

NSC KIPT participation in the CMS experiment: the history and present activities

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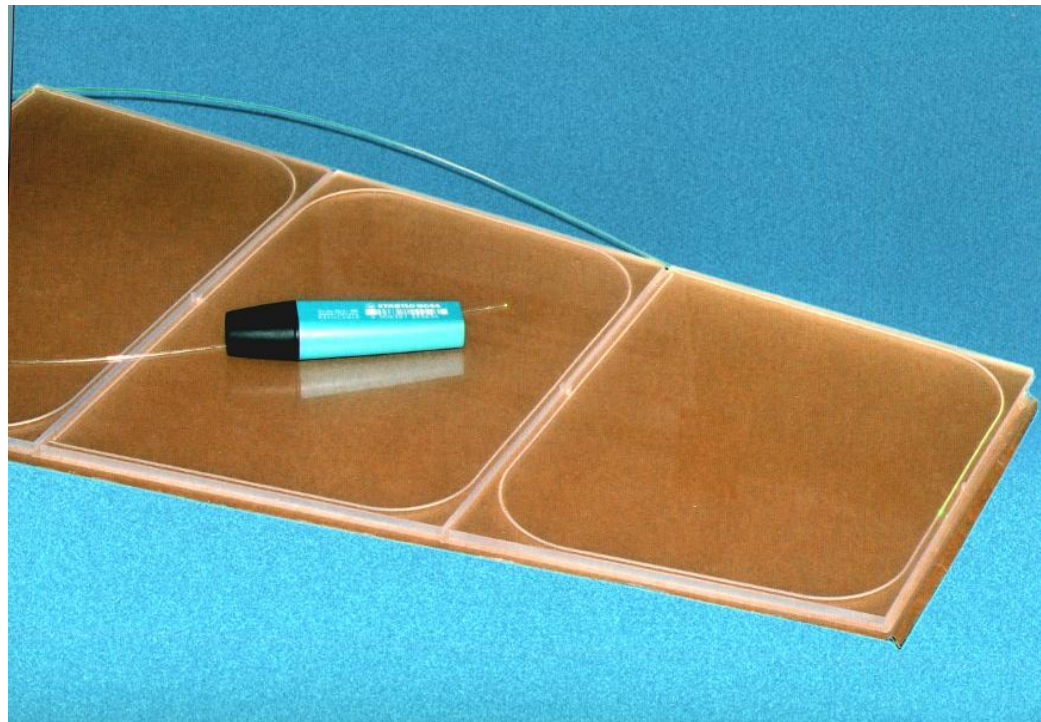
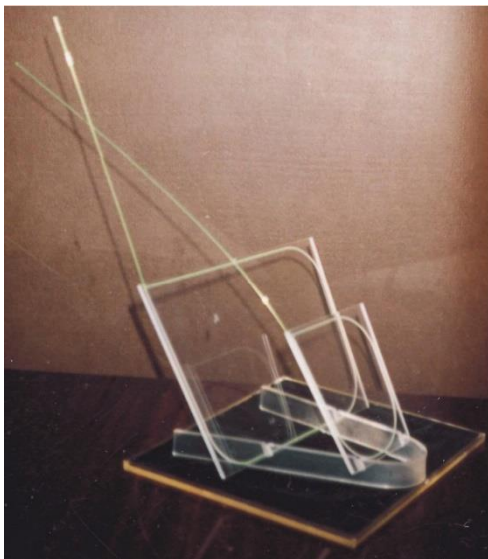
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NSC KIPT in CMS: Milestones



- ◆ 02.04.1993 – Memorandum of Agreement between Government of Ukraine and CERN
- ◆ 1993 – meeting with CERN representatives (incl. M. Della Negra) at NSC KIPT
- ◆ 1994 –1998 – R&D on CMS hadron calorimeter (HCAL) \Rightarrow search for “adequate” scintillator material for CMS HCAL; participation in HCAL-prototype manufacturing, beam-testing and computer simulation – *NSC KIPT (Kharkov-KIPT) jointly with ISMA (Kharkov-ISMA) and Kharkiv National University (KNU)*
- ◆ 1998 – 2002 – participation in mass production of scintillator (SCSN-85, Kuraray) tiles for CMS endcap HCAL (quality control based on light yield measurements)
- ◆ 2001 – 2009 – preparation for CMS data processing through construction of computer facility (WLCG site since 2005; commissioned in 2009 as CMS Tier-2 centre, T2_UA_KIPT), computer simulation of CMS physics and MC event production
- ◆ 2009 (LHC start-up) – now – participation in CMS HCAL support/upgrades, CMS computing infrastructure and physics analysis of CMS data

Mass production of scintillator tiles for CMS endcap HCAL



~22000 tiles of SCSN-81 (Kuraray) produced at ISMA (Kharkov-ISMA)
Quality control (based on light-yield measurements) carried out at NSC KIPT
(Kharkov-KIPT)

Activities at NSC KIPT within CMS experiment after LHC start-up



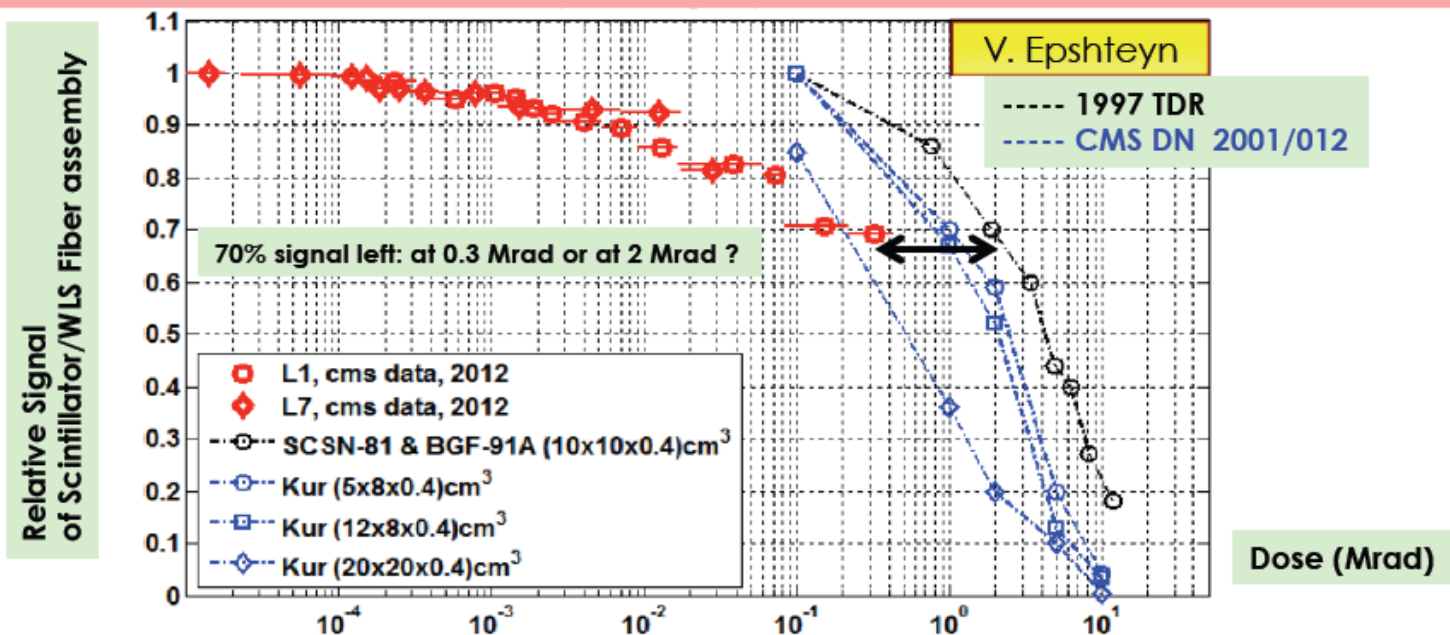
- **Support and upgrades of the CMS hadron calorimetry**
 - mainly focused on R&D studies of radiation resistance of scintillators using 10 MeV electron linac
 - in particular, dose-rate dependence of light output degradation in SCSN-81 scintillator (used in CMS HCAL) has been actively studied
- **CMS computing infrastructure for data processing**
 - support of T2_UA_KIPT Tier-2 centre
 - since LHC startup, >20 PB of CMS information has been transferred to T2_UA_KIPT
 - T2_UA_KIPT site has exhibited high quality of operation
- **Physics analysis of CMS data**
 - in the past – studies of observability with CMS of a Higgs boson (with mass above the on-shell ZZ decay threshold) decaying as $H^0 \rightarrow Z^0 Z^0 \rightarrow e^+ e^- (\mu^+ \mu^-) + \bar{\nu} \nu$
 - at present – search for SUSY signal (direct chargino and slepton pair production in pp collisions) on complete LHC Run 2 dataset [jointly with *Instituto de Fisica a de Cantabria, IFCA* (CMS AN-19-256)]

Understanding HE Radiation Damage:

Primary focus is to reconcile CMS HE RadDam results (Laser, 2012) with bench-mark measurements

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- critical dose range to understand: 0.01 Mrad – 2 Mrad and dose rates of < 0.1 krad/hr (10^{-4} Mrad/hr)
- Only then, we can really trust extrapolations to doses corresponding to 500fb^{-1} and 3000fb^{-1}



For CMS data at 22fb^{-1} (Red points), dose is calculated using FLUKA simulation (M. Guthoff)

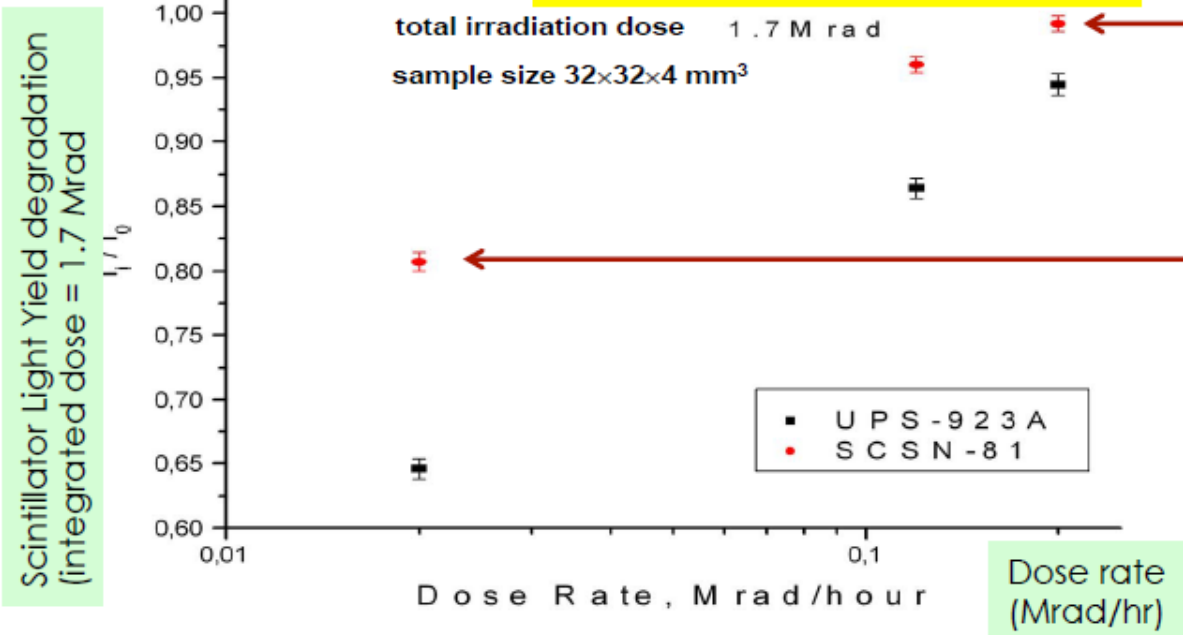
Measurements showed considerable disagreement with estimates made prior to LHC startup (during HCAL TDR preparation)

Signal light yield degradation vs dose rate (SCSN-81 and UPS-923A)

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Smaller dose rates imply larger damage !

Kharkov group:
Leonid Levchuk, Victor Popov, Pavel Sorokin



Dose=1.7 Mrad
Rate=0.2 Mrad/hr
97% signal left
(3% signal loss)

Dose=1.7 Mrad
Rate=0.02 Mrad/hr
80% signal left
(20% signal loss)

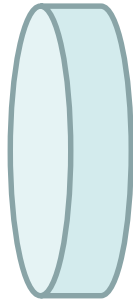
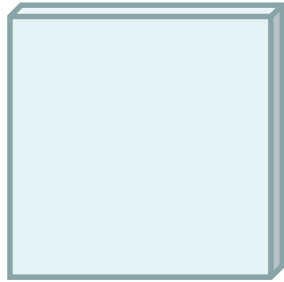
Rate at CMS HE:
 $\eta=3/L1 \rightarrow 10^{-4}$ Mrad/hr
(x200 lower than 0.02 Mrad/hr)

Test to be repeated with actual sigma-files/WLS fiber readout
(the measurement above done with PMT put against scintillator)

Repeat with gamma source, going down with rate to 0.1 krad/hr and dose to 0.3 Mrad:

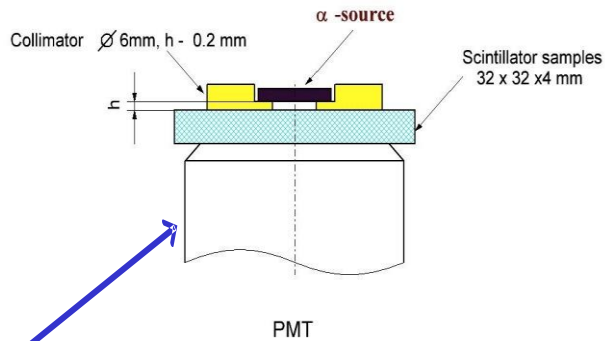
To follow up: would N₂ atmosphere help to reduce damage at low rates ?

Scintillator samples and irradiation/measurement details

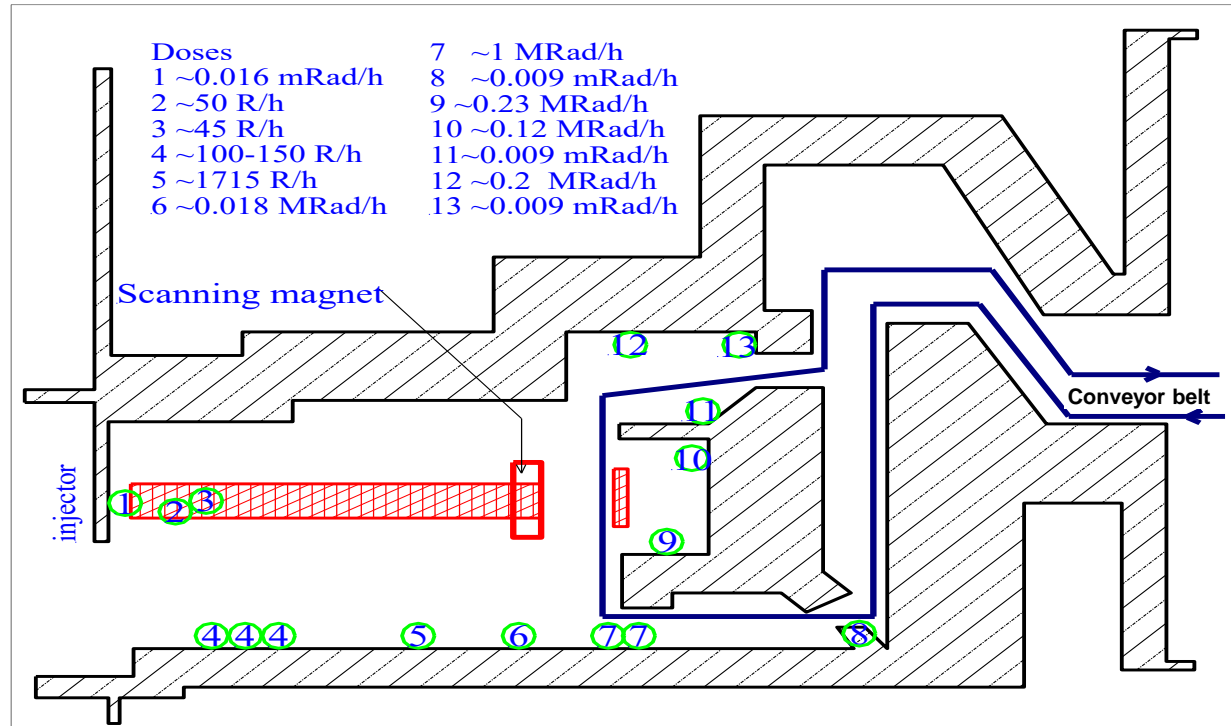


32×32 mm² “squares” and \varnothing 30 mm “circles” of thickness 3.8 and 4.0 mm from SCSN-81 & UPS-923A (ISMA, Kharkov)

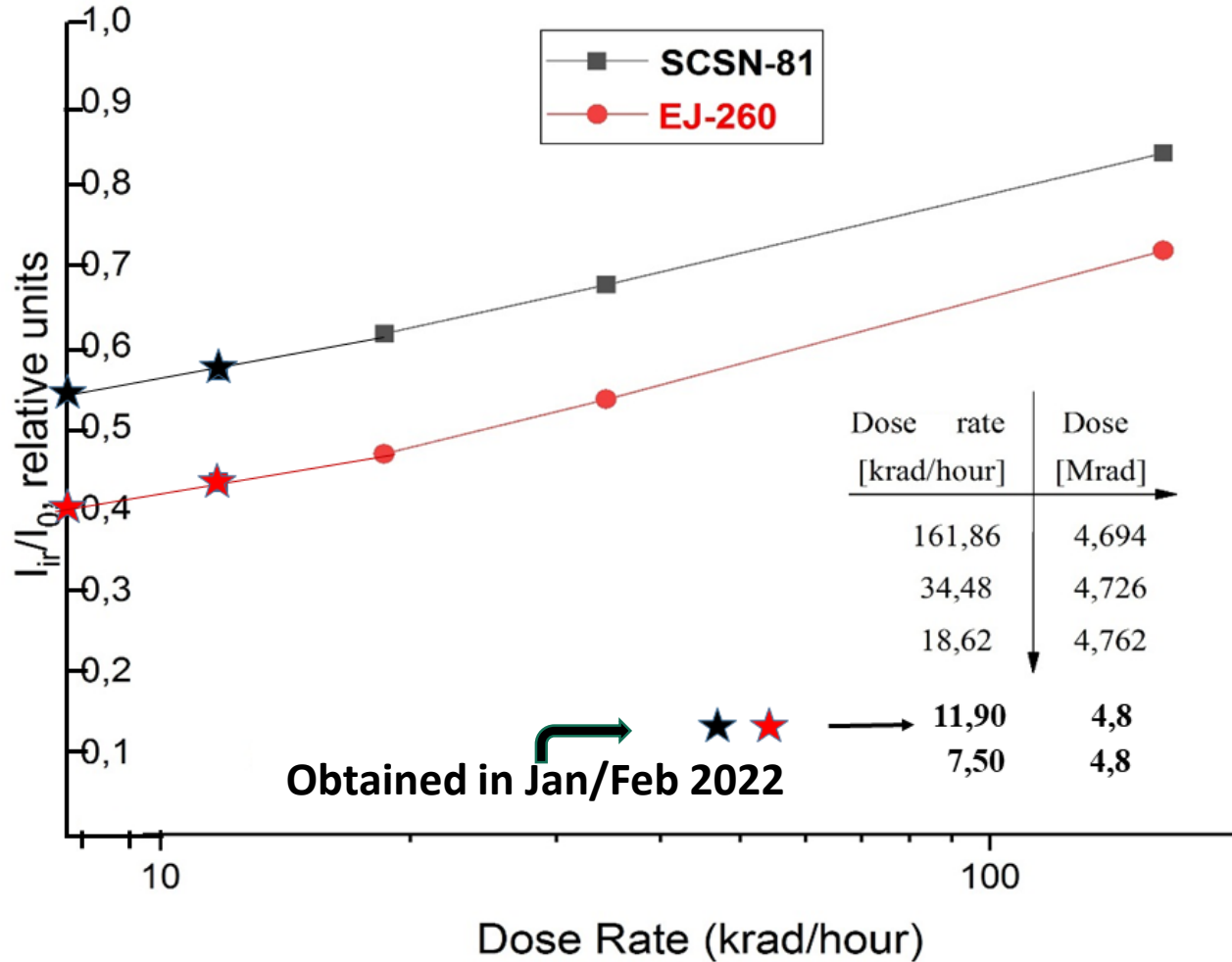
**Samples were irradiated at 10 MeV electron linac
(γ -radiation of broad spectrum up to ~10 MeV)
Dose measured by Harwell Red 4034 plastic
and FWT-60 film dosimeters**



Light-yield measurement
Samples attached “directly”
to PMT (no fiber);
 α -peak position is measured



Dose-rate dependence of light output degradation in plastic scintillators (example of KIPT results)





NSC KIPT participation in CMS computing infrastructure

Site:	Bar Graph:	Status Value:	outside	down
T2_IT_Legnano		0.988	0.991	
T2_RU_JINR		0.986	0.988	
T2_UA_KIPT		0.982	0.996	
T2_HU_Budapest		0.979	0.980	
T2_US_Wisconsin		0.975	0.983	
T2_ES_CIEMAT		0.973	0.981	
T2_US_Nebraska		0.960	0.960	
T2_CH_CERN		0.959	0.959	
T2_UK_London_IC		0.956	0.962	
T2_FR_GRIF_LLH		0.951	0.951	
T2_US_Purdue		0.950	0.953	
T2_US_MIT		0.945	0.948	
T2_DE_DESY		0.936	0.936	
T2_US_Caltech		0.933	0.939	
T2_KR_KISTI		0.932	0.940	
T2_IT_Bari		0.911	0.911	
T2_UK_SGrid_RALPP		0.906	0.911	
T2_RU_IHEP		0.901	0.901	
T2_US_Florida		0.897	0.919	
T2_UK_London_Brunel		0.883	0.887	
T2_FR_IPHC		0.883	0.893	
T2_DE_RWTH		0.879	0.882	
T2_US_UCSD		0.875	0.877	
T2_FR_GRIF_IRFU		0.867	0.882	
T2_BE_IHHE		0.864	0.871	
T2_BR_SPRACE		0.859	0.869	
T2_US_Vanderbilt		0.848	0.859	
T2_CN_Beijing		0.845	0.880	
T2_BE_UCL		0.845	0.865	
T2_RU_INR		0.834	0.866	
T2_EE_Estonia		0.828	0.844	
T2_FI_HIP		0.806	0.820	
T2_PT_NCG_Lisbon		0.802	0.808	
T2_CH_CSCS		0.787	0.819	
T2_UK_SGrid_Bristol		0.765	0.772	
T2_ES_IFCA		0.761	0.779	
T2_FR_CCIN2P3		0.760	0.948	
T2_PL_Swierk		0.744	0.757	
T2_TW_NCHC		0.732	0.752	
T2_IT_Pisa		0.700	0.719	
T2_AT_Vienna		0.683	0.753	
T2_TR_METU		0.660	0.664	
T2_IN_TIFR		0.649	0.669	
T2_IT_Rome		0.648	0.678	
T2_GR_Ioannina		0.600	0.602	
T2_BR_UERJ		0.516	0.690	
T2_RU_ITEP		0.288	0.304	
T2_PK_NCP		0.222	0.225	
T2_CH_CSCS_HPC		0.174	0.799	
T2_PL_Warsaw		0.162	0.287	
T2_KR_KNU		0.042	0.954	
T2_CH_CERN_HLT		0.005	0.031	
T2_RU_PNPI		0.000	0.000	
T2_RU_SINP		0.000	0.000	
T2_TH_CUNSTDA		0.000	0.000	

CMS Tier-2 site ranking based on readiness metrics for 4 years (24 Feb 2018 – 23 Feb 2022) preceding T2_UA_KIPT shutdown due to start of hostilities affecting NSC KIPT

<https://cmsst.web.cern.ch/ranking>

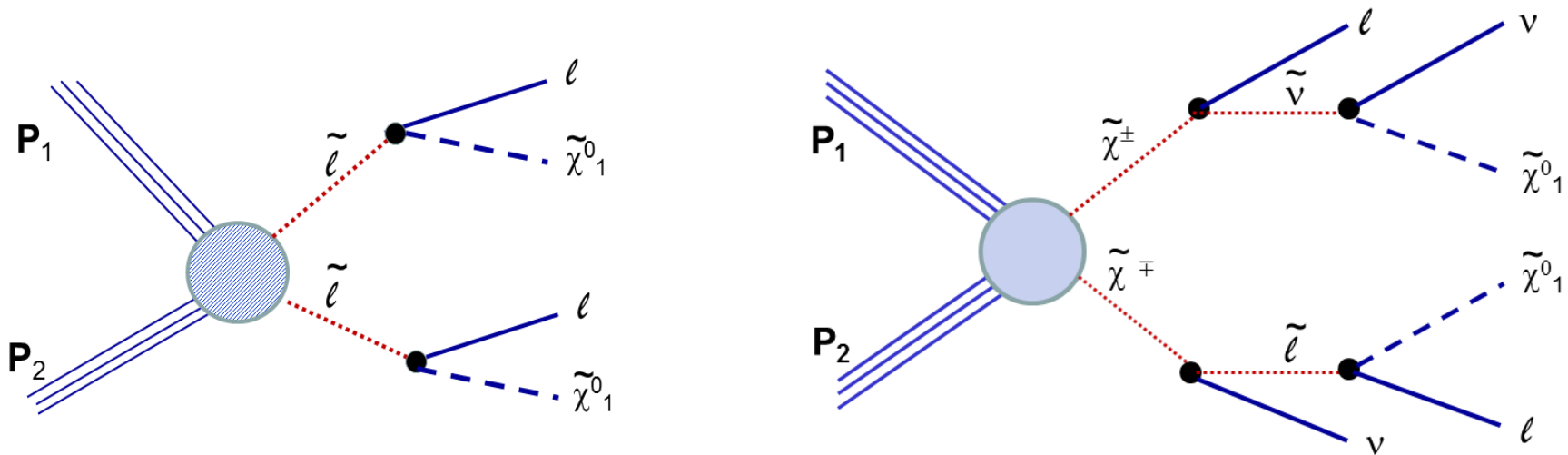
For the 4 years, T2_UA_KIPT readiness had been 98.2% of time, that was one of the best readiness indicators among all the CMS Tier-2 sites

Physics analysis of CMS data at KIPT (example of present activities)



Search for SUSY signals – direct slepton and chargino pair production in 13 TeV pp collisions through final states with 2 oppositely charged leptons (μ/e)

Implied simplified models:



Jointly with Instituto de Fisica a de Cantabria, IFCA
(CMS AN-19-256)

- ❑ Analysis is performed with coordination by SUSY PAG (SUSY/Leptonic subgroup)
- ❑ Preliminary results were reported at several SUSY/Leptonic meetings

A bit of geography...



An important extra (dramatic!) milestone – 24 Feb 2022

The institute was significantly damaged by shelling during military operations in 2022

NSC KIPT participation in CMS hadron calorimetry (HCAL) R&D studies and upgrades

Our experimental building at NSC KIPT (October 2022) ...



Stand for measurements of light output in scintillator samples was moved from this bld. (significantly damaged by shelling) to a less damaged one. Repair work was carried out on damaged units and electronics; installation of equipment was completed, and communication link between the stand and PC was re-established and upgraded.

As of spring 2024, the stand is in working order and ready for measurements



SiteReadiness 1 day status ranking of Tier2Sites

for 2023-Jul-01 00:00:00 to 2024-May-26 23:59:59 UTC

Site: Bar Graph: Status Value: outside downtime

Site	Bar Graph	Status Value	outside downtime
T2_IT_Legnaro		0.988	0.988
T2_ES_CIEMAT		0.970	0.976
T2_CH_CERN		0.970	0.970
T2_US_Purdue		0.970	0.970
T2_US_Wisconsin		0.964	0.964
T2_US_Nebraska		0.964	0.964
T2_AT_Vienna		0.964	0.964
T2_UK_SGrid_RALPP		0.958	0.958
T2_DE_DESY		0.949	0.954
T2_RU_JINR		0.937	0.937
T2_US_Caltech		0.931	0.933
T2_HU_Budapest		0.927	0.927
T2_UK_London_IC		0.924	0.930
T2_DE_RWTH		0.924	0.924
T2_FI_HIP		0.921	0.933
T2_US_Florida		0.915	0.918
T2_KR_KISTI		0.915	0.927
T2_IT_Bari		0.909	0.909
T2_CN_Beijing		0.906	0.906
T2_US_MIT		0.897	0.897
T2_US_UCSD		0.876	0.876
T2_BR_SPRACE		0.870	0.870
T2_RU_IHEP		0.870	0.870
T2_US_Vanderbilt		0.864	0.877
T2_BE_IHHE		0.858	0.866
T2_BE_UCL		0.840	0.855
T2_UA_KIPT		0.831	0.945
T2_IT_Rome		0.822	0.827
T2_PL_Swierk		0.813	0.813
T2_EE_Estonia		0.807	0.837
T2_FR_GRIF		0.785	0.785
T2_RU_INR		0.782	0.797
T2_FR_IPHC		0.752	0.771
T2_PT_NCG_Lisbon		0.710	0.710
T2_IN_IIFR		0.659	0.747
T2_CH_CSCS		0.653	0.720
T2_PL_Cyfronet		0.640	0.650
T2_IT_Pisa		0.601	0.616
T2_RU_ITEP		0.583	0.603
T2_TW_NCHC		0.565	0.565
T2_ES_IFCA		0.556	0.568
T2_UK_London_Brunel		0.532	0.532
T2_TR_METU		0.480	0.605
T2_UK_SGrid_Bristol		0.347	0.405
T2_BR_UERJ		0.335	0.463
T2_FR_GRIF_IRFU		0.269	0.659
T2_FR_GRIF_LLR		0.218	0.610
T2_LB_HPC4L		0.033	0.917
T2_PK_NCP		0.009	0.016
T2_GR_Ioannina		0.006	0.006

Support of T2_UA_KIPT Tier-2 centre



Intensive work was carried out to restore facility's power-supply system and fix detected hardware malfunctions. Necessary software configuration changes were implemented. Owing to successful completion of this work, full-scale participation of T2_UA_KIPT site in CMS data processing has been restored since July 2023.

CMS Tier-2 site ranking based on readiness metrics for ~11 months (1 July 2023 – 26 May 2024)
<https://cmsst.web.cern.ch/ranking>

T2_UA_KIPT with readiness of 83.1% (94.5% outside downtimes) is amidst reliable CMS Tier-2 sites. Downtimes have been caused by long power outages due to missile strikes on Ukrainian energy infrastructure

Since T2_UA_KIPT is the only Ukrainian site obtaining experimental information from the LHC for processing, its restart also means the resumption of processing of this information in Ukraine

Chargino pair production search: unblinding update

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National Institute of Science Education and Research

SUSY General Meeting

February 6th, 2024



Summary

- ❑ A wide range of work within the CMS experiment is successfully carried out at the NSC KIPT
 - ✓ these activities include participation in computing infrastructure for data processing, physics analysis of the data, and support/upgrades of CMS hadron calorimetry
- ❑ We were able to resume almost all of our CMS activities, despite the difficulties and complications set by hostilities in 2022
- ❑ Despite the fact that KIPT/CMS group is not numerous, our activities are still visible within CMS

Thank you!