Bachelor Thesis of science course in Electrical engineering of Aachen
University of Applied Sciences, Campus Jülich

Optical Scanning of an image plate by 2D-laserscanner
with integrated data logging

Yingna Wang

Mar. 2006

This Bachelor thesis has been carried out at the Institute of solid state research(IFF) of the Research Center Jülich(FZ Jülich)

<div>

Professor Tutor: Prof. Dr. Th. Brükel

Prof. Dr. Hans-Josef Ackermann
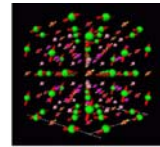
Technic helper: Klaus Bussmann

</div>

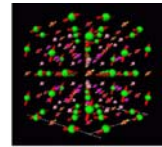This thesis was supervised by: _____

_____

I certify that this work has been carried out and written up entirely by myself. No literature references and resources other than those cited have been used.

Jülich, Mar. 2006 _____

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6. Use the SubVIs to build own Labview program

Control the movement of Laser

Data Process

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Chapter 1 Introduction of the whole system

The project is to scan a max. 600mm×600mm large area neutron image plate every 1mm grid with an installation of YAG-Laser beam that was displaced by a moving magnet motor controlled reflector system.

For each grid point there will be an analog measure value and then saved into a memory.

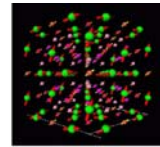It should be also possible that the data of each point from the memory can be read out and displayed into a graph.

The displace system and the electronic components of the GSI-Lumonics Group must work with the Class-3B-Laser mechanically to set up an experiment.

The Software used in the project will be the LabVIEW of the National Instrument Company related with the free interpreter program language Python.

☻ Practical work procedure:

1. Learn the Software LabVIEW to be familiar with using and also building programs.
2. Set-up the hardware system with the electronic components of the GSI-Lumonics Group and connect with the host computer with LabVIEW.
3. Install the program CLI.exe (Command Line Interface) from the CD of GSI Group, be familiar with the commands used in the program to control the system.
4. Use the LabVIEW to build up a second program to control the system with the subVIs that contained in the CD.
5. Also write one part program that can acquire and proceed the data to be displayed into a graph.

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☻ The original Project in IFF-FZ Jülich:

People involved:
Th.Brückel, A.Ioffe, E.Küssel,S.Massalovitch, M.Schlapp*, B.Schmitz

Forschungszentrum Jülich GmbH, Institut für Festkörperforschung, IFF - Streumethoden ⌐*TU Darmstadt, Fachbereich Material- und Geowissenschaften, Fachgebiet Elektronische Materialeigenschaften

We are constructing a two-dimensional position sensitive detector that will operate at the triple-axis spectrometer / diffractometer SV30 at the FZ Jülich.

The main features of this detector should be:

- the spatial resolution of about 1 mm;
- the large-area (~500x500 mm2) that provides a wide observation angle (up to 60 degree) both in vertical and horizontal direction;
- a high efficiency for thermal neutrons;
- the ability to operate in a relatively high gamma-background environment;
- the linear response in a wide dynamic range;
- relatively low price.

We are considering a neutron detector based upon hotostimulable storage phosphor doped by a neutron converter. However, the image plates with the ⬇Gd converter which are only commercially available, are rather sensitive to the gamma radiation and do not satisfy our requirements.
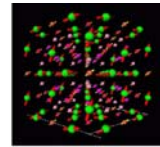
Therefore, we are developing a new approach based upon the use of a ⬇^{6}Li converter that is insensitive to the gamma background. Our analysis shows that a low (with respect to the Gd converter) neutron capture cross section of ^{6}Li converter can be compensated by the higher ⬇released energy and a proper optimization of the ⬇parameters of the image plate and the read-out system.

This research is carried out in collaboration with TU-Darmstadt, where the new different phosphors are under investigation (Prof. H. von Seggern, M.Schlapp).

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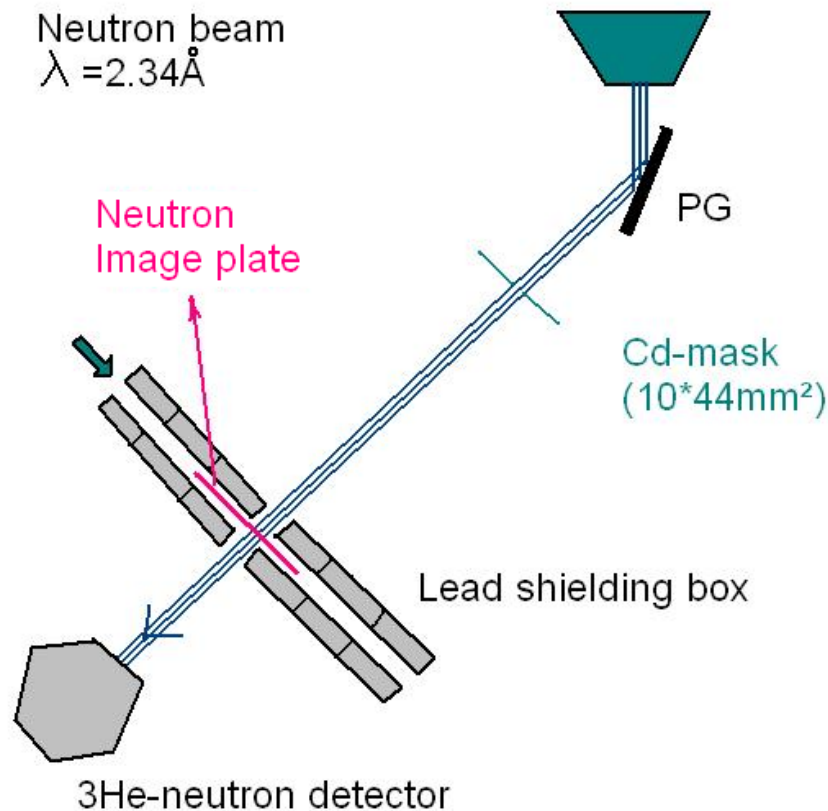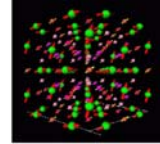
Chapter 2 Theory

Neutron image plates (NIPs) have found widespread application as neutron detectors for single-crystal and powder diffraction, small-angle scattering and tomography. After neutron exposure, the image plate can be read out by scanning with a laser. Commercially available NIPs consist of a powder mixture of BaFBr : Eu2+ and Gd2O3 dispersed in a polymer matrix and supported by a flexible polymer sheet. Since BaFBr : Eu2+ is an excellent x-ray storage phosphor, these NIPs are particularly sensitive to γ –radiation which is always present as a background radiation in neutron experiments. In this work we present results on NIPs consisting of KCl : Eu2+ and LiF that were fabricated into ceramic image plates in which the alkali halides act as a self-supporting matrix without the necessity for using a polymeric binder. An advantage of this type of NIP is the significantly reduced γ -sensitivity. However, the much lower neutron absorption cross section of LiF compared with Gd2O3 demands a thicker image plate for obtaining comparable neutron absorption. The greater thickness of the NIP inevitably leads to a loss in spatial resolution of the image plate. However, this reduction

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in resolution can be restricted by a novel image plate concept in which a ceramic structure with square cells (referred to as a 'honeycomb') is embedded in the NIP, resulting in a pixelated image plate. In such a NIP the read-out light is confined to the particular illuminated pixel, decoupling the spatial resolution from the optical properties of the image plate material and morphology. In this work, a comparison of experimentally determined and simulated spatial resolutions of pixelated and unstructured image plates for a fixed read-out laser intensity is presented, as well as simulations of the properties of these NIPs at higher laser powers.

-<Pixelated neutron image plates>

More details: http://www.iop.org/EJ/abstract/0022-3727/37/18/017/
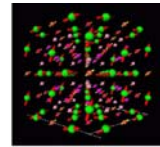
Chapter 3 About LabVIEW

3.1 Introduction of LabVIEW

What is LabVIEW?
National Instruments LabVIEW is an industry-leading software tool for designing test, measurement, and control systems. Since its introduction in 1986, engineers and scientists worldwide who have relied on NI LabVIEW graphical development for projects throughout the product design cycle have gained improved quality, shorter time to market, and greater engineering and manufacturing efficiency. By using the integrated LabVIEW environment to interface with real-world signals, analyze data for meaningful information, and share results, you can boost productivity throughout your organization. Because LabVIEW has the flexibility of a programming language combined with built-in tools designed specifically for test, measurement, and control, you can create applications that range from simple temperature monitoring to sophisticated simulation and control systems. No matter your project, LabVIEW has the tools necessary to make you successful quickly.
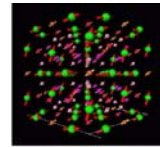
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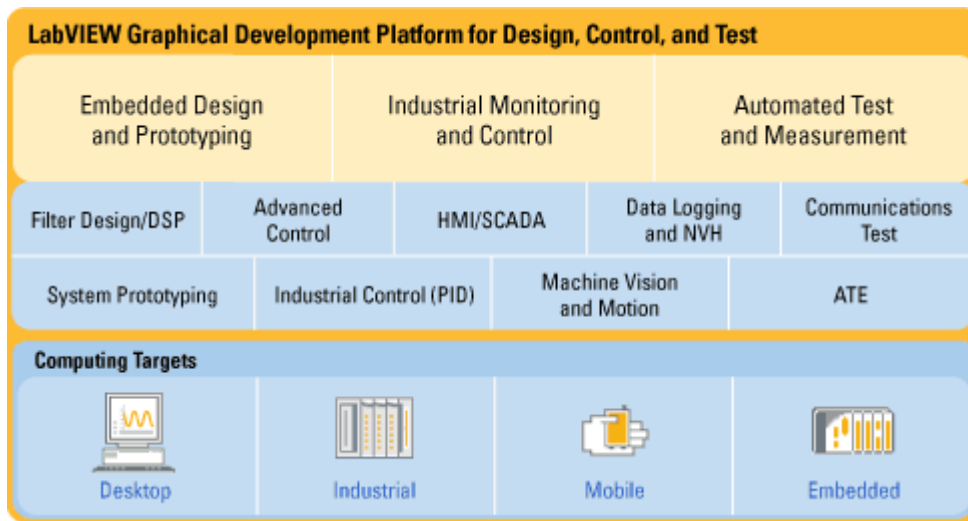
LabVIEW is a powerful and flexible development tool designed specifically for the needs of scientists and engineers. It used the graphical programming language **G** to create programs called **v**irtual **i**nstruments (**VI**s) in a flowchart-like form called a **block diagram**. The user interacts with the program through the **front panel**. LabVIEW has many build-in functions to facilitate the programming process.
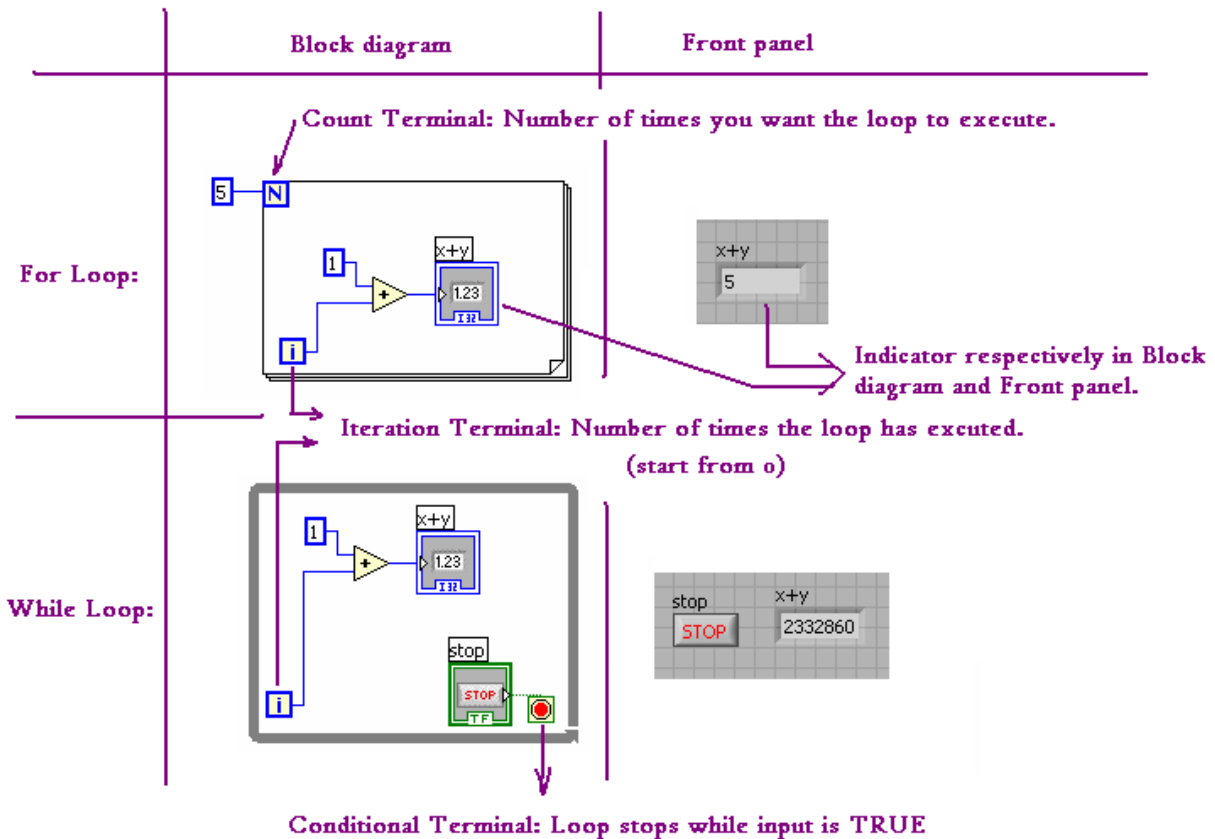
Block diagram: Pictorial representation of a program or algorithm . In G , the block diagram , which consists of executable icons , called nodes , and wires that carry data between the nodes , is the source code for the VI .

Front panel: The interactive interface of a VI . Modeled from the front panel of physical instruments , it is composed of switches , slides , meters , graphs , charts , gauges , LEDs , and other controls and indicators .

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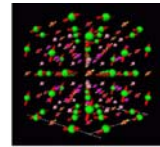
3.2 Basic use

☻ Example01: For loop and while loop

For loop: Calculate 5 times, the last time i=4, the indicator display the result i+1=5.

While loop: Keep on calculate till press the stop button, if the i=2332859 at that time, the indicator display the result i+1=2332860.

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For loop in other programming language:

Java

```java
for (int i=0; i<10; i++){
    System.out.println("The value of 'i' is " + i );
}
```

C++

```cpp
int i;
for (i=0; i<10; i++){
    cout << "The value of 'i' is " << i << endl;
}
```

Python

```python
for i in [1,2,3,4,5,6,7,8,9,10]:
    print "The value of 'i' is", i
```

☻ While loop in other programming language:

Java

```java
int i = 0;
while (i < 10){
    System.out.println("The value of 'i' is " + i);
    i++;
}
```
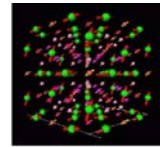
C++

```cpp
int i = 0;
while (i < 10){
    cout << "The value of 'i' is " << i << endl;
    i++;
}him
```
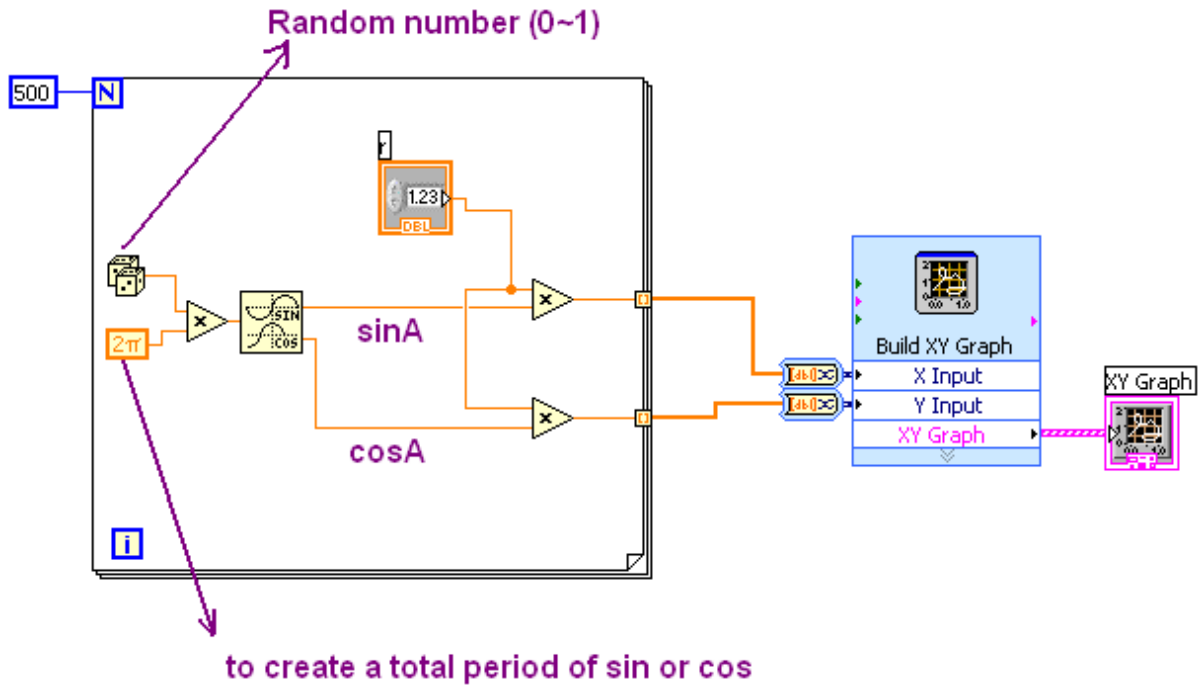
Python

```python
i = 0
while i < 10:
   print "The value of 'i' is", i
   i = i + 1
```

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☻ Example02: plot a circle using an XY Graph.
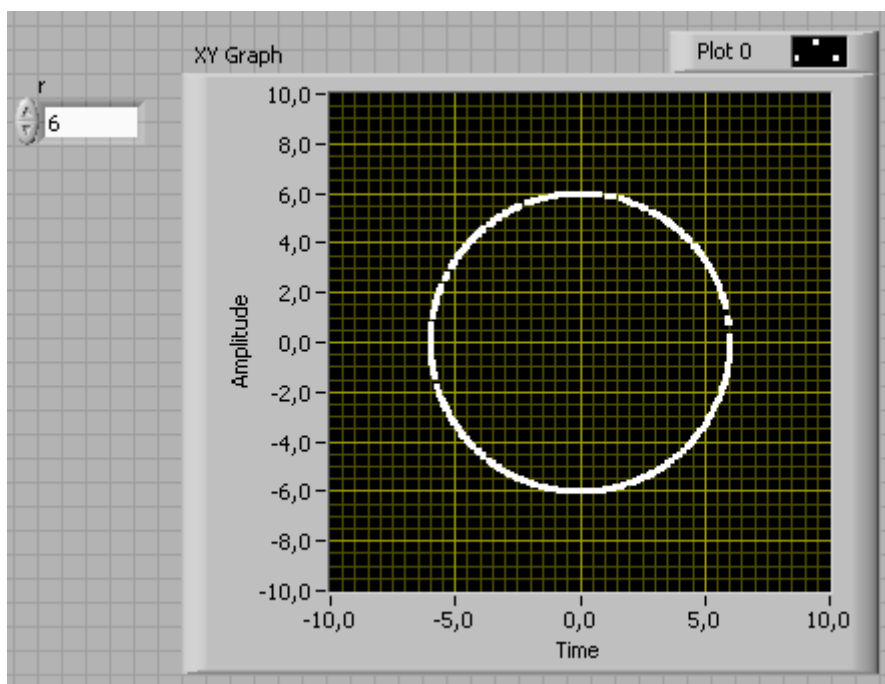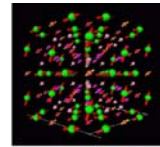

Random number (0~1)

to create a total period of sin or cos

The function of a circle is: $x^2+y^2=r^2$

$\rightarrow r^2*\sin^2 A + r^2*\cos^2 A = r^2$

$\rightarrow x = r*\sin A \qquad y = r*\cos A$

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☻ <u>Example03</u>: Data acquisition (DAQ)

Data acquisition is the process of gathering information in an automated fashion from analog and digital measurement sources such as sensors and devices under test. Data acquisition uses a combination of PC-based measurement hardware and software to provide a flexible, user-defined measurement system.
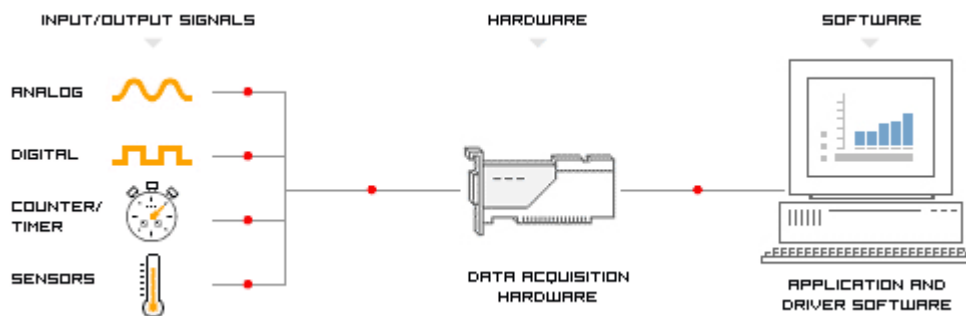
When you place the DAQ Assistant Express VI on the block diagram, the DAQ Assistant automatically appears. The DAQ Assistant is a graphical interface that we can use to configure measurement tasks and channels.

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Connect a Voltage source onto the DAQ board (analog input)
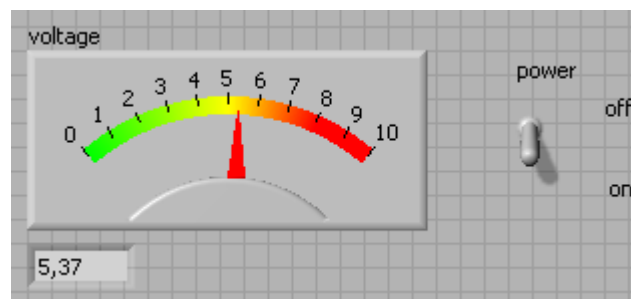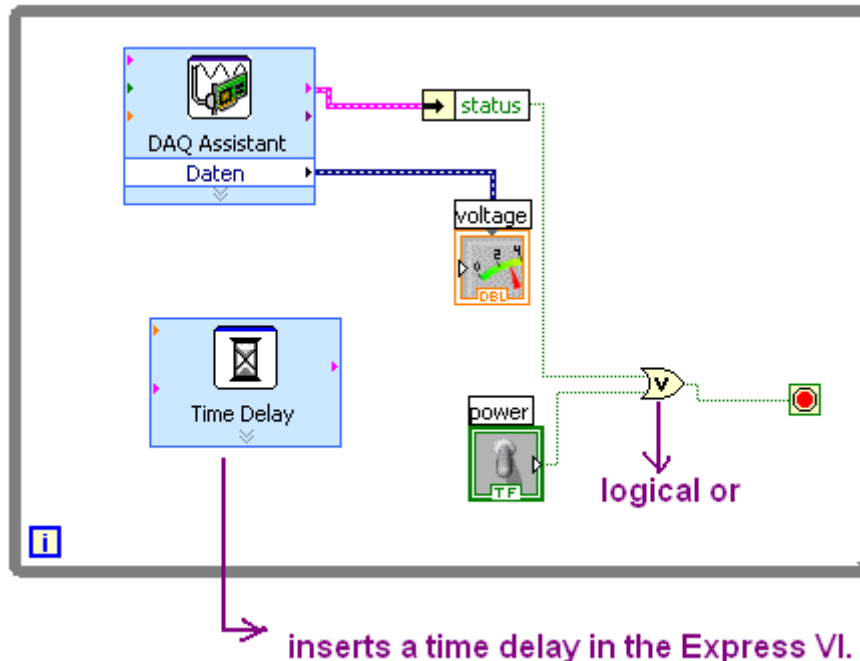
The LabVIEW graphical dataflow language and block diagram approach naturally represent the flow of your data and intuitively map user interface controls to your data, so you can easily view and modify your data or control inputs.

For experienced programmers, LabVIEW delivers the performance, flexibility, and compatibility of a traditional programming language such as C or BASIC. In fact, the full-featured LabVIEW programming language has the same

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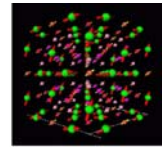
constructs that traditional languages have -- variables, data types, looping, and sequencing structures as well as error handling.

3.3 Application

● Acquire Data from a Data Acquisition Device

● Communicate with and Control an Instrument

● Acquire Data from a Sensor

● Process and Analyze Measurement Data

● Design a Graphical User Interface

● Save Measurement Data to File

● And also Use LabVIEW with Other Software Applications

● ……

Chapter 4 System Set-up

4.1 List of equipments

- Power Supply (±15V)

Typ:	MADS 15.1.6
A.-Nr.:	171-602-00 .02
U in:	115/*230V +10/-15% 50-400Hz
I in Max.:	0.8/0.4A

KNIEL System-Electronic GmbH D-76187 Karlsruhe/Germany

IS: 16880159

- SC2000 Scan Controller Board

GSI Lumonics
IS: 03071011

- X and Y Optical Scanners

GSI Lumonics
VM-500 C

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011-3040106
Patent
Pending
IS: 03070903/03070904

- 2 MiniSAX (Miniature Single AXis)

GSI Lumonics
Billerica, MA 01821 USA
Model Mumber: 002-3005051
IS: 03070905/03070906

- Laser beam

●Laser radiation avoid exposure to beam class 3B laser product
Iop: 1450mA
Power: ≥75mW
A-A1728-0109

Laser protect glasses
Laser 2000 GmbH- TÜV ISO 9001 zert.
Laserschutzbrille Modell 426
BOL-40-426
Wareneingang: 2210921
2203002

●Laser radiation class 2 (for safty)

- 1 Power Supply cable
- 2 Startup SAX Interface Cables, part# 712-74217
- 2 Enable Interlock SAX Interface Cables
- 2 Dual Axis Digital Servo Interface Cables
- 1 RS-232 Computer Interface Cable, part# 712-74214
- 1 Sync/Cal Ribbon Cable

- Host Computer
- CD of GSI Lumonics CD-ROM SC2000 CLI 2.1
- CD of LabVIEW 7.1

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4.2 Optical Scanners(VM500C)
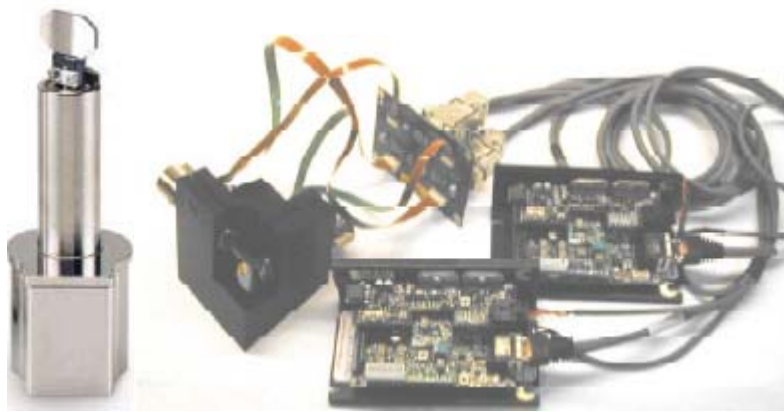
The VM500C Optical Scanner is member of the GSI Lumonics' High Performance VM family of Galvanometers. It's designed for advanced beam and image positioning, and offer high dynamic performance along with high accuracy and instrument grade performance.

The VM Series scanners use moving-magnet design together with the newly patented capacitive position detector that offers superior accuracy.

The moving magnet technology maintains the low inertia, high rigidity and low temperature characteristics of the M series predecessors, while allowing for increased bandwidth. This enables the scanner to move at higher speeds with more precise angular positioning.

The VM Series Scanners are optimized for both large and small signal applications, and provide improved drift, noise, and linearity.

Highest performance is achieved when the VM Galvanometer is mated with GSI Lumonics' newly designed mirror assemblies and an optimized GSI servo controller.

When the thermal control option is purchased with the complimenting servo driver, the built-in thermal blanket around the position detector that is a standard

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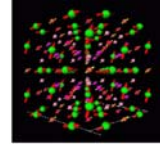
feature of all VM Series Galvanometers can be used to maintain a specific temperature, in order to eliminate temperature-related drift.

Using the thermal control option of the VM series scanners minimizes scanner offset and gain drift. The set point for temperature-regulated scanners must be above the highest expected ambient temperature but not above 50º C. For maximum stability, temperature controlled scanners may require thermal isolation from the scanner mount so that heat sinking by the mount does not interfere with temperature regulation.

Standard Mirrors (clear aperture)		Maximum Scan Angle*
VM500	4mm	±30º Optical
	5mm	±25º Optical
	6mm	±20º Optical

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DETAIL A
SCALE 8 : 1

SHAFT MARK APPROXIMATELY
AT 90° OF PD ZERO

2.0

45°

PIN 1

P1 8 PIN HEADER
MOLEX P/N 53398-0890

PIN 1

P2 7 PIN HEADER
MOLEX P/N 53398-0790

10.9

1.7

3.4

18.4

19.1

9.474

27.3

22.6

25.8

29.0

48.6

VM500C

P1		
1	CHASSIS GND
2	TEMP-
3	TEMP+
4	OSC GROUND
5	AGC
6	SIGNAL GND
7	POSITION-
8	POSITION+

P2		
1	SHIELD
2	MOTOR+
3	MOTOR+
4	MOTOR-
5	MOTOR-
6	HEATER+
7	HEATER-

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Mini SAX

The MiniSAX (Miniature Single AXis) servo controller is one of GSI Lumonics' most recent developments in galvanometric servo control technology. By taking advantage of the newest surface mount componen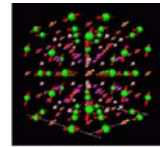ts, the MiniSAX provides full-function scan electronics at a size and cost less than many stripped down servo amplifiers. Advanced servo filtering techniques together with a low-coupling design provide extended bandwidths and improved response times. The MiniSAX was engineered with system designers in mind, incorporating a simple yet comprehensive and flexible interface structure. For the first time, laser system manufactures can purchase a truly high performance, cost effective galvanometer servo controller that allows convenient, "in-head" packaging.

The MiniSAX uses a modular design, providing the ability to readily configure the driver for specific applications. An optional filter module is available in a variety of adjustable notch frequency ranges. The frequency response of this module can be optimized to handle a variety of customer-supplied loads. A thermal control module is available to support GSIL's thermally regulated scanners, allowing use of the industry's lowest drift galvanometers.

The MiniSAX product line includes a variety of accessories that ease the integration into your manufacturing process. The MiniSAX mounting bracket provides convenient mounting surfaces and mates with either of two optional heatsinks. A test interface board allows easy access to a variety of important test points. Mating connectors and inexpensive assembly tools are available directly from GSI Lumonics. The MiniSAX Startup Kit is recommended for first time users and includes many of these valuable accessories.

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Command Input Characteristics
- ♦ Differential Voltage Range ±3 volts differential for full scale
- ♦ Input Impedance 5 KΩ differential

Position Output ±3 volts differential for full scale
Power Input
- ♦ Voltage ±15 to ±24 volts DC
- ♦ Quiescent Current +170mA, -150mA

> (servo enabled, galvo resting w/o error,
> no thermal controller)

Motor Drive Power
- ♦ Dynamic Current max. 2.5 Amps RMS
- ♦ Peak Current 10.0 Amps

Note: U20/U21 mounting screws should be tightened to a torque of 16 in-lb (1.8 N-M).
Control I/O Characteristics
- ♦ Servo Ready Open Drain, Active Low (50 mA max.)
- ♦ Servo Enable TTL/CMOS Compatible, Active Low
- ♦ Temp OK [*] Open Drain, Active Low (50 mA max.)

* Part of optional Temperature Controller Module
Protection
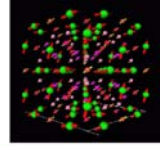- ♦ Fully Fused Motor Output, Automatic Gain

> Control, and Thermal Controller [1]
♦ Automatic Shutoff Over-position, Supply Undervoltage, Position Detector Inactive

Temperature Range 0°C to 50°C Operating
Size W *x* **L** *x* **H**

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(not including mounting bracket) $2\frac{1}{8}$" x $3\frac{3}{8}$" $x 1\frac{1}{4}$"

(54.5mm x 86.5mm x 31.35mm)

Weight 66 grams
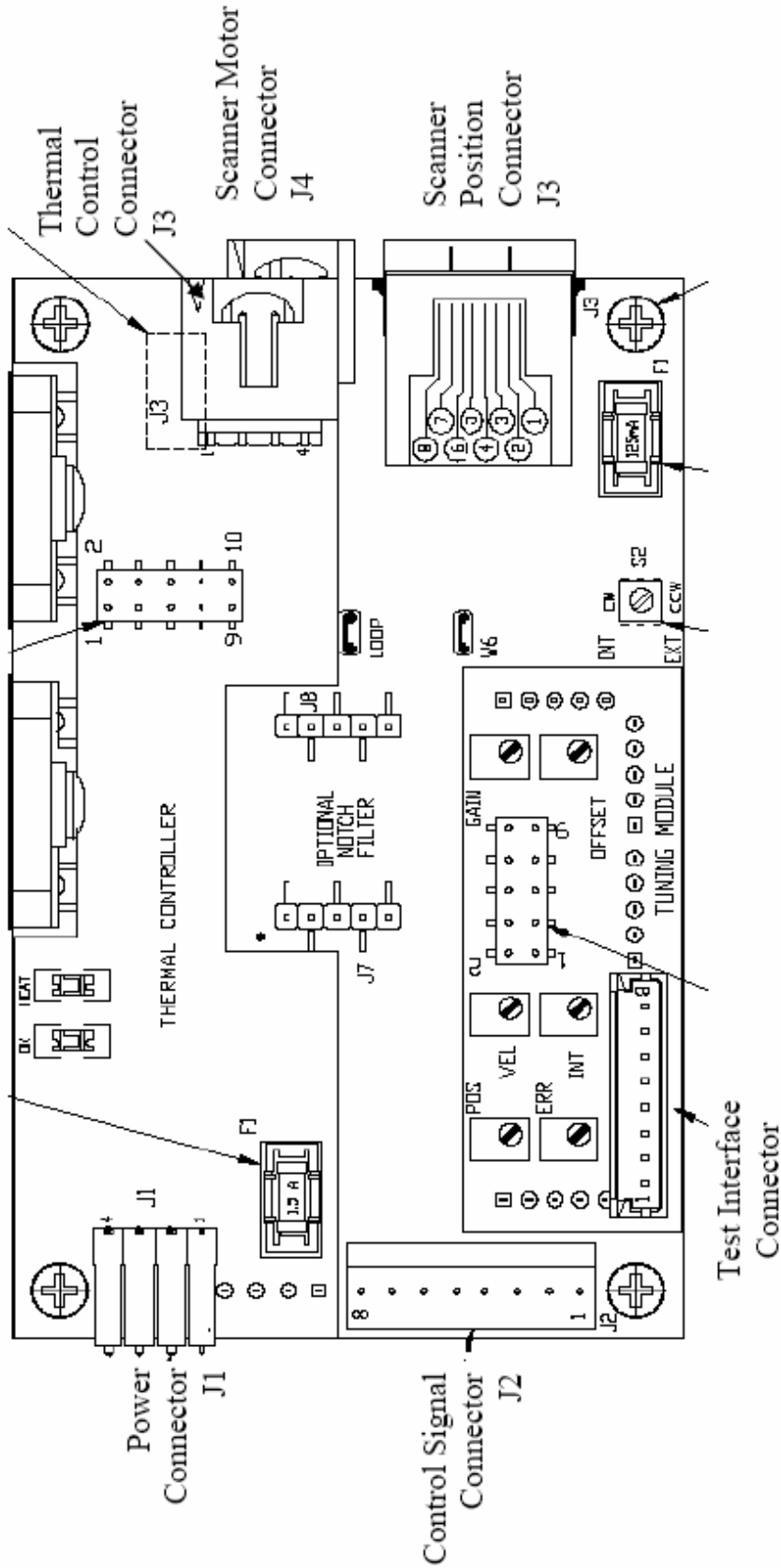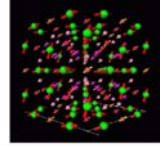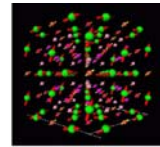(Includes all optional modules. Does not include mounting bracket)

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Figure 1: MiniSAX Connections

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4.4 GSI Lumonics SC2000 Digital Scan Controller

The SC2000 Scan Controller is designed to provide fast, accurate, user-friendly control over GSI Lumonics' MiniSAX and Dual Axis Digital servo amplifiers and associated peripherals. Using either the provided GSI Lumonics Command line interface software, or similar user-designed software, the controller can be programmed to operate in conjunction with a host computer or in a stand-alone configuration. The stand-alone configuration allows the user to run a series of programs, from non-volatile memory upon system power up, as well as trigger program execution using control input and output signals. Interfacing with a host computer, on the other hand, allows the user to choose a mode of operation, between the controller and the host, ranging from totally autonomous to tightly coupled.

The Scan Controller interfaces directly to the position command, position feedback, and binary communications of the servo amplifiers. This allows for full position control of the system and control of the enable/status interlock between the SC2000 and driver board. Likewise, this interface allows the user

to monitor position feedback from the galvo, as well as read calibration information digitally via the host computer.

In addition to controlling the servos, the Scan Controller has hooks to aid in the interface and control of other peripherals typically associated with scanning systems. These include sync inputs and outputs, a pixel clock system, a calibration/data capture system, and other functionality available to volume OEM system designers.
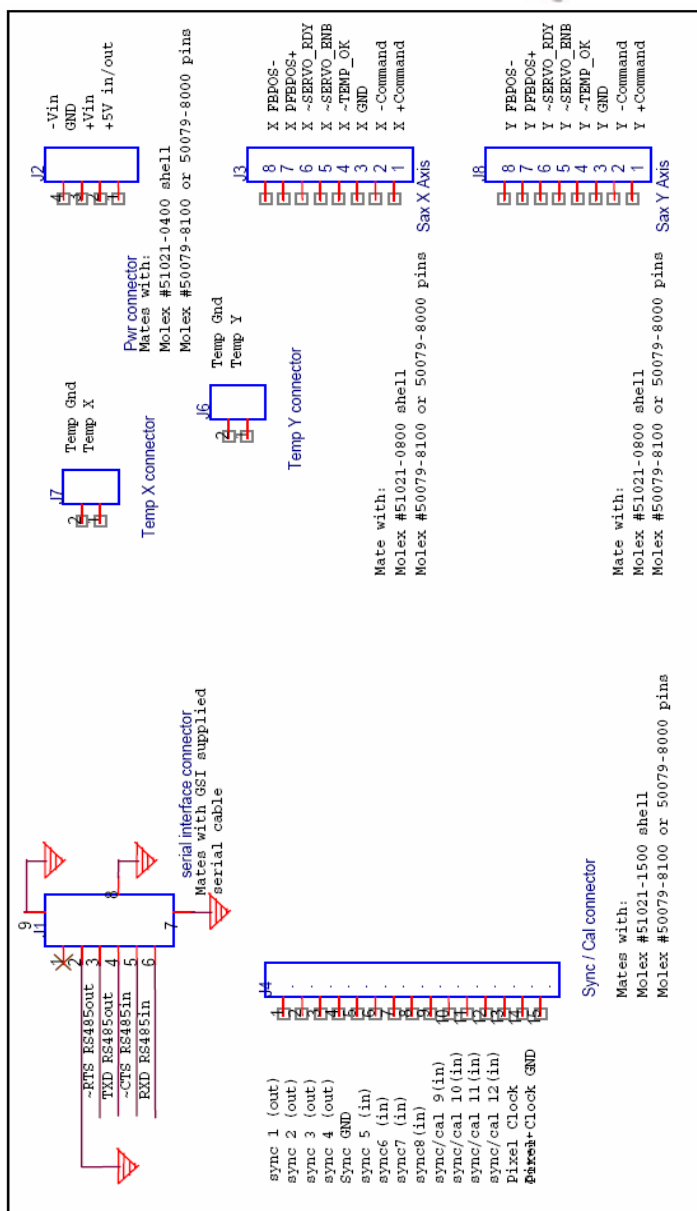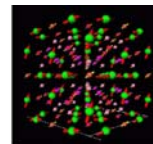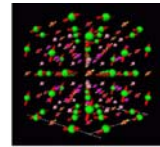
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Figure 1 Pinout of Scan Controller

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4.5 About Laser

Class 2:

Low risk to eyes. No risk to skin

Class 2 laser products are defined as those emitting visible light for which the natural aversion response to bright light (including the blink reflex) prevents retinal injury, including direct viewing of the laser beam with optics that could concentrate the laser output into the eye. These lasers do, however, present a dazzle hazard.
Lasers that were Class 2 under the previous version of 60825-1 remain Class 2 under the new scheme*

Warning label: DO NOT STARE INTO BEAM

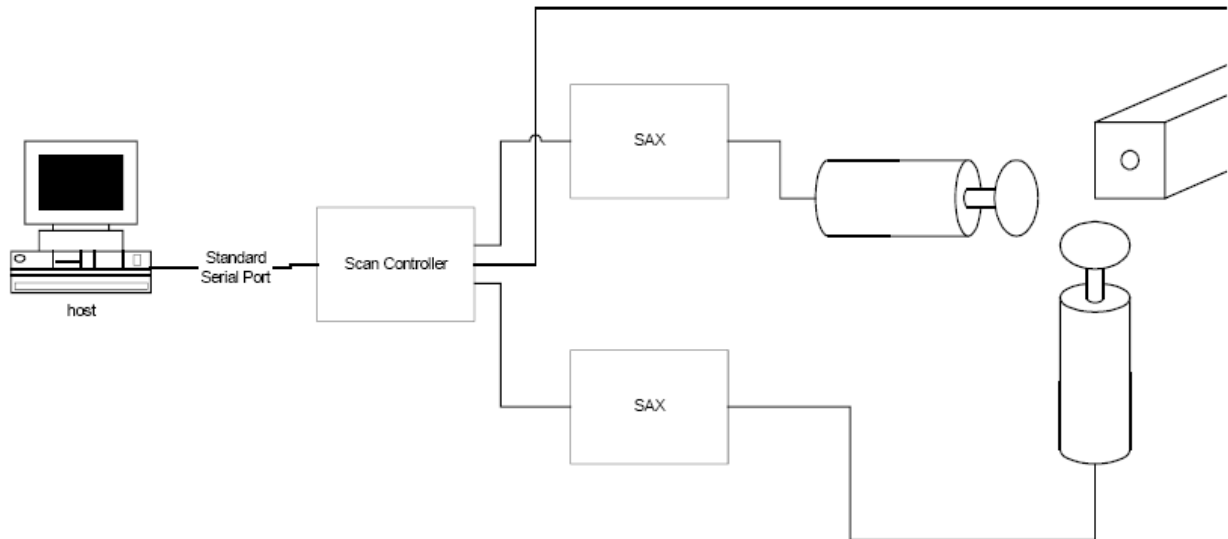Only use Class 2 for safety during the experiments in room.

Class 3B

Medium risk to eyes. Low risk to skin

Class 3B laser products are defined as those for which direct exposure of the eye is hazardous, even taking aversion responses into account, but scattered laser light is usually safe. The higher power Class 3B lasers are also a skin hazard, but the natural aversion response to localised heating generally prevents a skin burn. Lasers that were Class 3B under the previous version of 60825-1 but which operate at a wavelength in the range 0.3025 to 4 µm and have output beams that are either high divergence or large diameter may qualify.

Warning label: AVOID EXPOSURE TO THE BEAM

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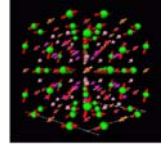
4.6 Hooking up the system

Step 1 Before you begin:

• Be sure power supply is turned off

• Be sure make all connections firmly. Loose connections may cause communications and/or performance problems

• Be sure wearing a properly grounded wrist strap or heel strap. Components on the SC2000 Controller board are highly sensitive to electrostatic discharge.
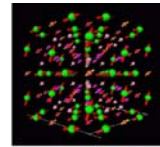
Step 2 Connecting the Power Supply:

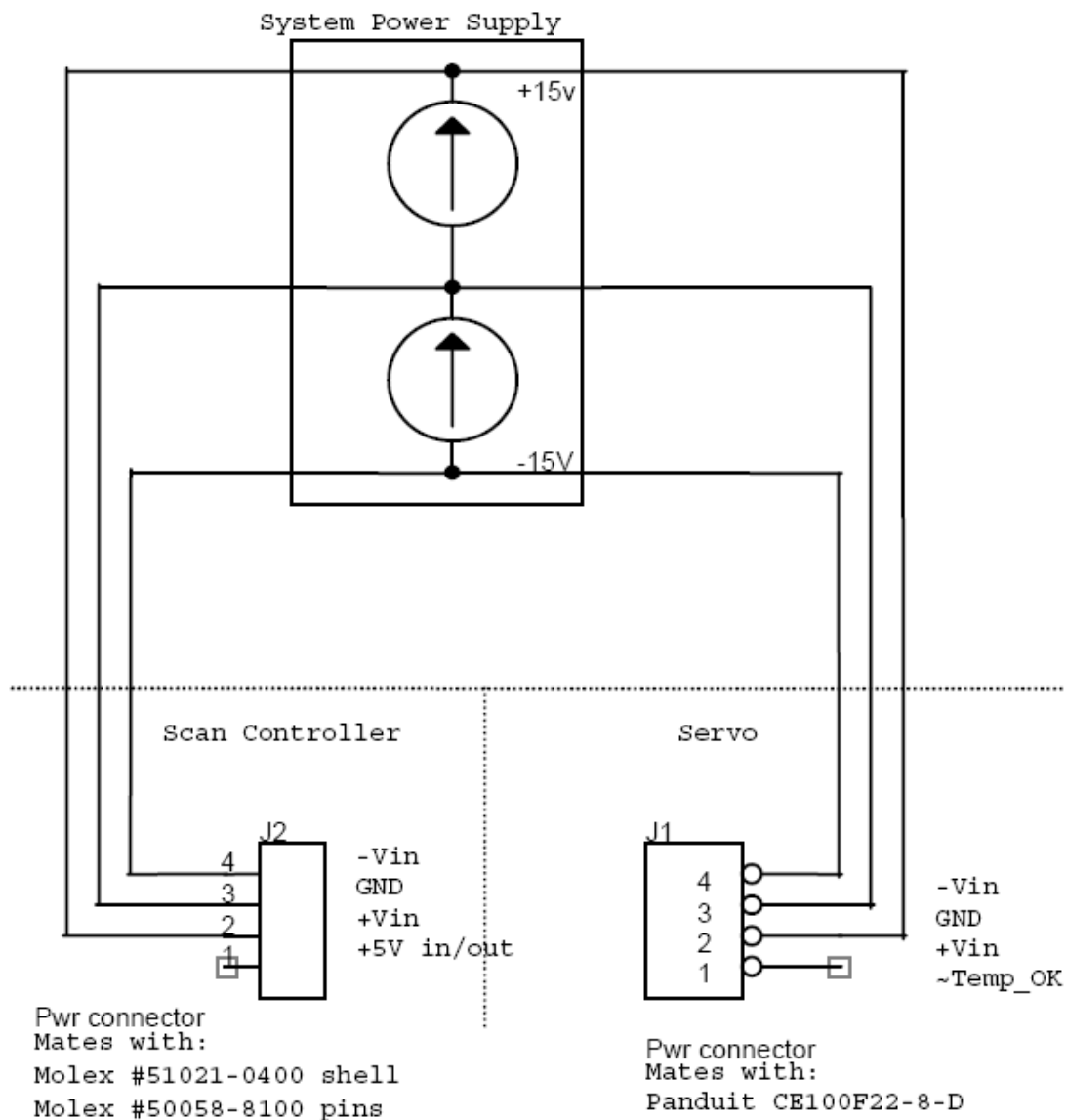• Using the provided power cable, connect the stripped leads to the power supply terminals as labeled:

+15V to the positive supply terminal

COM to the common terminal
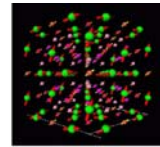
-15V to the negative supply terminal

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• Plug the power cable's Molex connector into the pwr connector, J2, on the SC2000 controller board.

Step 3 Connecting the servo Interface Cables:

For the MiniSAX servo amplifier:

• Using a Startup SAX Interface Cable (part numbered 712-74217), connect the X axis interface (J3) on the SC2000 to the X axis MiniSAX command interface (J2 on the SAX board).

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• Use the remaining Startup Interface Cable to connect the Y Axis interface (J8) on the SC2000 to the Y axis MiniSAX command interface (J2 on the SAX Board).

• Connect the X axis controller command interface, J3 on the SC2000, to the X axis servo command interface (J3 on the underside of the Digital Servo).

• Use the remaining command cable to connect the Y axis command interface, J8 on the SC2000 to the Y axis servo command interface (J4 on the underside of the of the Digital Servo).

Step 4 Connecting the Host Computer:

• Connect the provided Computer Interface Cable (part number 712-74214) to an available serial port on your host computer. Remember which serial port you use since you will need to know which port to address when communicating with the controller board.

• Connect the other end of the cable to the Serial Interface connector (J1) on the controller board.

Step 5 Sync/Cal Connections (Optional):

The Sync/Cal connector provides access to the synchronization/calibration I/O as well as the pixel clock output of the Scan Controller. Figure 3 shows a system using one of the (open drain) sync outputs and the auxiliary +5V output to power and control a diode laser module.
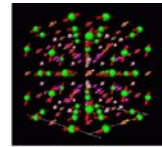
For further information on the Sync/Cal and pixel clock features of the scan controller, read the GSI Lumonics Scan Controller Users Manual.

For controlling a low power laser diode module:

• Connect laser diode (+) output to +5V output (J2, pin 1) of the Scan Controller

• Connect laser diode (-) output to sync gnd (J4, pin 5) on the Scan Controller

• Connect laser diode modulation control output to sync 1 (J4, pin 1) on the Scan Controller.

Note: User must supply a 4.7k pull up resistor between the +5V and Sync 1

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There are other ways to interface to a laser. For instance connect the + lead to +5V and the − lead to the sync pin. This would be good enough for users who don't need high performance switching.

Warning: Check the manufacturer's voltage and current specifications before hooking up a laser diode or any other peripheral. The open drain outputs on the Scan Controller (sync 1–4) are specified to sink up to 100mA continuous, and withstand peaks up to 40 V. These output must be clamped if inductive loads are to be driven (i.e. a small relay). Otherwise, the voltage transient generated at turn-off can destroy the sync output transistors.
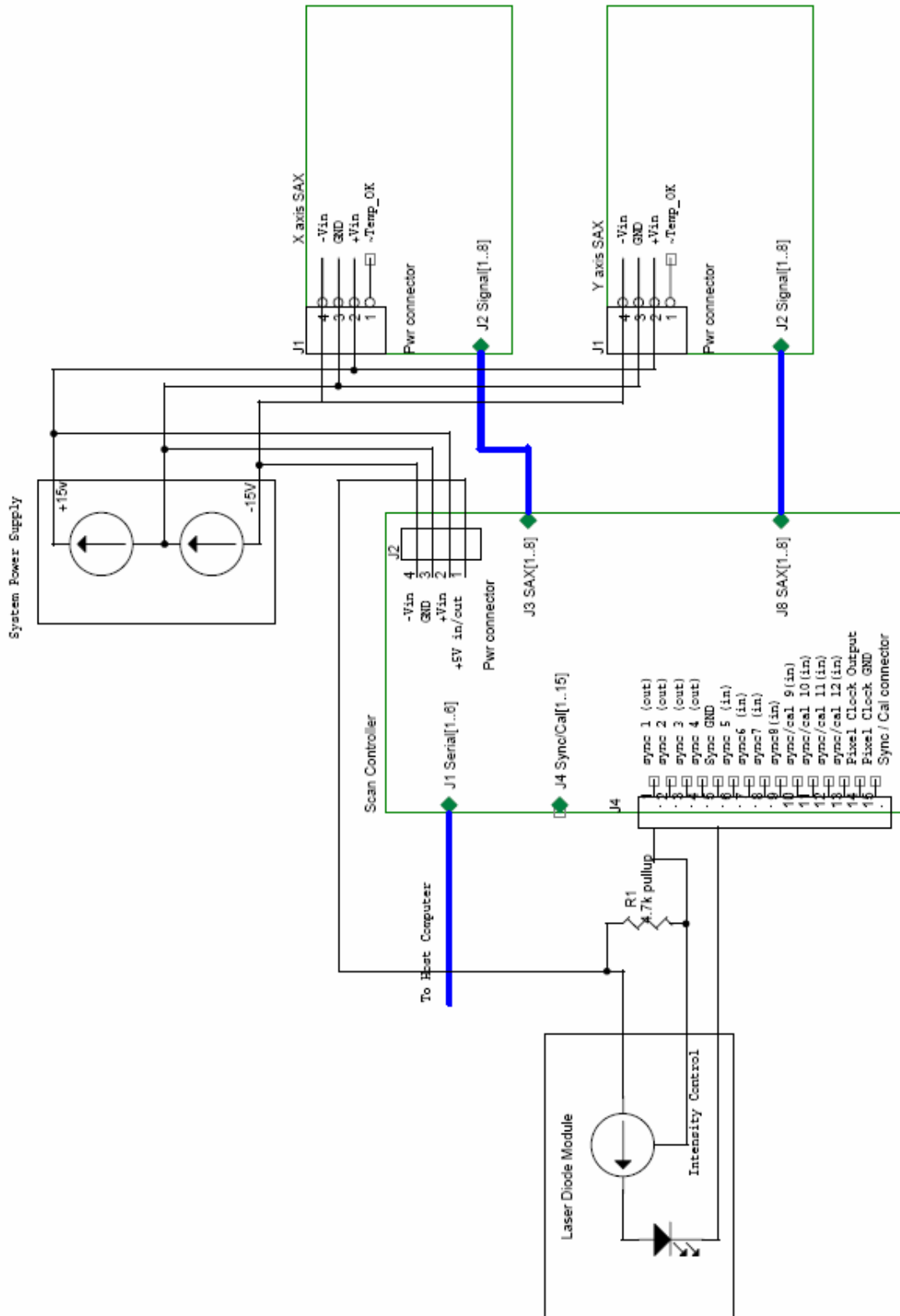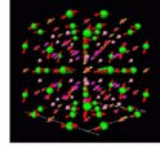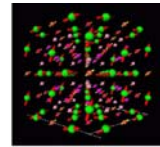
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Figure 3 Two axis MiniSAX system with laser diode control

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Step 6 Software Installation:

The GSI Lumonics Command Line Interface software discussed in the manual can be found on the provided CD-ROM. Read the ReadMe.txt file for the latest information and changes.

• To install the software run '<CDROM> :\install\disc 1\setup.exe'. The setup program will create a default installation directory (typically C:\GSI), install the application and support files and peripheral tools, create a program group and add an item in the Windows start menu.
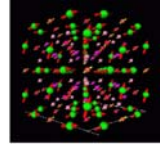
Step 7 Final Setup:

• If using a Servo/Galvo pair, connect galvo to driver board.

• Double check all connections to make sure they are correct and secure

Chapter 5 GSI Lumonics SC2000 support Program

5.1 Introduction of GSI Group

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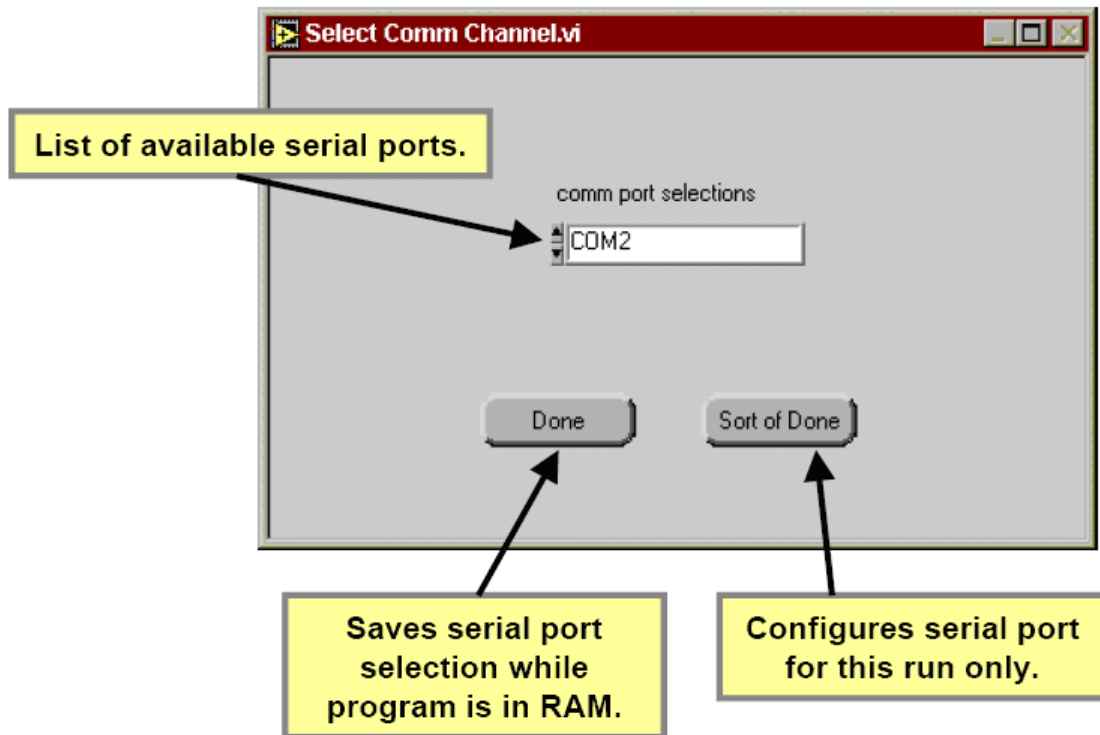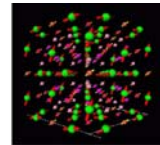*in der Helmholtz-Gemeinschaft*

With corporate offices in Billerica, MA, GSI Group develops and delivers the enabling technology solutions that bring customers' advanced manufacturing applications to life.

Their leading brands include precision motion products, lasers, and laser systems, and are used to boost efficiency and productivity in the global medical, semiconductor, electronics, and industrial markets.
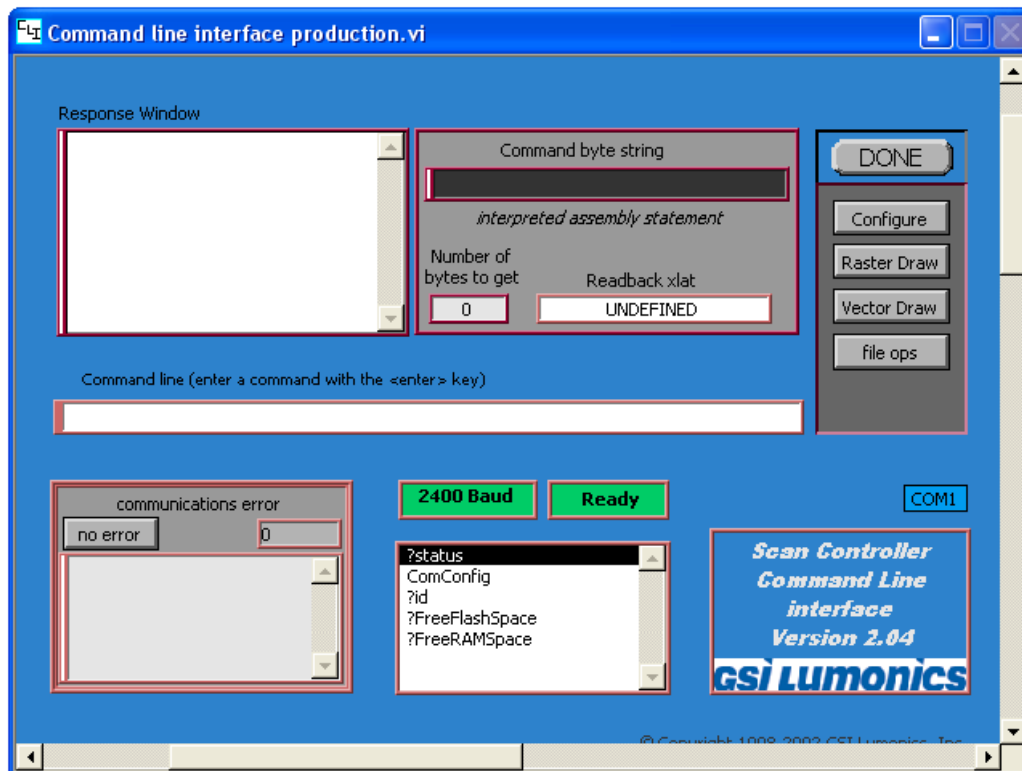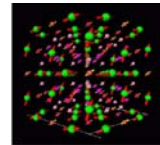
5.2 Introduction of the Support Program

The Command Line Interface software allows users to communicate with the Scan Controller quickly and easily. It is intended primarily as an environment for designing and programming stand-alone applications, and for system evaluation. Using Command Line Interface software during system evaluation provides a user-friendly learning environment in which functional capabilities of the Scan Controller can be understood and applied. Once the functionality and limitations of the Scan Controller are understood, designing host-based, real-time system programs becomes much easier. While pieces of the provided code can be utilized in host-based, real-time systems, that is not its primary intent.

When you start to run the CLI.exe ,it will automatically raise the Serial Port selector sub-window asking you to set the serial port device for Scan Controller communication. Choose one COM that was used and press 'Done' to enter your serial port.
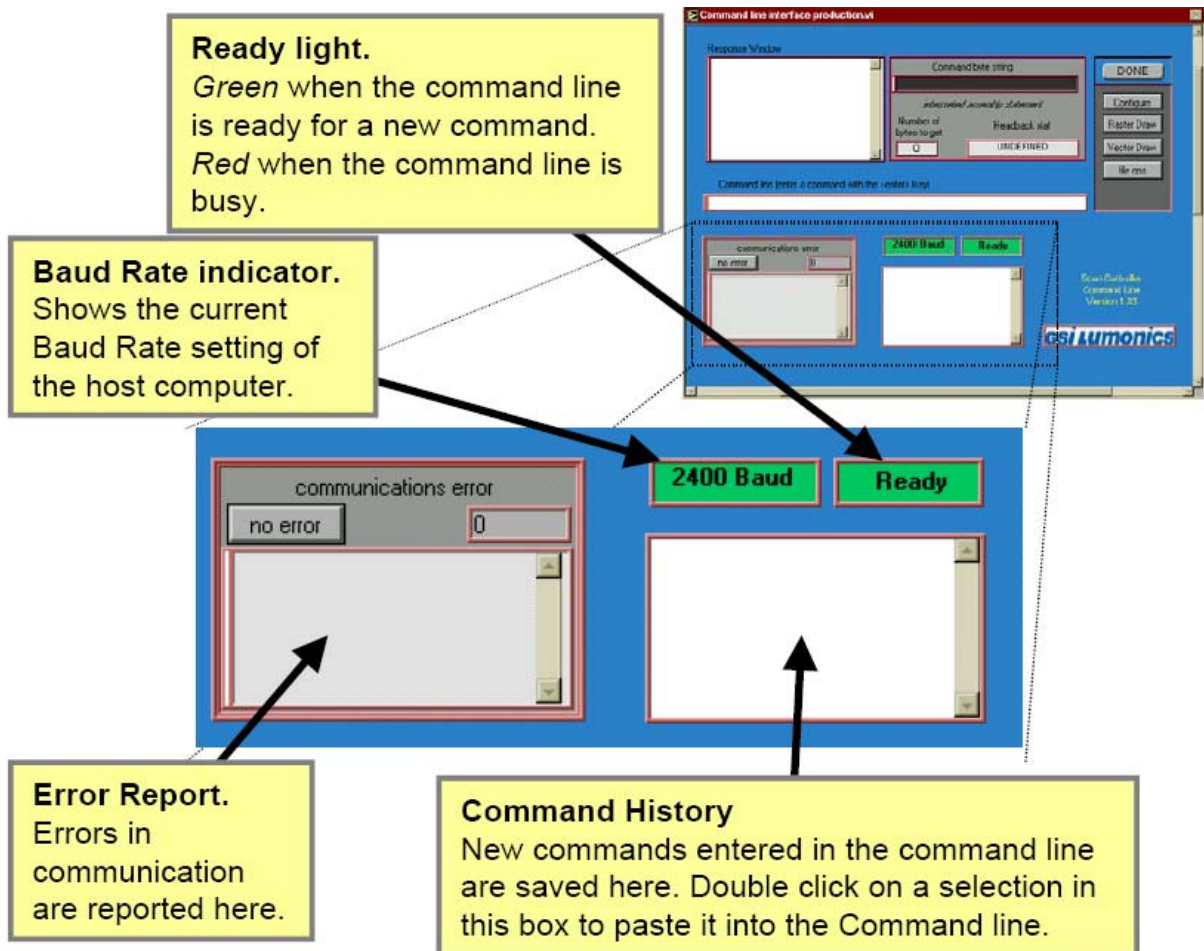
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Select Comm Channel.vi

List of available serial ports.

comm port selections

COM2

Done

Sort of Done

Saves serial port selection while program is in RAM.

Configures serial port for this run only.

Serial Port Declaration

Command line interface production.vi

Response Window

Command byte string

interpreted assembly statement

Number of bytes to get

Readback xlat

UNDEFINED

0

DONE

Configure

Raster Draw

Vector Draw

file ops

Command line (enter a command with the <enter> key)

communications error

no error

0

2400 Baud

Ready

COM1

?status
ComConfig
?id
?FreeFlashSpace
?FreeRAMSpace

Scan Controller Command Line interface Version 2.04

GSI Lumonics

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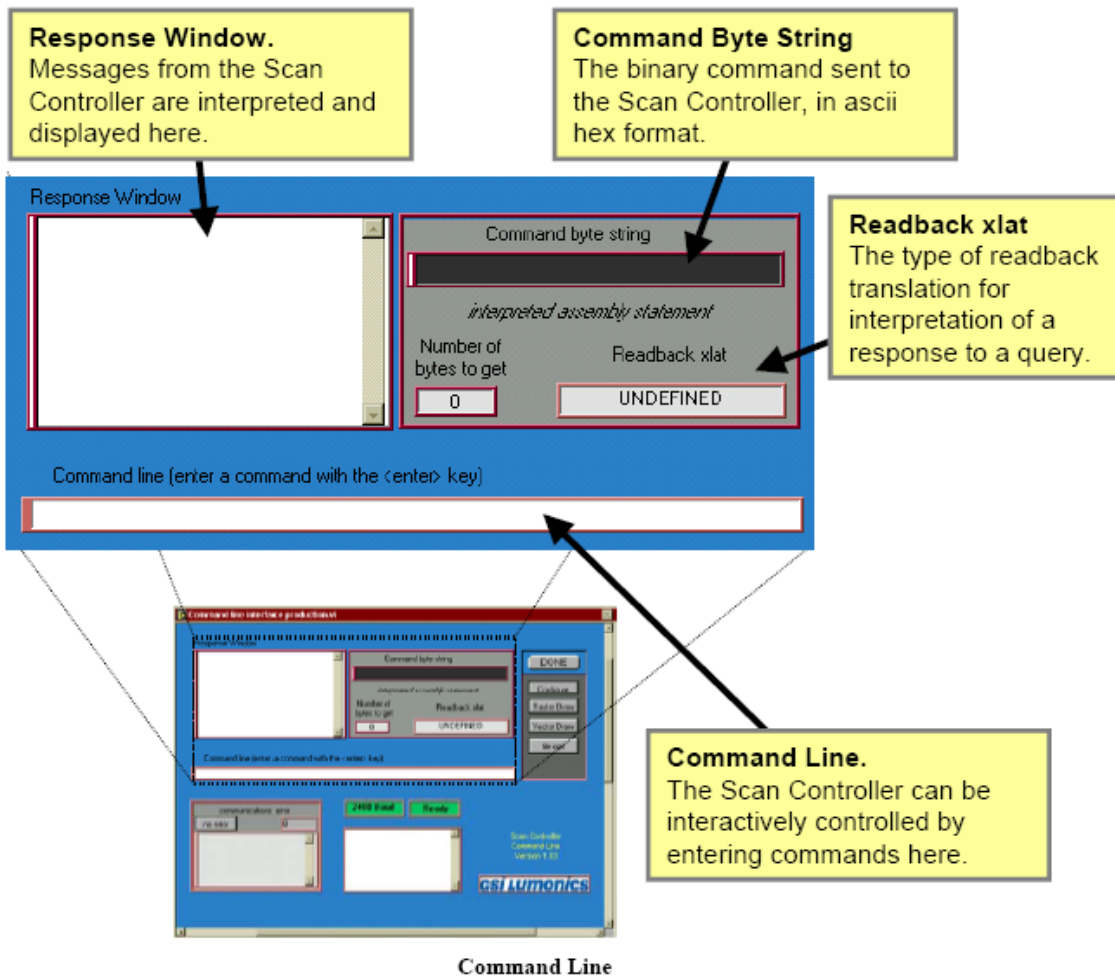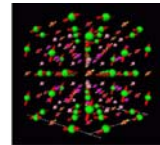
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in der Helmholtz-Gemeinschaft

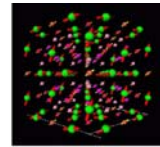## Here is the main Functions of the Command Line Interface Main Window:

Ready light.
Green when the command line is ready for a new command.
Red when the command line is busy.

Baud Rate indicator.
Shows the current Baud Rate setting of the host computer.

Error Report.
Errors in communication are reported here.

Command History
New commands entered in the command line are saved here. Double click on a selection in this box to paste it into the Command line.

Status Displays

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Response Window.
Messages from the Scan Controller are interpreted and displayed here.

Command Byte String
The binary command sent to the Scan Controller, in ascii hex format.

Readback xlat
The type of readback translation for interpretation of a response to a query.

Response Window

Command byte string

interpreted assembly statement

Number of bytes to get

Readback xlat

0

UNDEFINED

Command line (enter a command with the <enter> key)

Command Line.
The Scan Controller can be interactively controlled by entering commands here.

Command Line

Done button
Terminates the program.

Configure button
Raises the Configure sub-menu.

DONE

Configure

Raster Draw

Vector Draw

file ops

Raster Draw button
Raises the Raster Drawing op sub-menu.

Vector Draw button
Raises the Vector Drawing op sub-menu.

File ops button
Raises the file operation sub-menu.

Button Pad

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5.3 Command Reference

The Command Line Interface (CLI) and the Motion Assembler Component (MAC) incorporate assemblers that translate English language program commands into the binary language of the SC2000. Each command in defined in the assembly language context and then in the binary context, but note that the SC2000 will only accept commands uploaded in the binary format.

In order to exert the program efficiently we need to familiar with the Commands of the program especially these in boldfaced that will be used in the project.

?FreeFlashSpace : Returns byte count of available flash memory.

?FreeRAMSpace : Returns byte count of available SRAM.

?ID : Return system revision information.

?OpticalCal

?Position : Return the current position on the given axis.

?Status : Returns error information and clears error state.

?Sync

?Temp

?TempOK

AbortPgm : Halts the currently running program and disables servos.

ComConfig : Configure RS-232 serial port parameters for communication.

CreateFlashPgm : The action of Create Flash Program is to initiate the storage mechanism in the Scan Controller so that a program may be saved to non-volatile memory on-board the Scan Controller.

CreatePgm : Store a Scan Controller program in volatile memory on-board the Scan Controller.

DelayedLaserGate

DelayedSetFPS

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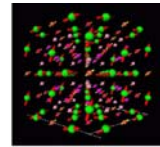
DelayedSetOutputSignal

DelayedSetSync

DelayedUnSetSync

DeltaPosition : Set the position of the current axis relative to the currentposition.

DeltaPositionXY : Set the vector position relative to the current position.

DeltaSlew : Move smoothly on the current axis relative to the currentposition.

DeltaSlewXY : Move smoothly relative to the current vectorposition.

DeltaTweakAxis : Apply gain and offset deltas to subsequent raster operations.

DeltaTweakAxisXY : Apply gain and offset deltas to subsequent vector operations.

Disable

Enable

End : Marks the end of a Scan Controller program.

ExecutePgm : Commence the execution of the named program.

ExecuteRasterPgm

ExecBinPgm

ExecSerialNumber

ExitPgm : Use ExitPgm to terminate programs by having them fall through repeat and waitsync [1-4] statements.

FlipExchangeAxis : Use FlipExchangeAxis to reverse the sense of one or both axis and to interchange the command stream between X and Y.

Ifexecutepgm

Ifexecuterasterpgm

Iftempoexecutepgm

Iftempoexecuterasterpgm

LaserGate

LaserModeSetup

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Nrepeat

PackMemory

Position : Set the absolute position of the current axis.

PositionXY : Set the absolute vector position.

Raster : Declare the target axis for subsequent single axis (raster) commands and place the Scan Controller in raster mode.

ReleasePgm

Repeat : The Repeat command will cause the Scan Controller program flow to return to the first instruction in the program where execution is repeated.

SaveConfigInFlash

SerialNumberSetup

SetAnalogOutput

SetConfigVar

SetFPS

SetGSS

SetLaserPower

SetMOFGains

SetMOFMode

SetMOFShift

SetOutputSignal

SetPWM

SetSetSyncDelay

SetSync

SetTicklePulses

SetUnsetSyncDelay

SetXPRGain

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SetXPROffset

SetYPRGain

SetYPROffset

Slew : Move smoothly to the given absolute position on the current axis in the specified number of tick counts.

SlewXY : Move smoothly to the given absolute vector position in the specified number of tick counts.

TransformAxis : Apply rotation or skew transformation to vector motion commands.

TweakAxis : Apply gain and offset to subsequent axis operations.

TweakAxisXY : Apply gain and offset to subsequent vector operations.

UnSetSync

Vector : Place the Scan Controller in vector mode.

Wait : Pause execution for the given number of tick counts.

WaitMOFDistance

WaitPosition : Pause Scan Controller program execution until the commanded position for the current axis is reached.

WaitPositionXY : Pause Scan Controller program execution until the commanded position is reached.

WaitSync

Explanation of Operational Modes

Overview: There are various modes of operation that overlap or are mutually exclusive depending upon those compared.

Raster Mode: A fundamental operating mode for either programs or immediate instructions in which all motion commands are directed to a specified axis.

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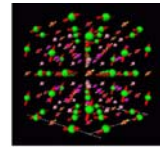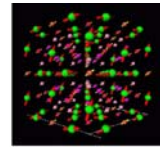
Vector Mode: A fundamental operating mode for either programs or immediate instructions where motion commands are simultaneously directed to both the X and Y axis.

Program Instruction Mode: When a program is running the operational context of the instructions of the program will be Program Instruction Mode. In contrast, query commands and the system configuration commands cannot be executed from a program, i.e. they are not valid in Program Instruction Mode.

Immediate Instruction mode: This is the idle mode of the Scan Controller, when a program is not running. Typically, every command can be executed from this mode except those that deal exclusively with the operation of programs, i.e. Repeat, Nrepeat, End, and ExecuteSerialNumber.

Dual Single Axis: This mode is only available when the ExecuteRasterPgm command is executed. This mode is characterized by two raster programs running concurrently, one on each axis.

Concurrent Instruction mode: This mode comes about when a program is running and you try to enter a command over the communications interface. Typically, commands valid for this mode are the query commands, AbortPgm and ExitPGM.

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5.4 Operation for Scan controller

1. Use the command '?status' to make sure there is no errors with the system. 'Success' shows in the Response window.
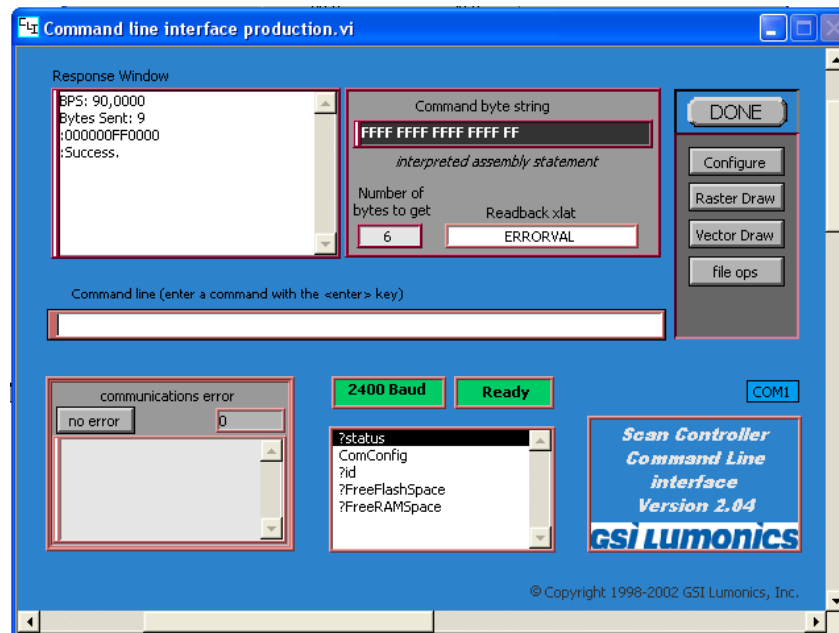
2. Fix the laser beam in a proper location, check the position and the direction of the scanning point?

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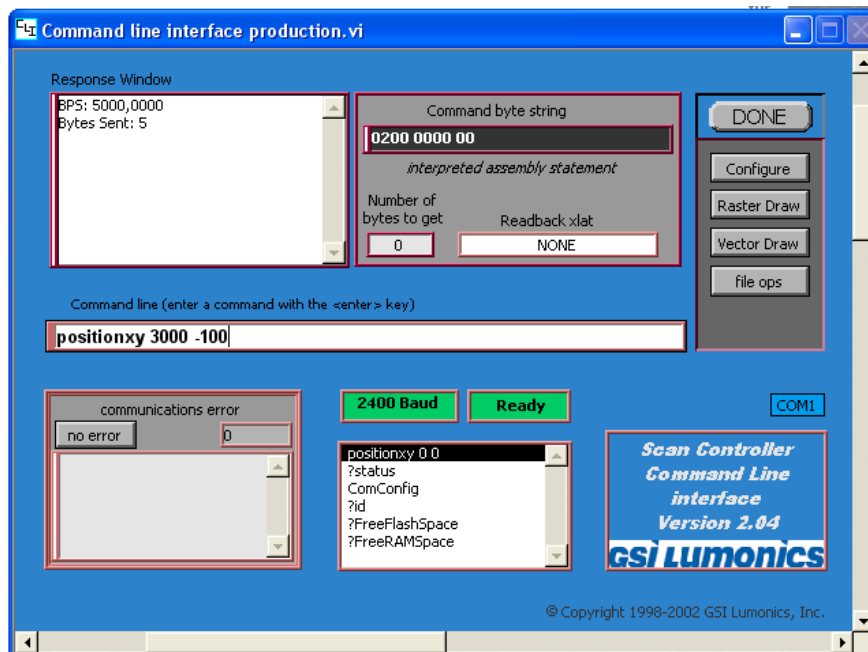
3. To correct the position and the direction of the moving point, we need to know how many degrees should be turned and how many steps should be changed to the 0 point. Then use the 'rotate calculator' to get the commands. After these commands entered into the command line the coordinate of the laser been will just changed to fit the image plate.

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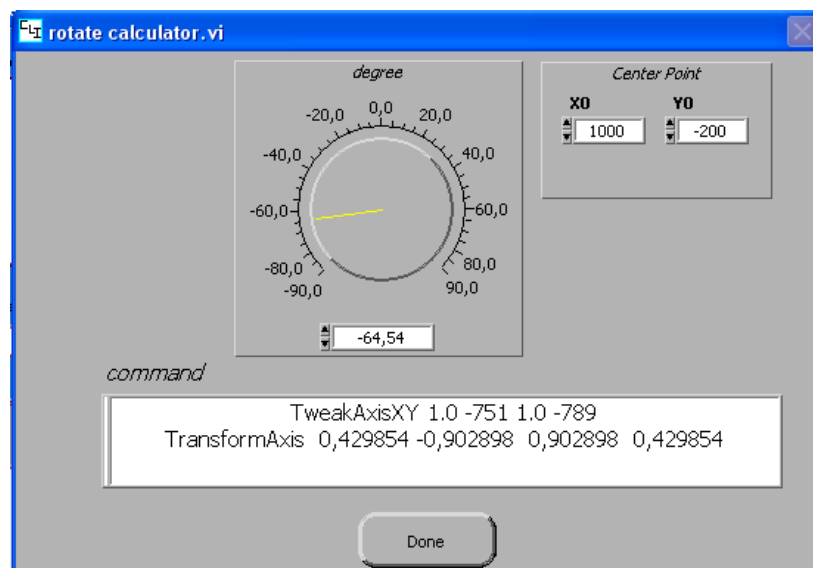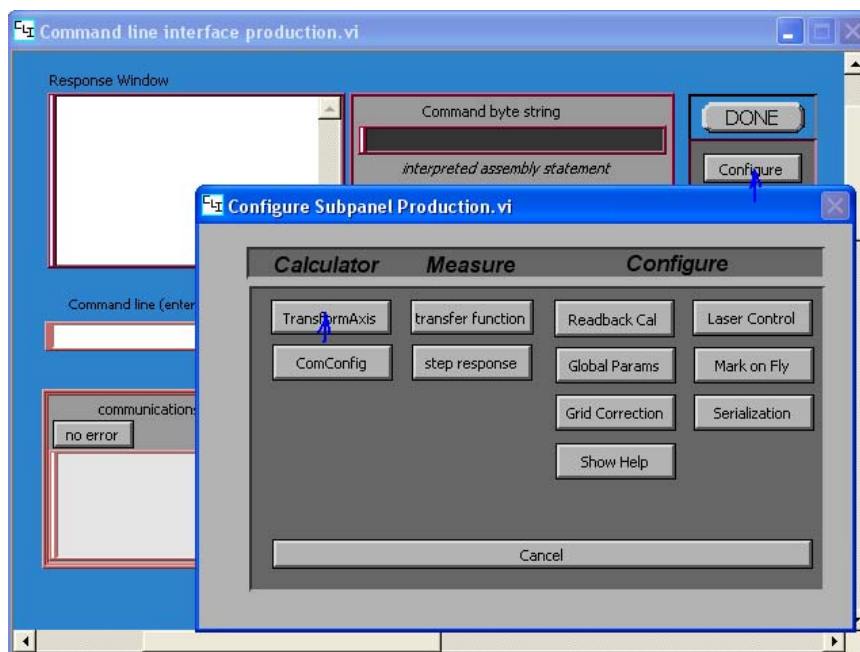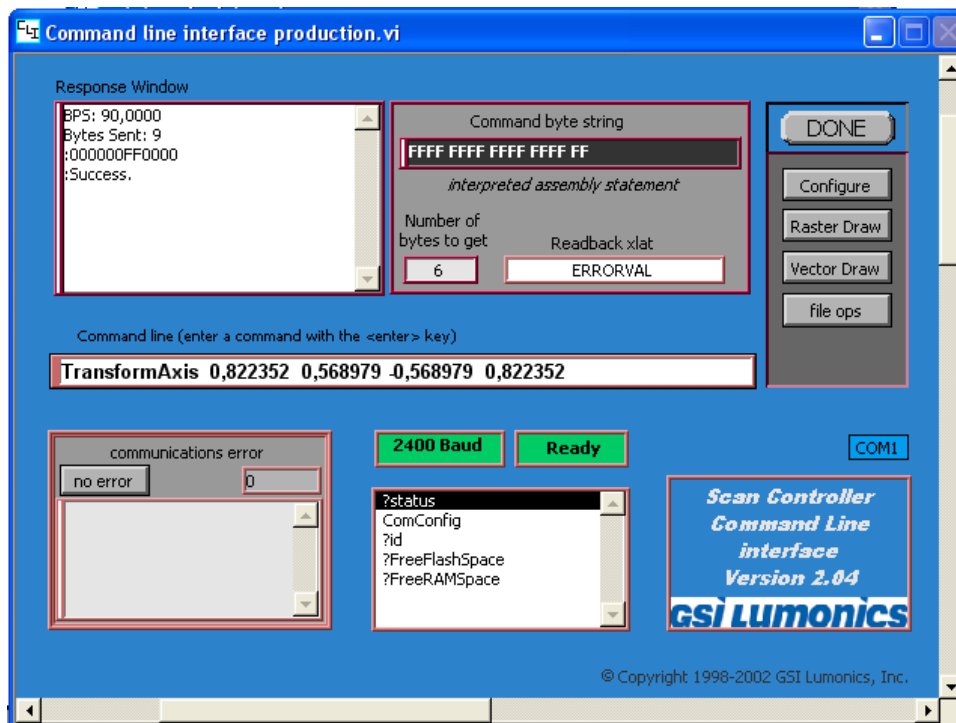
The project is to scan a max. 500mm×500mm large area neutron image plate every 1mm grid with the laser beam. But for experiment we use 10cm×10cm large area instead first.
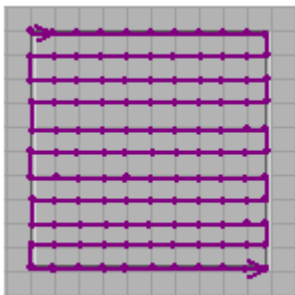
• Using a text editor, enter the text program.(example)

```
CreatePGM 1 'a'
Setsync 1
wait 100

slewxy 500 0 1
wait 100
slewxy 1000 0 1
wait 100
```

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……
wait 100
slewxy 4500 0 1
……
slewxy 4000 -5000 1
wait 100
slewxy 4500 -5000 1
wait 100
slewxy 5000 -5000 1
wait 100

positionxy 0 0
wait 100

repeat
end

• Save program as a .txt file in the desired directory. Running the Vector Mode Program

• Click on the [File Ops] button in the Main Program Window of the Command Line Interface.

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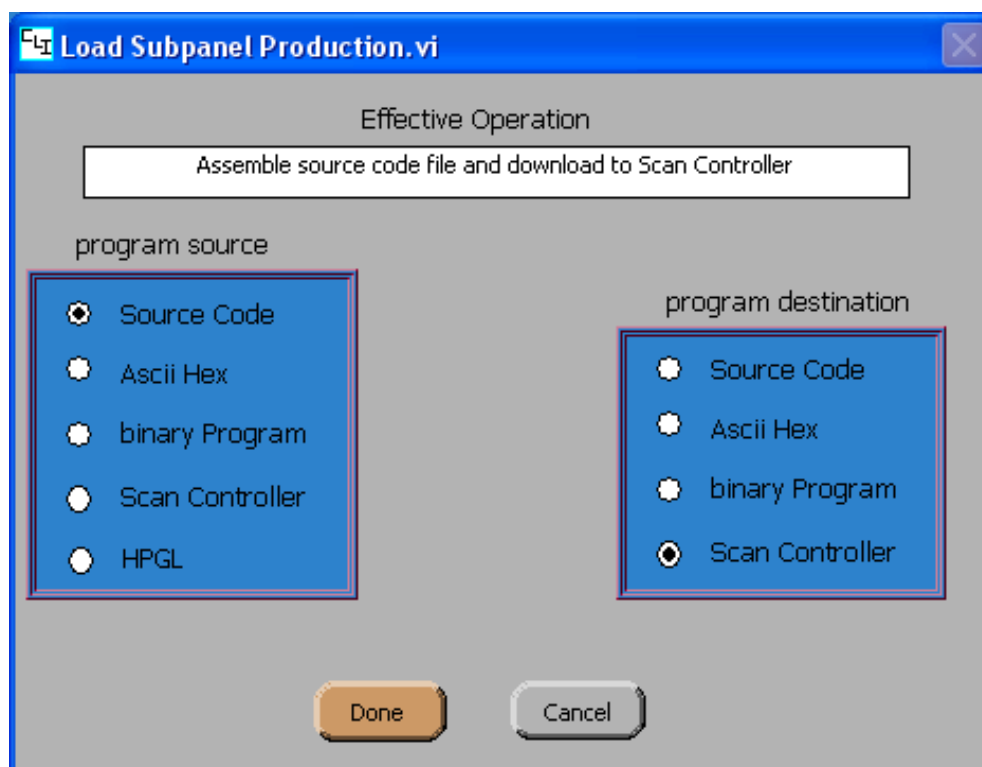
• In the Load Subpanel, select 'Source Code' as the Program Source and 'Scan Controller' as the Program Destination. Press Done.
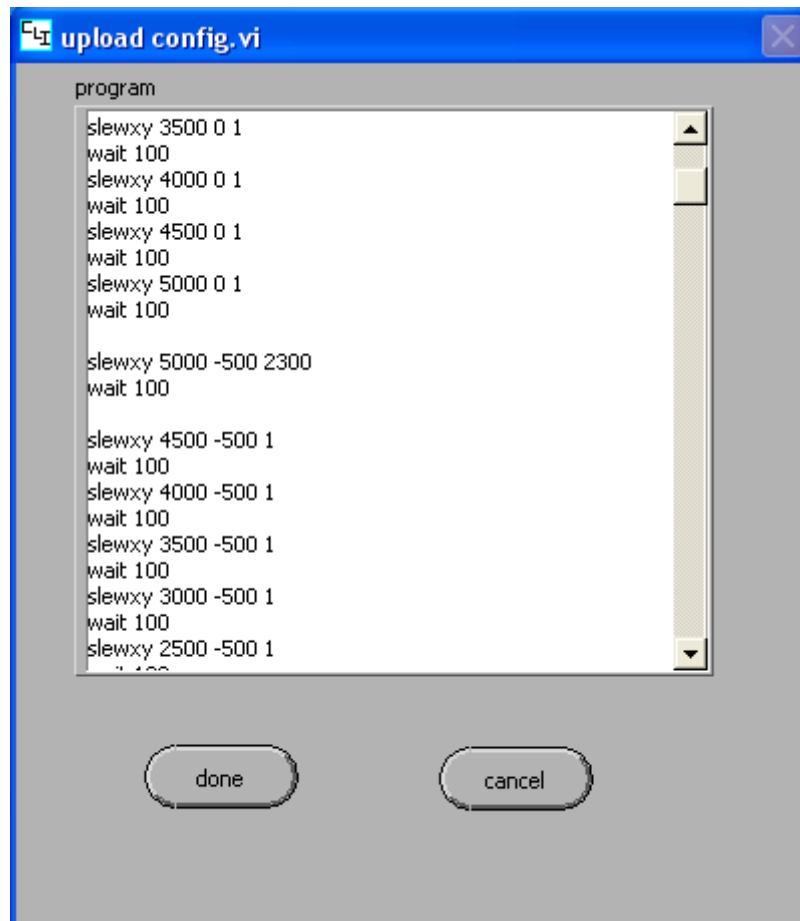
• In the File Dialog box, select the saved .txt program. Press 'OK'. This brings up the Upload Configuration Sub-window shown below. This window provides a type of stream editor where it is possible to change commands, add or remove lines or change the name of a program without changing the original source file.

• To Assemble and Upload the program click (Done). The program is then automatically assembled and uploaded into the Scan Controller. If the assembler detects an improperly formatted command in the program, assembly is halted and an error message is returned to the Main Program Window. If this occurs, correct the error in the text file and then reload the program. While the program is being assembled and uploaded, the Command Line 'Ready' indicator switches from green to red and indicates that the command line is Busy. Assembly and Uploading information is provided in the Response Window.

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• Once the upload is complete, and the Command Line 'Ready' Indicator turns green, execute the program. In the Command Line Window, enter:

Executepgm 'a'

The Scan Controller will then begin running the uploaded program and sending commands to the servo drivers.

<u>If nothing happens after entering the Executepgm command:</u>

• Check Scan Controller servo Interface connections.

• Be sure power is applied to servo boards and that galvos are properly connected.

• Execute a ?Status Query to check for possible communications failure.

• Make sure that 'a' was typed in quotes

<u>To Stop Program:</u>

ExitPgm acts as a soft stop and will run through the remainder of the program before stopping.

AbortPgm terminates the program immediately.

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5.5 Application

Command Line Interface also has many other functions. Such as scan a circle track, or even Letters in different fonts. And the Optical Scanners move quite fast that It seems to be coherent lines.

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Chapter 6 Use the SubVIs to build own Labview program
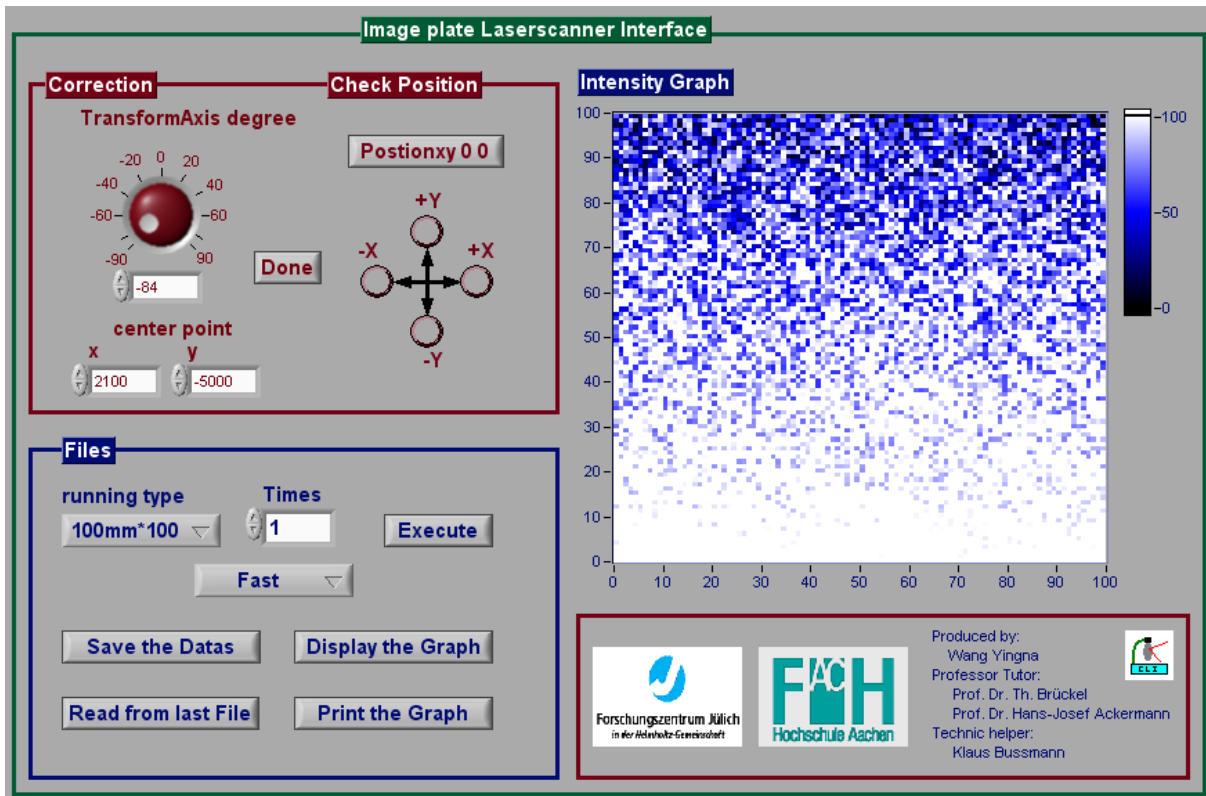
6.1 Control the movement of Laser
6.1.1 SubVIs from GSI Lumonics SC2000 Driver

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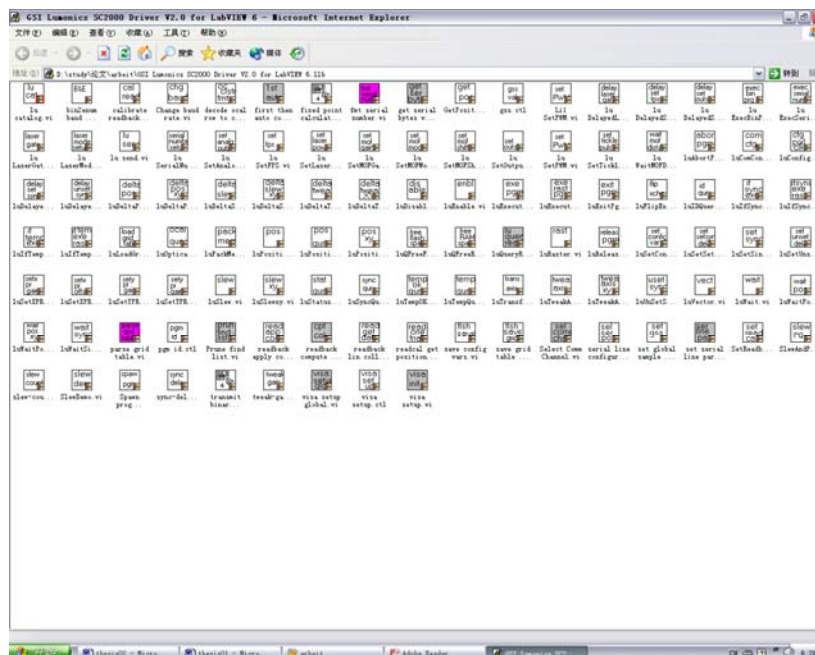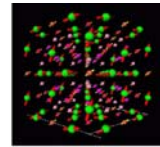
There is one catalog vi for the various SC2000 driver vis.
Browse the block diagram to find the vis most relevant to application.

The driver vis share some common characteristics including utilization of serial
VISA connections for communications with the Scan Controller. The vis are
written with the VISA reference number stored in a global variable.

Additionally, the input controls of some vis have their ranges adjusted to and
appropriate range of input values, with out-of-range behaviour set to 'suspend'.

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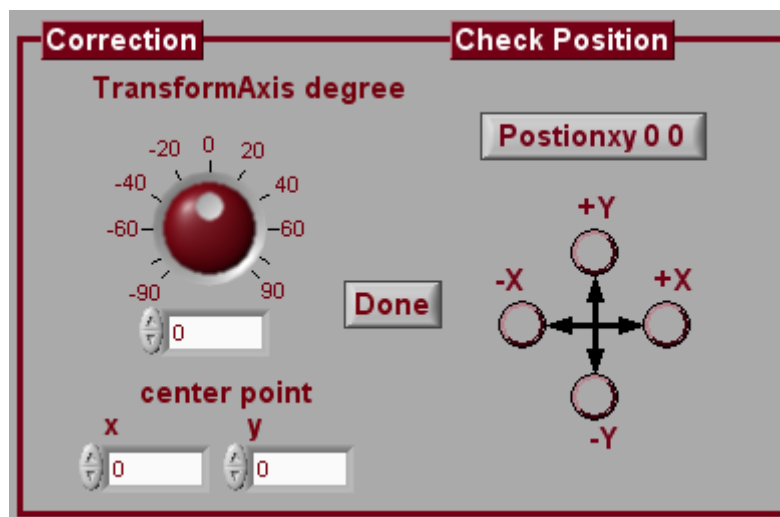*in der Helmholtz-Gemeinschaft*
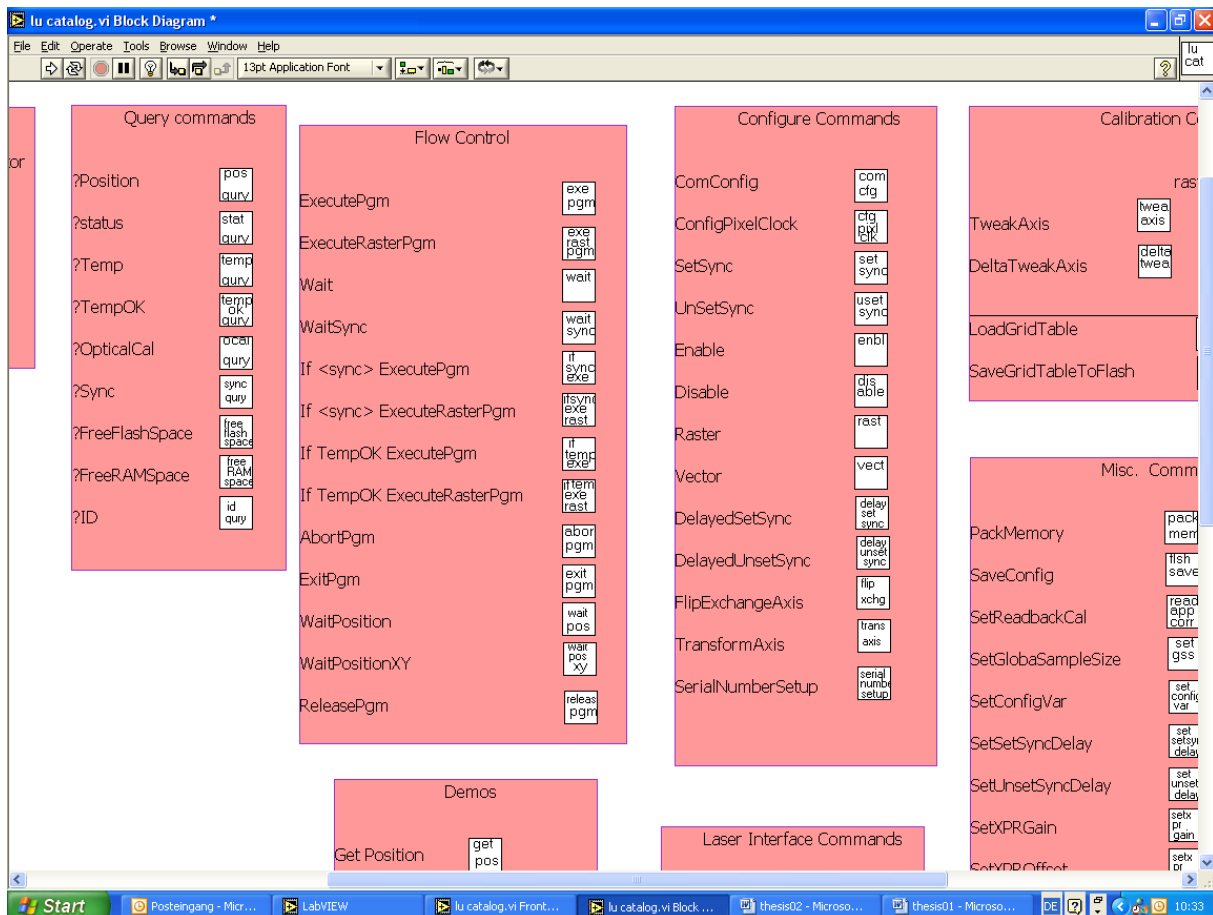
6.1.2 ComConfig set

Configure the baud rate, parity and stop bits settings of the RS-232 connection between the host computer and the Scan controller. Changes will be reflected both the Scan Controller and the host computer.

The default baud rate setting for RS-232 communication between the Scan Controller and the Host computer is 2400. RS-232 supports baud rates up to 115200. If the Command Line program is shut down, it will restart in its default setting of 2400 Baud. Likewise, if the Scan Controller is power cycled, it will power up at its default baud rate of 2400. If you choose to use a higher baud rate, you must reconfigure the system each time the program is restarted or the Scan Controller is power cycled. Failing to do so will result in a communications error.
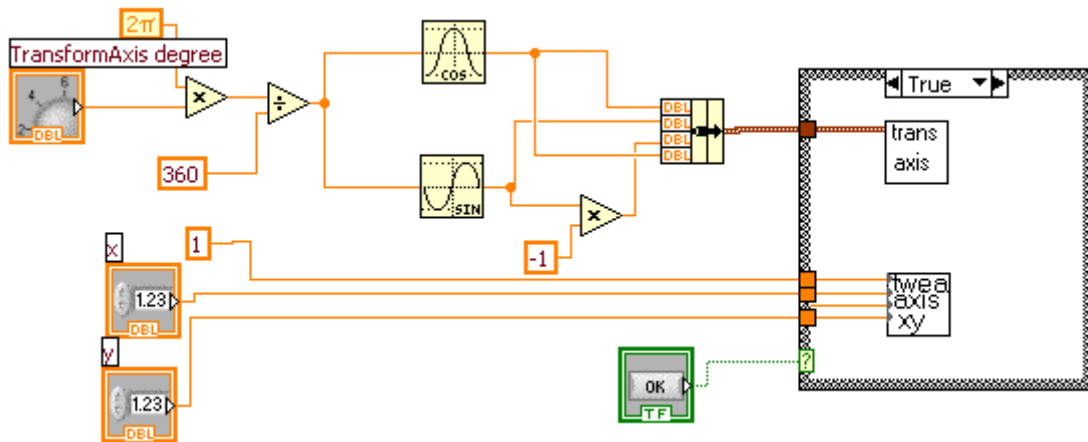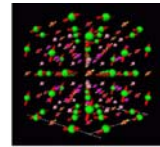
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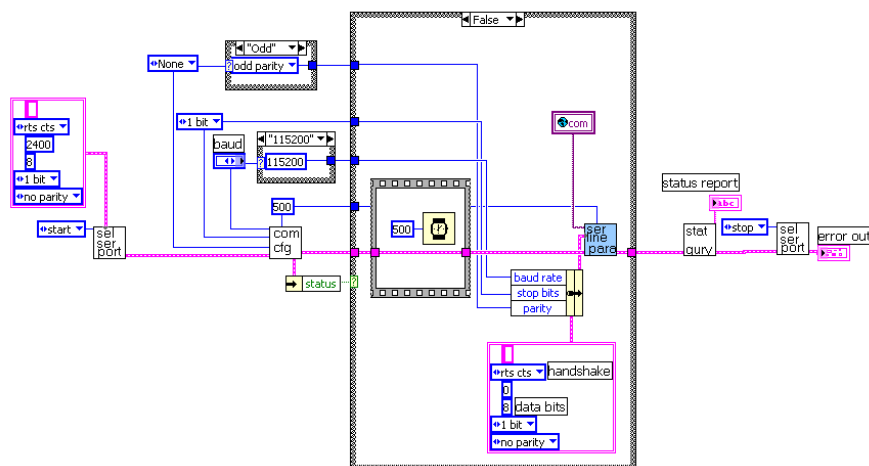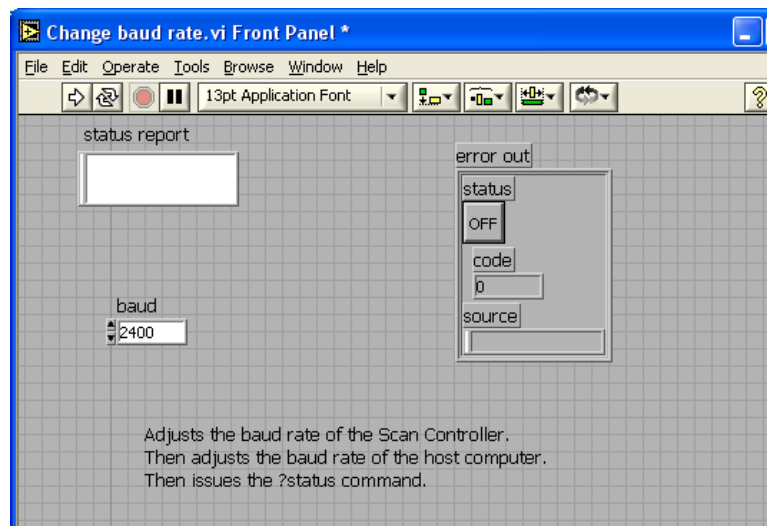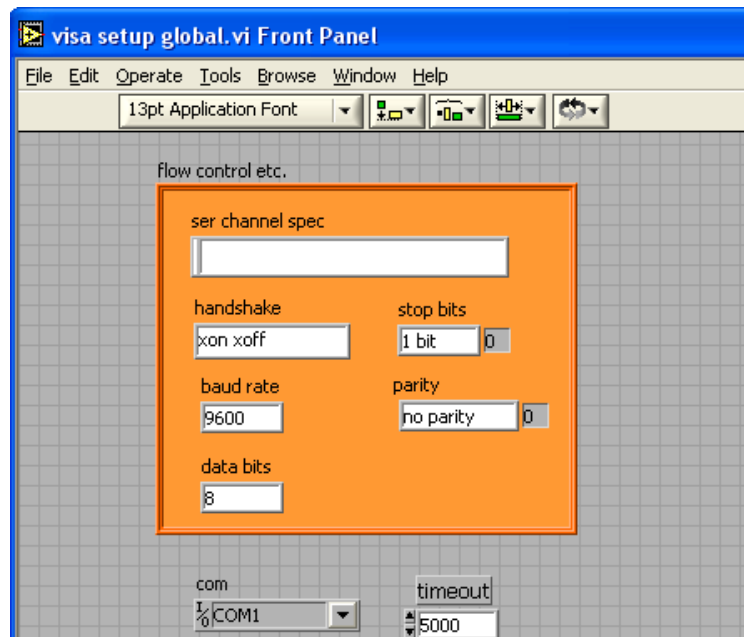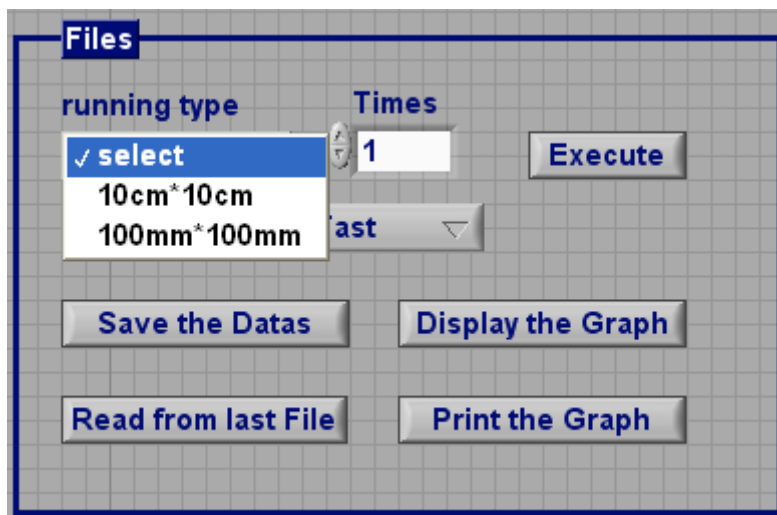
6.1.3 Correction the Laser Position

The two commands TransformAxis and TweakAxis which used to correct the Laser position can be written into the G language. And then work out with the two SubVIs.

TransformAxis a b c d
a=cos(α)   b=sin(α)   c=-sin(α)   d=cos(α)

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6.1.4 100mm×100mm Image plate scan

Instead of text program writing as in the Command line Interface, Labview can also write these graphically with the SubVIs (deltapositionxy.vi, wait.vi……)
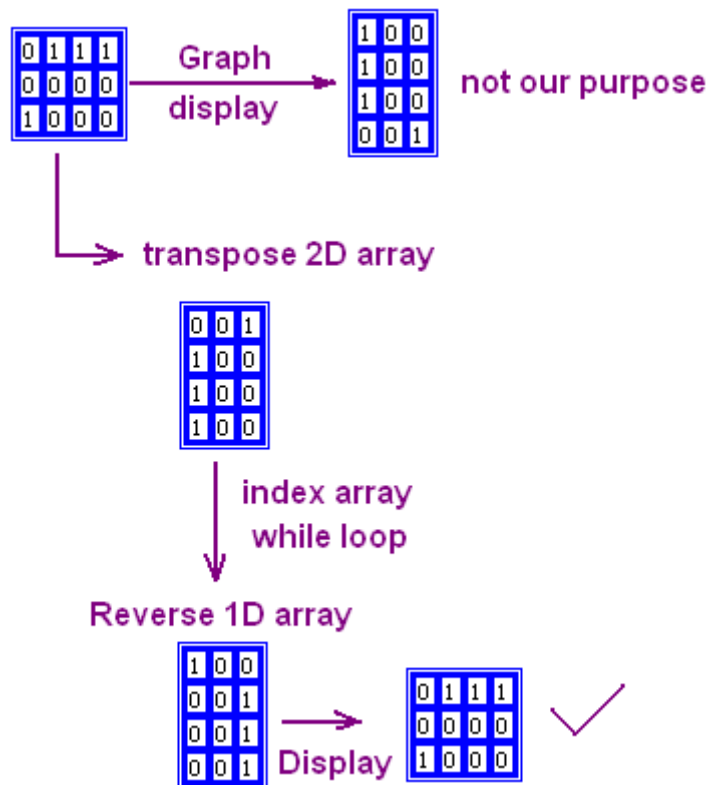
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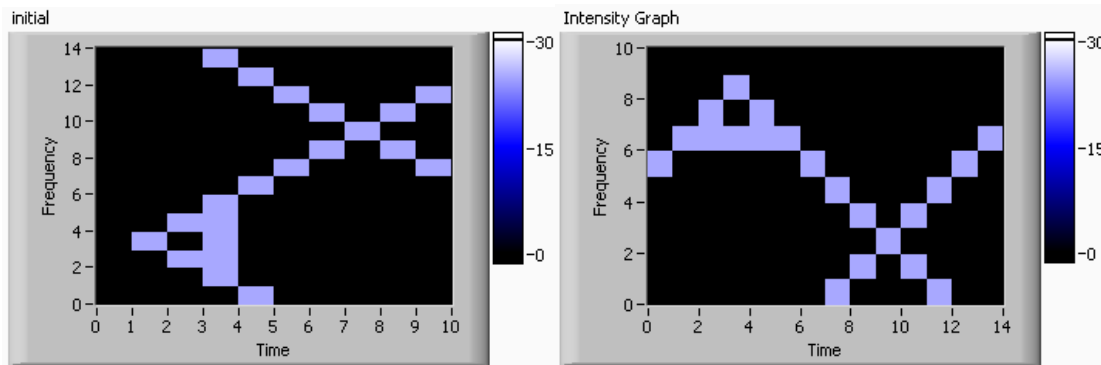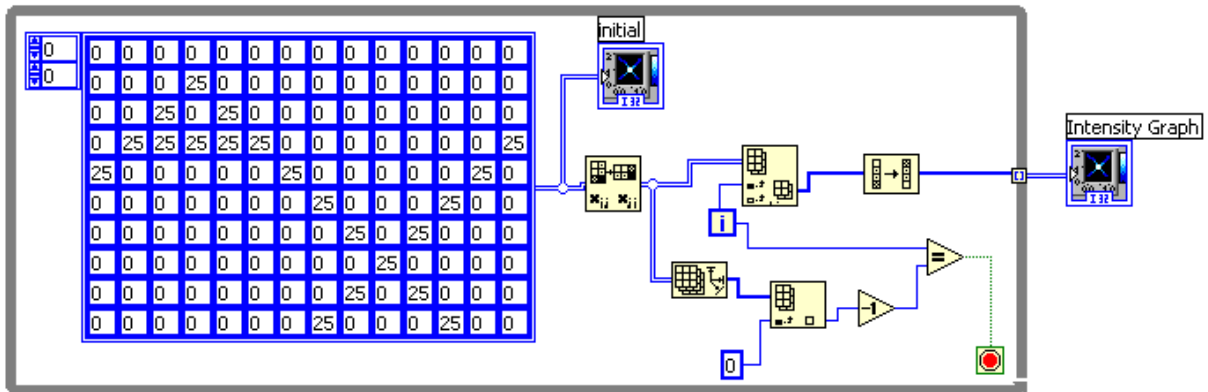Forschungszentrum Jülich
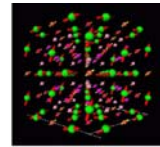*in der Helmholtz-Gemeinschaft*
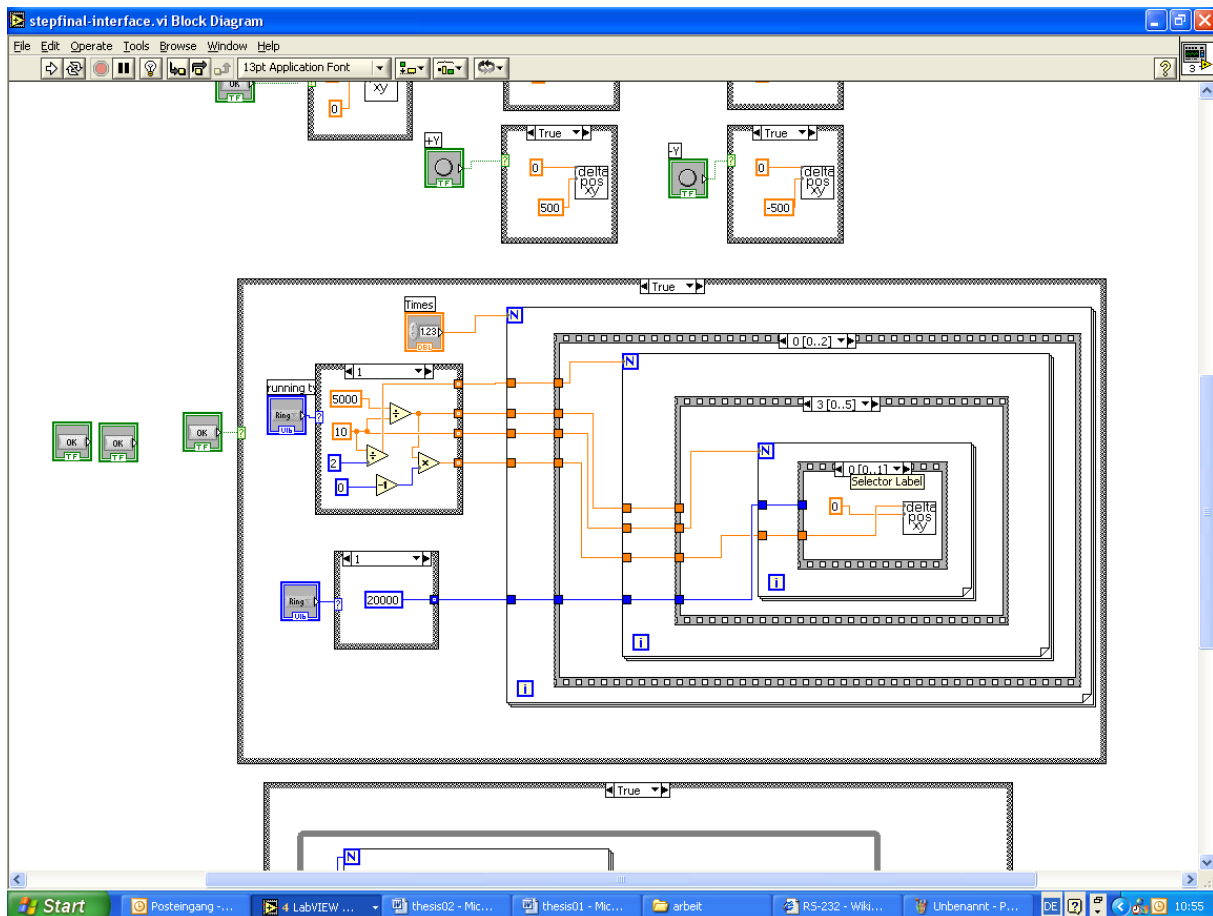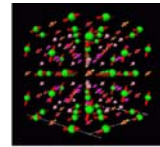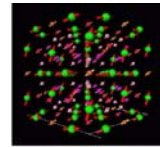
6.2 Data process
6.2.1 2D array into Intensity Graph

The data of each point from the memory should be read out and displayed into a graph. We will get a 1D-array data, divided into an 2D-array for analysis.

Take the following 2D-Array for example, if connect the array directly into the Intensity Graph, it just display the overturned graph. Then we should dispose this array with the Functions.

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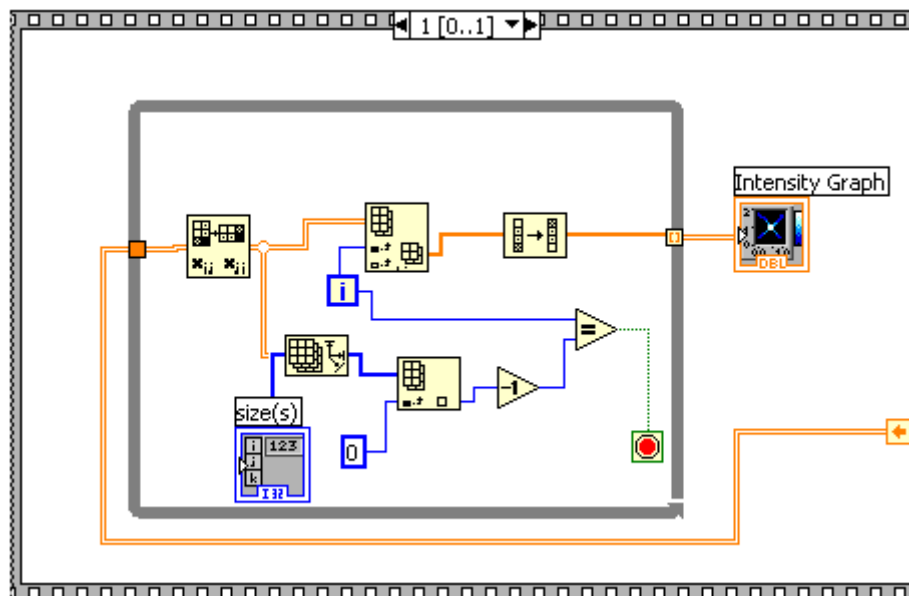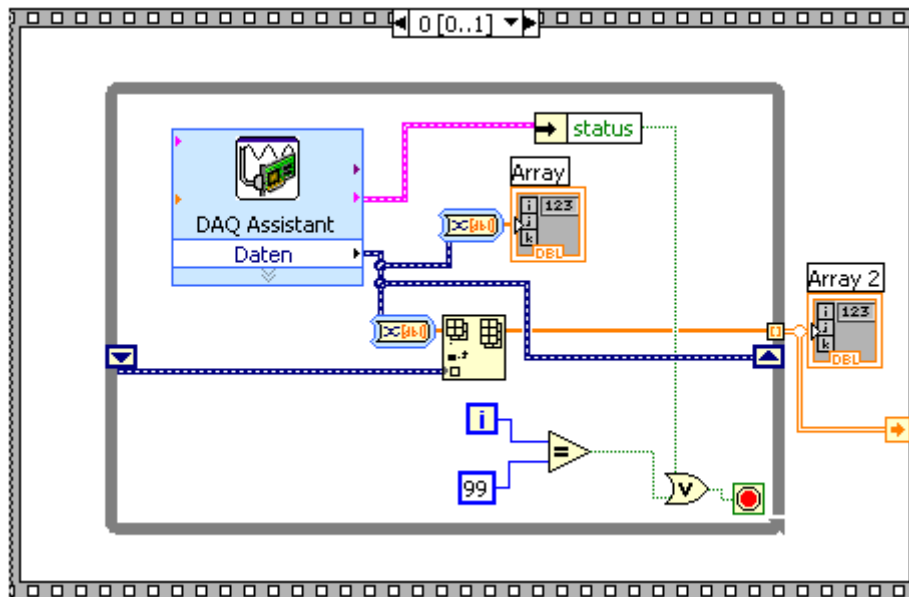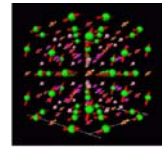*in der Helmholtz-Gemeinschaft*

6.2.2 Simulate the Data with a Voltmeter

Use stacked sequence structure to get the 2D array from the Voltmeter with DAQ Assistant first, then for analysis and display.
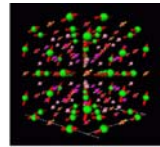
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Conclusions

After several weeks' experiments, I finished this design of the program for the Laser scanner. It can be used to scan 100mm×100mm large area and basically achieved the expectant request.

Although the system never used to scan any Image Plate reality, and still need to improve lots of things, but I really enjoyed the procedure and really learned a lot. Thanks all the people that helped me during these months, especially Prof. Dr. Th. Brükel, Prof. Dr. Hans-Josef Ackermann and Klaus Bussmann.

Thank you for everything!

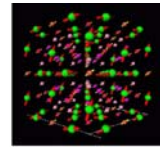So far, this graduation designing reaches the end.

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Appendix
- ☻ LabVIEW Documentation and Help Resources
- ☻ Serial Quick reference Guide

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