Updates on junctions, strangeness and further questions

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Overview

Junction fragmentation

Updates

- ➢ JRF-finding procedure reformulation
- ➢ Soft-leg treatment

Further studies

- ➢ Junction motion detailed study
- ➢ Fragmentation of curved strings?
- ➢ Λ_b/B^0 overprediction
  - ➢ General study into fraction of each baryon is produced from junctions

Strangeness and diquarks

Updates

- ➢ Close-packing
- ➢ Strange junctions
- ➢ Destructive interference of popcorn mechanism

Further studies

- ➢ Tuning project
- ➢ Effect on e^+e^- events
- ➢ Ξ_c/Λ_c underprediction
- ➢ p/π and Λ/K_S description simultaneously

Junction fragmentation

Junction fragmentation

→ **Go to JRF**

→ Fragment two softest strings first

→ Reflect each leg on the other side of the junction (“fictitious leg”) to form a dipole string

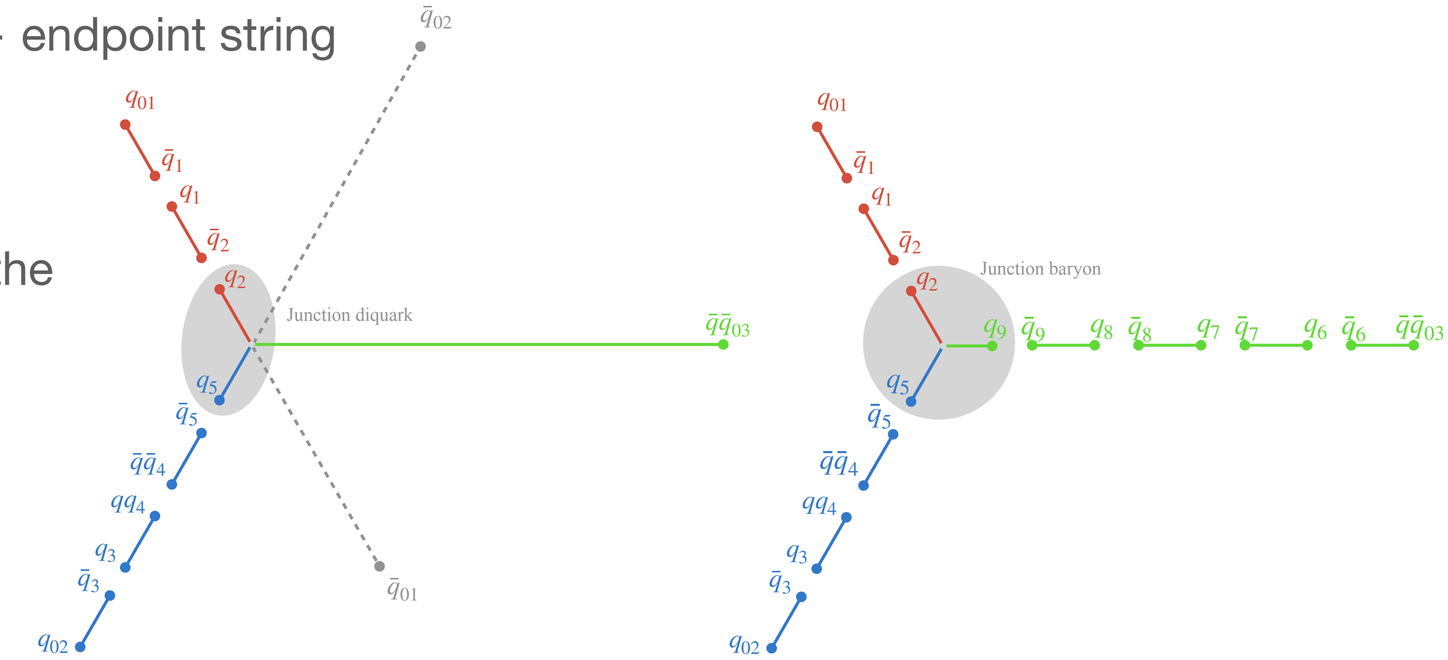
→ Form junction diquark

→ Fragment last leg by fragmenting diquark — endpoint string

Junction rest frame

→ Typically where the angle between each of the legs is 120° i.e. the **Mercedes frame**

Does a boost to the Mercedes frame always exist?



Junction Updates

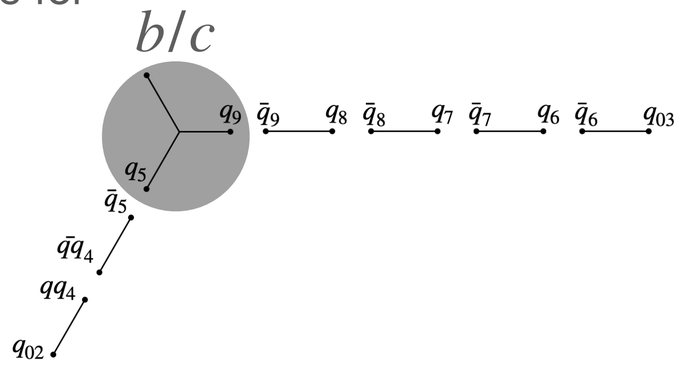
Λ_c/D^0 ratio shows importance of junctions on **heavy baryon production**, particularly at low $p_\perp$

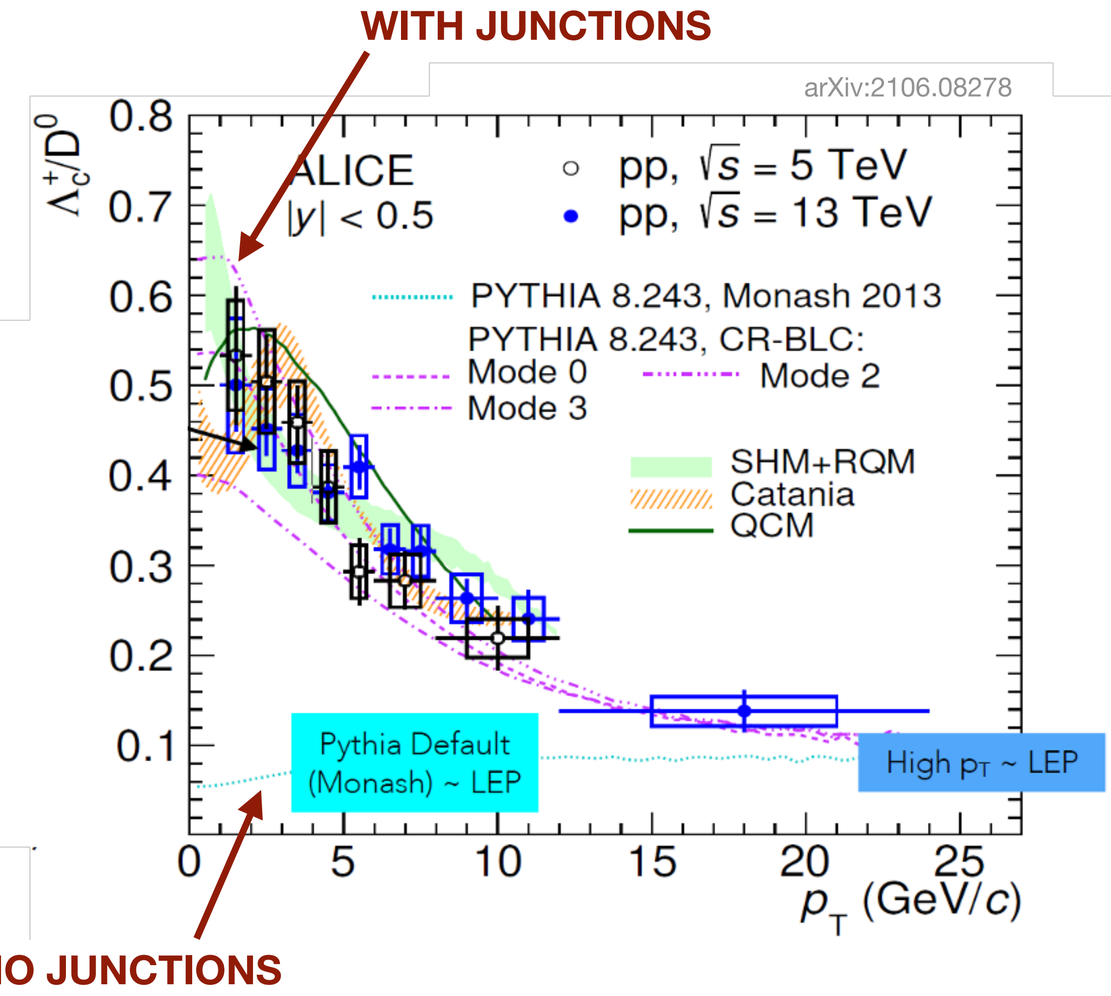
→ heavy baryons from junctions require soft leg treatment.

Previous modelling of junctions predominantly had high energy legs in mind e.g. baryon number violating SUSY decays and beam remnants

QCD-CR minimises string lengths

→ more likely to get **short strings involved in junctions**, which the construction wasn't made for





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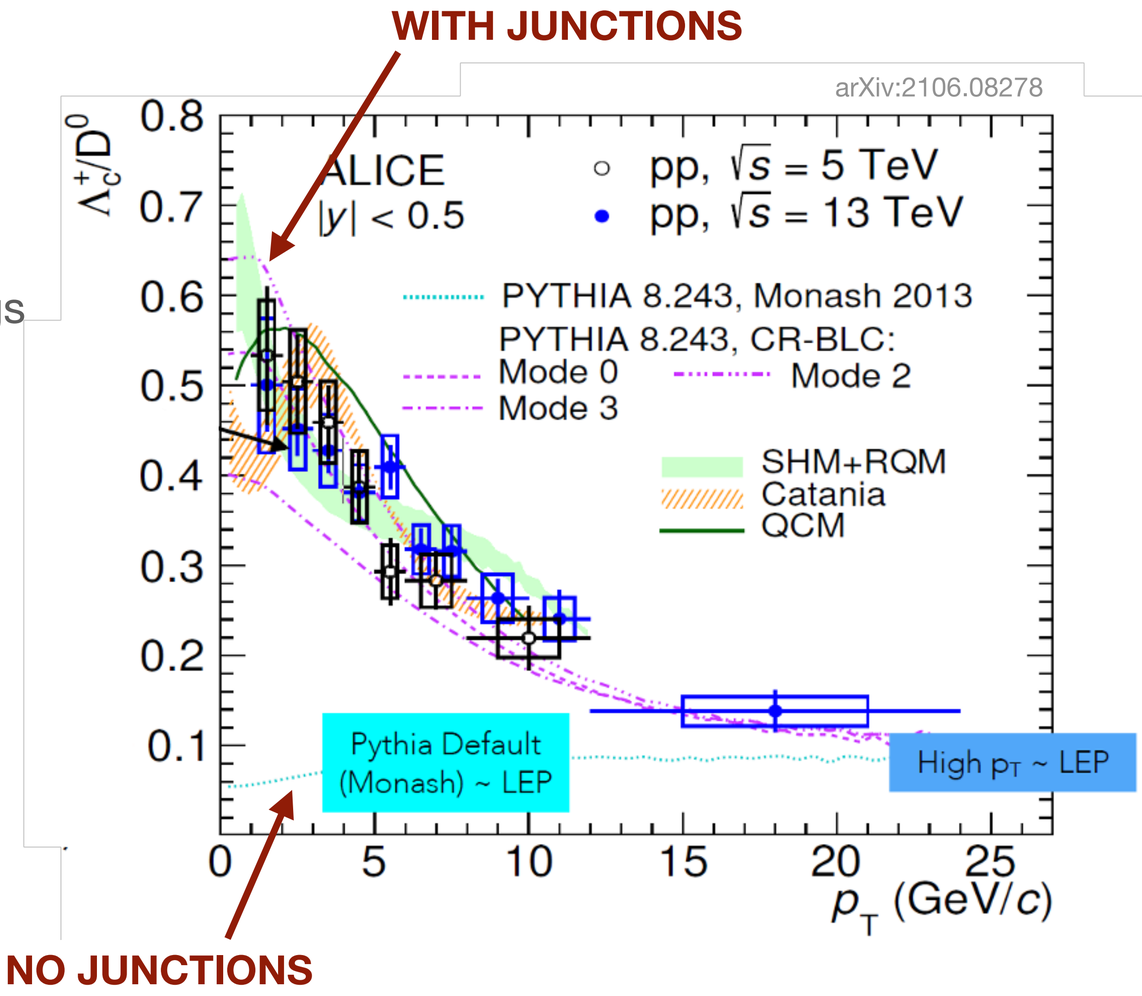
Aims of updates

→ **More careful treatment for soft leg cases**

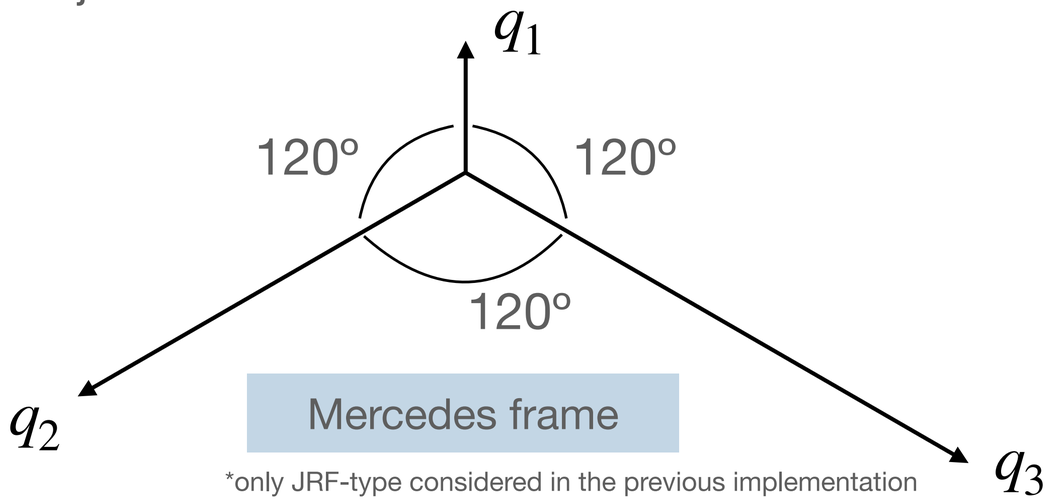
→ **Remove reliance on convergence in JRF calculations (which was failing for around 10% of events)**



Junction Rest Frame

What is the **junction rest frame?**

If the momenta of the junction legs are at 120° angles
→ the pull in each direction on the junction is equal
→ junction is at rest



Mercedes frame

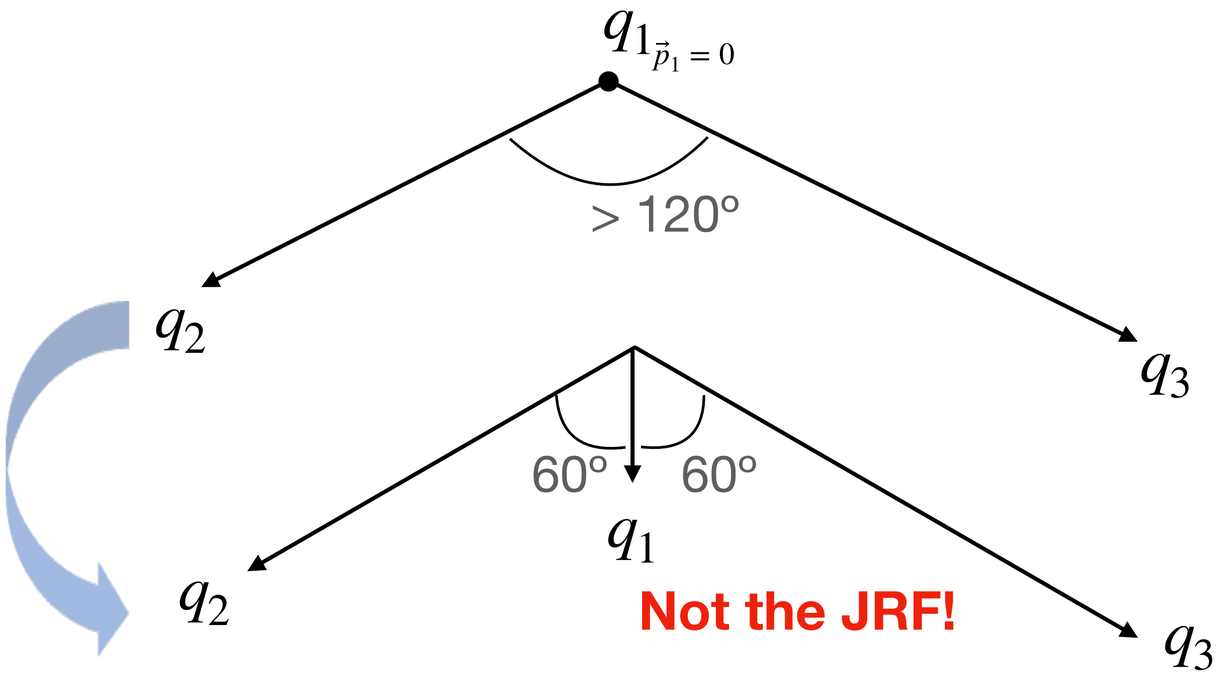
*only JRF-type considered in the previous implementation

Does a boost to the mercedes frame always exist?

Consider the following:

In the **rest frame of one of the partons**, and the angle between the other two partons is **greater than 120°**

*no special consideration for these cases in previous implementation



Soft leg treatment

The **junction gets "stuck"** to the soft quark, which we call a **pearl-on-a-string**

➢ More likely to occur for junctions with heavy flavour endpoints

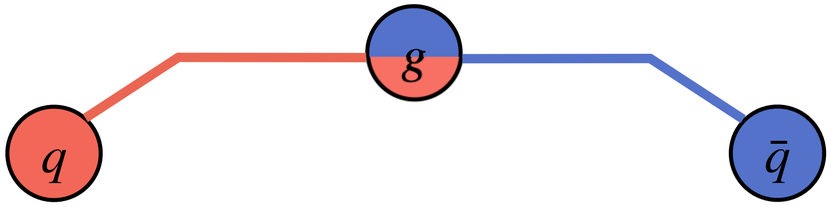
For a junction to make a **heavy baryon**, the junction leg with the heavy quark can't fragment (*i.e.* a "soft" junction leg) = **pearl-on-a-string!**

How do we fragment pearl-on-a-string cases?

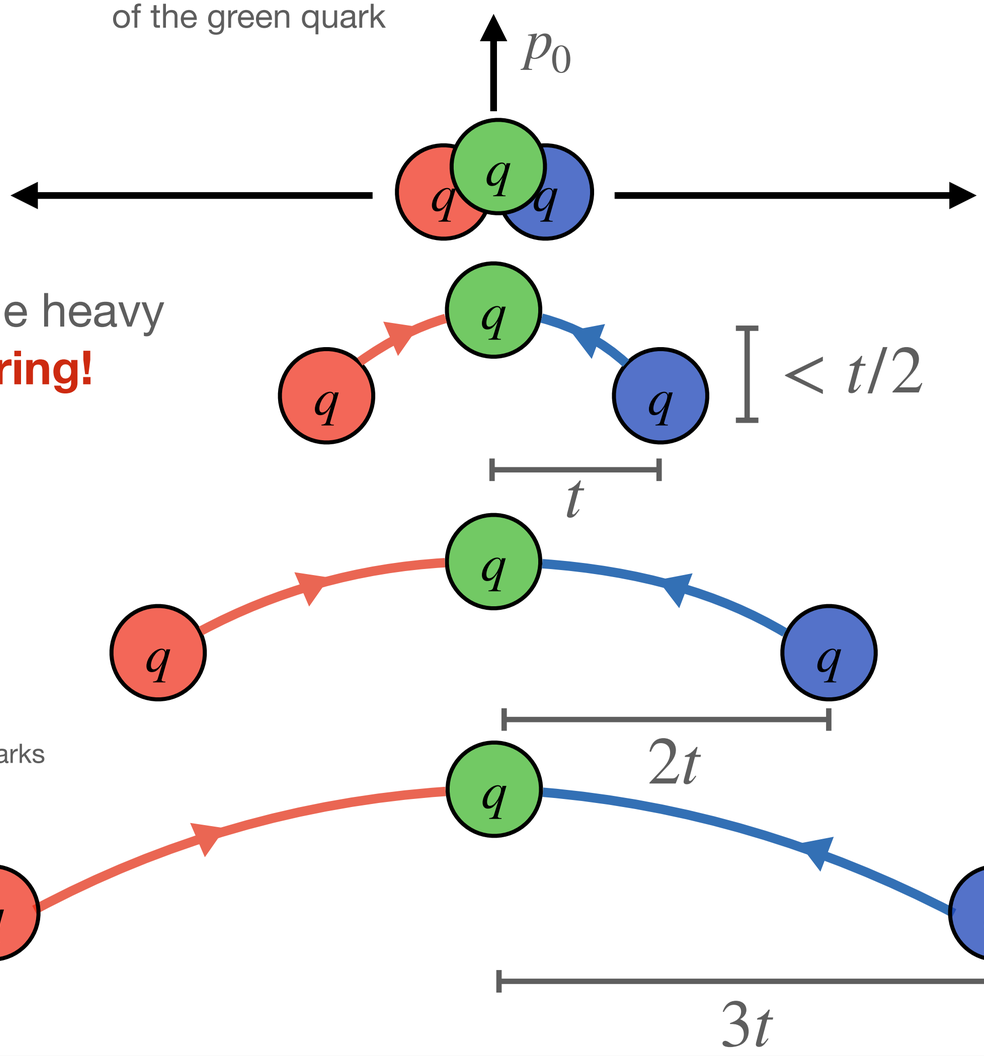
➢ Average over the pearl motion

➢ Fragment like a $q - g - \bar{q}$ string *typically only a good approximation for light quarks

$$\frac{dx}{dt} = \frac{1}{\sqrt{1 + \frac{m^2}{(p_0 - 2\kappa x)^2}}}$$



Example of pearl-on-a-string viewed in the Ariadne frame of the green quark



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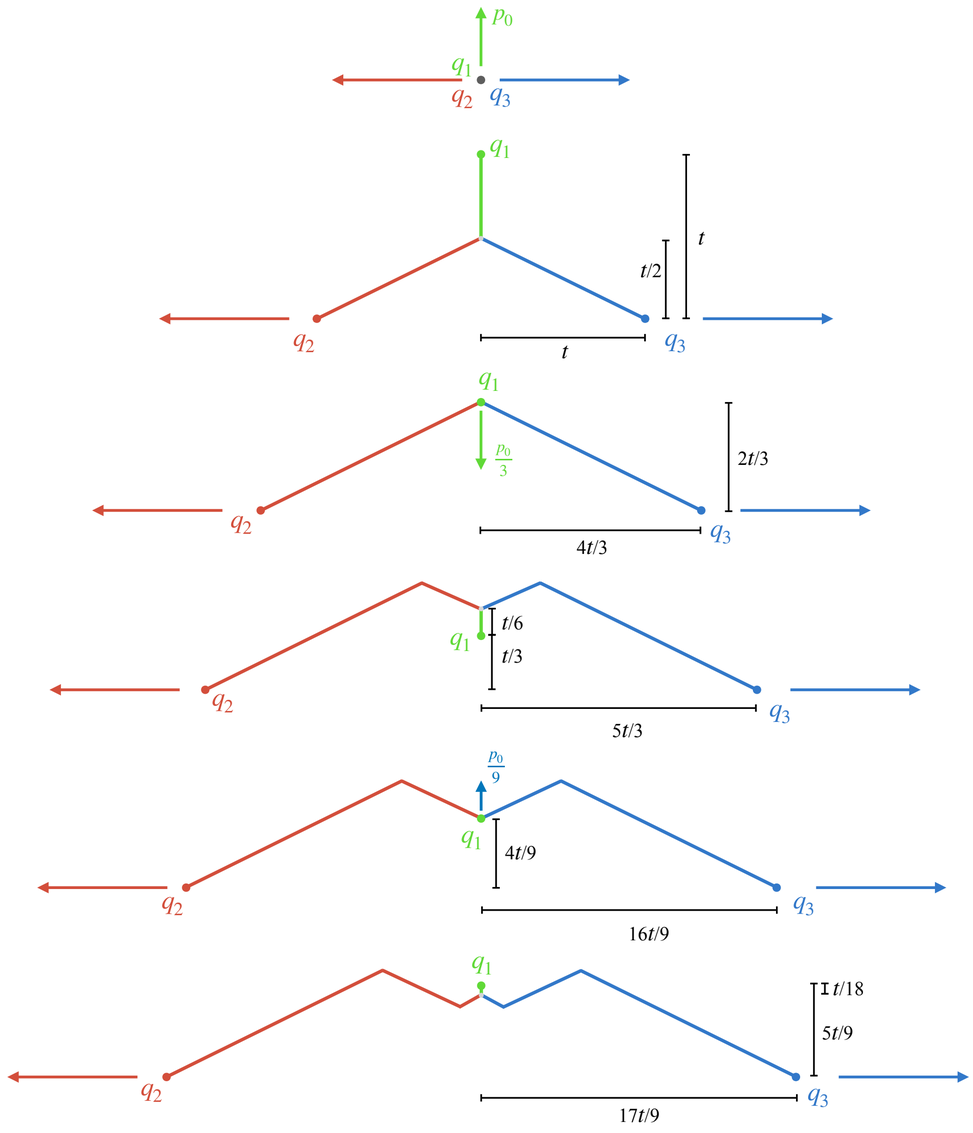
What if we have a Mercedes frame but a very soft leg?

➢ Allow for oscillations of the soft leg around the junction



Junction Rest Frame Finding

JRF-finding procedure

- What about junction systems with **gluon kinks**? → need an **“average” JRF**
- Defining the **average JRF**
  - Previous implementation → **average Mercedes frame**
  - Updated implementation → consider **junction motion over time** and average this motion

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Defining the **average JRF**

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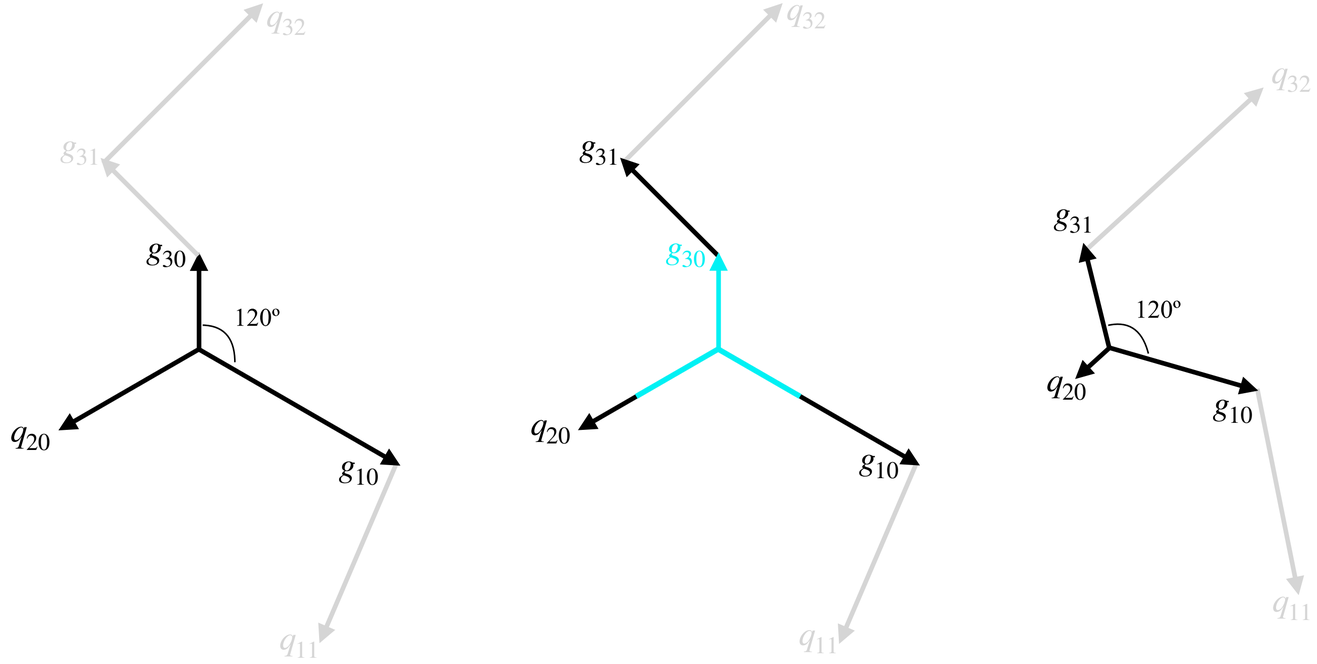
Updated implementation → consider **junction motion over time** and average this motion

→ Find JRF at different times

→ Which partons determine the **junction motion**

→ **How long** do these partons pull on the junction

→ What are the **next momenta** to determine the junction motion



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→ Which partons determine the **junction motion**

→ **How long** do these partons pull on the junction

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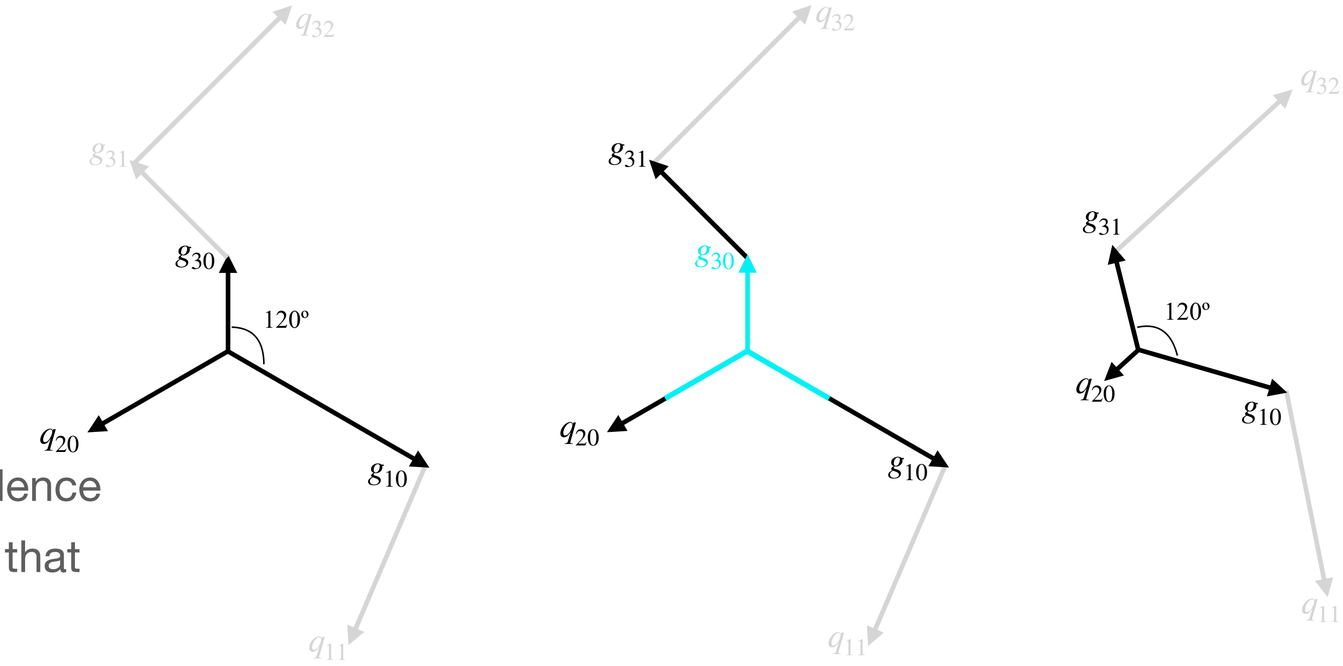
→ **Time-weighted average over junction velocities**

→ exponential decay is used to model time dependence but this is somewhat arbitrary; important point is that early JRFs contribute more than late ones



Assumptions and special cases

Small mass gluons that result in no Mercedes frame solution (pearl-like cases)

→ use rest frame of the gluon and use the gluon mass as the time weight as an approximation

Collinear partons

→ often encountered due to numerical precision issues given boosts and root finding procedure used to find the Mercedes frame

→ use the centre-of-mass energy/momentum and approximate the collinear pair as a diquark to capture the direction of motion of the junction

CR

→ use the rest frame of a massive parton for string length calculations if the Mercedes frame does not exist i.e. the early time JRF

Questions about junctions?

Junction motion detailed study

→ **When do we stop fragmenting towards the junction?**

Study of how stopping conditions effect junction baryon motion has been done for a fully symmetric case

Topologies with uneven legs result in the junction motion biased in the direction of the most energetic leg (i.e. the last leg)

→ Modelling of **last junction leg**

Junction diquark should be treated as coming from a string break and not set up the string axis ?

Λ_b/B^0 overprediction

→ study of Λ_b vs Λ_c production

→ other heavy flavour ratios such as Λ_b/Λ_c and B^0/D^0

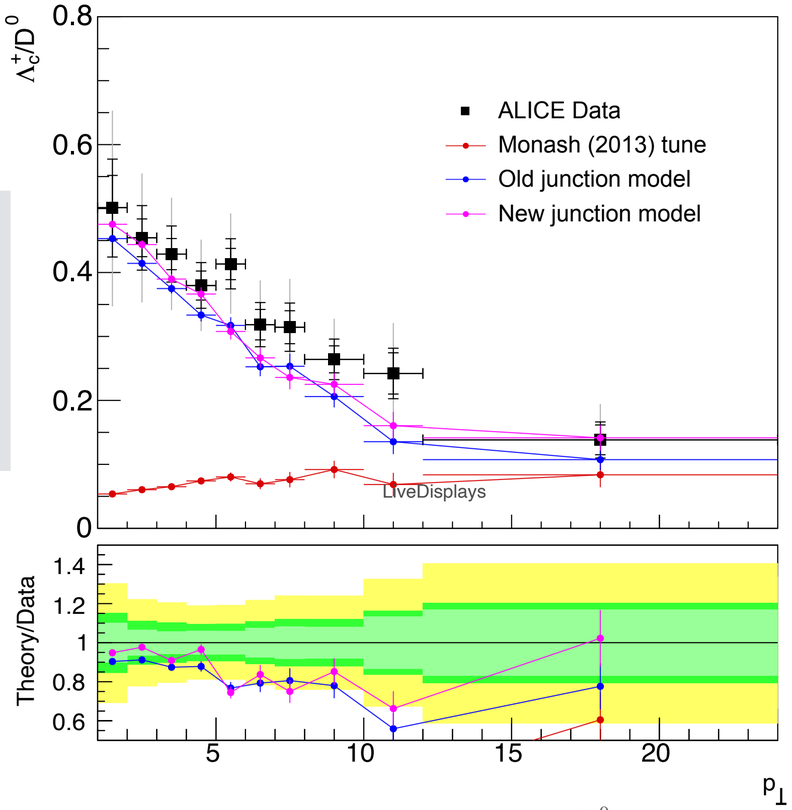
→ general study of what portion of each baryon comes from junctions

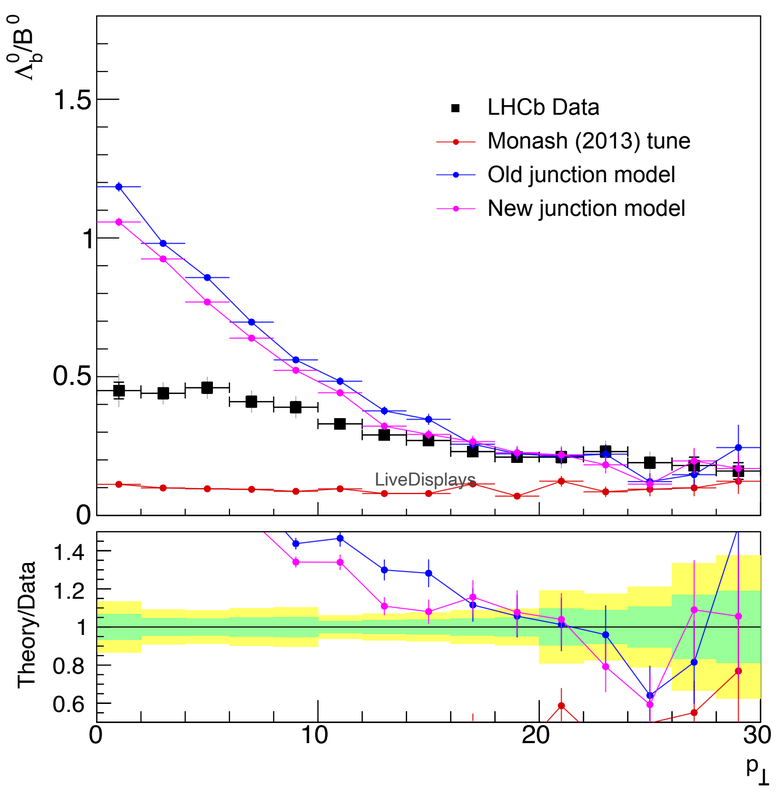
Questions about junctions?

Other questions

→ Fragmentation of curved strings?

→ String close to the junction?





*Note Λ_c/D^0 is lower than typically as probQQ1toQQ0join was reverted to its default values and left untuned. Value should be slightly lower than default value and this ratio should increase

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- ➢ Destructive interference of popcorn mechanism

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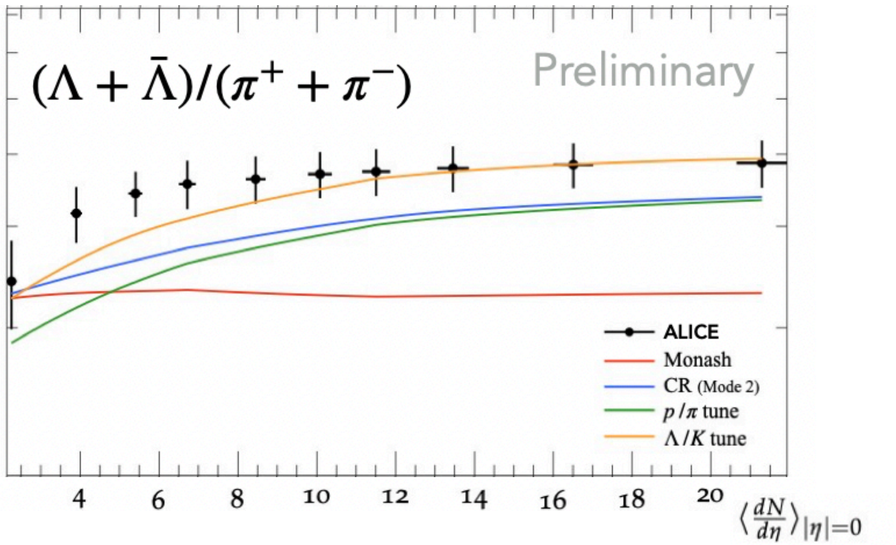
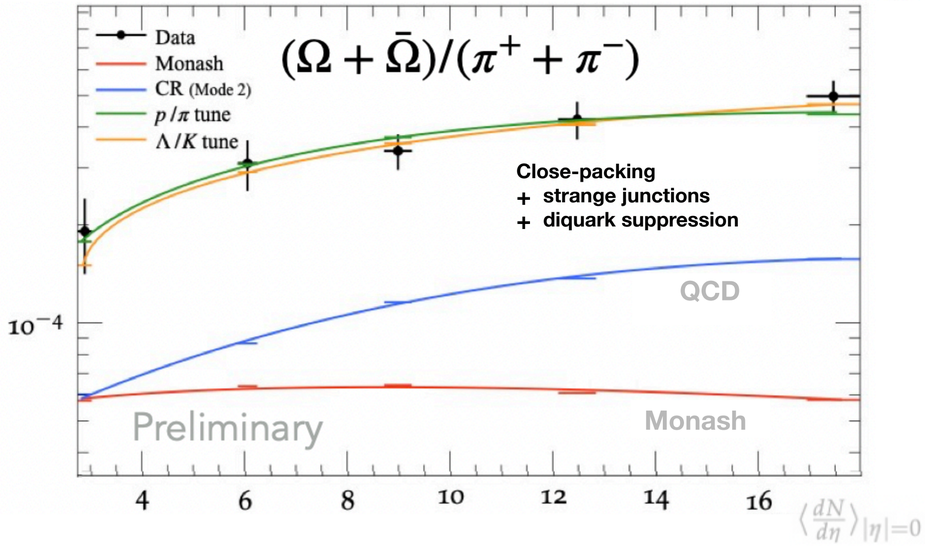
Strangeness Enhancement

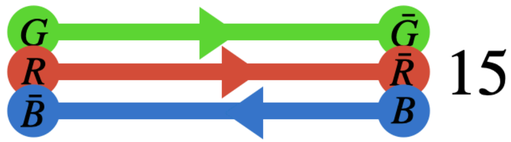




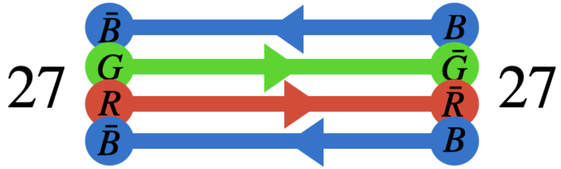
Close-packing

$p = 1$, $q = 1$ $\quad C_8 = 2.25C_F$

$p = 2$, $q = 0$ $\quad C_6 = 2.5C_F$



$p = 2$, $q = 1$ $\quad C_{15} = 4C_F$



$p = 2$, $q = 2$ $\quad C_{27} = 6C_F$

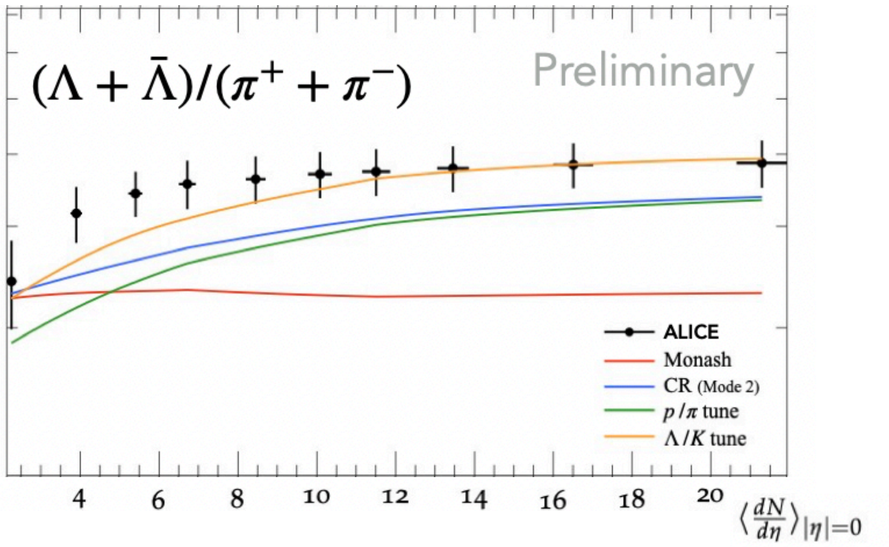
Dense string environments

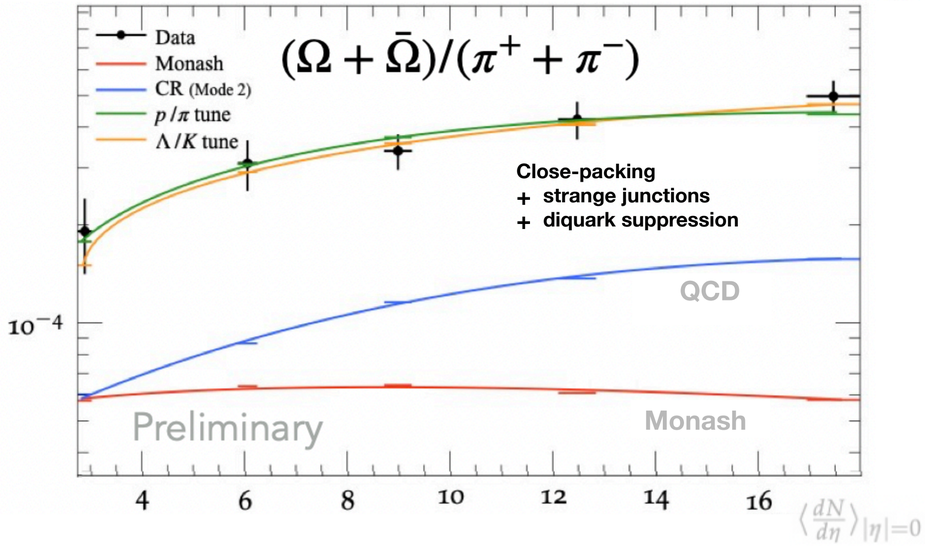
→ Casimir scaling of **effective string tension**

→ Higher probability of strange quarks

Updates:
Included different enhancement strength parameters for strangeness, pT and diquark production to allow for ambiguity in the model

Strangeness Enhancement





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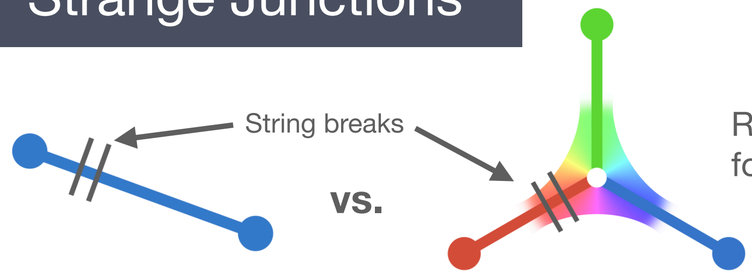
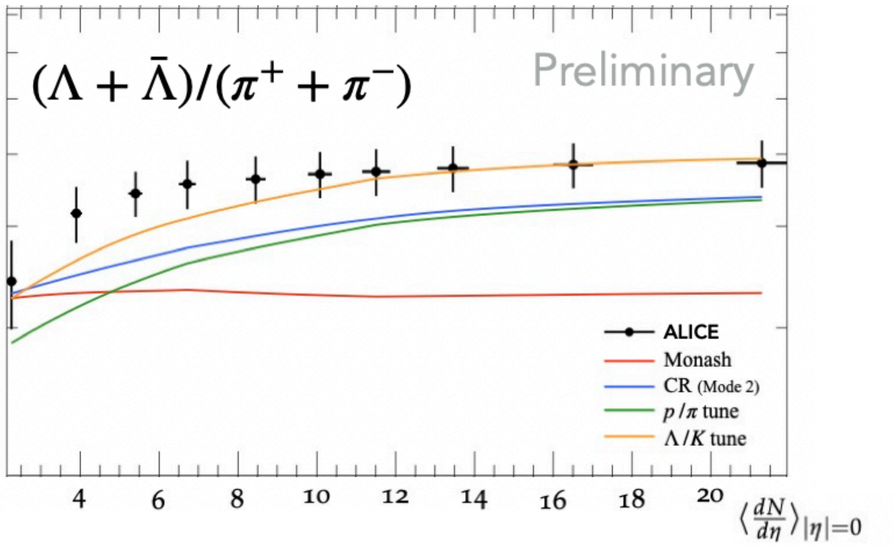
Strange Junctions

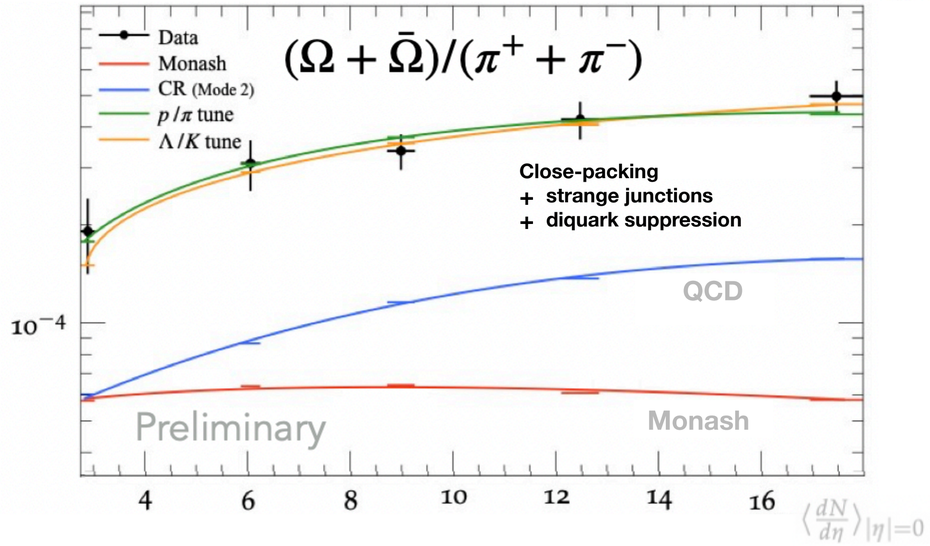


Results in strangeness enhancement focused in baryon sector

String tension could be different from the vacuum case compared to near a junction

Strangeness Enhancement





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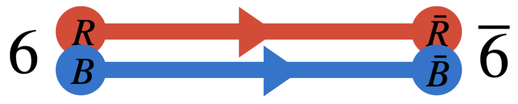

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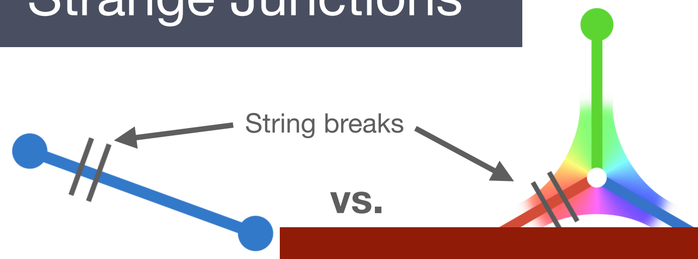
Strange Junctions



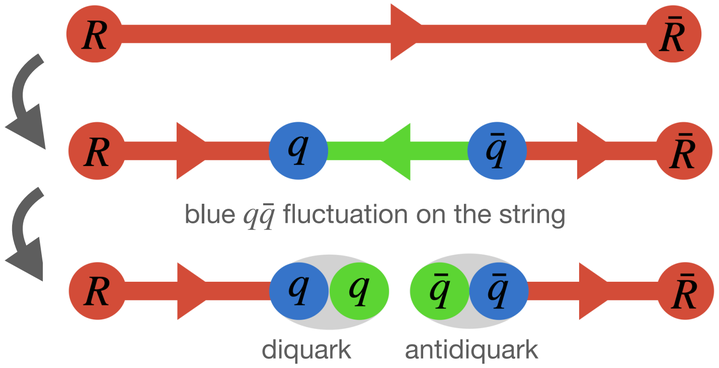
Results in strangeness enhancement focused in baryon sector

String tension vacuum case

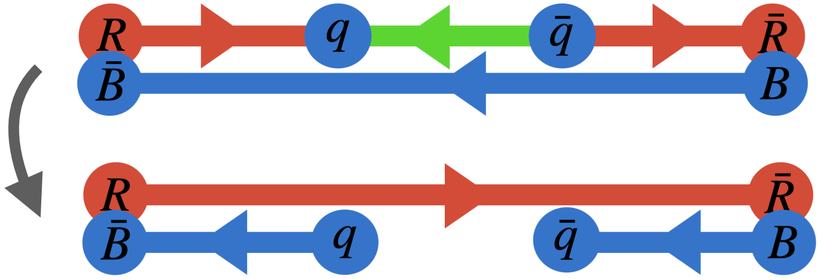
Even by forcing junctions to be very strange, not sufficient to describe Ξ_c

Diquark Suppression

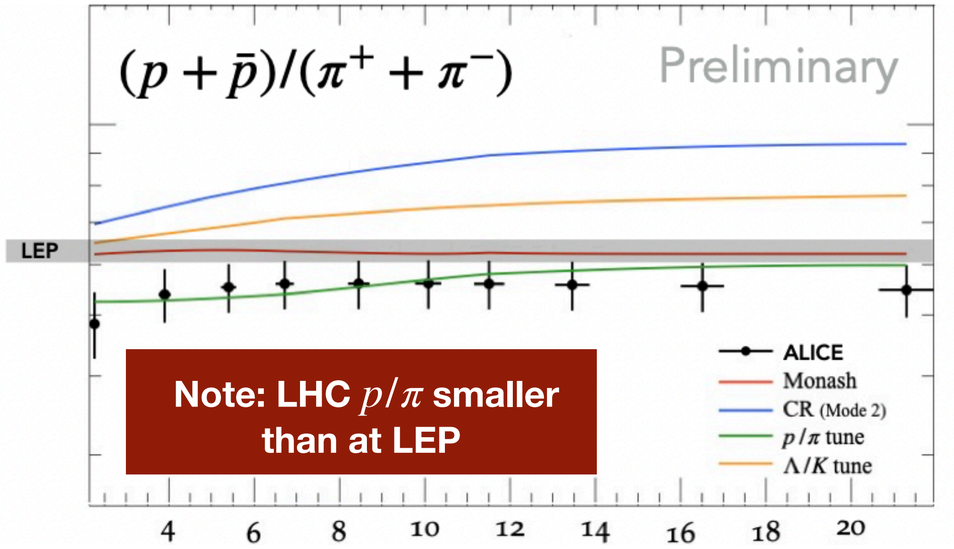
Diquark formation via **successive colour fluctuations** — popcorn mechanism

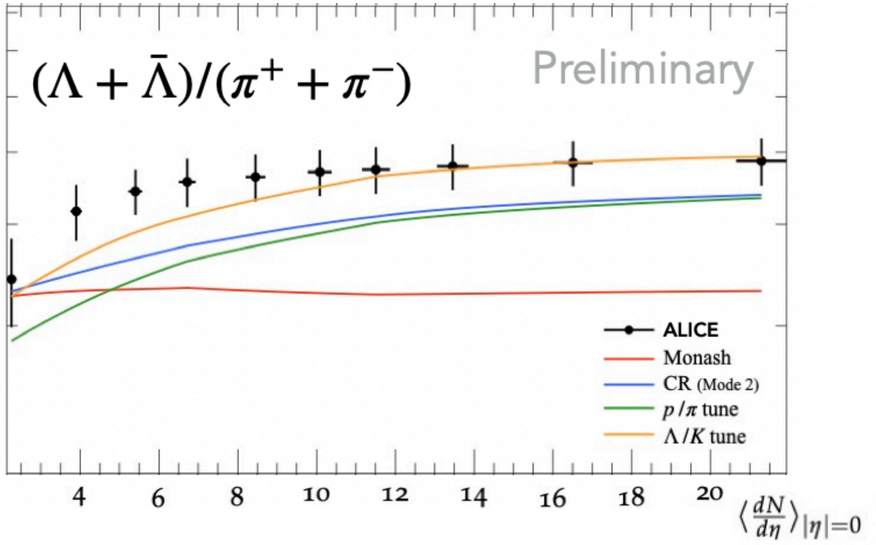


What if there's a blue string nearby?



blue $q\bar{q}$ fluctuation breaks nearby blue string, preventing diquark formation





Future studies

Close packing

- Study of **triplet vs octet** (clean experimental environments?)
- **LEP effects** and **strangeness in jets**
    - Need to construct model that works with jets and e^+e^- collisions

Strangeness overall

- **Ξ_c underprediction**
    - Study of formation in Pythia (i.e. junctions or diquarks). This will also be useful for studying the Λ_b and p over predictions

Diquark suppression

- Need CR colour tracing stored in the event to get probabilities more correct
    - Currently assume even distribution of colours of the given number of nearby strings
- **p/π and Λ/K_s ratios** described simultaneously

CR procedure

- Rewrite code
- Add probabilistic treatment to CR

Thank you for listening!