

# OneButtonMachine

automatic operation application

The screenshot displays the OneButtonMachine v.0.0.0-81-gba65133 interface, divided into several functional panels:

- Prepare ring:** Includes an INTERLOCK section with buttons for 'Open valves', 'Open Pinhole', and 'Open Lumos'. It features controls for 'Set cavity voltage' (Cav1: 50.00 mV, Cav2: 50.00 mV) and 'Enable Transmitter1/2'. A red status message at the bottom reads 'Storage ring not ready for injection'.
- Injection:** Shows 'Injection in progress' with a 'Current limit' of 400.00 mA. It includes 'Injection Off' and 'Kicker Off' buttons, and 'Close beam stoppers' controls. A red status message at the bottom reads 'Injection not finished'.
- Machine state:** Displays 'BeamDelivered' with a radiation warning icon. Key parameters include 'Current 368.98 mA', 'Energy 1.51 GeV', 'Slope -7.59 uA/s', and 'Injection ETA inf s'. It shows 'PLC and flags...' (MAG Linac, MAG Ring) and 'Valves linac/ring' status (All valves open).
- Beam dump:** Features 'Beam dump On' and 'Pinger On' buttons. It includes 'Drop cavity voltage' controls (Cav1: 50.00 mV, Cav2: 50.00 mV) and a 'Pinger Off' button. A red status message at the bottom reads 'Beam not dumped'.
- Deliver beam:** Contains 'Configure IDs' and 'Options...' buttons, and a 'Start experiment' button. A red status message at the bottom reads 'Beam not delivered'.
- OBM: FSV spectrum plugin:** A plot showing 'Signal power (dBm)' vs 'Frequency (MHz)'. It identifies 4 peaks with a span of 50.00kHz and a sample rate of 25.00Hz. The minimum distance between peaks is 300.00Hz (11 samples).
- OBM: PLC and flags:** A list of status flags, including 'B\_R1\_MPS\_GeneralInterlocks\_OK\_S' (No interlocks present), 'B\_Injection\_Enabled\_S' ('Start injection' flag), 'B\_MachineStatus\_Injection\_S' ('Injection on' flag), 'B\_MachineStatus\_BeamDump\_S' ('Beam dump on' flag), 'B\_MachineStatus\_BeamDelivered\_S' ('Start experiment' flag), 'B\_CallendarFlag\_MD\_Active\_S' (Machine day flag), 'B\_CallendarFlag\_UOD\_Active\_S' (User operation flag), 'CyclingIsRunning' (Cycling is now running), 'TuningEnabled' (Cavity power tuning is enabled), and 'playing' (PLENA is playing a voice message).

At the bottom of the interface, performance metrics are shown: '262.09 ms' and 'avg: 311.41 ms'.

# The idea

The application started as a simple limiting tool, which would stop injection once the desired beam current was reached.


This was to allow safe injection in a fully remote mode, accomodating not only delays in remote desktop connection, but also a possibility of connection break.

It quickly followed, that for reliable remote injection, automated cavity power control is needed as well.

The only logical next step was to automate remaining parts of injection process.

# Machine status

The screenshot shows a control interface for a particle accelerator machine. At the top, the 'Machine state' is 'BeamDelivered' with a radiation warning icon. Below this, a summary panel displays 'Current 368.98 mA', 'Lifetime 14.02 h', 'Energy 1.51 GeV', and 'I-τ 5.17 Ah'. A second summary panel shows 'Slope -7.59 uA/s' and 'Injection ETA inf s'. There are two tool windows: 'PLC and flags...' and 'Spectrum...'. Below these are buttons for 'MAG Linac' and 'MAG Ring'. The 'Valves linac' section shows four valves (K00-K03) with their respective voltages. The 'Valves ring' section shows a grid of valves, with a legend indicating 'All valves open'. The 'Cavities' section shows two cavities (1 and 2) with their voltages and power, and a 'Power locked' indicator. The 'Plungers' section shows two plungers (1 and 2) with their lengths. The 'Skew quads' section shows two skew quads (SCOSKW and SCISKW) with their currents. The 'Insertion devices' section shows three insertion devices (BL04ID, BL05ID, BL06ID) with their lengths. The 'Kicker Pinger' section shows two kicker/pinger magnets with their voltages. The 'Beam stoppers' section shows two beam stoppers.

Machine state: BeamDelivered 

Current 368.98 mA    Lifetime 14.02 h  
Energy 1.51 GeV    I-τ 5.17 Ah  
Slope -7.59 uA/s    Injection ETA inf s

PLC and flags...    Spectrum...

MAG Linac    MAG Ring

**Valves linac**  
K00 0.25 V  
K01 0.83 V  
K02 1159.29 V  
K03 0.10 V

**Valves ring**  
All valves open

**Cavities**  
1 270.93 mV 56.75 kW  
2 270.93 mV 56.23 kW  
Q7 Q8/9 ● Power locked

**Plungers**  
1 39.65 mm  
2 42.52 mm

**Skew quads**  
SCOSKW 0.01 A    SCISKW 1.50 A

**Insertion devices**  
BL04ID 210.00 mm  
BL05ID 48.86 mm  
BL06ID 15.60 mm

**Kicker Pinger**  
1633.70 V  
61.20 V

**Beam stoppers**  
1  
2

Status



Injection slope



Linac modulators



Diagnostic  
beamlines



Main cavities



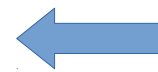
Power lock signal



Insertion devices



Machine state



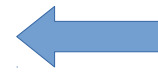
Estimated time to  
finish injection



Tool windows



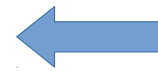
Valves



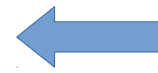
All required valves  
signal



Plungers



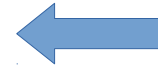
Skew quads



Pulse magnets



Beam stoppers





# Injection sequence

The injection sequence keeps track of the current and stops if the limit is met. During injection it increases main cavity power.

Power after injection is calculated automatically.

Plungers are moved during ramping.

Ramping and orbit correction control is not implemented yet.

**Injection** [Close]

- Injection On
- Injection in progress** Current limit 400.00 mA  
↓ Stop Cavity thresholds...
- Injection Off
- Kicker Off
- Close beam stoppers
- Lift cavity voltage Cav1 267,11 mV  
 Auto voltage ... Cav2 267,11 mV
- Ramping Context 0  
Snapshot 0
- Move plungers P1 41,00 mm  
P2 40,00 mm  
Energy 1.10 GeV
- Continue Run correction
- Tune plungers P1 41,00 mm  
P2 40,00 mm
- ▶▶ Insert current SCOSKW 0,00 A  
SCISKW 1,50 A
- Enable tuning
- AGC Off

**Injection not finished**



## Injection limit

**Current limit** [Close]

400,00 mA [Up] [Down] [Set]

## Power tuning

## Power calculation

**OBM: Auto voltage** [Close]

$U = 90,00 \text{ mV} + 0,48 * I$

## Plunger setting during ramping

## Dump sequence

Beam dump sequence performs a quiet beam dump procedure, without triggering radiation monitoring stations.

**Beam dump** [X]

●  Beam dump On PLENA

● Pinger On Voltage 6500,00 V

Step 500,00 V

Time 7,00 s

● Drop cavity voltage Cav1 50,00 mV

Cav2 50,00 mV

● Pinger Off

**Beam not dumped**

← Pinger increase

## Delivery sequence

Delivery sequence takes care of insertion devices positions and frontend states.

After all configuration is done it enables user experiments.

**Deliver beam** [X]

● Configure IDs Options...

● Configure all frontends

● User operation

● Start experiment PLENA

**Beam not delivered**

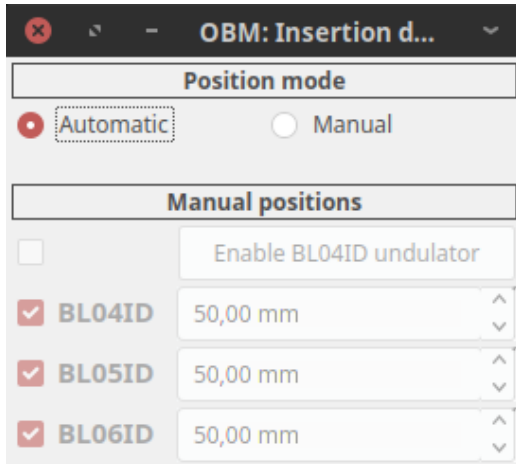
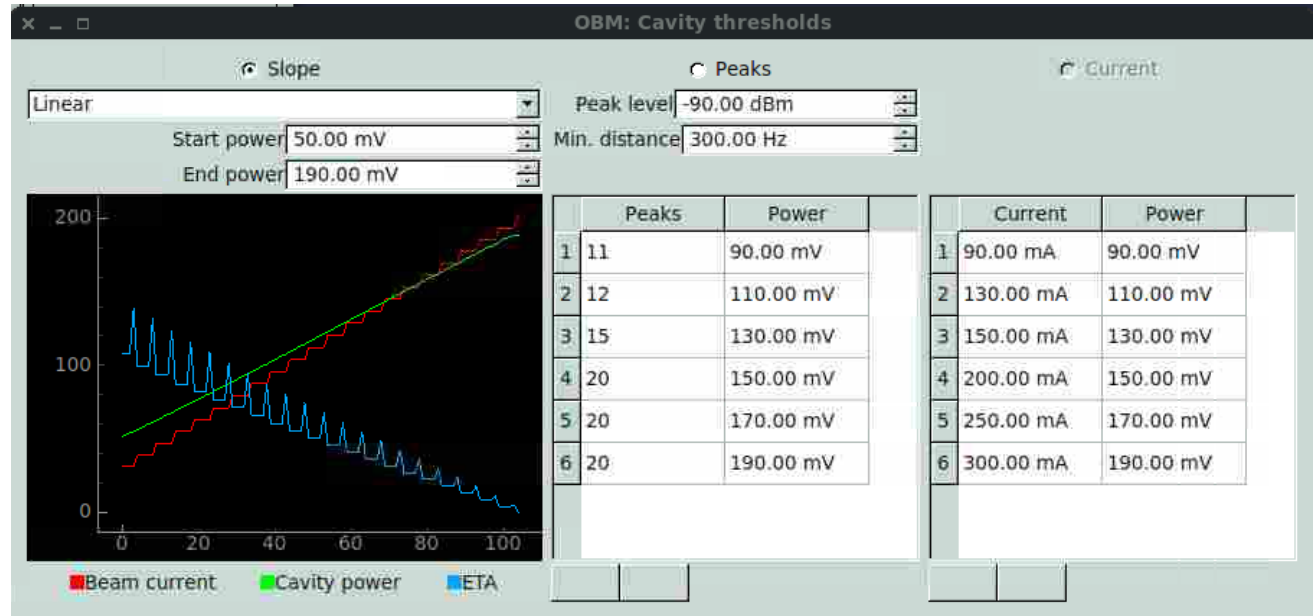
← Insertion devices positions

# Power tuning

Power tuning during injection can be done using two modes.

In slope mode, power increases linearly with current increase.

In peaks mode, power is increased in steps when there is enough peaks on spectrum.



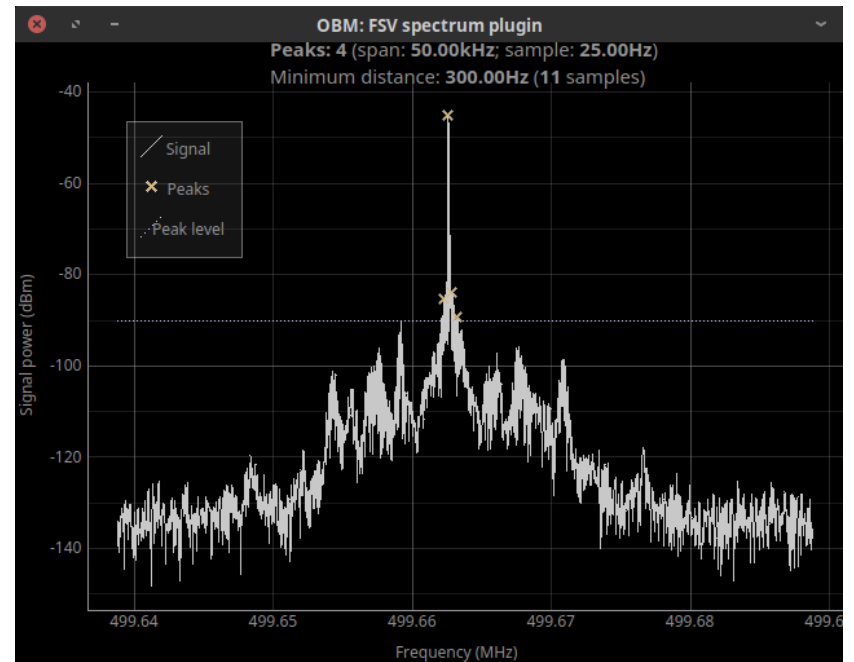
## Insertion devices positions

Insertion devices positions can be configured to automatic positions, which are the last positions set by the beamline.

Alternatively, values provided by the operator can be used.

# Spectrum view

Spectrum peak calculation and diagnostic view.



OBM: PLC and flags

- B\_R1\_MPS\_GeneralInterlocks\_OK\_S ● No interlocks present
- B\_Injection\_Enabled\_S ● "Start injection" flag
- B\_MachineStatus\_Injection\_S ● "Injection on" flag
- B\_MachineStatus\_BeamDump\_S ● "Beam dump on" flag
- B\_MachineStatus\_BeamDelivered\_S ● "Start experiment" flag
- B\_CallendarFlag\_MD\_Active\_S ● Machine day flag
- B\_CallendarFlag\_UOD\_Active\_S ● User operation flag

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- CyclingIsRunning ● Cycling is now running
- TuningEnabled ● Cavity power tuning is enabled
- playing ● PLENA is playing a voice message

# Flags

Flags window provides information on machine state and currently running operations.



# Outcomes

The most obvious outcome is the automation of the operator's work. This frees the operator to control and monitor other parameters during injection.

As the SOLARIS storage ring is operating in decay mode, it provides an easy way to reliably perform multi-step sequences, that need to be performed at least twice a day.

Some other, less obvious uses include:

- "Cheat sheet" and a learning tool for new operators
- Cavity power controller when playing with linac
- Basic diagnostic tool
- Running common operations without the need to dig through tens of GUIs