Central inclusive production of K^0_S at the experiment STAR

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Contents

- Motivation
- Experimental set-up
- Data a selection of events for the analysis
- Invariant mass K^0_S
- K^0_S yield
- Overview and plans for the future

Motivation

- research of central inclusive production in collisions of transversally polarised protons - reconstruction of K^0_S through its main decay channel $K^0_S \to \pi^+\pi^-$

CIP

- colliding protons stay intact
- central system X separated by rapidity gaps
- $p + p \to p + (h^+h^-) + X + p$

hadronic diffraction

- soft hadronic process
- LRG - large rapidity gap
- no quantum numbers exchange
- described by the Regge theory:
  - Pomeron exchange

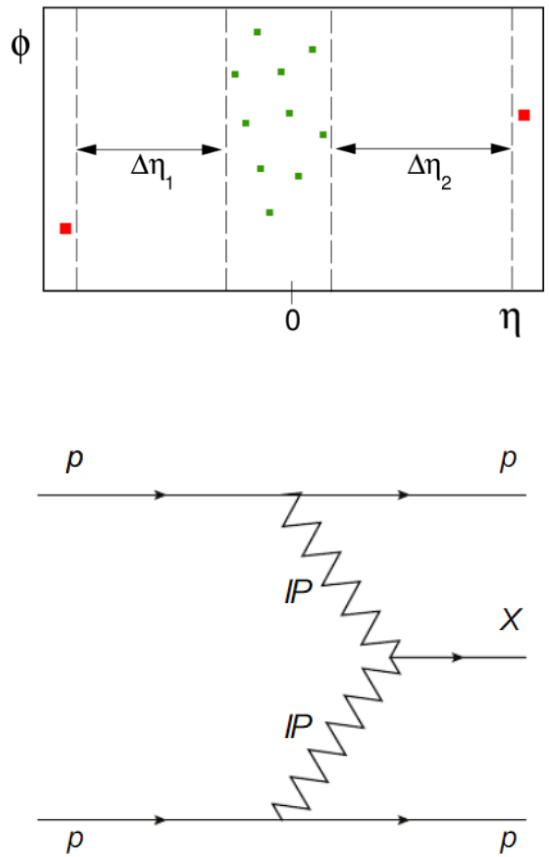

Fig.: Diagram of a diffractive process. [1]

Experiment STAR

TPC - Time Projection Chamber:

- length 4,2 m a radius 0,5 a 2,0 m
- membrane in the middle of its length with voltage -28 kV
- filled with a gas
- detection of charged particles together with TOF

TOF - Time of Flight:

- lateral area of the TPC cylinder
- Multi-gap Resistive Plate Chambers separated by alternating layers of glass and gas
- large voltage of the plates (> 10 kV)
- fast (time measurement resolution $60 - 100$ ps)

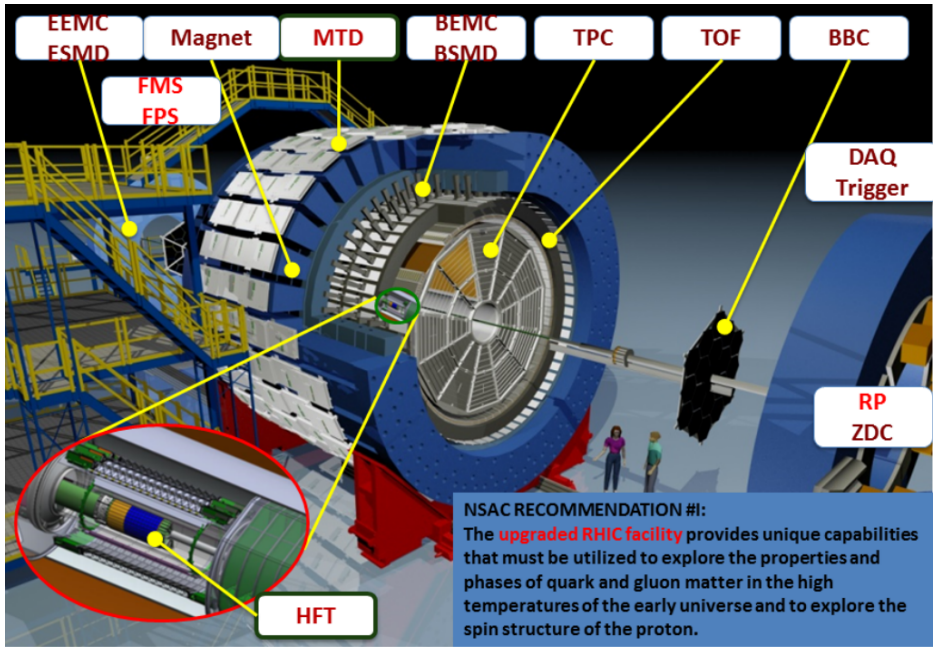

Fig.: STAR detector system. [2]

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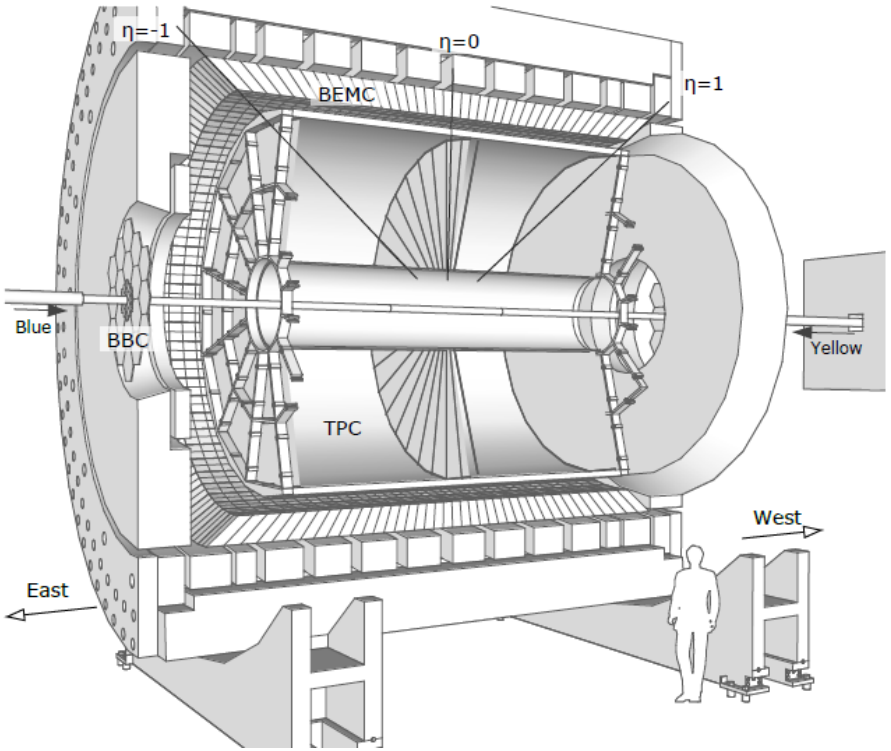

Fig.: Longitudinal cross section of the STAR central detector. [3]

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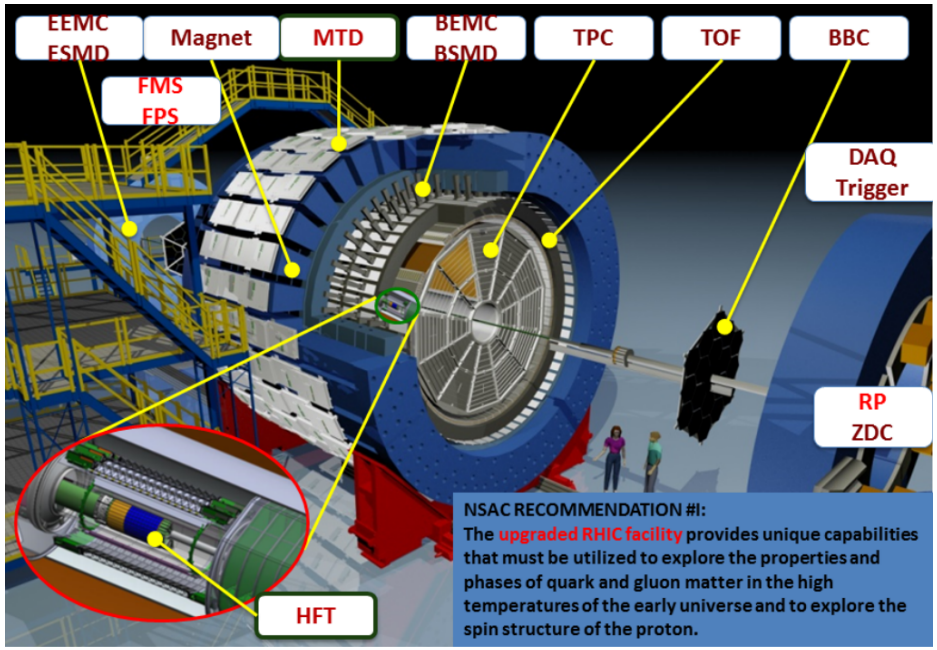

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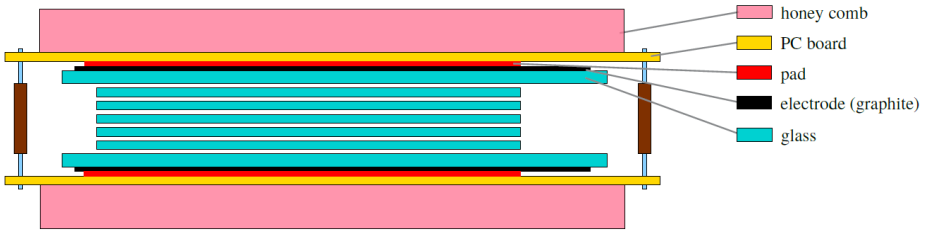

Fig.: Detail view of MGRP module. [4]

BBC - Beam Beam Counter:

- plastic scintillation detector placed at the ends of TPC cylinder
- composed of octagonal tiles
- used to check LRG

RP - Roman Pots:

- system composed of four stations
- each station has two Roman Pots
- each pot contains 4 silicon strip detectors ond one plastic scintillator

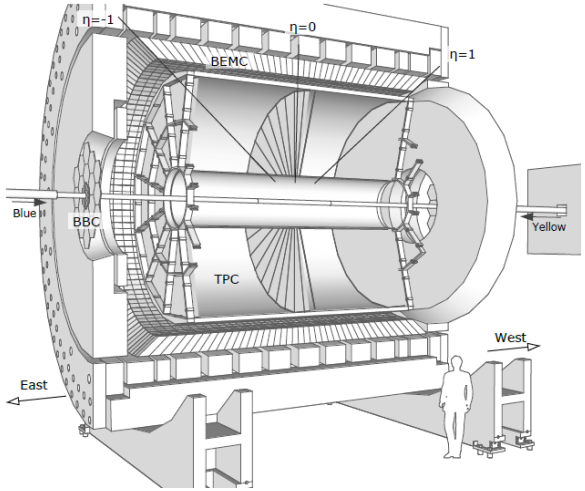

Fig.: Longitudinal cross section of the STAR central detector (3).

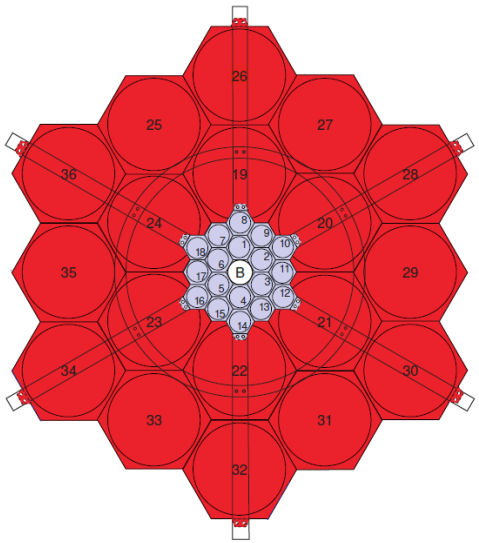

Fig.: Diagram of the tile layout in BBC. [4]

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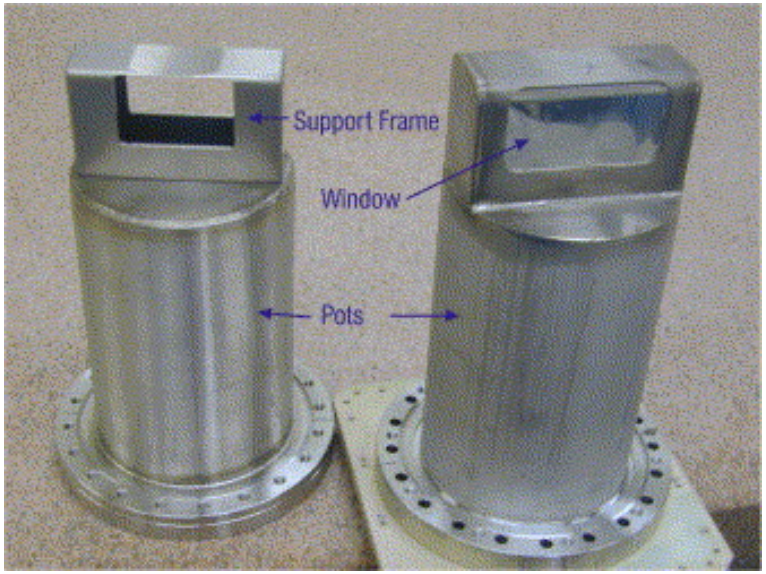
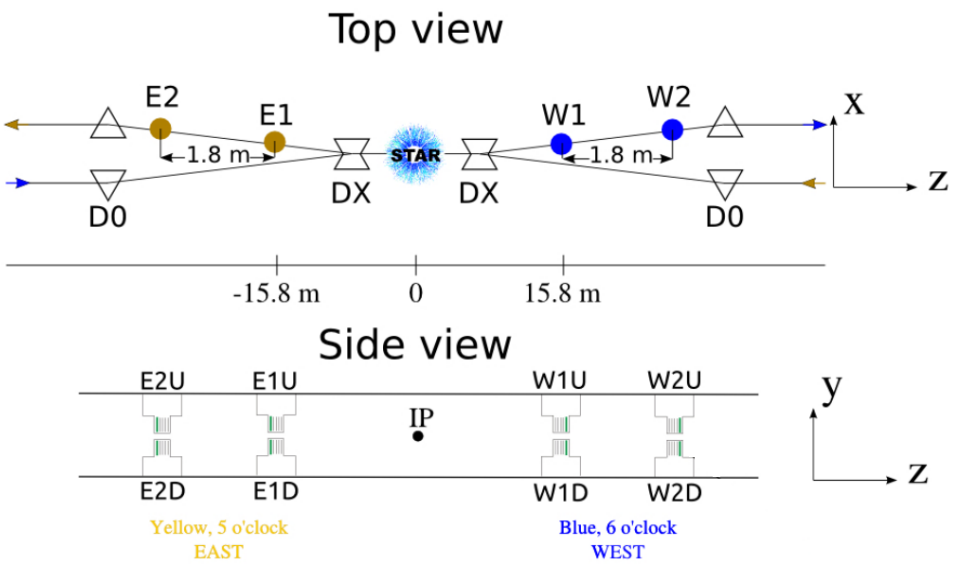


Fig.: Roman pot. [5]



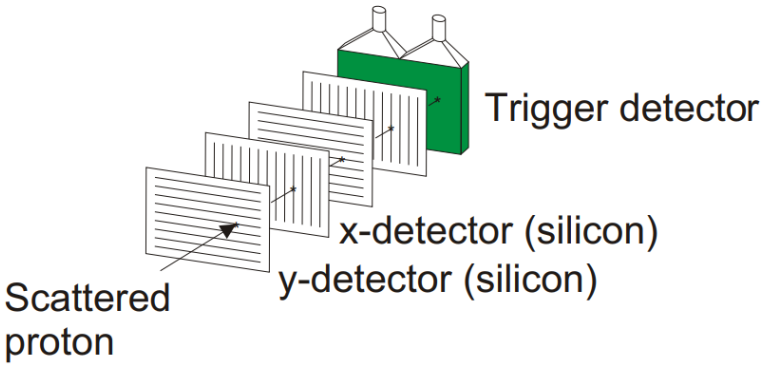


Fig.: Diagram of the silicon detector in RP. [7]

Data and selection of events for further analysis

pp collisions at $\sqrt{s} = 200$ GeV z Run17 - selection criteria

- CPT - central production trigger (830,167 million events)
- 2 RP tracks - exactly 2 tracks registered in RP
  - at least 3/4 detectors used for reconstruction
- fiducial RP cut - area of high geometric acceptance - high efficiency track reconstruction
  - $(p_x + 0.6)^2 + p_y^2 < 1.25$ GeV^2
  - 0.4 GeV $< |p_y| < 0.8$ GeV
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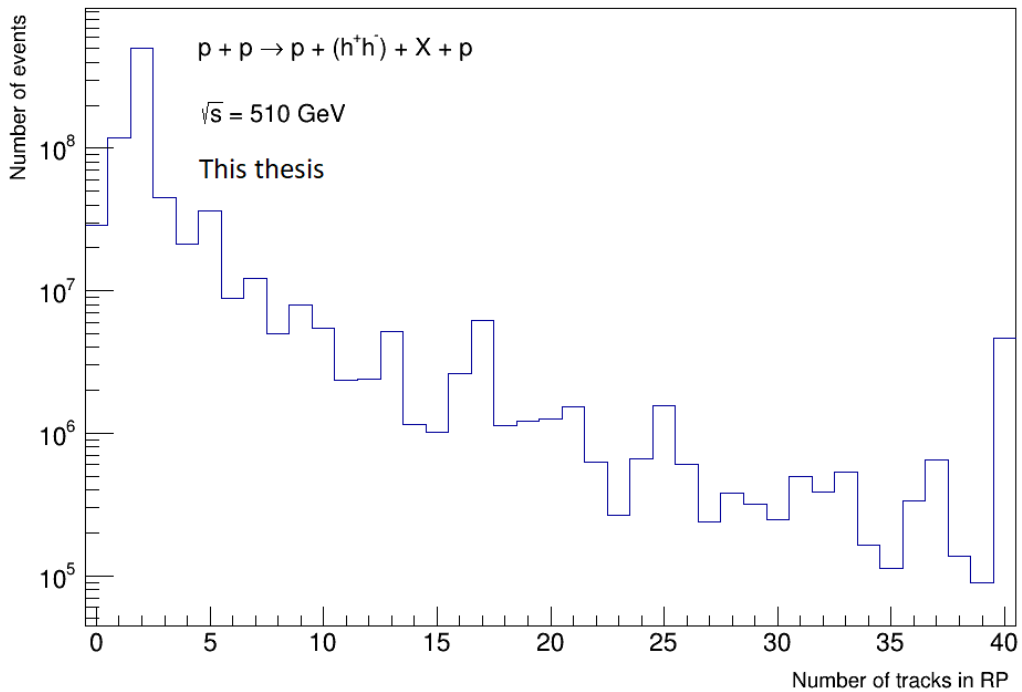

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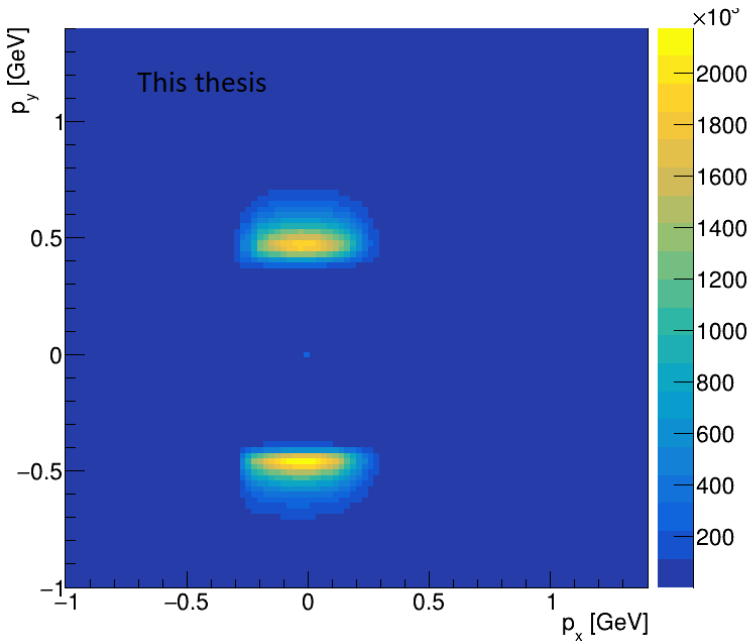

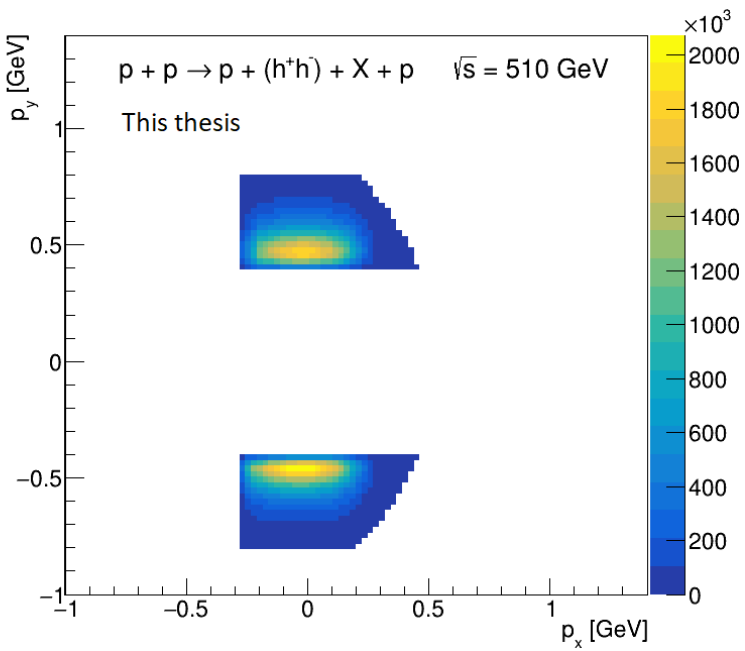

- 1 vertex - tracks coming from one vertex
- $|z_{vert}| < 80$ cm - from the centre of TPC - high geometric acceptance
- $|\eta| < 0.7$ - tracks in an area with sufficient TOF acceptance
- conditions defining TPC good quality tracks
  - $N_{\text{hits}}^{\text{fit}} \geq 25$ - min. number of points recorded in TPC used for track reconstruction
  - $N_{\text{hits}}^{dE/dx} \geq 15$ - min. number of points used for for energy loss calculation
  - $|DCA(z)| < 1$ cm - max. distance of closest approach of the tracks to the primary vertex in the z axis
  - $DCA(xy) < 1.5$ cm - max. distance of closest approach of the tracks to the primary vertex in the transverse xy plane

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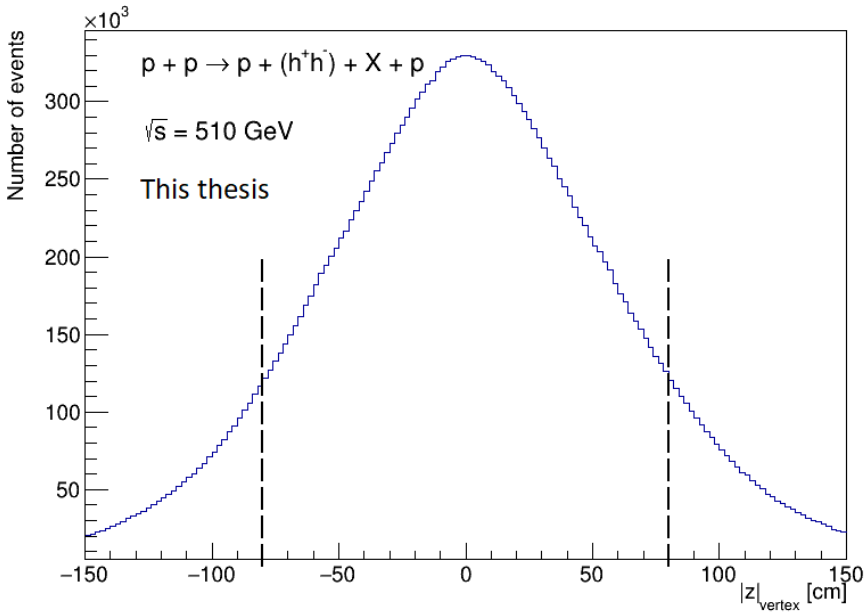

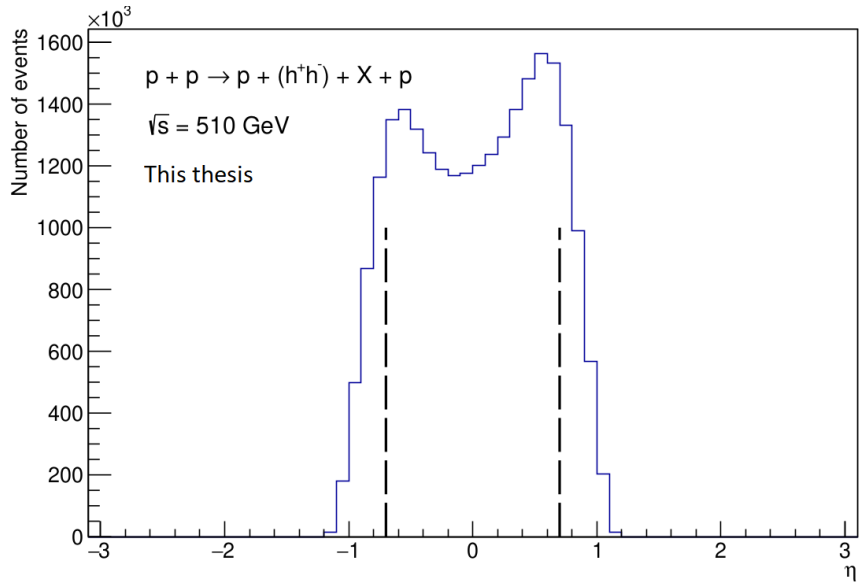

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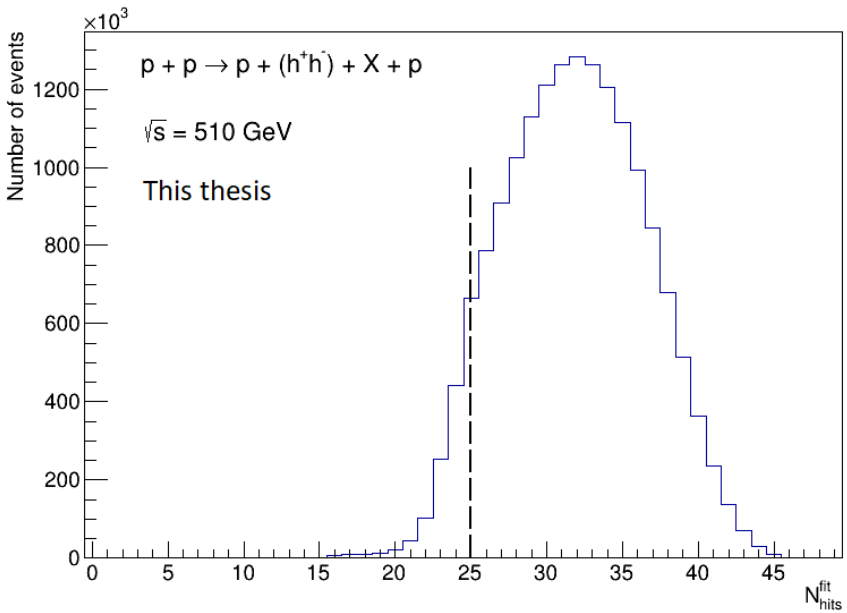

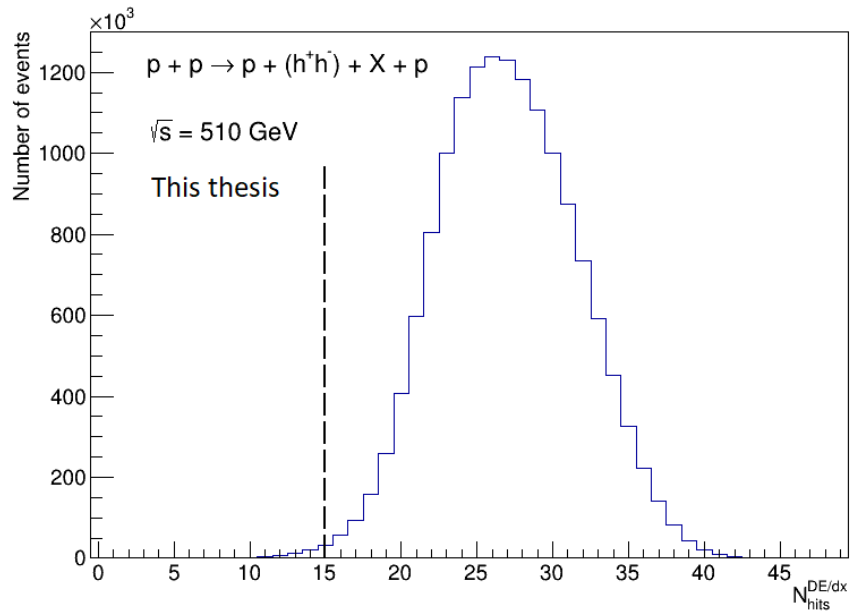

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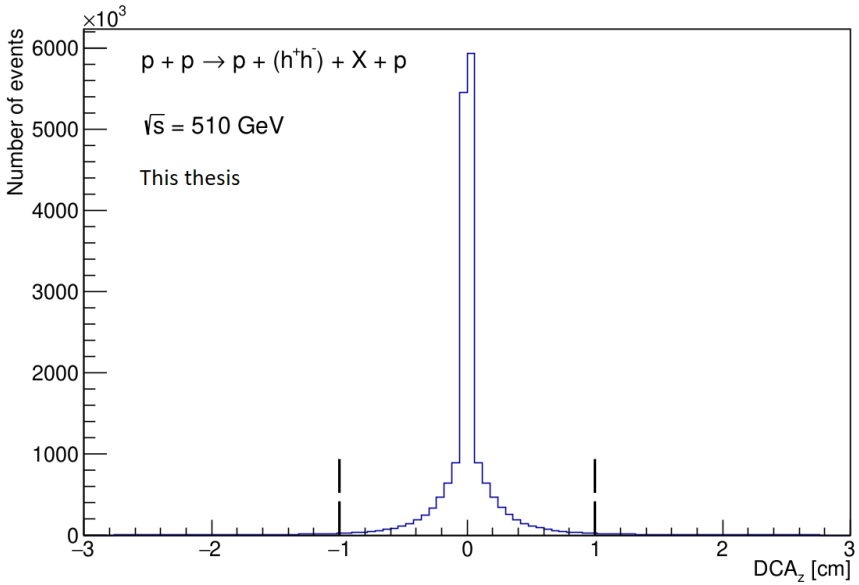

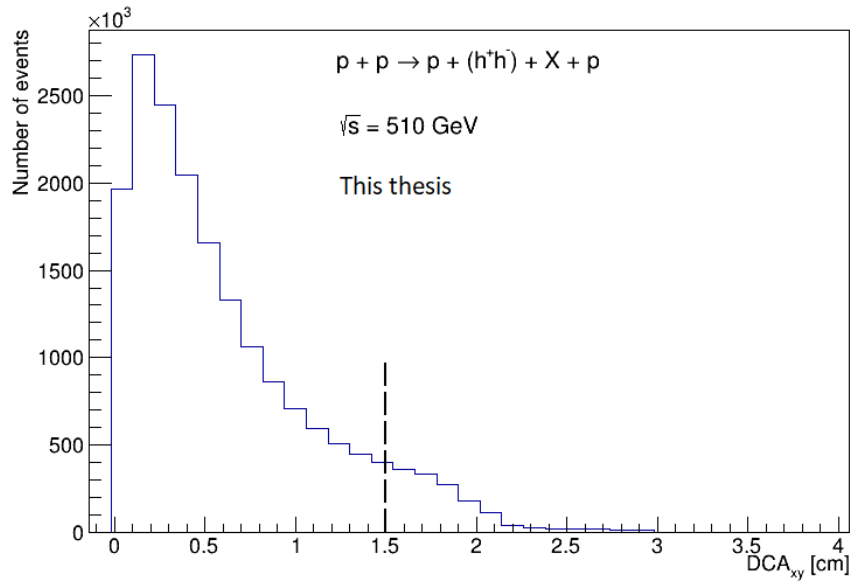

- 2 TOF tracks - exactly two track in TPC with associated hits in TOF
- $Q_{tot} = 0$ - total charge of the tracks ($\pi^+\pi^-$)

$\rightarrow$ 1,219 million events

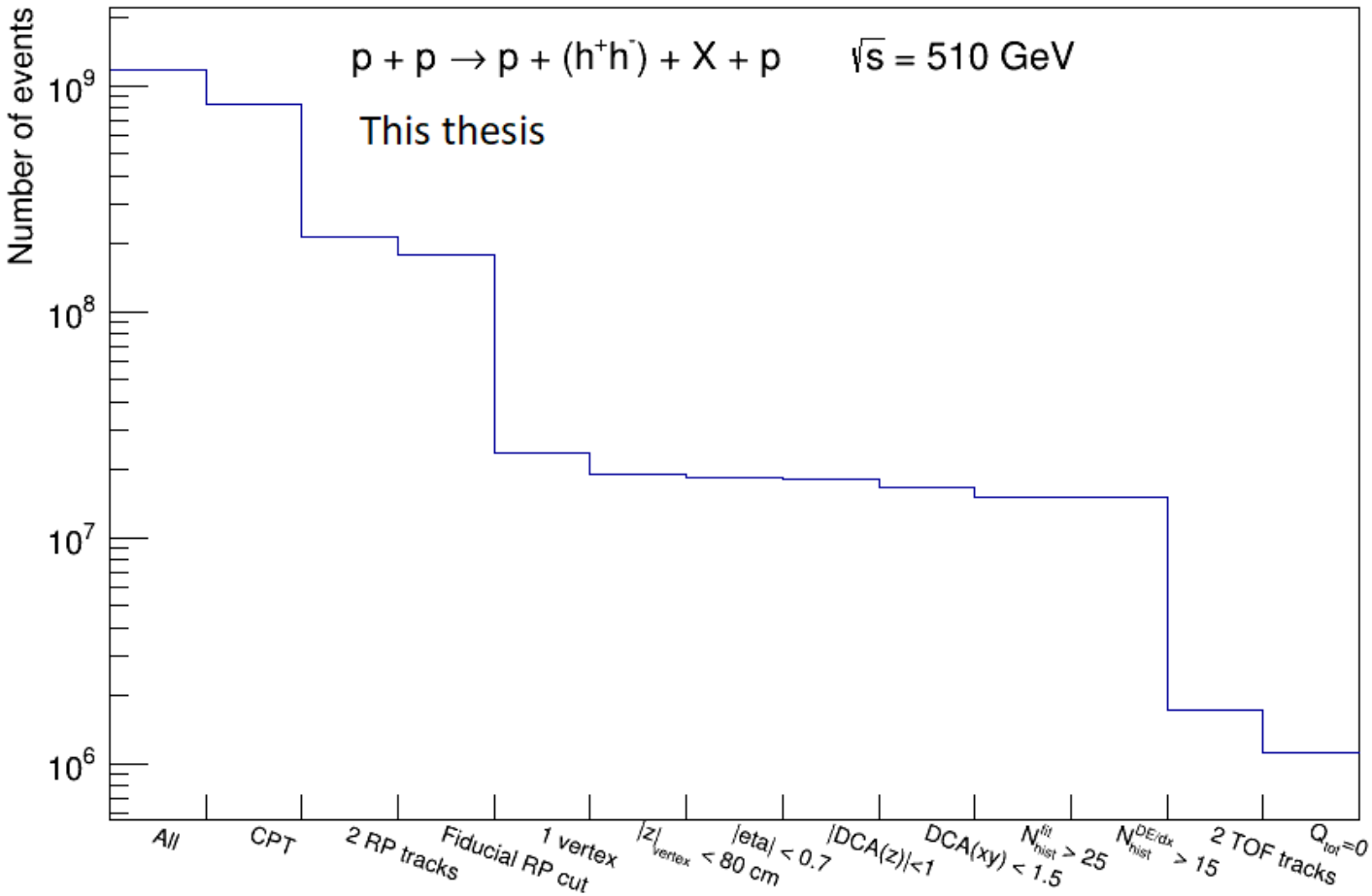

Fig.: Histogram representing steps of the event selection and gradual decrease of events meeting the criteria. Axis y in logarithmic scale.

Invariant mass of K^0_S

- distribution of invariant mass of pion pairs
- data fitted in the region of peak with a compound function (Gauss + polynomial of second degree)
- obtained $m_{K^0_S} = 496{,}4 \pm 0{,}1$ MeV/c^2
- from PDG $m = 493{,}677 \pm 0{,}016$ MeV/c^2
(PDG: https://pdg.lbl.gov/2014/tables/rpp2014-tab-mesons-strange.pdf)

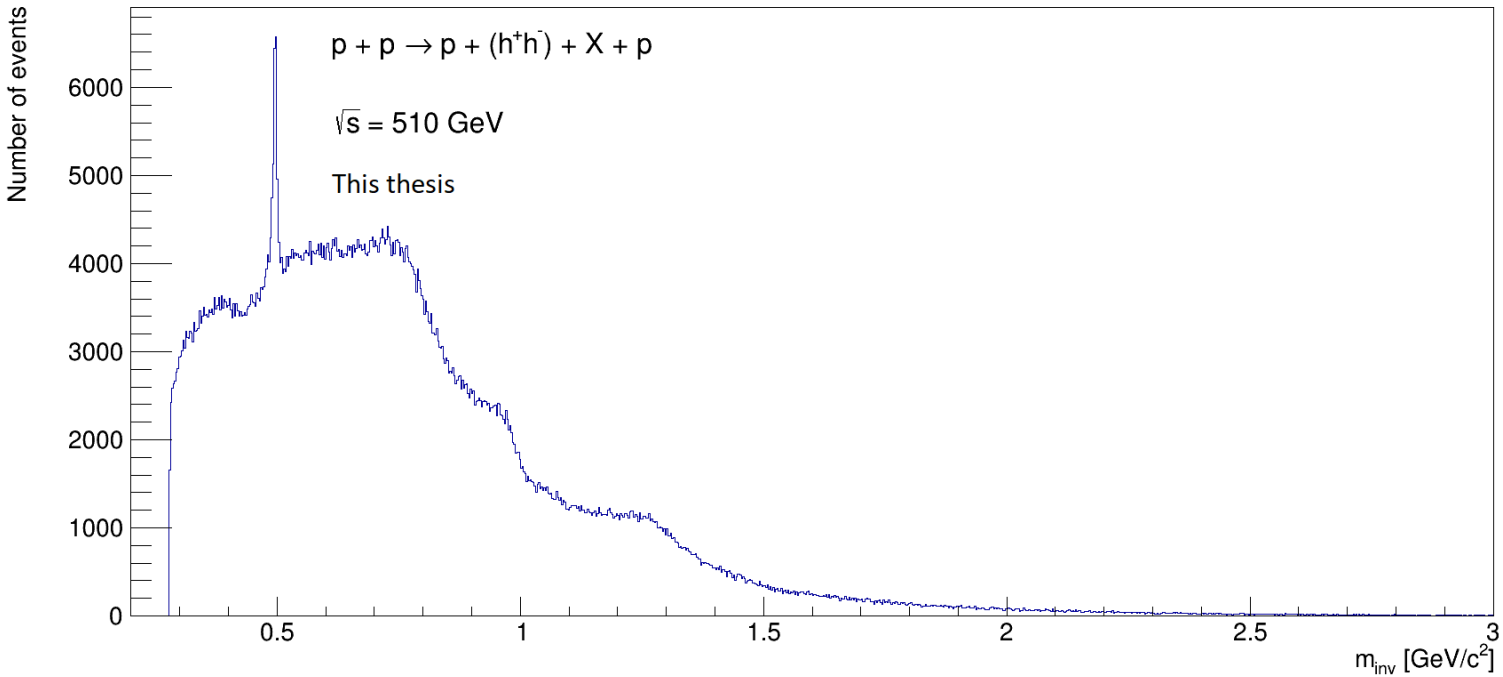

Fig.: Distribution of the invariant mass of pion pairs.

K^0_S yield

- data outside of peak region fitted with a polynomial function of second degree
- fitting function integrated on $m \pm 3\sigma$ and subtracted
- yield: 75 291 events in which the pion couple came from the decay of K^0_S

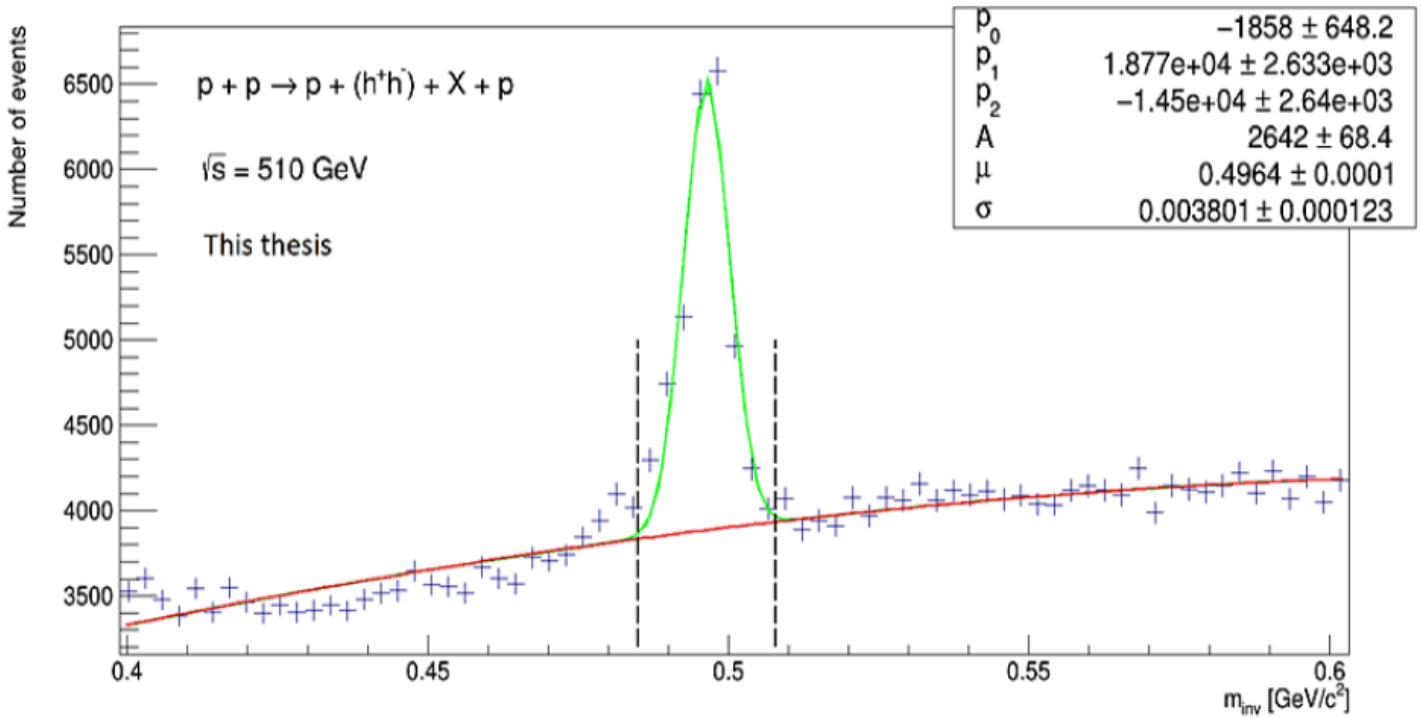

Fig.: Distribution of the invariant mass of pion pairs. Zoomed on the peak region $0{,}4 - 0{,}6$ GeV/c^2, on which the data were fitted.

Overview

- CIP of meson K^0_S in data from 2017
  - main decay channel into two pions $\pi^+\pi^-$
- invariant mass of K^0_S and its yield obtained from fits of the data
  $m_{K^0_S} = 496{,}4 \pm 0{,}1$ MeV/c^2, yield: 75 291

POSSIBLE FUTURE PLANS

- allow two or more tracks from the TPC with assigned hits in the TOF
  - statistical approach - finding the right combinations
  - specific pion pair coming from K^0_S decay
- particle identification of the final particles from K^0_S decay
  - emerging hadrons are assumed as pions (97% of the decays)

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THANK YOU FOR YOUR ATTENTION

Sources

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