline

- To investigate the potential gains in physics reach from improved PID provided by a cluster counting technique
- Using an existing analysis with heavy dependence on PID
- Parametrize the effect of cluster counting on the PID, without worrying about details

The Analysis

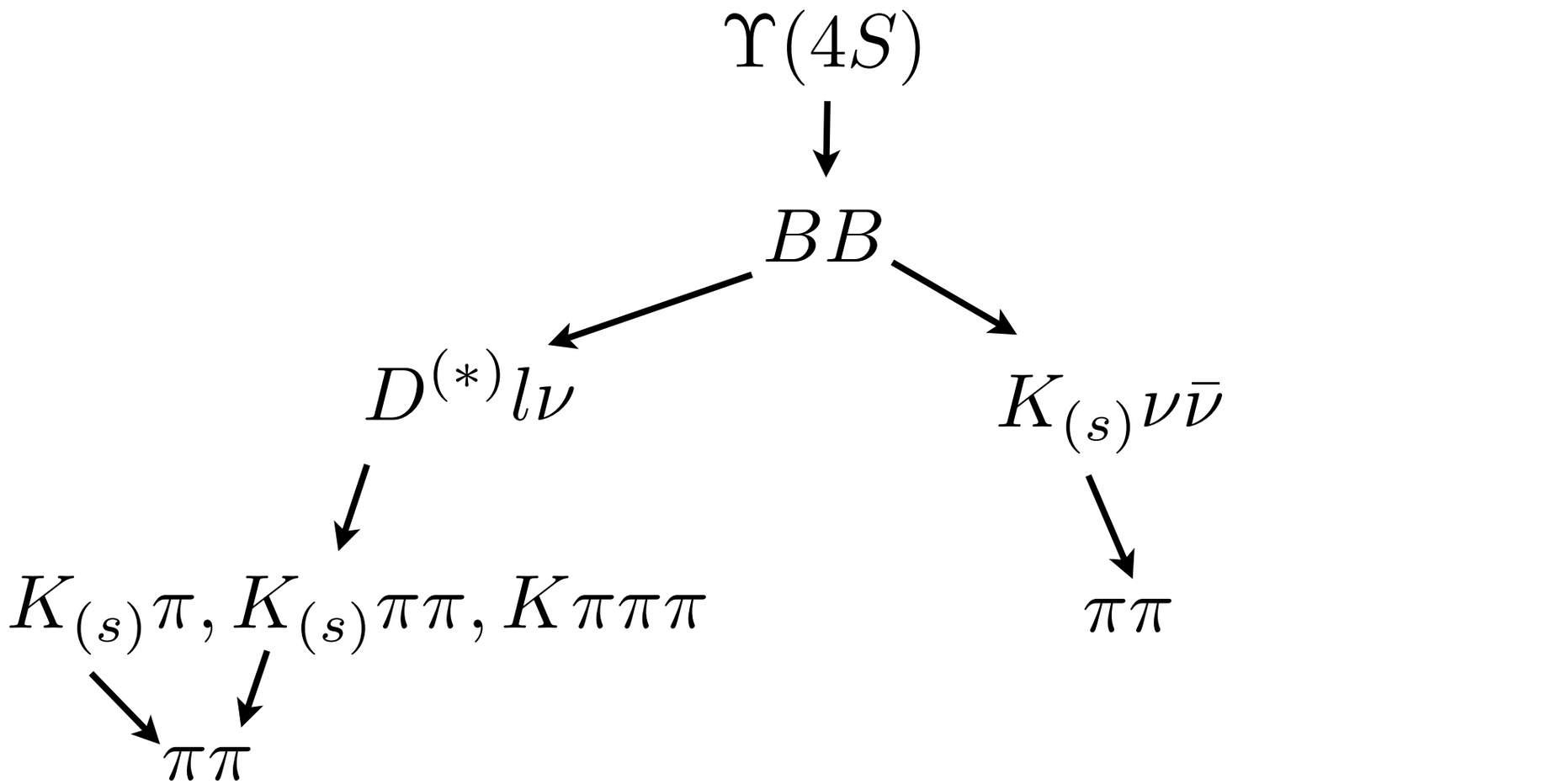
- Existing BaBar analysis of $B \to K \nu \bar{\nu}$
- Uses semi-leptonic recoil technique
- 10.1103/PhysRevD.82.112002

Why This Analysis?



- Even with standard model, arrives only with loops
- Many new physics models would greatly enhance the branching fraction by putting new particles in the loops
- Has already been done in FastSim for fPID

Semi-Leptonic Recoil



Recoil, fully reconstructed

Rest of the event

Missing Energy and E_{extra}

Signal and background have large amounts of missing energy, signal from neutrinos, background from missing particles.

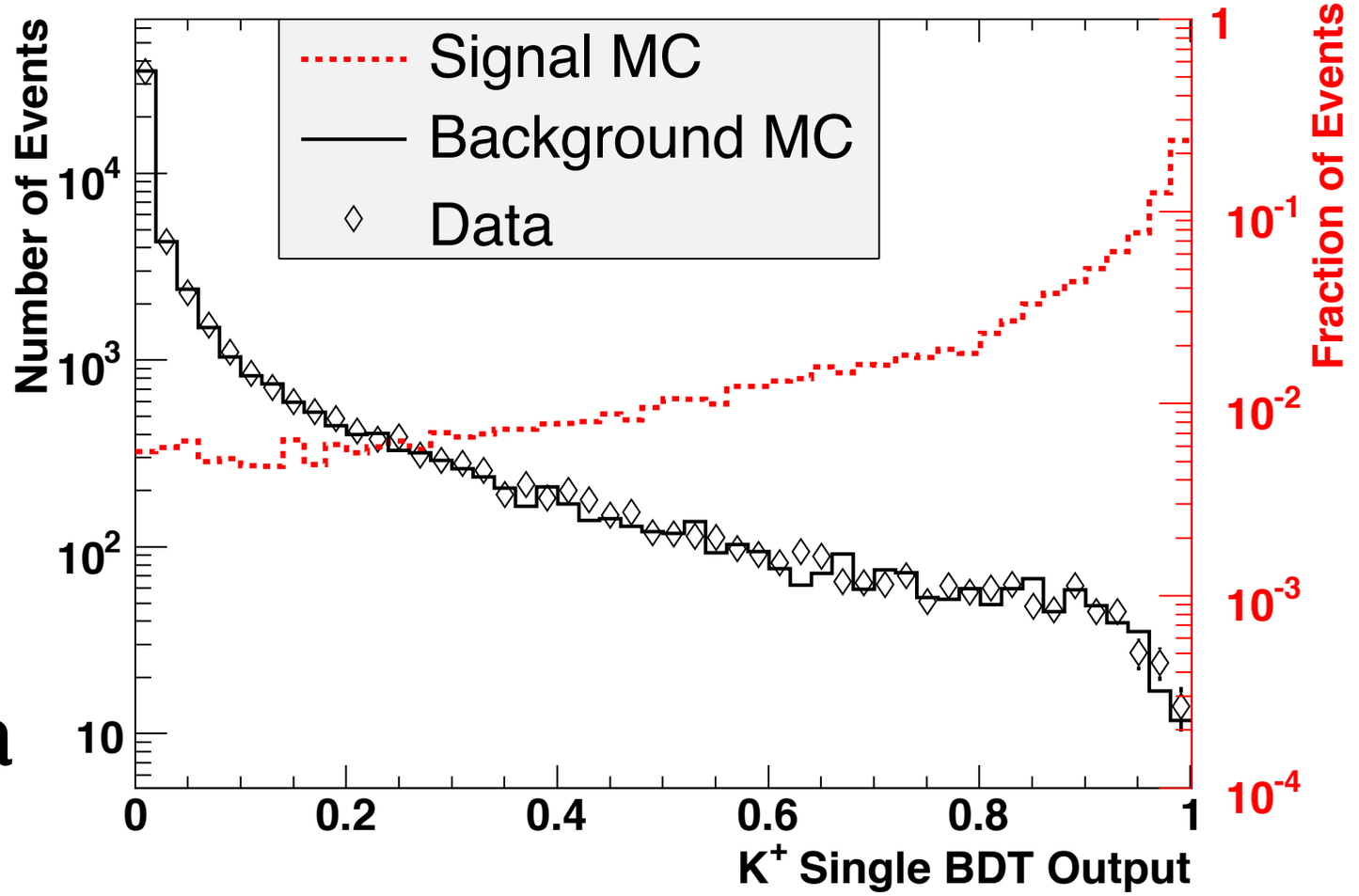
Signal has very little extra detector activity, background has lots.

Resulting Measurement

$$\mathcal{B} = \frac{N_{obs} - N_{bkg}}{\epsilon N_B}$$

Signal Efficiency

Number of B mesons



Reference paper claims a 90% confidence:

$$\mathcal{B} < 5.6 \times 10^{-5} \quad B^0 \to K^0 \nu\bar{\nu}$$

$$\mathcal{B} < 1.3 \times 10^{-5} \quad B^+ \to K^+ \nu\bar{\nu}$$

How can Clusters Help?

- Calculate the required luminosity to obtain the same constraint with and without cluster counting.
- See how much running time (and thus cost) is saved for the same precision.
- Alternatively, for the same luminosity, see how much better is the constraint.

Parametrized Cluster Counting

In FastSim, dE/dx measurement for each DCH hit is drawn from a normal distribution with mean given by the Bethe formula.

$$\mu = \left[\frac{dE}{dx}\right] \qquad \sigma = \frac{p_1}{1.622 \times 10^{-3}} \left[\frac{dE}{dx}\right]^{p_2} L^{p_3}$$

Path length

PacTrk/Dch_SuperB_Measures.xml:

```
<device name="DchdEdx" type="dEdx"
    HitType="3"
    trunc_frac="0.7"
    dedx_par1="0.00154"
    dedx_par2="1"
    dedx_par3="-0.34" />
```

Fraction kept for truncated mean, but not actually necessary.

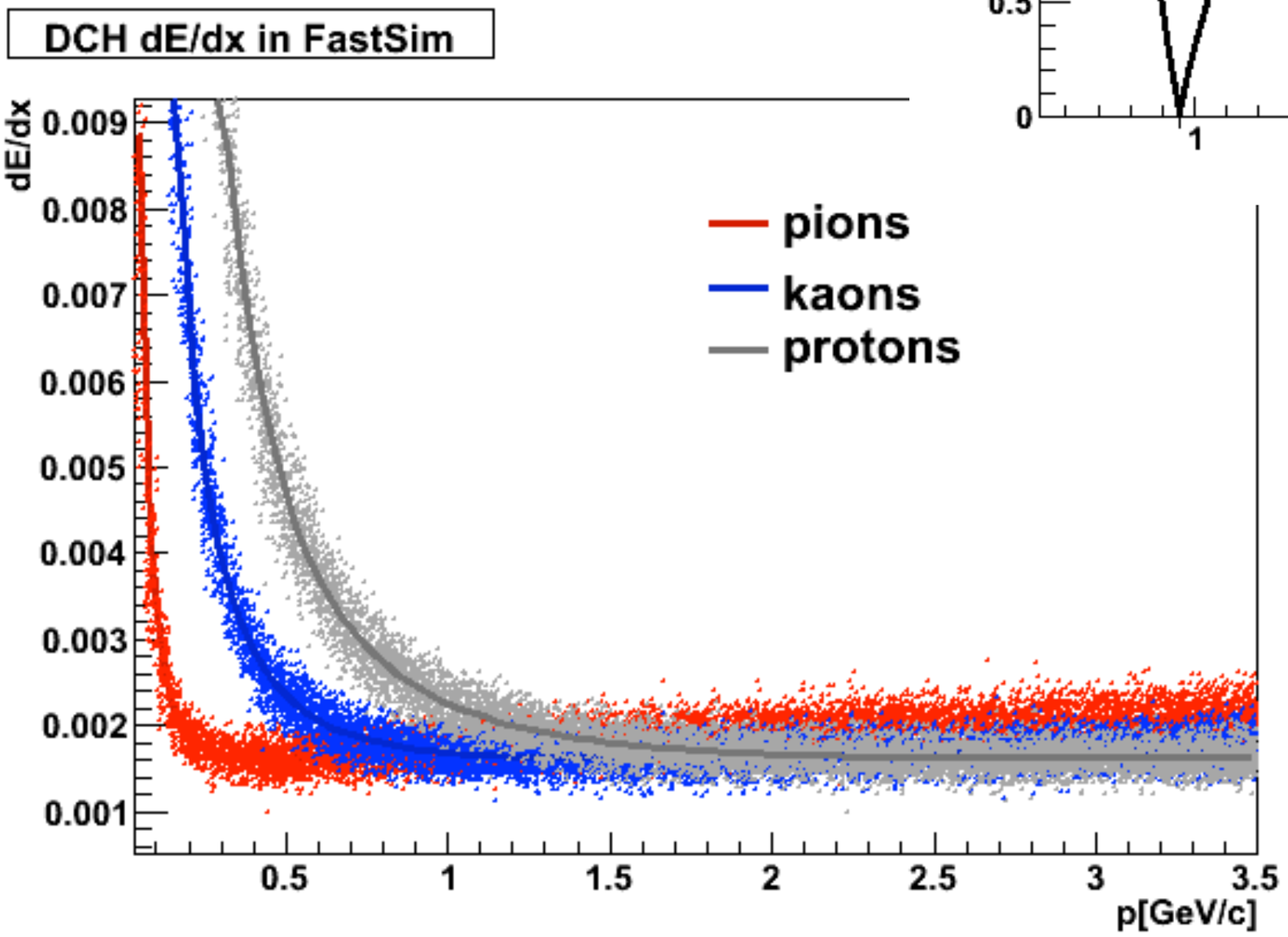
p_1

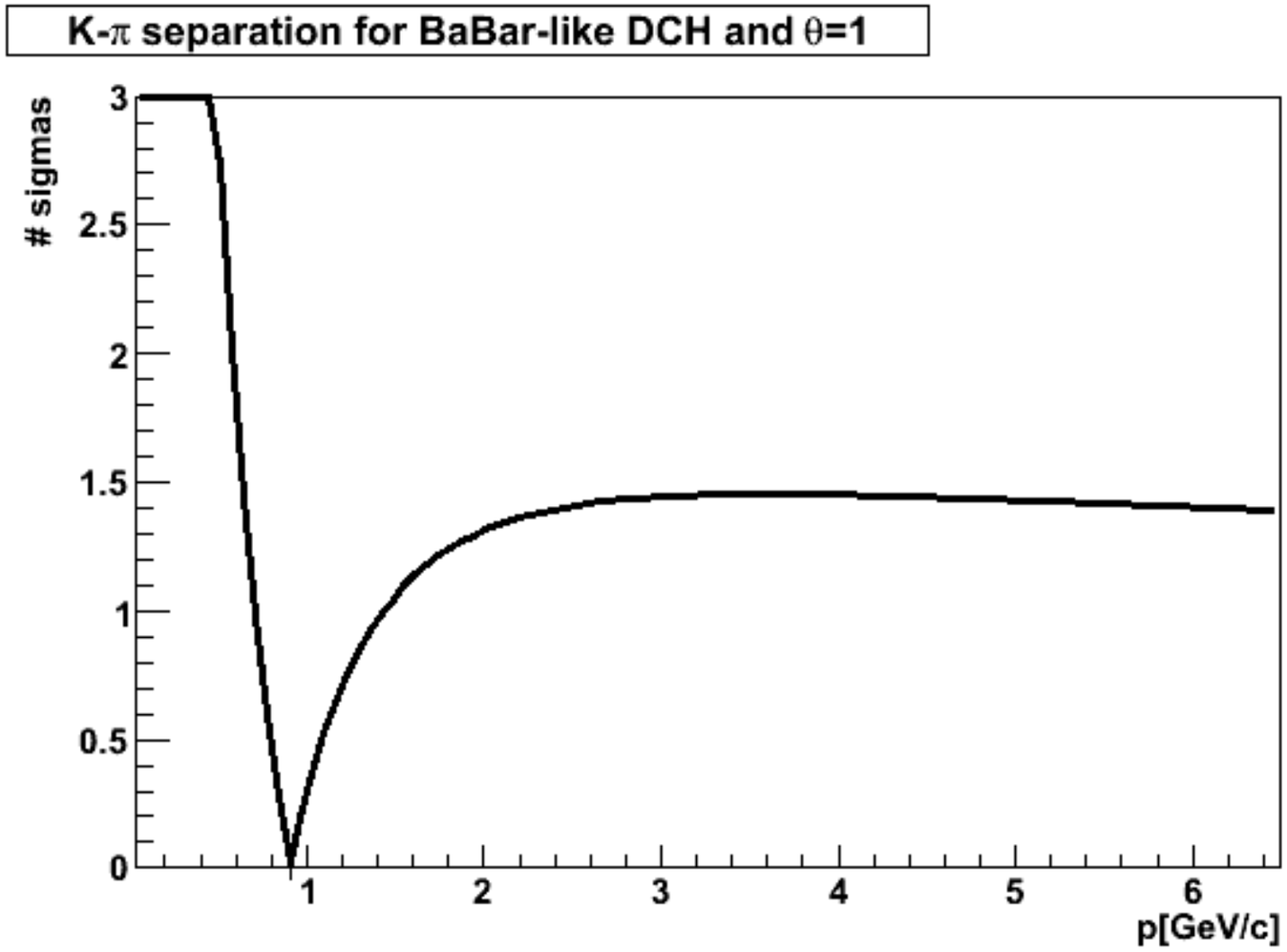
p_2

p_3

Play with these numbers

From SuperB Wiki





Progress So Far

- FastSim is difficult to use, the FastSim tutorial tomorrow should help
- Can generate signal events following a tutorial on the SuperB wiki (and fixed many parts of that tutorial!)
- This talk should generate some advice and feedback from experts