Studies of parton shower and TMDs distribution in e-p collision

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HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

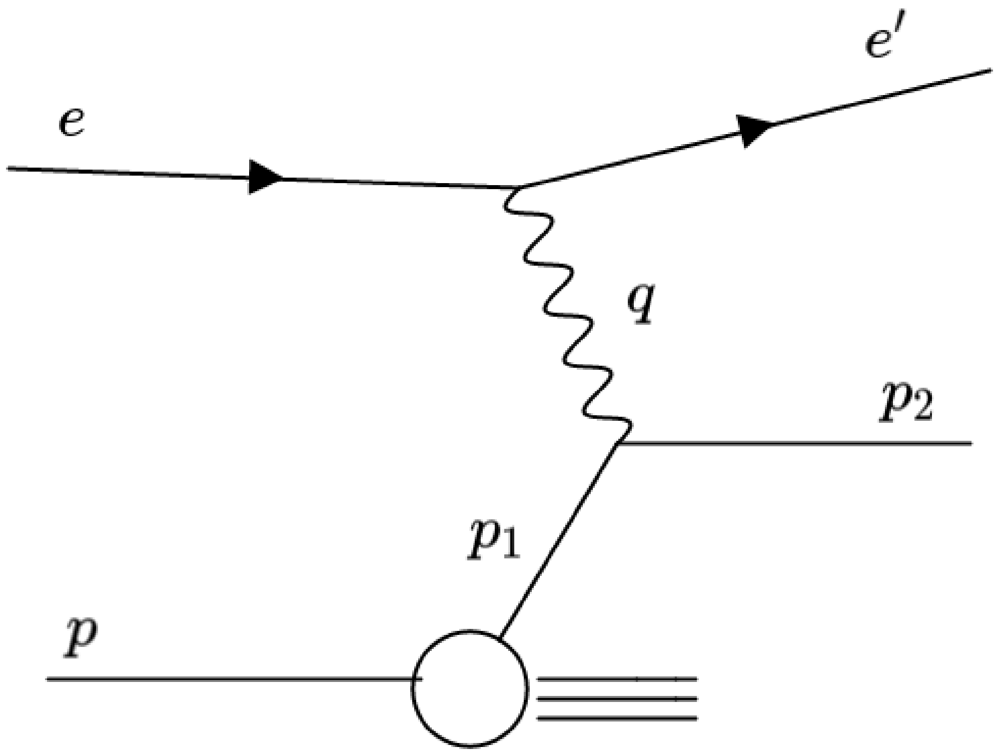
DESY.

Project task:

- Using PYTHIA8 and RAPGAP for DIS with the old, prepared data
- new data processing
- Writing Rivet plug-in for σ reduced with combined data
- comparing the PS effect
- Comparing histograms σ reduced with PYTHIA 8 and RAPGAP generator for new data
- Comparing intrinsic kT and kT with PS for small and big Q^2 range

Deep inelastic scattering:

- probe the insides of hadrons
- Initial mass is not equal to final mass
- Kinetic energy of final state and initial state is not conserve
- $Q^2 >> M^2$
- $$x = \frac{Q^2}{2M\nu}$$



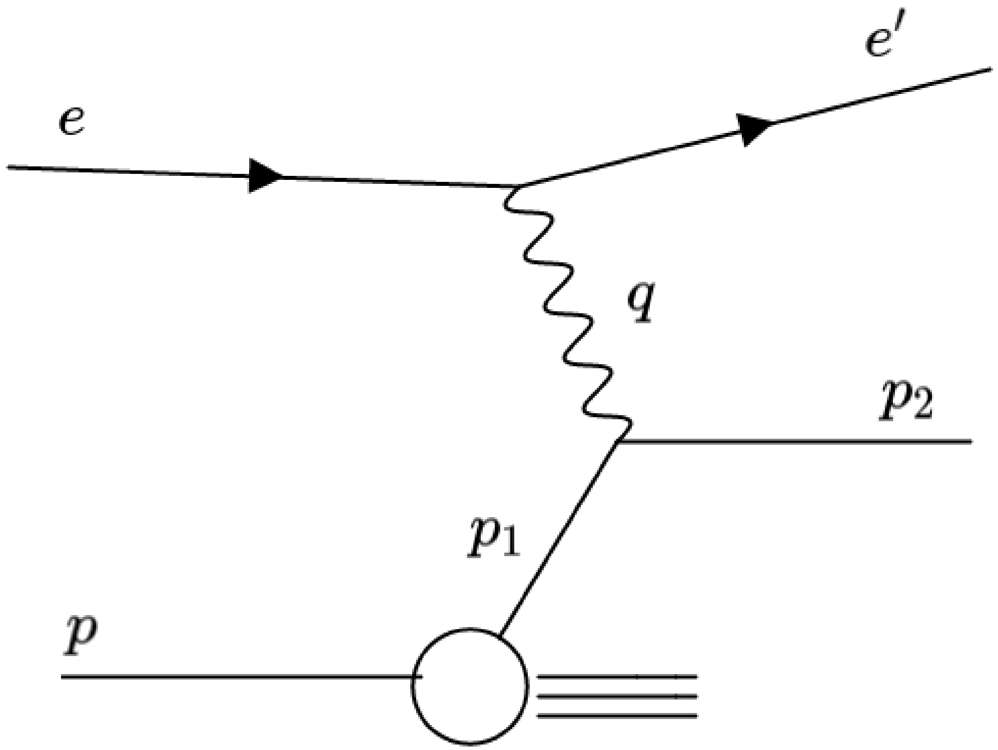
Some calculation:

- Collinear

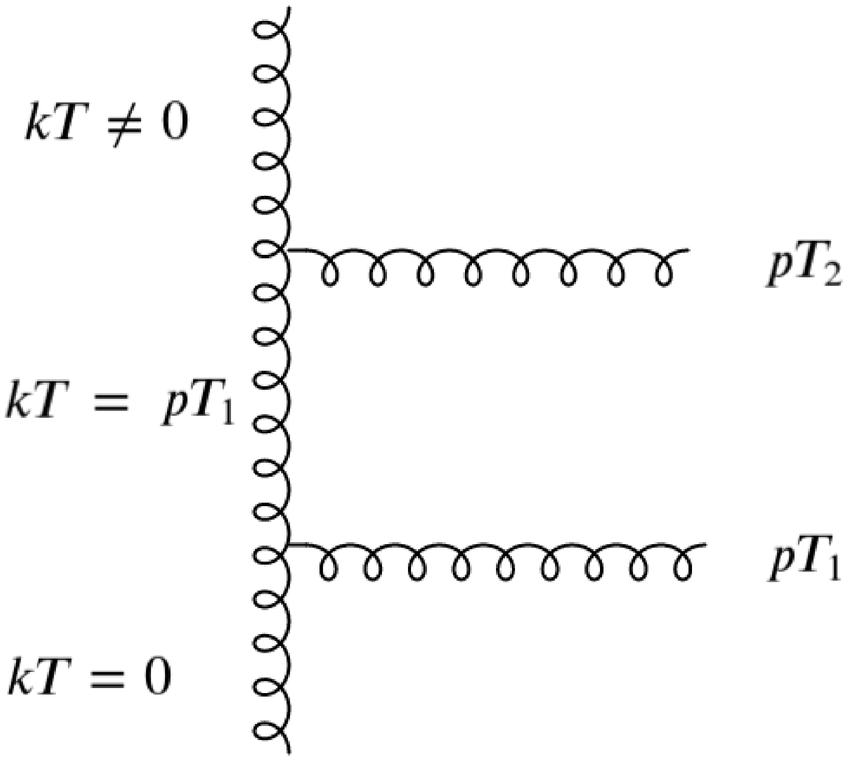
$$q + p_1 = p_2$$
$$p_1 = \xi p$$
$$(q + \xi)^2 = p_2^2$$
$$q^2 + 2q\xi p + (\xi p)^2 = p_2^2$$
$$p_1 = p_2 = 0$$
$$2q\xi p = -q^2$$
$$\xi = \frac{Q^2}{2qp} \Rightarrow \xi = x$$

- TMD

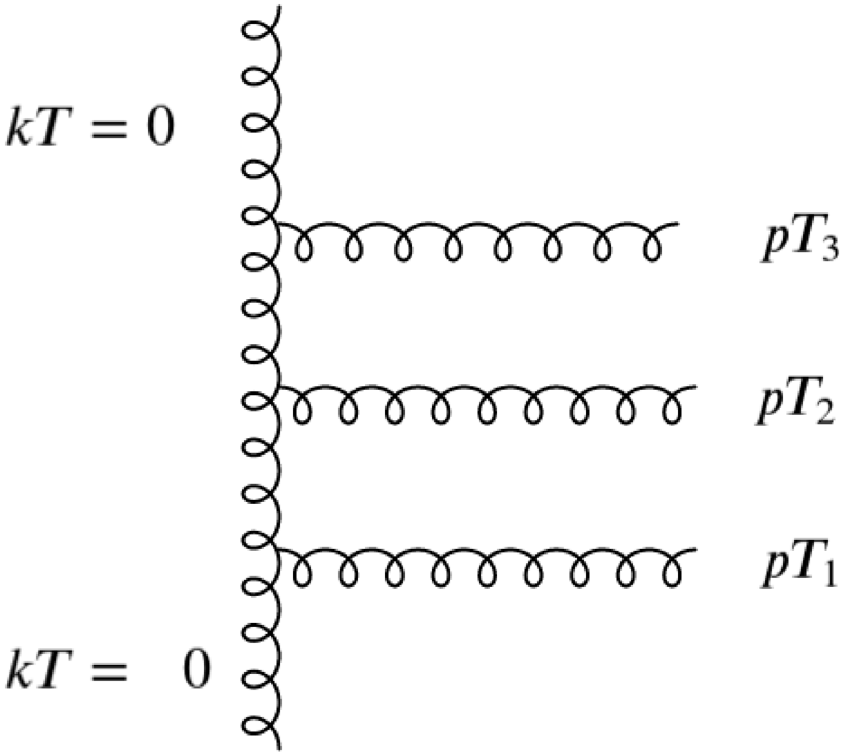
$$p_1^2 = -k_\perp^2$$
$$p_1 = \xi p$$
$$(q + \xi)^2 = p_2^2$$
$$q^2 + 2q\xi - k_\perp^2 = p_2^2$$
$$p_1 = p_2 = 0$$
$$2\xi pq = -q^2 + k_\perp^2$$
$$\xi = \frac{-q^2}{2pq}(1 - \frac{k_\perp^2}{p^2}) \Rightarrow \xi = x(1 - \frac{k_\perp^2}{p^2})$$



Distinguish between global recoil and dipole recoil

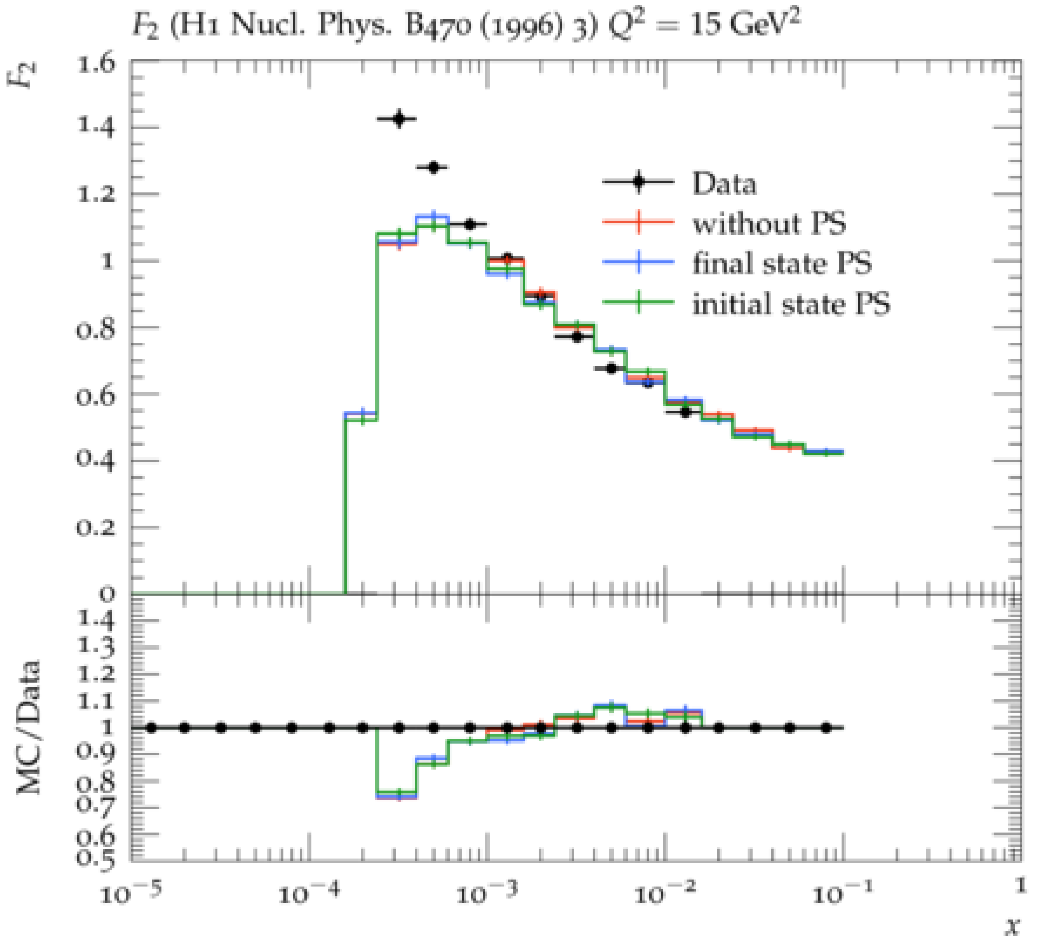


- Default shower

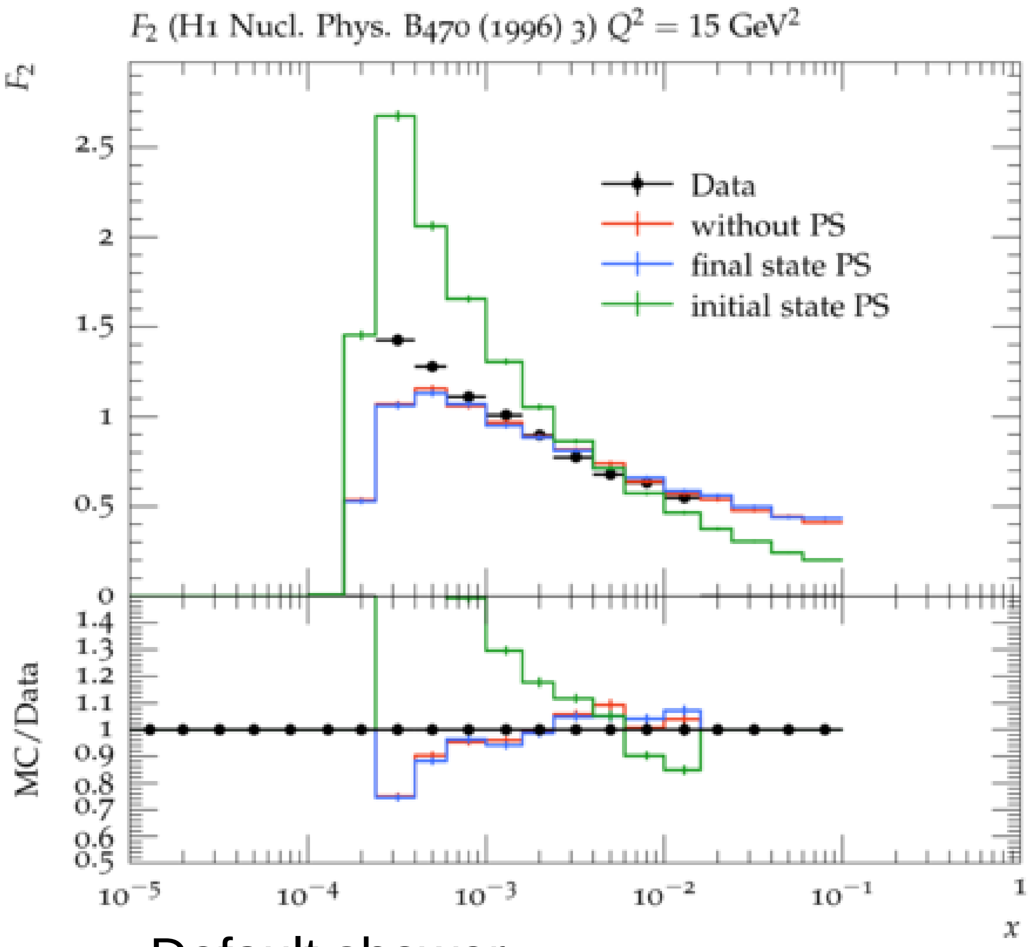


- Dipole recoil

F_2 function for old data in Q^2 = 15 GeV^2 with Pythia 8 generator

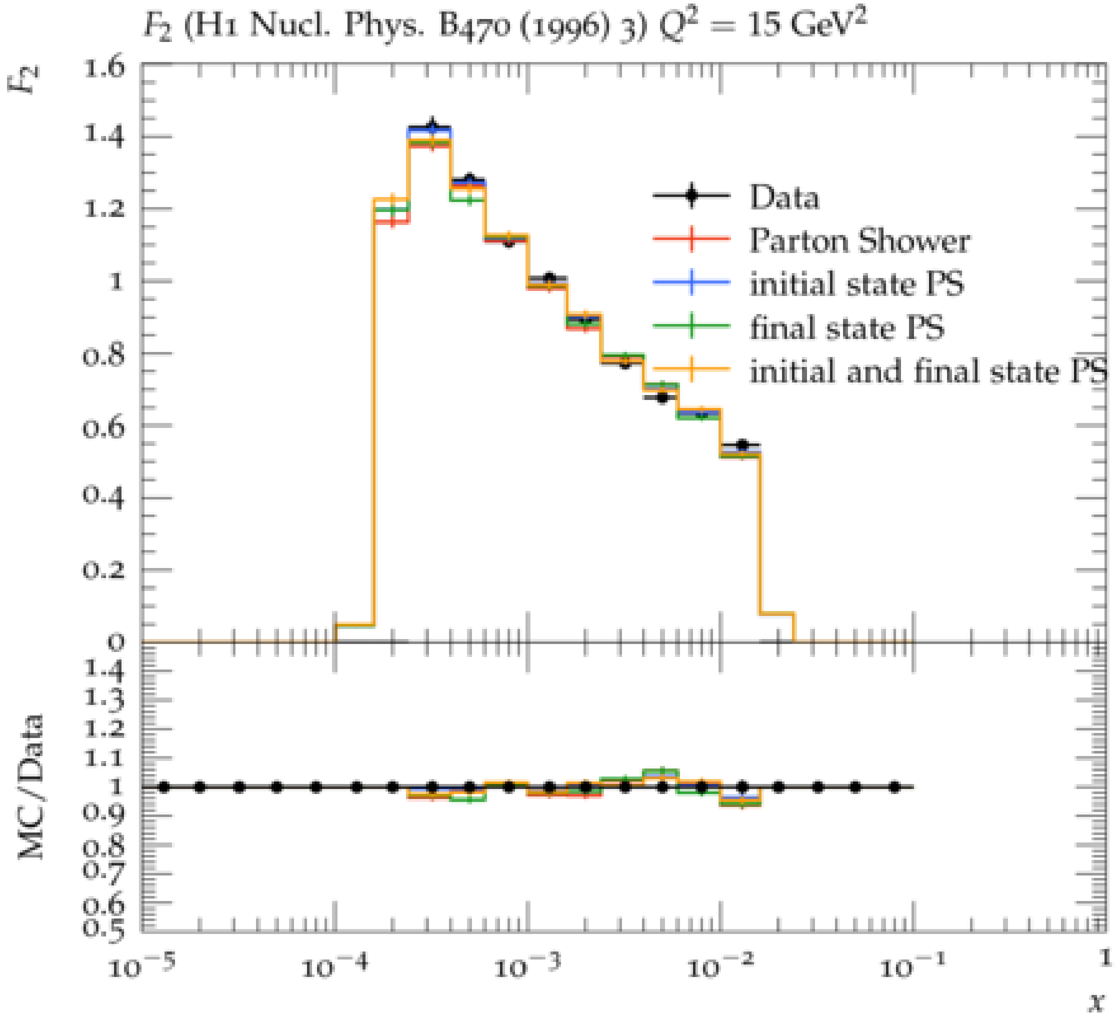


- Dipole Recoil



- Default shower

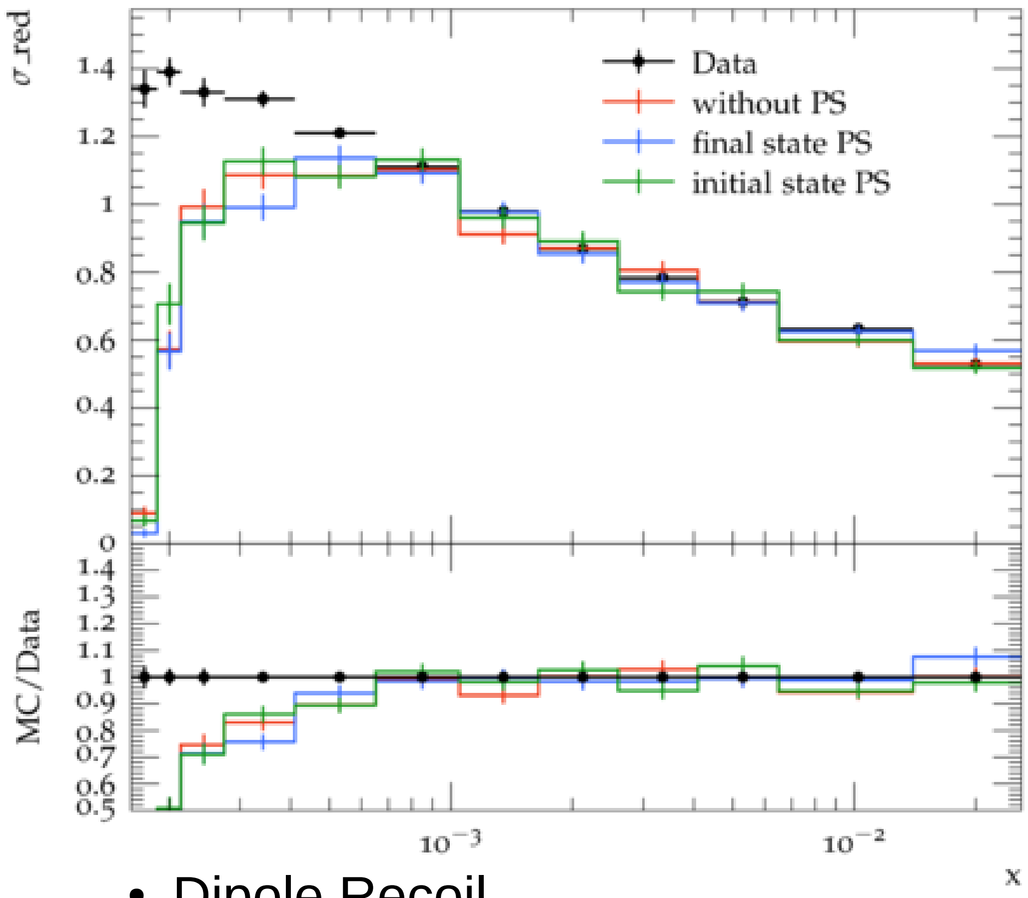
F_2 function with RAPGAP generator, Q^2 = 15 GeV^2



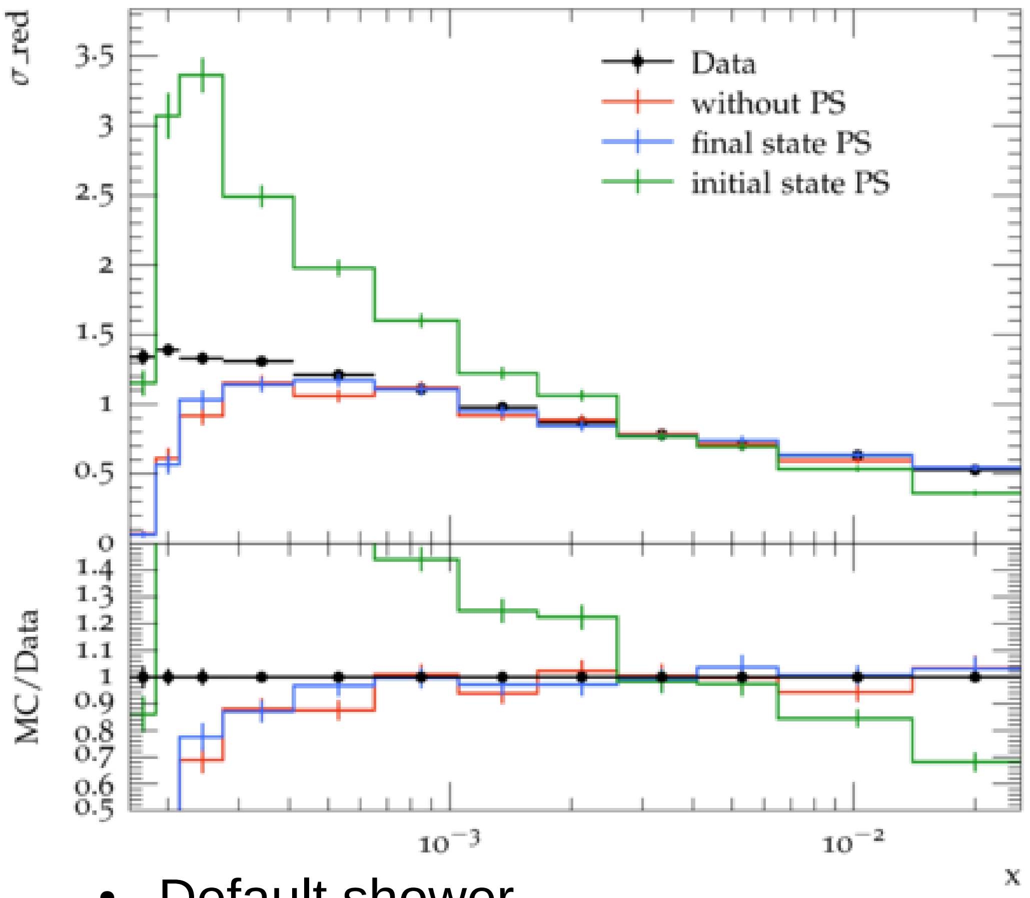
Data processing (from .txt to .yoda)

```
range_Q2[32] = ( Q2>=10000. && Q2< 15000. );
range_Q2[33] = ( Q2>=17000. && Q2< 24770. );
range_Q2[34] = ( Q2>=25000. && Q2< 42000. );
range_Q2[35] = ( Q2>=45000. && Q2< 70000. );

   //          Q2                        x       x_min    x_max    sigma    sigma_min    sigma_max
input_file>>Q2>>data[0]>>data[1]>>data[2]>>data[3]>>data[4]>>data[5]>>data[6]>>data[7];
//errors calculation
x_min=x_max;
x_max=( (x_buffer[i+1]- x_buffer[i]) /2);
if(x_max<0) x_max=x_min;


for(int j=0; j<histogram_number; j++)
{
    if(range_Q2[j])
    {
        if(counter2 != j )
        {
            counter2 = j;
                //title,path, type..
            if(j!=0) output_file<<"END YODA_SCATTER2D_V2"<<endl;
            if(j>=0 && j<9) output_file<<"\nBEGIN YODA_SCATTER2D_V2 /REF/H1_2015_I1377206/d01-x01-y0"<<to_string(counter2+1)
            else output_file<<"\nBEGIN YODA_SCATTER2D_V2 /REF/H1_2015_I1377206/d01-x01-y"<<to_string(counter2+1)<<endl;
            output_file <<"IsRef: 1"<<endl;
            output_file <<"Variations: []"<<endl;
            if(j>=0 && j<9) output_file <<"Path: /REF/H1_2015_I1377206/d01-x01-y0"<<to_string(counter2+1)<<endl;
            else  output_file <<"Path: /REF/H1_2015_I1377206/d01-x01-y"<<to_string(counter2+1)<<endl;
            output_file <<"Type: Scatter2D"<<endl;
            output_file <<"---"<<endl;
            output_file <<"# xval        xerr-    xerr+    yval"<<endl;

            //x errors calculation for first x
            x_min = x_max;
        }
        output_file<<scientific<<data[2]<<'\t'<<x_min<<'\t'<<x_max<<'\t'<<data[5]<<'\t'<<data[6]<<'\t'<<data[7]<<endl;


    }
}
```

σ reduced for different PS with PYTIA8 for Q^2= 15 GeV^2

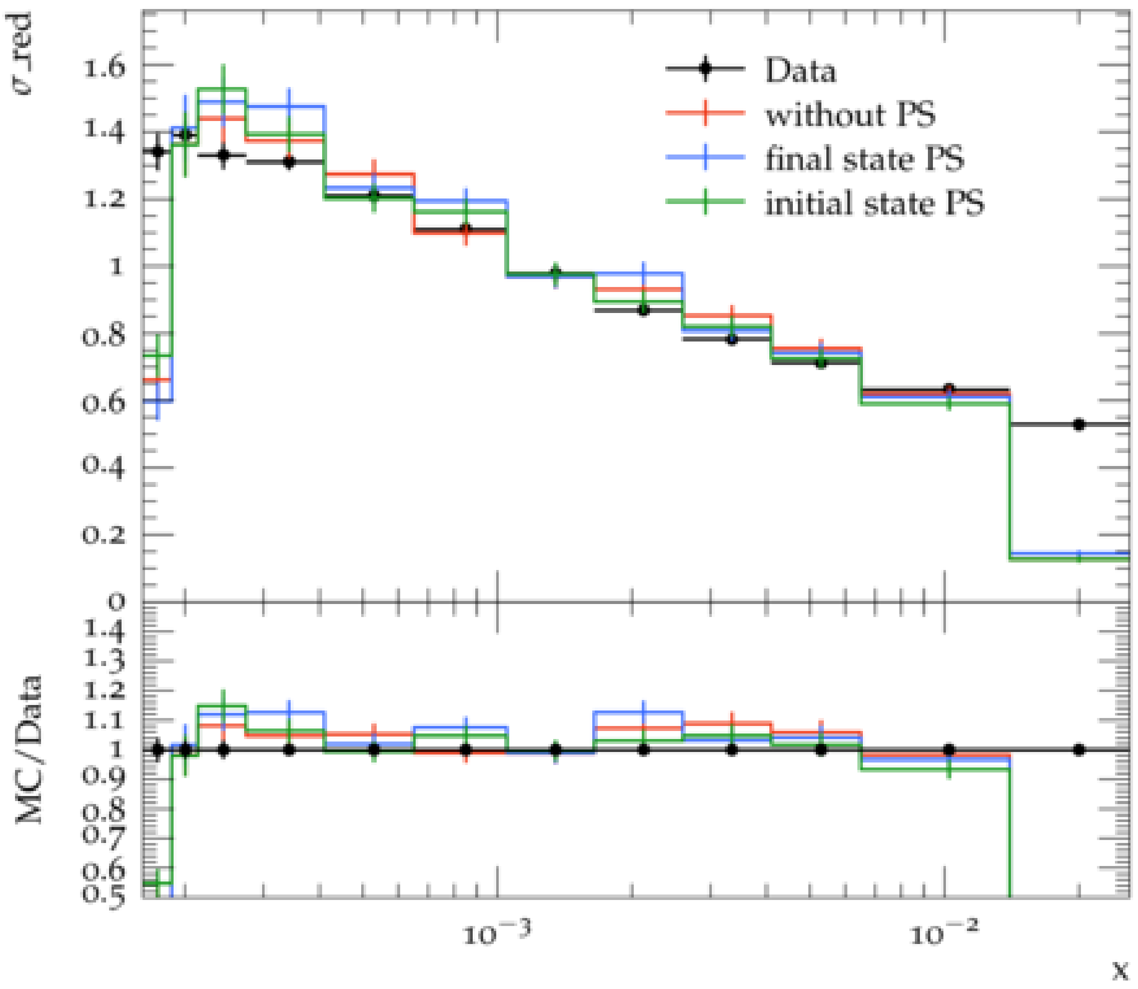


- Dipole Recoil



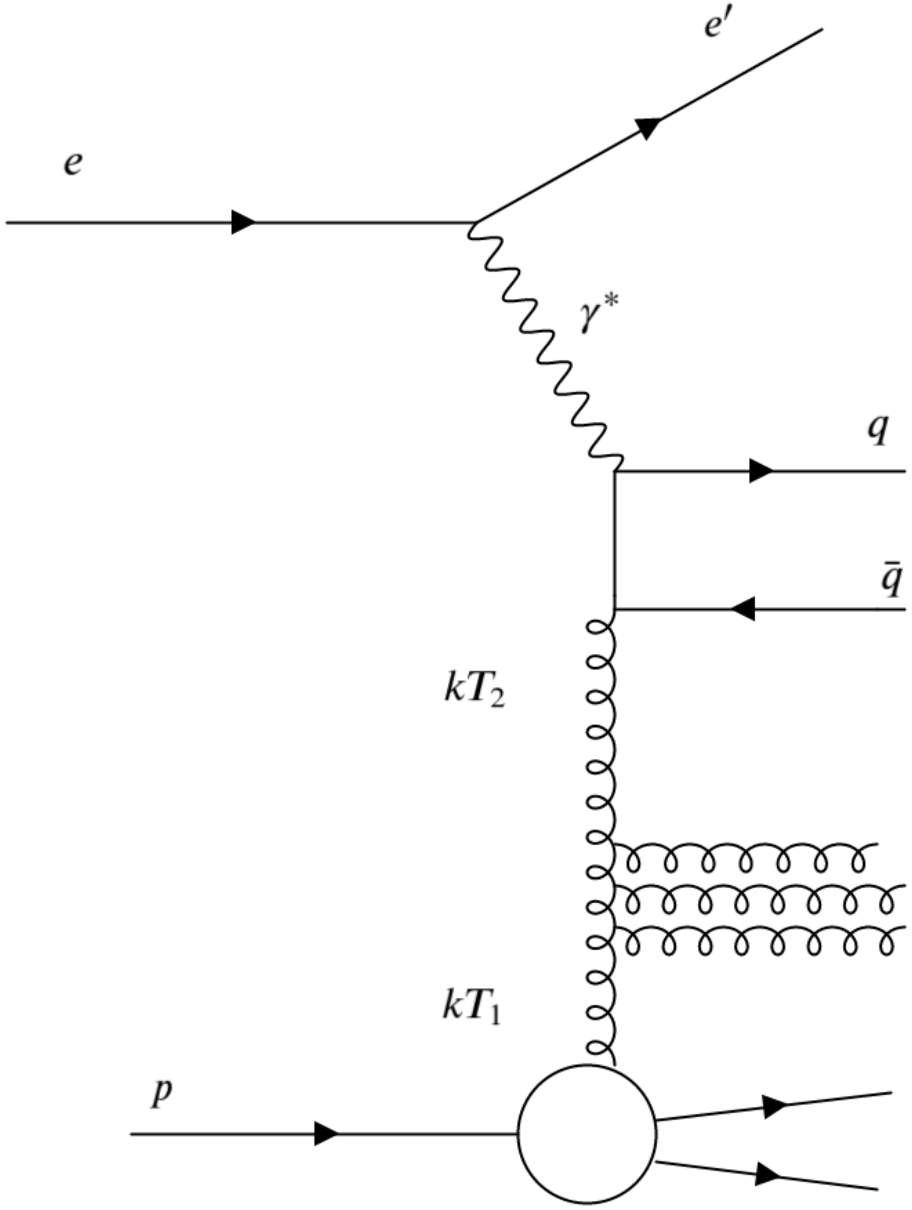
- Default shower

σ reduce for different PS with RAPGAP Q^2= 15 GeV^2

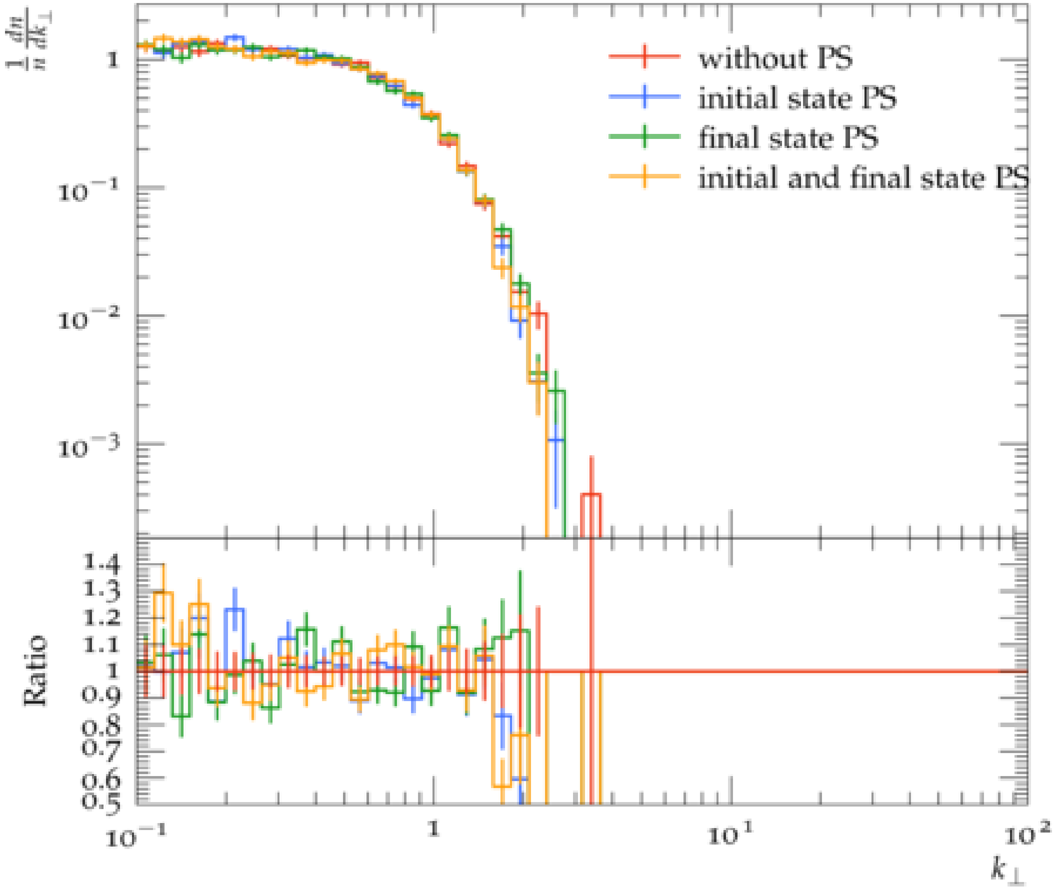


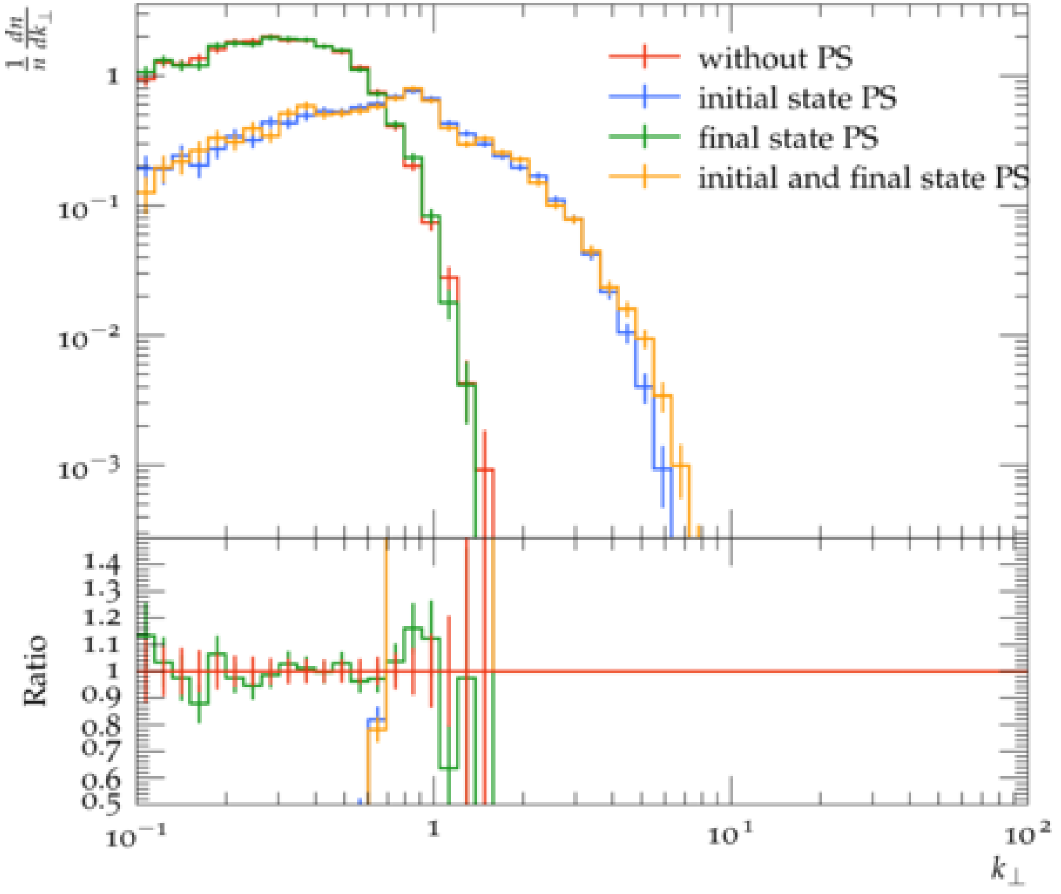
kT studies

- kT_1 => intrinsic kT
- KT_2 => kT with the initial parton shower

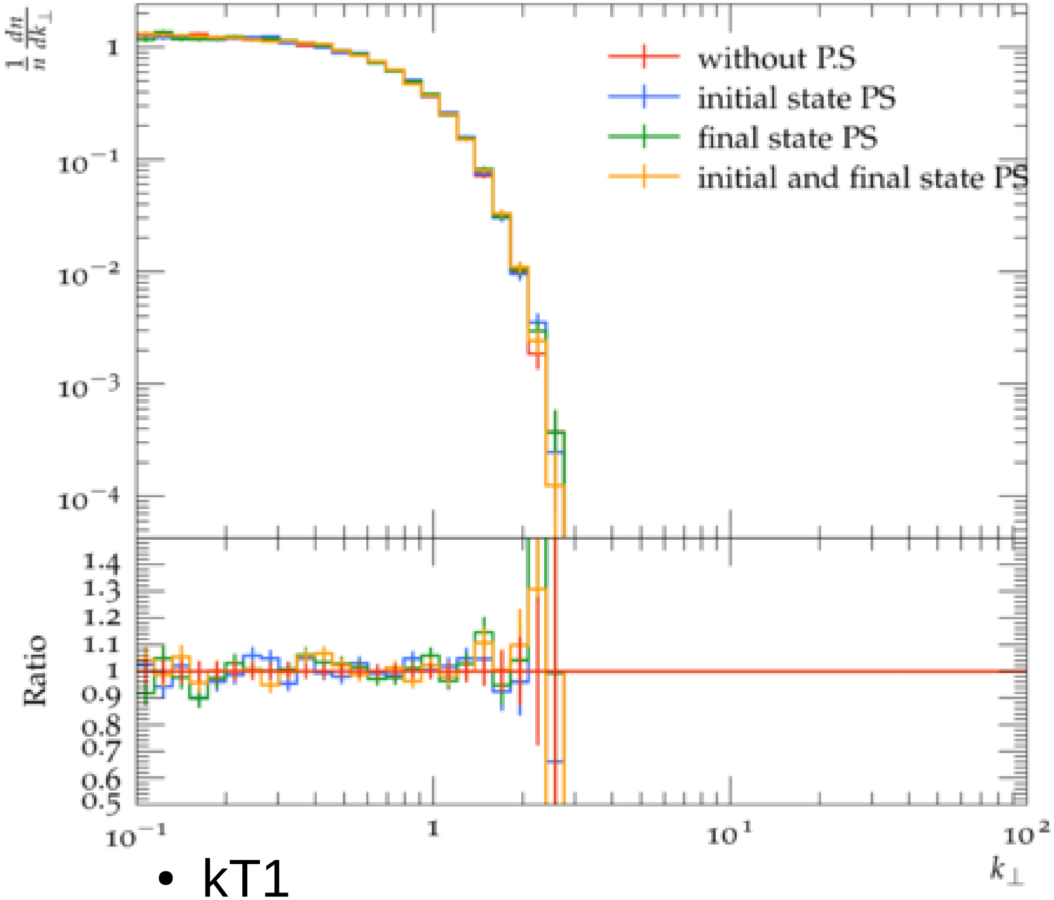


Histograms of kT1 and kT2 for small Q^2 range ($40\ GeV^2$ - $100\ GeV^2$)

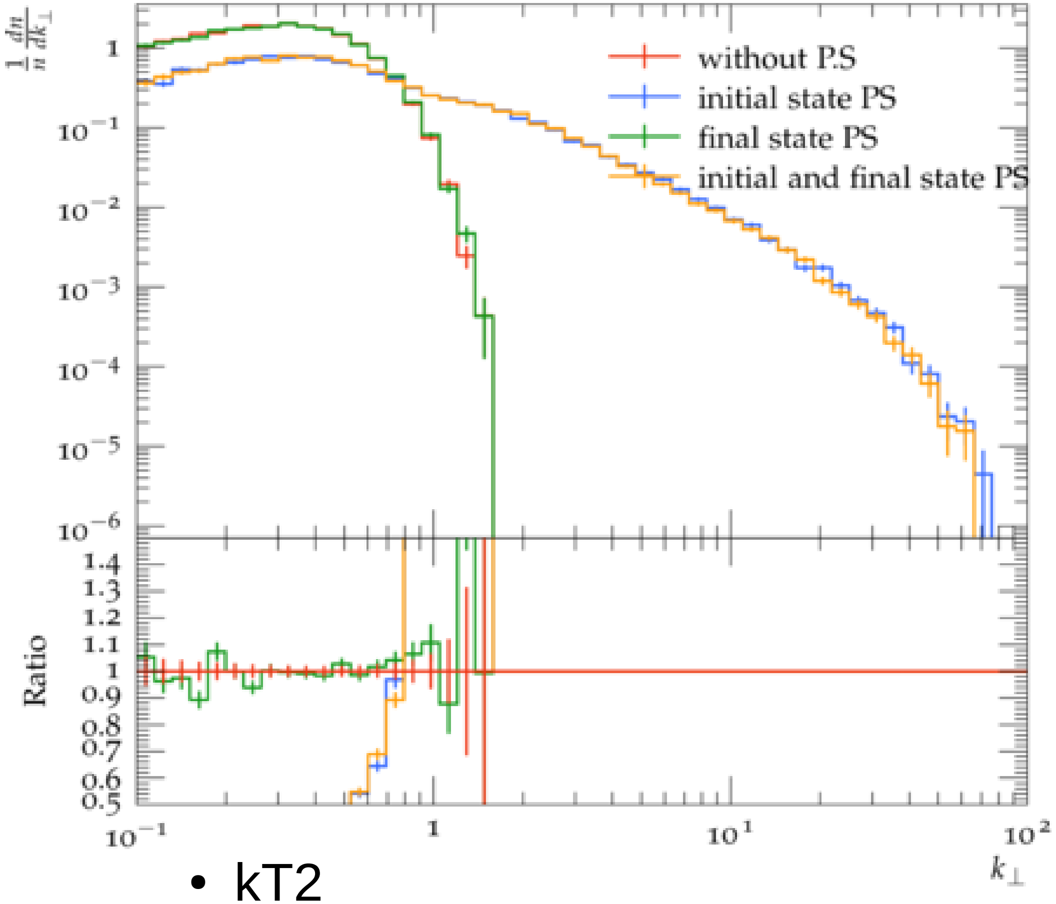




Histograms of kT1 and kT2 for big mall Q^2 range ($25000\ GeV^2 – 45000\ GeV^2$)



- kT1



- kT2

Summary:

- Significant parton shower effect
- Special treatment to count parton shower
- Significant difference between dipole recoil and default shower

Thank you.