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PROPOSAL FOR 3 GHz AUTOMATIC CONDITIONING IN CTF3

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Abstract

An outline is given of a scheme to automate 3 GHz conditioning in CTF3. Relatively minor hardware modifications will be required. The software requirements are more demanding and will require both a workstation application and a time-critical programme resident in a VME chassis.

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1 Introduction

Presently, all 3 GHz conditioning in CTF3 is done manually and is extremely time consuming. It consists of slowly increasing the RF power from the klystron as a function of parameters such as the vacuum level in the waveguides and accelerating structures until nominal operating levels are achieved. The output power is changed by adjustment of a mechanically variable attenuator at the klystron RF input. Forward and reflected powers are observed on an oscilloscope and vacuum signals on a PC-based data acquisition system running LabVIEW installed in the klystron gallery. Much valuable operation time could be gained by automating this process and such a scheme is outlined in this note.

For a conditioning programme to be effective, it will have to be written in two parts. One part containing the time-critical components will be contained in a VME chassis. This will monitor forward and reflected power and vacuum signals and react quickly (ideally pulse-to-pulse) on the klystron drive level. The three existing DCTFRFM VME chassis will be the logical place for this to reside. They already contain the arbitrary waveform generators for controlling pulse compression as well as fast ADC cards for acquiring detected RF waveforms.

The software running in the VME chassis will be supervised by a second part of the conditioning programme that will consist of a high-level workstation application. This will contain the user-interface and link to the database and will also be used for controlling equipment not associated with the DCTFRFM chassis, such as the modulator.

It is important to note that, before starting the programme, the klystron must already be fully conditioned in diode mode to slightly above 100 % of the PFN/klystron voltage needed for nominal output power. This should be done up to nominal pulse length and with the PFN flatness optimised at the maximum value.

The experience gained with this project, as well as much of the software, will be valuable for a future 30 GHz automatic conditioning system.

2 Hardware requirements

Some hardware additions and modifications will be required:

Detected RF signal acquisition

Struck 3300 8-channel 100MS/s ADC cards are already installed in the DCTFRFM DSC’s for monitoring detected RF waveforms. For each klystron the following signals are already foreseen to be digitised:

Arbitrary waveform generator output
Klystron output forward amplitude
One accelerating section input forward amplitude
One accelerating section input forward phase
One accelerating section output forward amplitude
One accelerating section output forward phase

For the conditioning programme, two additional signals should be added:

Klystron output reflected amplitude
One accelerating section input reflected amplitude

Four Struck 3300 cards will therefore be required in each of the VME chassis.

Processor upgrade

Four conditioning programmes could be running in the same DCTFRFM VME chassis simultaneously. Whether or not the processor needs to be upgraded for this remains to be seen.

Vacuum monitoring in DCTFRFM DSC's

For the PC-based data acquisition system referred to in Section 1, cables have already been installed for relaying vacuum ion pump signals to the klystron gallery. A maximum of six signals can be selected for the waveguide system associated with each klystron.

In order for the programme to react fast, the vacuum signals must be read in the DCTFRFM DSC's. A 32-channel scanning ADC card will be sufficient for all the vacuum signals for the four klystron systems contained in one DSC. An inexpensive module with a maximum sampling speed of only 10µs per channel will be sufficiently fast. Standard AB/CO hardware should be used.

Control of driver amplifier output power

At present, the driver amplifier output power cannot be controlled remotely. However, this was foreseen and a card exists that can be added into the amplifier for this purpose. It consists of an 8-bit DAC for controlling the bias of the penultimate stage. Installation will require all amplifiers being removed and reinstalled.

Switching on and off these amplifiers is already done remotely via a PLC module and the simplest will be to use another PLC module for controlling the amplifier's output power. It should be associated with the DCTFRFM DSC.

3 Programme conception

A much simplified chart of the algorithm's structure is shown in Figure 1. The workstation part will have overall control. It will also directly control equipment that is not associated with the DCTFRFM chassis (e.g. pulse length and modulator voltage).

Once started and after a klystron has been selected, the workstation user-interface will allow many parameters to be set at run-time and to be changed during conditioning. They will be stored in the database so that previously used values for each klystron do not all have to be re-entered each time the programme is started. They include:

Pulse compression

Select conditioning with or without compression.

Modulator

Allowable modulator voltage range.

Klystron forward power

Start, stop and step size values.

Pulse length

Start, stop and step size values.

Vacuum

Lower threshold above which power is no longer increased.
Upper threshold above which power is decreased.
Possibility to ignore reading.

Reflected power

Lower threshold (% of forward power) above which power is no longer increased.
Upper threshold (% of forward power) above which power is reduced.
Number of consecutive threshold crossings required to activate power change.

Missing energy in klystron forward output pulse

Threshold (% of forward power) above which power should be reduced.
Maximum number of missing energy threshold crossings before conditioning aborted.

Interlocks

For specified interlocks, maximum number of trips after which abort conditioning.

Once the “start” button is pressed the workstation programme will set an appropriate modulator voltage for the required klystron power level. At the starting value of pulse length, the driver power will be increased to the starting value. The fast loop in the VME chassis will then continue increasing power unless stalled by vacuum activity, excess reflected power or missing energy in the klystron output. During this process the workstation application may increase modulator voltage if required. When maximum power is reached, the power is ramped down and the process is repeated for the next step in pulse length. The modulator will be restarted in the event of a trip. However, as a precaution, there will be a defined number of times the programme can do this before conditioning is aborted. The programme should check that the current read klystron forward power corresponds approximately to the value expected for the set value of modulator voltage and klystron drive level. In case of an anomaly, conditioning will stop and the modulator will be put on stand-by. Other incidents that will cause this to occur include too many klystron forward pulses with missing energy and communication errors.

The user interface should give the current status of conditioning. This should also be logged in the database.

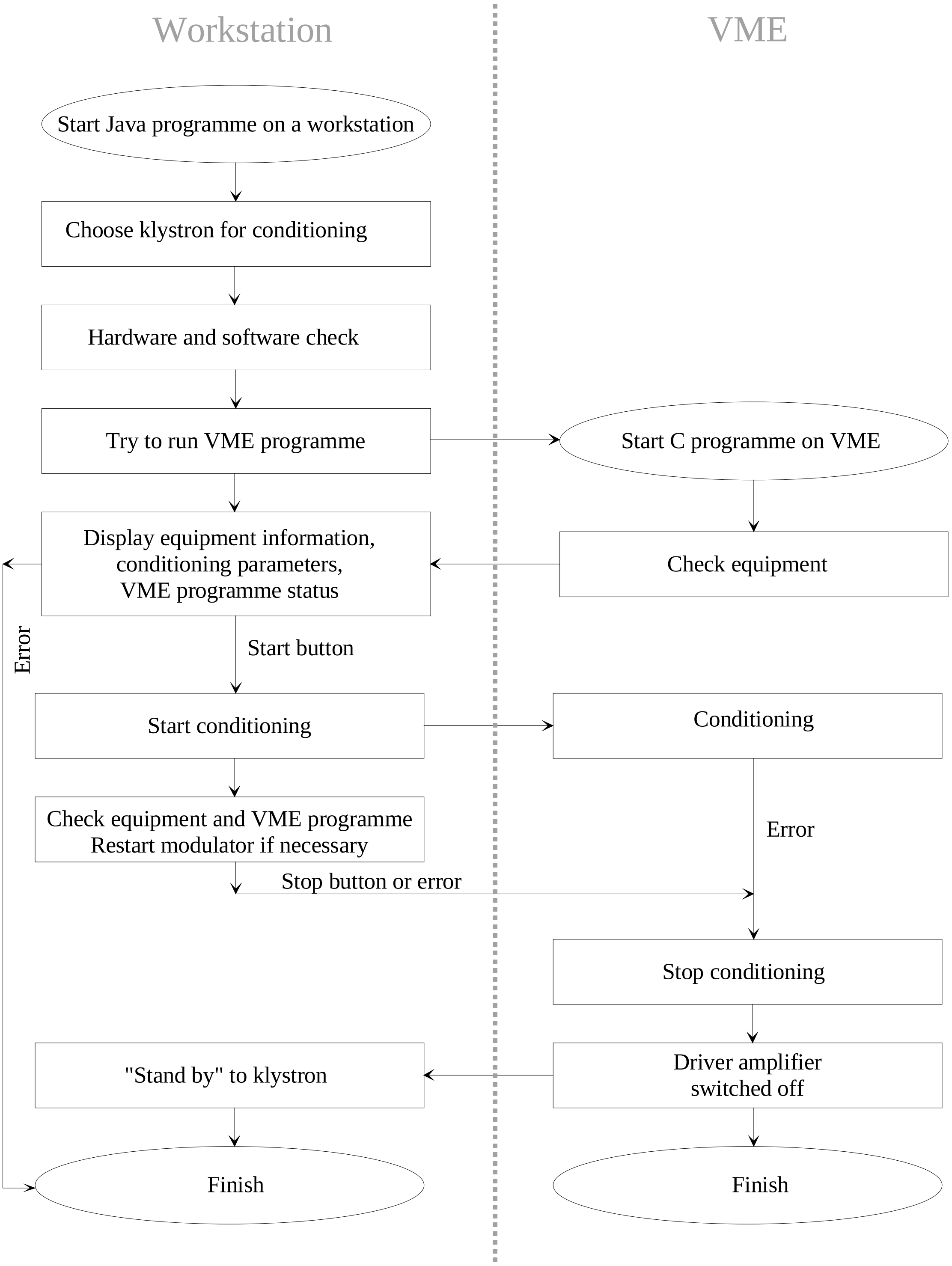

Figure 1 Simplified programme structure