Studies for the PANDA software trigger

F. Nerling[*1,2], *A. Denig*[3], *K. Götzen*[1], *D. Kang*[2], *R. Kliemt*[1], *K. Peters*[1,4], *and the PANDA Collab.*[1]
[1]GSI, Darmstadt, Germany; [2]HIM, Mainz, Germany; [3]Univ. Mainz, Germany; [4]Univ. Frankfurt, Germany

The PANDA experiment is one of the key experiments at the future FAIR facility that provides an anti-proton beam of momenta 1.5–15 GeV/c with excellent energy resolution. Using an hydrogen (proton) and various nuclear targets, PANDA will carry out a broad physics programme comprising topics of hadron spectroscopy, nucleon structure, hadron in nuclei as well as hypernuclear physics.

Given the production cross-sections for the reactions of interest either not being known precisely or being predicted by theory to be rather small (pico- to nanobarn range), the average design luminosity (for the high luminosity mode) is projected to be $L = 2 \cdot 10^{32}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. The high total $\bar{p}p$ cross-section of about 60-100 mb results in an average reaction rate of $\dot{N} = 20$ MHz, reaching peak values of up to $\dot{N} \approx 40$ MHz. With an average event size of 10–20 kB, we expect a total raw data rate of roughly 200 GB/s. Assuming a duty cycle of 50 %, the data stream would produce 3000 PB per year to be stored, and thus the data rate has to be reduced by about a factor of 1000 in order to reduce the required storage capacity down to affordable few PB per year. Due to the similarity of the detector signatures of interesting signal and background events, a sophisticated filtering strategy has to be developed that goes far beyond conventional hardware based trigger schemes and that is based on the concept of a trigger-less read-out. This approach of continous sampling and buffering of the data, i.e. without any classical gated trigger signal, allows to pre-analyse the data in order to decide to either reject or keep events and write them to disc. Technically, the challenge is to perform a high-level reconstruction procedure online and provide the information to effectively separate signal from background events already during data taking.

* F.Nerling@gsi.de

Table 1: List of physics channels presently under study.

Physics topic	Reaction channel	Trigger
Electromagn.	$p\bar{p} \to e^+e^-$	$p\bar{p} \to e^+e^-$
Exotics	$p\bar{p} \to \phi\phi$	$\phi \to K^+K^-$
Charmonium	$p\bar{p} \to \eta_c\,\pi^+\pi^-$	$\eta_c \to K_S K^-\pi^+$
	$p\bar{p} \to J/\psi\,\pi^+\pi^-$	$J/\psi \to e^+e^-$
	$p\bar{p} \to J/\psi\,\pi^+\pi^-$	$J/\psi \to \mu^+\mu^-$
Open charm	$p\bar{p} \to D^0\overline{D}{}^0$	$D^0 \to K^-\pi^+$
	$p\bar{p} \to D^+D^-$	$D^+ \to K^-\pi^+\pi^+$
	$p\bar{p} \to D_s^+D_s^-$	$D_s^+ \to K^+K^-\pi^+$
Baryons	$p\bar{p} \to \Lambda\bar{\Lambda}$	$\Lambda \to p\pi^-$
	$p\bar{p} \to \Lambda_c\bar{\Lambda}_c$	$\Lambda_c \to pK^-\pi^+$
Background	$p\bar{p}$ generic (DPM)	–

The present studies are restricted to a subset of 10 physics reaction channels (Tab. 1), still covering the main physics topics addressed by PANDA, at 4 different centre-of-mass energies, covering the whole range of about 2–5.5 GeV/c accessible by PANDA. In total a set of $\sim$150 observables has been explored and those, which allow for an efficient signal to background separation, are applied in addition to the initial cuts on the corresponding invariant masses. The studies were carried out using events generated by a simple toy Monte Carlo and compared to the results obtained from the full detector simulation using `PandaRoot`. As optimisation approach, two strategies have been realised, optimisation for high signal detection efficiencies and for strong background suppression.

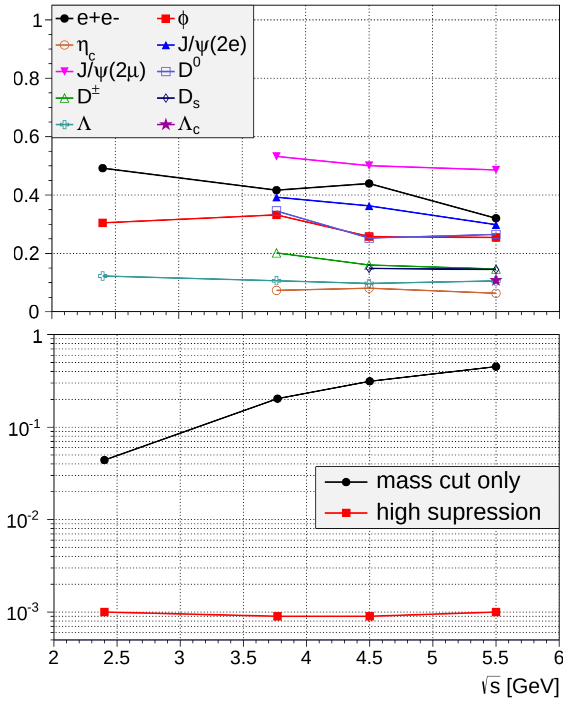

Figure 1: Compilation of present results: Achieved signal detection efficiencies *(top)* when optimising for a 10^3 background reduction factor *(bottom)*.

The present results based on the full detector simulation are summarised for the ansatz of optimisation for background suppression in Fig. 1. The achieved signal efficiencies vary from about 6–50 %, strongly depending on the given physics channel, while the intended background suppression factor is met over the full range of centre-of-mass energies. More realistic results will come soon, and even though more work is needed also on the hardware side, these first preliminary results serve as a proof of principle.

 DOI:10.15120/GR-2015-1-MU-HADRONS-08