DISSERTATION

Cool Science

ausgeführt am Atominstitut

der Technische Universität Wien
Fakultät für Physik

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Matrikelnummer: 9-18-27-15-21-36

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Wien, am 08.04.2020

"The Setesh guard's nose drips."
TEAL'C

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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.

change server n in lab? Fanton 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 Electron beam setup

2.1 Charatarization of a working CRT

HAMEG HM507 oscilloscopes [7] were used for testing purposes. These contain a D14-363GY/123[8] CRT hereinafter abbreviated as 'D14', 'tube', or 'CRT'. Although the HM507 has only a bandwidth of 0 MHz to 50 MHz, which is not sufficient for the hyperfine splitting frequency of 461.7 MHz of ^{39}K, it was used nevertheless because of its simple construction and availability. A schematic view of the device is shown in fig. 2.1 with the back pin arrangement in fig. 2.2.

http://www.to

The voltages and currents of the necessary pins to drive the CRT were measured using a 2.5 kV probe with an attenuation ratio of and are summarized in table 2.1. It was not possible to measure pin g3 directly. Therefore a HVPS (section 2.2) was used to set a voltage and the beam diameter was observed. The best focus was achieved with the voltage mentioned in the table. The voltage offset of x-, and y-plates was not possible to measure directly, since it varies with time to draw the necessary image on the phosphor screen. The given values in table 2.1 are the mean of the minimum and maximum measured voltage. The deflection coefficient is summarized in table 2.2.

model number

1:100 or 100:1

current?

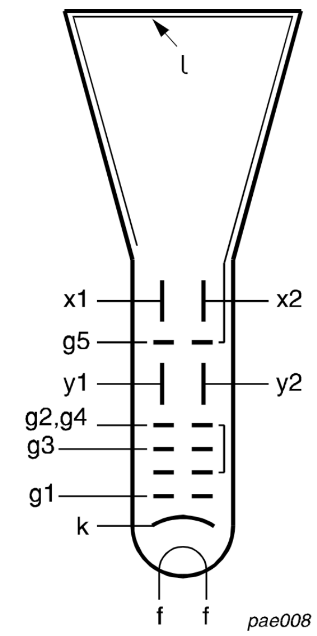

Figure 2.1: Electrode configuration (from [8])

how to cite figure

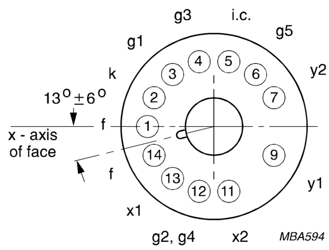

Figure 2.2: Pin arrangement, bottom view (from [8])

how to cite figure

Table 2.1: D14-363GY/123 CRT pin measurements

current empty or '-' symbol

number	pin	voltage/V	current/µA
1	f	-1.99×10^3	86.6×10^3
2	k	-2.00	-7.6
3	g1	-2.03	0
4	g3	-1.813×10^3	
5	i.c.	71.7	0.1
6	g5	64.0	7.2
7	y2	78	
9	y1	78	
11	x2	96	-
12	g2, g4	71.0	0
13	x1	96	-
14	f	-1.97×10^3	-86.2×10^3

Table 2.2: D14-363GY/123 deflection coefficient (from [8])

how to cite source

horizontal	M_x	19 V/cm
vertical	M_y	11.5 V/cm

2.2 High Voltage Power Supply HVPS

To produce high dc voltages to drive the CRT, four HCP 14-6500 power supplies[9] were used. They were named ‘HVPS 1’ to ‘HVPS 4’ and can provide up to ±6.5 kV and 2 mA. To connect the output to the CRT pins, BNC cables were refitted with a save high voltage (SHV) connector on one side while on the other end the BNC connector was kept (fig. 2.3). A 6 kV probe was used to obtain the breakdown voltage, which is around 3 kV caused by the coaxial cable which was not built do sustain high voltages.

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yellow probe

somewhere 2.5-
find exact valu

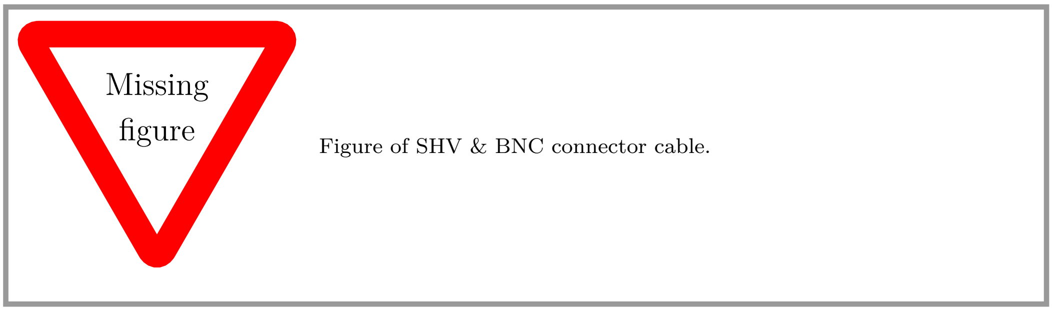

Figure 2.3: Coaxial cable with SHV and BNC connector.

2.2.1 Ripple measurement

Each power supply was measured for its ripple with a set voltage of 2 kV. A 2.5 kV probe (attenuation ratio)was connected to an oscilloscope set to ac coupling with a timescale of 1 ms. To get the electronic noise of the oscilloscope itself, the probe was shorted and the noise measured. A picture of a measurement is shown in fig. 2.4 with the values summarized in table 2.3.

100:1 or 1:100

Table 2.3: HVPS ripple

device	ripple/mV
short	116
HVPS 1	136
HVPS 2	138
HVPS 3	194
HVPS 4	204

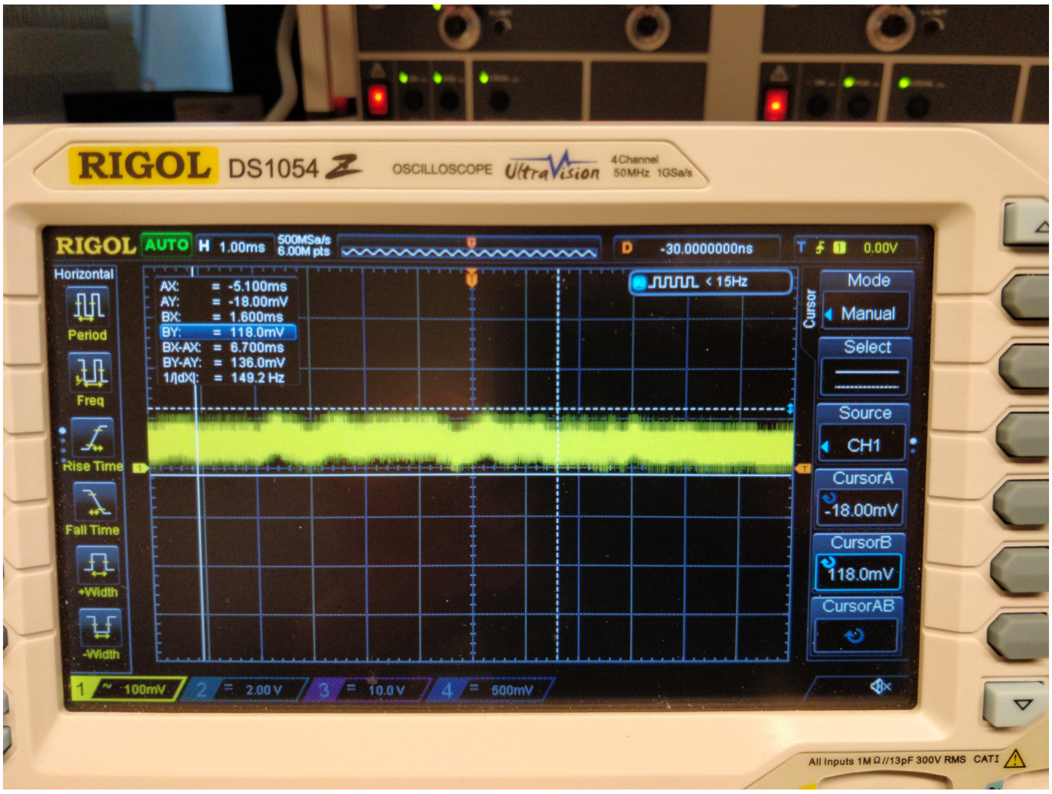

Figure 2.4: Measurement of HVPS ripple.

2.3 CRT wiring

A schematic of the supplied power is shown in fig. 2.5. A small ac or dc voltage is necessary to drive the heater filament f. This part of the setup is explained in section 2.4.

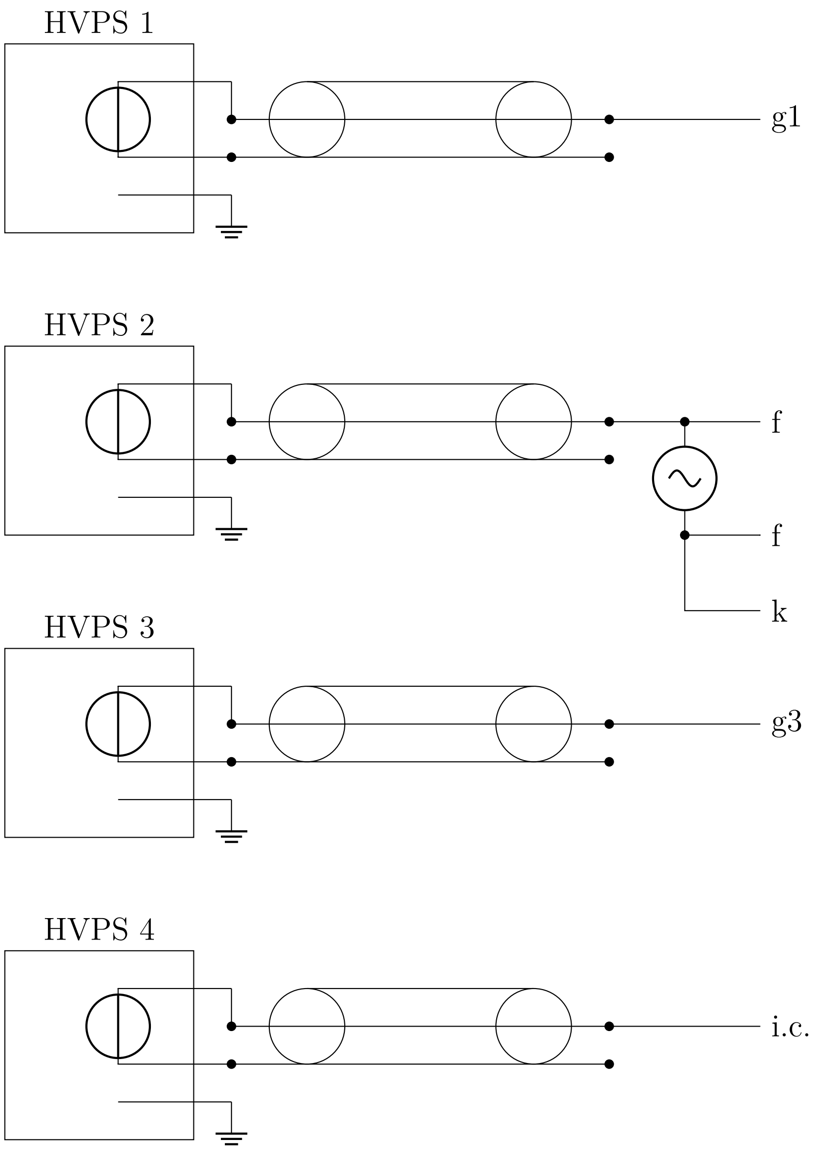

Figure 2.5: Schematics of supplying CRT pins with power.

2.4 Heater

The heater provides an adjustable ac voltage, which is used to regulate the temperature of the cathode. In the cold state, the heater filament has a an electrical resisitance of approximately 15 Ω, when the filament is hot, this value rises to 90 Ω. The normal heater voltage for the D14-363GY/123 during operation is 6.0 V to 6.6 V according to [8]. Our ac-power supply (figure 2.6 shows its circuit diagram) consists of an isolation

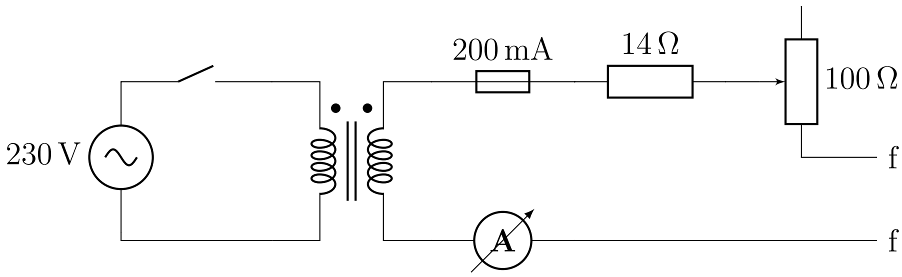

Figure 2.6: Circuit diagram of filament power supply.

check if really 14 Ω or if it event exists

transformer (from grid voltage to 12 V), its primary and secondary circuits are isolated up to 4 kV [10]. The power supply has two banana plug sockets to connect to the heater filament. It is connected to the transformer in series with a 100 Ω potentiometer. Using the full resistance, there is a voltage of approximately 5.7 V applied to the heater filament, by lowering the resistance this value can goes up to nearly the full voltage of the transformer. The current running through the filament is measured with an integrated amperemeter [11] that measures currents up to two 2 A with mA accuracy.

At the beginning of operation it is recommendable to set the maximum resistance and slowly increase the current to the desired value once the filament is heated up. As the resistance of the cold filament is significantly lower, high onset currents could otherwise damage it.

Todo list

namechange? 2
http://www.tobiastiecke.nl/archive/PotassiumProperties.pdf 4
model number 4
1:100 or 100:1 4
current? 4
how to cite figure 5
how to cite figure 5
current empty or '-' symbol 6
how to cite source 6
find name of big yellow probe 7
somewhere 2.5-4, find exact value 7
Figure: Figure of SHV & BNC connector cable. 7
100:1 or 1:100 7
check if really 14 Ω or if it event exists 10

References

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