

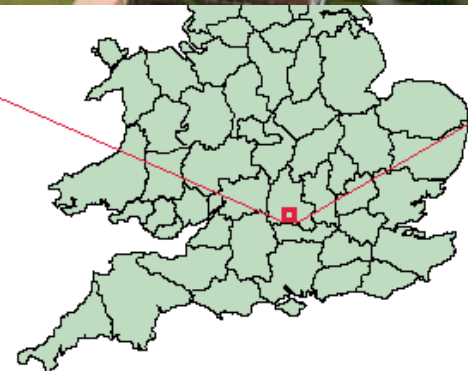
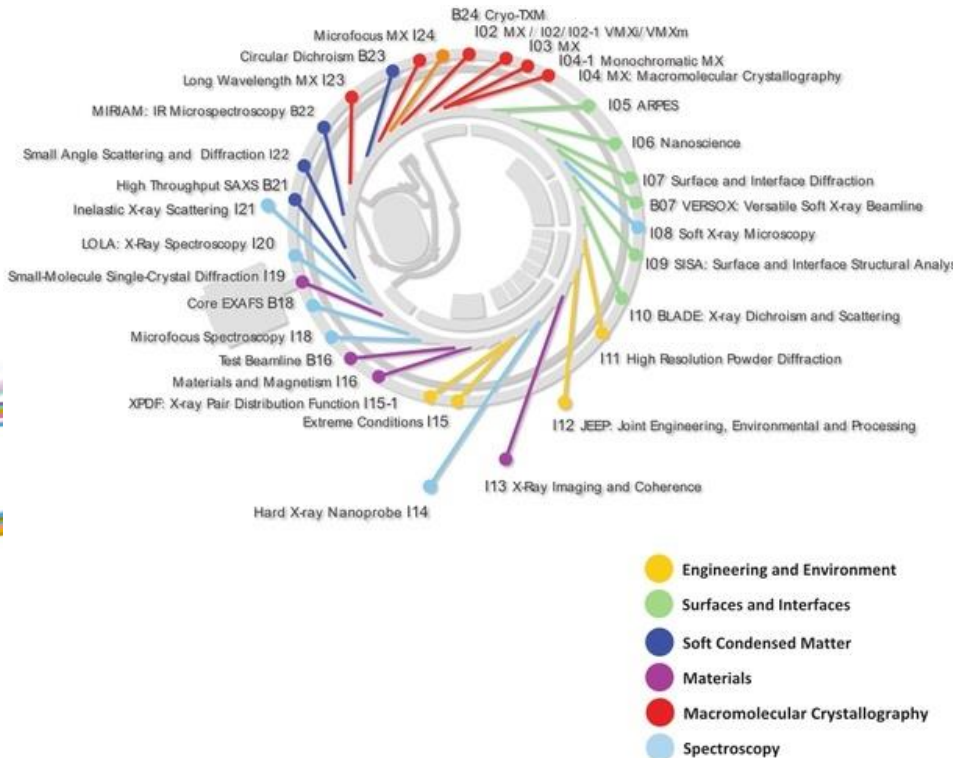
Trend Analysis Software.

Adrian Johnson
Senior Operations Technician
Diamond Light Source

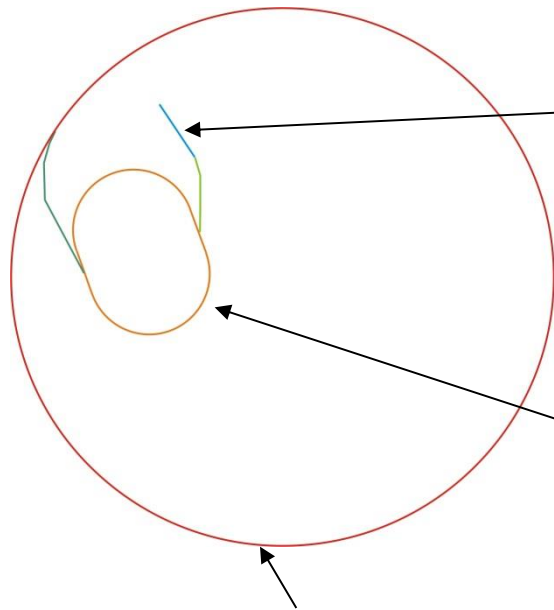


Overview of Diamond

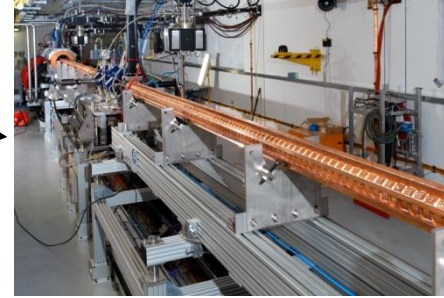
- 3rd Generation Light Source.
- Opened for Users in 2007.
- Currently 26 operational Beamlines.
- 4 Beamlines currently under construction.
- Total of 32 Beamlines by 2017.



Overview of Diamond Accelerators



100MeV Linac



3GeV Booster



3GeV Storage Ring

- 561.6m Circumference.
- 300mA stored beam.
- Running in Top up (10min cycles).

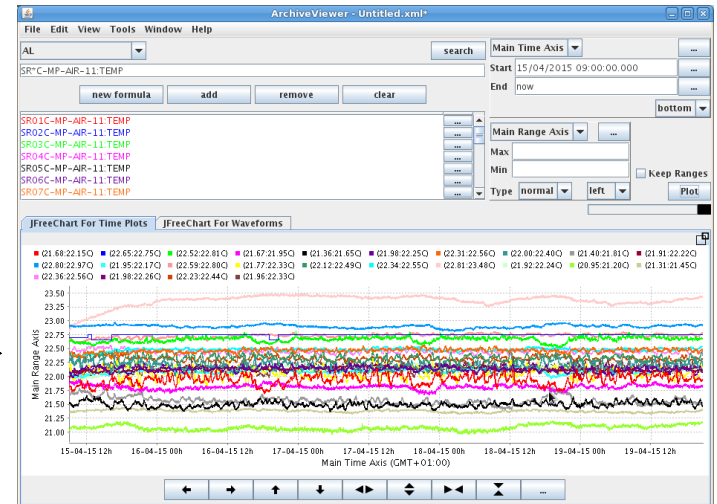


Archive Data Available

- Diamond uses EPICS Control System & Data Archive.
- Over 110,000 Process Variables (PV's) are Archived.
- Not all of them are of interest.
- Interested in things such as;
 - Water Flows,
 - Temperatures,
 - Pressures,
 - Voltages,
 - Currents,
 - Beam Diagnostics.

Archive Data Available

- Just looking at Storage Ring Temperatures, as an example.
 - Approx. 1300 temperature pvs are Archived.
 - 336 Water Temperatures
 - 360 Vessel Temperatures
 - 288 PLC Temperatures
 - 192 Vessel Thermocouples
 - 96 Control Cabin Temperatures
 - 24 Tunnel Air Temperatures →



- Using Archive viewer to examine 1300 PVs is impractical.
- Using a system that rolls this data up into 6 displays, much easier and quicker.

Trend Analysis Software

- Software Overview.
 - Provide early indication/warning of potential problems.
 - Read archive data on weekly basis
 - Beam conditions tend to change weekly.
 - Provide indication of:
 - Rising / Falling trends,
 - 'Out of character' data.
- Requests 250 data points per pv.
 - Number actually returned depends on archiving method
- Takes ~30s to retrieve data for ~300 pvs.
- Written in python.

Trend Analysis Software

- Set-up GUIs

PV Array

PV List

Form1

Run Dates - Set up for Trending

Select year: 2015

Select run: Run 1 No. of MD days: 7

(excluding Start up days)

Last MD day of Start Up (dd/mm/yy): 12/01/15

Machine Development Date (dd/mm/yy): 20/01/15

Machine Development Date (dd/mm/yy): 27/01/15

Machine Development Date (dd/mm/yy): 03/02/15

Machine Development Date (dd/mm/yy): 10/02/15

Machine Development Date (dd/mm/yy): 17/02/15

Machine Development Date (dd/mm/yy): 24/02/15

Machine Development Date (dd/mm/yy): 03/03/15

End Date of User beam (dd/mm/yy): 09/03/15

Form1

PV Set up for Trending

Select Area: MPS

Select File to Edit: SR Vessel Temperatures

Enter New Filename: SR Vessel Temperatures

Delete data from beam trips? Stabilisation time after beam trip (hrs): 5

Enter a list of PVs. Enter an Array of PVs

PV	From Cell	To Cell
SRxxC-MP-FLNGE-11:TEMP	01	24
SRxxC-MP-EBPM-11:TEMP	01	24
SRxxC-MP-FLNGE-21:TEMP	01	24
SRxxC-MP-CRTCH-21:TEMP	01	24
SRxxC-MP-CRTCH-22:TEMP	01	24
SRxxC-MP-CRTCH-23:TEMP	01	24
SRxxC-MP-FLNGE-22:TEMP	01	24
SRxxC-MP-EBPM-22:TEMP	01	24
SRxxC-MP-EBPM-23:TEMP	01	24
SRxxC-MP-XRAY-31:TEMP	01	24
SRxxC-MP-XRAY-32:TEMP	01	24
SRxxC-MP-CRTCH-31:TEMP	01	24
SRxxC-MP-CRTCH-32:TEMP	01	24
SRxxC-MP-VESSL-31:TEMP	01	24
SRxxC-MP-FLNGE-31:TEMP	01	24

Form1

PV Set up for Trending

Select Area: SR RF

Select File to Edit: SR RF Sys 2 IOT Cooling

Enter New Filename: SR RF Sys 2 IOT Cooling

Delete data from beam trips? Stabilisation time after beam trip (hrs): 0

Enter a list of PVs. Enter an Array of PVs

PV
SR-RF-WATER-20:TEMP
SR-RF-IOT-20:TEMP
SR-RF-IOT-21:TEMP1
SR-RF-IOT-22:TEMP1
SR-RF-IOT-23:TEMP1
SR-RF-IOT-24:TEMP1
SR-RF-RACK-21:TEMP
SR-RF-RACK-22:TEMP
SR-RF-RACK-23:TEMP
SR-RF-RACK-24:TEMP
SR-RF-RFPGU-21:FLOW
SR-RF-RFPGU-22:FLOW
SR-RF-RFPGU-23:FLOW
SR-RF-RFPGU-24:FLOW

Trend Analysis Software

- Main GUI

Form1

Ops - PV Trending

MPS SR Vessel Temperatures

2015 Run 1 Week 1

0 to 1%

Recalculate

PV List

Form1

Ops - PV Trending

SR RF SR RF Sys 3 IOT Cooling

2015 Run 1 Week 8

Show +ve % Change % Spread in Data

Show -ve

0 to 10%

0 1 2 3 4 5 6 7 8 9 10

Beam Trips Removed. Stabilisation time = 2 hrs

Data last Calculated/Saved: Fri, 13 Mar 2015 00:42:40

- SR-RF-WATER-30:TEMP
- SR-RF-IOT-30:TEMP
- SR-RF-IOT-31:TEMP1
- SR-RF-IOT-32:TEMP1
- SR-RF-IOT-33:TEMP1
- SR-RF-IOT-34:TEMP1
- SR-RF-RACK-31:TEMP
- SR-RF-RACK-32:TEMP
- SR-RF-RACK-33:TEMP
- SR-RF-RACK-34:TEMP
- SR-RF-RFPGU-31:FLOW
- SR-RF-RFPGU-32:FLOW
- SR-RF-RFPGU-33:FLOW
- SR-RF-RFPGU-34:FLOW

Comments:

PV Array

Form1

Ops - PV Trending

MPS SR Vessel Temperatures 0 to 10%

2015 Run 1 Week 2

% Change % Spread in Data

0 1 2 3 4 5 6 7 8 9 10

Data last Calculated/Saved: Thu, 12 Mar 2015 02:13:51

Beam Trips Removed. Stabilisation time = 5 hrs

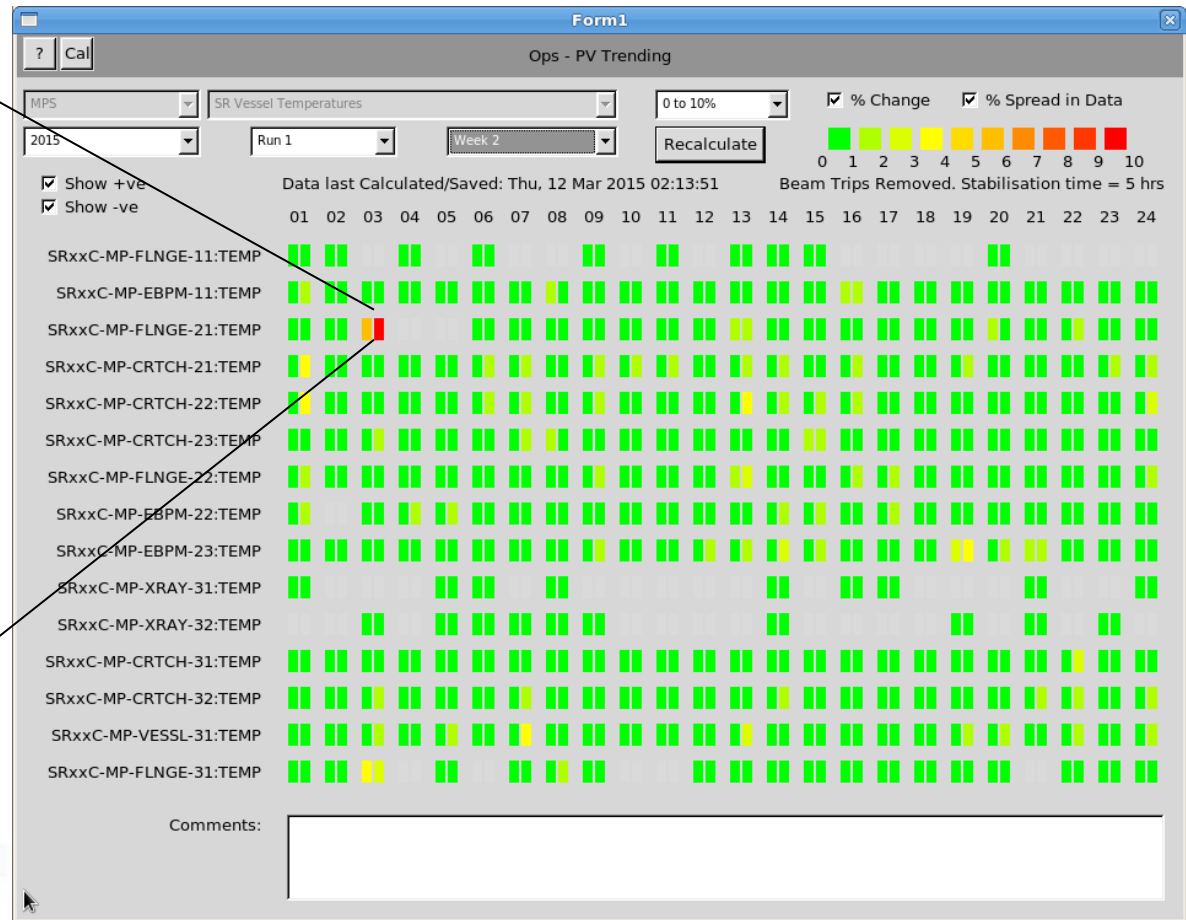
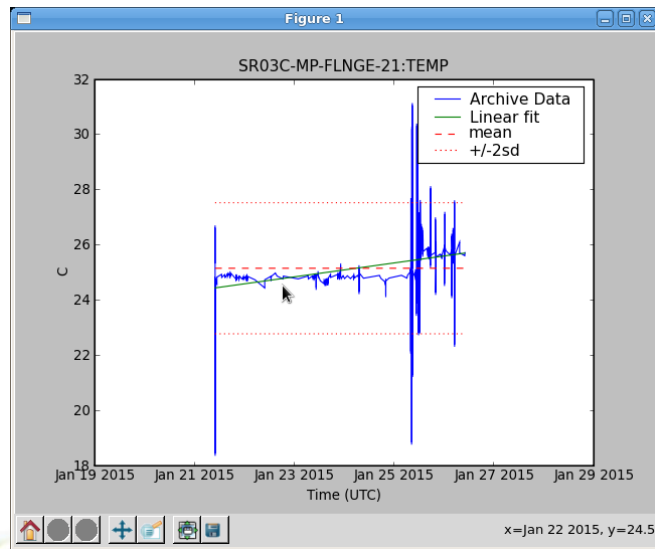
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SRxxC-MP-FLNGE-11:TEMP	■	■		■		■			■		■		■	■							■			
SRxxC-MP-EBPM-11:TEMP	■	■		■		■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-FLNGE-21:TEMP	■	■	■	■		■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-CRTCH-21:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-CRTCH-22:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-CRTCH-23:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-FLNGE-22:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-EBPM-22:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-EBPM-23:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-XRAY-31:TEMP	■			■	■	■		■					■	■	■					■				■
SRxxC-MP-XRAY-32:TEMP			■	■	■	■	■	■	■	■			■							■		■		■
SRxxC-MP-CRTCH-31:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-CRTCH-32:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-VESSL-31:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
SRxxC-MP-FLNGE-31:TEMP	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Comments:



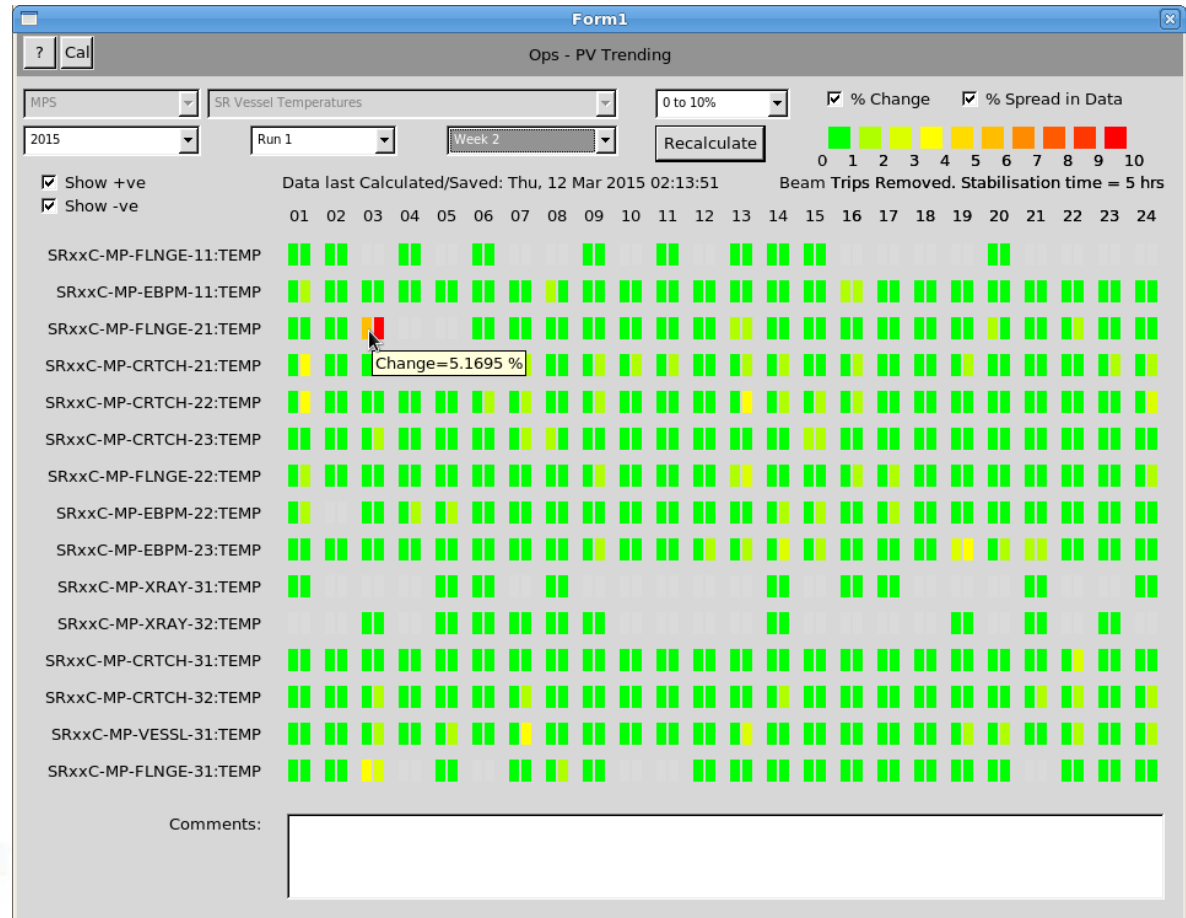
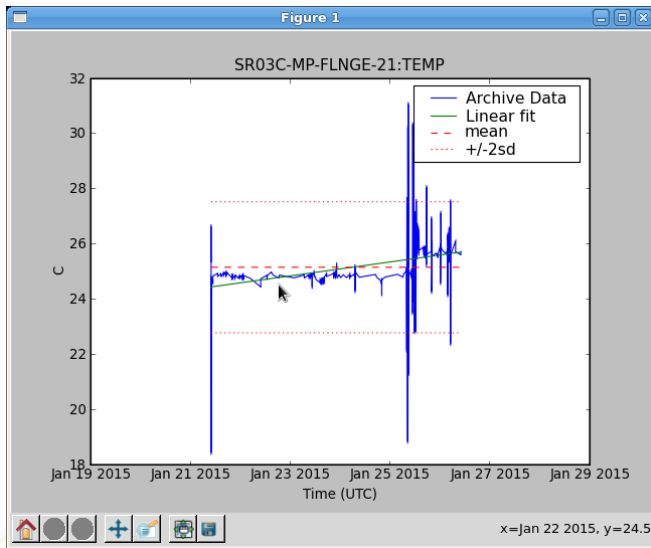
Trend Analysis Software

- Clicking on an Indicator opens Archive data for that one PV



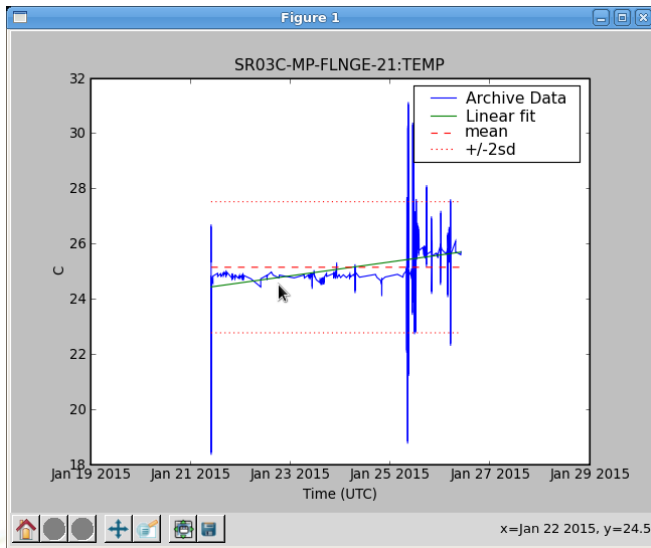
Trend Analysis Software

- Mouseover Left Indicator Shows % Change of linear fit



Trend Analysis Software

- Mouseover Right Indicator Shows % Spread in data



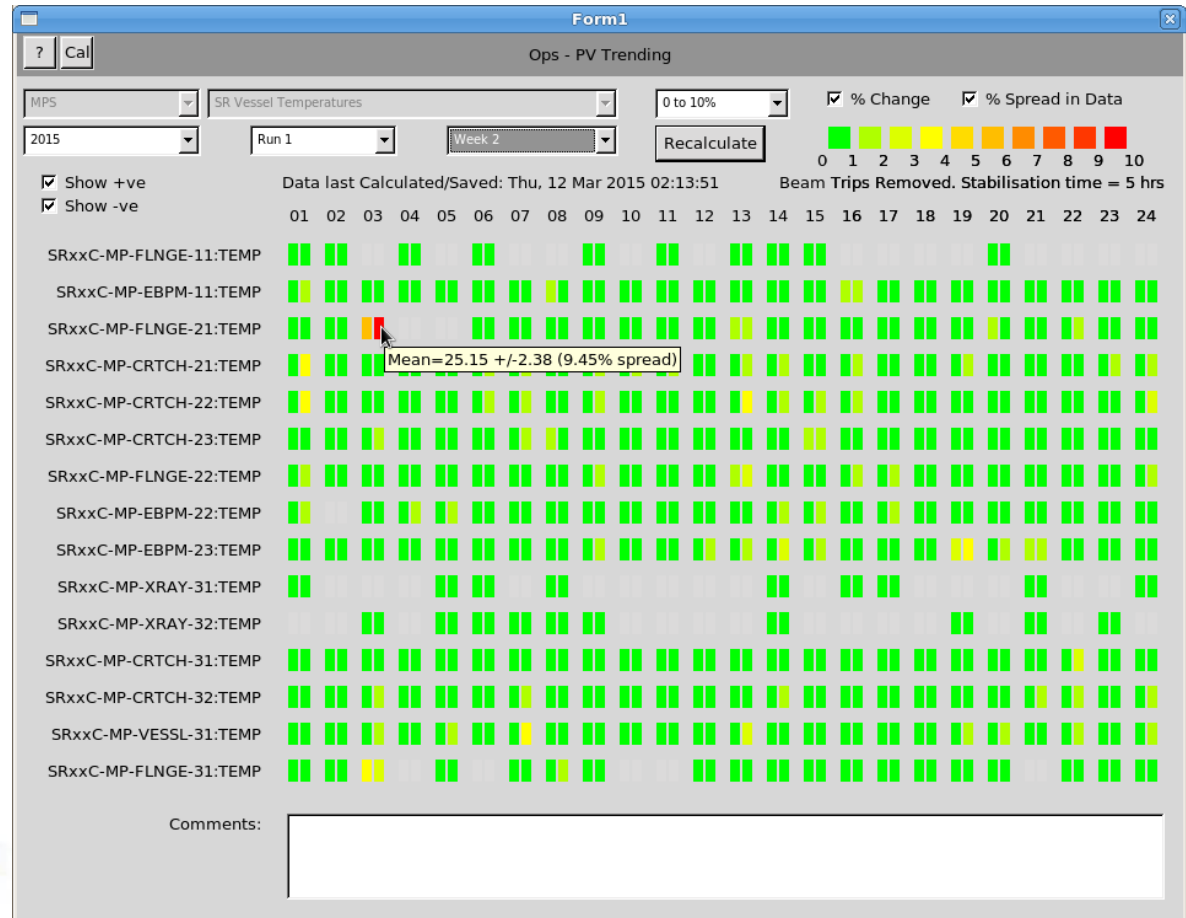
SR03C-MP-FLNGE-21:TEMP

HIHI = 50.0 °C

HIGH = 40.0 °C

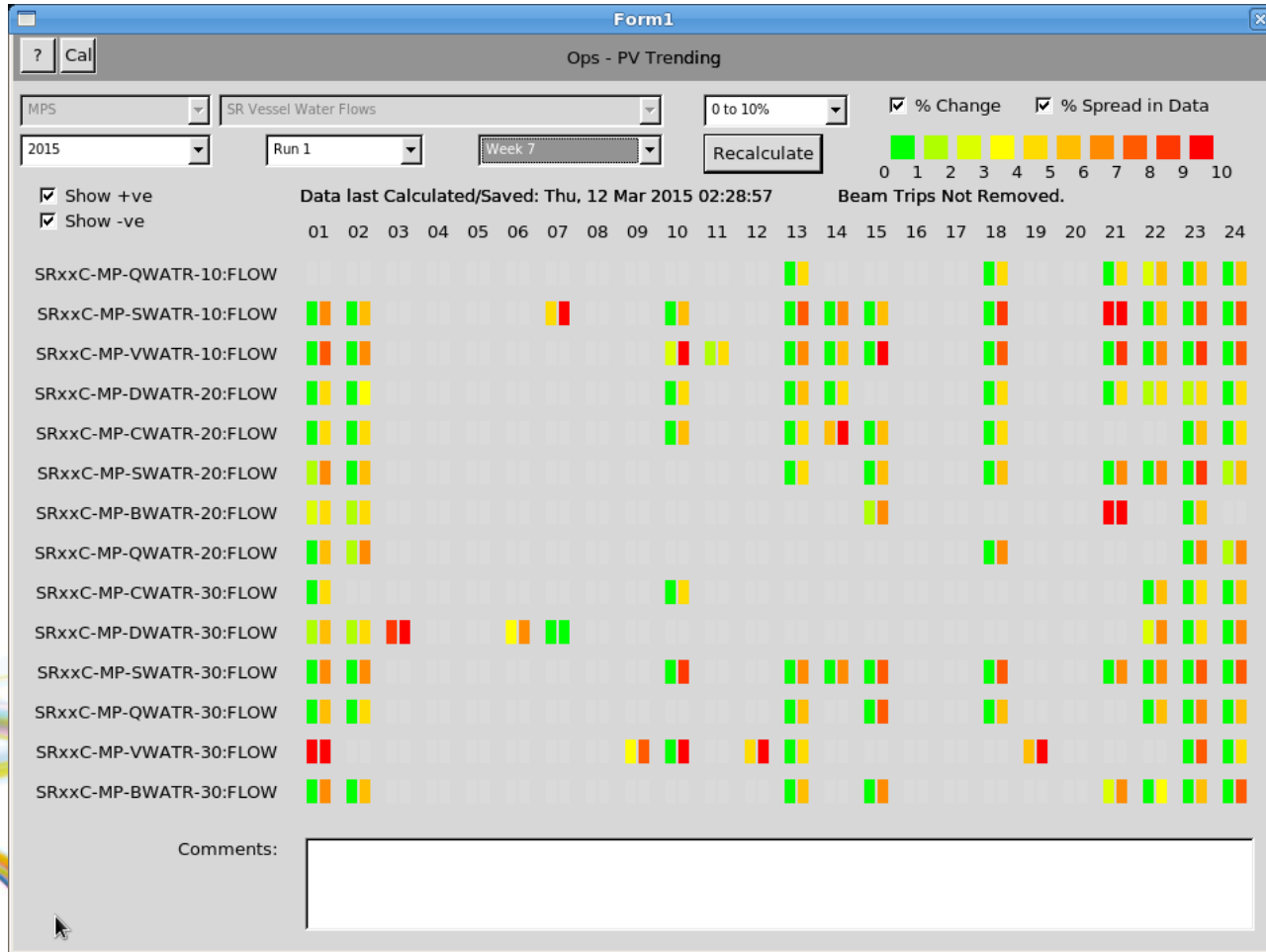
LOW = 10.0 °C

LOLO = 0.0 °C



Trend Analysis Software

- Not always as obvious as previous example.



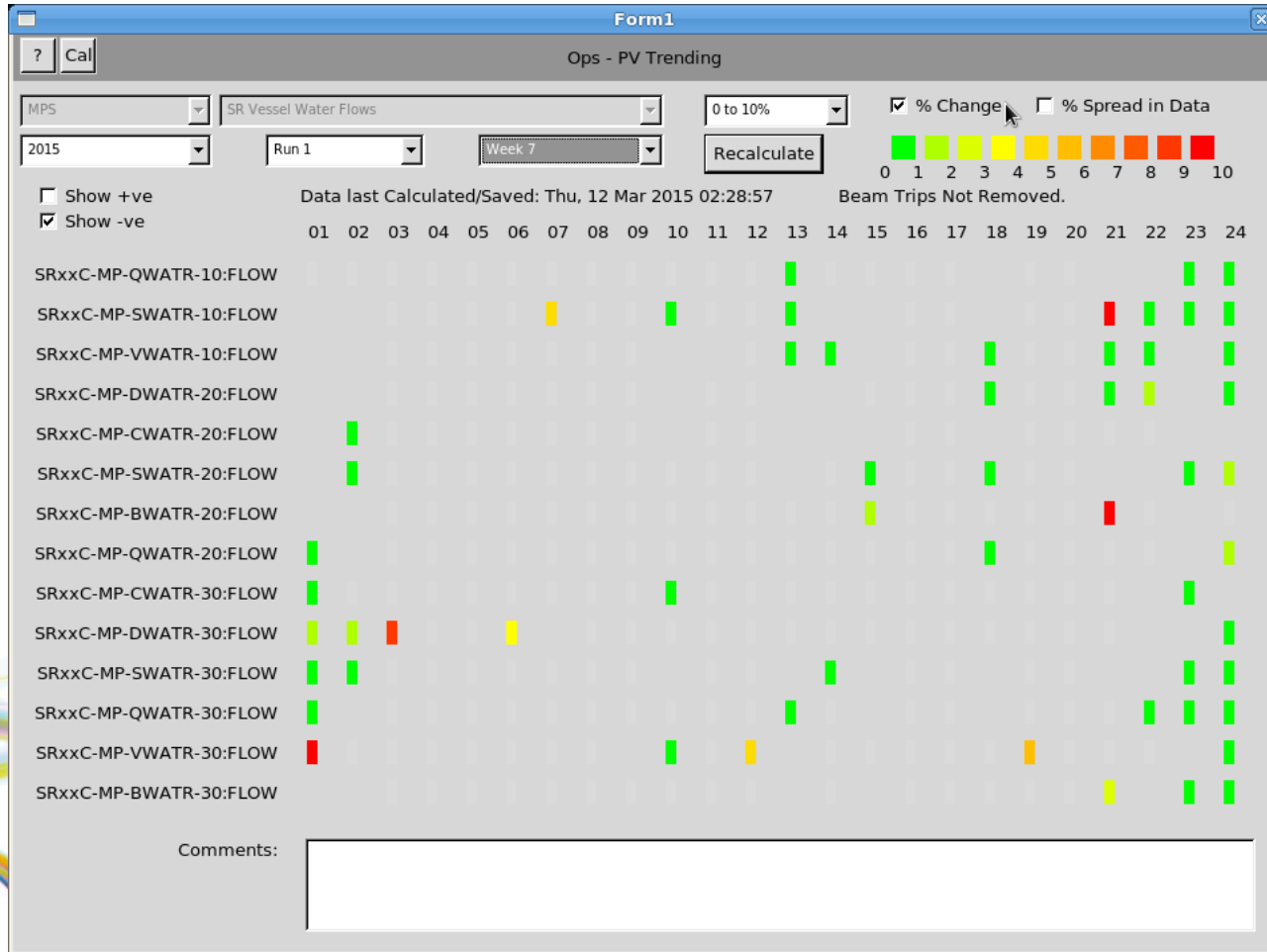
Trend Analysis Software

- Hide increasing % change.

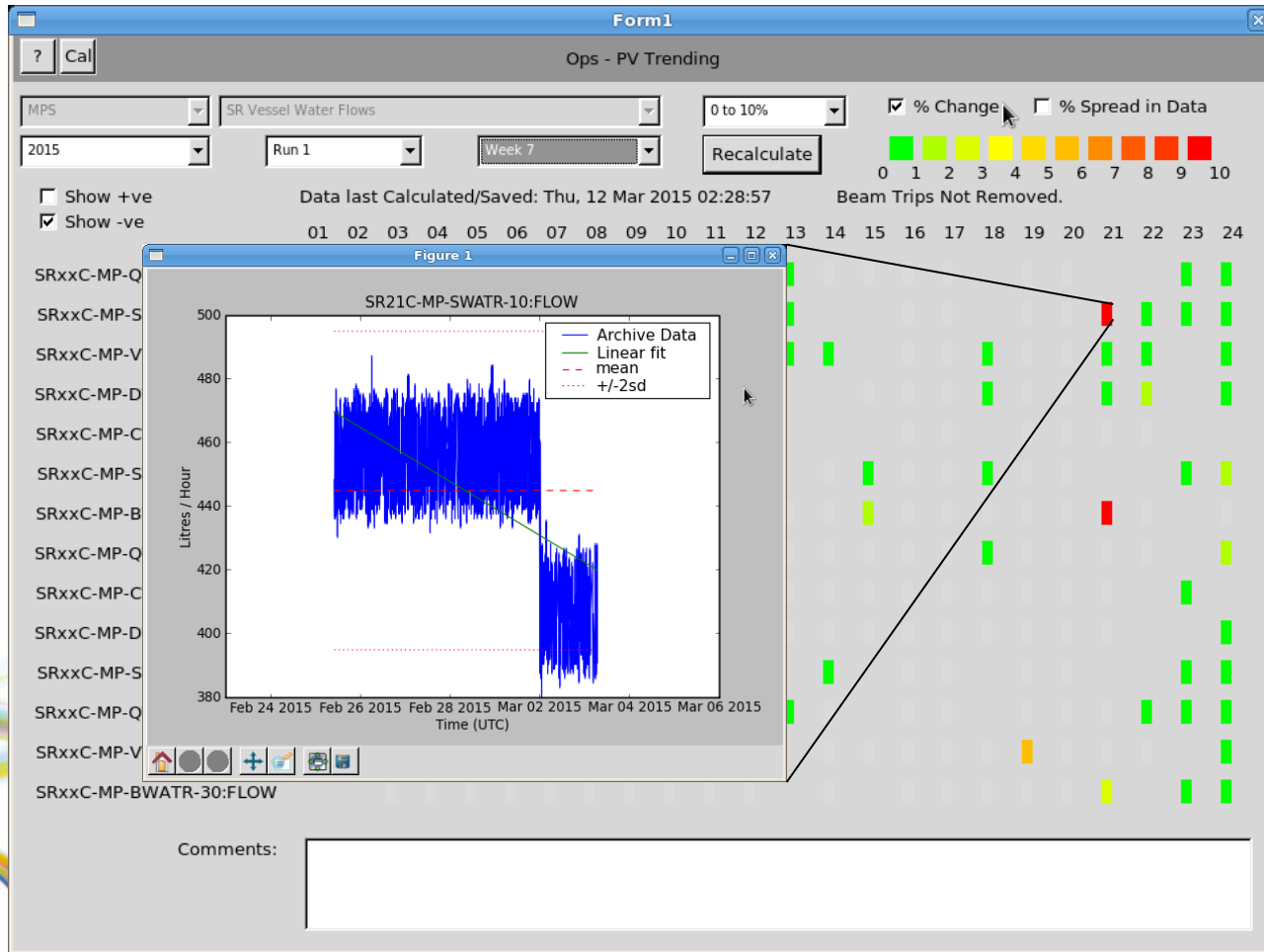


Trend Analysis Software

- Hide % spread.

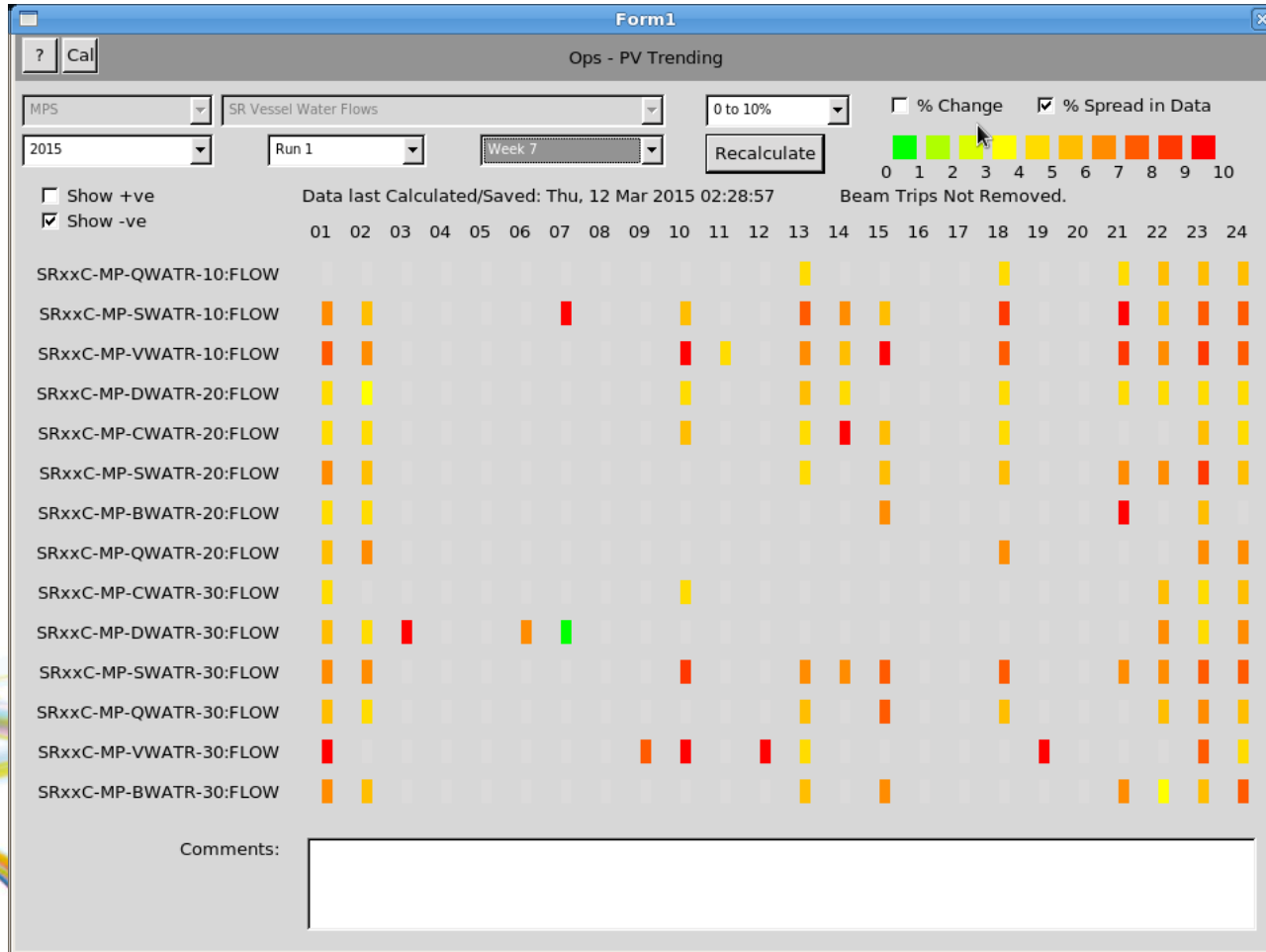


Trend Analysis Software



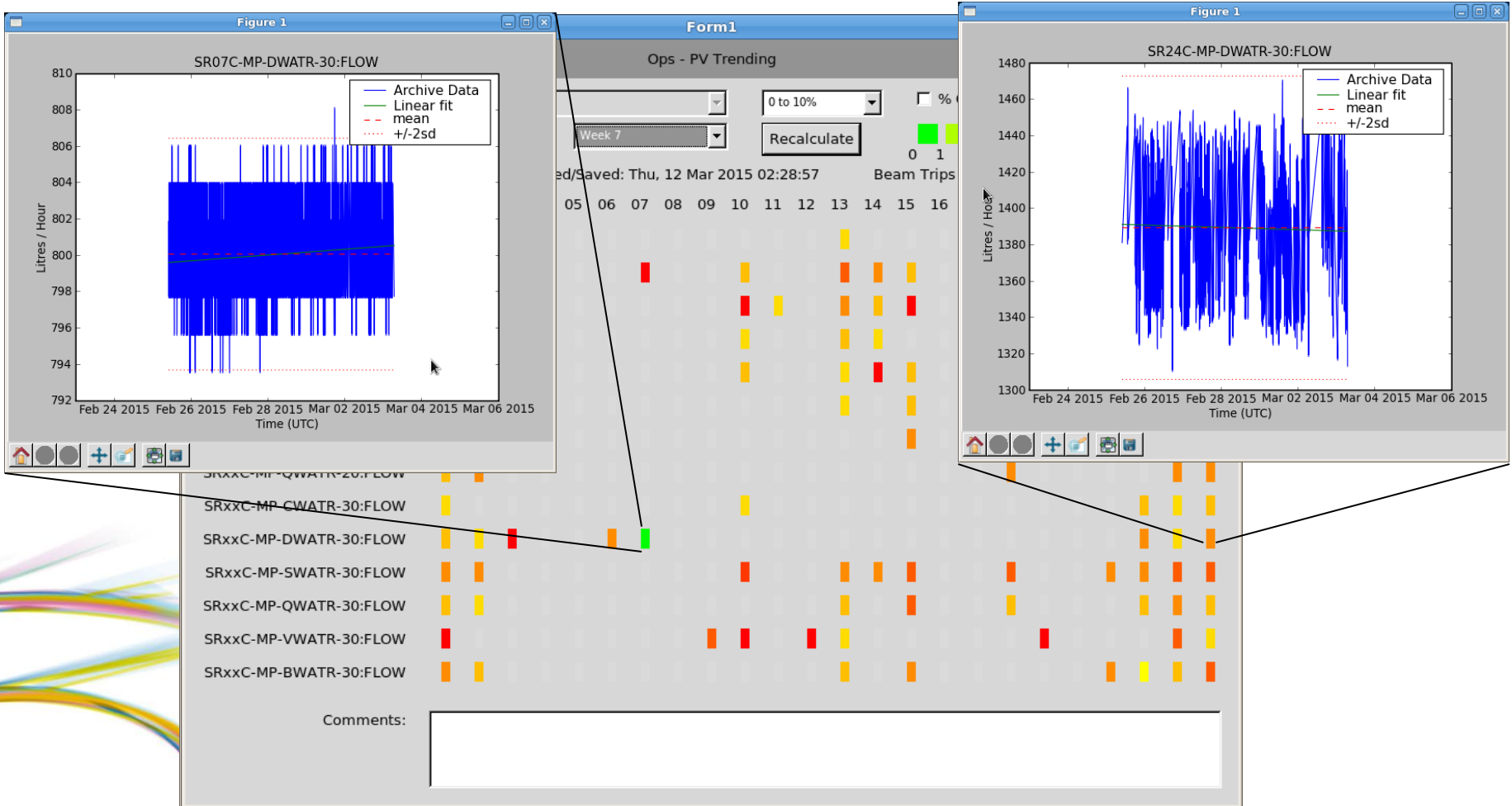
Trend Analysis Software

- Show % Spread only.



Trend Analysis Software

- Show % Spread only.



Where Next

- Currently the analysis is done manually on Sun or Mon
 - To gather enough data during the week.
 - Repairs / further investigation can be done during Machine Development Tuesdays.
 - Only gets done by One Operator,
 - Depending on shift patterns / leave it might not get done.
- Write a script only 'gui-less' version that is scheduled to run every Monday morning.
 - E-mail results for further investigation.

Summary

- The trend analysis software enables large arrays of archive data to be assessed:
 - Quickly,
 - For rising / falling trends,
 - For noisy / failing / failed sensors.
- Thereby providing early indication of potential problems.