Light Nucleus Production in p+p & d+Au

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Outline:
• Results so far...
• Embedding Request...
• Run-9 200 & 500 w/ TOF
  PID
  Bunch ID
  Cuts
  Cross-sections
Existing Results on $B_2$

$B_A = \sigma_A / \lbrack \sigma_N \rbrack^A$

where the cross-sections are evaluated at same momentum

$B_A = d/p^2$

where cross-sections are formed at same $P_T/A$ & $y=0$, $\Delta y=1.0$

deuterons relative to protons is largest in “elementary collisions”...

• factor of $\sim 40$ larger than in $A+A$ according to the trend (blue squares)

• essentially independent of beam energy ... also unlike $A+A$

where’s the RHIC results?!?
where does the RHIC data fall?
...we have p+p @ 62, 200, & 500 GeV & d+Au @ 200 GeV

Conventional Wisdom:
- p+p: several strings stretched between 2 hadrons
  ...B2 ~ 0.02
- γ+p: fewer strings
  ...B2 ~ 0.01
- e+e: only one string
  ...B2 ~ 0.003
- A+A: lots of strings, but strong rescattering kills all d’s except those that form very late
  ...B2 ~ 0.0003

Fig. 3a, b. a Possible string breakup process with a pn pair. b Space-time structure of the breakup
Comparisons to world’s data.....

<table>
<thead>
<tr>
<th>Summary* so far:</th>
<th>Experiment</th>
<th>Coalescence Picture:</th>
<th>Pythia+(\Delta p)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p+p, 200 GeV, Run-8:</td>
<td>(B_2 = 0.02 \text{ GeV}^2)</td>
<td>(R \sim 3.3 \text{ fm}, \ p_o \sim 180 \text{ MeV})</td>
<td>(\Delta p \sim 210 \text{ MeV})</td>
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<tr>
<td>d+Au, 200 GeV, Run-8:</td>
<td>(B_2 = 0.01 \text{ GeV}^2)</td>
<td>(R \sim 4.2 \text{ fm}, \ p_o \sim 150 \text{ MeV})</td>
<td>(\Delta p \sim 180 \text{ MeV})</td>
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</table>

(*) No tracking & PID efficiency, absorption, or feeddown corrections yet!
Light nucleus production & Jets in p+p and d+Au....

Plot proton & deuteron cross-sections and $B_A$ values separately for
- events in which no jet(s) reconstructed...  "UE"
- tracks not associated with a Jet...
- tracks associated with a Jet...

Does $B_A$ depend on UE vs Jets?
Different nucleus production mechanisms?
Are R & $p_0$ different?

Must calculate $B_2$ via invariant cross-sections vs $P_T$-hat...
the same analysis strategy is typically used when doing HBT in jets...
can also use $1/(P_T N_{ev} d\phi) dN/dP_T/d\phi$ and set $\phi$ via jet axis

Need to respin the data: Jet Makers not set up exactly as this analysis requires...

1. StVpdCalibMaker (locate vertex that VPD/TOF sees)
2. JetMakers with Modified StBET4pMaker (use consistent vertex!)
   see http://www.star.bnl.gov/HyperNews-star/protected/get/jetfinding/1003.html and replies
3. Call StBTofCalibMaker and MyAnalysisMaker to analyze Jets and Tracks
Large increase in BA with increasing Jet Energy for (anti)nucleons & nuclei in Jets remains!
Pair Normalized 2 “proton” relative momentum distributions, gated on Jet Energy

Higher-energy Jets $\rightarrow$ proton pairs more “focussed” (decreasing $<\Delta p>$ )
$\rightarrow$ Consistent with observed increasing $B2$ vs $E_{jet}$
Embedding Request

1. pbar, dbar, & tbar p+p 62 GeV, Run-6 P06ie
2. pbar, dbar, & tbar p+p 200 GeV, Run-8 P08ie
3. pbar, dbar, & tbar d+Au 200 GeV, Run-8 P08ie

1 particle per event...

Max pT: 1.5 GeV for pbar
3.0 GeV for dbar
4.5 GeV for tbar

Eta range includes EEMC: -1.5 < η < 2.0

No special treatment of jets in terms of placing simulated particles in specific events....

Need to specify run numbers in specific periods of each run (see following pages)...

Request submitted 4/30/2010..... Looks it’s close to starting (?)
Run-9 Data: p+p @ 200 & 500 GeV: big datasets, low-material, ~3/4 TOF!

TPC dE/dx (keV/cm) vs p (GeV/c)

TOF 1/β vs p (GeV/c)

What’s this junk?!?!
Plot TOF not $1/\beta$....

The ugly blob @ $1/\beta \sim 4.5$ is coming from “Bunch ID shifts” (TOF electronics errors)
One can simply require tof $< 32$ns (solid dE/dx PID exists for these momenta)
Better to remove the offending run numbers (see next pages)
Shifts are coming from well-defined trays....

I’ve generated the BunchID shift Run & Tray list for both 200 and 500 GeV

Ready to be input to the STAR dB

User chooses to skip the whole Run ...or just the shifted Tray(s)
Optimizing the TOF and Track Cuts to get best TOF PID
Black: all tracks with $1/\beta > 0$  Green: good $\pi/K/p$ PID via simple $M^2$ cut
Ratios.... ("PID Efficiency per track")
dE/dx-Bichsel vs. Momentum with various PID techniques.....

proton
deuteron
triton

all

TPC
PID

TOF
PID
Cross-sections and $B_A$ with TPC (solid) and TOF (open) PID

I still have some PID contamination issues....

Need to
- optimize TOF cuts
- efficiency/trk from ratio
- “unified PID”
- Repeat Jet correlations
Playing with a different style of PID.....

TOF $M^2$ vs $dE/dx$ in separate momentum bins... (200 MeV/c wide)

0-0.2 GeV/c

Still very crude at the moment.....
just set a $M^2$ window and $dE/dx$ lower limits....

Will be improved... ...next week
B_2 \sim 0.02
...trend from lower-energy data...
M^2 cut too tight...
Increasing B2 with Jet Energy trend still apparent....
Autocorrelation? (question from my talk @ March 2010 Collab. Mtg.....)

Plot Jet Energy spectrum....

Black Jet does not include p or d....
Red Jet contains a p but no d...
Magenta Jet contains a d but no p...

Counts

Normalized

particle

antiparticle