One of the Goals of the NA61/SHINE (SHINE SPS Heavy Ion and Neutrino Experiment) experiment is to provide hadron production reference measurements for the T2K neutrino oscillation experiment\(^1\). Shown here are results of pion cross sections from pilot data collected in October 2007.

http://na61.web.cern.ch

\(^1\) See Mark Hartz Talk on T2K Saturday
The NA61/SHINE detector at CERN SPS

- **Thin target**: 2.5x2.5x2 cm³, int. length ~ 0.04, ~600k triggers in 2007
- **Long target (T2K replica)**: 90 cm Ø = 2.6 cm, int. length ~ 1.9
- **3 BPDs** (Beam position detectors)
- **5 TPCs** \( \sigma(p)/p^2 \sim 10^{-4} \)
- **3 Time of flight**: FTOF resolution ~120 ps, TOF L, R resolution ~70 ps

<=Added in 2007 for T2K measurements and extended in 2009

**Example of a p+C interaction at 30 GeV**
Particle identification

- Combined ToF-dE/dx PID over the whole momentum range:
  - Very high purity pion yields
  - Bi-dimensional max-likelihood fits to extract the yields

Example of a fit to the dE/dx distribution between 0.7<p<0.8 GeV/c and 140<Theta<180 mrad

Max. Likelihood fit to the combined ToF-dE/dx distribution between 3<p<3.2 GeV/c and 40<Theta<60 mrad
Analysis methods

3 independent analysis methods have been implemented

• **h minus analysis:**
  - only for $\pi^-$, >90% of negative hadrons are $\pi^-$.  
  - pure tracking with no pid-large acceptance.  
  - consider all negative tracks and remove electrons and $\kappa$- with a global Monte Carlo correction.

• **Dedicated $dE/dx$ below 1 GeV/c:**
  - Fast change of energy loss with momentum.  
  - $\pi^+$ and $\pi^-$ large acceptance  
  - PID based only on $dE/dx$.  
  - Global MC correction.

• **Analysis based on combined ToF+$dE/dx$ PID:**
  - $\pi^+$ and $\pi^-$  
  - Request particles in ToF ->High purity PID over whole momentum range, but reduced acceptance.  
  - Select maximum acceptance regions to minimize MC corrections  
  - Step by step MC correction

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**MC correction factor**

- $\pi^-$ 140$<\Theta<$180 mrad bin
- $\pi^+$ 140$<\Theta<$180 mrad bin
- $\pi^+$ 40$<\Theta<$60 mrad bin
Systematical errors

h minus

dE/dx below 1 GeV/c

ToF+dE/dx

example for 140<\Theta<180 mrad bin

example for 140<\Theta<180 mrad bin

example for 40<\Theta<60 mrad bin

Typical value around 6%
Results

Differential cross-sections for pion meson production in p+C interactions at 31 GeV/c as a function of laboratory momentum ($p$) and polar angle ($\Theta$) - only statistical errors are shown.

[Graphs showing cross-sections for different momentum ranges and polar angles for positive and negative pions, with data points and error bars.]
Summary

• First results on π⁺ spectra in p+C interactions at 31 GeV/c have been obtained: preprint arXiv:1102.0983 [hep-ex], submitted to Phys. Rev. C

• Those results are currently used and provide useful input for the T2K beam simulation.

• 10 times larger set of data in 2009. Calibration almost complete, analysis will start soon.

• 2007 data from long target is currently been analyzed ->crucial because an important part of the neutrino flux in T2K comes from target re-interactions. PID capabilities are similar to short target.

• 10M long target triggers in 2010 run to be calibrated and analyzed.

• Ongoing work and fast progress in extracting kaon cross sections from 2007 data.

• Knowledge of kaon x-section is important since kaons contribute to about 33% of the νₑ contamination of the T2K beam.
THANK YOU!