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

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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

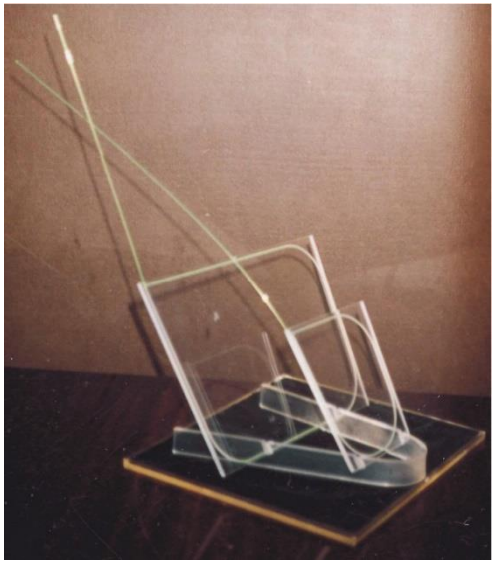
- 1994 –1998 – R&D on CMS hadron calorimeter (HCAL) ⇒ search for “adequate” scintillator material for CMS HCAL; participation in HCAL-prototype manufacturing, beam-testing and computer simulation – *NSC KIPT (Kharkov-KIPT) jointly with ISMA (Kharkov-ISMA) and Kharkiv National University (KNU)*

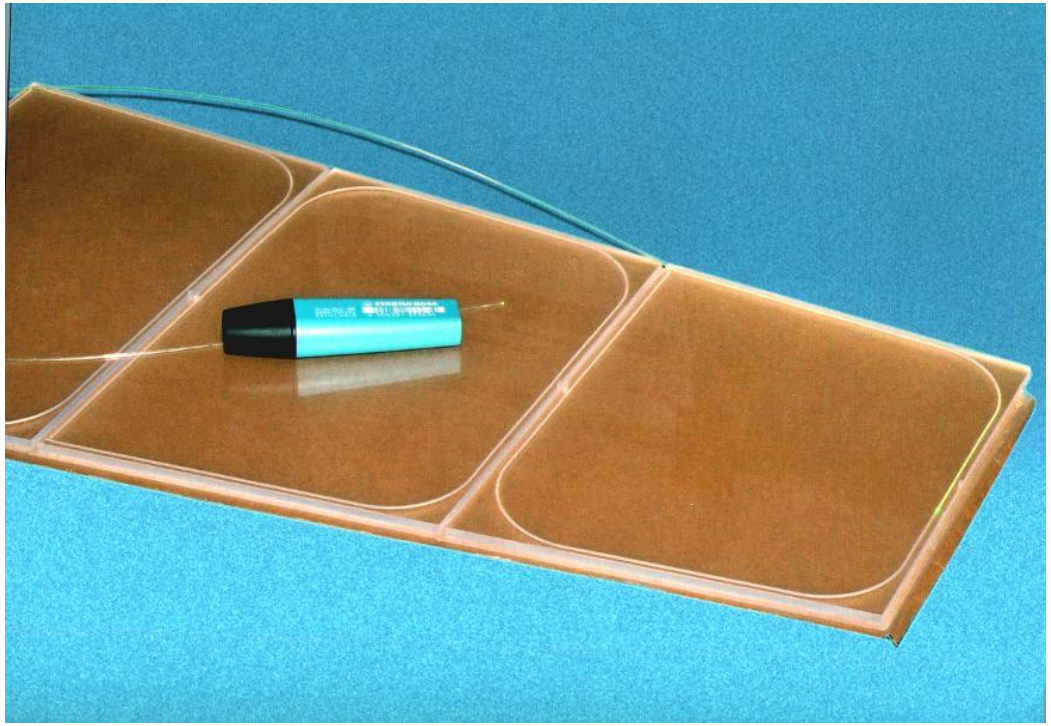
- 1998 – 2002 – participation in mass production of scintillator (SCSN-85, Kuraray) tiles for CMS endcap HCAL (quality control based on light yield measurements)

- 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 $H^0 \rightarrow Z^0Z^0 \rightarrow e^+e^-(\mu^+\mu^-) + \bar{\nu}\nu$
- ➢ 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)]

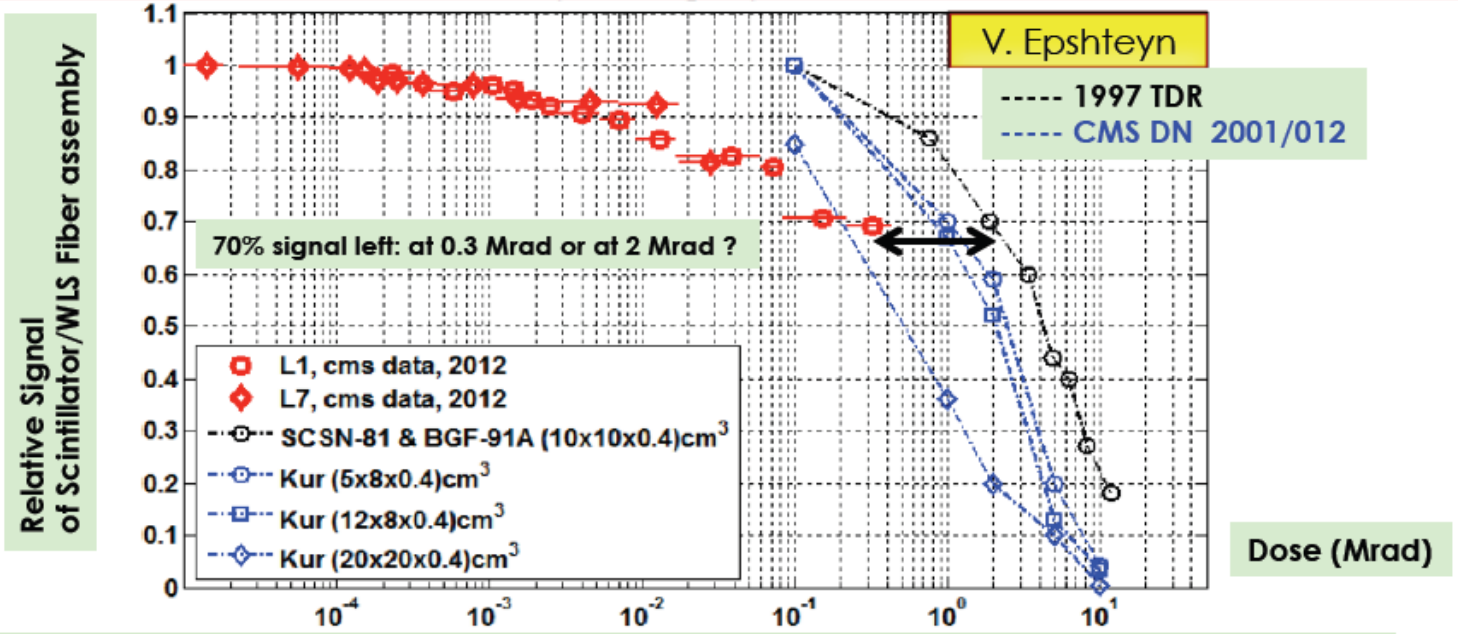
Slide from report by HCAL PM (P. de Barbaro), CMS Week, Dec 2013

Understanding HE Radiation Damage:

4

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

- 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 3000 fb^{-}



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

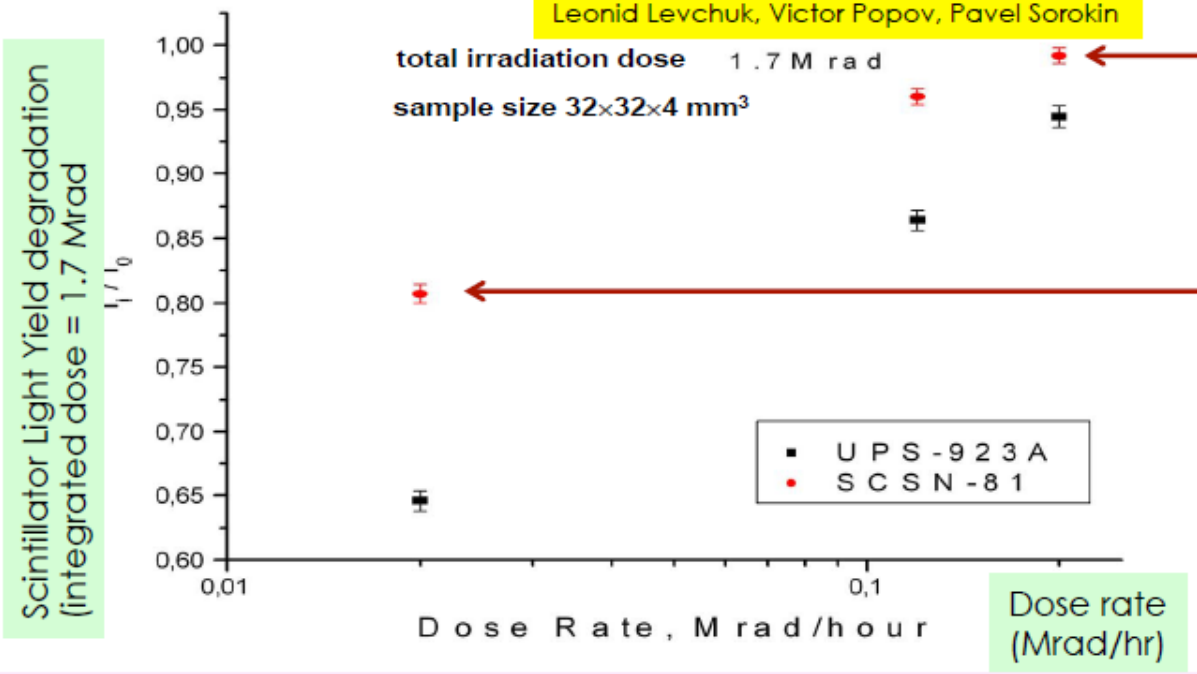
P. de Barbaro, U. of Rochester 12/5/13

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)

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)

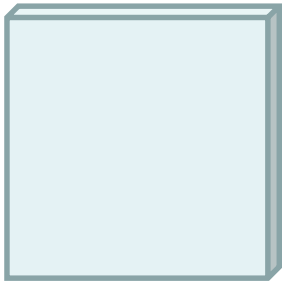
Dose=1.7 Mrad
Rate=0.02 Mrad/hr
80% signal left
(20% signal loss)

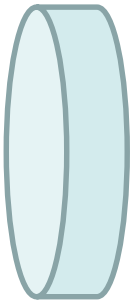
Rate at CMS HE:
η=3/L1 -> 10^{-4} Mrad/hr
(x200 lower than 0.02 Mrad/hr)

Test to be repeated with actual sigma-tiles/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 ?

Pawel de Barbaro, U. of Rochester 12/10/13

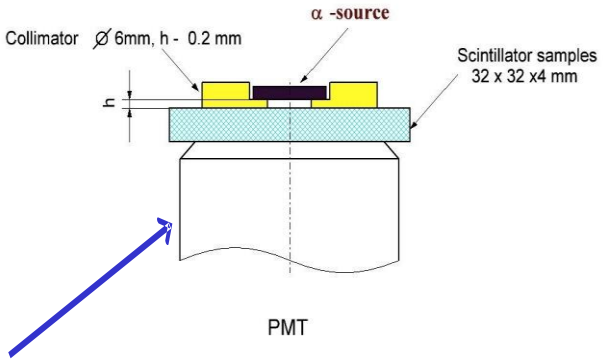
Scintillator samples and irradiation/measurement details



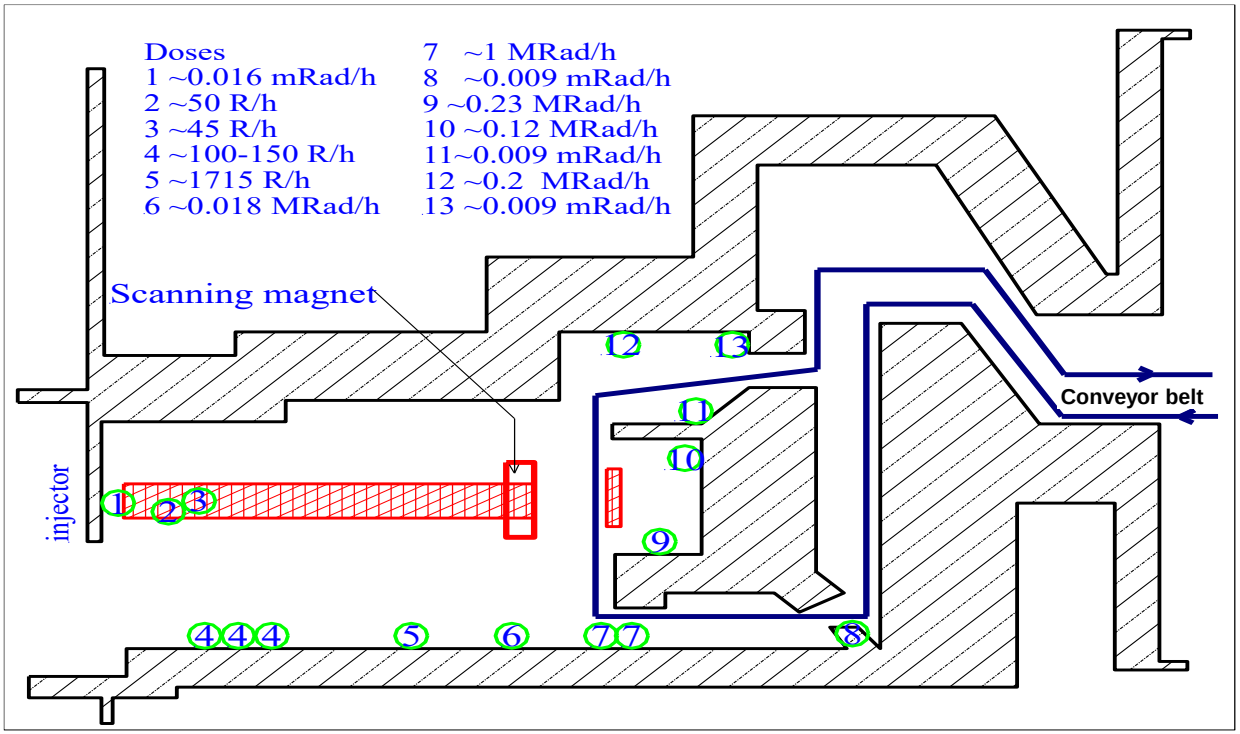


32×32 mm^2 "squares" and ∅ 30 mm "circles" of thickness 3.8 and 4.0 mm from SCSN-81 & UPS-923A (ISMA, Kharkov)

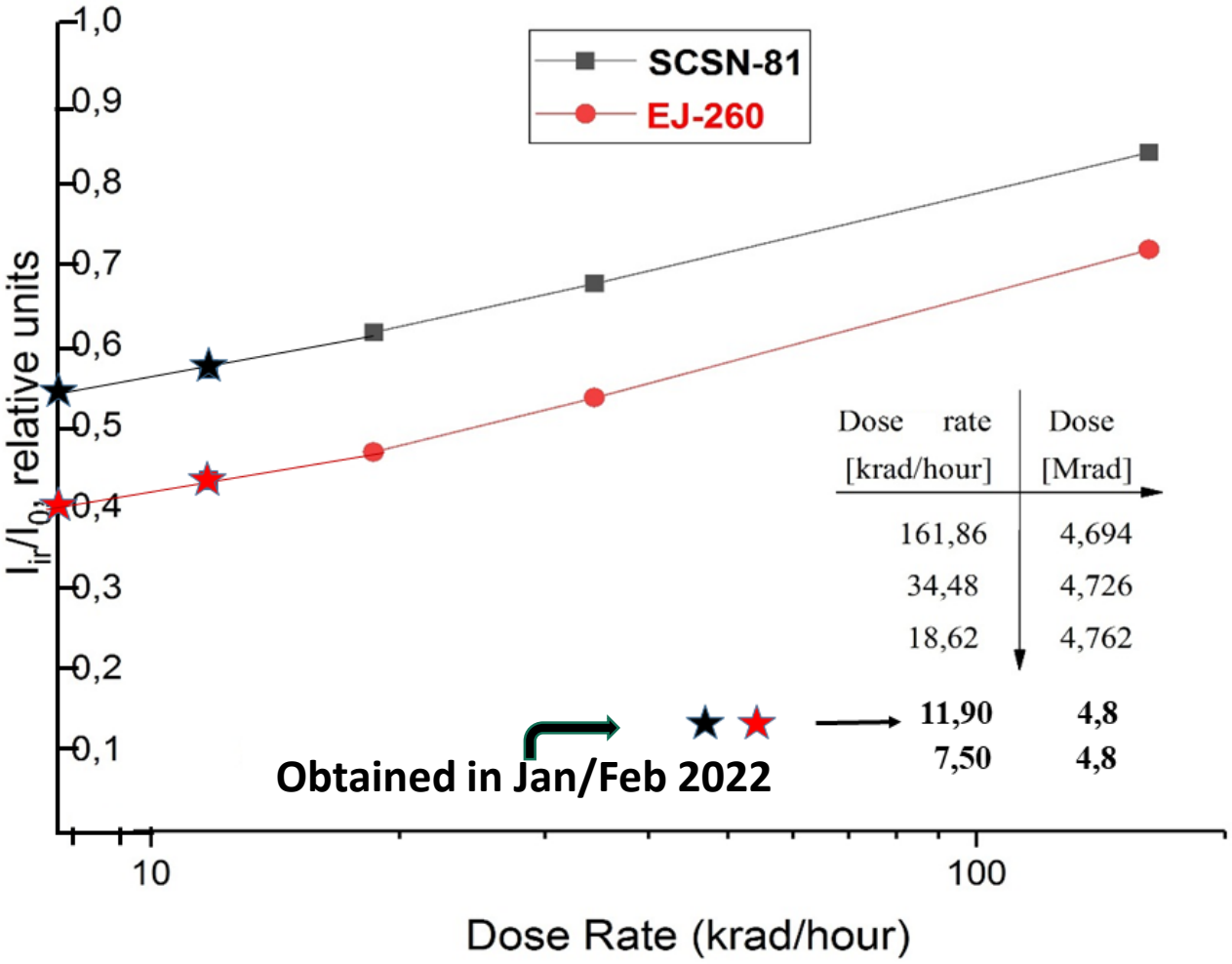
Samples were irradiated at 10 MeV electron linac (γ-radiation of broad spectrum up to ~10 MeV)
Dose measured by Harwell Red 4034 plastic and FWT-60 film dosimeters



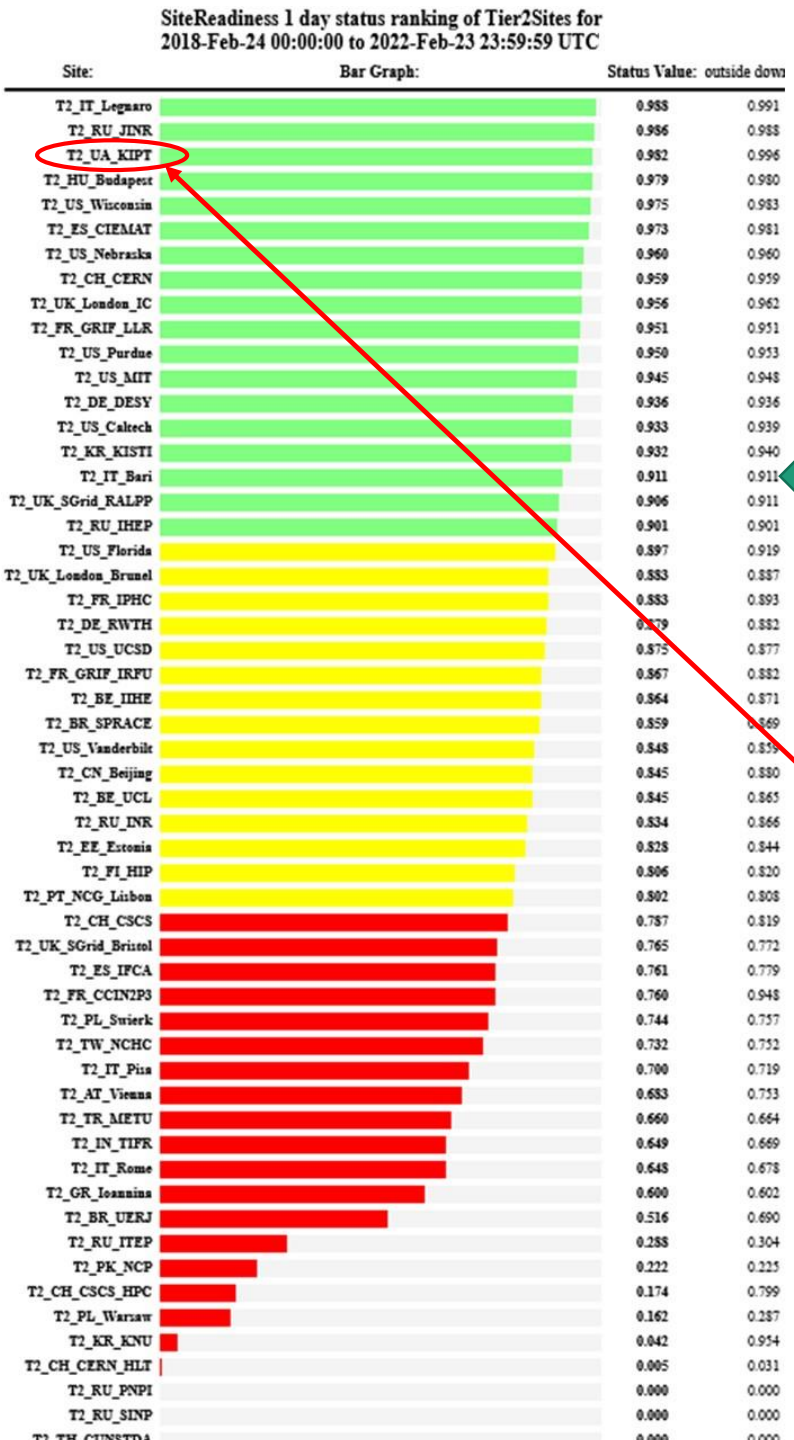
Light-yield measurement
Samples attached "directly" to PMT (no fiber);
α-peak position is measured



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



NSC KIPT participation in CMS computing infrastructure



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

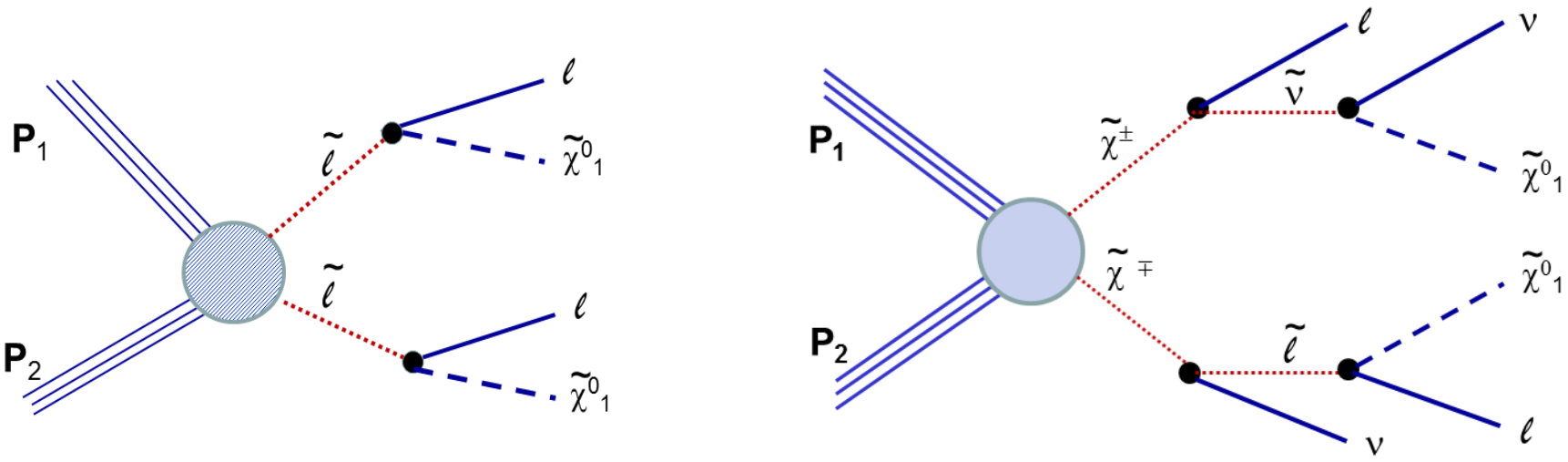
https://cmssst.web.cern.ch/ranking

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

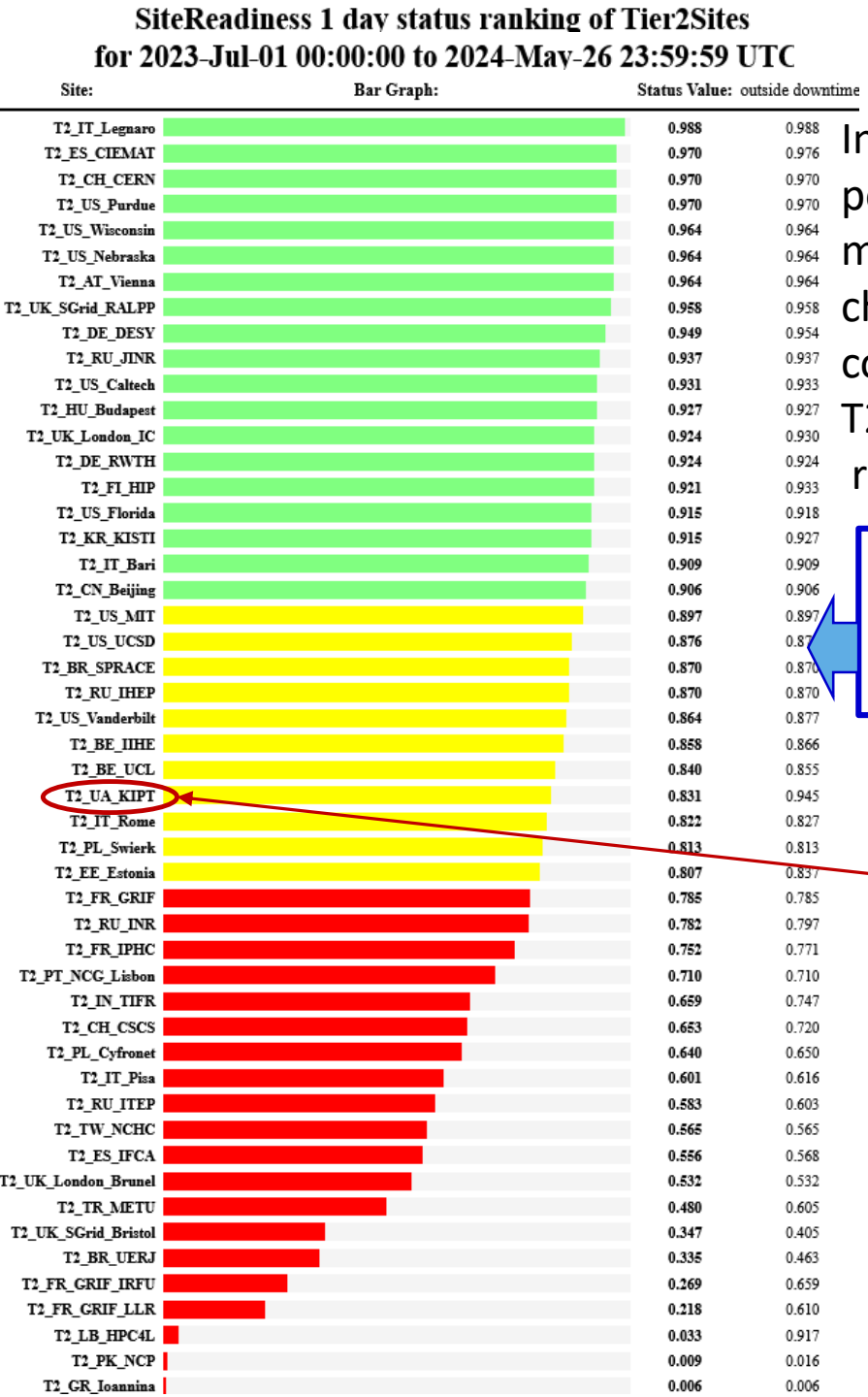
The institute was significantly damaged by shelling during military operations in 2022

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



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://cmssst.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

JAVIER BROCHERO, PABLO MARTINEZ, **PABLO MATORRAS-CUEVAS**
JONATAN PIEDRA, LUCA SCODELLARO

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LEONID LEVCHUK, SERGIY LUKYANENKO

National Science Center Kharkov Institute of Physics and Technology

TRIBENI MISHRA, SANJAY SWAIN

National Institute of Science Education and Research

SUSY General Meeting

Feburary 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!