

# Status of the RDMS CMS Computing

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The Compact Muon Solenoid (CMS) is a high-performance general-purpose detector at the Large Hadron Collider (LHC) at CERN. More than twenty institutes from Russia and Joint Institute for Nuclear Research (JINR) are involved in Russia and Dubna Member States (RDMS) CMS Collaboration. A proper computing grid-infrastructure has been constructed at the RDMS institutes for the participation in the running phase of the CMS experiment. Current status of RDMS CMS computing is presented here.

Key words: grid computing, CMS experiment, RDMS CMS collaboration, CMS Tiers

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Russia and Dubna Member States (RDMS) CMS collaboration was founded in 1994 [Matveev, Golutvin, 1996]. The RDMS CMS takes an active part in the Compact Muon Solenoid (CMS) Collaboration [CMS Collaboration..., 1994] at the Large Hadron Collider (LHC) [WhatLHC] at CERN [CERN Homepage]. RDMS CMS Collaboration unites more than twenty institutes from Russia and Joint Institute for Nuclear Research (JINR) member states. RDMS scientists, engineers and technicians were actively participating in design, construction and commissioning of all CMS sub-detectors in forward regions of the setup. RDMS CMS physics program was developed taking into account the essential role of these sub-detectors for the corresponding physical channels. RDMS scientists made large contribution for preparation of study QCD, Electroweak, Exotics, Heavy Ion and other physics at CMS. The overview of RDMS CMS physics tasks and RDMS CMS computing activities are presented in [Gavrilov, 2011; Gavrilov, 2016]. RDMS CMS computing support should satisfy the LHC data processing and analysis requirements at the running phase of the CMS experiment [CMS Collaboration..., 2005].

During the last decade, a proper grid-infrastructure for CMS tasks has been created at the RDMS CMS institutes, in particular, at the Institute for High Energy Physics (IHEP) in Protvino, Joint Institute for Nuclear Research (JINR) in Dubna, Institute for Theoretical and Experimental Physics (ITEP) in Moscow, Institute for Nuclear Research (INR) of the Russian Academy of Sciences (RAS) in Moscow, Skobetsyn Institute for Nuclear Physics (SINP) in Moscow, Petersburg Nuclear Physics Institute (PNPI) of RAS in Gatchina, P.N.Lebedev Physical Institute (LPI) in Moscow and National Scientific Center Kharkov Institute of Physics and Technology (NSC KIPT) in Kharkov. In the CMS global grid-infrastructure of these RDMS CMS sites operate as CMS centers of Tier-2 level with the following names: T2\_RU\_IHEP, T2\_RU\_JINR, T2\_RU\_ITEP, T2\_RU\_INR, T2\_RU\_SINP, T2\_RU\_PNPI, T2\_UA\_KIPT.

A stable and successful operation of several RDMS CMS Tier-2 centers and years of operating experience lead to creation the CMS Tier-1 center in Russia as an integral part of the central data handling service of the CMS Experiment (CMS Tier-1 in Dubna). Currently, the JINR realizes a large-scale project to create a Tier-1 computer center for the CMS experiment in the accordance with a decision (adopted by the WLCG project in 2011) to establish a Tier-1 level distributed center for the LHC experiment in Russia on the base of RCC «Kurchatov institute» and JINR. Tier-1 center for CMS at JINR is working as a full-scale CMS Tier-1 since 2015 [Astakhov et al, 2012; Astakhov et al, 2016].

In line with the CMS computing requirements for the data-taking phase of the experiment, now the RDMS CMS grid-sites provide:

- the computing and data storage resources in full;
- centralized deployment of actual versions of CMS specialized software (CMSSW);
- data transfers between the CMS grid-sites with the usage of the FTS grid-service based on VOBOS grid-services for CMS with the Phedex Server;
- SQUID proxy-servers for the CMS conditions DB access;
- certification of network links at the proper data transfer rates between JINR and CMS Tier-1 and Tier-2 centers;
- daily massive submission of CMS typical jobs by the CMS Hammer Cloud system;
- CMS data replication to the JINR data storage system in accordance with RDMS CMS physicists' requests;
- participation in the CMS Monte-Carlo physical events mass production in accordance with the RDMS CMS physicists' scientific program.

## **Status of RDMS CMS sites (July, 2016) (sites as in the CMS sitedb):**

T2\_RU\_IHEP - OK

T2\_RU\_INR – WR\* (downtime due to temporary connectivity problems)

T2\_RU\_ITEP – WR (problems to be resolved in the nearest time)

T2\_RU\_JINR - OK  
T2\_RU\_PNPI - WR  
T2\_RU\_SINP – WR (no funding to replace equipment; it is expected to get funding by early 2017)

T2\_UA\_KIPT - OK  
T3\_BG\_NCPHEP – critical state  
T3\_BG\_UNI\_SOFIA - OK  
T3\_RU\_FIAN – downtime  
T3\_RU\_MEPHI – even not in the Dashboard  
\*) “WR” – “waiting room” (site is not “OK”)

It is planned to include MIPT (Moscow Institute of Physics and Technology, State University, Dolgoprudny) resources into the CMS global computing infrastructure as Tier-2 or Tier-3 (not defined yet).

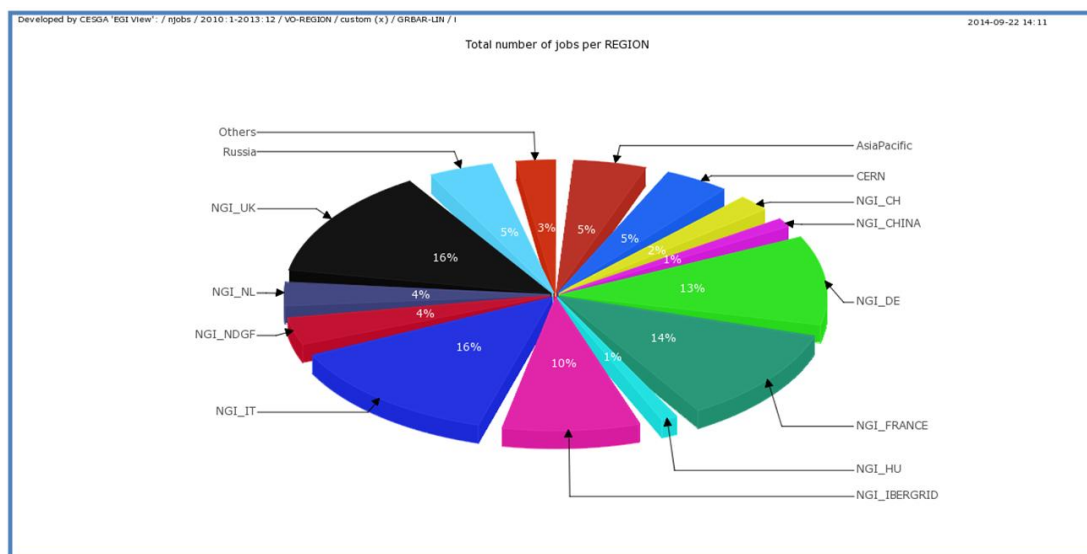


Fig1. Number of jobs in CMS Virtual Organization from June, 2015 to July, 2016

As it can be seen in Fig.1, during 2015-2016 years the contribution of RDMS CMS sites into CMS jobs processing is at level of 2.01%.

From August, 2015 to July, 2016 175 TB data have been transferred to RDMS CMS sites and 902 TB were transferred to CMS centres.

A group of RDMS CMS specialists takes an active part in the CMS Dashboard development (grid monitoring system for the CMS experiments) (<http://dashboard.cern.ch/cms>).

The dedicated CMS remote worldwide-distributed centers (ROC) were built in various scientific organizations. The JINR CMS Remote Operation Center (ROC) was founded in the 2009 year to provide participation in CMS operations of a large number of RDMS CMS collaborating scientists and engineers. MSU and IHEP ROCs were started-up two years after. RDMS CMS ROCs provide the following functions:

- monitoring of CMS detector systems;
- data monitoring and express analysis;
- shift operations;
- communications of the JINR shifters with personal at the CMS Control Room (SX5) and CMS Meyrin centre;
- communications between JINR experts and CMS shifters;
- coordination of data processing and data management;
- training and information .

RDMS CMS physicists work in the WLCG environment, and now we are having more than 30 members of CMS Virtual Organization.

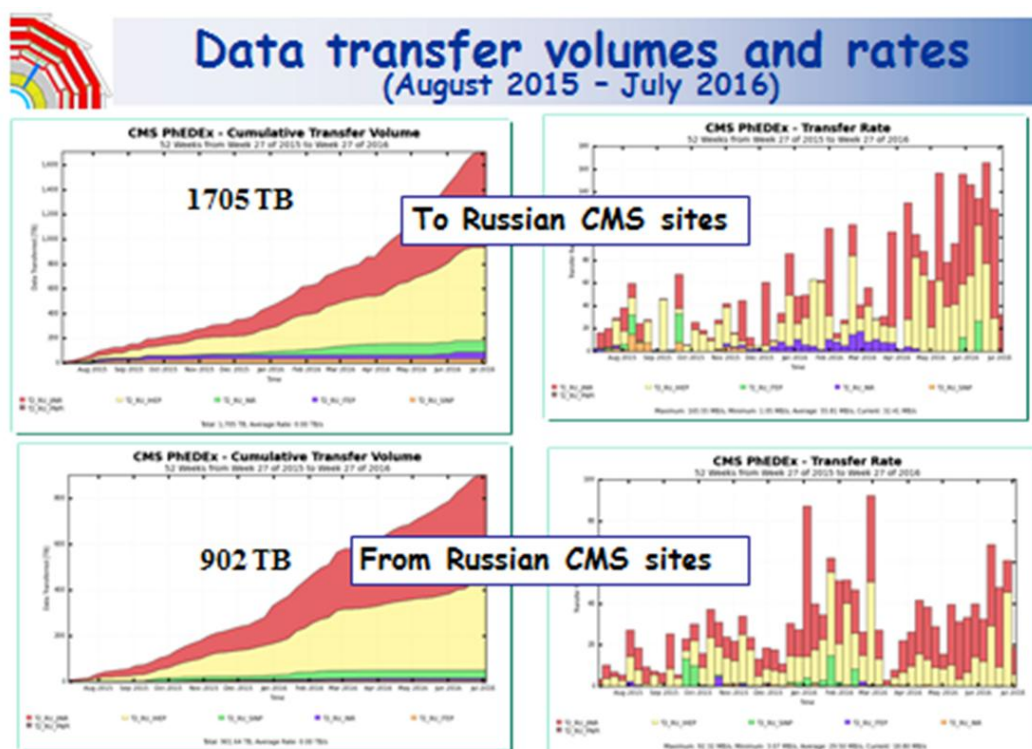


Fig.2. Data Tranfers (2015-2016)

## Summary

A stable and successful operation of CMS Tier-1 in Dubna is the main achievement of last years.

RDMS Tier-2 sites contribute in the CMS Data Processing and Analysis Tasks. They are involved actively into data processing and analysis (as of CMS Physics Groups associated sites). CMS Regional Operation Centers in JINR/MSU/IHEP/FIAN are operated for remote monitoring of detector systems and data express-analysis.

There is still a number of problems (financial for the most part) preventing RDMS Tier-2 sites to increase their resources and operation stability. By now not all RDMS Tier-2 sites fully answer the CMS Computing Requirements.

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