1 A_{LL} into subprocesses

I hope what I state is mostly obvious but I would like to establish a notation in which we can discuss and analyze.

The A_{LL} we measure comes from qq, qg and gg scattering. In a PYTHIA framework there are also events that come from "minbias" without being attached to a specific subprocess. But lets ignore those for now.

We measure A_{LL} in a bin of some kinematic observable. For inclusive measurements this is usually p_T. For the two body final states we will be most concerned with here this will more often be in terms of observables we can relate to the partonic kinematic observables x_1, x_2, $\cos(\theta^*)$ such as $\eta_3 + \eta_4$, $\eta_3 - \eta_4$ and M_{inv}. But no matter how the bin is defined we can write the value measured in a bin, A_{LL}(bin), in terms of the subprocesses as

$$A_{LL}(bin) = (\sum_{k=1}^{K} P^k_{q1}(x_{q1}, p_T) P^k_{q2}(x_{q2}, p_T)\ \hat{a}^{k,qq}_{LL}(\theta^*) + \sum_{l=1}^{L} P^l_{q1}(x_{q1}, p_T) P^l_{g2}(x_{g2}, p_T)\ \hat{a}^{l,qg}_{LL}(\theta^*) +$$

$$\sum_{m=1}^{M} P^m_{g1}(x_{g1}, p_T) P^m_{q2}(x_{q2}, p_T)\ \hat{a}^{m,qg}_{LL}(\theta^*) + \sum_{n=1}^{N} P^n_{g1}(x_{g1}, p_T) P^n_{g2}(x_{g2}, p_T)\ \hat{a}^{n,gg}_{LL}(\theta^*))$$

$$\div (K + L + M + N)$$

Here I identify the quarks, q, and the gluons, g, as coming from proton 1 and 2 thus giving two terms for qg scattering. There are K, L , M and N events contributing to the qq, qg, gq, and gg processes. (Thinking ahead to PYTHIA rather than integrals of cross sections.) Any event is characterized by the partonic x of the two partons involved, p_T and θ^* determining the the partonic spin correlation $\hat{a}_{LL}$ and implicitly the cross section. The polarization of each parton is notated by P and is of course a function of x and the evolution scale indicated by p_T.

1.1 Extracting ΔG sensitivity

The quark distributions are pretty well known. So there are in general two unknowns, P_{g1} and P_{g2}. We are assuming that the range of the kinematic variables allowed in the bin is narrow enough that correlations between them are small and thus only the relevant normalization between the terms is important. Thus generic P_{g1} and P_{g2} across the 4 terms has some meaning.

How do we deal with 2 unknowns?

In some cases there will be a large overlap in the x values for g1 and g2. Then we collapse into a situation with one unknown, $P_{g1} \sim P_{g2}$, and a quadratic equation to solve.

When the x of the two gluons is asymmetric, as it will be in the endcap, it may be that one of the qg terms dominates and the gg term is small, particularly if the kinematics included in the bin has been well chosen, as in γ-jet in the endcap. Then again information on the g polarization is directly extractable and we can deal with the other small terms as corrections with uncertainties.

In the general case I suggest we consider looking at the derivatives of A_{LL}(bin) wrt. P_{g1} and P_{g2} when using different PDFs, for example GRSV-std, GRSV=0, GRSV(ΔG $<$ 0) and GSC. Then when you evaluate the derivatives, it tells you how well you will know the polarization of the gluons in that bin for a given statistical precision of A_{LL}(bin). One can imagine bins where qg and gg cancel (or add) their sensitivities. Of course we are trying to help ourselves by selecting kinematics so that qg dominates.

1.2 What do we need from Monte Carlo?

The first question is what bins to consider. Tai has already been plotting against $\eta_3 + \eta_4$, cos(θ^*) and M$_{inv}$. It will probably make some sense to plot vs. x$_{min}$ and x$_{max}$ as well. I am unsure what analysis infrastructure is available in the endcap or FMS region including MC files. Maybe we will have to address these regions by hand if possible. I do have a spread sheet I used. It has most everything but unpol. parton distributions which I would need at various evolved scales. If we stick to PYTHIA can we use just the generated events without detector simulations?

We definitely want to make p_T cuts by region as discussed in developing the triggers for this year. This is to concentrate on the regions where we can expect mostly qg scattering. In order to involve at least one parton with x>0.2 we need graded p_T thresholds by region. We should consider something like

$\eta_3 + \eta_4 >$	p_T (GeV)
3	4
2	7
1	12
0	15
-1	12

We of course may want to iterate on these once we see the sensitivities and try to optimize.

Now for any bin we want to accumulate various averages of kinematic quantities and observables. And I think we want these per process for each bin, (each of the 4 terms) qq, qg, gq and gg. Probably easiest to make histos of

P_1, P_2, $\hat{a}_{LL}$, p_T, $\cos(\theta^*)$, x_1 and x_2

in addition products like

$x_1 x_2$, $P_1 \hat{a}_{LL}$ and $P_2 \hat{a}_{LL}$

1.3 What can we get done?

This is the big question. Nu wants drafts of the BUR by mid-March. This and the white paper need to go to the PAC which I believe is May 8-9. The documents will probably be sent out a week ahead of time but one should expect only minor changes and filling in of place holders the week before going out. Last chance for text updates is then probably week of April 21. Probably can feed slides for presentation up till May 2. There will be various deadlines between now and then and we will need to show some progress to justify including text and place holders for figures.

/N/u1/sowinski/star/spinpwg/diJets/LOanal.tex