

*ICTF*  
*Progress on the MICE RF System*



*Andrew Moss*

*ASTeC*

*TIARA Mid term meeting*

*12<sup>th</sup> 14<sup>th</sup> June 2012*

*CIEMAT*

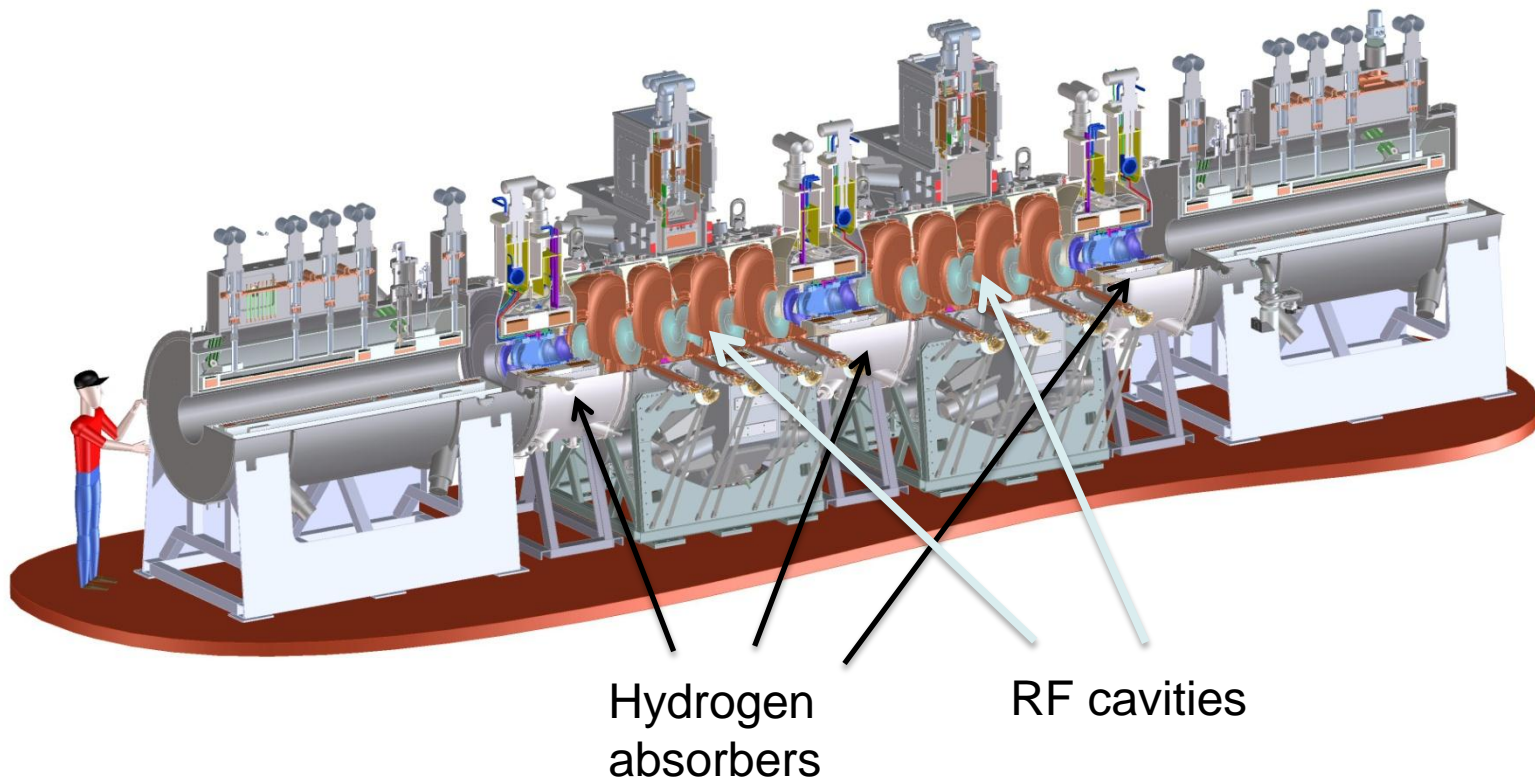


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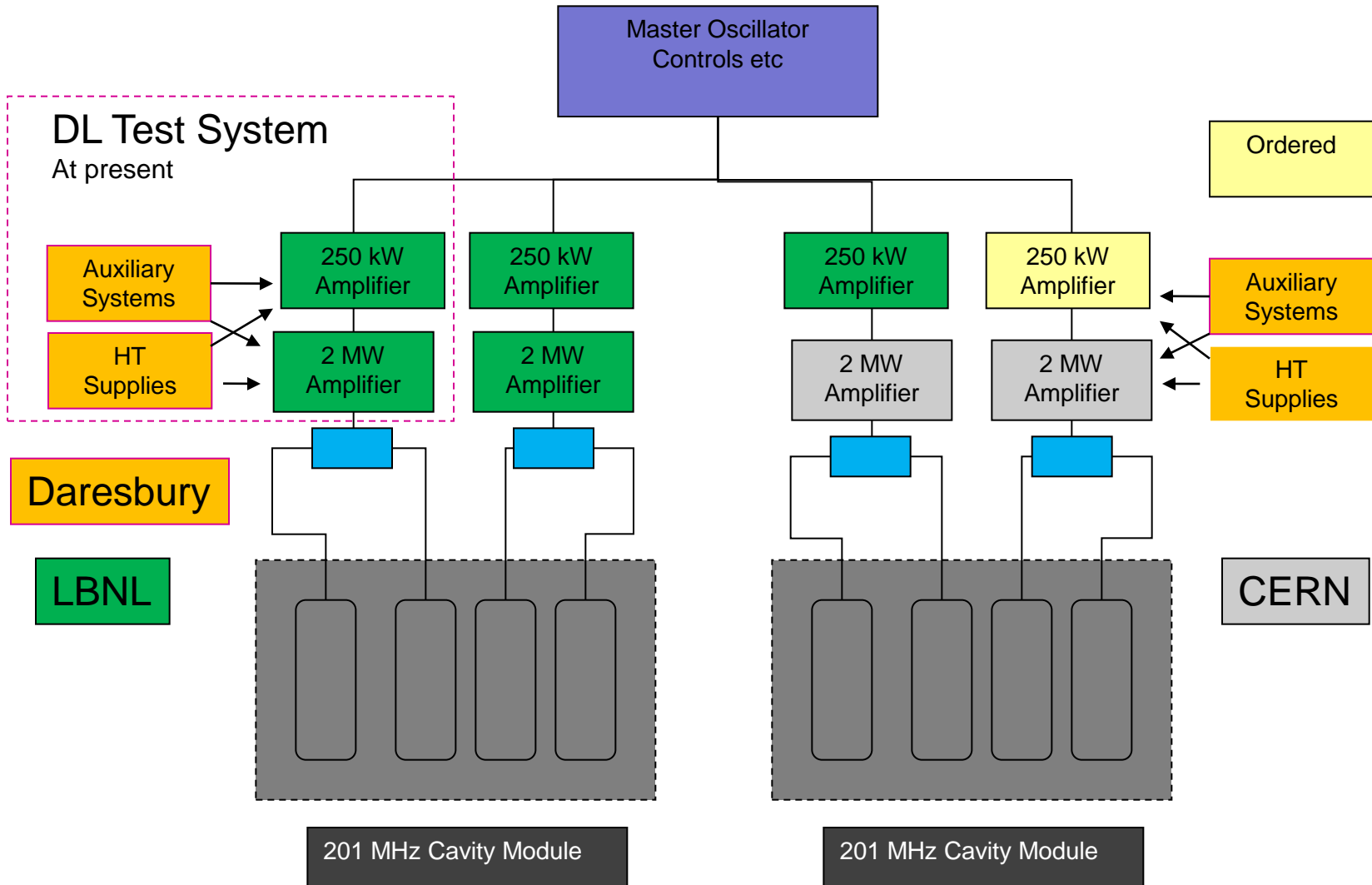
- Brief amplifier introduction and status
- Amplifier testing
- Results of RF review
- Hall layout
- ICTF upgrade amplifier
- Conclusion

# *Muon Ionisation Cooling Experiment*

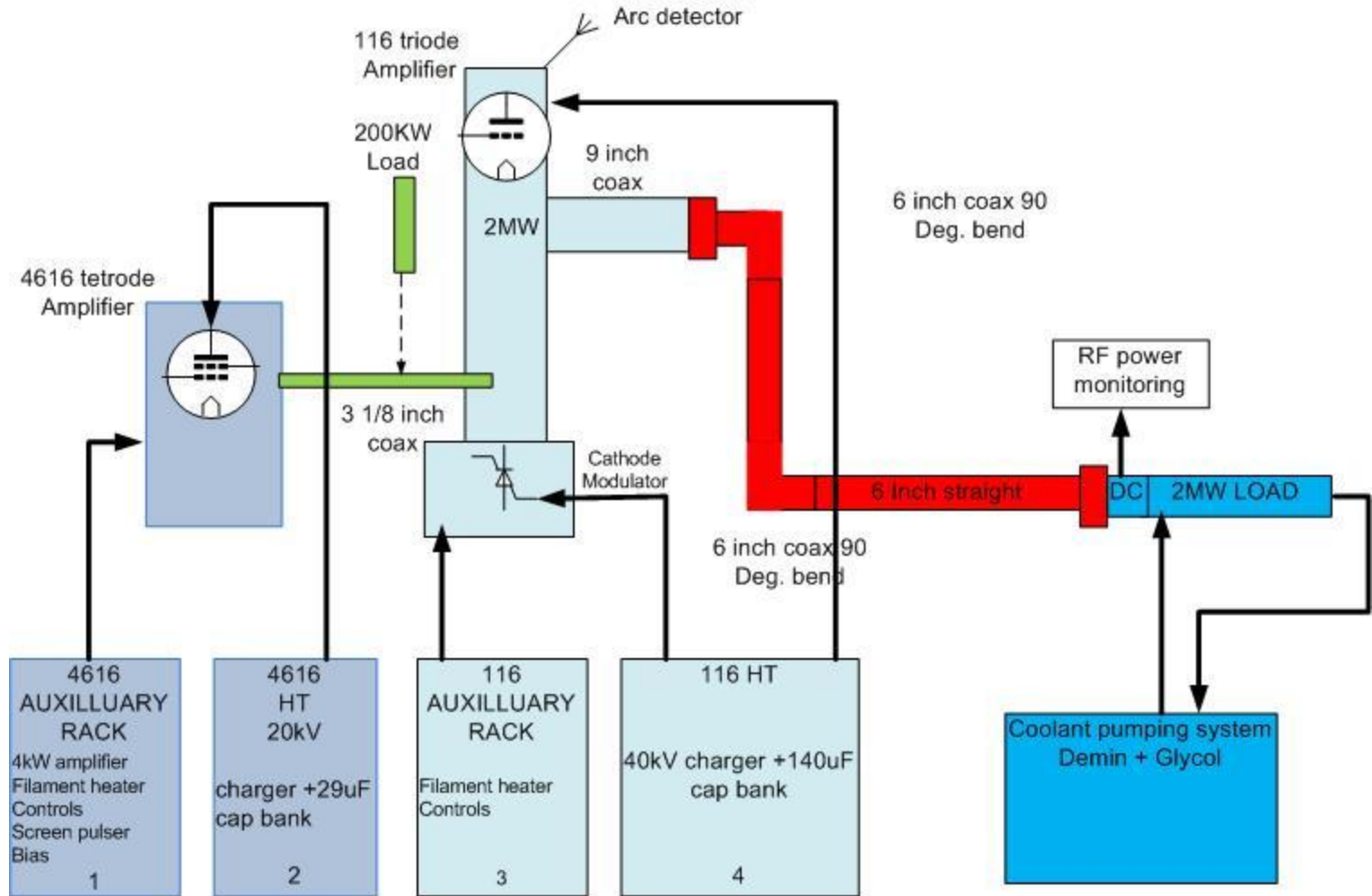
## *MICE*



# RF system components



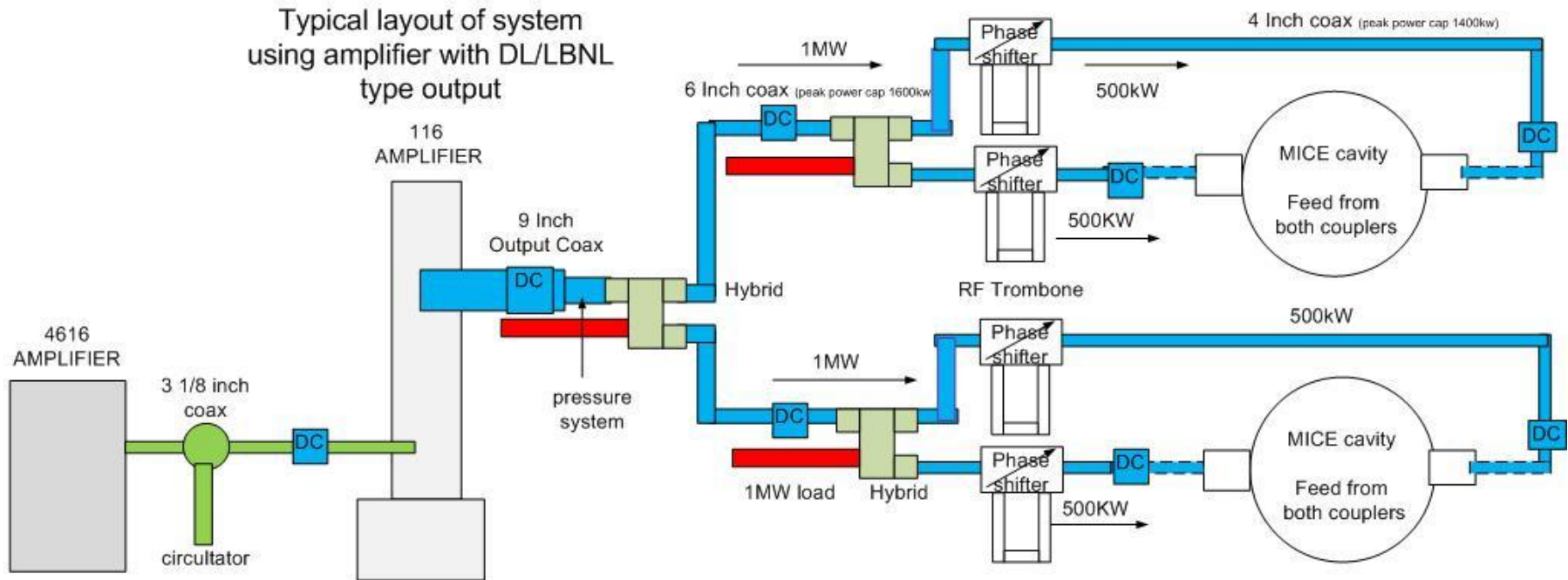
# Test system at Daresbury



Daresbury test setup for proving amplifiers/power supplies

## *Amplifier layout*

Typical layout of system using amplifier with DL/LBNL type output



4616  
AUXILLUARY  
RACK

4616  
HT

116  
AUXILLUARY  
RACK

116 HT RACK &  
CAPACITOR BANK

DC = directional coupler= power measurement

# Amplifiers

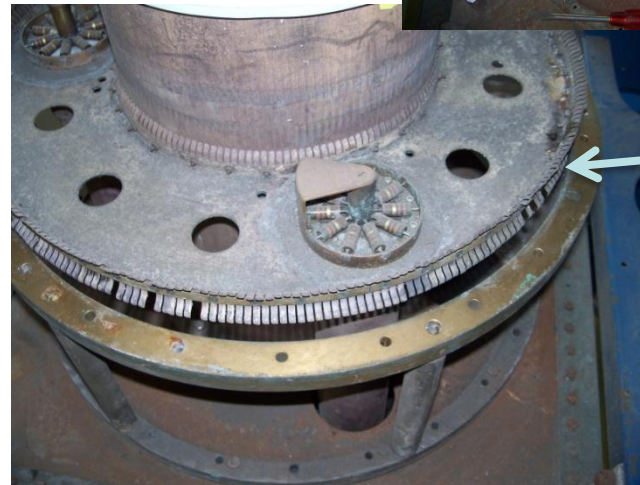


TH116 Triode cavity

4616 tetrode cavity



Triode grid circuit



## *Status of Amplifiers and power supplies*

- Test bay at DL is operational and able to test amplifiers and power supplies as they become available
- First 250kW amplifier has operated at 100kW with old tube, then 240kW with new tube fitted during 2012
- First TH116 high power amplifier has operated at 1MW during 2011 using an old RAL tube – new tube fitted now, awaiting test with driver at 200kW – should produce 2MW
- Two further 250kW amplifiers are being refurbished now
- Two refurbished 2MW CERN amplifiers refurbished but awaiting assembly and high power test
- Still need to build 3 more sets of power supplies – including set for TIARA tests in experimental hall
- One more 250 kW amplifier has been bought, and is currently under test at the manufacturers - operating at full power



# *Refurbished TH116 Triode amplifier*



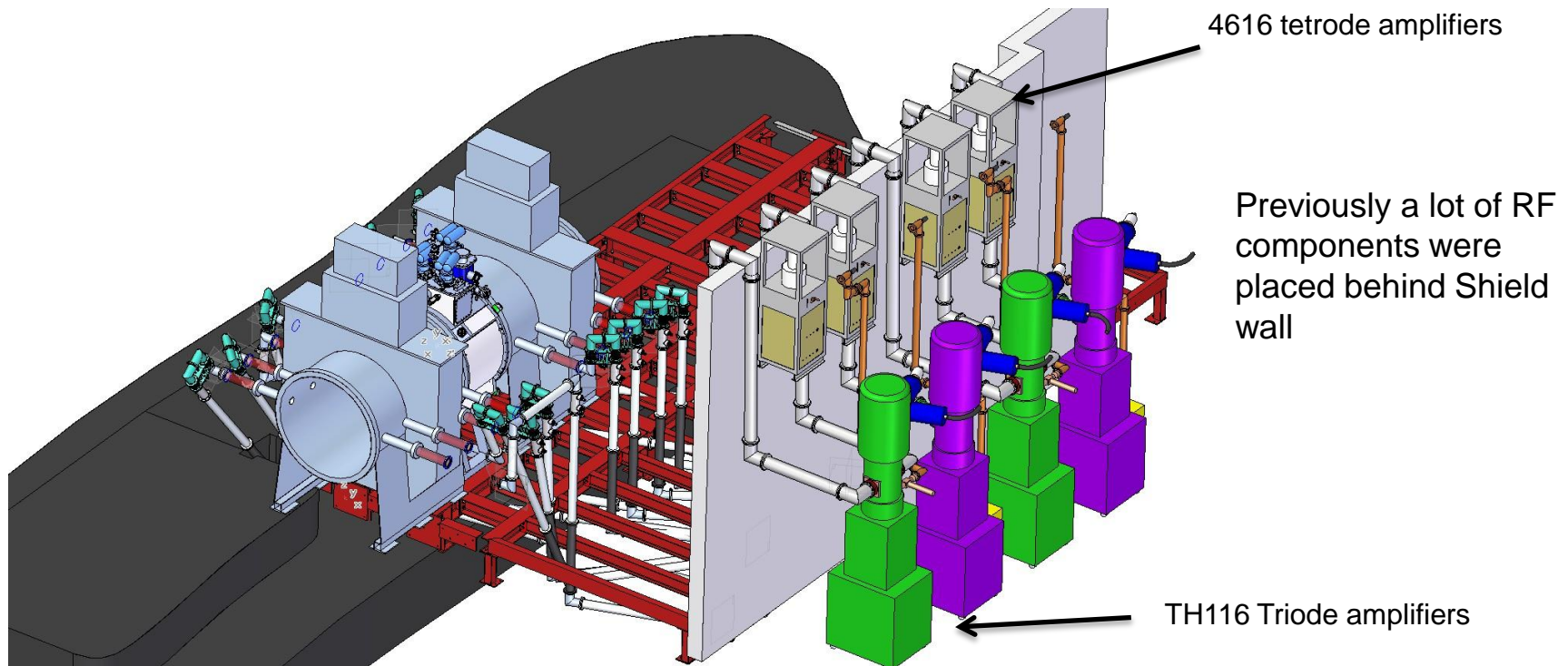
## *RF and power supply testing*

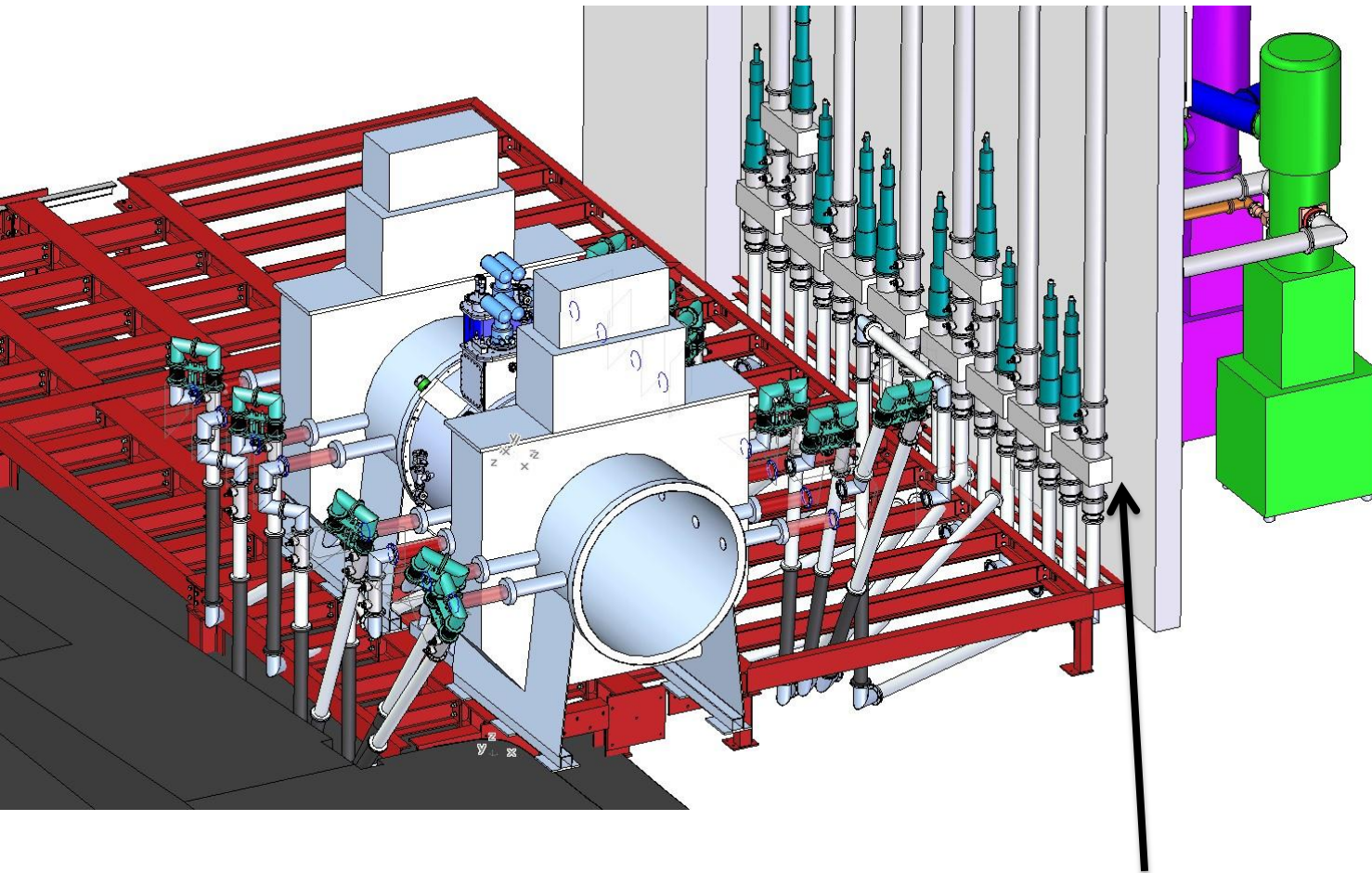
- A number of power supply and amplifier issues have been solved during testing so that stable operation can be achieved
- System pushed to 1MW RF output with 50% electrical efficiency, good gain and no noticeable microwave or X Ray leakage



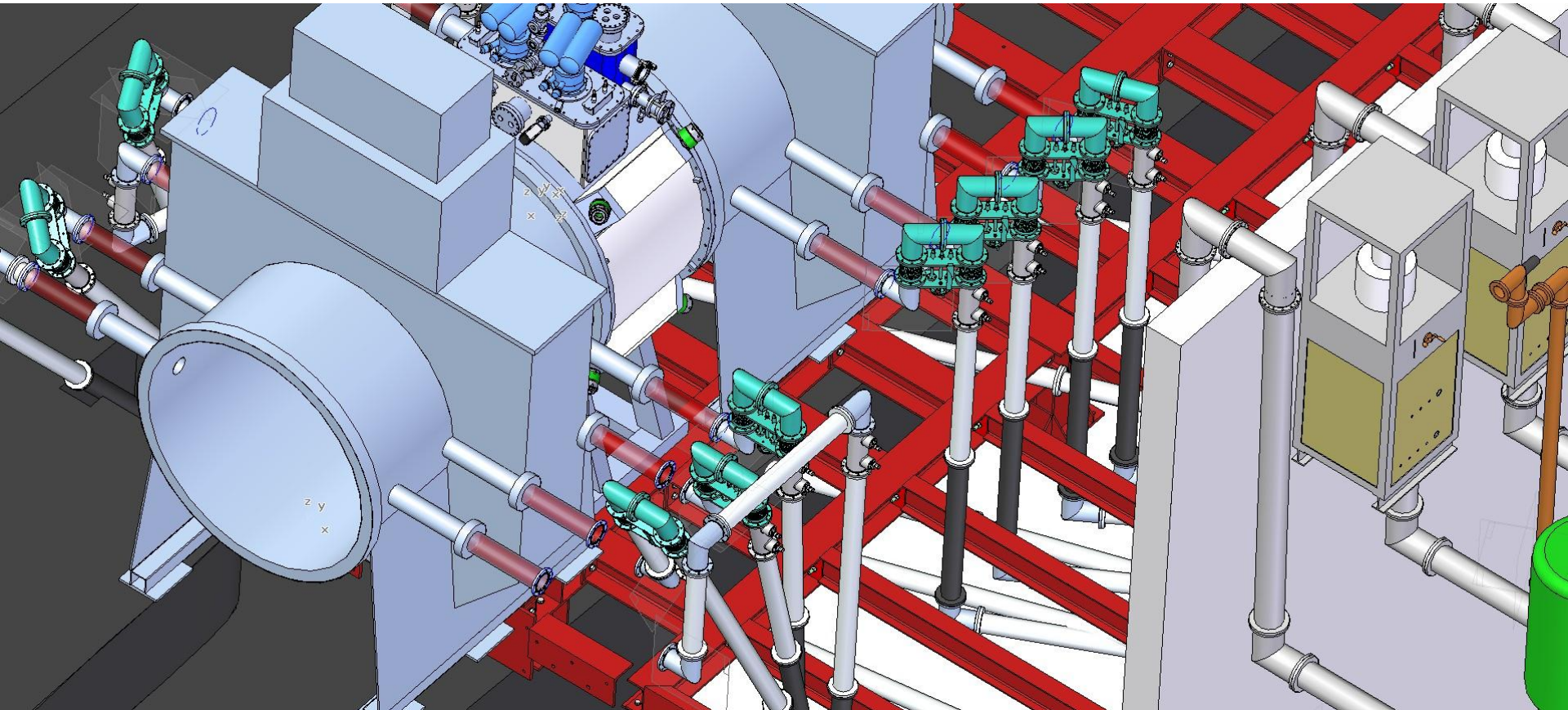
# Review of the ICTF RF system

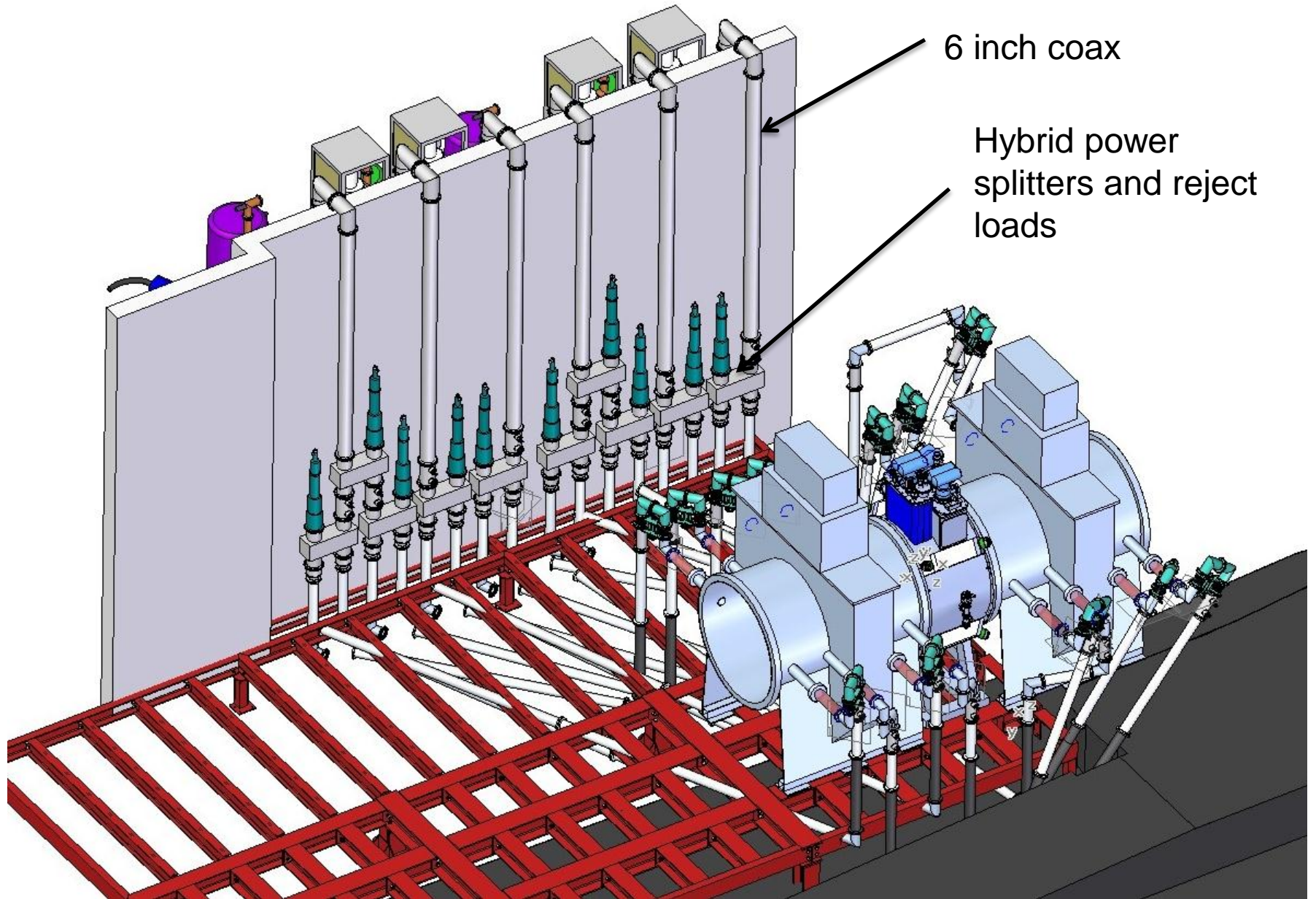
- Review meeting held in December 2011 to assess all aspects of current RF system design and strategy - praise for the design work we had done and the results with the amplifiers
- The main concern of the review panel was of the RF coax layout, the panel suggested a different layout that would improve access to the amplifiers and simplify the coax runs.
- This was taken on board and a new layout designed

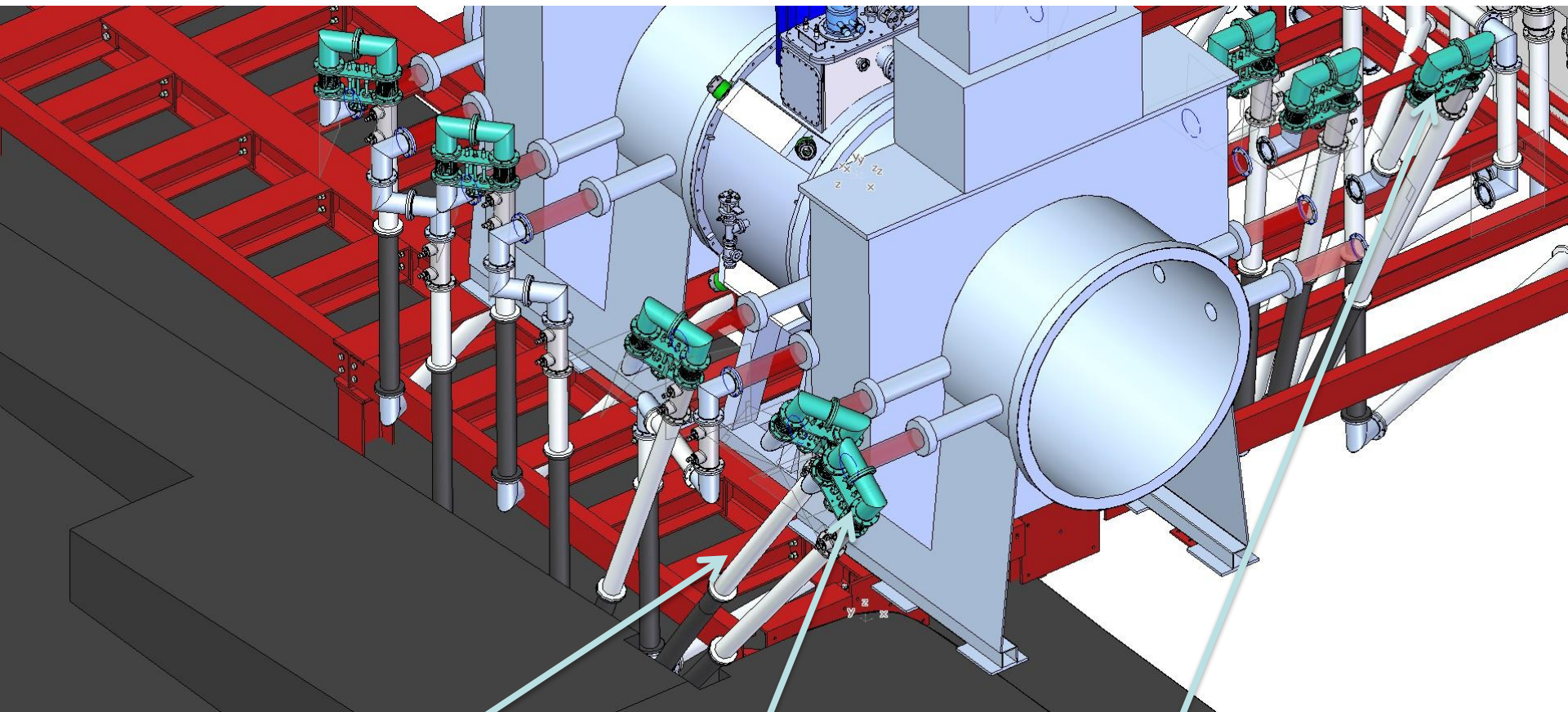




Hybrid power splitters on inside of magnetic shield wall







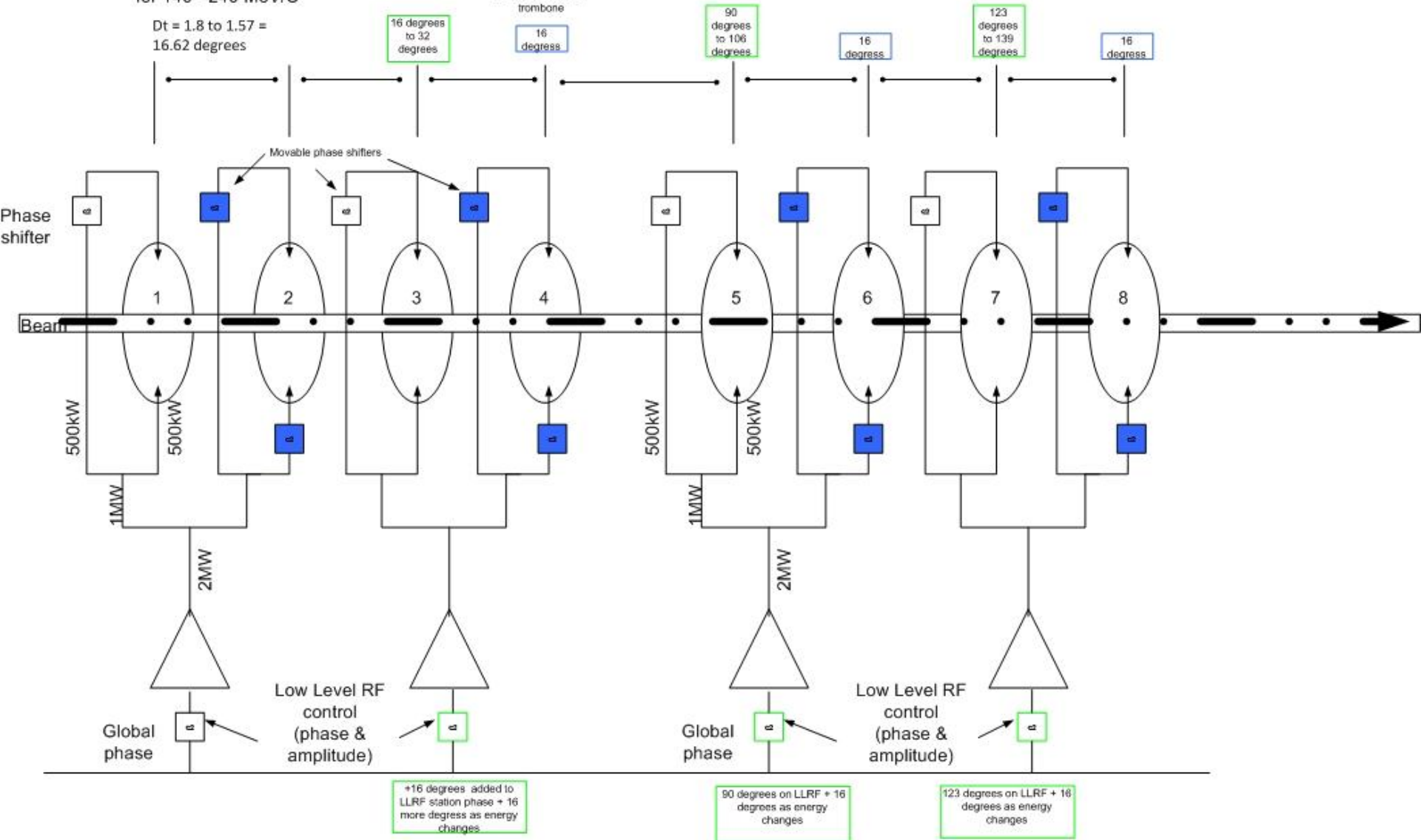
4 inch coax

Manual phase shifters used to adjust phase length

for 140 - 240 MeV/c

$Dt = 1.8 \text{ to } 1.57 = 16.62 \text{ degrees}$

16 degrees = 6.6 cm of travel = 3.3 cm in a trombone



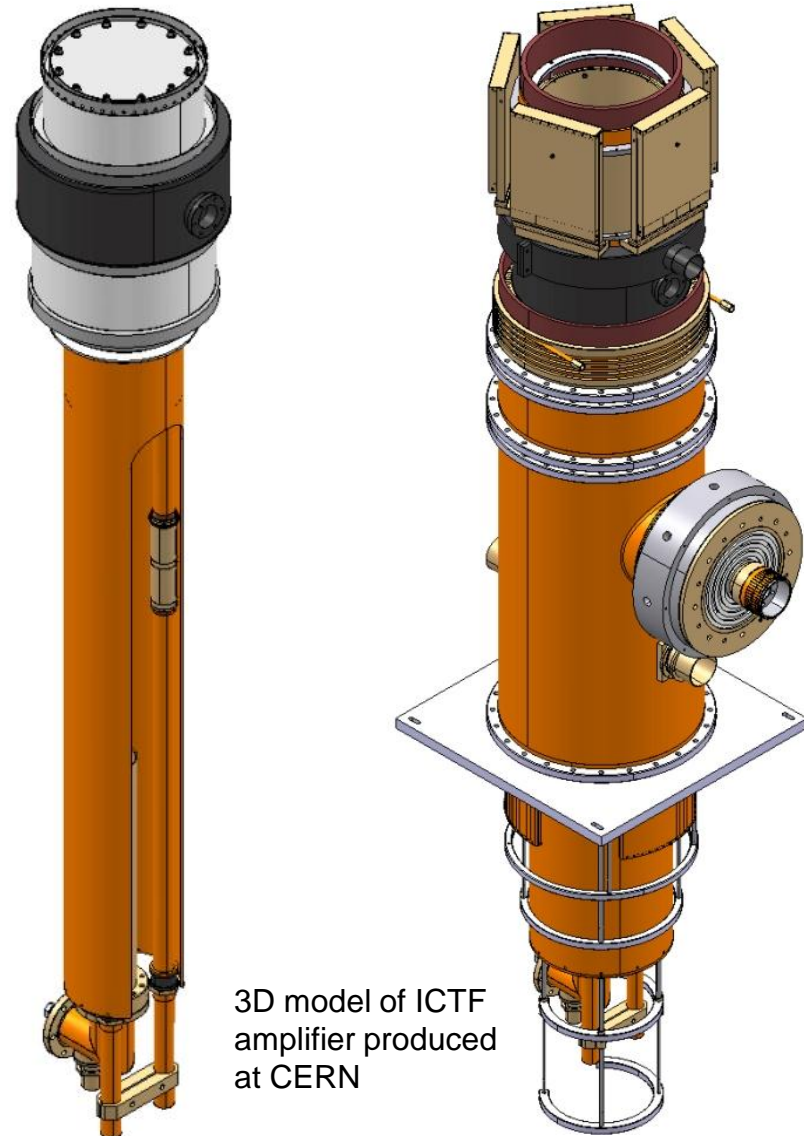


## *RF to beam synchronisation*

- Cavity phase and amplitude will be stabilised to 0.5 deg and 1% with the ability to run as high a gradient as possible
- Muon particles will arrive randomly in the cooling channel for acceleration at various energies
- Cavity phase angle will have to be measured and time stamped for analysis after a period of running
- Time of flight detectors along the cooling channel will be used to trigger electronics to measure and digitise the state of the cavity phase angle to  $< 15$  pS
- Groups from Sheffield and Strathclyde University's in conjunction with DL and LBNL are working on possible solutions for this area of the experiment

## *task 7.2 : Novel pulsed RF power amplifier design*

- Work has started on a review of the state of development of diacrode systems in the international community.
  - One goal of this review is to identify designs or recommendations of “best practice” that can be incorporated into the design that will be developed.
  - In particular, contact has been made with Los Alamos where diacrode tests are in progress.
  - Taking into account the results of these tests will be important in the development of the amplifier design for the ICTF.
  - A visit to Los Alamos facilities took place in March 2012 where the diacrode was seen operating at 3.1MW
  - TIARA pulse conditions will be tried and expect to produce 3.5MW with report to follow
- First deliverable : Simulation of Diacrode complete, planned 31/5/12.
  - Drawings of the diacrode amplifier have been procured from THALES.
  - These drawings will be essential when the design work on the ICTF amplifier starts in earnest.
  - The space constraints of the application in the ICTF Hall will require special consideration.



3D model of ICTF amplifier produced at CERN

## *Summery*

- One amplifier system and its associated power supplies has been assembled and tested to 1MW so far
- We plan to replicate the power supplies and install them in the ICTF hall at RAL – this will allow testing to continue and satisfy TIARA requirements
- RF review has prompted a new round of optimisation of coax distribution that looks to make things easier in a number of areas, space around the amplifiers, lower transmission loss, easier to install
- 3D cad model of ICTF upgrade amplifier has been done, tests at Los Almos with TIARA conditions will feed into the optimisation of the eventual design