Data Management at JET with a look forward to ITER

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JET (Joint European Torus) Largest Tokamak to date
Day 1, June 1983

Located at Culham Science Centre, Abingdon, Oxfordshire, UK

Operated by UKAEA on behalf of EFDA (European Fusion Development Agreement)
JET (www.jet.efda.org) → ITER (www.iter.org)

JET Enhancements
ITER relevant Engineering and Physics

2x2x2
Plasma Volume x10
Data Management at JET

Finance, Contracts, HR
Planning
Plant Maintenance
Diagnostics Data Handbook
Experimental planning
Machine Configuration
Publications
Account management
Management systems

Electronics Structured data

Document management

Change requests
Experimental Logs
Fault Reporting
Network Management
Access Control
Statistics

JET Control Systems
Experimental setup
Control
Data Acquisition
Data Analysis
Data Storage

Not all as integrated as we would like
Hierarchical and Modular Architecture

Three-level hierarchical and modular control system structure in hardware and software:

- Central/Supervisory - level 1
- Subsystem - level 2
- Component - level 3

Subsystem per major Plant System
Vacuum, Poloidal Field, RF Heating ...

10 Subsystems for ~70 Diagnostics

Same structure applicable to Machine Control and to Diagnostics

21 subsystems in total

Autonomy at Subsystem Level
JET Experiment Pulse Cycle

Offline Analysis → Pulse Preparation
Intershot Analysis
Data Storage → Data Collection
Pulse
Control/Diagnostic → Setup/Validation
Countdown

**JET is pulsed**
25 pulses per day
~70,000 since 1983
Two shifts 06:30 - 22:30
Pulse every ~ 30 minutes
~30-40s of plasma
Maximise Repetition Rate

**ITER will be pseudo-continuous**
(60mins of plasma)
**Pulse Preparation, Setup, Validation**

**Hierarchical State Machine**

**JET**

**Subsystem**

**Hardware**

**Experiment**

**Component**

**Pulse Preparation - Cross-Subsystem (Level-1)**

- Single view of plant, 22,000 parameters
- JET-developed ASCII database - sets values in L2 databases
- Experimental Schedules and pulses, old pulse settings
- 400 Plug-in codes, Scenarios, “Flight Simulation”
- Same tool + DB, different views for Physicists, Engineers
- Machine Setup, Machine Safety Pre/Post pulse checks,

**Control/Setup - Subsystem (Level-2)/Component (Level-3)**

- Plant Status Image = LiveDatabase built from hardware tree
- Pre/Post-Pulse actions (experiment tree)
- Data-driven :- Synoptic Displays, Continuous Recording, Trend Displays
- Alarms, Setpoints, Waveforms, Level-2 Logic, Component Frameworks,
- RDF-based CODAS Configuration Language
- Real-time Applications, Ethernet, ATM, ATCA, analogue
- VME (VxWorks, 68k, PPC), PC (Windows, Linux), CAMAC

**Plant Interfaces**

- CAMAC, Eurocard, VME, PCI, CPCI, RS232, GPIB, PLCs, ATCA
- Ethernet - HTTP protocol - “Black-boxes” c.f. ITER Plant Systems

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Control System Databases

Level-1 JET-Wide
- Pulse Schedule
  - LOAD
- Level-1 Old Pulse Settings
  - COPY
- Static Database
  - BUILD
  - COPY

Level-2 21 Subsystems
- Hardware Tree
  - BUILD
- IO Device Data
  - Signal calibrations (Static database)
- Live Database
  - COPY
  - Pre-pulse actions (Static structure)
  - Dynamic Content)
  - Post-pulse actions

Level-3 Components
- STATIC BUILD
- DYNAMIC
- USER
- PRE-PULSE
- POST-PULSE

Hardware / Real-time applications
Program / Monitor state via ethernet
(HTTP "black-box" protocol)
Real-time Control

Ongoing growth area on JET
Fundamental on ITER
Streaming data
Real-time analysis, control, protection
See Rob Felton poster - WPPA22

Figure 1. Overview of Feedback Control
Data Collection, Transfer, Storage, Analysis

Large/Late Pulse File (LPP) Data Collection

10 GE Datnet Backbone

4 x 10GE Trunking

10 GE Switch

LPF Data Collectors

Mass Data Store
E4900 8 x UltraSparcIV Dual-threaded processors, Solaris 10, ZFS

Cache Disk
50 TB (Usable)
ANS ATA-based RAID

Raw Data (JPF)

IPF QPF JPF DPF LPF

Processed Data (PPF)

New Data

Mirrored Disk

JPF Server

PPF Server

All processed data stored centrally

Multi-tier Data Collection

IPF Immediate Pulse File
QPF Quick
JPF JET (Required Intershot)
DPP Delayed (non-plasma data)
LPF Large/Late

Continuously sampled data (max 0.25Hz) are recorded in a separate system

Central Physics File (CPF)

SAS

Recovered Files

Write to tape

Recovered Files

Recover Copies

StorageTek Silo
5788 Slots
9940 200GB (400)
9840 200GB (40)

Camac

I, O, J, D, PF Data Collection

Serial Highway 40Kbps

PCI-VME-SHD

IPF QPF JPF DPF

Multi-tier Data Collection

Network

Data Collection

Data Analysis

Data Storage

03/10/2007
Scheduling Problem

- ~80 codes are run intershot
- Database models dependencies of codes on raw data and each other (processed data)
  - Critical path analysis
- Codes scheduled in parallel based on dependencies
- Multi-tier collection strategy
  - Fine tuning of raw data availability
  - Critical part of intershot is complete before end of data collection
- Communication via processed data files
  - Some work on web using services
  - Integrated data analysis
- JET-like intershot analysis will not exist on ITER
  - Must be available in real-time
Mass Data Store

- **Raw Data (IPF, QPF, JPF, DPF, LPF) - Read-Only**
  - All data accessed via subsystem + pulse number (= file) and signal name
  - Home-grown (1981) data format, File headers contain signal information
  - Client-server data access
  - Home-grown file system-based indexing system holding meta data, ZFS

- **Processed Data (PPF) - Read / Write**
  - Client-server data access
  - MIMER RDBMS
    - Meta data indexing system
    - Access by pulse number, signal name
  - NetCDF data files
  - File management same as for raw data

- **Central Physics File (CPF)**
  - SAS Database
  - Access via SAS or SQL
  - Migrating to Postgres for the underlying data

- **MDSplus provides remote data access**
MDSplus – Model Data System

- See www.mdsplus.org
- MIT, CNR RFX-Padova, LANL – first developed late-1987
- “.. allows all data from an experiment or simulation code to be stored into a single, self-descriptive, hierarchical structure”
- JET provides MDSplus glue layer to raw (JPF) and processed (PPF) data
- Most Tokamaks provide MDSplus server
- Many analysis and display programs are MDSplus aware
- Installed in > 30 Labs world-wide, De-facto standard (ITER will keep concept)
- Provides Remote Data Access (RDA)
- Globus version using X.509 certificates for authentication, e.g. remote writes

- MDSplus provides the basic functional requirements of the ITER data access system from the users perspective
- Extensions have been proposed to cover continuous data acquisition as part of the ITER conceptual design
JET Experimental Data Volumes

~10GB / pulse = 0.25TB/day
2010 ~60GB / pulse?
c.f. LHC 10PB/year?

Simulation data volumes are becoming significant

~40TB in 25 years
Where will ITER be different? (1)

See Jo Lister talk “Status of the ITER-CODAC (COntrol Data Access and Communication) Conceptual Design”, ID=1422, 08:30, Thursday

• Long-pulse / Pseudo-continuous
  - Merge pulsed and continuous data acquisition
  - Streaming data with varying sampling rates
  - Same for all data sources e.g. CODAC internal data
  - Single access layer to all data
  - Single signal naming scheme as part of a wider plant naming scheme
    • Rules to be developed, URIs (RFC 3986), managed namespaces, Qnames
  - Data access via absolute time
    • But pulse number and relative times to events in pulses / segments
  - Novel data mining and data classification techniques
All fusion data is time series

Long-pulse experiments imply new techniques for data analysis
Pattern recognition - RDBMS + SQL

Data encoded according to discrete set of values (code alphabet) $f(gradient)$
Pattern recognition via string comparison

Alternative Methods
Pattern recognition can be based on concavities or other features of the signals

SQL query

```
select * from Codes where Type like 'BOL5' and
(Code like '%$[z,d][z,d][a,c][a,c]%' or Code like '%$[a,c][a,c][a,c][a,c][z,d][z,d]%')
```

J.Vega CIEMAT

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Where will ITER be different? (2)

• All project data can have an associated time
  - Requirement to play back history - training or enquiries into incidents
  - Software, configuration data as well as plant data
  - Concept of future as well as past e.g. for experiment planning purposes
  - Full data provenance
    • publications back to ADC boards, firmware, software versions ...

• Slow control (e.g. machine conditioning) = Plasma Control
  - Single Schedule Editor and real-time Scheduler is required?
  - Just a question of scheduling with different time scales?
  - Extend to Experiment planning, Maintenance scheduling, Shutdown planning?
    • Campaign = Year, Shutdown planning=year/month/day, Experiment = Week/Day, 
      Session = Day/Half-Day, Pulse=Hour, Machine conditioning=Hour, Maintenance 
      scheduling=Month, Segment in pulse=Minute, Control mode=Second, Plasma 
      Event=millisecond

• Real-time analysis, control, protection
  - General trend on fusion devices today, See Rob Felton poster - WPPA22
Where will ITER be different? (3)

- **Data Volumes and Rates**
  - ~10PB/year in 2016? c.f. LHC
  - ~10GB/s
  - Underestimates?
    - 1977 JET design figures JET suggested that less than 20GB data would be collected to the end of the project life in 1990. (170GB were collected).

- **Much more modelling, model data set sizes will be significant**
  - Simulations running in real-time, comparable data volumes?
  - 1m of burning plasma simulation = 1TB

- **Archive all raw data? Only novel data? ...**
  - Cost is small by comparison to ITER investment so archive all

- **Data mirroring at partner sites?**
  - provides backup functionality

- **Internet age**
  - Commercial / open-source solutions widely available
  - Very little should be developed in-house
ITER – Single Project-wide Database?

• Single logical database to last the project lifetime
  - Documents, CAD, Structured Data, Plant Naming System, Signal Naming Scheme, Software, Planning, IT
  - Construction, Operations, Maintenance, Decommissioning
  - Administration, Engineering, Physics
  - Experimental Planning, Operations, Data Storage, Analysis, Publications
  - Control and Data Acquisition Systems
    • Data driven and generated from the database
  - All data has an associated time – keep history - full provenance
  - Management Systems
    • Processes, Quality, Risk Management, Obsolescence Management ...

• Self-description of the plant systems delivered “in-kind” – 7 partners
  - Cubicles, modules, wiring, signals, software, firmware, history ...
Summary

• JET hierarchical and modular system architecture
  - Hierarchical ~1981 subsystem (level-2) databases still in use
  - Level-1 control layered above - JET-wide setup, increased functionality
  - Raw data pulse file data formats unchanged since ~1981, processed data file formats have changed
  - Client-server - underlying technology changes hidden from end-users

• JET has large number of heterogeneous support databases
  - Developed at different times, by different groups and using different technologies - in-house and commercial systems
  - Integration between them is not always ideal

• ITER is starting with a clean sheet
  - All-embracing project-wide database to last the project lifetime
    • Derivation of control system data
End
backup slides
ITER (2) – courtesy jo.lister@iter.org

Logbook data, characterising the operation and analysis, to track the experimental activity

Analysed data, with version control, traceability, ownership

Bookmarked data, characterising the operation, written during and after the pulses

Undersampled data, logged continuously, logging rate varies, compressed

Full data, logged continuously, logging rate varies, compressed

Continuous time
SQL:2006

Merge RDBMS and XML technologies

“ISO/IEC 9075-14:2006 defines ways in which SQL can be used in conjunction with XML. It defines ways of importing and storing XML data in an SQL database, manipulating it within the database and publishing both XML and conventional SQL-data in XML form. In addition, it provides facilities that permit applications to integrate into their SQL code the use of XQuery, the XML Query Language published by the World Wide Web Consortium (W3C), to concurrently access ordinary SQL-data and XML documents”

http://en.wikipedia.org/wiki/SQL

Data-driven control system based on web services?
Simple Extrapolation from JET to ITER

JET 50-60GB/pulse 2010, 150 days, 25 pulses/day

ITER - Same number of plasma seconds/year

60 x 2 x 2 x 2 = 480GB/pulse in 2016

480 x 25 = 12TB/day x 150 = <10PB /year in 2016

c.f. LHC 10PB/year in 2007
ITER (3) - courtesy jo.lister@iter.org
Mass Data Store Technology (1)

- **SUN E4900 server**
  - 2 x (4 UltraSparc4 1.2GHz dual core processors with 32GB RAM) S10
  - Zones used to isolate services
- **Trunked 4*1Gb/s ethernet for incoming and outgoing data**
- **3 separate disk areas**
  - Spool - 0.7TB ANS ATA-based mirrored disk for incoming data
  - Cache - 60TB ANS ATA-based RAID cache disk - 57% full
    - Raw data is compressed (ADPCM)
    - Cost-based deletion algorithm
  - Recalls - 0.5TB ANS ATA-based RAID
- **ZFS**
  - Migrated from SUN Volume Manager and UFS during 2007
- **Veritas Netbackup**
- **9940B (200GB native) StorageTek drives**
  - ACSLS tape management (Oracle)
  - 3 tape copies - security
Cost-based deletion algorithm $f(\text{last access time}, \text{size})$ to manage the cache space
JET provides key contributions to predict ITER performance

Cross section of present EU D-shaped tokamaks compared to the ITER project

Confinement time $\tau_E = \frac{W_{\text{plasma}}}{P_{\text{input}}}$
Data Access

- The data shows file access times although fusion data is analysed at signal level, not files
  - Client-server technology, JPF server, PPF server, MDSplus server
  - The servers retrieve files from tape and extract signals
JET Prospects

- JET Extension through Framework Programme 7 in Support of ITER
- Shutdown March 2007
  - ITER-like RF Antenna
  - High Frequency Pellet Injector
  - Many diagnostics
- November 2008
  - Plasma Control Upgrade
- June 2009
  - ITER-like Wall (Be)
  - ITER-like Divertor (W)
  - Neutral Beam Power Increase
  - Many diagnostics
- Extra 43GB / pulse in 2010

Modelling storage requirements
1m of ITER integrated burning plasma simulation yields 1TB data?

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Electra Database

Simplified Entity Relationship Diagram

CATALOGUE

MODULE TYPE
(2,022)
CADF CAMAC 16 ch 10kHz ADC (INCA)
VPLS VME Crate controller
UXD1 Eurocard ADC

MODULE
(45,767)
CADF/0070
VPLS/0023
UXD1/0105

FUNCTIONAL POSITION (FP)
(33,993)
YRF/CADF/0010 10th CADF module in RF
YC1/UXD1/0004 4th UXD1 module in C1
YVC/VPLS/0002 2nd VPLS module in VC

LOCATION

SITE
Stores
Spare
Lost
QA
Write-Off

SUBSYSTEM
YRF ICRF Heating
YC1 Magnetics Diagnostic
YVC Vacuum

STATUS
G Good
T Test
F Faulty
A Acceptance
W Withdrawn

EVENT
(273,770)
UXD1/0106 G Stores 01/01/1998
UXD1/0105 T QA 23/05/1996
UXD1/0105 F WOF 04/03/2005
CADF/0070 G YRF/CADF/0010 11/02/2002

~ 270,000 EVENT Records since ~1980

Neglecting:
Configurations, Modifications,
Firmware, Purchase Orders,
Suppliers, Components,
Document / Drawing links,
Cables, Signals, Work
specifications

UKAEA
Fusion Working in Europe

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### Module and Functional Position Histories

**Expanded FP History. Follow history of FP and installed modules at any level in the hierarchy**

**Unusual to have such a detailed audit-trail**

---

**History of item: CADF/0070**

<table>
<thead>
<tr>
<th>Date / Time</th>
<th>Status</th>
<th>Location</th>
<th>Config</th>
<th>ROM/Mod</th>
<th>M0d</th>
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<tr>
<td>08/11/2004 14:55:17</td>
<td>Withdrawn</td>
<td>WOF</td>
<td>...</td>
<td>0</td>
<td>E</td>
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<tr>
<td>05/06/2004 15:55:25</td>
<td>Test</td>
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<td>0</td>
<td>E</td>
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<tr>
<td>15/08/2004 15:55:34</td>
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<td>JQA</td>
<td>...</td>
<td>0</td>
<td>E</td>
</tr>
<tr>
<td>11/02/2002 15:55:54</td>
<td>Good</td>
<td>YRF/CADF/0010</td>
<td>...</td>
<td>0</td>
<td>E</td>
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<tr>
<td>17/07/2001 08:52:10</td>
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<td>STR</td>
<td>...</td>
<td>0</td>
<td>E</td>
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<tr>
<td>17/07/2001 08:52:23</td>
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<td>YTM/CADF/0001</td>
<td>...</td>
<td>0</td>
<td>E</td>
</tr>
<tr>
<td>10/07/2001 10:51:49</td>
<td>Test</td>
<td>IMP</td>
<td>...</td>
<td>0</td>
<td>E</td>
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<tr>
<td>08/05/1995 15:13:35</td>
<td>Good</td>
<td>YRF/CADF/0005</td>
<td>...</td>
<td>0</td>
<td>D</td>
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<tr>
<td>25/11/1994 11:08:22</td>
<td>Good</td>
<td>STR</td>
<td>...</td>
<td>0</td>
<td>D</td>
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<tr>
<td>25/11/1994 11:08:34</td>
<td>Good</td>
<td>SPA</td>
<td>...</td>
<td>0</td>
<td>D</td>
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<tr>
<td>25/11/1994 15:45:52</td>
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<td>JQA</td>
<td>...</td>
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<tr>
<td>15/09/1994 09:49:15</td>
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<td>20/05/1994 11:40:06</td>
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<td>JQA</td>
<td>...</td>
<td>0</td>
<td>D</td>
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<tr>
<td>15/04/1994 07:20:32</td>
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<td>JQA</td>
<td>...</td>
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<td>14/04/1994 17:41:16</td>
<td>Good</td>
<td>YRF/CADF/0001</td>
<td>...</td>
<td>0</td>
<td>D</td>
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<tr>
<td>27/08/1993 08:07:33</td>
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<td>YTM/CADF/0001</td>
<td>...</td>
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<td>C</td>
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<tr>
<td>02/07/1993 08:04:28</td>
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<td>STR</td>
<td>...</td>
<td>0</td>
<td>C</td>
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<td>02/07/1993 08:08:06</td>
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<td>SPA</td>
<td>...</td>
<td>0</td>
<td>C</td>
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<td>01/07/1993 15:45:55</td>
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<td>0</td>
<td>C</td>
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**History of functional position: YRF/CADF/0010**

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<td>CADF/0080 G</td>
<td>...</td>
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<td>CADF/0113 G</td>
<td>...</td>
<td>D</td>
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<tr>
<td>23/05/1995</td>
<td>CADF/0088 G</td>
<td>...</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30/08/1997</td>
<td>CADF/0146 G</td>
<td>...</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>09/07/2001</td>
<td>CADF/0146 G</td>
<td>...</td>
<td>E</td>
<td>Dummy Mod Level</td>
<td></td>
</tr>
<tr>
<td>12/07/2001</td>
<td>CADF/0002 G</td>
<td>...</td>
<td>E</td>
<td>Redeployed</td>
<td></td>
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<tr>
<td>11/02/2002</td>
<td>CADF/0070 G</td>
<td>...</td>
<td>E</td>
<td>Replaced suspect</td>
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<tr>
<td>08/01/2005</td>
<td>CADF/0226 G</td>
<td>...</td>
<td>E</td>
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**Func.Posn**

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<tbody>
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14/11/1997 CADF/0135 G ... D Fe
14/11/1997 YRF/CPSI/0025 ...
20/12/2001 T JQA ... ...
07/06/2002 T JQA ... ...
07/06/2002 G SPA ... ...
07/09/2002 G YRF/CPSI/0021 ...
20/12/2001 CPSI/0032 G ... D Re

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14/11/1997 YRF/CPSI/0025 ...
01/05/1996 CPSI/0124 G LOW ...
01/04/1996 YRF/CPSI/0025 LOW ...
29/06/2002 T JQA LOW ...
01/07/2002 G SPA LOW ...
04/07/2002 G YRF/CPSI/0011 LOW ...
29/06/2002 CPSI/0014 G LOW ...
24/01/2005 CPSI/0196 G HIGH ...
001 ... R Also see dwg: 6020 dwg: 3724 ...
30/08/1997 YRF/CPSI/015 G ...
30/08/1997 YRF/CADF/0010 ...
09/07/2001 G YRF/CPSI/0010 ...
12/07/2001 T JQA ...
12/07/2001 G JRA ...
12/07/2001 G YRF/CPSI/0011 ...
09/07/2001 CADF/0146 G ... B Du...
12/07/2001 CADF/0002 G ... B Re...
11/02/2002 CADF/0070 G ... B Re...
# Stock Management

## Current configurations for itemtype: UXD1

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<th>Parent</th>
<th>MaxSp</th>
<th>MinSp</th>
<th>Notes</th>
<th>Dt</th>
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<tbody>
<tr>
<td>???</td>
<td>C</td>
<td>Undecided</td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAA</td>
<td>C</td>
<td>Range +/- 250mV, all channels</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>BAA</td>
<td>C</td>
<td>Range +/- 1V, all channels</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>CAA</td>
<td>C</td>
<td>Range +/- 2.5V, all channels</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>DAA</td>
<td>C</td>
<td>Range +/- 10V, 8 channels, 10kHz</td>
<td></td>
<td>4</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>DAX</td>
<td>C</td>
<td>Differential, +/- 1V, 8 channels, 10kHz</td>
<td></td>
<td>2</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>DBA</td>
<td>C</td>
<td>Range +/- 16V, 8 channels, 54kHz</td>
<td></td>
<td>2</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>DCA</td>
<td>C</td>
<td>Range +/- 16V, 8 channels, 118kHz</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>EAI</td>
<td>C</td>
<td>Range +/- 25V, all channels</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>FBA</td>
<td>C</td>
<td>Range +/- 100V, all channels</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes ITSH</td>
<td></td>
</tr>
<tr>
<td>GBB</td>
<td>C</td>
<td>Range +/- 50mV, 10kHz band, 4 odd Ch only</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes YZ/SC</td>
<td></td>
</tr>
<tr>
<td>HCB</td>
<td>C</td>
<td>Range +/- 50mV, 1kHz band, 4 odd Ch only</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes YZ/SC</td>
<td></td>
</tr>
<tr>
<td>HGG</td>
<td>C</td>
<td>Range +/- 50mV, 1kHz band, low offset</td>
<td></td>
<td>1</td>
<td>1</td>
<td>Notes YZ/SC</td>
<td></td>
</tr>
<tr>
<td>HAB</td>
<td>C</td>
<td>Current log amplifier, 100pA to 10mA</td>
<td></td>
<td>2</td>
<td>1</td>
<td>Notes YZ/SC</td>
<td>HAB</td>
</tr>
<tr>
<td>HZB</td>
<td>C</td>
<td>As HAB but with two monitoring ch’s</td>
<td></td>
<td>0</td>
<td>0</td>
<td>Notes YZ/SC</td>
<td></td>
</tr>
</tbody>
</table>

## Components used for itemtype: UXD1

<table>
<thead>
<tr>
<th>Component</th>
<th>Supplier</th>
<th>Part No.</th>
<th>Bin</th>
<th>Comment</th>
<th>Current Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNA118P INST Amp</td>
<td>FARN FARN</td>
<td>121-2388 845-842</td>
<td>LCONAB</td>
<td>RoHS Compliant</td>
<td>50</td>
</tr>
<tr>
<td>KX102-7955PC PROM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>XG40B11-4PQ100BC FPGA</td>
<td></td>
<td>1C0245</td>
<td>1C0B30</td>
<td></td>
<td>3</td>
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<tr>
<td>ADC CS5102A-LF 2.0kHz</td>
<td>SEQU</td>
<td>CS5102A</td>
<td>1C0037</td>
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<td>34</td>
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<tr>
<td>LNA118P</td>
<td>FARN</td>
<td>182-8534 483-126</td>
<td>IQ1B01</td>
<td></td>
<td>24</td>
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<tr>
<td>HGPL-7100 CMOS Comparator</td>
<td>KENC</td>
<td>HCPL-7100</td>
<td>1C00B2</td>
<td>Replaced by HGPL7100</td>
<td>96</td>
</tr>
<tr>
<td>HGPL-2531 Coupler</td>
<td>KENC</td>
<td>HCPL-2531</td>
<td>1C00B3</td>
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<td>49</td>
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<tr>
<td>HGPL-2231 Coupler</td>
<td>KENC</td>
<td>HCPL-2231</td>
<td>1C00B3</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>DG590C1 Multiplexer</td>
<td>KENC</td>
<td>DG590C1</td>
<td>1C0224</td>
<td>Obsolete</td>
<td>73</td>
</tr>
<tr>
<td>AMP DSYTEM</td>
<td>ABAC</td>
<td>CSP285P</td>
<td>1C0259</td>
<td></td>
<td>221</td>
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<tr>
<td>ILD32 Power MOSFET</td>
<td>RS</td>
<td>1B9-049B</td>
<td>1C0239</td>
<td></td>
<td>729</td>
</tr>
<tr>
<td>4-waypack</td>
<td>BOUC</td>
<td>450SY-101-121</td>
<td>1R0231</td>
<td></td>
<td>2500</td>
</tr>
<tr>
<td>PW745-4 Transformer 31</td>
<td>BURR</td>
<td>PW745-4</td>
<td>1C0231</td>
<td>Uninstalled</td>
<td>396</td>
</tr>
<tr>
<td>PW740-3 Diode Bridge</td>
<td>BURR</td>
<td>PW740-3</td>
<td>1C0231</td>
<td>Uninstalled</td>
<td>88</td>
</tr>
<tr>
<td>PW740-1 Diode Bridge</td>
<td>BURR</td>
<td>PW740-1</td>
<td>1C0231</td>
<td>Uninstalled</td>
<td>81</td>
</tr>
</tbody>
</table>

## Min, Max number of spares to be held

**Stock Summary for itemtype: UXD1**

<table>
<thead>
<tr>
<th>STOCKS</th>
<th>Held:</th>
<th>314</th>
<th>Total delivered to date</th>
<th>314</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordered</td>
<td>0</td>
<td>b</td>
<td>Still Outstanding</td>
<td>0</td>
</tr>
</tbody>
</table>

**LOCATION**

- **Used**: 235
  - In required FPs
  - In non-required FPs
- **Withdrawn**: 17
  - Excludes items in stores
- **Non-Returning Site**: 17
  - Usually lost or scrapped
- **Person**: d
  - Issued to a person

**SPARES**

- **Spares Held**: 20
  - Minimum: 14
  - Maximum: 20

**ANALYSIS**

- **Requirements**: 270
  - Number of required FPs
  - Vacancies: 44
  - Excess: -2
  - a + b - c - d - e - f

**Obsoletes**

The Burr-Brown PW745-4 transformers (4 per board) ceased production in 1995 but are now held for a maximum of 470 modules (UXD1+UXT1), including those already built. Since then the PW745-1 driver chip (1 per board) and PW740-3 diode bridge (4 per board) have ceased production and limit our future build (ref. order placed with L1-components in June 2005, obtained 25 and 53 pieces respectively). See 15.1.2001, updated June 2005.
Object Monitoring System (OMS)

plant://pf/tstatus:1 specifies a live-database signal
alarm://mc/alarm-ident specifies an alarm
alarm://mc/alarm-ident?help specifies the help text for an alarm
level1://l1/parameter specifies a Level 1 parameter from the default database
level1://ye/l1/parameter specifies a Level 1 parameter from the YE database
wave://tf/wave-form-name specifies the latest version of a waveform
wave://tf/wave-form-name:version specifies a particular version of a waveform
udp://sa/ident specifies a User Defined Point
level1-array://tf/array-name specifies an array
real-time://pf/point specifies a point from the Real Time Acquisition system
(file://TF/jet/pf/etc/file specifies the file /jet/pf/etc/file should be monitored by the OMS server on TF)
cfr:number specifies the text of a CODAS Fault Report
jetlog:thing specifies an item in the JET log.
snmp://command?target specifies an SNMP command to be executed on a particular target
xdc:/ specifies a complete list of ALL xterminal users
xdc://mmi-cn1-1 specifies the xterminal users of terminals being managed by mmi-cn1-1
ppf://ppf-ident-string specifies data from a PPF dataset on the IBM mainframe.
It could be a list of signals in the PPF or the data associated with a particular signa
Pulse Preparation – Level-1 Software

Centralised Supervisory Control Database

~20,000 Parameters
~600 plug-in codes

Pulse Schedule Editor

Previous Settings

~40,000 Previous Pulses

Pulse Schedules

Organised by Task Force

Offline Flight Simulation

UKAEA  Fusion Working in Europe

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JET Data Analysis

Central Data Storage

JET Pulse File (JPF)
- Machine parameters
- Raw diagnostic data
- Pulses ~ 54,500
- Upto ~ 1GB per pulse
- Total 4.0TB (1.4TB compressed)
- < 25 pulses/operation day 25GB data

Processed data PPF
- ~ 2.5 million data files
- 30-100MB/Pulse
- 1TB Total
- ~ 100 DDA’s (signal sets)/Pulse

CPF Central Physics File
- Selected time points
- Constants
- Scalars
- Profiles
- 1-3MB/Pulse

Routine Processing

Processing Chain 1
- Magnetics Geometry
- Global Power, RF, NB
- Temperature
- Density averages
- Detailed Magnetic Equilibrium, Flux surfaces
- Temperature and density profiles
- Spectroscopy, Bolometry
- Energy confinement
- Neutron rates

Processing Chain 2
- Time slices
- Electron Temperature
- Electron Density
- Ion Temperature
- Ion Density
- Bolometry
- Transport

Detailed pulse analysis
- Full energy and particle transport analysis

Data Validation
- Re-processing

User Access
- All JET Off-line users
- Further Analysis

User Access
- SOLARIS Users
- LINUX Users
- NT Users

Firewall
- External Access via Internet
- MDSplus Access
- RDA HTTP Access

Control Room
- JET Experiment
- Jotter
- Control room
- Reports etc.

Central Data Storage

Jotter
- Control room
- Reports etc.

UKAEA
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Some of the other JET Databases

- **Jet Logging**
  - Experiment comments, Fault Logging
- **Statistics**
  - CPU, Network measurements etc, Capacity planning
- **Experimental planning**
- **Machine configuration**
- **CODAS Support Databases**
  - Cubicle Design/Documentation, Inventory Management, Document Management
  - Product handler - software releases and installations
- **Diagnostic Data Handbook**
  - Explains the meanings of the measurements
- **Solaris Control System**
  - NIS
  - Access control database - user, role of user, location of user, state of JET
- **IT Systems**
  - Account management, Management Systems, Hardware, Software requests, Planning, Maintenance scheduling
- **Publications / Pinboard**

Not all as integrated as we would like
"Patterns in signals" approach: time-series data. An example in JET

ECE signals: electron temperature

All patterns follow the same behaviour but during different time

- A fall
- A growing slope
  - More abrupt in the 3rd case
- A flat zone
- A fast rise
- A flat top
Plant Systems delivered “in-kind”

• Self-description of the plant systems delivered “in-kind”
  - Cubicles, modules, wiring, signals, software, firmware, history ...
  - Merged into centralised CODAC / ITER-wide database
  - Schemas supplied by ITER

• Single plant and signal naming scheme
  - Rules to be developed
  - Universal Resource Identifiers (URIs). See RFC 3986
    - http://www.iter.org/ns/ ns=namespace
  - Qualified Names or Qnames
    - e.g. signal: = http://www.iter.org/ns/signal/
    - signal:neutrons/14mev_neutron_flux
  - URL equivalent of URI gives meta data access
    - Access to data as appropriate