

BNCT Demonstrator

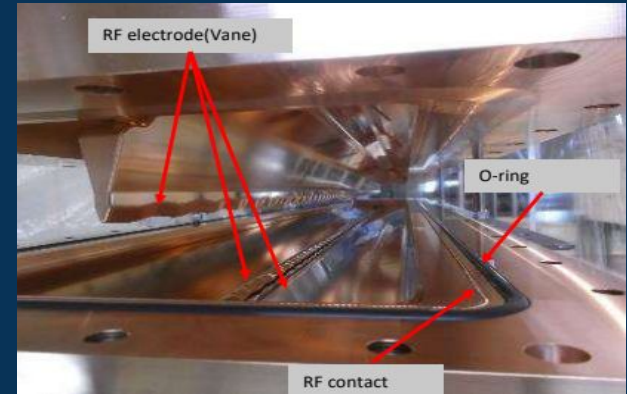


- The Hungarian Academy of Sciences Center for Energy Research is funding a 10 M€ Boron-Neutron Capture Therapy (BNCT) technology demonstrator near Budapest
- In the fall of 2021, we were asked to implement Blinky-Lite for the global control system interfacing and interconnecting the:
 - Ion source
 - Radio Frequency Quadrupole (RFQ) particle accelerator
 - Radio Frequency (RF) Power amplifier
 - Lithium Target Station

RFQ Particle Accelerator



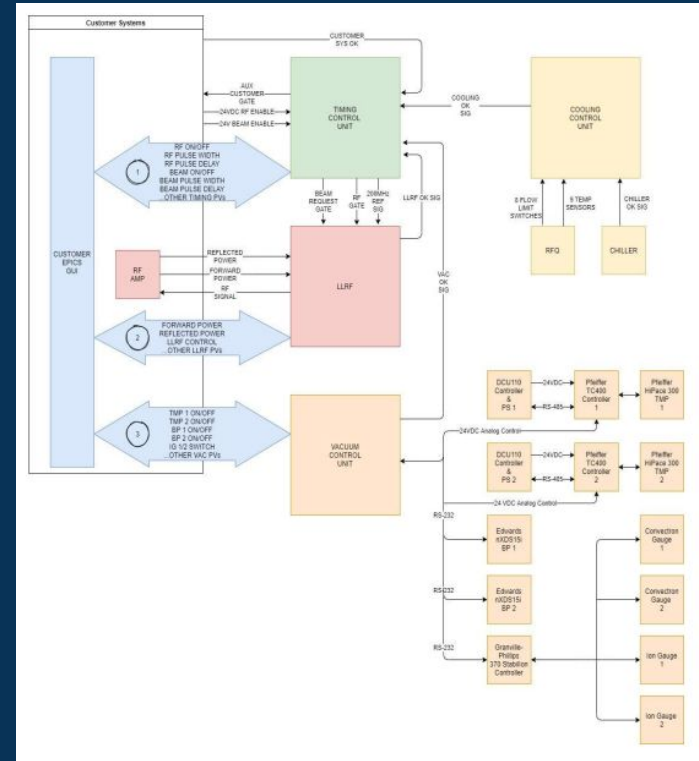
- The RFQ is the main component of the BNCT technology demonstrator.
 - The RFQ accelerates protons to an energy of 2,500,000 Volts
 - where the protons then hit a Lithium target to produce thermal neutrons for therapy
- The RFQ was manufactured by Time-Merit Co. Ltd from Hiroshima, Japan
 - Length: 3 meters
 - Weight: 4000 kg.
 - Copper purity > 99.99%,
 - machining precision: 30 um.



RFQ Timeline



- The RFQ was to be installed in November 2021 but postponed to March 2022 due to Covid-19.
- In January 2022, the lead engineer for the Time-Merit RFQ left the company abruptly due to Covid-19
 - leaving no documentation for the the electronic controls (RF regulation, cooling, vacuum)
- Time-Merit was unable to find a suitable replacement.
- On March 1, 2022, we promised to redesign, build, install and test the complete RFQ control system
 - by 1 June 2022
 - We completed this task by 15-May-2022



All open source



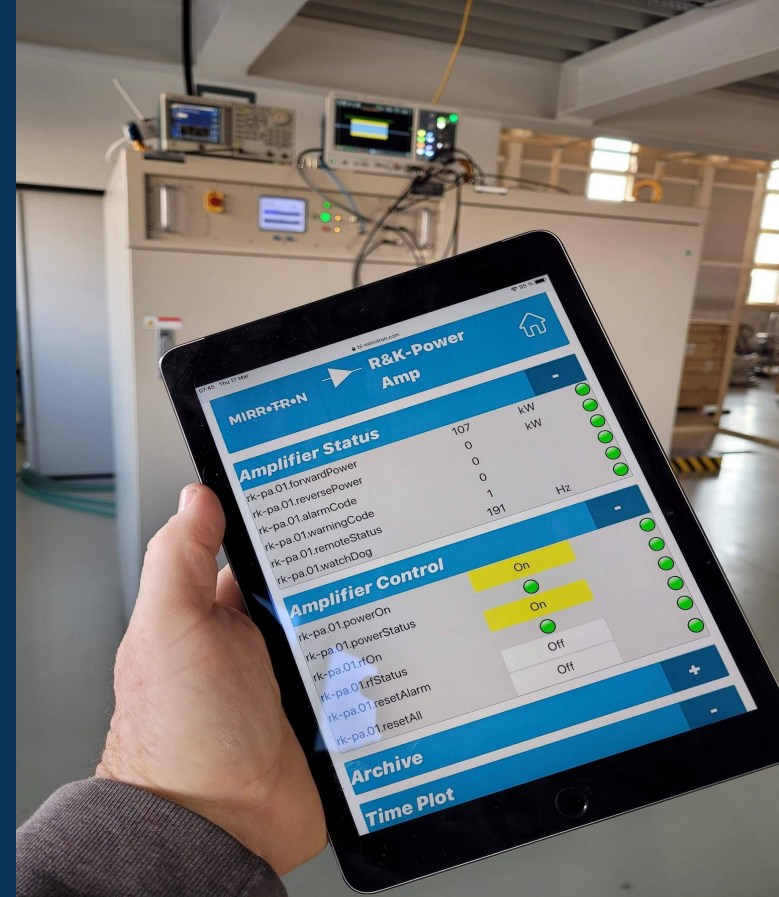
The screenshot shows the GitHub profile for 'bl-mirrotron'. The profile header includes the name 'bl-mirrotron' with a location tag 'Hungary' and a 'Follow' button. Below the header are navigation tabs for 'Overview', 'Repositories' (26), 'Projects', 'Packages', 'Teams', 'People' (3), and 'Settings'. The main content area displays the README for the 'The Mirrotron RFQ Control System'. The README features a grid of six images: a building at night, a hand holding a smartphone displaying a control interface, a large industrial machine, a close-up of blue fiber optic cables, a hand holding a tablet with a control interface, and a close-up of a circuit board with blue fiber optic cables. Below the images is a paragraph of text: 'The Mirrotron Radio Frequency Quadrupole (RFQ) is part of a compact neutron source that is being built in Martonvásár Hungary. The compact neutron source consists of five major systems'.

The screenshot shows the repository list for the 'bl-mirrotron' organization. The list contains 26 repositories, each with a name, a small green progress indicator, and a 'View' button. The repositories listed include: 'github', 'bl-mirrotron.github.io', 'mirrotron-base', 'mirrotron-uk-pa-bray', 'v005-hacking-pump-bray', 'mirrotron-rfq-vevacub-cube', 'mirrotron-rfq-vevacub-bray', 'mirrotron-user-guide', 'mirrotron-rfq-flow-bray-outlet', 'mirrotron-rfq-flow-bray-inlet', 'mirrotron-rfq-temp-bray-outlet', 'mirrotron-rfq-temp-bray-inlet', 'mirrotron-rfq-flow-cube', 'mirrotron-rfq-temp-cube', 'mirrotron-rf-passer-scope-bray', 'mirrotron-rlt-scope-bray', 'mirrotron-rfq-list-saver-cube', 'gateGen-125-bray', 'mirrotron-phase-detector-bray', 'mirrotron-rlt-arc-bray', 'mirrotron-dm-bray', 'mirrotron-rfq-temp-bray', 'mirrotron-rfq-flow-bray', 'mirrotron-uk-pa-timer-cube', 'mirrotron-uk-pa-timer-bray', and 'mirrotron-uk-pa-ult-bray'.

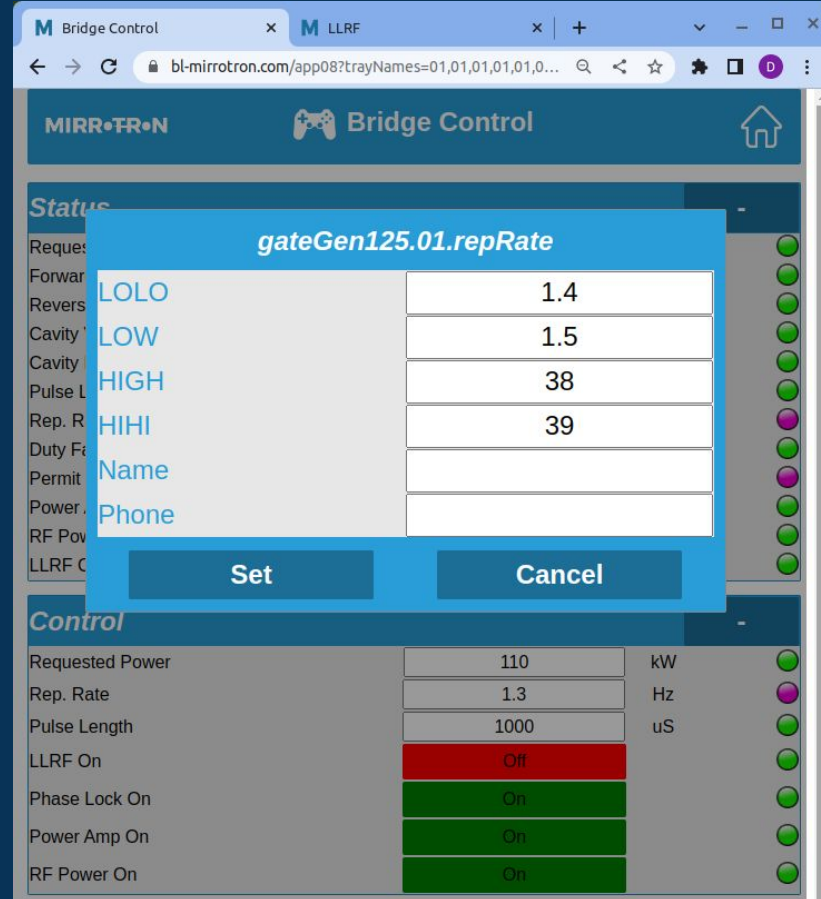
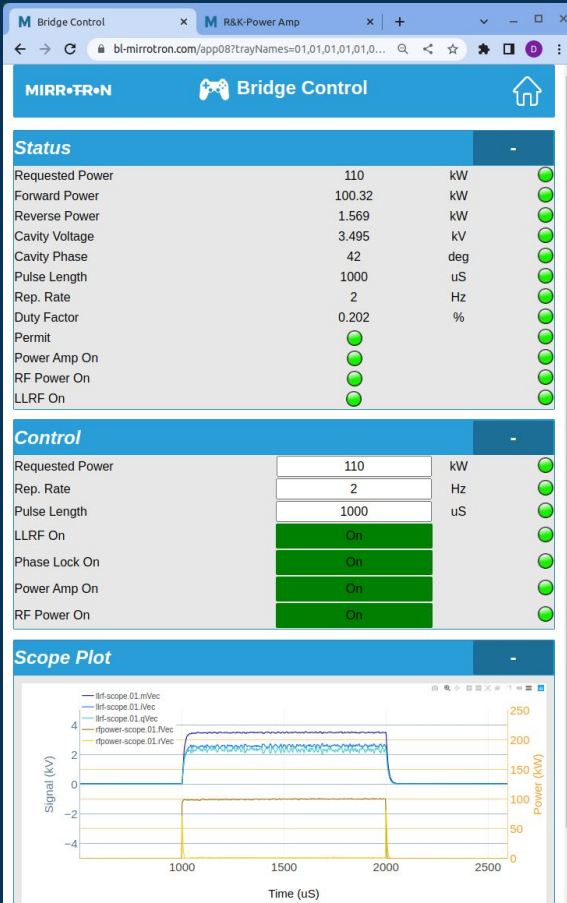
Mirrotron Applications



The screenshot shows a web browser window with the URL `bl-mirrotron.com/apps`. The page features a blue header with the "MIRR•TR•N" logo and a home icon. Below the header is a "Bridge Control" button with a game controller icon. The main content area is a grid of 16 application buttons, each with an icon and a label: Alarm Scanner, Machine Permit, Post Mortem, Logbook, Power Amplifier, RFQ Vacuum, RFQ Water Temp, RFQ Water Flow, LLRF, Timing, and Manuals, Core Apps. At the bottom, there is a user information section showing "User: dmccginnis427" and "Time left: 07:51:53", with "Renew" and "Logout" buttons.



Dashboard Application



Machine Permit and Alarm Scanner



M Machine Permit x M LLRF

bl-mirrotron.com/app07?trayNames=01

MIRR•TR•N Machine Permit

Status

Watchdog	26630	●
Permit	●	●

Systems

rfq-temp.inlet	OK	●
rfq-temp.outlet	OK	●
rfq-flow.inlet	OK	●
rfq-flow.outlet	OK	●
scroll-pump.01	OK	●
scroll-pump.02	OK	●
rfq-vacuum	OK	●
rf-src	OK	●
timing	Permit	●

User

+

M Alarm Scanner x M LLRF

bl-mirrotron.com/alarmScanner

MIRR•TR•N Alarm Scanner

Alarms

Cube	Value	Unit	Alarm
rk-pa.01.warningCode	9095		●
gateGen125.01.repRate	1.2	Hz	●
gateGen125.01.permit	0		●
machine-permit.01.permit	0		●
machine-permit.01.gateGen125/01	1		●

Warnings

Cube	Value	Unit	Warning
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User: dmcginnis427

Time left: 04:48:54

[Renew](#) [Logout](#)

Post Mortem Application



Browser tabs: M Post-Mortem, M LLRF
URL: bl-mirrotron.com/postMortem

MIRROTRON Post-Mortem

Abort List

Date	Action
22-07-28 09:48	Display
22-07-28 09:47	Display
22-07-28 09:46	Display
22-07-28 09:40	Display
22-07-26 14:31	Display

User: dmcginnis427
Time left: 04:46:16

[Renew](#) [Logout](#)

Browser tabs: M Post-Mortem, M LLRF
URL: bl-mirrotron.com/postMortem

MIRROTRON Post-Mortem

Abort List

Date	Action
22-07-28 09:48	Display
22-07-28 09:47	Display
22-07-28 09:46	Display
22-07-28 09:40	Display
22-07-26 14:31	Display

Alarm List - 22-07-28 09:48

Cube	Value	Unit	Alarm
gateGen125.01.repRate	1.2	Hz	●
gateGen125.01.permit	0		●

User: dmcginnis427
Time left: 04:44:33

[Renew](#) [Logout](#)

Logbook Application



The Logbook application interface is displayed in three browser windows. Each window shows a table of log entries with columns for Date, Author, Title, and Action. The interface includes a header with 'MIRROR•TR•N' and 'LogBook', and a footer with 'User: dmcginnis427' and 'Time left: 04:40:42'. A modal window is open in the middle screenshot, showing a form for adding a new entry with fields for Title, Text, and a description.

Date	Author	Title	Action
22-07-28 09:58	dmcginnis427	System Testing for documentation	Display Edit Delete
22-07-26 13:59	psipos	Bridge control app test	Display Edit Delete
22-07-26 09:44	dmcginnis427	Data pooling added to control system	Display Edit Delete
22-07-19 12:11	dmcginnis427	Analysis of RFQ tutorial session	Display Edit Delete
22-07-19 09:20	psipos	RFQ tutorial	Display Edit Delete
22-07-17 18:50	dmcginnis427	Scaler Alarm App upgraded	Display Edit Delete
22-07-17 18:48	dmcginnis427	Added Post-Mortem app	Display Edit Delete
22-07-17 18:40	dmcginnis427	Added Post-Mortem State Broadcast on all trays	Display Edit Delete
22-07-15 10:46	dmcginnis427	Timing system added to the machine permit system	Display Edit Delete
22-07-15 10:42	dmcginnis427	Duty factor and beam pulse length added	Display Edit Delete
22-07-15 10:39	dmcginnis427	EasySetupForm tray added	Display Edit Delete
22-07-14 18:20	dmcginnis427	Added averaging to scope sample and holds	Display Edit Delete
22-07-14 17:32	dmcginnis427		Display Edit Delete
22-07-14 15:55	dmcginnis427		Display Edit Delete
22-07-14 09:46	dmcginnis427		Display Edit Delete
22-07-14 09:38	dmcginnis427		Display Edit Delete
22-07-14 08:52	dmcginnis427		Display Edit Delete
22-07-11 11:10	dmcginnis427		Display Edit Delete
22-07-11 11:08	dmcginnis427		Display Edit Delete
22-07-10 08:58	dmcginnis427		Display Edit Delete

User: dmcginnis427
Time left: 04:40:42
[Renew](#) [Logout](#)

User: dmcginnis427
Time left: 04:38:26
[Renew](#) [Logout](#)

User: dmcginnis427
Time left: 04:37:51
[Renew](#) [Logout](#)

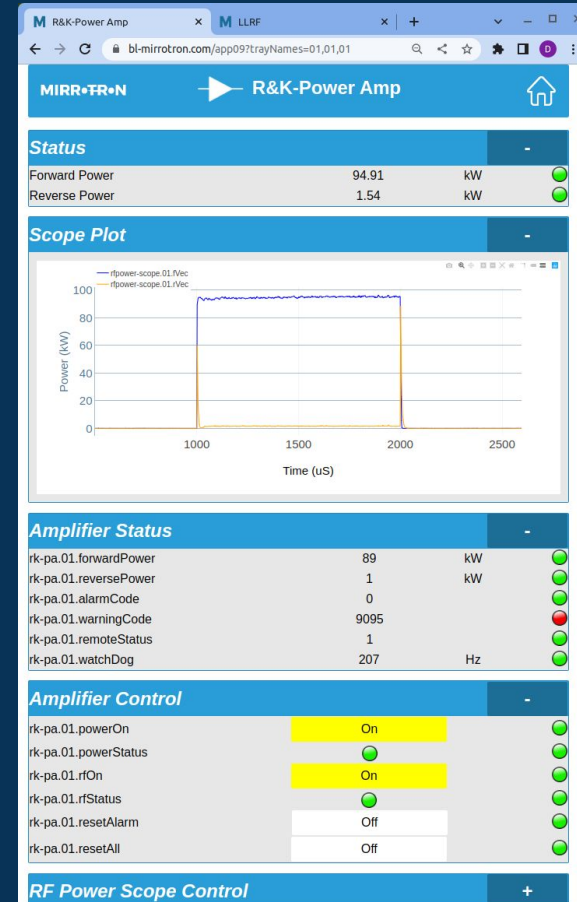
Error
You are not the author.

RF Power Amplifier

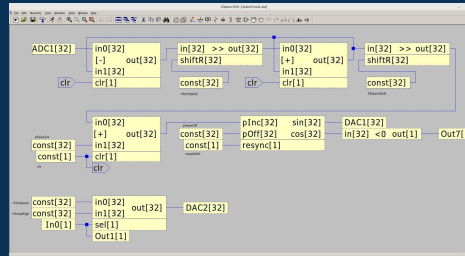
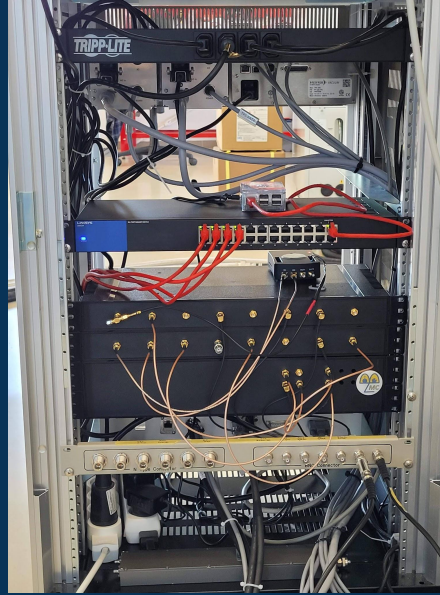
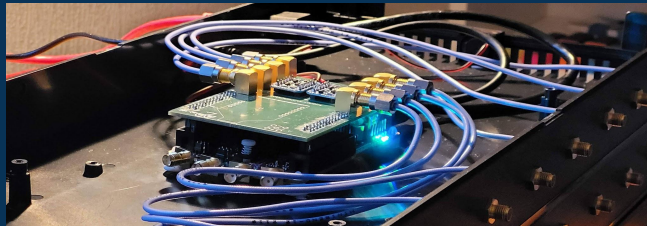
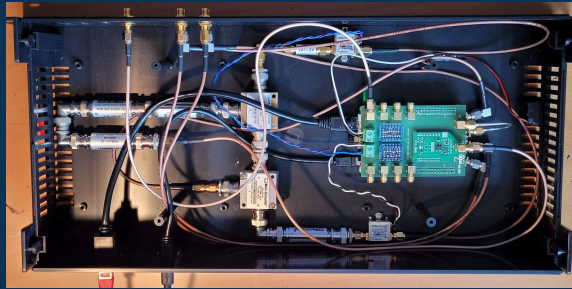
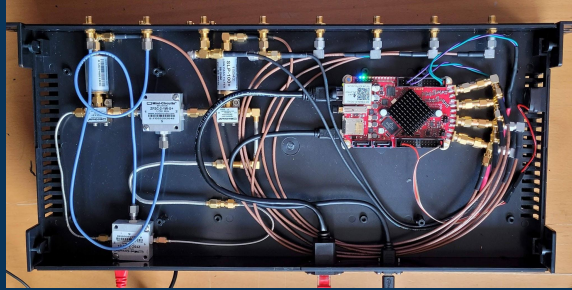


1.3 M€, solid state RF power amplifier (SSA) to Blinky-Lite.

- The amplifier consists of 84 power transistors with 12 independent parameters for a total of 1008 devices
- The amplifier provides 300kW @200MHz
- Modbus TCP interface



RFQ RF Regulation



MIRR+TR+N
LLRF
🏠

Status

Magnitude	82.91	unit	🟢
Phase	106.2	deg	🟢

Scope Plot

Global Control

Timeline Period	100000	uS	🟢
RF Gate Start	1000	uS	🟢
RF Gate Stop	2000	uS	🟢
Frequency	200.315	MHz	🟢
High Amp.	0.25	unit	🟢
Phase Target	125	degrees	🟢
Phase Lock Gain	0.5		🟢
Phase Lock Ctr	On		🟢
Magnitude	82.91	unit	🟢
Phase	106.2	deg	🟢

Archive +

RF Source Control +

Phase Detector Control +

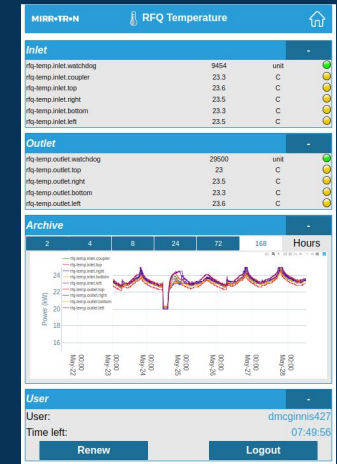
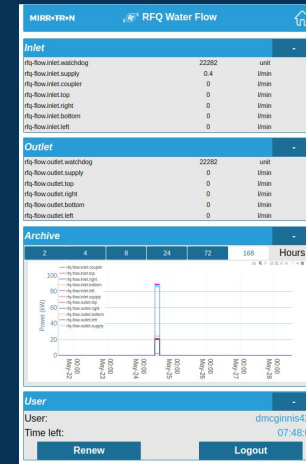
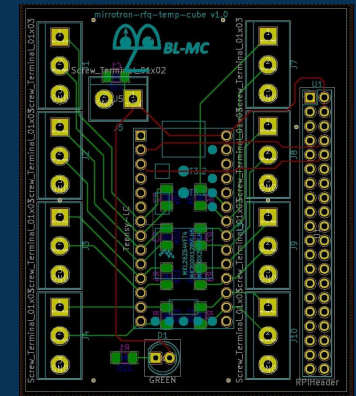
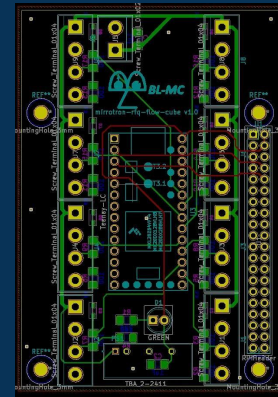
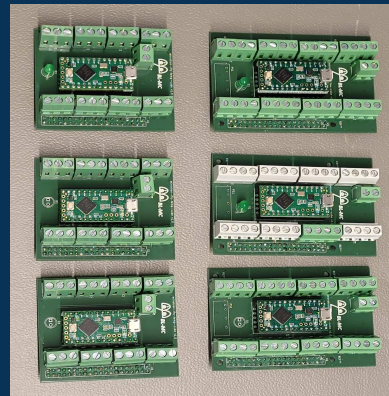
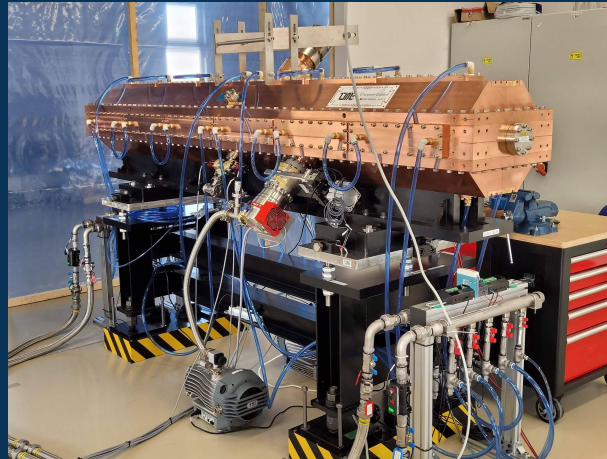
Timer Control +

Scope Control +

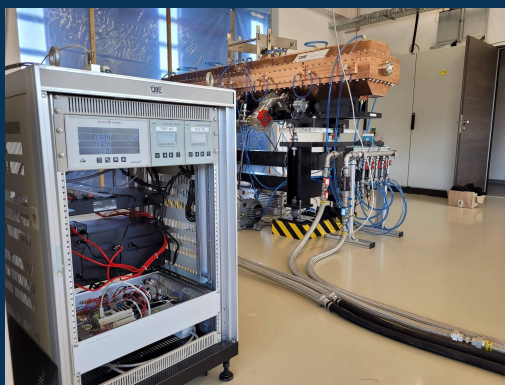
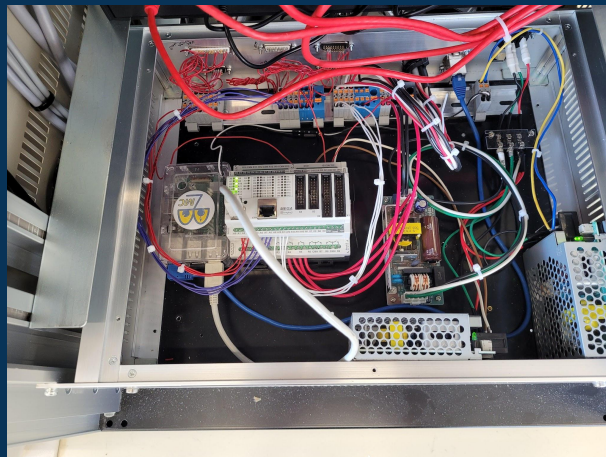
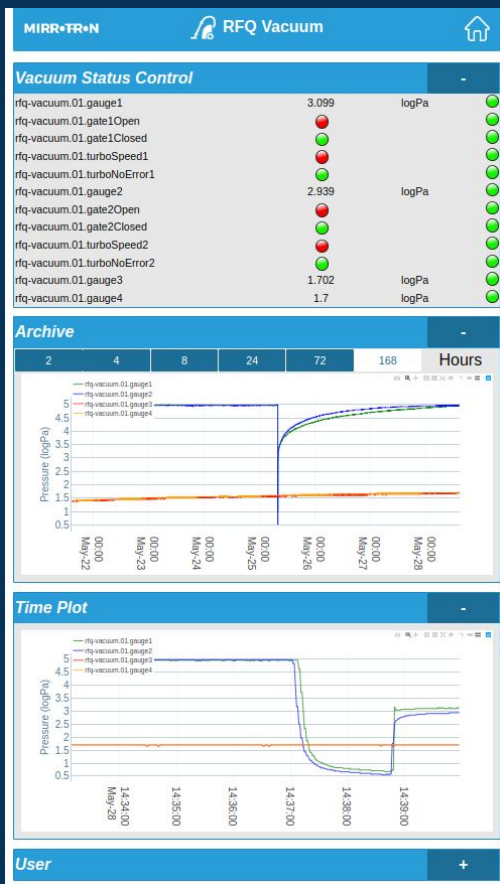
WatchDog +

User +

RFQ Cooling



RFQ Vacuum






Core Applications


A screenshot of a web browser displaying the 'Core Applications' interface. The browser tabs show 'Core Applications' and 'LLRF'. The address bar shows 'bl-mirrotron.com/core'. The page header includes the 'MIRROTRON' logo, a 'Core Applications' title with a small icon, and a home button. The main content area features two columns of application buttons: 'Access Log', 'Scalar Plotter', 'Scalar Viewer', 'Vector Plotter' on the left; and 'Settings Log', 'Scalar Archive Plotter', 'Alarm Scanner', 'Vector Archive Plotter' on the right. At the bottom, a grey box displays user information: 'User: dmccginnis427' and 'Time left: 04:16:58', with 'Renew' and 'Logout' buttons below.


M Core Applications x M LLRF x + - □ x


← → ↻ 🔒 bl-mirrotron.com/core 🔍 ↵ ☆ ⚙️ □ D ⋮


MIRROTRON  Core Applications 


 **Access Log**


 **Scalar Plotter**


 **Scalar Viewer**

 **Vector Plotter**

 **Settings Log**

 **Scalar Archive Plotter**

 **Alarm Scanner**

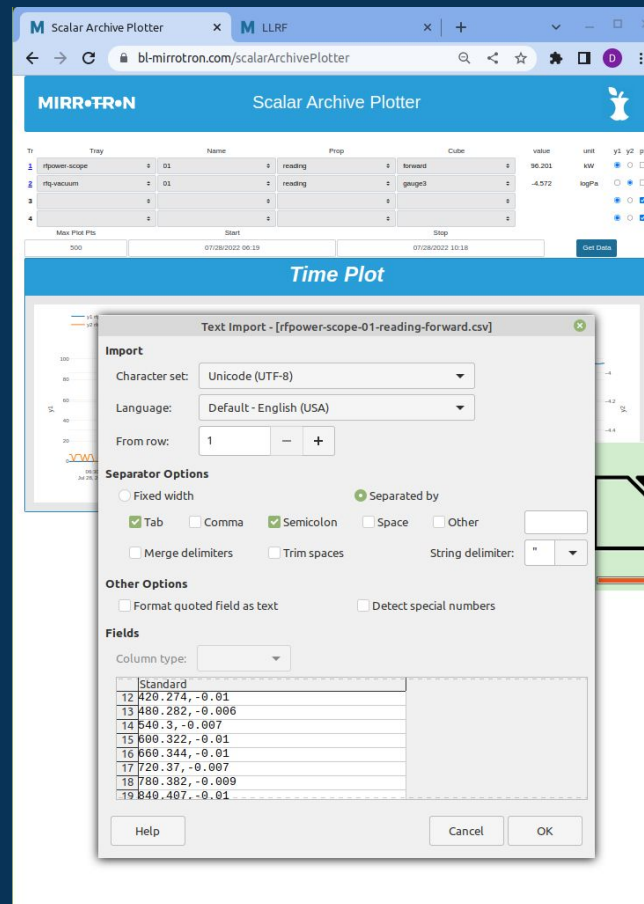
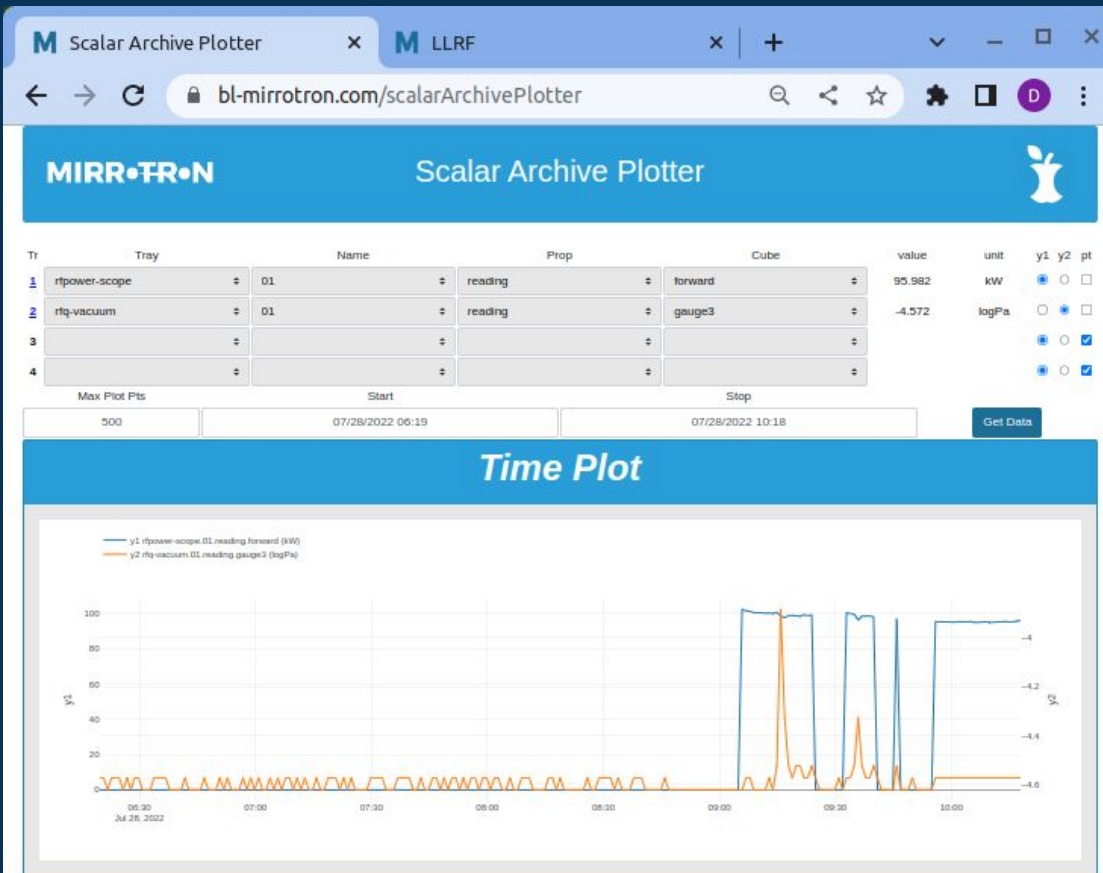
 **Vector Archive Plotter**

User: dmccginnis427

Time left: 04:16:58

Renew **Logout**

Archive Plotters and Export



RFQ Online Documentation




M RFQ Manuals

MIRROTRON RFQ Manuals

- Vacuum System Startup +
- Vacuum System Shutdown +
- Cooling System Startup +
- Cooling System Shutdown +
- Cooling System Maintenance +
- LLRF and Timing System -

RF Frequency Source



The RF Frequency Source is a piece of equipment used for generating RF signals. It consists of a main unit and a control panel. The control panel has several buttons and a display. The main unit has a large cooling fan and a power switch.

The amount to add is 1,500 mg per liter of water.

Be sure to add the Contolime K6300 when you supply water. If you don't add the Contolime K6300, the cavity will be damaged.

User +

M RFQ Manuals

MIRROTRON RFQ Manuals

- Vacuum System Startup +
- Vacuum System Shutdown +
- Cooling System Startup -

Procedure 5
Start up the chiller No.1 and No.2.



Push RUN/STOP button.

Press and hold 3 seconds RUN/STOP button.

The RUN indicator lights up when the chiller is activated.

- Cooling System Shutdown +
- Cooling System Maintenance +
- LLRF and Timing System +

User +

M RFQ Manuals

MIRROTRON RFQ Manuals

- Vacuum System Startup +
- Vacuum System Shutdown +
- Cooling System Startup -

Procedure 6

Check the leak.
If you find a leak, turn off the chiller immediately.

Turn off the chiller



Press and hold 3 seconds RUN/STOP button.

- Cooling System Shutdown +
- Cooling System Maintenance +
- LLRF and Timing System +

User +

M RFQ Manuals

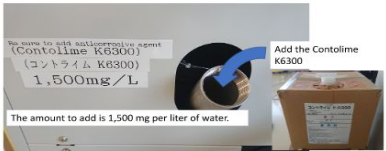
MIRROTRON RFQ Manuals

- Vacuum System Startup +
- Vacuum System Shutdown +
- Cooling System Startup +
- Cooling System Shutdown +
- Cooling System Maintenance -

Add the water

Procedure 5

Add the Contolime K6300



The amount to add is 1,500 mg per liter of water.

Be sure to add the Contolime K6300 when you supply water. If you don't add the Contolime K6300, the cavity will be damaged.

- LLRF and Timing System +

User +