

# HINS 325 MHz Cavity Test Cave RF System Commissioning Procedure

Bob Webber

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## Introduction

325 MHz “Cavity Test Cave (Cave) commissioning is the activity of establishing RF power through the waveguide system, the 3 1/8” coaxial RF power switch, and the 3 1/8” coaxial RF power distribution system into the cavity test cave. There are two RF transmission lines into the Cave, one capable of 250kW and one capable of 25kW; both lines are included in this procedure. Commissioning includes verifying the performance and safety of these RF power distribution and control systems.”<sup>1</sup>

This document details the steps to be performed for the Cave RF system commissioning task. This document is not intended to be a 325 MHz Cavity Cave operating manual nor does it describe procedures for testing particular RF cavities or components in the 325 MHz Cavity Test Cave.

Figure 1 is a block diagram of the 325 MHz RF Power Distribution System. This commissioning procedure is primarily concerned with sections downstream of the coax switch.

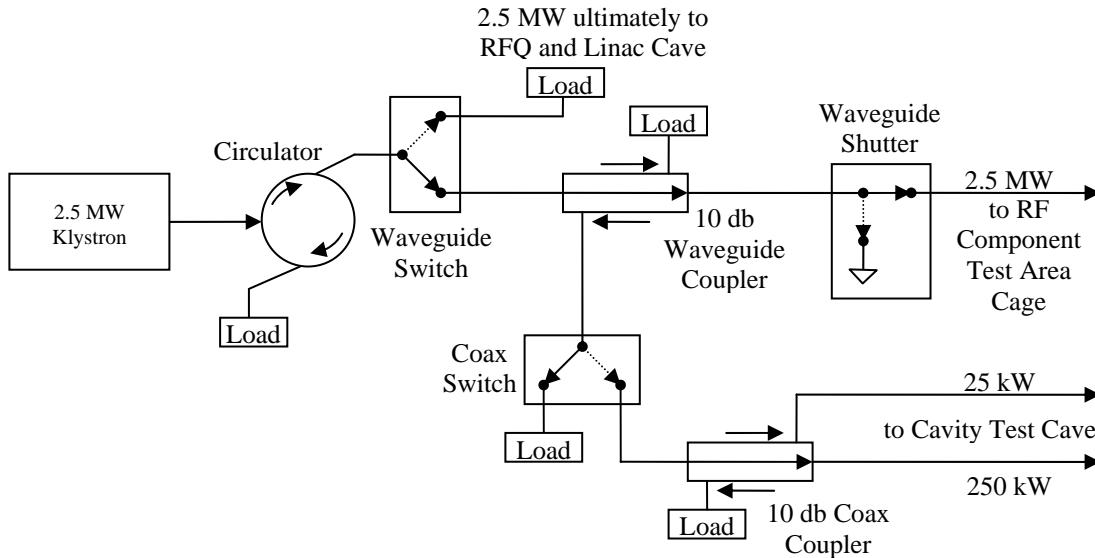


Figure 1. RF Power Distribution System

<sup>1</sup> “HINS RF Commissioning Run Plan”, Beams-doc #2616

## **Prerequisites**

The Run Plan requires the following documentation prior to starting 325 MHz Cavity Cave commissioning. Check that these documents are available.

- Approved Cave interlock and search/secure procedures (by AD ES&H)
- Approved RF Cave LOTO procedure (use 325 MHz RF Power Distribution System LOTO Procedure ADDP-RF-7902, Beams-doc #2701)
- Approved klystron/modulator operating procedures (HINS White Binder in MDB)
- RF and Klystron Equipment Interlock Test Procedure/ Checklists for Cave commissioning (this document and klystron/modulator operating procedure)
- 325 MHz Cavity Test Cave commissioning procedure (this document)

Tasks that must be completed:

- Full or conditional completion of klystron commissioning
- Completion of the RF Cage commissioning procedure at least through “Commission Waveguide Up to Shutter and 3 1/8” Coax Up to Coax Switch”
- Final Area/Equipment Walkthru – M. Andrews, TBD
- Verification of required RF power distribution system configuration – R. Webber or designee

## **Required Configuration for Cavity Test Cave Commissioning**

The RF distribution system shall be configured such that RF power may be applied to any part of both the waveguide and the coaxial sections of the distribution system except downstream of the waveguide shutter.

- 1. The waveguide switch shall be positioned (not necessarily locked) to direct RF energy toward the Cave. (Note: subsequent to completion of klystron commissioning, operation into the RF load at the other position of the waveguide switch is acceptable, although it is not the position for Cave commissioning.)
- 2. The waveguide shutter shall be locked in closed position.
- 3. The coaxial RF port in the RF Component Test Cage shall be blanked off with a conducting plate, unless Cage commissioning has been completed and resultant RF Cage operational procedures are followed.
- 4. The coaxial switch in the 3 1/8” coaxial line shall be positioned as required by steps in this commissioning procedure.
- 5. The ends of each of the two 3 1/8” coaxial RF transmission lines inside the Cave shall be terminated with suitable RF load or conducting plate.

- \_\_\_\_\_ 6. The Cave, an enclosure secured by an AD ES&H Dept. interlock system, shall be secured according to the interlock procedures prior to any operation with the coax switch in the “Cave” position (unless interlock change request has been approved by AD Safety to operate under other conditions).

## **Procedure**

1. With waveguide switch positioned to direct the power into the immediately attached RF load, follow the klystron/modulator operating procedure to turn on and warm up klystron to 2.5 MW output power with 3.5 msec RF pulse width.
2. Reduce klystron power output level to 500 kW.
3. Turn off klystron/modulator and set the waveguide switch position to direct power toward the RF Cage/Cavity Cave.
4. Verify that the coaxial switch is still in the LOAD position.
5. Turn on klystron/modulator to 500 kW klystron output power.
6. Measure and record forward and reverse signal levels and computed forward and reverse power levels at the klystron output coupler. The klystron reverse power should be low, at least 20db lower than the forward power. If this is not the case, this must be resolved before proceeding.
7. Measure and record forward and reverse signal levels and computed forward and reverse power levels at the circulator coupler. The circulator forward power should agree closely with the klystron forward power measured in step #2. The circulator reverse power should be about 20% lower than the forward power. If this is not the case, this must be resolved before proceeding.
8. Measure and record forward and reverse signal levels and computed forward and reverse power levels at the 3 1/8" coax coupler immediately upstream of the 3 1/8" coax switch. The forward and reverse powers should be in agreement with similar measurements made at this klystron power level as part of the RF Cage Commissioning procedure. If this is not the case, this must be resolved before proceeding.
9. Measure and record forward and reverse signal levels and computed forward and reverse power levels at the 3 1/8" coax coupler immediately downstream of the 3 1/8" coax switch. The forward and reverse power levels should both be small, at least 40db lower than those observed upstream of the coax switch. If this is not the case, this must be resolved before proceeding.
10. Turn off klystron/modulator and set the coax switch position to direct power toward the Cave.
11. Turn on klystron/modulator at 500 kW klystron output power.
12. Measure and record forward and reverse signal levels and computed forward and reverse power levels at the 3 1/8" coax coupler immediately downstream of the 3 1/8" coax switch. The forward power should be in agreement with that

measured at the coupler upstream of the switch in step #8 and the reverse power should be at least 15 db lower. If this is not the case, this must be resolved before proceeding.

13. Measure and record forward and reverse signal levels and computed forward and reverse power levels at the 3 1/8" coax coupler in the 250 kW transmission line inside the Cave. The forward power should be approximately 10% less than that measured in step #12 and the reverse power should be at least 15 db lower than the forward power. If this is not the case, this must be resolved before proceeding.
14. Measure and record forward and reverse signal levels and computed forward and reverse power levels at the 3 1/8" coax coupler in the 25 kW transmission line in the Cave. The forward power should be approximately 10db less than the forward power measured in step #12 and the reverse power should be at least 15 db lower than that. If this is not the case, this must be resolved before proceeding.
15. Repeat steps #12-14 at klystron output power levels of 1000, 1500, 2000, and 2500 kW while being watchful of possible sparking in waveguide and/or coax transmission line system. Any sparking must be resolved before proceeding further.
16. At klystron output power of 2500 kW and using loop antenna, snoop around all 3 1/8" coax transmission line joints looking for RF leaks. If any particular joint is 20 db worse than typical of the other coax line joints, it must be noted and the problem resolved.
17. Turn off klystron/modulator and set the coax switch to the LOAD position.
18. Turn on klystron/modulator at 2.5 MW klystron output power.
19. Measure and record forward signal levels and computed forward power levels at the 3 1/8" coax couplers immediately upstream and immediately downstream of the 3 1/8" coax switch to determine isolation provided by the switch at this power level.
20. Turn off klystron/modulator and lock the coax switch in the LOAD position.

### **Definition of Completion of Cavity Test Cave Commissioning**

RF power shall have been successfully delivered to Cave at >200 kW and >20 kW peak pulse power into the respective distribution paths at 3.5 millisecond RF pulse length and with maximum duty cycle supported by the presently installed modulator charging power supply.

AND under those conditions:

- 1. Power level and timing controls have been demonstrated to operate as designed.
- 2. RF equipment interlocks have been demonstrated to function satisfactorily.
- 3. RF leakage from relevant sections of the RF power distribution system has been verified as acceptable within guidelines of Fermilab ES&H and Radiological Control Manuals and IEEE Standard C95.1.

- 4. The 3 1/8" coaxial switch attenuation has been measured at klystron output power of 2.5 MW.
- 5. Power coupler calibrations shall have been established.
- 6. Any sparking issues shall have been resolved.

AND an approved Cavity Test Cave operating procedure is available.