16th International Toki Conference (ITC-16) 2006, P9-04

National Institute for Fusion Science, National Institutes of Natural Sciences, Japan

Nonstop Loss-less Data Acquisition and Storing Method for Plasma Motion Images

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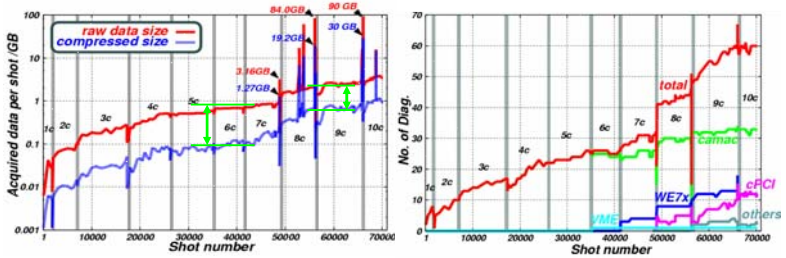
◆ Backgrounds:



- LHD data acquisition system, **"LABCOM system"**, has been fully functional for **steady-state** operations. **(max. 80 MB/s/diag)**
- New CompactPCI (PXI) digitizer can continue frame grabbing at full rate. A VGA color camera outputs **70.3 MB/s**.

↓

"Data explosion" occurred!

- Image data occupies the greater part of storage volume.
- Current **"zlib"** compression algorithm becomes **slow and even less compressive** for 2-D image data.

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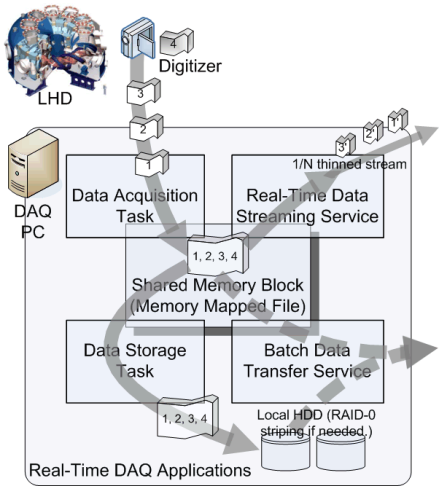
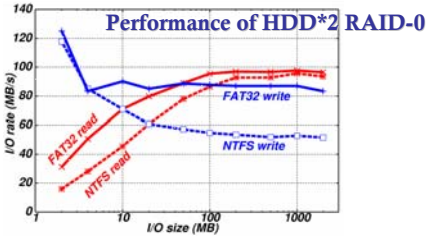
How can we improve them? The "loss-less" is mandatory.

◆ RT Stream & Store Architecture:





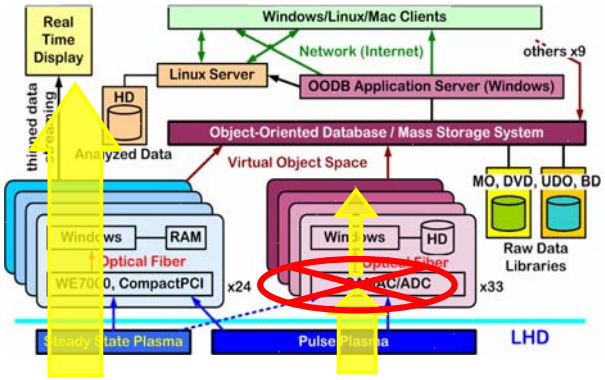
RT Streaming ...

- Max. 80 MB/s streaming is even possible, but **1/N thinning** is available by client request.
- Streams are sent by **UDP/IP**, not heavy TCP/IP.

RT Storing ...

- Stream is stored into **multiple 10 s chunks** by every signal channel.
- Faster **RAID-0 (striping)** is necessary if >50 MB/s.

◆ LHD DAQ:



RT streaming is possible. ~ 80 MB/s

RT streaming is "not" possible. ~ 1 MB/s (legacy)

- **As a camera signal contains time series of 2-D frames, the whole data become much bigger as one channel output. e.g. color VGA: 703 MB/10 s.**
- **Data retrieval by each frame must be fast. -> Storing by frame, not by channel, is needed.**

◆ Compression Algorithm Examination:

Deterioration of compression ratio from 2003 to 2004:

	7c	8c	Increased (%)
raw (MB)	868.3	2111.8	243.2
comp. (MB)	164.5	640.7	389.6
comp. ratio (%)	18.9	***30.3***	--

"zlib" compression ratios for 1-D & 2-D data:

	raw (MB)	comp. (MB)	ratio (%)
waveform	1372.1	377.8	27.5
image	739.8	262.6	***35.5***
TOTAL	2111.8	640.4	***30.3***

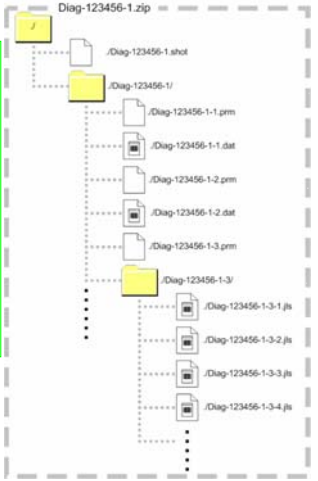
Comparison of loss-less image compression algorithms:

	comp. (byte)	ratio (%)	cpu time (s)
zlib	217493	***39.1***	0.113
png	192958	34.7	0.220
JPEG-LS	137651	***24.7***	***0.031***

- **Embedded compression algorithms should be automatically changed between 1-D::zlib & 2-D::JPEG-LS.**
- **Compressed size ~ 1/4 again!**

◆ Portable Archive File:

- **Standard "zip" archive format having *"Shot/Channel/(Frame)"* sub-folders with data & meta-info. text files in each.**
- **All wave & image data are stored as independent files compressed in archive.**
- **"zip" has fast seeking index inside.**



◆ Summary & Future:

- **"LABCOM"** system has been fully functional for nonstop loss-less image acquisition for plasma diagnostics, with max. **80 MB/s/diag** bandwidth.
- Full-rate streaming and storing are even possible in RT.
- **JPEG-LS** should be used for image data instead of **zlib** for wave signals, maybe in other scientific fields.