Spin Physics Detector



Elastic proton-proton scattering at the first stage of the NICA collider operation

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Elastic p - p scattering at NICA SPD

Abramov et al, Phys.Part.Nucl. 52 (2021) 6, 1044-1119

 Allow to study the applicability of Regge approach in the construction of pN amplitudes.

 A_y -vector analyzing powers; Even measurement of the ratio A_y^p/A_y^d at low t gives valuable information on the transverse spin-spin term in NN amplitudes;



- To test some effects in specific kinematic regions $(\sqrt{s} = 5 7 \ GeV, -t = 5 10 \ GeV^2, \theta_{cm} \approx 90^\circ)$:
 - deviation from predictions in form of oscillations;
 - polarisation asymmetries;
 - color transparency phenomenon.

SPD Straw tube detector

Barrel part: 8 parts are installed in a carbon frame. Each octant consists of 30 double layers of straw tubes. Tubes are installed under variable angles to the beam orientation.



Each end cup consists of 8 coordinate planes assembled together and they form *X*, *Y*, *U*, *V* coordinate system. A free octagonal zone is formed in the center of the block, in which a vacuum tube with a diameter of up to 30 cm is located.

Used generators and geometry

Pythia8, minimum bias, $\sqrt{s} = 10 \ GeV$

* PYTHIA Process Initialization		*
I I We collide p+ with p+ at a CM energy of 1.000e+01 GeV I I		
I Subprocess	Code I I I	Estimated max (mb) I
<pre>I I non-diffractive I A B -> A B elastic I A B -> X B single diffractive I A B -> X X single diffractive I A B -> X X double diffractive I A B -> X X double diffractive I A B -> A X B central diffractive I * End PYTHIA Process Initialization</pre>	 101 102 103 104 105 106	 2.531e+01 7.114e+00 2.583e+00 2.583e+00 8.662e-01 0.000e+00
	0	

Average acceptance $(pp \rightarrow pp)$: $\approx 0.017 \%$ Estimated $N_{events}^{elastic} = 6.1e + 08$, $(\tau_{data \ taking} = 10^7 s)$.



(Fermilab)

 $p^{\uparrow}-p^{\uparrow}$

10

(COSY, Julich)

 $p\uparrow - p\uparrow$

10²⁹

10²⁸

FTFGen,
$$\sqrt{s} = 5 \ GeV$$

Using G4HadronInelasticDataSet() Try 1 cross_secel 0.000000e+00 cross(mb)in= 8.953248e+00 cross(mb)el= 0.000000e+00

Average acceptance ($pp \rightarrow pp$): $\approx 2.27 \%$ Estimated $N_{events}^{elastic} = 2.2e + 08 \ (\tau_{data \ taking} = 10^7 s)$. (RHIC, BNL)

 $p\uparrow - p\uparrow$

100

Selection criteria

- MCtrack is associated with MCparticle;
- Final state exists (track is fitted);
- Two charged particles in the final state;
- Charge of final state particles == 2;
- The decision on the signal event is taken on the level of MCtruth;

Signal event: $pp \rightarrow pp$ or $pp \rightarrow pp + \gamma$

Background event is basically any other event with two positively charged particles in the final state and any number of neutral particles.

Background events



Generated and reconstructed events

 $\sqrt{s} = 10 \ GeV$



Acceptance distributions



Hit map in Straw

 $\sqrt{s} = 10 \ GeV$

9



Momentum resolutions

 $p_{rec} - p_{gen}$ Plots are shown only for signal events, $\Delta p/p =$ *p*_{gen} $\sqrt{s} = 5 \ GeV$ $\sqrt{s} = 10 \ GeV$ d/d ∆p/p hResTheta signal 2626 Entries Mean x 8.819



30

25

15

10

 10^{3}

10²

10

Reconstructed kinematic distributions





Coplanarity cut







Summary

- Due to Straw EC geometry we will have low acceptance for elastic events. But, still the expected number of events is large.
- We can use a cut on coplanarity value + angle between final state particles to suppress the background events.