Seminarium zdawczo-odbiorcze

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Narodowe Centrum Badań Jądrowych

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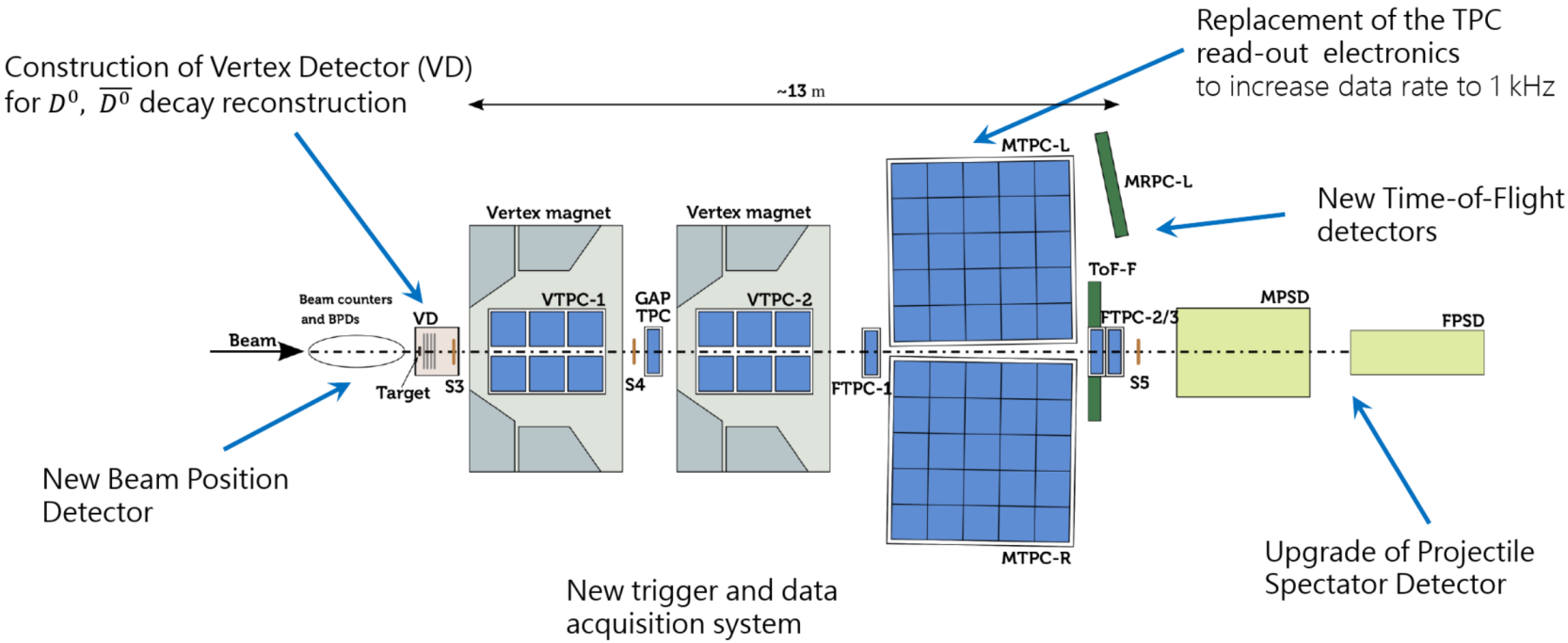
NA61/SHINE experiment at SPS - detector



- Large acceptance, full forward hemisphere ($p_T \to 0$),
- PID: dE/dx via TPC and m^2 via ToF,
- Ion (Be, Ar, Xe, Pb) and hadron (p, $\pi^{\pm}$, $K^{\pm}$) beams, targets including liquid H_2,
- p_{beam} : $13A \to 158A$ GeV/c ($\sqrt{s_{NN}}$: $5.1 \to 17.3$ GeV).

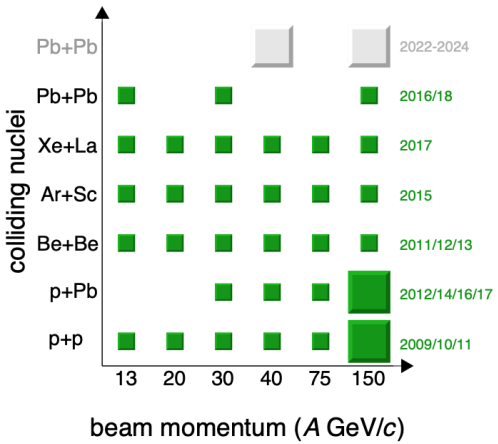
Upgrade of the NA61/SHINE detector system

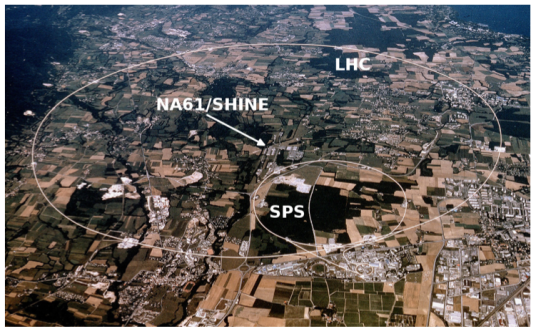
The arrows indicate the upgraded parts of the detector setup. A new vertex detector has been added to increase the accuracy of the reconstruction of secondary vertices while the replacement of the TPC read-out electronics allowed to increase the data collection rate to 1kHz.

- B.Maksiak was responsible for the so called DRS (DRS – Domino Ring Sampler) system for the readout of non-TPC detectors: beam counters, Beam Position Detectors (BPDs), Time-of-Flight detectors (ToF/MRPC) and Projectile Spectator Detector (PSD). Almost 100 DRS4 boards were installed, connected to 32 readout computers, and integrated with the Data Acquisition system of the experiment.

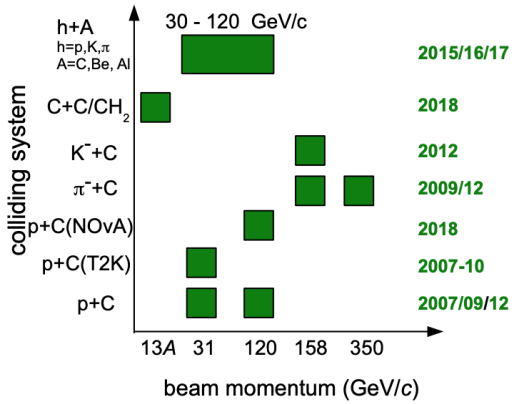
NA61/SHINE experiment at SPS - physics

SHINE = SPS Heavy Ion and Neutrino Experiment





$\sqrt{s_{NN}}$ = 5.1–17.3(27.4) GeV



Strong interactions

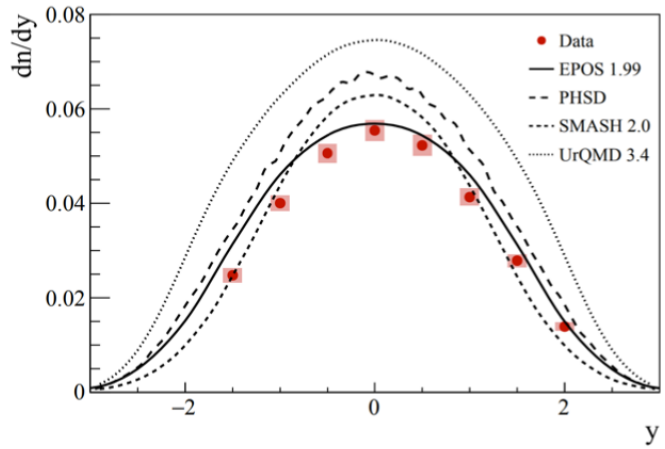
- study properties of the onsets of deconfinement and fireball
- search for the critical point of strongly interacting matter
- direct measurements of open charm

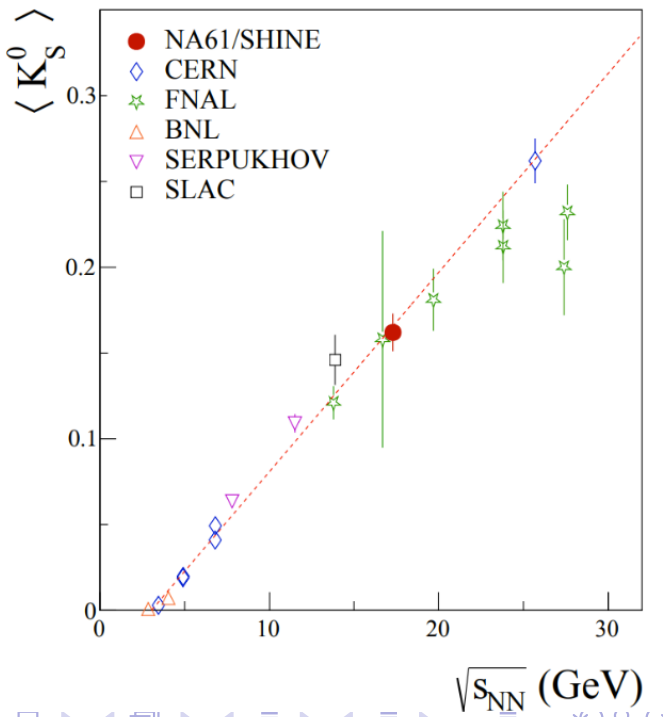
Cosmic rays and neutrinos

- measurements for neutrino programs at J-PARC and Fermilab
- measurements of nuclear fragmentation cross section for cosmic ray physics

Publications - K^0_S production

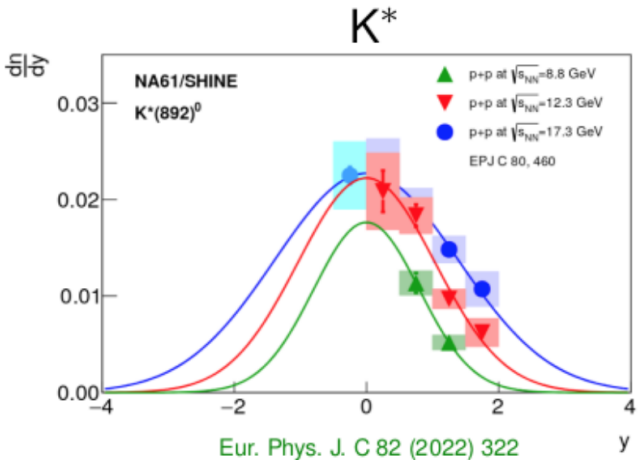
- K^0_S meson production in inelastic p+p interactions at 158 GeV/c beam momentum measured by NA61/SHINE at the CERN SPS (*Eur.Phys.J.C 82 (2022) 1, 96*),
- Mean multiplicity: $\langle K^0_S \rangle = 0.162 \pm 0.001 \pm 0.011$,
- Model predictions deviate by up to 20% from the measurements.



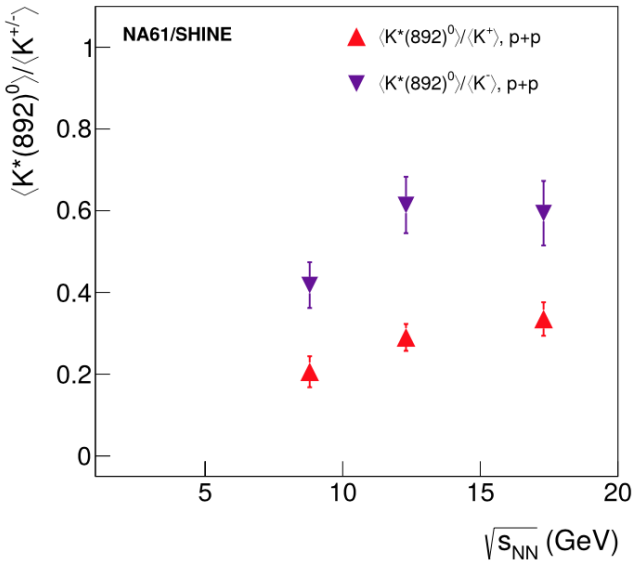


Publications - $K^*(892)^0$ production

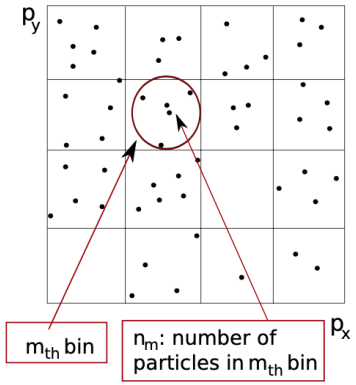
- $K^*(892)^0$ meson production in inelastic p+p interactions at 40 and 80 GeV/c beam momenta measured by NA61/SHINE at the CERN SPS (*Eur.Phys.J.C 82 (2022) 4, 322*),
- $K^*(892)^0$ was reconstructed in $K^* \rightarrow K^+ + \pi^-$ channel, the yield is affected by regeneration and rescattering processes,
- Results on $K^*(892)^0$ mass and width were included in PDG.

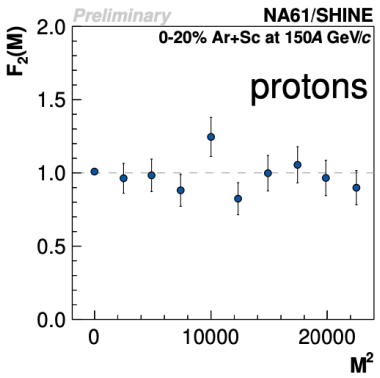


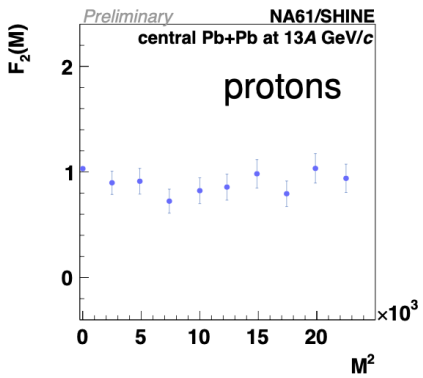
Eur. Phys. J. C 82 (2022) 322

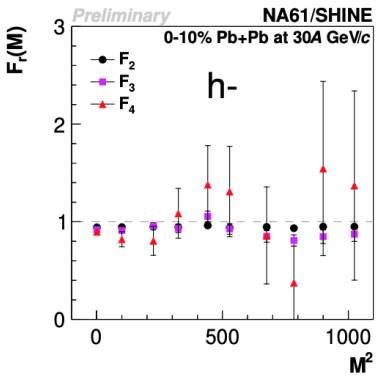


Intermittency analysis









$$F_r(M) = \frac{\left\langle \frac{1}{M}\sum_{m=1}^{M} n_m(n_m-1)\ldots(n_m-r+1)\right\rangle}{\left\langle \frac{1}{M}\sum_{m=1}^{M} n_m\right\rangle^r},$$

where $\langle \ldots \rangle$ denotes averaging over events, M the number of cells

- CP $\rightarrow$ a power-law scaling $F_r(M) \sim M^{\phi_r}$

- No indication of critical point in F_2 for protons from Ar+Sc interactions at $13A \rightarrow 150A$ GeV/c, Pb+Pb at $13A$ and $30A$ GeV/c as well as in F_2, F_3 and F_4 for negatively charged hadrons in Pb+Pb interactions at $30A$ GeV/c

Dileptons as QGP probe

- Dileptons are an excellent probe of QGP properties because they are not affected by the strong interaction. Their invariant mass spectrum carries information on the modifications of hadron properties in QCD matter (e.g. ρ vector meson broadening) and, indirectly, about the deconfinement and the restoration of chiral symmetry.
- The region below top SPS energy almost unexplored, a notable exception is the CERES measurement (low-mass dileptons at $\sqrt{s} = 8.8$ GeV).
- NA61/SHINE is able to detect electrons, pions and baryons at the same time therefore we can expect new results for several semileptonic decay channels eg.:

$$\eta \to \pi^+\pi^- e^+ e^- \, , \Delta \to p e^+ e^- \, , \Sigma \to e^+ e^- + X$$

- Feasibility studies on muonic pairs reconstruction using a new muon detector are being performed by our colleagues from Świerk.

Dileptons in NA61/SHINE

Firsts attempts of dilepton extraction in NA61/SHINE:

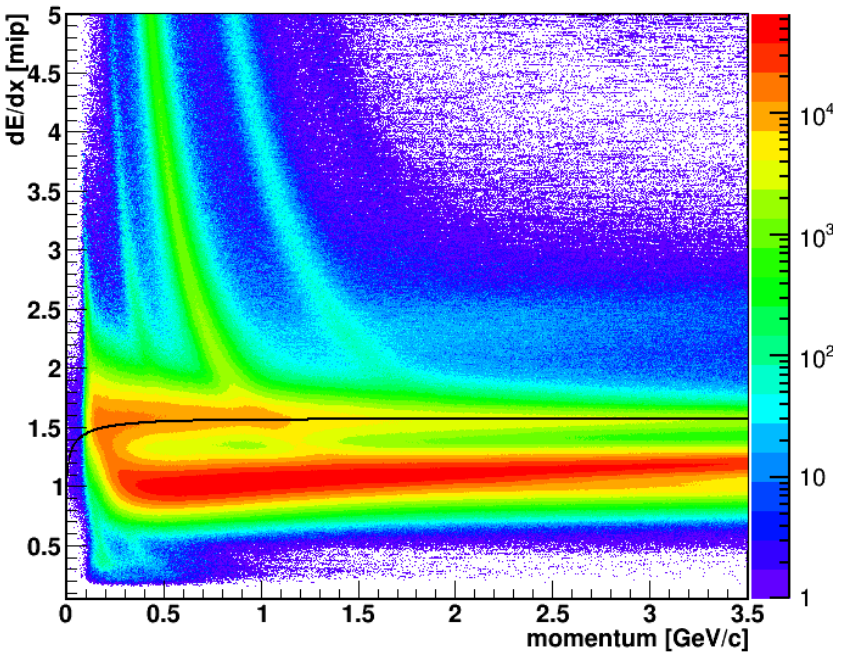


Figure: Specific energy loss dE/dx vs momentum from NA61/SHINE.

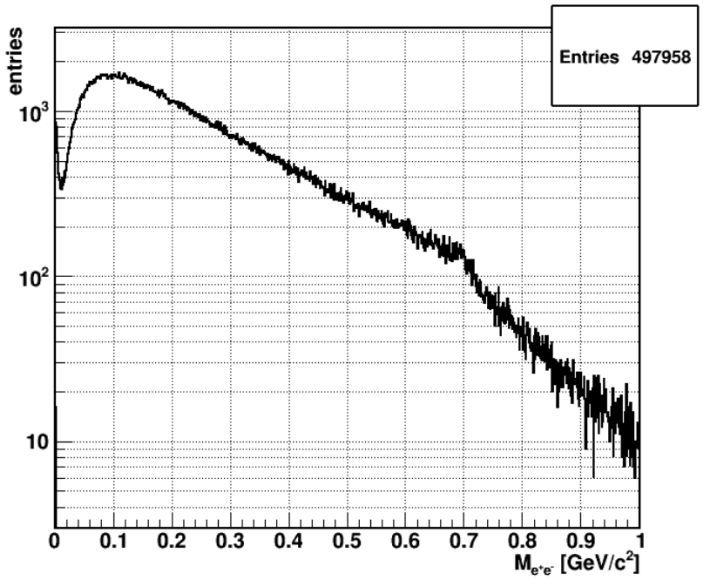


Figure: Invariant mass of e^+e^- pairs from Xe+La collisions at 158A GeV.

Grants

- Projekt badawczy Konsorcjum NA61/SHINE, GRIEG nr 2019/34/H/ST2/00585 Badanie produkcji powabu w zderzeniach ciężkich jonów.
- Projekt badawczy Nr 2021/WK/10 Min.Edukacji i Nauki Eksperyment NA61/SHINE w CERN

Summary

The NCBJ DBP/BP3 group is taking part in multiple NA61/SHINE activities, from hardware (detector upgrade) to low and high level software-type works (DRS, data taking, calibration). We are also performing physical analyses using the collected data (e.g. dileptons and rare meson and baryon decays, two particle correlations, etc).

NCBJ group in NA61/SHINE has recently gained new members: M. Bielewicz (TJ3), Ł. Świderski (TJ3), J. Szewiński (TJ2), D. Rybka (TJ2), P. Adrich (TJ1).

In 2022, final results on K_s^0 and $K^*(892)$ were published (see slides 5 and 6).