STATUS OF NSC KIPT PARTICIPATION IN CMS EXPERIMENT AT LHC

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Some of recent public results of the CMS experiment at the Large Hadron Collider (LHC) are shown. NSC KIPT involvement in the experiment is discussed, with presenting institute's participation in the CMS distributed computing infrastructure for data processing, physics data analysis and upgrades of the CMS forward hadron calorimetry. The present status and future prospects of these activities are outlined.

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In 2024, Run 3 of the Large Hadron Collider (LHC) was continued with a record energy of proton-proton collisions of 13.6 TeV, and the peak luminosity exceeding $2 \cdot 10^{34}$ $cm^{-2}s^{-1}$. In the CMS experiment, the rate of event selection by the high-level trigger (HLT) for offline processing was ~2.5 kHz, which is ~2.5 times higher than in the LHC Run 2 (2015-18). As a result, a sample of events (proton-proton collisions at 13.6 TeV) corresponding to an integral luminosity of more than 120 fb^{-1} has been recorded for the year. Thus, the CMS experiment has already recorded ~190 fb^{-1} of experimental information on proton-proton collisions at 13.6 TeV for the LHC Run 3 (2022-2024).

Based on the processing of data taken in LHC Run 2 and Run 3, a number of new outstanding results have been obtained for the year. These include, in particular, significant results of the studies of the Higgs boson properties, as well as important results related to both the study of phenomena within the Standard Model (SM) and searches for signals of "new physics" beyond the SM.

Over the past year, a wide range of activities within participation in the CMS experiment has been carried out at the NSC KIPT. In particular, successful operation has been supported for the CMS Tier-2 (T2) center, T2_UA_KIPT, which is the only Ukrainian computing facility that takes part in the distributed processing of LHC data.

In 2022 – 2023, large-scale work was carried out to restore the facility's power-supply system (considerably damaged due to the hostilities in 2022), and a detailed analysis of the state of its computing and disk nodes was accomplished, with fixing detected hardware malfunctions. In addition, the necessary software configuration changes for the center were prepared to provide the earliest possible resumption of its operation. Owing to the successful completion of these works, the full-scale participation of the T2_UA_KIPT center in the CMS distributed data processing has been restored since the beginning of July 2023. Since this center is the only Ukrainian site obtaining experimental information from the LHC for processing, this also means resumption of processing of this information in Ukraine.

In 2024, successful participation of the center in the general test of the readiness of the entire CMS infrastructure for recording, distribution and processing of experimental information ('Data Challenge 2024') was provided. Reconfiguration of the facility's data storage system and its migration from the DPM platform to the dCache system was completed, in accordance with the requirements of the EGI and WLCG grid infrastructures.

Since the resumption of T2_UA_KIPT operation in July 2023, a satisfactory (about 88%) center's readiness for the CMS data processing has been provided (see Figure and Ref. [1]), and more than 3.6 PB of information has been transferred to the site for processing, which is ~3 times greater than its total mass disk storage capacity.

The physics analysis of the CMS data aimed at the search for the SUSY signal, the direct chargino pair production in proton-proton collisions at 13 TeV, was also continued in 2024. Estimates of systematic uncertainties were performed for the analyses of CMS data obtained separately in the first and second half of 2016, as well as in 2017 and 2018. A statistical analysis was carried out to set the limits on possible masses of the lightest chargino and neutralino, and the importance of taking systematic errors into account has been shown. Exploiting the CMS "standard" packages for the statistical analysis of data had resulted in distortion of results in case of crossing signal regions (SR). The SR optimization with excluding their overlaps has provided a satisfactory agreement between the results of computer simulation and the experiment.

Also, activities continued at the NSC KIPT within the CMS endcap calorimetry upgrade program. The stand for light yield measurements in scintillator samples was moved to a premise that was not damaged by the hostilities of 2022. Repair work has been carried out on the stand damaged equipment and electronic units, and installation of the equipment and upgrade of the communication line with the PC were completed. As of the beginning of 2025, the stand is in working order and ready for measurements.

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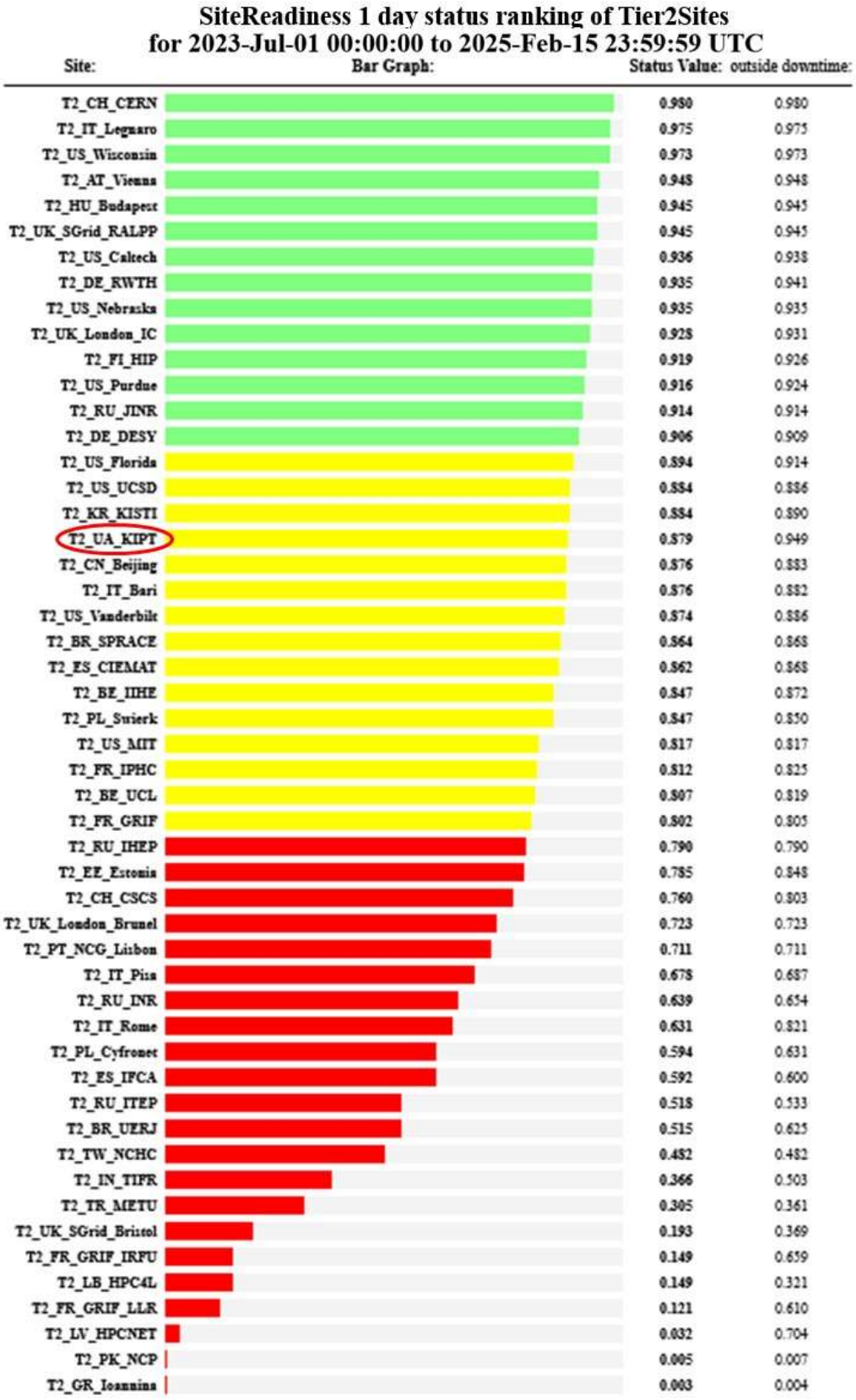

CMS Tier-2 site ranking based on the readiness metrics for 19.5 months (01.07.2023 – 15.02.2025) since resumption of T2_UA_KIPT operation (see Ref. [1])

REFERENCES

1. CMS Site Ranking Selection, https://cmssst.web.cern.ch/ranking.