DISSERTATION

Cool Science

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Contents

1 Cicero Word Generator

This chapter describes the installation and initial setup of Cicero Word Generator[1] on a PC running Windows 10 with analog and digital cards from National Instruments (NI). The code is freely available on Github[2]. This chapter contains only differences, problems, and possible solutions encountered when Cicero was installed for the PC 'Fritz Fantom' which will be used for the QuaK experiment. It is therefore advised to use the technical and user manual[3] in conjunction. The titles in this chapter and font style with `Courier` and **Boldface** was mirrored to fit the manual.

1.1 Installation of National Instruments drivers

Before setting up the Cicero Word Generator, it is necessary to install the newest .NET Framework[4] from Microsoft. For the first installation of NI drivers, NI-DAQmx (version 9.3), NI-VISA (newest version), and NI-4888.2 (newest version) should be downloaded from the National Instruments website[5]. When installing the NI drivers it is possible to get an 'Runtime Error!'. In this case it is necessary to set the Regional format settings of Windows 10 to 'English (United States)'[6].

1.2 Installation of National Instruments Cards

After installation of the necessary drivers, the physical cards can be inserted into the PCIe slots on the motherboard. On 'Fritz Fantom' the digital card (NI PCIe-6537B) was installed in PCIe bus 3 while the analog cards (NI PCIe-6738) were installed in PCIe bus 4 and 5.

1.3 Configuring Atticus

After installation of the NI cards, Atticus should be launched for the first time and closed without changing any settings. After this, the NI-DAQmx drivers should be updated to the newest version. If version 9.3 was not used when launching Atticus in this step, it could result in an error. After this, "Configuring Atticus" on the user manual can be followed. The **Server Name** was set to 'Fritz_Phantom'. **Dev1** to **Dev3** were set in the same ascending order as the physical installation on the motherboard.

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Phantom

1.3.1 Configure hardware timing / synchronization

For synchronization, a **Shared Sample Clock** was used with **Dev1** being the master card. The settings are summarized in table 1.1 and table 1.2. For **Dev3** 'SampleClock-ExternalSource' should be set to '/Dev3/RTSI7'. The 'SampleClockRate' is set to 350 kHz since this is the fastest rate with all 32 analog channels active. It is possible to raise this to 1 MHz by only using 8 channels (1 channel per bank).

Table 1.1: Settings for **Dev1**.

Setting	Value
MasterTimebaseSource	
MySampleClockSource	DerivedFromMaster
SampleClockRate	350000
UsingVariabletimebase	False
SoftTriggerLast	True
StartTriggerType	SoftwareTrigger

Table 1.2: Settings for **Dev2**.

Setting	Value
MasterTimebaseSource	
MySampleClockSource	External
SampleClockExternalSource	/Dev2/RTSI7
SampleClockRate	350000
UsingVariabletimebase	False
SoftTriggerLast	False
StartTriggerType	SoftwareTrigger

1.4 Configuration and Basic Usage of Cicero

After setting up the Atticus server, Cicero can be configured. In step 3.c. it is necessary to write the full IP address and not ‘localhost’. Once step 6 is finished, Cicero should run without any problems.

1.5 Saving of Settings and Sequences

The ‘SettingsData’ of the Server Atticus are saved in C:\Users\confetti\Documents \Cicero_Atticus\Cicero\SettingsData while the ‘SequenceData’ of Cicero are saved in C:\Users\confetti\Documents\Cicero_Atticus\Cicero\SequenceData.

1.6 Sequence length limit

The duration of a sequence is limited to $2^{32}/(16 * 32 * 350\,\mathrm{kHz}) = 23.967\,\mathrm{s}$ coming from a 32-bit application, 16 bit per channel, 32 channels in a NI PCIe-6738 card, and 350 kHz clock rate.

2 CRT handling

2.1 Opening CRTs

In order to hit the ^{39}K cloud with an electron beam, it is necessary to cut open the CRT. This section explains the different methods which were tried and which resulted in clean and easy cuts. All slices were made in a glove box filled with nitrogen gas (fig. 2.1) to avoid oxygen poisoning of the cathode.

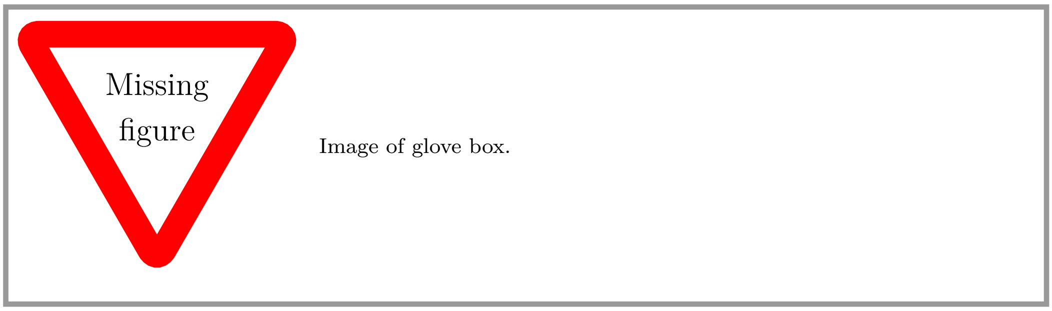

Figure 2.1: Glovebox filled with nitrogen gas to open CRTs.

2.1.1 Rotary tool

First, a small hole was drilled in the center of the CRT pins to pressurize the CRT with nitrogen. Then a diamond wheel attached to a rotary tool was used to cut the glass. This method was tried twice, but did not work well, as the method produced a lot of glass dust, which adhered to the electron optics. Another obstacle is the plastic box, since it is not fully transparent and therefore made more difficult to see inside.

2.1.2 Wire cutting

Higher success was achieved by cutting the glass with a heated wire. Two wires were put through the glove box, each ending in a ring terminal. A small height adjustable stage was built out of optical table parts (fig. 2.2) in which the CRT was put vertically and looped by a thin wire . When looping the wire it is important to keep a small gap to avoid an electrical short. Therefore two notches were made in which the wire was fixed.

wire dimension material

The assembly was put inside the glove box which was subsequently filled with nitrogen. A current of approximately 2 A to 2.5 A was used to heat the thin wire which resulted in a breaking point inside the CRT glass. This method does not require a CRT pressurization before the cut. In order to not destroy a device by mistake, this procedure can first be tested on drinking glasses.

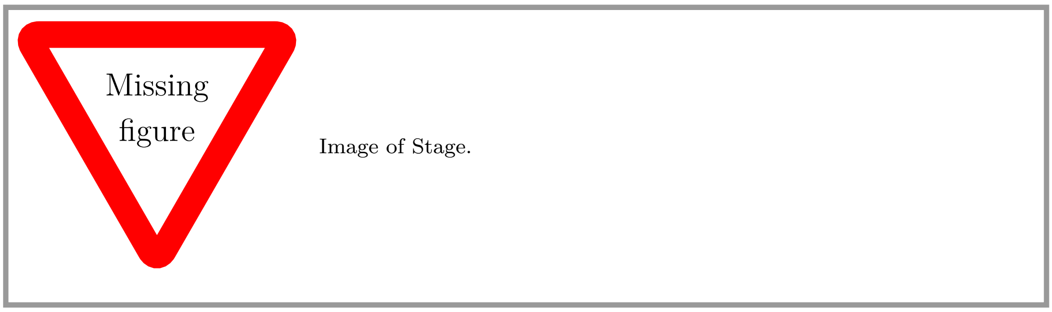

Figure 2.2: Stage to cut CRT with wire.

2.2 Oxygen poisoning

As mentioned in it is paramount to avoid contact of the cathode with oxygen. Therefore tests with a broken CRT were made to test on how well it can be isolated from air.

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The first experiment consisted of filling a drinking glass put upside-down with helium and putting a lighter after a set amount of time. If the fire goes off, it means that oxygen did not get inside. This was tested successfully from 0.5 min to 10 min.

Next, plastic wrap was put on top of the glass filled with nitrogen by a rubber band. The glass was put with the open side up from 3 min to 10 min after which it was turned upside down and the foil was removed. A lighter was put inside and the flame went out again.

To improve the sensitivity, a He leak tester was used. For the first two tests, one plastic foil and one rubber band were used, for the third test three foils and two rubber bands, and for the last test an aluminum foil was hot glued on the CRT to seal it. The measurement locations are shown in fig. 2.3. As shown in table 2.1 using rubber band and clear foil results in the highest leakage while the glue seals much better (glue avg). But care needs to be taken in order ensure that the whole CRT is sealed since even a

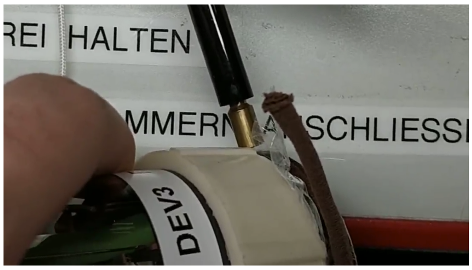
which table bet

small leak can result in a rate around an order of magnitude above the background (glue max).

Table 2.1: He leak test.

location	leak rate/(10^{-5} mbar l/s)
1 plastic foil, 1 rubber band	
background	8
plastic foil	20
He gas cylinder	200
1 plastic foil, 1 rubber band	
background	7
plastic foil	20
rubber band	40
3 foils, 2 rubber bands	
background	20
plastic foil	30
rubber band	70
1 aluminum foil, hot glue	
background	6
glue avg	7
glue max	60
aluminum foil	8

(a) plastic foil



(b) rubber band

(c) glue

(d) aluminum

Figure 2.3: Measurement locations of He leakage.

Todo list

References

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