User Manual
Control software for CryoTrap test

M.Mohan

VIRGO/EG0

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Change Record

Version	Date	Section Affected	Reason / Remarks
V1R0	25 June 2012	All	First version
V1R1	10 July 2012	5.2.1.2	Valve states corrected from ON/OFF to OPEN/CLOSED Clearer picture for Figure 12
V1R2	17 June 2013	2.1	Replaced picture of old cryotrap with new picture.

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1 Introduction

1.1 Purpose

This document provides and overview of the software used to test the cryotrap and explains how to use it.

1.2 Scope

The document is designed to be used by engineers when testing the cryotrap. It provides an architectural overview and explains how to use some of the software tools available.

1.3 Related documents

[1] J. v. d. Brand, "NIKHEF PROJECT PLAN: CRYOLINKS Cryogenic vacuum links to isolate interferometer arms for Advanced Virgo," Nikhef, National Institute for Subatomic Physics, P.O. Box 41882, Amsterdam, the Netherlands , June 18, 2010.

[2] Mohan, "https://tds.ego-gw.it/ql/?c=8978," 27 04 2012. [Online].

[3] Ballardin, "https://workarea.ego-gw.it/ego2/ego/itf/software/auth-only/documents-for-cryotrap," 08 02 2012. [Online].

[4] Cavaliere, "https://workarea.ego-gw.it/ego2/virgo/advanced-virgo/vac/1st-cryotrap-test/vacuum-equipment-for-1st-test-27apr2012/CryoTrap_Control_Test.pptx/," 04 2012. [Online].

[5] tango, "http://ftp.esrf.eu/pub/cs/tango/MAXlab/tango_training_MAX_lab.ppt," [Online].

[6] mohan, "Updating the Cryotrap readout equipment," [Online]. Available: https://tds.ego-gw.it/ql/?c=9021.

[7] Mohan, "A GENERAL DEVICE DRIVER SIMULATOR TO HELP COMPARE REAL," in *ICALEPCS2011, Grenoble, France*, Grenoble, 2011.

[8] lal, "http://www.lal.in2p3.fr/," [Online].

[9] "Tango Home Page," [Online]. Available: http://www.tango-controls.org/.

2 Cryotrap

This section gives an overview of the cryotrap and the design architecture.

2.1 Cryotrap Description

A cryotrap is used in the vacuum to trap gases and vapours by condensing them on a cold surface. In EGO's case they are used to keep out water contaminants. [1]

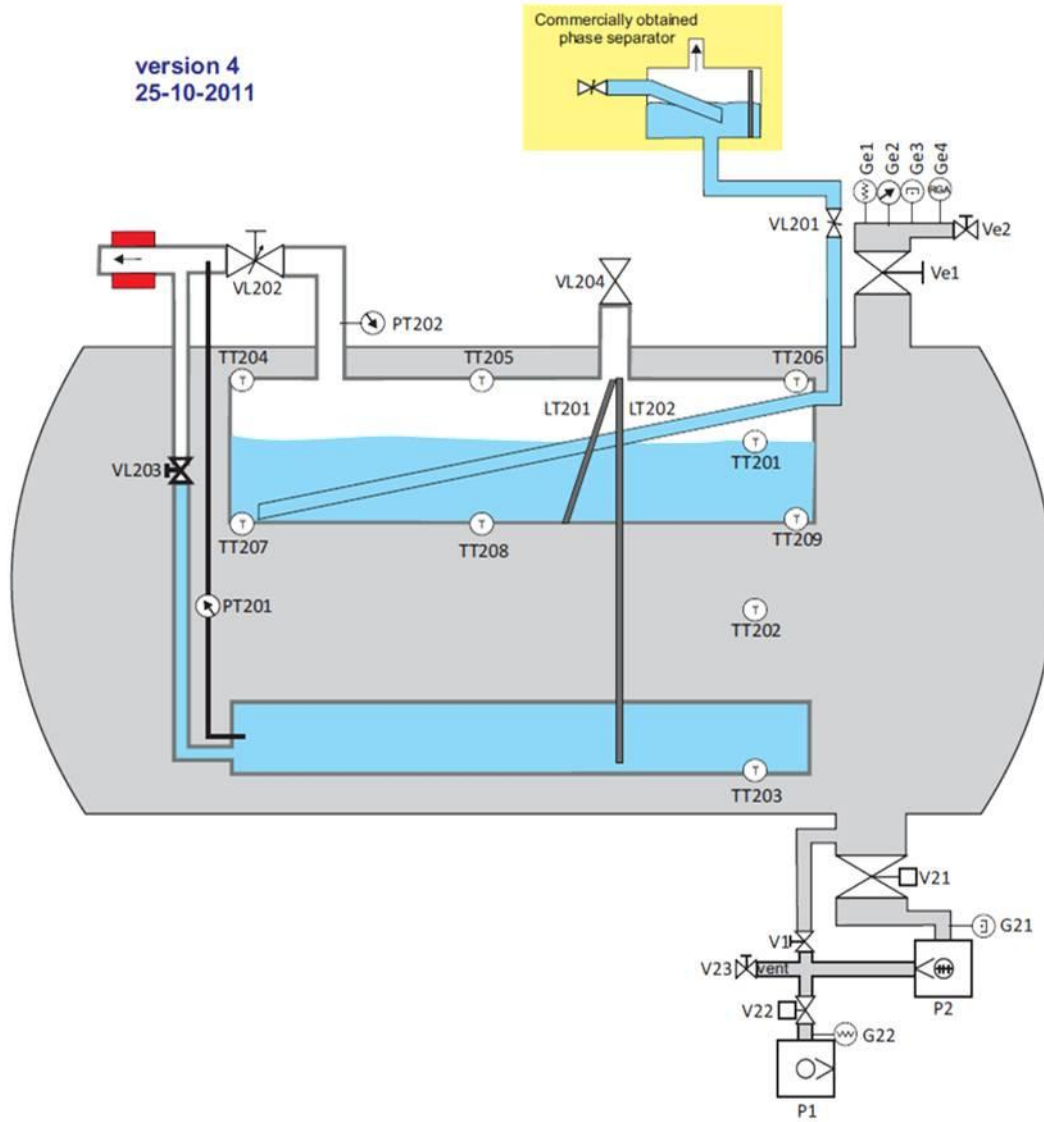*Figure 1: Picture of Cryotrap (being tested).*
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Figure 2: Diagram of Cryotrap

2.2 Cryotrap Control Architecture

The cryotrap control is based on 3 layers. An electronic layer, a plc layer and a tango software layer.
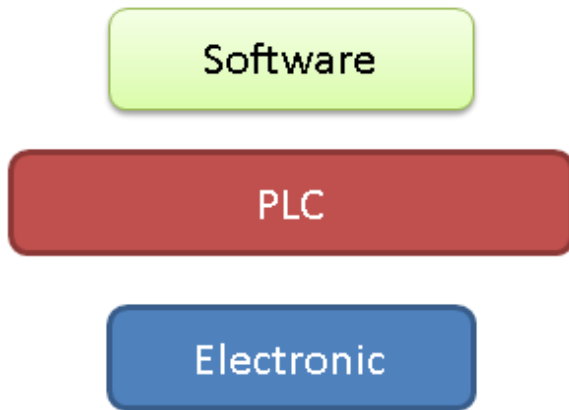

Figure 3: Architecture Overview

The control layers are

1. Software layer. The software controls the cryotrap via the plc. Valves and pumps are controlled by writing to a modbus address on the plc. Temperature and states are monitored by reading from modbus addresses on the plc. [4]. Safety logic is built in to the plc to prevent users damaging the cryotrap.

2. PLC Layer. The plc controls the electronics. It sets relays to open and close valves. It also reads temperature and pressure into a modbus memory area. Safety logic is built in to the plc to prevent users damaging the cryotrap. [3]. See the PLC user guide for further details. https://tds.ego-gw.it/ql/?c=9044

3. Electronic Layer. These are the switches to control valves and read pressure and etc... Safety logic is built in to the electronic prevent users damaging the cryotrap. [2]

3 The Tango Software bus

Tango architecture uses what is referred to as a "software bus" [8]. Tango uses a device server program to read devices. The Cryotrap device server is a program which reads/writes to a plc using modbus/tcp protocol. The device server then puts the data onto the software bus where tango clients can access the data.

Several tango clients read and write to the cryotrap device server via the tango bus. Clients include a human machine interface (synoptappli), a trend recorder (mambo) and a programming interface (PyTango).
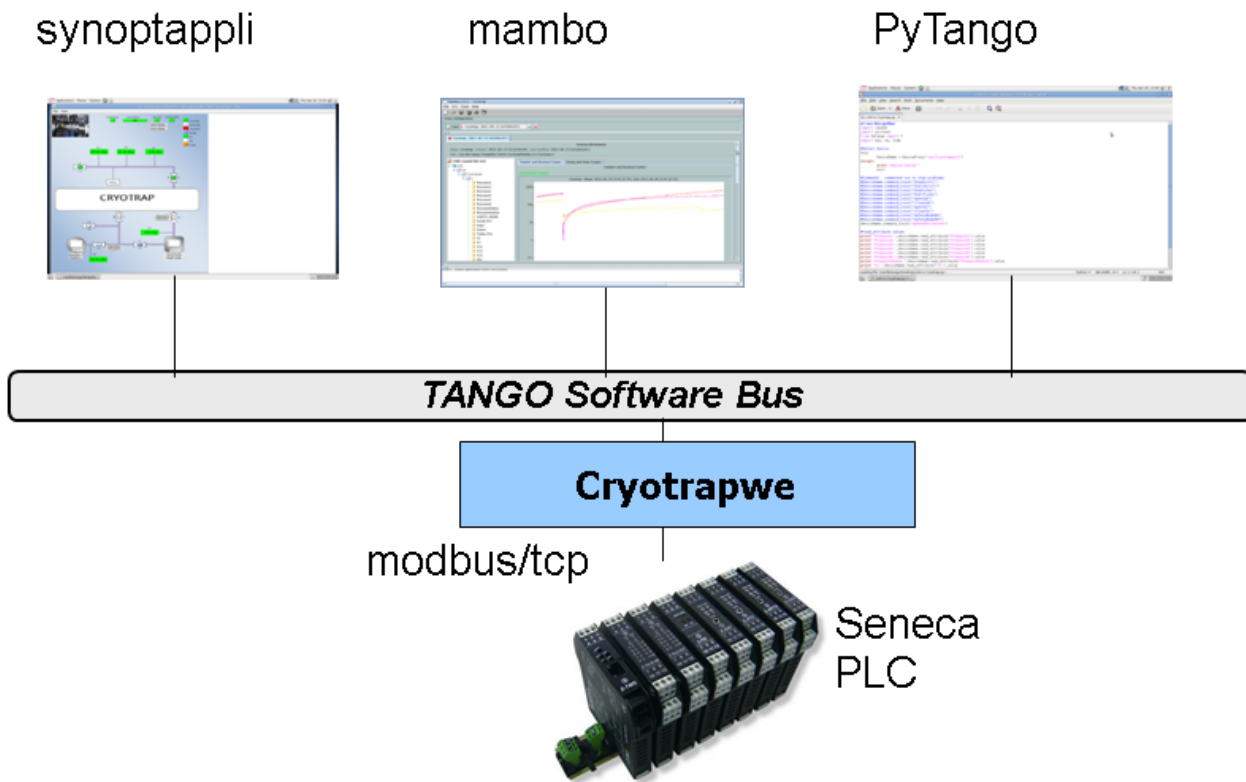

Figure 4: Tango software bus

4 Connecting laptop to the cryotrap

All the tango software is installed on a laptop. The laptop is connected directly to the lan port on the plc.

Note: The lan can also be connected over the internet but this means communication may be affected by network traffic. In future a separate lan port on the computer could be used for network connection [9].

1. Direct Connection

Ip=168.205.75.219
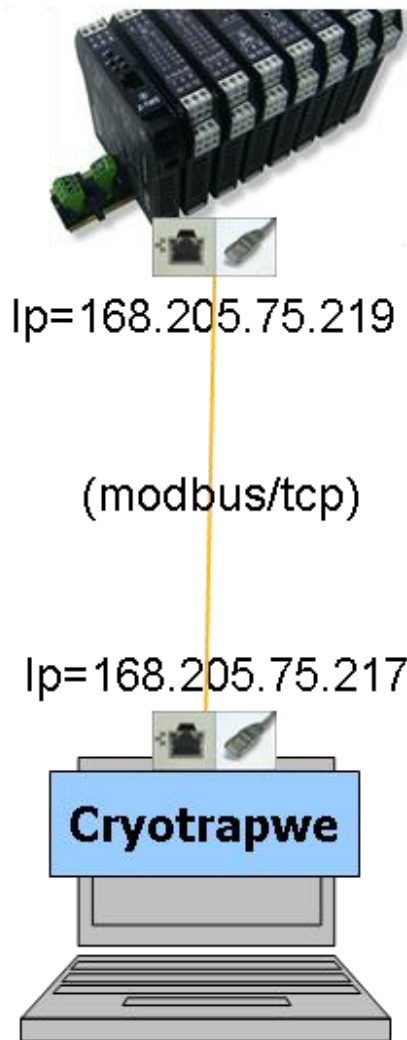
(modbus/tcp)

Ip=168.205.75.217

Cryotrapwe

Figure 5: Connecting the computer

The device server instance (Cryotrapwe) running on the laptop communicates with the plc over a lan using modbus/tcp protocol.

5 Software User Guide

5.1 Tango desktop Overview

At boot up the tango program to connect with the cryotrap is automatically started. Authorised users can access the control software at login. Below is the desktop view of the user "tango" who has full read/write privileges to the cryotrap. Other users will have more restricted privileges.
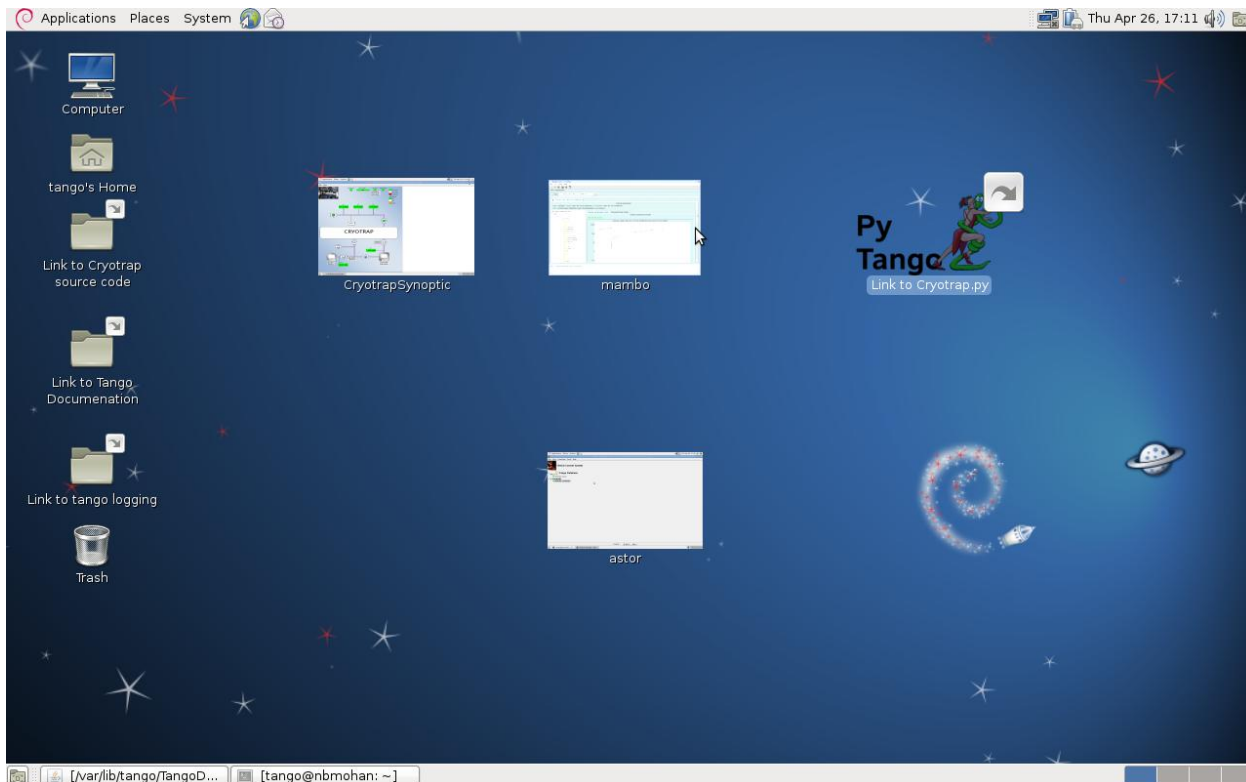

Figure 6 The tango desktop view

The desktop contains icons which launch client applications when clicked although these clients can also be launched from the command line.
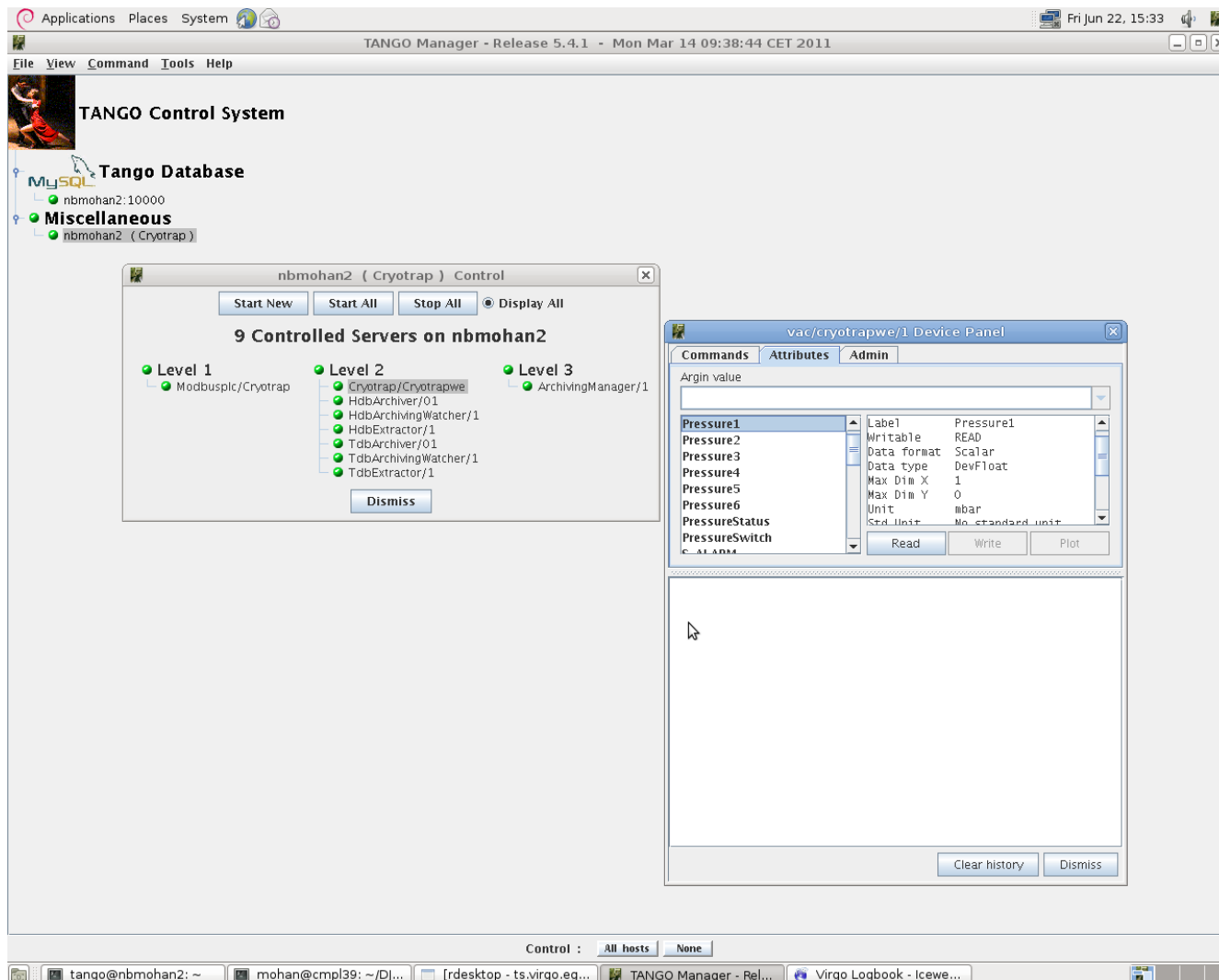
5.2 astor

Figure 7: astor

All device servers are started automatically at boot time and astor is a tool to control the various tango device servers.

Two device servers are used to control the cryotrap
- The Modbusplc server is used to read and write to the plc using modbus/tcp protocol.
- The Cryotrap server uses the Modbusplc server to read and interpret plc values.

The other device servers shown (e.g. HdbArchiver/01) were developed by Soleil and are used by the mambo data archiving tool.

Users with appropriate access control privileges can use astor to test servers. Full documentation for astor is provided at the link below.

http://www.esrf.eu/computing/cs/tango/tango_doc/tools_doc/astor_doc/index.html

5.2.1 Cryotrap Device Server

The cryotrap device server reads and interprets all plc values once per second. Commands can also be sent to the cryotrap The commands can be tested using the astor tool by right clicking the device Cryotrap/Cryotrapwe and selecting "Test Device".

5.2.1.1   Cryotrap Commands

Listed below are commands that can be sent to the cryotrap.

Command	Meaning	Comment
Init	Initialise the Cryotrap	Automatically called at start-up
State	Get state of Cryotrap	ON or FAULT or ALARM
Status	Get status of Cryotrap	A string value showing status
StartScroll	Start the scroll pump	
StopScroll	Stop the scroll pump	
StartTurbo	Start the turbo pump	
StopTurbo	Start the turbo pump	
OpenV21	Open valve V21	
CloseV21	Close valve V21	
OpenV22	Open valve V22	
CloseV22	Close valve V22	
SafetyModeOn	Switch On Safety Mode	
SafetyModeOff	Switch Off Safety Mode	ALL safety including plc and hardware is disabled. **Use with care** as the cryotrap can be damaged.
UpdateAttributes	Updates all attributes	This command is called once per second. Updates all values and sets the cryotrap State to ON or FAULT or ALARM

Figure 8: Cryotrap Command list

5.2.1.1.1 SafetyModeOn command

Safety Mode is on by default and is used to protect to the cryotrap. .When safety mode is ON the electromagnetic valves V21 and V22 can only be opened under certain conditions and a user may not open the valve unless those conditions are met.
An Error message will pop up telling the user the reason they cannot open a valve.

Operation Command	SafetyMode generated Exceptions
OpenV21	Cannot open V21unless turbo_p21 is ON
OpenV21	Cannot open V21 unless Ve1 is open
OpenV21	Cannot open V21 if GE2>4mbar
OpenV21	Cannot open V21 if GE1>4mbar
OpenV22	Cannot open V22 unless scroll_p22 is ON
OpenV22	Cannot open V22 if V1 open and Ve1 open and Pressure1 < 0.1 mbar

Figure 9: Safety mode generated exceptions

5.2.1.1.2 SafetyModeOff command

SafetyModeOff option is used for testing. When this mode is selected all hardware and software safety is turned off and exceptions above will not be generated. **When safety mode is turned off the cryotrap can be damaged**.
The state and status of the cryotrap is still updated every second and illegal states will cause the state to be in ALARM mode (orange).

5.2.1.2 Cryotrap Attributes

Attributes contain values to be monitored for the cryotrap. Available attributes can be viewed by clicking on the Attributes tab in Astor. As can be seen from table most attributes return a state value and the overall state and status of the cryotrap is determined from these values.

Attribute	Value returned
Pressure1	MaxiGauge Pressure 1 in mBar (GE1)
Pressure2	MaxiGauge Pressure 2 in mBar (GE2)
Pressure3	MaxiGauge Pressure 3 in mBar (GE3)
Pressure4	MaxiGauge Pressure 4 in mBar (not attached)
Pressure5	MaxiGauge Pressure 5 in mBar (G21)
Pressure6	MaxiGauge Pressure 6 in mBar (G22)
PressureStatus	MaxiGauge Pressure Status 1=on,2=off e.g. 1,1,1,2,1,1
PressureSwitch	ON or OFF
S_ALARM	ALARM state
S_OPEN	OPEN state
S_CLOSE	CLOSE state
S_FAULT	FAULT state
S_MOVING	MOVING state
S_ON	ON state
S_OFF	OFF state
S_UNKNOWN	UNKNOWN state
SAFETY_MODE	ON or OFF
Scroll_P22	ON or OFF or MOVING
Turbo_P21	ON or OFF or MOVING
State	Cryotrap state: ON or FAULT or ALARM
Status	"various values"
V1	OPEN or CLOSE or MOVING or FAULT
V2	OPEN or CLOSE or MOVING or FAULT
V21	OPEN or CLOSE or MOVING or FAULT
V22	OPEN or CLOSE or MOVING or FAULT T
V23	OPEN or CLOSE or MOVING or FAULT
Ve1	OPEN or CLOSE or MOVING or FAULT
Ve2	OPEN or CLOSE or MOVING or FAULT
ModbusRegister50	This is the value of Modbus register 50. This is an important register which is displayed for debugging purposes.

Figure 10: Cryotrap Attribute Values

5.2.1.3 Cryotrap state and status

The cryotrap attributes are updated once per second. The overall state and status of the cryotrap is determined based on these values. Three cryotrap states are possible ON or FAULT or ALARM. The status provides more detailed information. A list or cryotrap states and status is shown below.

STATE	STATUS	COMMENT
ON	ON	Operation mode
FAULT	ModbusPLC init FAULT	Modbus device server Initialisation fault
FAULT	modbus UpdateAttrib FAILED	Failure reading attributes
FAULT	modbus_device->state FAULT	Modbus device server fault
ALARM	G22>8mbar ,V21 , V22 not closed	Pressure G22 is above 8 mbar but V21 and V22 are not closed.
ALARM	GE1<0.1mbar, V1 open and V22 not closed	Pressure GE1 is less than 0.1 mbar but V1 and V22 are not closed
ALARM	PressureSwitch OFF but V22 not closed	The pressure switch is off but V22 is not closed
ALARM	Turbo_p21 not ON and V21 not closed	The turbo pump is on but V21 is not closed
ALARM	Scroll_P22 not ON and V21 not closed	The scroll pump is on but V21 is not closed
ALARM	PressureSwitch OFF but V21 not closed	The pressure switch is off but V21 is not closed

Figure 11: States and Status values for the Cryotrap server

Notes:
1. Only one status message is displayed at a time. If there is more than one fault the FAULT or ALARM with highest priority will be set in status.
2. All state and status are values also recorded in the log files.
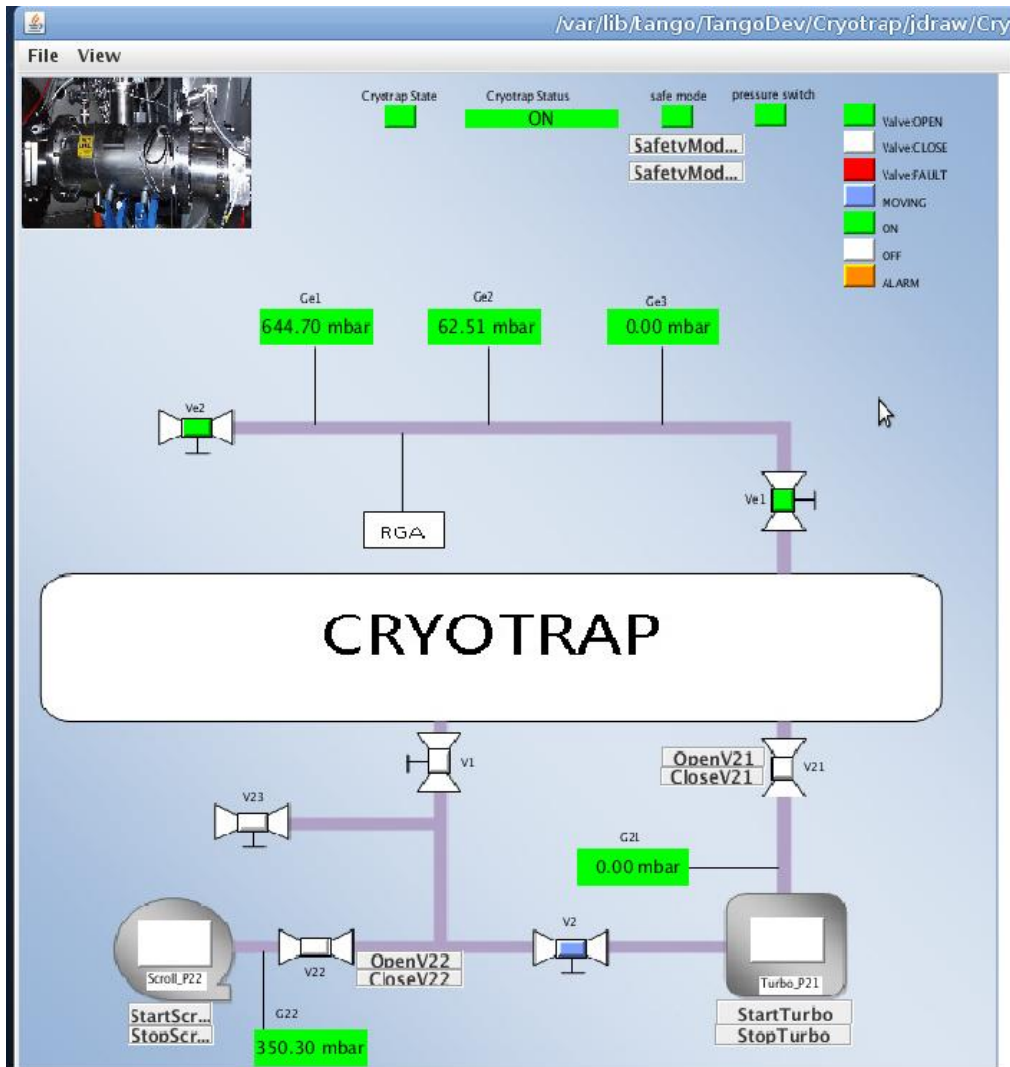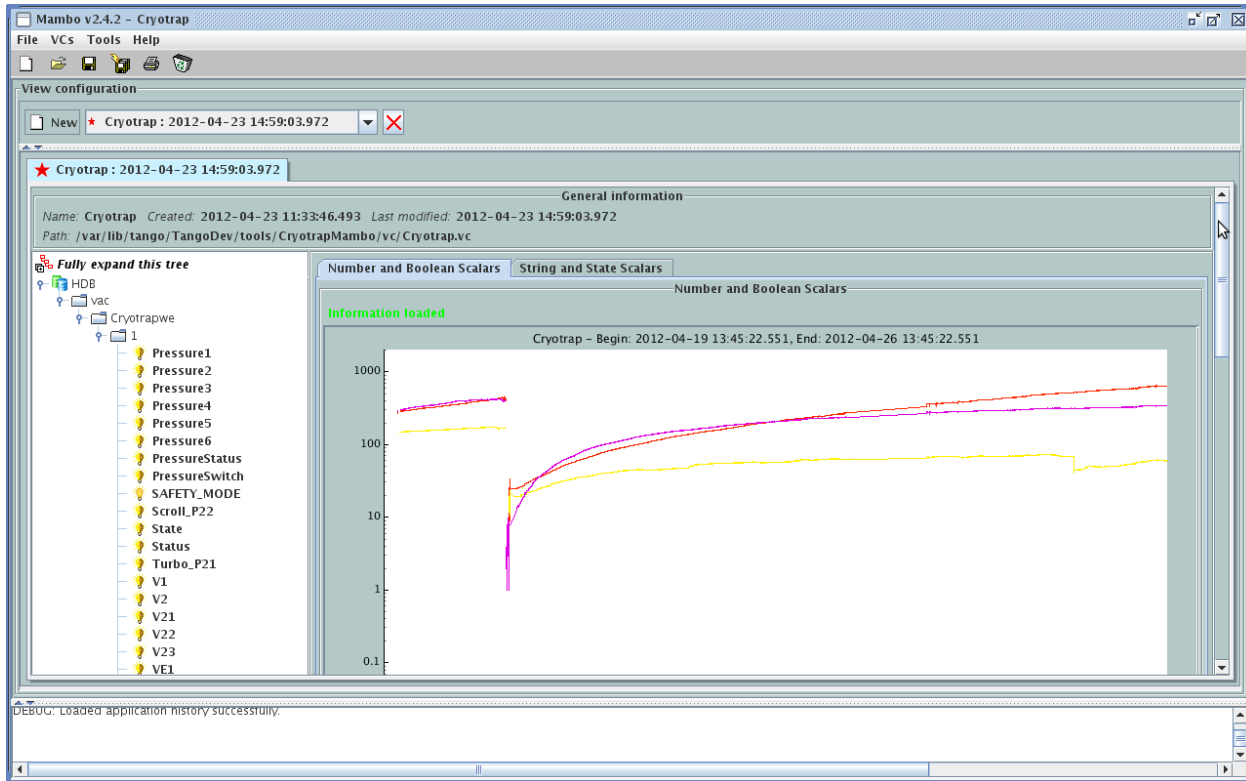3. The above rules are subject to review.

5.3 synoptappli

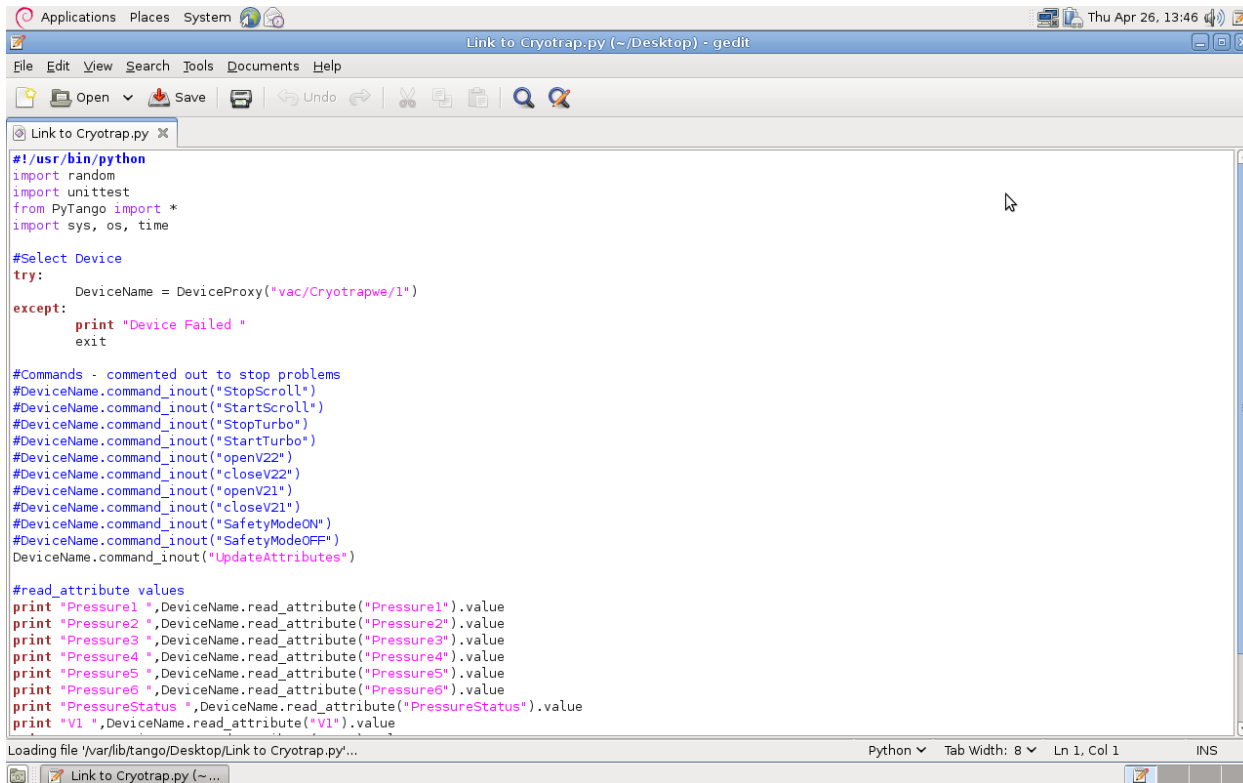
Figure 12 synoptappli Crytroptrapsynoptic.jdw

The synoptappli client provides a user friendly display of the cryotrap server.
The state and status of the cryotrap are displayed at the top.
When safety mode is on exceptions listed in Figure 9 appear as a pop up window.

5.4 mambo

The mambo tool was developed at the Soleil synchrotron. It provides trend data information over days, months or years. The states of all attributes are recorded and the values can be exported as a table or displayed in graph form.

5.5 PyTango

A link on the desktop provides an example program to access the Cryotrap values using the tango python interface PyTango. PyTango is described in the list below.
http://www.tango-controls.org/static/PyTango/latest/doc/html/index.html

Two other example programs are below.

Program 1: Open valve v22

```
DeviceName = DeviceProxy("vac/Cryotrapwe/1")
DeviceName.command_inout("openV22")
```

Program2: Print state of valve v22

```
DeviceName = DeviceProxy("vac/Cryotrapwe/1")
print "V22 ",DeviceName.read_attribute("V22").value
```

5.6 Other tango information

5.6.1Access Control

The user "tango" has full access to the cryotrap but other users have limited access. Another user will see the same interface but when a command is issued they are informed that they are not authorised for some commands (depending on authorisation allowed)..
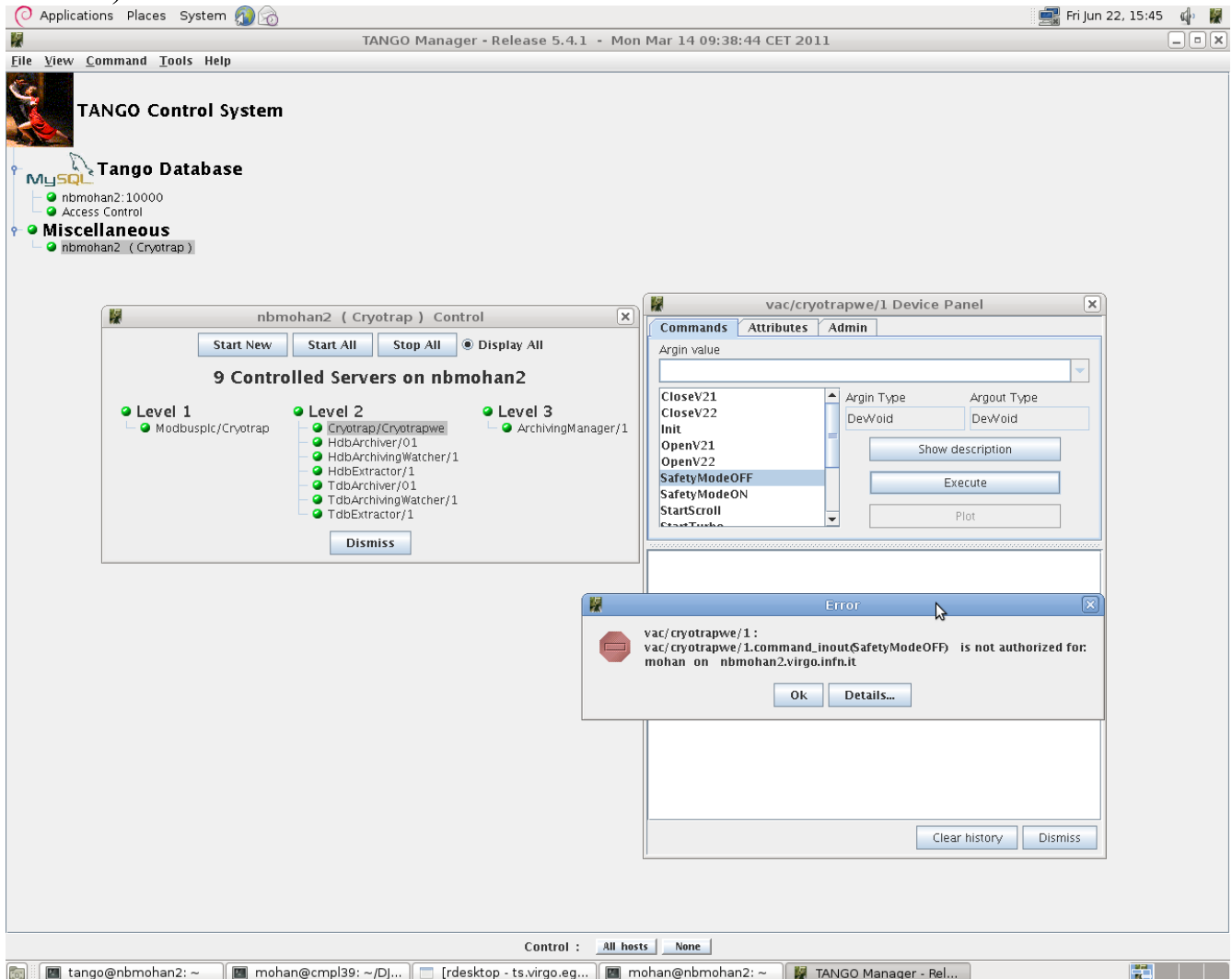

Figure 13: Authorisation Message

5.6.2 Other tango tools

The clients described above synoptappli, mambo and PyTango display the Cryotrap server information in different ways. There are also many other tools available for tango such as…
logviewer – to display logs
atkmoni – to view graphs
etc…

5.6.3 Documentation

Information on tango is available at
http://www.tango-controls.org/
Documentation for tango tools is available at…
http://www.tango-controls.org/Documents/tools