RF Workshop 16-17 April 2012 , Daresbury

Aims:

-- finalize specifications of the MICE RF system

-- prepare response to RF reviewers

-- Initiate MICE-wide RF group

    -- take steps to prepare to deliver the RF system at RAL

    -- update WBS

    -- include a RF system test as necessary

Excellent organization
(Sue Waller, Alan Grant, Andy Moss, Ken Long)

Agenda

Monday, April 16, 2012

14:00 – 14:10 Aim of Workshop
Speaker: Ken Long
Slides:

14:10 – 14:30 MICE experimental programme and constraints on the RF system
Speaker: Alain Blondel
Slides:

14:30- 15:00 Response Report submitted to Review Panel
Speaker: Andy Moss
Slides:

15:00 – 15:30 RF Power Specification
Speaker: Andy Moss
Slides:

15:30 – 15:50 Coffee/Tea

15:50 – 17:30 Specification & RF System Test Discussion
Convener: Ken Long
Slides:

Working Dinner……

To ensure completion of aims, I propose:

- Discussion scheduled at 15:50 includes:
  - Specification, response to feedback and shopping list
- Revised drafts will be produced by AG/KL before dinner, if possible, to allow final comments by lunch 17Apr12;
- KL will revise documents during tour of Plant Room 1 and circulate final revision for final session

Discussion will lead to completion of the organisational aim and I will prepare a slide or two to document what we've agreed for presentation at the end of 17Apr12

Tuesday, April 17, 2012

09:00 – 09:30 DAQ considerations
Speaker: Paul Smith
Slides:

09:30 – 10:00 Integration with MICE DAQ
Speaker: Yordan Karadhzov
Slides:

10:30 – 11:00 LLRF/DAQ Open Discussion
Slides:

11:00 – 11:20 Coffee/Tea

11:20 – 11:50 Gradient, Cavity Phasing & Phase Control
Speaker: Kevin Roland
Slides:

11:50 – 12:20 RF Cavities
Speaker: Derun Li
Slides:

12:20 – 13:45 Lunch

13:45 – 14:30 Visit plant room 1 - Amplifier commissioning

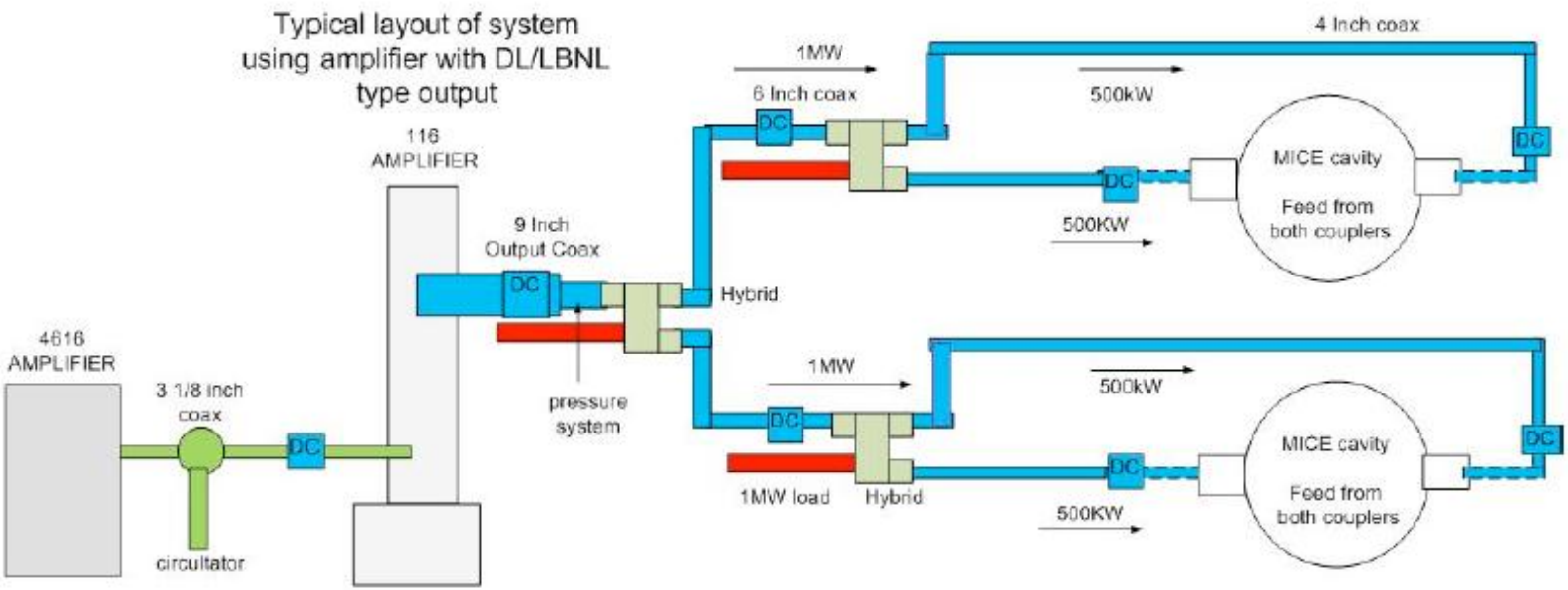
14:30 – 14:50 RF Layout
Speaker: Alan Grant
Slides:

14:50 – 15:10 Coffee/Tea

15:10 - 16:30 Specification, schedule and procurement discussion
Convener: Ken Long
Slides:

OUTCOME 1   Specification document

-- MICE note 372 --



important decision: cavity phase between the two cavities powered by a given amplifier is fixed (no phase shifters)
This is enough to provide 98% ao maximum between 140 and 240 MeV/c operation and saves at least as much power loss in 'trombones'

Table 1: Relative phase of neighbouring cavities for the muon momentum range of interest to MICE.

Momentum (MeV/c)	Total Energy (MeV)	Kinetic Energy (MeV/c^2)	Gamma	Beta (v/c)	Transit Time ns	Phase Shift (degrees)
140	175.40	69.74	1.686	0.805	1.814	131.46
160	191.74	86.08	1.842	0.840	1.740	126.05
180	208.72	103.06	2.003	0.866	1.686	122.17
200	226.19	120.54	2.168	0.887	1.647	119.29
220	244.06	138.40	2.338	0.904	1.616	117.11
240	262.23	156.57	2.510	0.917	1.593	115.41

Phase and amplitude control

Difference was made betwween ‘control’ and ‘measurement’

Phase and amplitude control will be provided for the RF amplifier system at the 0.5 degree and 1% level. It will be possible to operate the system both with and without the control loop.

NB operation with the control loop ➔ loss of power by 15-20%

Previous studies of the reconstruction of the phase and amplitude of the electric field at the time of passage of the muon have yielded the following specification for the diagnostics [1]:

- Phase measurement: ±5 degrees;
- Amplitude measurement: 1%.

This was discussed by Paul Smith who is taking up the measurement of phase and amplitude wrt passage of muon through apparatus.

MICE RF Power System Requirements

Amplifier system		
Parameter	Value	Unit
Frequency	201.25	MHz
Peak Power Level	2	MW
Repetition Rate	1	Hz
RF Pulse Length	1	mSec
Average RF Power Level	2	kW
Electrical to RF Conversion Efficiency	50	%
Rise time of RF power ramp		ms
Power distribution system		
Pressure of N2 gas in coax lines	1.5	Bar
Maximum power delivered to each coupler	500	kW

Phase and amplitude control		
Relative phase of cavity pair powered by single TH116 amplifer	124	Degrees
Phase control	0.5	Degrees
Amplitude control	1%	
Open loop operation	Optional	
RF cavity		
Central resonant frequency	201.25	MHz
Quality Factor, Q_o	44000	
Cavity R/Q	26750	Ohm
3dB Bandwidth	7.5	kHz
Tuning Range	±230	kHz
Nominal Accelerating Gradient	8	MV/m

Concerning regulation of phase and amplitude:

1. phase regulation by pair of cavities is enough and simplifies the system

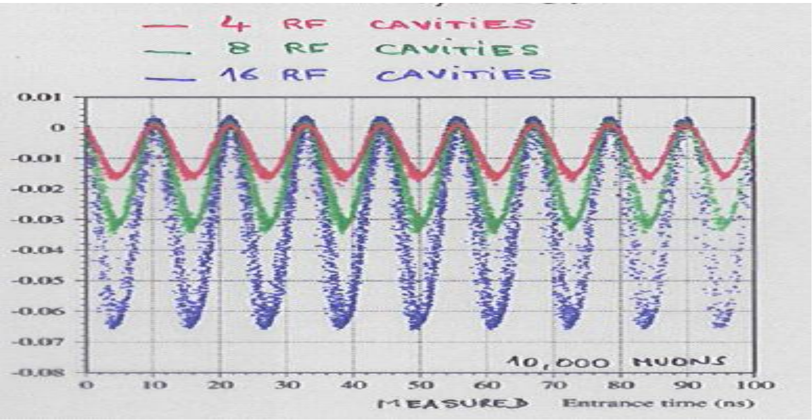
2. what is really needed is ability to know phase and gradient for each muon

there is no unique way of doing this and this should be an outcome of this workshop

With which precision?

-- Absolute scale of amplitude
-- Global phase shift (time delay) between RF system and TOF system

will both come from analysis of large samples of muons in operation.



WBS (I)

Muon Ionisation Cooling Experiment: WBS				
MICE	Level 2	Level 3	Level 4	
	2.1-Project Management			Nichols
		2.1.1-UK Project management		Grant
		2.1.2-Schedule coordination		Hanson
		2.1.3-Hall schedule		Grant
		2.1.4-Hall Management		Greenall
	2.2-MICE-Muon-Beamline			Long
		2.2.1-Target		Hodgson
			2.2.1.1-Assembly	Tarrant
			2.2.1.2-Stator	Barber
			2.2.1.3-DAQ&Cntrl	Smith
			2.2.1.4-Software	Hodgson
		2.2.2-Decay-solenoid		Bayliss
		2.2.3-Conventional magnets		Nebrensky
		2.2.4-Diffuser		Blackmore
	2.3-MICE-Hall Engineering and infrastructure			Hayler
		2.3.1-Integration engineering		Tarrant
		2.3.2-Virostek shielding		Hayler
		2.3.3-Services		Nichols
		2.3.4-Radiation shutter		Hayler
		2.3.5-Integration-of-Step-IV		Hayler
		2.3.6-Integration-of-Step-VI		Virostek
	2.4-MICE-Detectors and instrumentation			Bross
		2.4.1-TOF		Bonesini
		2.4.2-cKOV		Cremaldi
		2.4.3-Tracker		Long
			2.4.3.1-Trigger-distribution	MacWaters
		2.4.4-EMR		Asfandiyarov
			2.4.4.1-EMR Mechanics	Cadoux
		2.4.5-KL		Tortora
		2.4.6-Luminosity monitor		Soler

WBS (II)

	2.5-MICE-Magnet systems	2.5.1-Focus-coil-module 2.5.2-Coupling magnets 2.5.3-spectrometer solenoids		Preece Bradshaw Gourlay Virostek
	2.6-MICE Liquid hydrogen delivery system and absorbers	2.6.1-Control engineering 2.6.2-Cryogenic support 2.6.3-liquid hydrogen absorber 2.6.4-Solid absorbers		Watson Warburton Courthold Ishimoto Snopok
	2.7-RF Systems	2.7.1-RF Power source 2.7.2-RF Cavities 2.7.3-RF Power distribution 2.7.4-Low level RF		Kevin Ronald Moss DeMello Grant Peter Corlett
	2.8-Computing	2.8.1-Software 2.8.2-Grid 2.8.3-Networking 2.8.4-Computing support		Colling Rogers Nebrensky Macwaters Wilson
	2.9-Operations	2.9.1-Online reco. 2.9.2-DAQ/Trigger 2.9.3-Controls & Monitoring 2.9.4-MLCR		Coney Coney Karadzhov Hanlet Macwaters

CONCLUSION

THE MICE RF team has a large and essential work in front of them!

BEST WISHES to Kevin and collaborators

System test

Aim: Good operation and integration of RF system in the MICE hall and in the MICE experiment.

Do it soon enough so that remaining flaws or dont-know-how-to-do issues are identified as early as possible.

Only sensible place to do is MICE hall

After Step Iv is completed

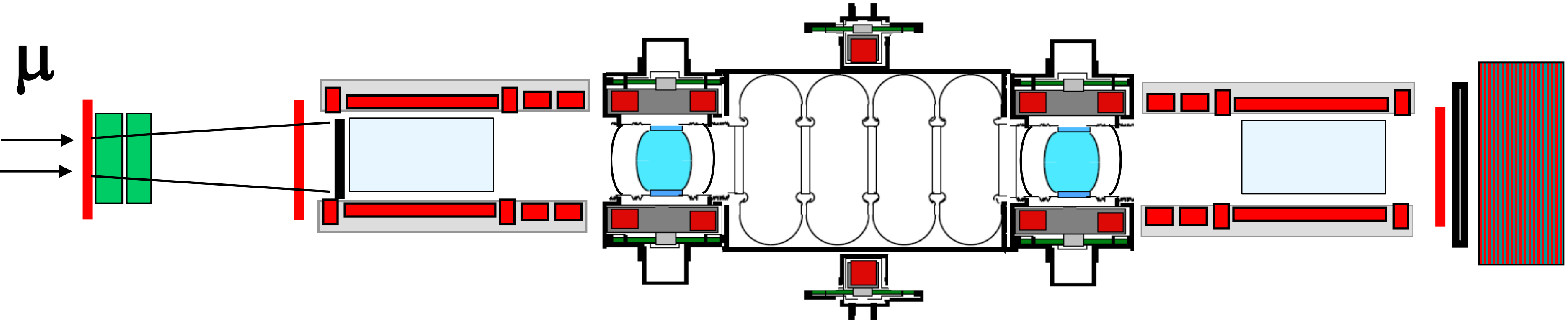
Best is if cavity (ies) are in the final position so that we dont have to modify the planned RF piping for it.

Dont need the magnetic fields for this particular exercize

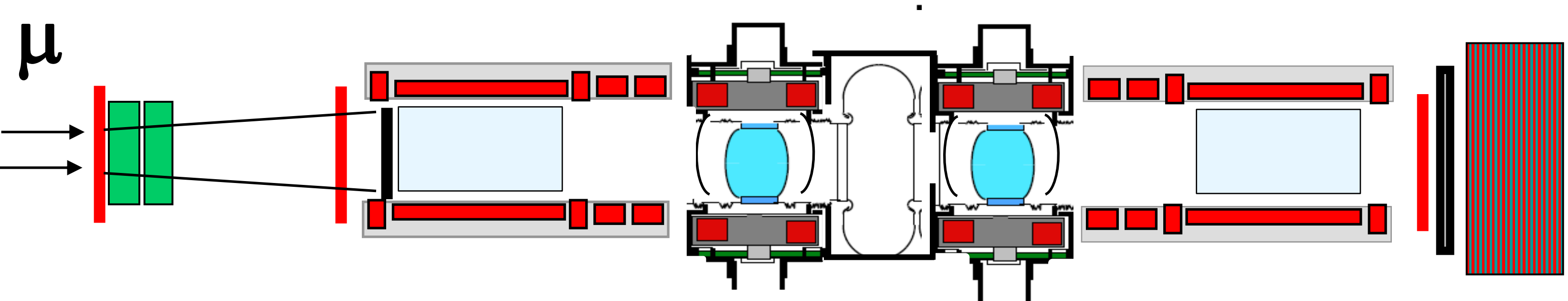
Beam could be useful

Solution 1: single RF vessel
Solution 2 4-cavity RF vessel without CC if this is possible

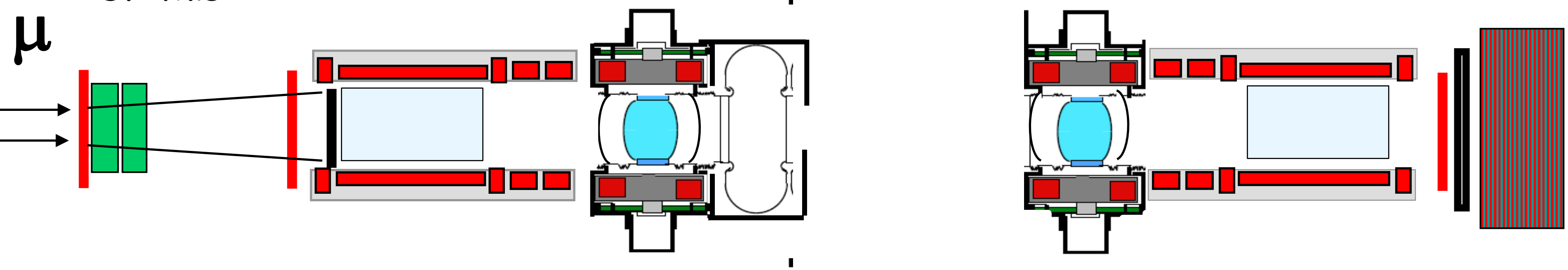
Step V, nominal



Solution 1 using a copy of the single cavity RF vessel



Or this:



solution 2: RF system test RFCC module without CC magnet ?