RF Controls and Tuning Issues

MICE CM44

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Introduction

- Status of EPICS controls for the RF system.
  - Personal perspective.
- Controls Matrix by Tim, Kevin, et al.
- EPICS and PLC implementation by Peter Owens and Adrian Oates.
- Device list and parameter naming convention.
  - Work in progress.
- Thoughts on tuning.

Controls Matrix

- “Ctrls mat-69-ALLSTATES.xlsx”

Note1: Anode dissipation:
Pa = Va X Ia - RFout
Stepping through the States will be commanded by operater push-buttons on the RF GUI
Parameter numbers will be replaced, by parameter names, in due course.

								"OFF" State	"AUX ON" State	"EXTENDED STANDBY	"STANDBY" State	"BIAS ON" State	"HT ON" State	"RF ON" State	"R
	This row shows the pre-requisites to start execution of the state:									"AUX ON" State achieved; "E	"EXTENDED STANDBY" Stat	"STANDBY" State achieved;	"BIAS ON" State achieved;	"HT ON" State achieved;	"F "R
step seque	This row lists, by parameter number, the imperative order of execution of the sub-steps required for this State to be achieved.									NR	NR	13 Turn on 4616 grid PSU ; 11 Set 4616 grid voltage; 32 execute 116 cathode bias reset; 33 turn on 116 grid psu	37 and 38 check PPS perm	37 and 38 check PPS perm	37
ameter nur	parameter	"Enable" – binary-state output from control system	"Indication" - Binary-state Input to control system	Setpoint - analog	Readback - analog	Value	Comments								
									System must NOT be in remote	System in remote control??	Remote control? TBD				
1	4kW solid state amplifier	Enable via PSU PLC. (Also receives timing pulses, from pulse generator, via PSU PLC)	Amplifier on indication from PSU PLC to EPICS	no	no	"On" indication on RF GUI			NR	NR	NR	NR	NR	Enable SSPA; "amplifier o	"ar
2					Forward power; analogue to ctrl system (NOT an LLRF	0-10? = 0 to 4kW	>>>TPS to check whether SSPA has intrinsic SWR protection		NR	NR	NR	NR	NR	Indicate forward power on (	Inc

- Need additional info on which devices provide these parameters.

Parameter Naming Convention

- Meeting with Pete at DL.

- Proposal from Pete:
  - follow standard MICE convention: **device**[:*sub_system*]:**record**
    - **device** is the name of a physical device that is part of the RF system.
    - A device may optionally specify a *sub_system* if necessary.
    - The **record** identifies an individual property of the device.
  - **device** has the format **MICE-DDD-TTT-CCCC-NN**
    - **DDD** – is the domain and specifies the geographical part of the device name. E.g. CVU and CVD.
    - **TTT** – is the technical area that the device belongs to.
    - **CCCC** – is the component and defines the type of device.
    - **NN** – is a two digit number giving the instance of the device.

- Writing naming convention document.

Parameter Naming Convention: Domains and technical areas

- Domains
  - **CVU** – Upstream cavity
  - **CVD** – downstream cavity
  - **ENV** – Environment monitoring, e.g. radiation monitoring, ~~SF6~~ G3

- Technical areas
  - **RFP** – Devices that are part of the RF power amplification chain.
  - **VAC** – Devices that control or monitor vacuum in the cavity.
  - **WCO** – Devices that control or monitor water cooling.
  - **ACO** – Devices that control or monitor air cooling.
  - **GCO** – Devices that control or monitor glycol cooling.
  - **HYD** – Hydraulic devices (e.g. for mechanical tuners).
  - **DIA** – Cavity specific diagnostic devices including environmental monitoring (e.g. temperature)

Parameter Naming Convention: RFP devices

- DSSA – Dressler LPPA 2045-C solid state amplifier
- IPS – ISIS HT PSU (IPS-01 for 4616 and IPS-02 for 116)
- XPS3 – Xantrex XFR 300-4 PSU (for the 4616 grid.)
- XPS6 – Xantrex XFR 600-2 PSU (for the 4616 screen.)
- QPG – Quantum 9530 pulse generator
- APS – Agilent power sensor. (Attached to directional couplers?).
- APM – Anritsu power meter. (Attached to directional couplers?)
- MPM? – ??? Mains power module for the crates.
- CIU – Charger interface unit for 4616.
- FHC4 – Filament heater control unit for 4616.
- FHC1 – Filament heater control unit for 116.
- PLC1 – PLC module for the 116.
- PLC4 – PLC module for the 4616.
- ALE – A.L.E. 802L HV charging power supply.
- CPS – cathode power supply for 116.
- ETC – ??? Eurotherm 3504 Controller for filament heater. Is this controlled indirectly via the FHC?

Parameter Naming Convention: DIA and VAC devices

- VAC
  - SPC – Digitel Small pump control for the 4616 ion pump.
  - VIG – Vacuum ion gauge (??? brand and model). Monitors vacuum inside cavity couplers.

- DIA
  - TP – ??? temperature probe.

Controls Matrix

- Add device names to “Ctrls mat-69-ALLSTATES.xlsx”

		This row lists, by parameter number, the imperative order of execution of the sub-steps required for this State to be achieved.								NR
ameter nun	Device name	parameter	Enable – binary-state output from control system	Indication – Binary-state Input to control system	Setpoint analog	Readback - analog	Value	Comments		
									System must NOT be in rer	System in remote co
1	RFP-DSSA	4kW solid state amplifier	Enable via PSU PLC. (Also receives timing pulses, from pulse generator, via PSU PLC)	Amplifier on indication from PSU PLC to EPICS	no	no	“On” indication on RF GUI		NR	NR
2	RFP-DSSA					Forward power; analogue to ctrl system (NOT an LLRF function)	0-10? = 0 to 4kW	>>>TPS to check whether SSPA has intrinsic SWR protec	NR	NR
3	RFP-PLC4 (check which label on PLC this corresponds to)	4616 crowbar heater		"Crowbar OK"			"Crowbar OK" indication on RF GUI	Indicates that crowbar heater warm-up timer has finished.	NR	NR
4	RFP-PLC4 (check which label on PLC this corresponds to)	4616 Air supply		"Air OK"			"Air OK" indication on RF GUI		"Air OK" indication from 461	Air OK indication fr

- Some unknown devices. Mainly LLRF, tuners and cavities.

Plans and Questions

- Finalise device list and parameter naming convention.
  - Details from LLRF, fast monitoring and environment (SF6, radiation, etc.).
- Check interfaces for the devices.
- Update controls spreadsheet with new parameter names and convert to MICE EPICS spreadsheet format.
- Questions:
  - Check turn on procedure.
    - Castell keys and Aux On, standby states.
  - Include interlock devices?

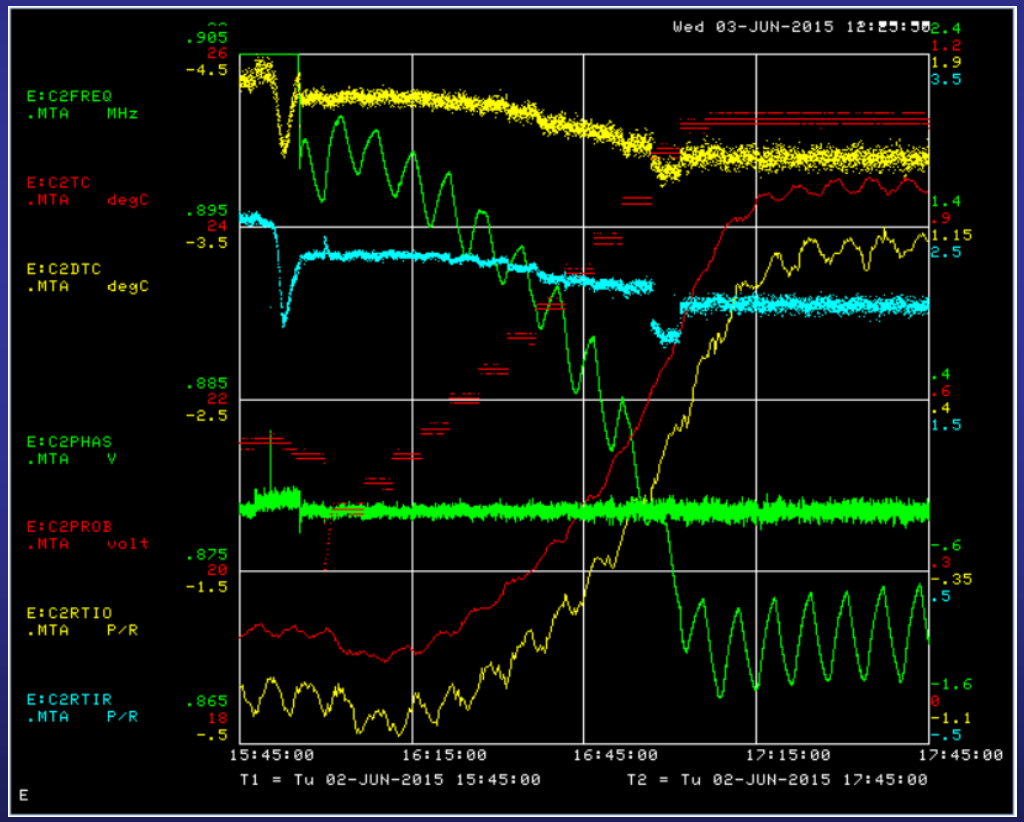
Tuning

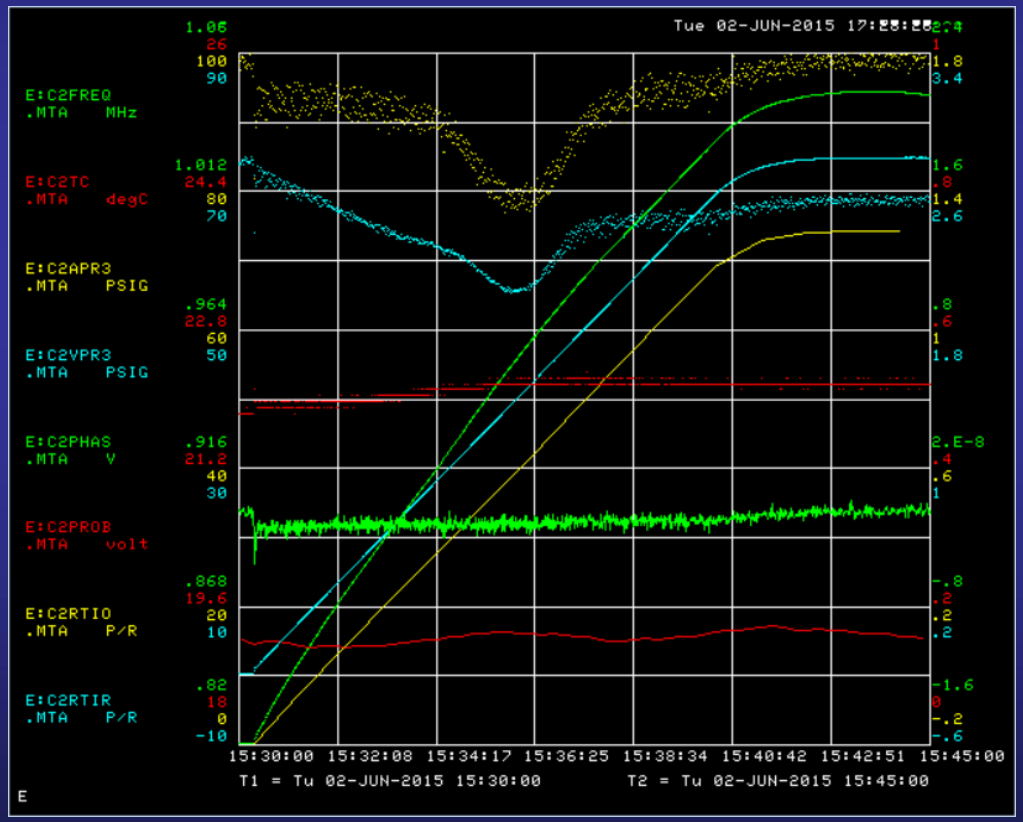
- Need to tune
  - While ramping up.
    - Resonant frequency variation as cavity warms up.
  - Tuning in steady state.
    - Resonant frequency should not change.

- Tuning methods
  - Mechanical tuners.
    - Hardware from LBNL. Software needs to be developed (EPICS).
    - Input (frequency) from LLRF?
    - Deformation?
  - Cooling water.
    - Adjust flow?
  - LLRF?
    - Variable frequency and bandwidth of amplifiers.

Info from Yagmur

- Copper mass of cavity = 227 kg
- Tuning rate vs actuator gas pressure = about +3/-4 kHz/psi
- Tuning rate vs cavity body temperature = about -6 kHz/C





Tuning

- Avoid having all tuning systems running simultaneously!

- Some questions:
  - What is available water flow rate and can this be remotely controlled?
  - Can we adjust frequency of LLRF while ramping up?
  - What is mechanical tuner psi-tuner arm movement relationship?

- Can we adjust frequency with LLRF while coming up to operating temp and only adjust cooling water flow?
- Once at operating temperature (35 °C) turn on mechanical tuners.