# Concept of data storage prototype for Super-C-Tau factory detector

**Dmitriy Maximov for the Super-C-Tau Collaboration**

Budker Institute of Nuclear Physics and Novosibirsk State University, Novosibirsk, Russia

D.A.Maksimov@inp.nsk.su

**Abstract**

*The physics program of experiments at the Super-$c\tau$ factory with a peak luminosity of $10^{35}\ cm^{-2}s^{-1}$, and Detector construction followed from it, gives strong requirements to Data Acquisition and Data Storage systems. Detector data storage is one of the key component of the detector infrastructure, so it must be reliable, highly available and fault tolerant shared storage. It is mostly oriented (from end user point of view) for sequential but mixed read and write operations and is planed to store large data blocks (files). According to CDR of Super-C-Tau factory detector data storage must have very high performance (several Tbps in both directions simultaneously) and significant volume (tens and hundreds of Petabytes). It is decided to build a series of growing prototypes to investigate storage and neighboring technologies. First prototype of data storage is aimed to develop and test basic components of detector data storage system such as storage devices, networks and software. This prototype is designed to be capable to work with data rate of order 10 Gbps. It is estimated that about 5 computers with about 50 disks in total should be enough to archive required performance. The prototype will be based on Ceph storage technology. Ceph is a distributed storage system which allows to create storage solutions with very flexible design, high availability and scalability.*

## 1. Physics & Detector

A Super-$c\tau$ factory (CTF)[1] is an electron-positron collider operating in the range of center-of-mass (c.m.) energies from 2 to 5 GeV with a high luminosity of about $10^{35}$ cm$^{-2}$c$^{-1}$.

The main goal of experiments at CTF is a study of the processes with $c$ quarks or $\tau$ leptons in the final state using data samples that are 3–4 orders of magnitude higher than collected today at CLEO-c and BES-II detectors.

Useful event rates and rates of Bhabha events at different energies as well as rates from cosmic events are presented in Table 1. The cross section of the nonresonant hadron production at these energies is ∼20 nb, which corresponds to the counting rate of 20 kHz at the luminosity of $10^{35}$ cm$^{-2}$c$^{-1}$.

**Table 1:** *The luminosity, physical cross section, rates of useful events, Bhabha events at different energies, rates from cosmic events.*

| | $J/\psi$ | $\psi(2S)$ | $\tau\bar{\tau}$ | $\psi(3770)$ | $\tau\bar{\tau}$ | $\Lambda_c\bar{\Lambda}_c$ |
|---|---|---|---|---|---|---|
| $E_{\rm cm}$, MeV | 3097 | 3686 | 3700 | 3770 | 4250 | 4650 |
| L, $10^{34}$cm$^{-2}$s$^{-1}$ | 7.7 | 9.2 | 9.2 | 9.4 | 10 | 10 |
| $\sigma$, nb | ∼3400 | ∼640 | 2.5 | ∼6 | 3.5 | 0.5 |
| f, kHz | 260 | 60 | 2.3 | 5.6 | 3.5 | 0.5 |
| Bhabha, kHz | ∼90 | ∼80 | ∼80 | ∼80 | ∼60 | ∼50 |
| Cosmics, kHz | ∼2 | | | | | |

As follows from the data above, the maximum readout rate of useful events will reach 300–400 kHz. The average size of a single event is estimated to be 30 kB.

1. Project of a Super Charm-Tau factory at the Budker Institute of Nuclear Physics in Novosibirsk, Conceptual Design Report (2011), https://ctd.inp.nsk.su/

## 2. Computing

Networking and computing infrastructure is going to play one of the key roles in operating the experiment at the CTF detector.

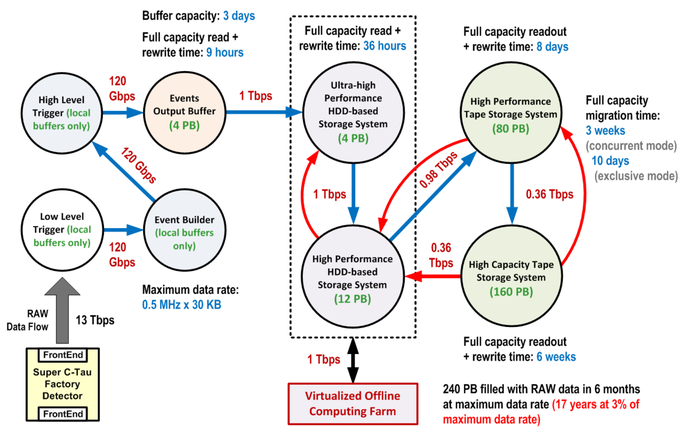


**Figure 1:** *Detailed diagram of the data flow originating from the detector and going through its TDAQ, offline data processing and storage systems.*

## 3. Storage prototype achitecture

First prototype of data storage is planned to model 1:100 part of the production storage system. It is aimed to develop and test basic components of detector data storage system such as storage devices, networks and software.

Key features and planned parameters of prototype:

- Based on CEPH storage technology;
- Data rate: 10 Gbps;
- Contains 5 machines, 10+50 disks (SSD+HDD) in total;

Storage prototype will be deployed at BINP General Computing Facility (GCF).

Some performance measurements of current BINP/GCF CEPH cluster (contains 6 machines, 24 HDD disks in total) presented at Figures 2, 3, 4, 5, 6, 7, 8 and 9.

The given data shows relatively moderate results comparing to the requirements. Comparison of planned and current configuration of clusters shows the opportunity of performance growth.

### 3.1 Performance 4kB blocks

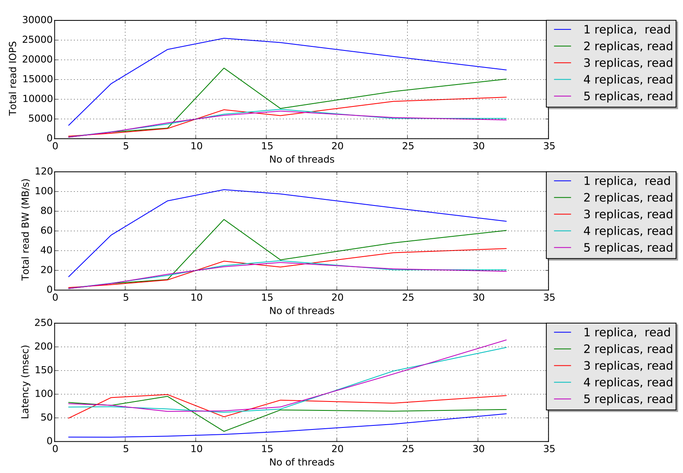


**Figure 2:** *Read operations performance with 4kB blocks at read test*

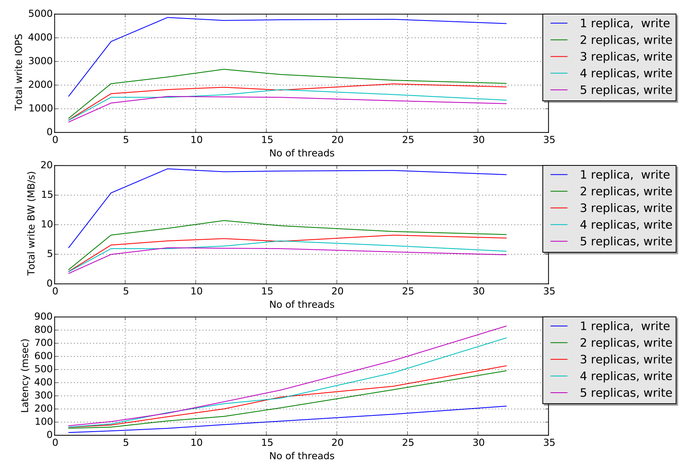


**Figure 3:** *Write operations performance with 4kB blocks at write test*

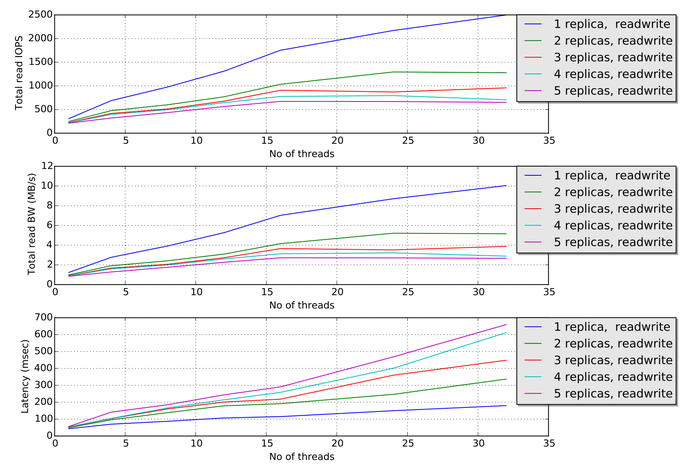


**Figure 4:** *Read operations performance with 4kB blocks at read+write test*

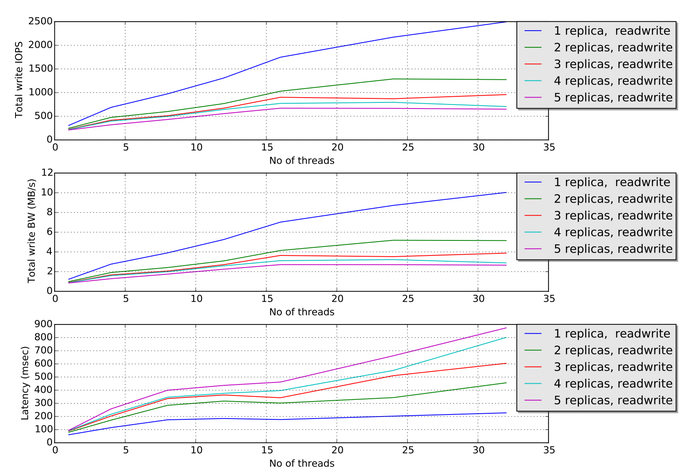


**Figure 5:** *Write operations performance with 4kB blocks at read+write test*

### 3.2 Performance 64kB blocks

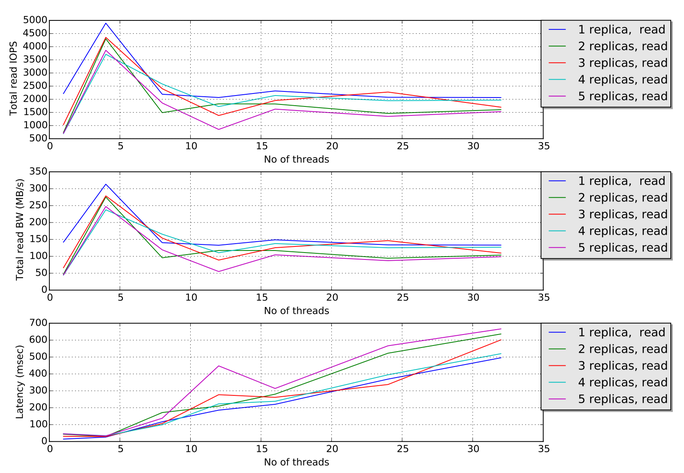


**Figure 6:** *Read operations performance with 64kB blocks at read test*

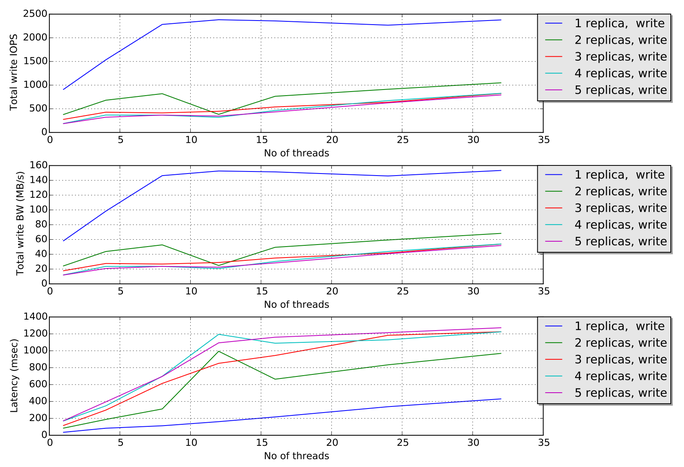


**Figure 7:** *Write operations performance with 64kB blocks at write test*

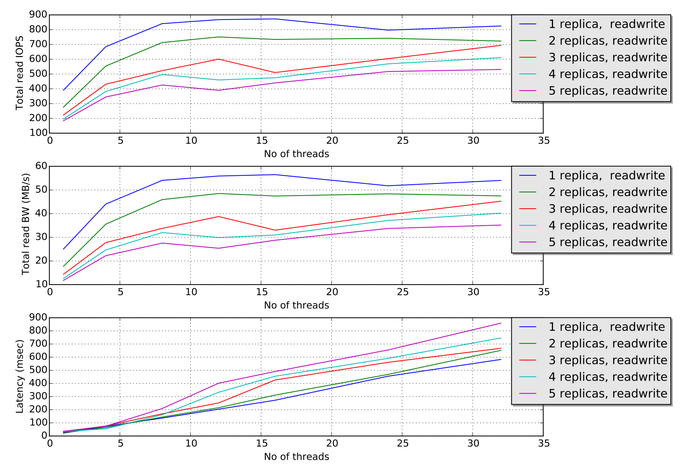


**Figure 8:** *Read operations performance with 64kB blocks at read+write test*

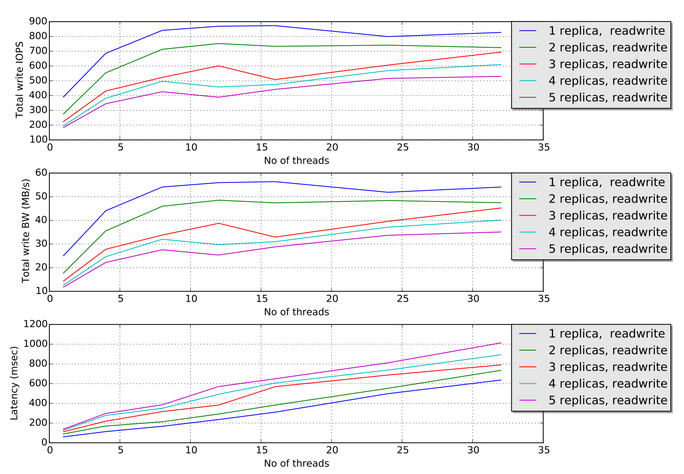


**Figure 9:** *Write operations performance with 64kB blocks at read+write test*