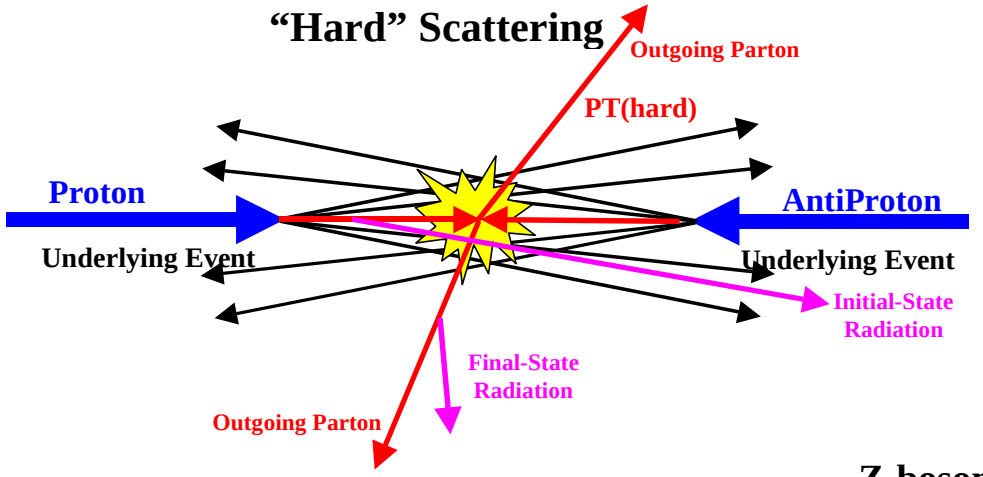
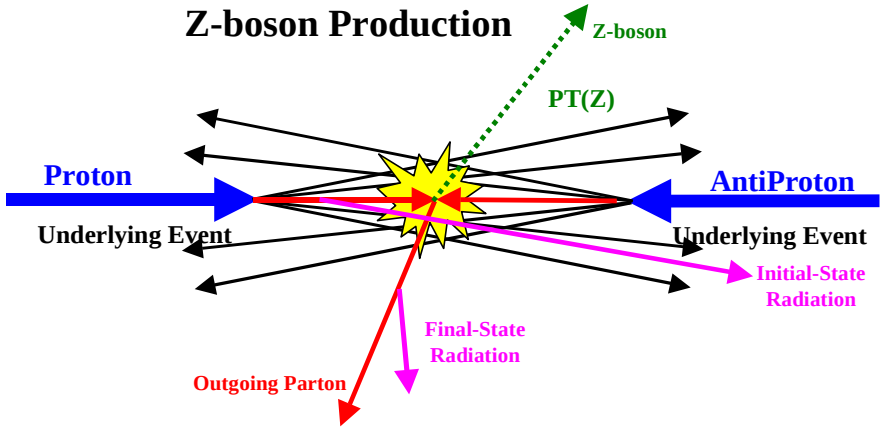
The Underlying Event: DiJet vs Z-Jet

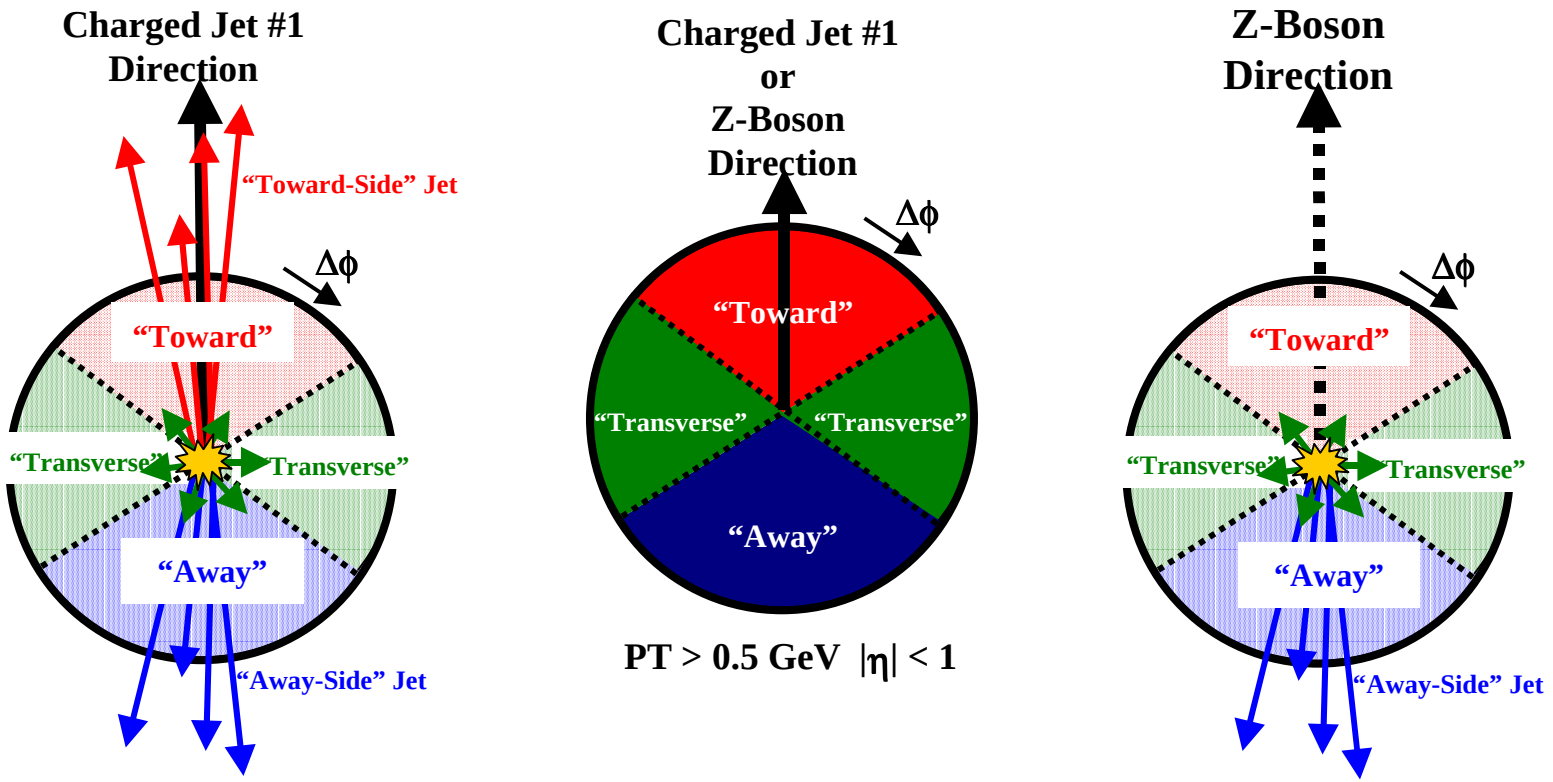


Refer to
Min-Bias +JET20
as
DiJet Data

The "underlying event"
consists of the
beam-beam remnants
and
initial-state radiation

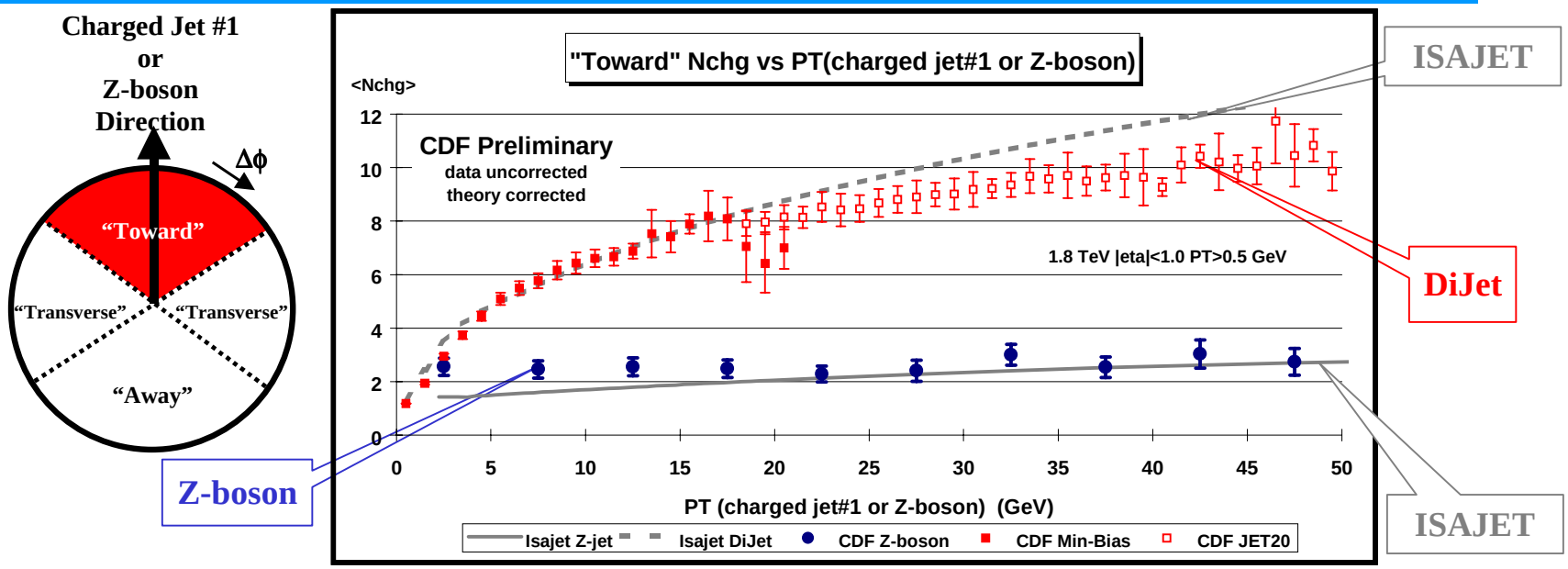


Charged Particle Δφ Correlations



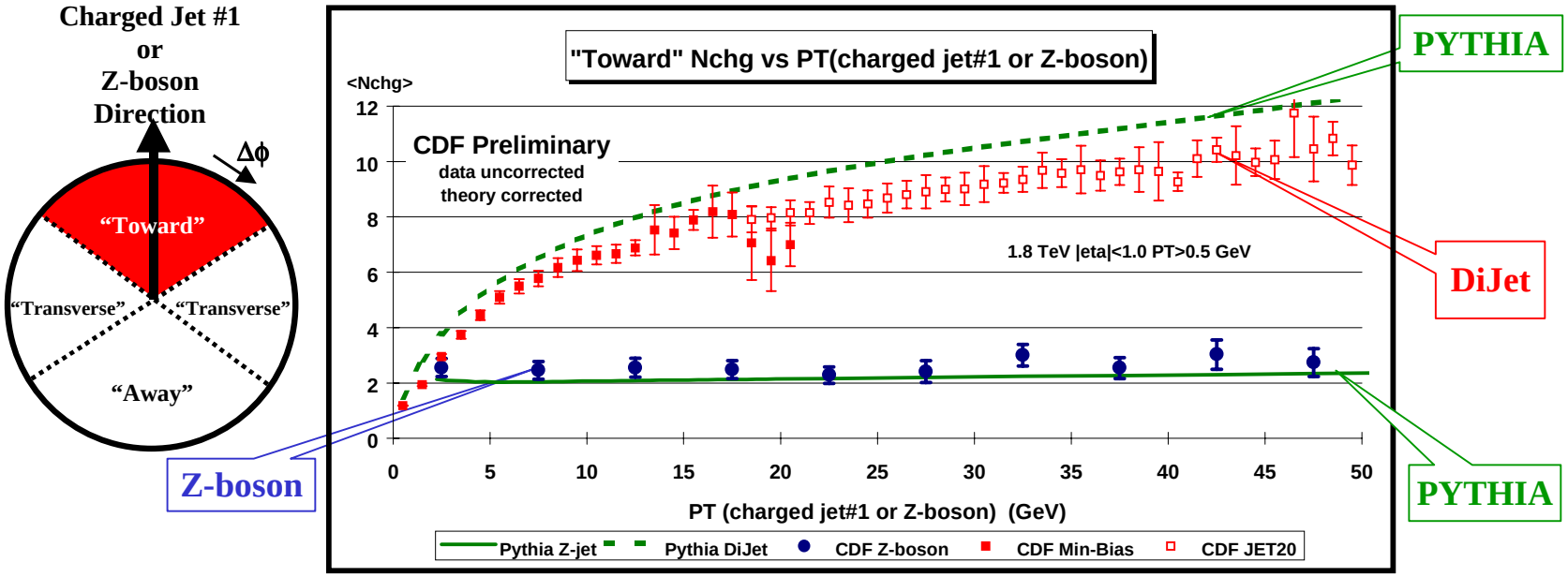
- Look at charged particle correlations in the azimuthal angle Δφ relative to the leading charged particle jet or the Z-boson.
- Define $|\Delta\phi| < 60^o$ as "Toward", $60^o < |\Delta\phi| < 120^o$ as "Transverse", and $|\Delta\phi| > 120^o$ as "Away".
- All three regions have the same size in η-φ space, $\Delta\eta \times \Delta\phi = 2 \times 120^o$.

DiJet vs Z-Jet "Toward" Nchg



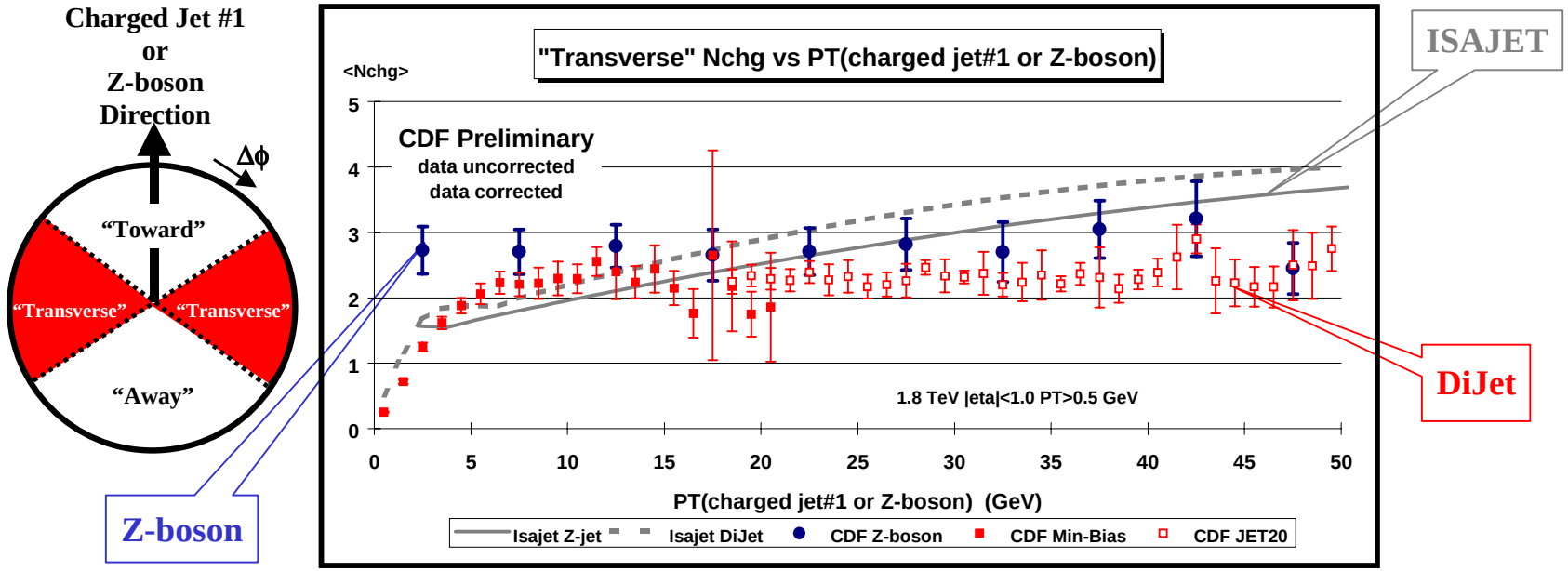
- Comparison of the dijet and the Z-boson data on the average number of charged particles (P_T > 0.5 GeV, |η| <1) for the "toward" region.
- The plot shows the QCD Monte-Carlo predictions of ISAJET 7.32 for dijet (dashed) and "Z-jet" (solid) production.

DiJet vs Z-Jet "Toward" Nchg



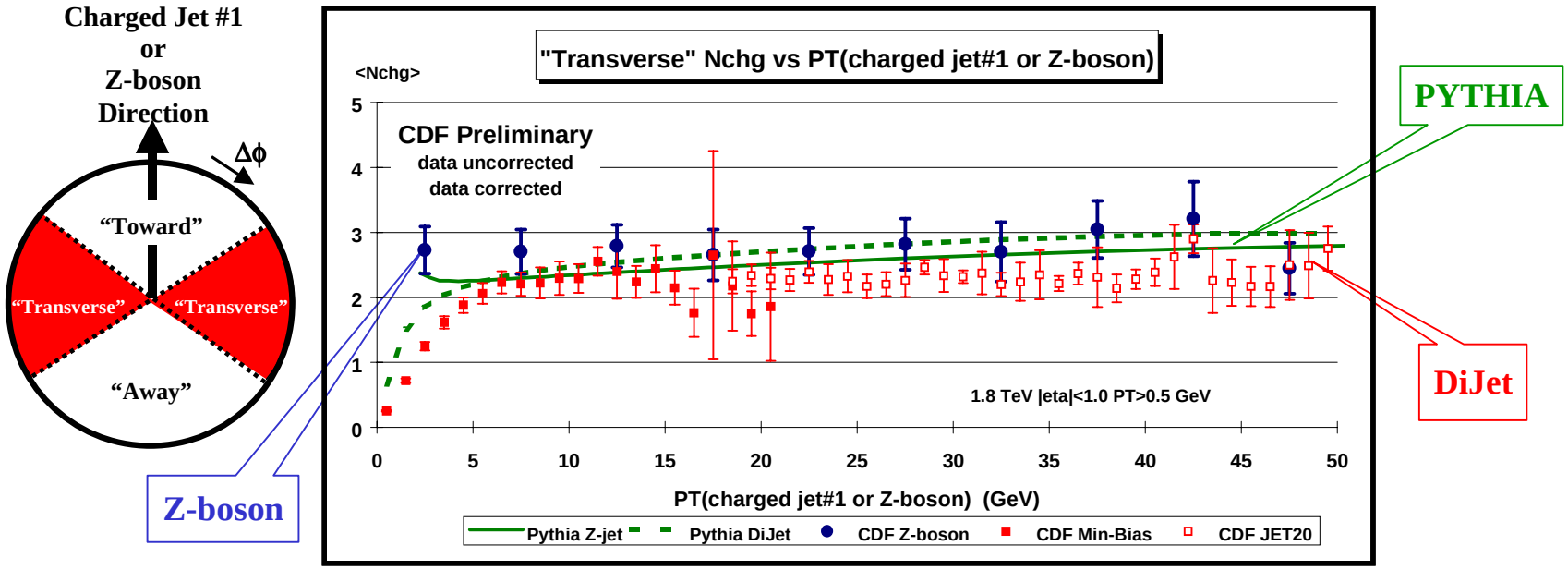
- Comparison of the dijet and the Z-boson data on the average number of charged particles (P_T > 0.5 GeV, |η| <1) for the "toward" region.
- The plot shows the QCD Monte-Carlo predictions of PYTHIA 6.115 for dijet (dashed) and "Z-jet" (solid) production.

DiJet vs Z-Jet "Transverse" Nchg



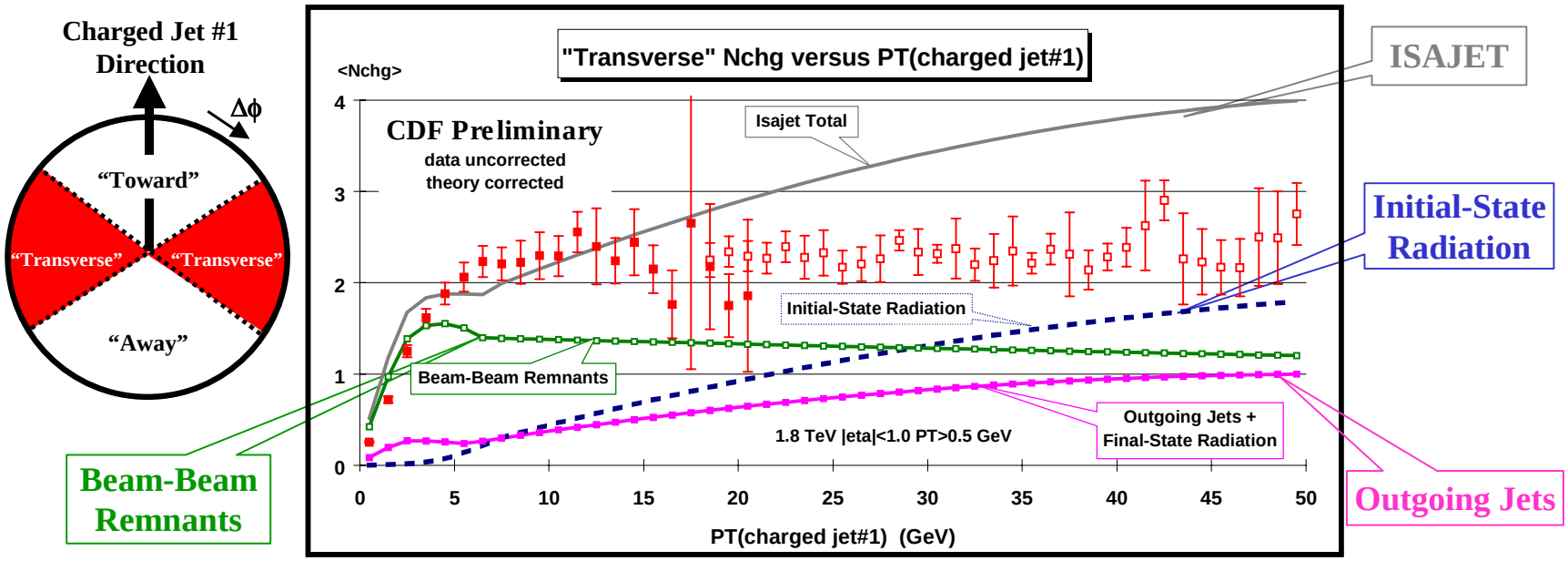
- Comparison of the dijet and the Z-boson data on the average number of charged particles (P_T > 0.5 GeV, |η| <1) for the "transverse" region.
- The plot shows the QCD Monte-Carlo predictions of ISAJET 7.32 for dijet (dashed) and "Z-jet" (solid) production.

DiJet vs Z-Jet "Transverse" Nchg



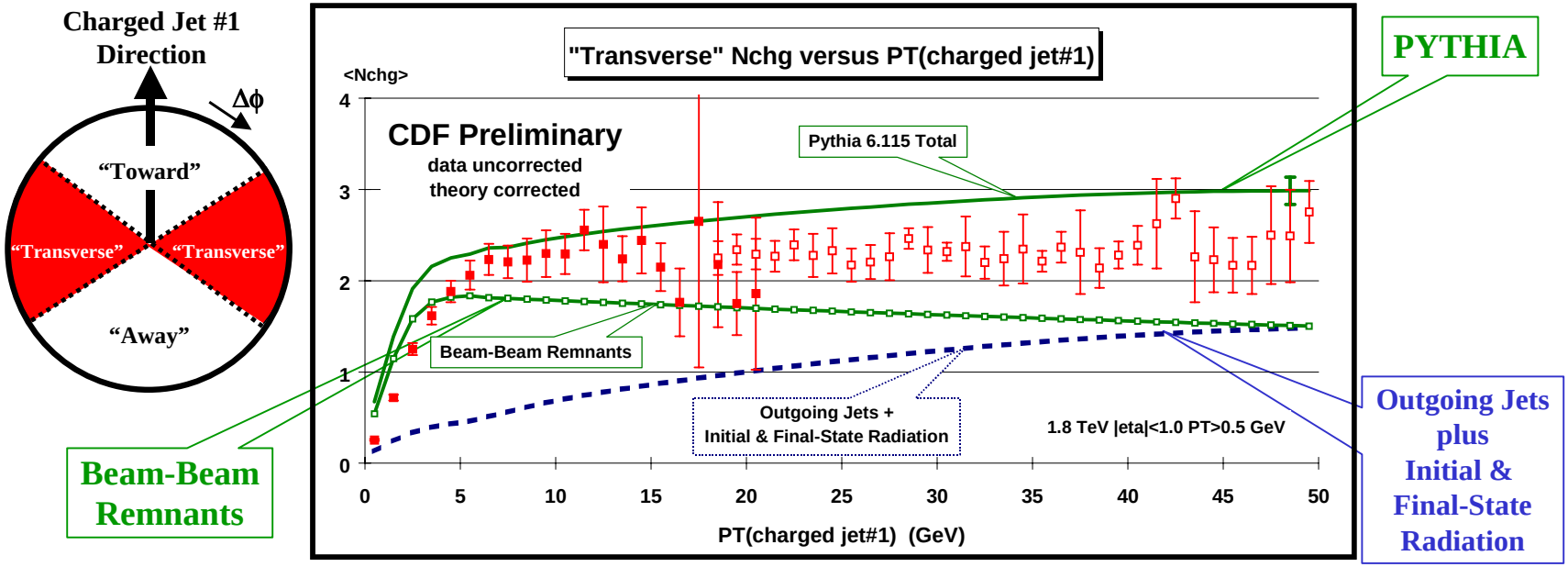
- Comparison of the dijet and the Z-boson data on the average number of charged particles (P_T > 0.5 GeV, |η| <1) for the "transverse" region.
- The plot shows the QCD Monte-Carlo predictions of PYTHIA 6.115 for dijet (dashed) and "Z-jet" (solid) production.

DiJet: "Transverse" Nchg versus PT(chgjet#1)



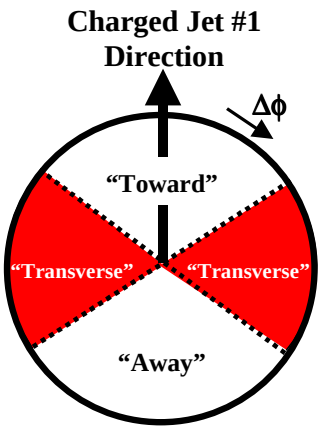
- Plot shows the dijet "transverse" <Nchg> vs P_T(chgjet#1) compared to the QCD "hard" scattering predictions of ISAJET 7.32.
- The predictions of ISAJET are divided into three categories: charged particles that arise from the break-up of the beam and target (beam-beam remnants), charged particles that arise from initial-state radiation, and charged particles that result from the outgoing jets plus final-state radiation.

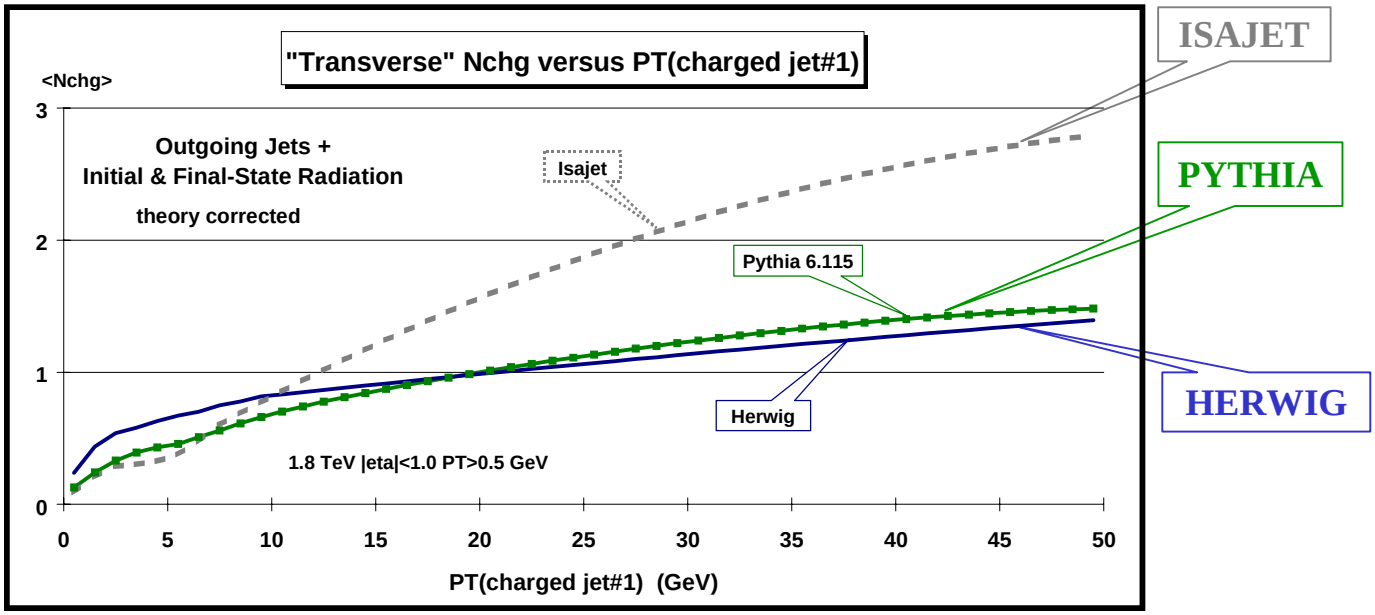
DiJet: "Transverse" Nchg versus PT(chgjet#1)



- Plot shows the dijet "transverse" <Nchg> vs P_T(chgjet#1) compared to the QCD "hard" scattering predictions of PYTHIA 6.115.
- The predictions of PYTHIA are divided into two categories: charged particles that arise from the break-up of the beam and target (beam-beam remnants); and charged particles that arise from the outgoing jet plus initial and final-state radiation (hard scattering component).

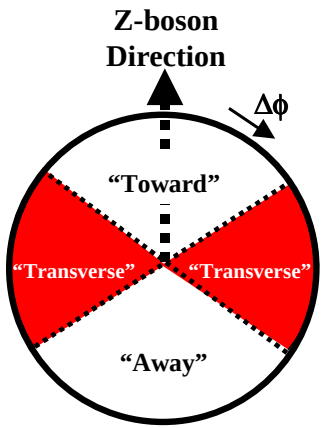
DiJet: "Transverse" Nchg versus PT(chgjet#1)

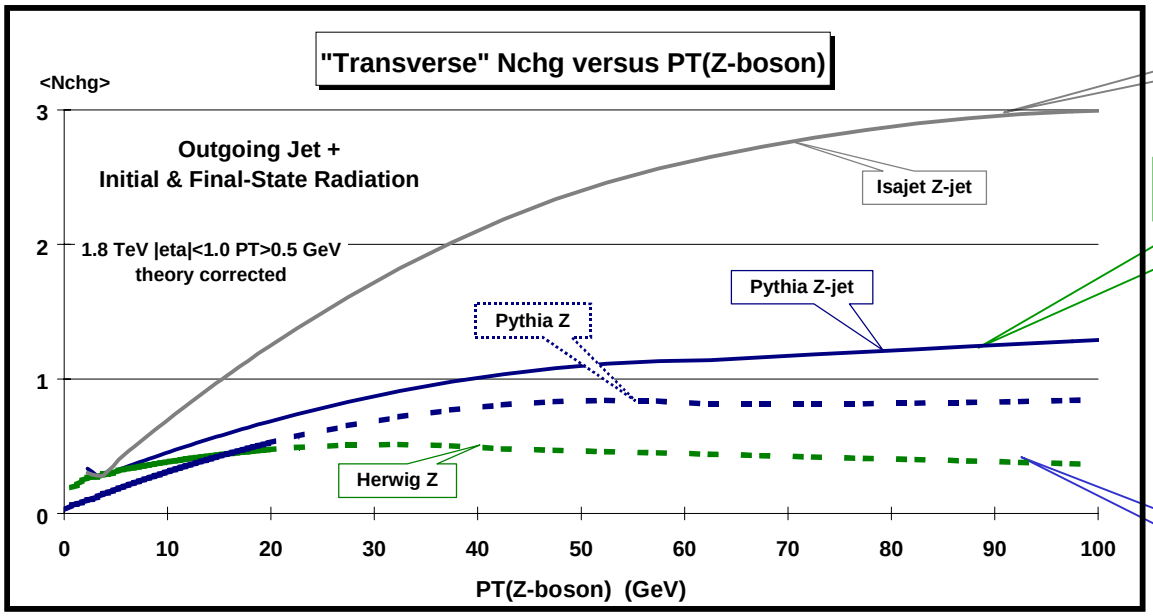




- QCD "hard" scattering predictions of HERWIG 5.9, ISAJET 7.32, and PYTHIA 6.115.
- Plot shows the dijet "transverse" <Nchg> vs P_T(chgjet#1) arising from the outgoing jets plus initial and finial-state radiation (hard scattering component).
- HERWIG and PYTHIA modify the leading-log picture to include "color coherence effects" which leads to "angle ordering" within the parton shower. Angle ordering produces less high P_T radiation within a parton shower.

Z-boson: "Transverse" Nchg versus PT(Z)





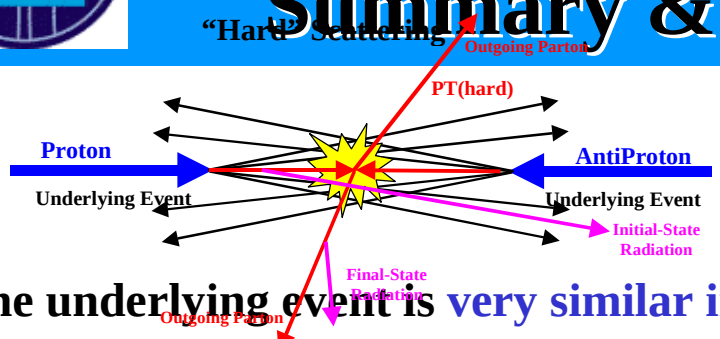
ISAJET Z+jet

PYTHIA Z+jet

HERWIG Z

- QCD Monte-Carlo predictions of HERWIG 5.9 ("Z"), ISAJET 7.32 ("Z-jet"), and PYTHIA 6.115 ("Z", "Z-jet").
- Plot shows the Z-boson "transverse" <Nchg> vs $P_T(Z)$ arising from the outgoing jets plus initial and finial-state radiation (hard scattering component).
- Same effect seen in dijet production.

The Underlying Event: Summary & Conclusions



The "Underlying Event"

- **The underlying event is very similar in dijet and the Z-boson production as predicted by the QCD Monte-Carlo models. The "toward" region in Z-boson production is a direct measure of the underlying event.**
- **The number of charged particles per unit rapidity (height of the "plateau") is at least twice that observed in "soft" collisions at the same corresponding energy.**
- **None of the QCD Monte-Carlo models correctly describe the underlying event. Herwig and Pythia 6.125 do not have enough activity in the underlying event. Pythia 6.115 has about the right amount of activity in the underlying event, but as a result produces too much overall multiplicity. Isajet has a lot of activity in the underlying event, but with the wrong dependence on P_T(jet#1) or P_T(Z). None of the Monte-carlo models have the correct P_T dependence of the beam-beam remnant component of the underlying event.**