τ-Charm Factory (τCF) Data Acquisition and Offline Requirements*

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A single most important factor one has to consider while designing an offline reconstruction system, and similarly in the case of an on-line trigger, is its bandwidth[1]. *A priori*, if there were no limitations to the number of bytes of data that one can push to (and from) the computer CPUs, one could - by multiplying the number of processors - reduce the clock processing time to an (almost) arbitrarily small value. In general, if a Data Acquisition (DAQ) System is capable of pushing N events per second across a bus while utilizing a fraction F of its bandwidth, one can process in an offline system based on the same single bus (and assuming the size of an output event equal to the size of an input one) $M \leq N/(2 * F)$ events per second. A number of parallel computers (nodes) required in such a system is $K = M * t$, t being the reconstruction time per event in the node used. To go beyond M, one has to multiply the number of complete systems (buses).

The bandwidth requirements for τCF are quite modest by modern standards, defined by the present or proposed high rate fixed target and $p - \bar{p}$ collider experiments[2–3]. The DAQ system and the offline reconstruction are relatively simple and do not represent any fundamental obstacles.

The τCF is planned to operate in two different physics modes - at J/Ψ peak and in the "continuum", say at the $D\bar{D}$ threshold.

Running at J/Ψ will be limited to perhaps a few months. The finite size of the systematic errors defines a point when the statistical errors are no longer important and further data taking is not advantageous to the precision of a physics result. Thus even writing all events, preferable for physics reasons and quite feasible using modern DAQ

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systems, leads to a sample of data which can be analysed in a reasonable time in a modern offline computer system.

The $e+e-$ cross section at the $D\bar{D}$ threshold is much smaller, and the DAQ system requirements are very modest. The runs will be longer, yielding large data sets. However, the CPU requirements can be easily met using the presently available technology.

Table I summarizes the essential information relevant to planning the DAQ and offline systems in those two running modes. The following assumptions were made: luminosity $L \approx 0.5 \times 10^{33}\ cm^{-2}s^{-1}$; cross sections $\sigma(J/\Psi) \approx 2\mu b$, $\sigma(D\bar{D}) \approx 20nb$; event size 20 kb; running time - 1×10^6 seconds at J/Ψ, and 1×10^7 seconds ("a year") at the $D\bar{D}$ threshold.

(Events originating in the beam-gas interactions will contribute additional background events, however - see Jon Thaler's contribution in these Proceedings - since their number will not change significantly the DAQ requirement I have ignored them for simplicity).

TABLE I.

running mode	event rate	data rate	event sample
J/Ψ	1000 Hz	20 Mb/s	1×10^9
$D\bar{D}*$	10 Hz	0.2 Mb/s	1×10^8

From the technical standpoint the DAQ does not represent a challenge. There exist designs of DAQ systems capable of handling easily even much higher data rates[2–5]. Using barrel-shifters and parallelism it is possible to build a DAQ system capable of pushing 250 Mb of data and at the cost below 500000 US dollars[4]. Also, writing even a thousand events per second on a tape is not a problem, the experiment E791[2] at Fermilab is preparing to write similar rates in the forthcoming fixed target run at FNAL.

Assuming the offline reconstruction time of 10 seconds (VAX780) per event, one needs 333 VAX780-years and 33 VAX780-years to reconstruct the J/Ψ sample and the $D\bar{D}$ sample respectively. (I assumed here that the offline system is operational 3×10^7 seconds per calendar year.) With the presently existing computer technology (e.g. MIPS R3000 chips based on RISC technology, equivalent to 20 VAX780 each) this is not difficult to do. For example, using just four Silicon Graphics 4D/240S UNIX machines, each employing four 25 MHz R3000 MIPS chips allows to do the complete offline reconstruction of the J/Ψ and $D\bar{D}$ samples in 8 months and about 3.5 weeks respectively. A single 4D/240S costs about 65000 US dollars with a 35% University discount.

One has to remember, however, that the price of the complete offline system will be higher. At present it is the peripherals, rather than the CPU, which determines the final cost of a system. Realizing that CPU is no longer a bottleneck should allow physicists to plan and design the final shape of their offline computer system according to their needs. Hopefully such a system could be as user friendly as possible. This should be the dominant theme in its design.

In an attempt to get a glimpse at how the HEP community perceives its computer needs I have asked the τCF Workshop participants to respond to a questionnaire. Perhaps not surprisingly the number of responses was small. I hope that this is because most of the participants were busy solving much more difficult problems with the detector or machine design. I should like to believe that it is by now recognized that the offline reconstruction is a very important part of planning a new experiment and an appropriate effort should be devoted to think about the details.

To summarize the results of a questionnaire:

1) It was felt that 1 month is a desired time to get the reconstruction done.

2) UNIX was widely recognized as an operational system offering the best performance-to-price ratio and worth investing some effort to convert the VAX code, if necessary.

3) Most respondents felt that it is desirable to maintain uniformity of the computer systems used in the collaborating institutions.

4) 8-mm cassettes (each with capacity of 10-12 9-track 6250 bpi tapes) and IBM cartridges (each with capacity of about three 9-track 6250 bpi tapes) were considered the preferred media for raw data storage; optical disks of the future and hard disks were the choice as the medium for DST and μDST storage.

5) All respondents agreed that the heavy offline reconstruction and Monte Carlo generations should be done centrally.

6) There were very mixed, strong and often contradictory opinions about the data management system, database system and the memory management systems; I think this

reflects the fact that this area has been, historically, neglected in the past experiments. It is also the one where perhaps one can do a lot to improve the user friendliness of the offline system; it is a very rapidly changing field, one may only hope that within a few years the choice will be clear and obvious.

7) Similarly mixed opinions were expressed about the organization of code development, code management, package development etc; the reasons are the same as in the previous question; one can only hope that τCF makes an effort to at least avoid past mistakes.

8) There is a growing feeling that physicists should liberate the High Energy Physics from FORTRAN; modern languages (C, ADA...) offer many features which facilitate the memory management and the code management issues.

It is no longer difficult to provide sufficient CPU power to reconstruct the data fast. The τ-Charm Factory should benefit from the experience of several large experiments presently underway - CDF, LEP experiments, D0, high rate fixed target at FNAL, CEBAF - in designing its offline structure and programming environment in a much more user friendly way than it has been done in the past. I consider this the biggest challenge facing the τCF Offline Group. Many of the answers to those organizational questions may become known within the next few years, hopefully in time for the τCF to benefit from them.

REFERENCES

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