Science & Technology Facilities Council

ASTeC

ISIS

Imperial College London

WARWICK

Universidad del País Vasco

Euskal Herriko Unibertsitatea

UKNF / PASI Plenary Meeting

FETS Mechanical Engineering Update

10th November 2011

by Peter Savage

A brief outline of the current and possible future engineering challenges for the FETS.....

Talk contents

1) RFQ manufacture
2) RFQ ancillaries
3) RFQ assembly
4) Klystron power delivery
5) RGIS
6) MEBT Engineering
7) Downstream of the MEBT

RFQ Manufacture

The RFQ Physics design and Engineering design is complete and the Engineering drawings have been completed. The next phase is manufacture.

Thirteen companies have been investigated as possible manufacturers of the FETS RFQ.

We require a manufacturer to have (at least):

- 4 axis milling capability (to ensure features can be machined with minimum operations).
- Capacity to machine over one metre in length (in effect ~1.5m travel).
- Machines that give the required accuracy.
- Inspection facilities.
- Experience with machining copper.
- Experience with low volume high specification work.

Three manufacturers have been identified that meet these requirements and quotes for manufacture have been requested.

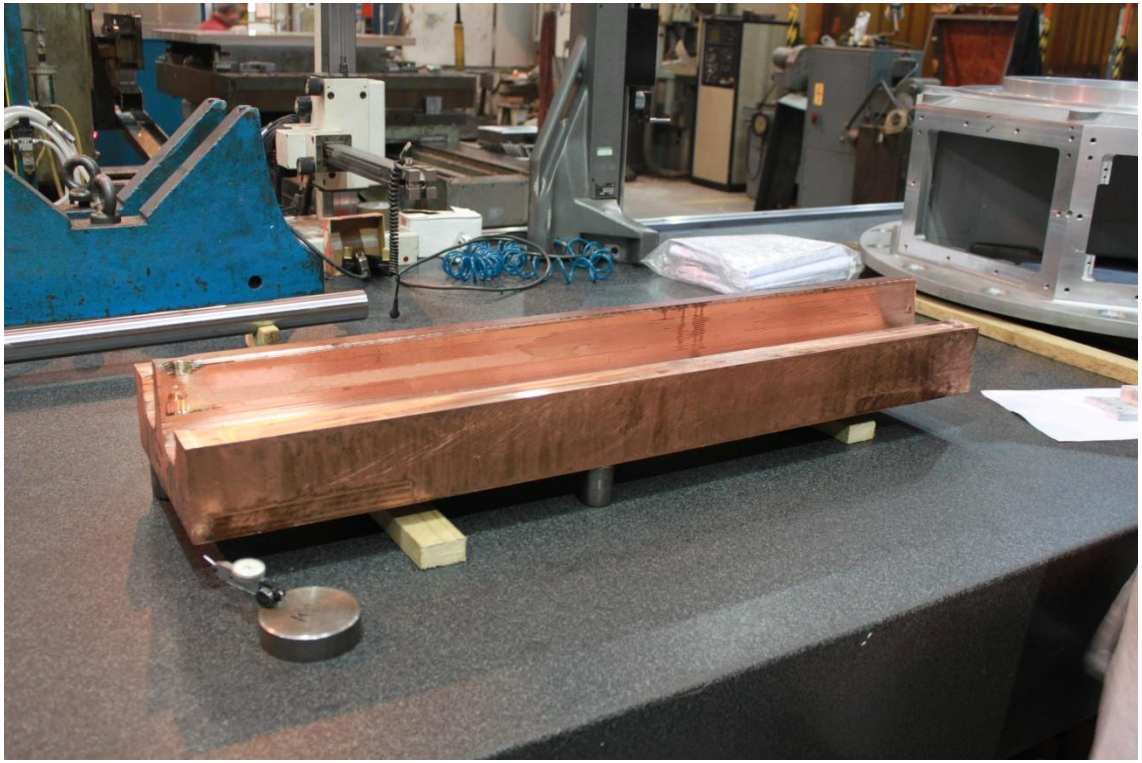
Meetings are currently underway to facilitate a hand-over to OM (Outside Manufacturing) at RAL once the quotes have been received.

OM will then take the manufacturing specification to SSC in Swindon who will manage the agreement with the supplier from then on.

1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

Who? Pete, Alberto, OM

RFQ Manufacture



NAB Precision Engineering Ltd machined the outer face of one major vane block flat and then machined one roughing pass of the internal vane profile maintaining a distance of at least 10mm from the finished profile.

This was done to assess the deformation due to the internal stresses that are induced during the hot rolling production process.

A sufficient number of roughing passes will be required tuntil the copper is stable to less than the finished tolerances.

This deformation of the outer face was measured after the vane profile machining was performed. The result was a very encouraging 0.10mm.

Who? Pete, Alberto, OM

RFQ Manufacture

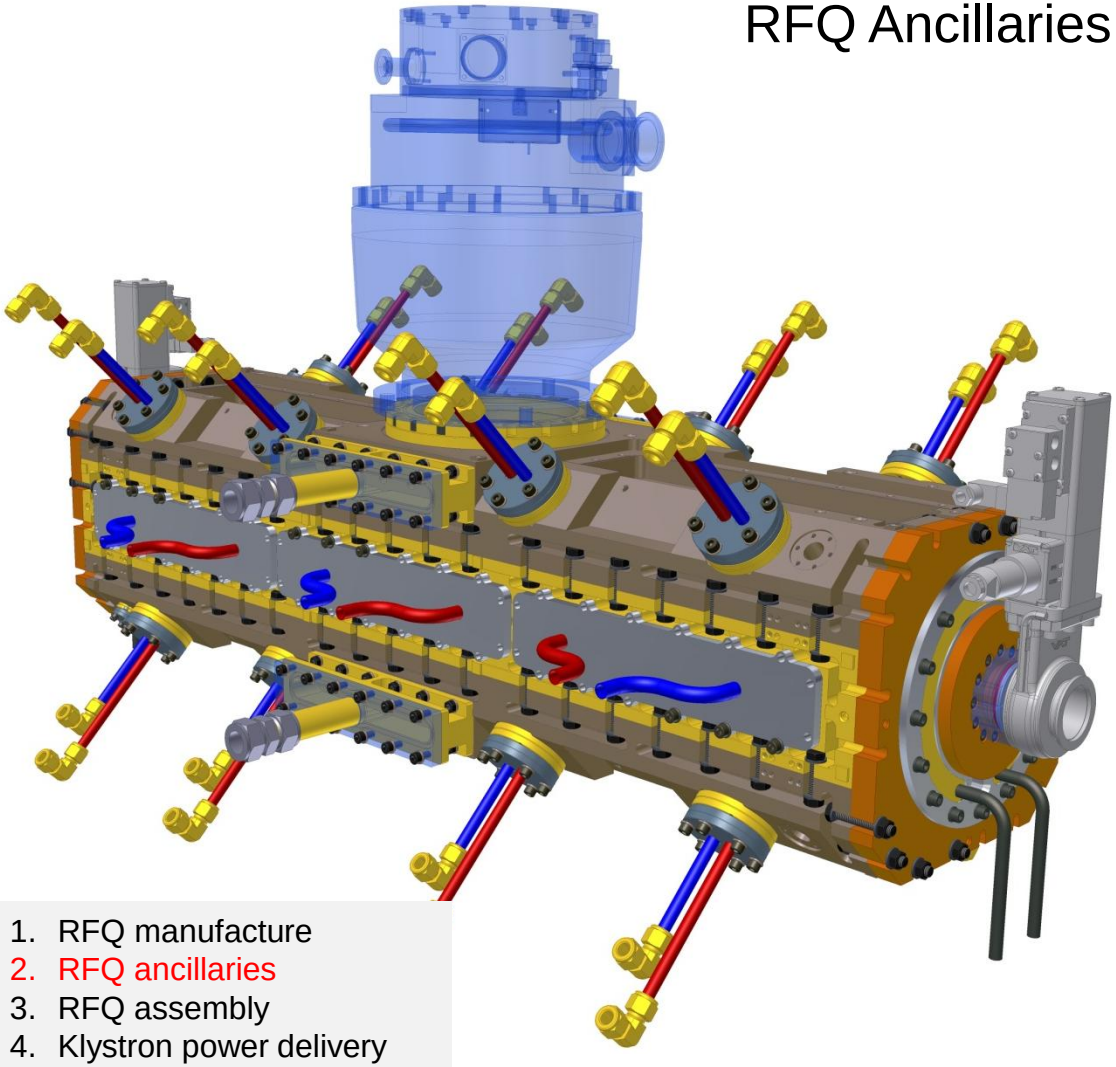
The machine shown is typical of the type of machine required to produce the RFQ. Large, rigid and precise – not a combination that many manufacturers invest in.

Who? Pete, Alberto, OM

Talk contents

1) RFQ manufacture
2) RFQ ancillaries
3) RFQ assembly
4) Klystron power delivery
5) RGIS
6) MEBT Engineering
7) Downstream of the MEBT

RFQ Ancillaries



1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

The 2 major and 2 minor vanes will be made by OM but the RFQ is an assemble of many components. The following lists those components:

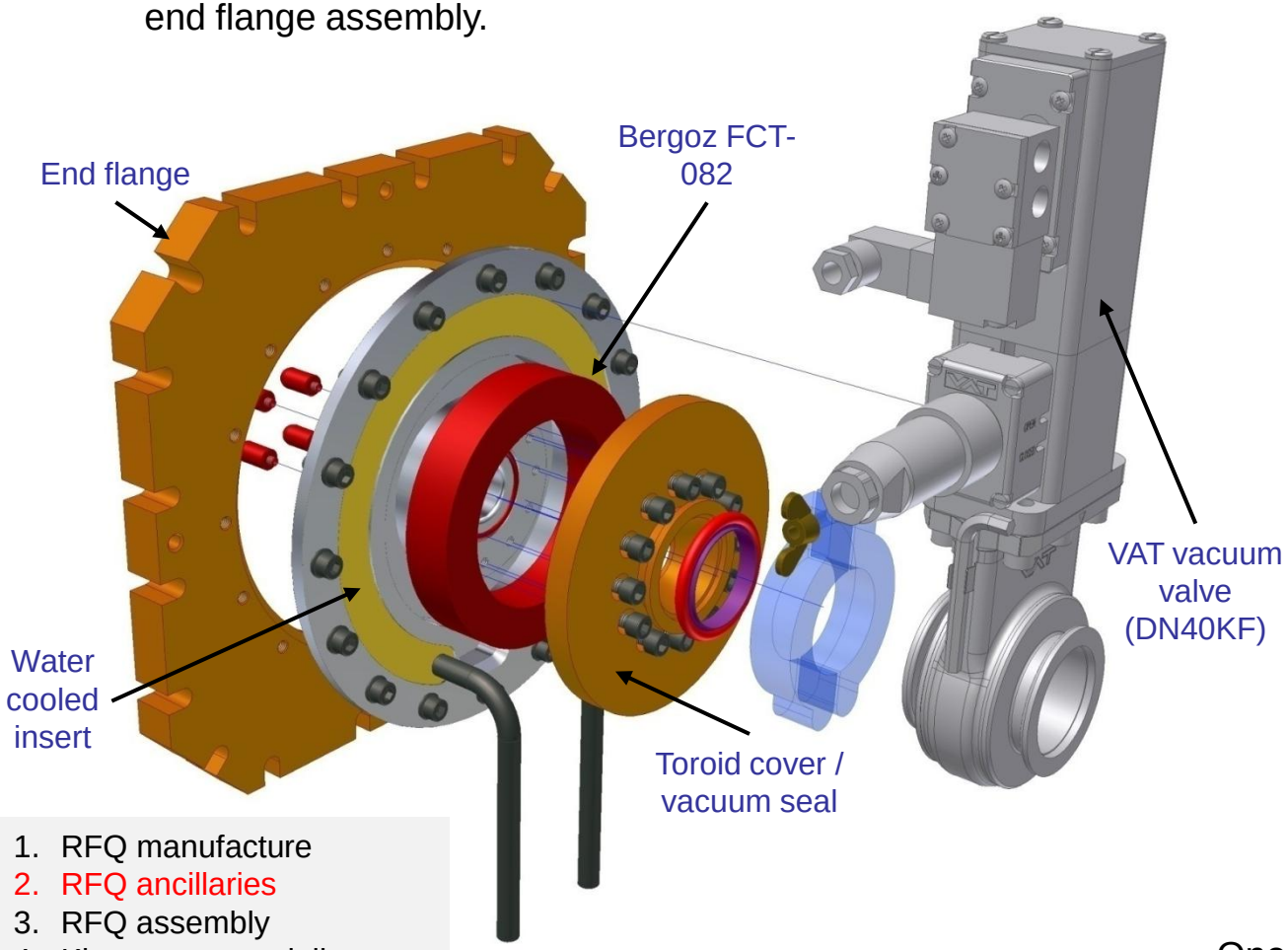
- 2 end flange assemblies
- 16 tuner assembles
- 8 probe port plug assemblies
- 4 major vane baffle assemblies
- 6 minor vane baffle assemblies
- 2 vacuum port flanges
- 4 vacuum port cooling manifolds

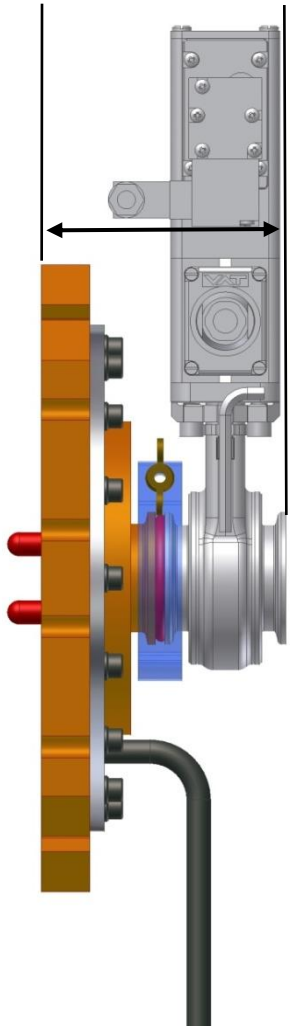
- Over 100 parts that will be made in the HEP group workshop at Imperial College. Delivery is scheduled for Spring 2012.

Who? Pete, Ian Clark

RFQ Ancillaries

An exploded view showing the end flange assembly.





Side view

1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

Who? Pete, Ian Clark

One of the design specifications was to keep the assembly length to a minimum to keep the input beam requirements flexible.

Talk contents

1) RFQ manufacture
2) RFQ ancillaries
3) RFQ assembly
4) Klystron power delivery
5) RGIS
6) MEBT Engineering
7) Downstream of the MEBT

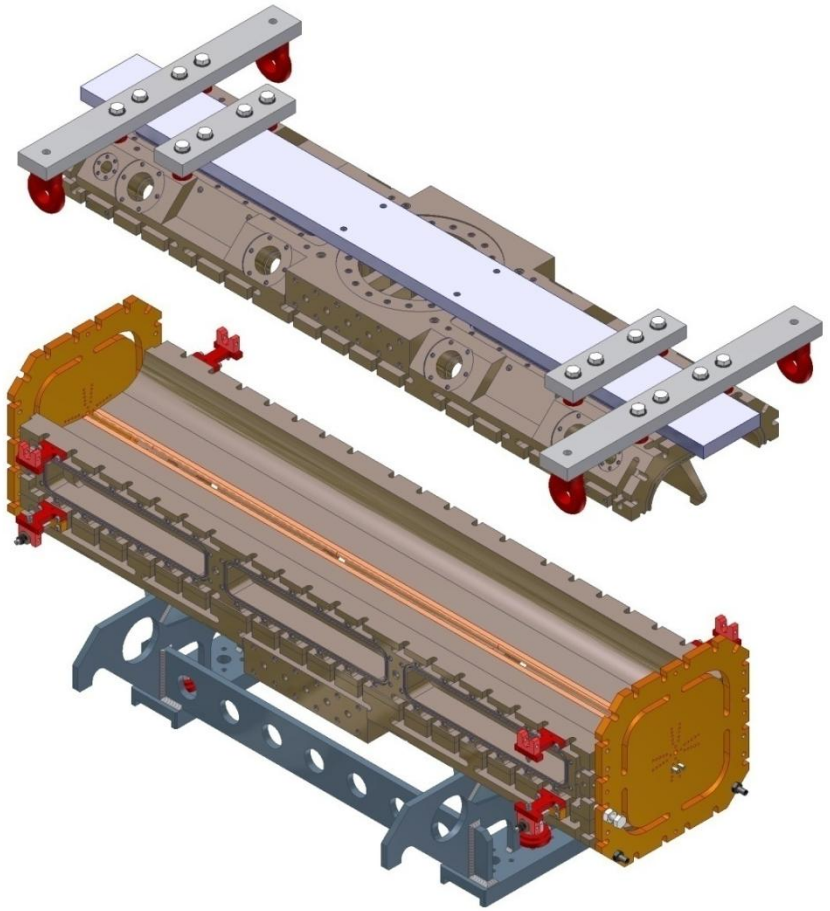
RFQ Assembly

When our chosen manufacturer has successfully manufactured our RFQ vanes it will be the job of the FETS team to assemble and align them to a high degree of accuracy.

We have developed an assembly procedure that includes:

- Vane to vane assembly and alignment to less than 10 microns precision.
- Alignment of the assembled RFQ onto the FETS accelerator line.

In addition to assembly and alignment the RFQ and all the associated assemblies will require vacuum testing.



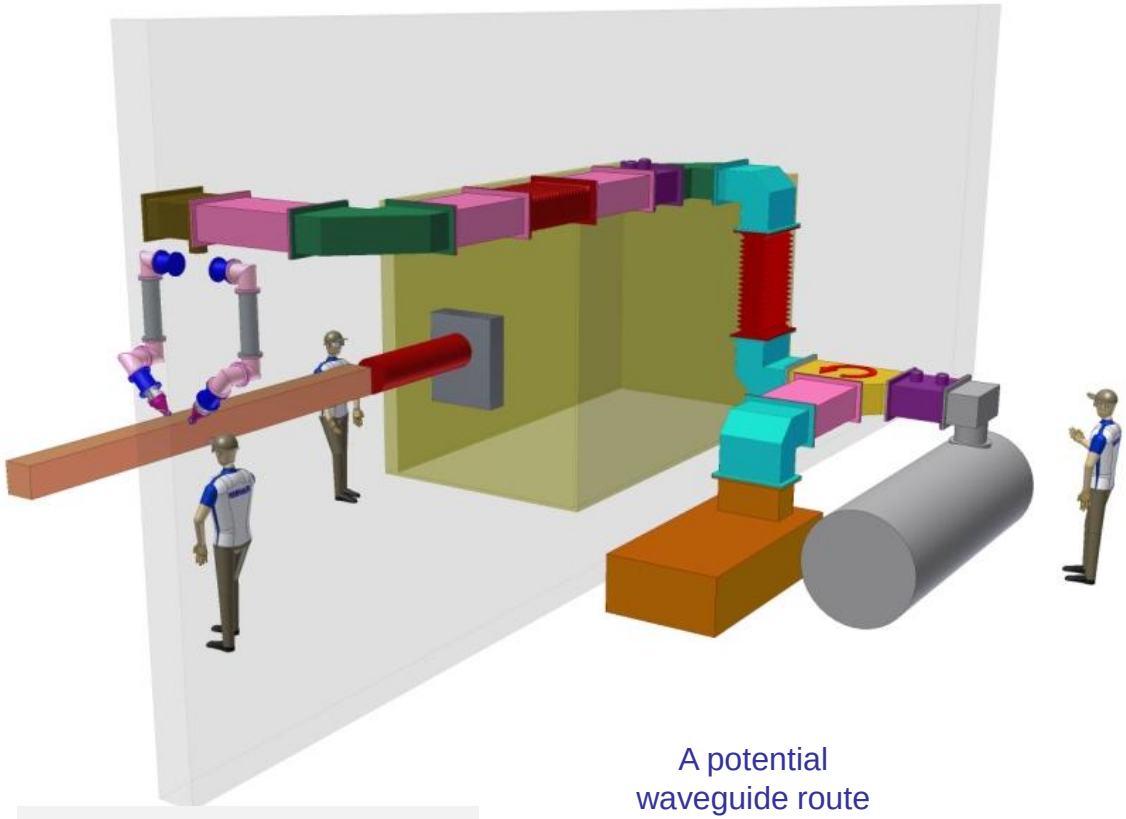
1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

Who? Alberto, Pete, FETS team, Dave Wilsher, Jim Loughrey

Talk contents

1) RFQ manufacture
2) RFQ ancillaries
3) RFQ assembly
4) Klystron power delivery
5) RGIS
6) MEBT Engineering
7) Downstream of the MEBT

Klystron Power Delivery



A potential waveguide route

1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

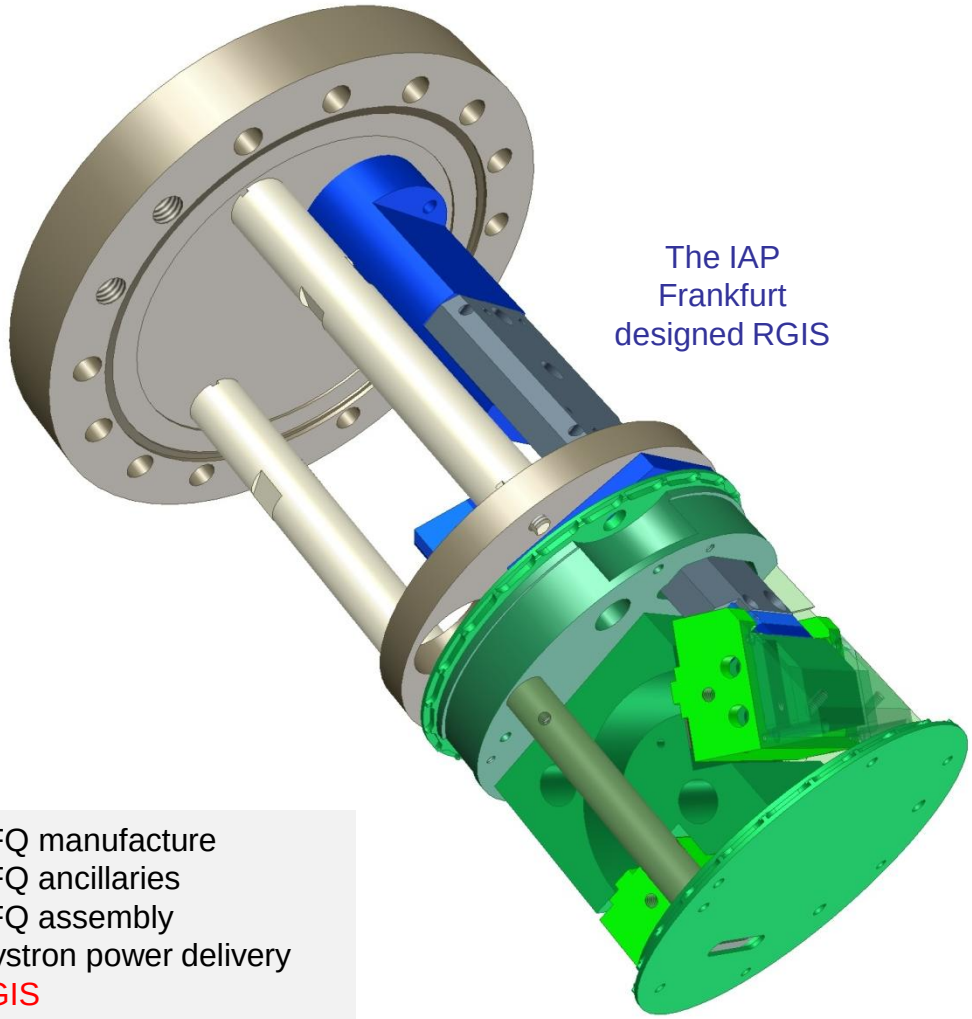
Who? Saad, Pete, Phil, ESSB

- We need to transport power from the Klystron to the RFQ.
- A waveguide run has been designed to take power to a point level with the RFQ.
- The coaxial cable to RFQ section will be designed after completion of RFQ shielding design.
- Quotes for waveguide have been received – Saad Alsari
- Circulator – being built in Spain
- Coupler design – being designed by ESS Bilbao
- Design in flexibiility to extend waveguide and shielding to MEBT.
- Plan is to use 2 couplers with option to extend to 4 couplers if power density demands.

Talk contents

1) RFQ manufacture
2) RFQ ancillaries
3) RFQ assembly
4) Klystron power delivery
5) RGIS
6) MEBT Engineering
7) Downstream of the MEBT

Residual Gas Ion Spectrometer (RGIS)



The IAP Frankfurt designed RGIS

Experiments by Juergen Pozimski into the beam recovery time following a perturbation and the effects of the residual gas interactions at the low energy end of FETS has prompted the development of a RGIS.

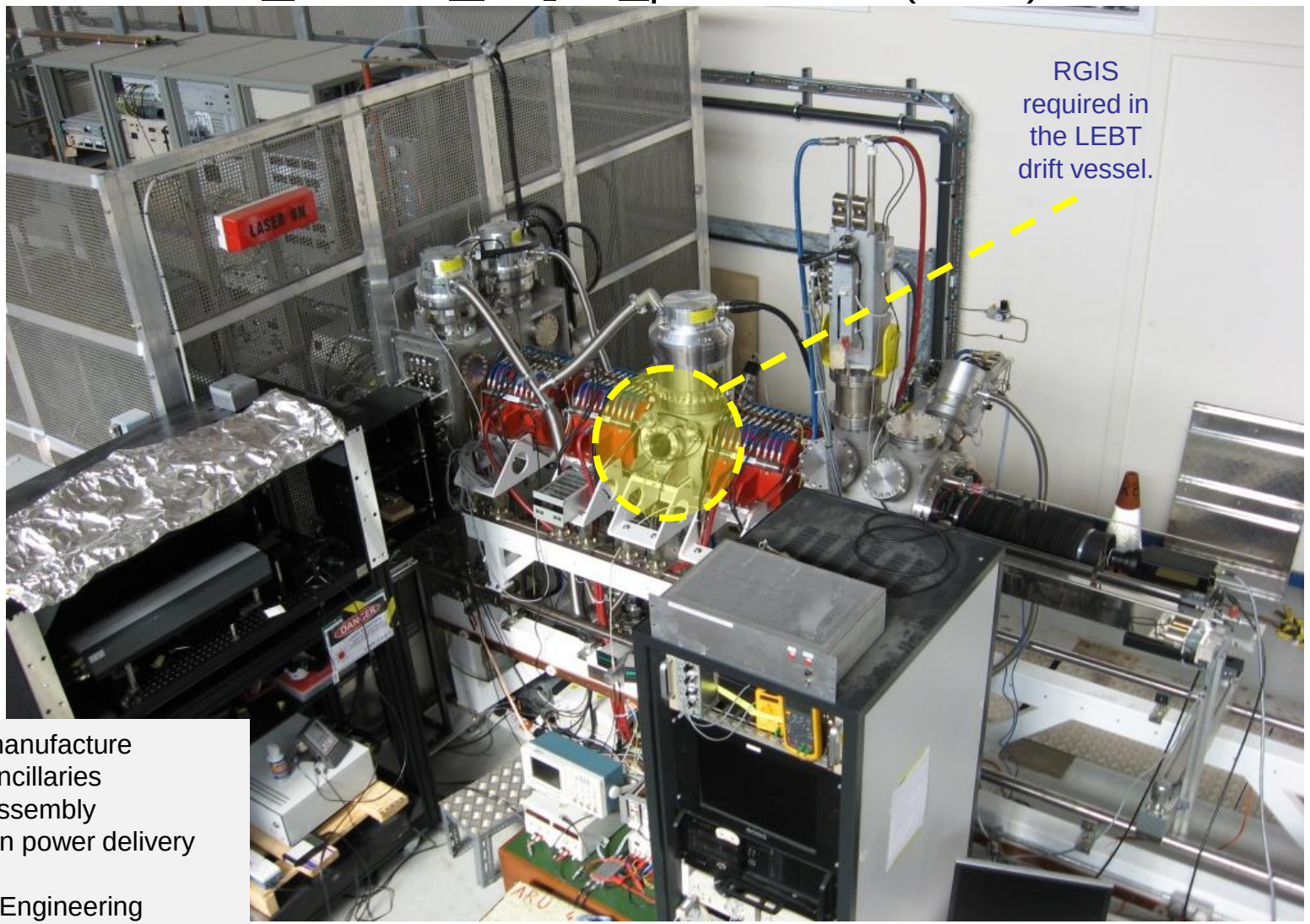
Existing designs from IAP Frankfurt will be modified to suit the LEBT diagnostics vessel on FETS.

The goal is to complete the design and manufacture within two to three months.

1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

Who? Juergen, Trevor, Pete

Residual Gas Ion Spectrometer (RGIS)



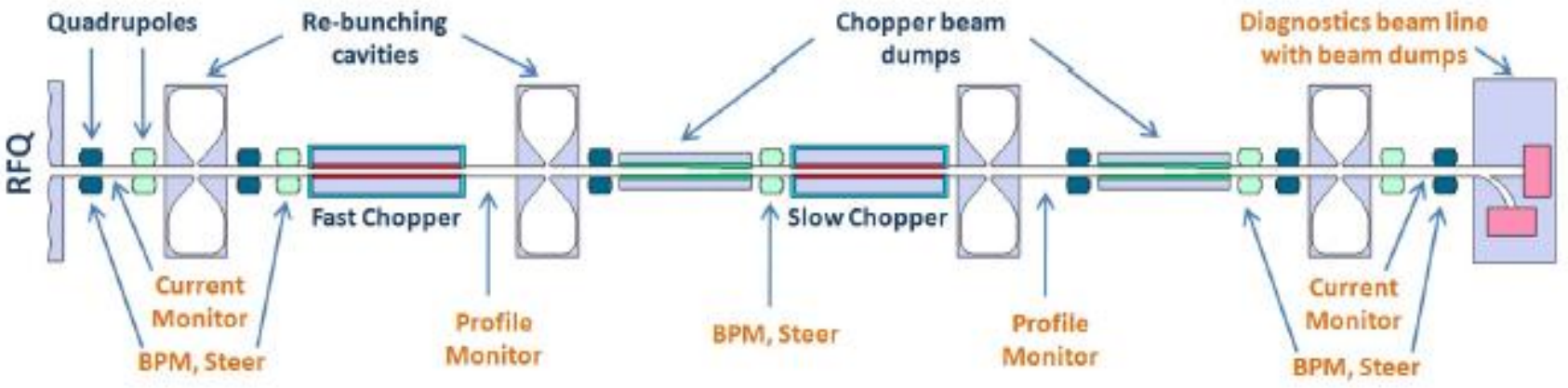
1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

Who? Juergen, Trevor, Pete

Talk contents

1) RFQ manufacture
2) RFQ ancillaries
3) RFQ assembly
4) Klystron power delivery
5) RGIS
6) MEBT Engineering
7) Downstream of the MEBT

Medium Energy Beam Transport (MEBT) Engineering



- Ciprian has been working on the MEBT beam transport design.
- The time is approaching to start work on the Engineering design to turn the ideas into reality.
- It's a large job but should be reasonably well understood and is modular.

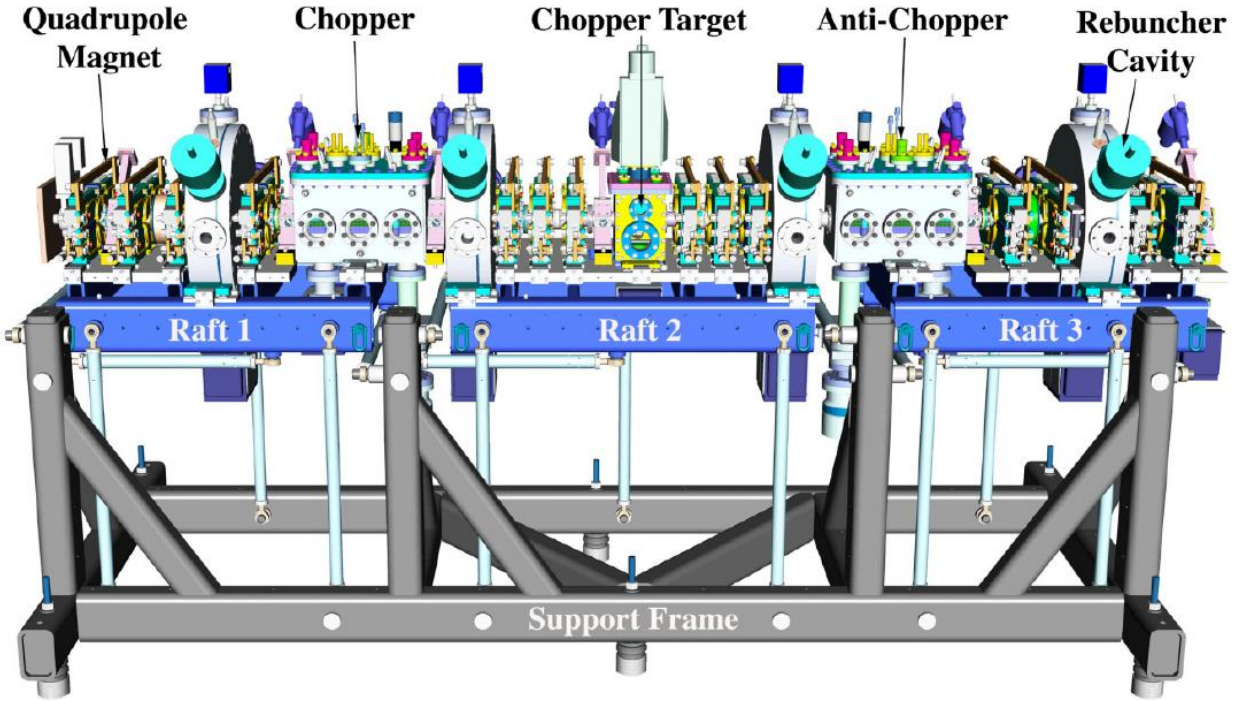
The main components are:

- Chopper – we need well defined interfaces
- Beam position monitors
- Quadrupoles
- Re-bunching cavities
- Beam pipes and bellows
- Support and alignment structures

1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

Who? Ciprian, Mike, Pete

MEBT Engineering



The SNS MEBT shown here gives an idea how the finished FETS MEBT will look.

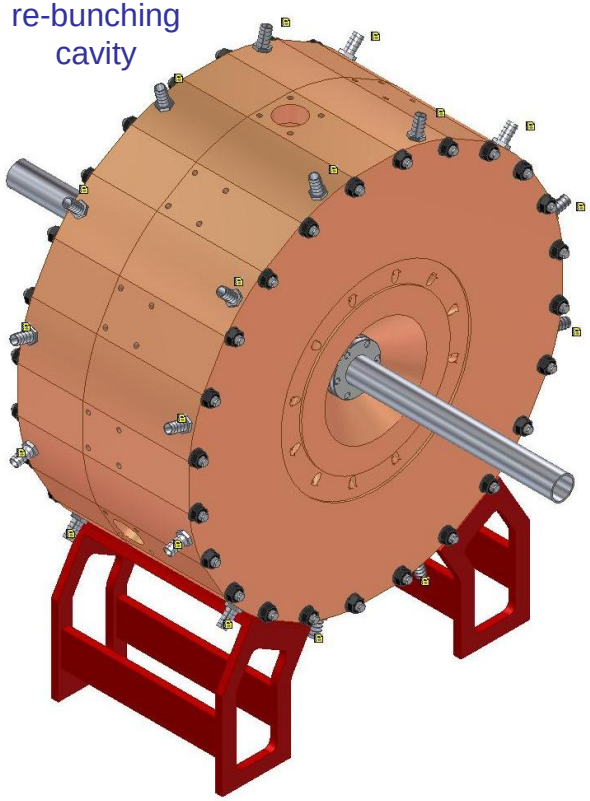
1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

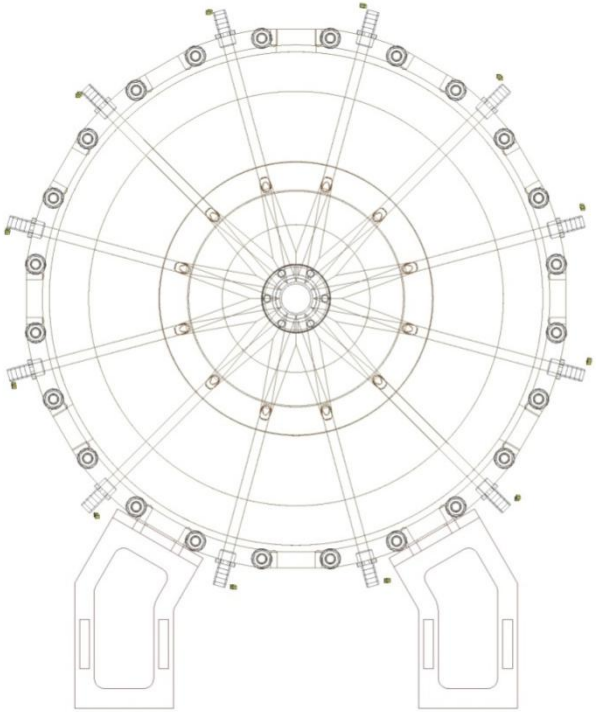
We are planning a three year Engineering program starting April 2012:
Year 1: Engineering Design
Year 2: Engineering drawings and preparation for manufacture.
Year 3: Manufacture, procurement and installation.

Who? Ciprian, Mike, Pete

MEBT Engineering

Isometric view of re-bunching cavity





Face detail view of re-bunching cavity

We have made a first pass design of an RF cavity – enough to understand what may be involved. This is based upon the CERN design. The main production techniques involved are:

- Machining copper
- Gun drilling
- Vacuum brazing
- Electro-polishing

And the experience from the FETS development so far will help with:

- Kinematic support
- Automated tuning
- Vacuum sealing

1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

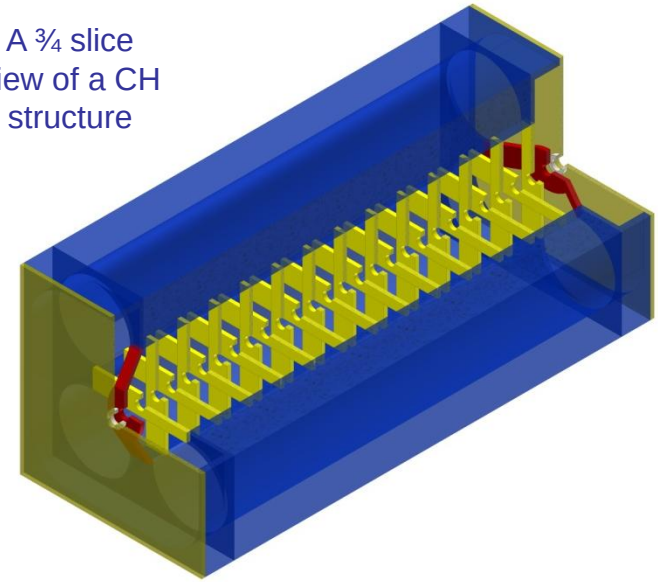
Who? Ciprian, Mike, Pete

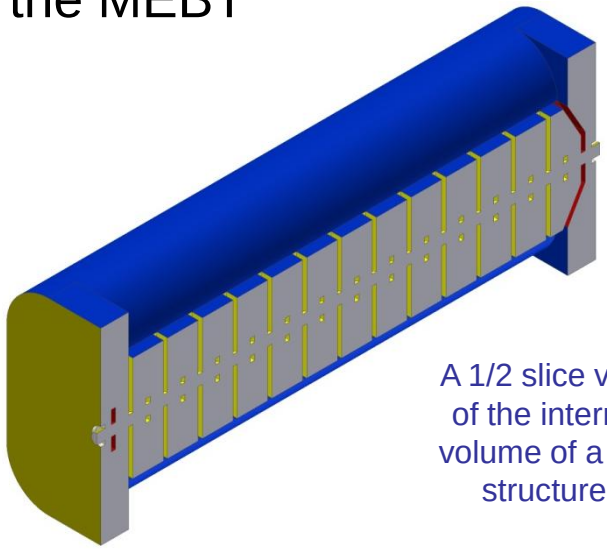
Talk contents

1) RFQ manufacture
2) RFQ ancillaries
3) RFQ assembly
4) Klystron power delivery
5) RGIS
6) MEBT Engineering
7) Downstream of the MEBT

Downstream of the MEBT

A ¾ slice view of a CH structure





A 1/2 slice view of the internal volume of a CH structure.

At Imperial College a design program is underway to model CH and IH accelerating structures. The program method can follow the method developed for the RFQ – i.e. results from the finite element (FE) models lead to modifications to the CAD model which are then fed back into the FE model.
This design loop allows the Engineering and Physics designs to proceed in parallel. The manufacture of a CH or IH cold model is planned.

Other plans could include a study of spoke cavities as used by ESS Lund and the development of a prototype FFAG for the PAMELA project.

1. RFQ manufacture
2. RFQ ancillaries
3. RFQ assembly
4. Klystron power delivery
5. RGIS
6. MEBT Engineering
7. Downstream of the MEBT

Who? Morteza, Juergen, Pete

Thank you.