June 2011

Proposal for continuation of the Front End Test Stand

The FETS Collaboration

Management annexes

Introduction

The annexes which follow present the full costings for the next three years of the Front End Test Stand program. The basis for the costing is as follows:

- The capital and staff costs have been estimated in calendar year 2011. Following STFC guidelines, on annual inflation rate of 2.5% for equipment and of 3.5% on staff costs has been assumed. The cost estimates presented in the tables that follow, therefore, should be regarded as planning estimates;
- For most STFC staff (named Staff) the 2011 fEC have been used, for some STFC staff band-average annual costs have been used. For Universities, the 2011 fEC for the staff member in question has been used;
- VAT has been added to the equipment costs by work package at the rate of 20%;
- A working margin of 10% as well as a contingency of 20% has been added to the costs.

Annex A – Work package details

Project:	**Front End Test Stand**
WP Title:	
WP Number:	**1**
WP Manager:	**Alan Letchford**
Start Date:	**April 2012**
End Date:	**March 2015**

Objectives

The RAL Front End Test Stand (FETS) is an essential part of the R&D towards the high power proton driver needed for a future high-power proton source. Applications include upgrades the ISIS spallation-neutron source, the Neutrino Factory and the Muon Collider. The purpose of the FETS is to provide a facility to conduct full-power beam tests of a high-speed beam chopper. In previous years the collaboration has worked very well and the project has gained real momentum. The ion source and the Low Energy Beam Transport (LEBT) have been commissioned and the RFQ will be manufactured during the present financial year. Over the next three years, it will be necessary to carry out the following tasks:

- *Ion source:* Detailed theoretical and experimental analyses of the ion-source plasma. Design, construction and commissioning of upgraded ion source with the aim to improve beam quality and to reduce droop of long beam pulses (>1ms);
- *LEBT:* Optimisation of LEBT, RFQ injection studies;
- *RFQ:* Test of full, high-power RF installation, assembly of RFQ, conditioning of RFQ surfaces, vacuum tests, RF tests and cooling tests. Commissioning of RFQ with beam;
- *MEBT and Chopper:* Detailed engineering designs of MEBT and Chopper system. Manufacturing and test of MEBT components, assembly of MEBT and commissioning with beam;
- *Beam Diagnostics:* Design, construction and commissioning of conventional MEBT beam diagnostics. Commissioning of improved laser-wire profile scanner; Engineering design, manufacture and commissioning of laser based emittance scanner;
- *CH linac:* RF and particle dynamics design of a CH linac. Mechanical design of a low energy CH cold model, machining, construction and RF test of the cold model; and
- *Future of FETS:* Deliver reports on various options for further utilisation of FETS.

Resources requested

PROJECT:	Front-end test stand	Cost Profile
Issue Date:	25/06/2011	
Manager:	A. Letchford	
Start Date:	2012	
End Date:	2014	

Staff	2012/13		2013/14		2014/15		Total	
	Fraction	£k	Fraction	£k	Fraction	£k	Fraction	£k
Ion source development and LEBT optimisation								
STFC-ISIS								
Faircloth	0.50	45.03	0.50	46.61	0.25	24.12	1.25	115.77
Lawrie	0.50	54.03	0.50	55.92	0.50	57.87	1.50	167.82
Letchford	0.05	5.40	0.05	5.59	0.05	5.79	0.15	16.78
Warwick								
Back	0.35	40.93	0.35	42.37	0.35	43.85	1.05	127.15
RFQ comissioning								
Imperial-Physics								
Pozimski	0.20	25.68	0.20	26.58	0.20	27.51	0.60	79.76
Alsari	0.80	36.00	0.60	27.95			1.40	63.95
Bontoiu	0.50		0.50		0.50		1.50	
Savage	0.60	32.85					0.60	32.85
vice Jolly	1.00	104.92	1.00	108.59	1.00	112.40	3.00	325.91
STFC-ISIS								
Letchford	0.25	27.01	0.23	25.16	0.20	23.15	0.68	75.32
Lawrie	0.10	10.81	0.05	5.59			0.15	16.40
MEBT								
STFC-ISIS								
Clarke-Gayther	1.00	90.07	1.00	93.22	1.00	96.49	3.00	279.78
Letchford			0.15	16.77	0.15	17.36	0.30	34.14
Imperial-Physics								
Savage	0.20	10.95	0.80	45.34	0.80	46.92	1.80	103.21
D.Clarke	0.20	12.70	0.20	13.14	0.20	13.60	0.60	39.43
Kurup	0.19	20.18					0.19	20.18
Alsari			0.10	4.66	0.10	4.82	0.20	9.48
Diagnostic								
STFC-ASTEC								
Gabor	1.00	79.88	1.00	82.68	1.00	85.57	3.00	248.13
Imperial-Physics								
Pozimski	0.10	12.84	0.10	13.29	0.10	13.75	0.30	39.88
Alsari	0.10	4.50	0.10	4.66	0.10	4.82	0.30	13.98
RHUL								
Alessio	0.25	20.7	0.25	21.4245	0.25	22.17436	0.75	64.30
Boorman	0.25	20.7	0.25	21.4245	0.25	22.17436	0.75	64.30
UCL								
Jolly	0.2	23.12335	0.2	23.93267	0.1	12.38515	0.50	59.44
The future of FETS - transition to a beam facility								
STFC-ISIS								
Letchford	0.10	10.81	0.10	11.18	0.10	11.57	0.30	33.56
Imperial-Physics								
Pozimski	0.05	6.42	0.05	6.64	0.05	6.88	0.15	19.94
Pasternak	0.10	11.88	0.10	12.30	0.10	12.73	0.30	36.91
Kurup			0.25	27.85	0.25	28.83	0.50	56.68
Bontoiu	0.50		0.50		0.50		1.50	
Huddersfield								
Student A	1.00		1.00		1.00		3.00	
Edgecock	0.05	6.27	0.05	6.49	0.05	6.72	0.15	19.48
STFC-Fellow								
Joint fellow A	0.50	46.58	0.50	48.21	0.50	49.89	1.50	144.67
Management and infrastructure								
STFC-ISIS								
Letchford	0.30	32.42	0.30	33.55	0.30	34.72	0.90	100.69
Engineering support	1.00	63.26	0.50	32.74	0.50	33.88	2.00	129.88
Technical support	1.50	136.66	1.50	141.44	0.38	36.60	3.38	314.70
Craft	1.00	57.57	0.88	52.14	0.38	23.13	2.25	132.83
Imperial-Physics								
Savage	0.20	10.95	0.20	11.33	0.20	11.73	0.60	34.02
Brambilla	0.05	2.52	0.05	2.61	0.05	2.70	0.15	7.83
Barlow	0.05	3.55	0.05	3.67	0.05	3.80	0.15	11.02
Khaleeq	0.10	5.04	0.10	5.22	0.10	5.40	0.30	15.67
Greenwood	0.10	5.04	0.10	5.22	0.10	5.40	0.30	15.67
Beuselinck	0.10	9.79	0.10	10.14	0.10	10.49	0.30	30.42
Pozimski	0.05	6.42	0.05	6.64	0.05	6.88	0.15	19.94
Rolling-grant staff totals	0.10	9.79	0.10	10.14	0.10	10.49	0.30	30.42
Staff totals:	**15.09**	**1093.49**	**14.50**	**1102.27**	**11.85**	**926.11**	**41.44**	**3121.88**
Ion source development								
Source body * 2				15.00				15.00
Powersupply						15.00		15.00
Plasma diagnostics		15.00						15.00
Diagnostics								
Dipole		30.00						30.00
Detector Laser emittance				25.00				25.00
Readout electronics						20.00		20.00
RFQ								
RF components		30.00						30.00
Parts for commissioning / replacement				10.00		10.00		20.00
Chopper								
Slow chopper Material and construction				50.00		30.00		80.00
Slow chopper electronics		60.00						60.00
Fast chopper Material and construction				45.00		25.00		70.00
Fast chopper electronics		55.00						55.00
Medium-energy beam transport								
Vacuum generation and V diagnostics		60.00		15.00				75.00
QP magnets		25.00						25.00
QP Powersupply PS				25.00				25.00
RF cavities				35.00				35.00
RF generation						80.00		80.00
Diagnostics		10.00		20.00		10.00		40.00
Infrastructure								
Cooling, Power distribution, Controls, mechanics		20.00		20.00		20.00		60.00
Shielding and safety		50.00		50.00				100.00
Inflation		***8.87***		***15.69***		***16.15***		***40.72***
Eqipment total		**363.88**		**325.69**		**226.15**		**915.72**
VAT		72.78		65.14		45.23		183.14
Working margin (10%)		43.67		39.08		27.14		109.89
Contingency (20%)		87.33		78.17		54.28		219.77
Consumables		5.00		5.00		5.00		15.00
Travel		10.00		10.00		10.00		30.00
Total:		**1676.14**		**1625.35**		**1293.90**		**4595.39**

Following STFC guidelines, inflation at 3.5% has been added in the staff lines while inflation at 2.5% has been added (and called out explicitly) in the equipment request.

Annex B1 – Staff effort by institute

PROJECT:	FETS
Issue Date:	25/06/2011
Manager:	A. Letchford
Start Date:	2012
End Date:	2014

Staff effort table

Staff	2012/13		2013/14		2014/15		Total	
	Fraction	£k	Fraction	£k	Fraction	£k	Fraction	£k
STFC-Fellow								
Joint fellow A								
Front-end test stand: WP 1	0.50	46.58	0.50	48.21	0.50	49.89	1.50	144.67
Total	**0.50**	**46.58**	**0.50**	**48.21**	**0.50**	**49.89**	**1.50**	**144.67**
STFC-ASTEC								
Gabor								
Front-end test stand: WP 1	1.00	79.88	1.00	82.68	1.00	85.57	3.00	248.13
Total	**1.00**	**79.88**	**1.00**	**82.68**	**1.00**	**85.57**	**3.00**	**248.13**
STFC-ISIS								
Clarke-Gayther								
Front-end test stand: WP 1	1.00	90.07	1.00	93.22	1.00	96.49	3.00	279.78
Faircloth								
Front-end test stand: WP 1	0.50	45.03	0.50	46.61	0.25	24.12	1.25	115.77
Lawrie								
Front-end test stand: WP 1	0.60	64.83	0.55	61.51	0.50	57.87	1.65	184.21
Letchford								
Front-end test stand: WP 1	0.70	75.64	0.83	92.26	0.80	92.60	2.33	260.50
Engineering support								
Front-end test stand: WP 1	1.00	63.26	0.50	32.74	0.50	33.88	2.00	129.88
Craft								
Front-end test stand: WP 1	1.00	57.57	0.88	52.14	0.38	23.13	2.25	132.83
Technical support								
Front-end test stand: WP 1	1.50	136.66	1.50	141.44	0.38	36.60	3.38	314.70
Total	**6.30**	**533.06**	**5.75**	**519.92**	**3.80**	**364.68**	**15.85**	**1417.66**
Huddersfield								
Edgecock								
Front-end test stand: WP 1	0.05	6.27	0.05	6.49	0.05	6.72	0.15	19.48
Student A								
Front-end test stand: WP 1	1.00		1.00		1.00		3.00	
Total	**1.05**	**6.27**	**1.05**	**6.49**	**1.05**	**6.72**	**3.15**	**19.48**
Imperial-Physics								
Alsari								
Front-end test stand: WP 1	0.90	40.50	0.80	37.26	0.20	9.64	1.90	87.41
Barlow								
Front-end test stand: WP 1	0.05	3.55	0.05	3.67	0.05	3.80	0.15	11.02
Beuselinck								
Front-end test stand: WP 1	0.10	9.79	0.10	10.14	0.10	10.49	0.30	30.42
Bontoiu								
Front-end test stand: WP 1	1.00		1.00		1.00		3.00	
Brambilla								
Front-end test stand: WP 1	0.05	2.52	0.05	2.61	0.05	2.70	0.15	7.83
D.Clarke								
Front-end test stand: WP 1	0.20	12.70	0.20	13.14	0.20	13.60	0.60	39.43
Greenwood								
Front-end test stand: WP 1	0.10	5.04	0.10	5.22	0.10	5.40	0.30	15.67
vice Jolly								
Front-end test stand: WP 1	1.00	104.92	1.00	108.59	1.00	112.40	3.00	325.91
Khaleeq								
Front-end test stand: WP 1	0.10	5.04	0.10	5.22	0.10	5.40	0.30	15.67
Kurup								
Front-end test stand: WP 1	0.19	20.18	0.25	27.85	0.25	28.83	0.69	76.86
Pasternak								
Front-end test stand: WP 1	0.10	11.88	0.10	12.30	0.10	12.73	0.30	36.91
Pozimski								
Front-end test stand: WP 1	0.40	51.36	0.40	53.16	0.40	55.02	1.20	159.53
Savage								
Front-end test stand: WP 1	1.00	54.76	1.00	56.67	1.00	58.66	3.00	170.08
Total	**5.19**	**322.25**	**5.15**	**335.83**	**4.55**	**318.66**	**14.89**	**976.74**
RHUL								
Alessio								
Front-end test stand: WP 1	0.25	20.70	0.25	21.42	0.25	22.17	0.75	64.30
Boorman								
Front-end test stand: WP 1	0.25	20.70	0.25	21.42	0.25	22.17	0.75	64.30
Total	**0.50**	**41.40**	**0.50**	**42.85**	**0.50**	**44.35**	**1.50**	**128.60**
UCL								
Jolly								
Front-end test stand: WP 1	0.20	23.12	0.20	23.93	0.10	12.39	0.50	59.44
Total	**0.20**	**23.12**	**0.20**	**23.93**	**0.10**	**12.39**	**0.50**	**59.44**
Warwick								
Back								
Front-end test stand: WP 1	0.35	40.93	0.35	42.37	0.35	43.85	1.05	127.15
Total	**0.35**	**40.93**	**0.35**	**42.37**	**0.35**	**43.85**	**1.05**	**127.15**
Grand total	**15.09**	**1093.49**	**14.50**	**1102.27**	**11.85**	**926.11**	**41.44**	**3121.88**

Annex B2 – FETS project-grant-funded staff effort by institute

PROJECT:	FETS
Issue Date:	25/06/2011
Manager:	A. Letchford
Start Date:	2012
End Date:	2014

Project grant staff profile

Staff	2012/13		2013/14		2014/15		Total	
	Fraction	£k	Fraction	£k	Fraction	£k	Fraction	£k
STFC-Fellow								
Joint fellow A								
Front-end test stand: WP 1	0.50	46.58	0.50	48.21	0.50	49.89	1.50	144.67
Total	**0.50**	**46.58**	**0.50**	**48.21**	**0.50**	**49.89**	**1.50**	**144.67**
STFC-ASTEC								
Gabor								
Front-end test stand: WP 1	1.00	79.88	1.00	82.68	1.00	85.57	3.00	248.13
Total	**1.00**	**79.88**	**1.00**	**82.68**	**1.00**	**85.57**	**3.00**	**248.13**
STFC-ISIS								
Clarke-Gayther								
Front-end test stand: WP 1	1.00	90.07	1.00	93.22	1.00	96.49	3.00	279.78
Faircloth								
Front-end test stand: WP 1	0.50	45.03	0.50	46.61	0.25	24.12	1.25	115.77
Lawrie								
Front-end test stand: WP 1	0.60	64.83	0.55	61.51	0.50	57.87	1.65	184.21
Letchford								
Front-end test stand: WP 1	0.70	75.64	0.83	92.26	0.80	92.60	2.33	260.50
Engineering support								
Front-end test stand: WP 1	1.00	63.26	0.50	32.74	0.50	33.88	2.00	129.88
Craft								
Front-end test stand: WP 1	1.00	57.57	0.88	52.14	0.38	23.13	2.25	132.83
Technical support								
Front-end test stand: WP 1	1.50	136.66	1.50	141.44	0.38	36.60	3.38	314.70
Total	**6.30**	**533.06**	**5.75**	**519.92**	**3.80**	**364.68**	**15.85**	**1417.66**
Huddersfield								
Edgecock								
Front-end test stand: WP 1	0.05	6.27	0.05	6.49	0.05	6.72	0.15	19.48
Student A								
Front-end test stand: WP 1	1.00		1.00		1.00		3.00	
Total	**1.05**	**6.27**	**1.05**	**6.49**	**1.05**	**6.72**	**3.15**	**19.48**
Imperial-Physics								
Alsari								
Front-end test stand: WP 1	0.90	40.50	0.80	37.26	0.20	9.64	1.90	87.41
Barlow								
Front-end test stand: WP 1	0.05	3.55	0.05	3.67	0.05	3.80	0.15	11.02
Brambilla								
Front-end test stand: WP 1	0.05	2.52	0.05	2.61	0.05	2.70	0.15	7.83
D.Clarke								
Front-end test stand: WP 1	0.20	12.70	0.20	13.14	0.20	13.60	0.60	39.43
Greenwood								
Front-end test stand: WP 1	0.10	5.04	0.10	5.22	0.10	5.40	0.30	15.67
vice Jolly								
Front-end test stand: WP 1	1.00	104.92	1.00	108.59	1.00	112.40	3.00	325.91
Khaleeq								
Front-end test stand: WP 1	0.10	5.04	0.10	5.22	0.10	5.40	0.30	15.67
Kurup								
Front-end test stand: WP 1	0.19	20.18	0.25	27.85	0.25	28.83	0.69	76.86
Pasternak								
Front-end test stand: WP 1	0.10	11.88	0.10	12.30	0.10	12.73	0.30	36.91
Pozimski								
Front-end test stand: WP 1	0.40	51.36	0.40	53.16	0.40	55.02	1.20	159.53
Savage								
Front-end test stand: WP 1	1.00	54.76	1.00	56.67	1.00	58.66	3.00	170.08
Total	**4.09**	**312.46**	**4.05**	**325.70**	**3.45**	**308.17**	**11.59**	**946.32**
RHUL								
Alessio								
Front-end test stand: WP 1	0.25	20.70	0.25	21.42	0.25	22.17	0.75	64.30
Boorman								
Front-end test stand: WP 1	0.25	20.70	0.25	21.42	0.25	22.17	0.75	64.30
Total	**0.50**	**41.40**	**0.50**	**42.85**	**0.50**	**44.35**	**1.50**	**128.60**
UCL								
Jolly								
Front-end test stand: WP 1	0.20	23.12	0.20	23.93	0.10	12.39	0.50	59.44
Total	**0.20**	**23.12**	**0.20**	**23.93**	**0.10**	**12.39**	**0.50**	**59.44**
Warwick								
Back								
Front-end test stand: WP 1	0.35	40.93	0.35	42.37	0.35	43.85	1.05	127.15
Total	**0.35**	**40.93**	**0.35**	**42.37**	**0.35**	**43.85**	**1.05**	**127.15**
Grand total	**13.99**	**1083.70**	**13.40**	**1092.14**	**10.75**	**915.62**	**38.14**	**3091.46**

Annex B3 – FETS rolling-grant-funded staff effort by institute

PROJECT:	FETS	Rolling-grant staff profile							
Issue Date:	25/06/2011								
Manager:	A. Letchford								
Start Date:	2012								
End Date:	2014								
	Staff	**2012/13**		**2013/14**		**2014/15**		**Total**	
	Imperial-Physics								
	Beuselinck								
	Front-end test stand: WP 1	0.10	9.79	0.10	10.14	0.10	10.49	0.30	30.42
	Total	**0.10**	**9.79**	**0.10**	**10.14**	**0.10**	**10.49**	**0.30**	**30.42**
	Grand total	**0.10**	**9.79**	**0.10**	**10.14**	**0.10**	**10.49**	**0.30**	**30.42**

Annex B4 – Overview of FETS project costs

PROJECT:	**FETS**
Issue Date:	**25/06/2011**
Manager:	**A. Letchford**
Start Date:	**2012**
End Date:	**2014**

Overview of project costs

Work package		2012/13		2013/14		2014/15		Total	
Id	**Name**	Fraction	£k	Fraction	£k	Fraction	£k	Fraction	£k
Staff effort, summary by institute									
Front-end test stand									
1	*Front-end test stand*								
	STFC-Fellow	0.50	46.58	0.50	48.21	0.50	49.89	1.50	144.67
	STFC-ASTEC	1.00	79.88	1.00	82.68	1.00	85.57	3.00	248.13
	STFC-ISIS	6.30	533.06	5.75	519.92	3.80	364.68	15.85	1417.66
	Huddersfield	1.05	6.27	1.05	6.49	1.05	6.72	3.15	19.48
	Imperial-Physics	5.19	322.25	5.15	335.83	4.55	318.66	14.89	976.74
	RHUL	0.50	41.40	0.50	42.85	0.50	44.35	1.50	128.60
	UCL	0.20	23.12	0.20	23.93	0.10	12.39	0.50	59.44
	Warwick	0.35	40.93	0.35	42.37	0.35	43.85	1.05	127.15
	Staff sub-totals	*15.09*	*1093.49*	*14.50*	*1102.27*	*11.85*	*926.11*	*41.44*	*3121.88*
	Staff totals	**15.09**	**1093.49**	**14.50**	**1102.27**	**11.85**	**926.11**	**41.44**	**3121.88**
Non-staff cost summary									
Front-end test stand									
1	*Front-end test stand*		582.65		523.08		367.79		1473.52
	Non-staff sub-totals		*582.65*		*523.08*		*367.79*		*1473.52*
	Non-staff totals		**582.65**		**523.08**		**367.79**		**1473.52**
Total staff and non-staff by work package									
Front-end test stand									
1	Front-end test stand		1676.14		1625.35		1293.90		4595.39
	Sub-totals		*1676.14*		*1625.35*		*1293.90*		*4595.39*
Grand totals			**1676.14**		**1625.35**		**1293.90**		**4595.39**

Annex C – Gantt chart

ID	Task Name	2012/13	2013/14	2014/15
1	**Ion source and LEBT**			
2	Simulations of ion source plasma.			
3	Experimental determination of plasma parameters in the ion source by means of			
4	Design of upgraded 2X source			
5	Engineering and construction of upgraded 2X source			
6	Commissioning of ion source and evaluation of ion source performance			
7	**RFQ**			
8	RF couplers manufacture			
	RFQ assembly and installation			
10	RFQ RF tests			
11	First beam at the RFQ exit			
12	Investigation of FETS-RFQ properties and comparison with simulations finished			
13	**C-H structure**			
14	Detailed RF simulations of 324 MHz CH structure finished			
15	Particle tracking for CH linac finished			
16	Construction of a CH cold model and RF measurements finished			
17	**MEBT**			
18	Engineering of chopper design			
19	Mechanical design of MEBT			
20	Procurement of MEBT components			
21	Manufacture of chopper assemblies			
22	MEBT installation			
23	MEBT equipment commissioned			
24	First MEBT beam			
25	**Diagnostics**			
26	Design of MEBT diagnostic			
27	Installation of MEBT diagnostics			
28	MEBT diagnostic operational.			
29	1D-transversal beam profile system commissioned at FETS.			
30	2D-transversal profile system and reconstruction operational at FETS.			
31	Operational emittance measurement system at FETS.			
32	**Future of FETS**			
33	R&D Advanced RF sources			
34	IDR for an High Power proton beam centre at RAL.			
35	R&D on CH structures for high power linac			
36	R&D on FETS for slow Neutron / isotope production			
37	R&D on FETS as FFAG injector			
38	RDR for a High Power proton beam centre at RAL.			

Green : R&D phase, Yellow : Design & Construction phase, Red : Installation and Commissioning phase, Blue beam delivery

Annex D – Project deliverables

It is expected that project reports will be made periodically (annually). These milestones largely appear as the end-points of the steps in the Gantt chart of Annex C.

1	**Ion source and LEBT**	
1.1	Detailed simulations of ion source plasma.	31/12/2012
1.2	Experimental determination of plasma parameters in the ion source by means of Langmuir probes, optical spectrometers and particle energy spectrometers.	30/06/2013
1.3	Design of upgraded 2X source	30/06/2013
1.4	Engineering and construction of upgraded 2X source	31/12/2013
1.5	Commissioning of ion source and evaluation of ion source performance	30/06/2014
2	**RFQ**	
2.1	RF couplers manufacture finished	30/06/2012
2.2	RFQ assembled and installed	30/06/2012
2.3	RFQ RF tests finished	30/09/2012
2.4	First beam at the RFQ exit	30/03/2013
2.5	Investigation of FETS-RFQ properties and comparison with simulations finished	31/06/2014
3	**C-H structure**	
3.1	Detailed RF simulations of 324 MHz CH structure finished	30/06/2012
3.2	Particle tracking for CH linac finished	30/06/2013
3.3	Construction of a CH cold model and RF measurements finished	31/06/2014
4	**MEBT**	
4.1	Fully engineered chopper design complete	30/09/2012
4.2	Mechanical design of MEBT finished	30/09/2012
4.3	Procurement of MEBT components	30/06/2013
4.4	Manufacture of chopper assemblies complete	30/06/2013
4.5	MEBT installation complete	31/12/2013
4.6	MEBT equipment commissioned	30/03/2014
4.7	First MEBT beam	31/06/2014
5	**Diagnostics**	
5.1	Design of MEBT diagnostic finished	30/06/2012
5.2	Installation of MEBT diagnostics complete.	31/12/2013
5.3	MEBT diagnostic operational.	30/06/2014
5.4	1D-transversal beam profile system commissioned at FETS.	30/09/2012
5.5	2D-transversal profile system and reconstruction operational at FETS.	31/09/2013
5.6	Operational emittance measurement system at FETS.	31/09/2014
6	**Future of FETS**	
6.1	Report on advanced RF sources	30/09/2012
6.2	IDR for an High Power proton beam centre at RAL.	31/06/2013
6.3	Report on CH structures for high power linac	30/12/2013
6.4	Report on FETS for slow Neutron / isotope production	31/06/2014
6.5	Report on FETS as FFAG injector	31/09/2014
6.6	RDR for a High Power proton beam centre at RAL.	31/03/2015

Annex E – Risk analysis tables

Hardware activities, in particular the beam chopper, involve a higher degree of risk because they involve untried technologies. Other parts of FETS are the extension of tried technologies and largely low risk activities. The risk analysis on the basis of likelihood/Impact measured by 1= low;2=medium;3=high. The Risk factor is then (Likelihood × Impact) generating a result between 1 (very low) and 9 (very high).

Technical risk

An analysis of the main technical risks for each of the tasks is given below

WP	Description	Likelihood (0-5)	Impact (0-5)	Risk	Mitigation
1	Unable to further reduce the beam emittance from the ion source.	1	2	2	Collimation after the source at the cost of some beam current is possible.
1	Not possible to understand or control current droop in long pulses.	1	2	2	Operate at reduced beam current for long pulse lengths.
2	RF couplers cannot deal with required power.	2	2	4	Increase number of couplers with further RF power splitting.
2	Bolted design doesn't meet RF and vacuum requirements.	2	4	8	Braze RFQ and lose maintainability.
2	Unable to flatten RFQ field.	1	4	4	Operate RFQ at sub-optimal voltage.
2	Unable to tune RFQ.	1	5	5	Re-machine to correct resonant frequency.
2	Unable to achieve RFQ design voltage.	1	4	4	Operate at below design voltage with reduced efficiency.
2	Insufficient RFQ cooling	2	3	6	Operate at reduced RF duty factor.
4	Chopper deflectors do not meet impedance and bandwidth specification.	2	5	10	Re-evaluate design.
4	Chopper beam dumps cannot dissipate power.	2	3	6	Operate with reduced beam duty factor.
4	MEBT cavities cannot be tuned.	1	4	4	Re-machine cavities.
4	Beam loss above expectation.	2	3	6	Operate at reduced beam intensity.
5	Unable to detect sufficient photo-detached electrons.	2	3	6	Increase laser power, improve discrimination in electronics.
5	Reconstruction has insufficient resolution	2	2	4	Increase the number of profiles at cost of measurement time.

Financial risk

A large amount of hardware is required to complete FETS with an associated risk related to the cost of the equipment. In all cases the cost given are the best estimates based on experience of similar scale hardware acquisitions. Much of the equipment is similar in nature to other projects undertaken by FETS contributors or associated departments however in the nature of an R&D activity there are some uncertainties. Allowance for the cost uncertainties and a contingency for unexpected costs has been made.

Annex F – Collaborators

Members of the FETS community will carry out the work proposed. Where appropriate, collaborations will be initiated with members of the international community. Of particular importance will be the close collaboration with the ESS collaboration (Bilbao and Lund) and with our colleagues at CERN. We shall to continue to develop our close collaboration with the high power proton facilities in the US and Japan

From UK industry the following companies will collaborate on the “future of FETS” programme:

- Siemens UK

Collaboration with the following individuals will be especially valuable:

- J. Lettry (Linac 4 , Ion sources) , CERN CH-1211, Geneva 23 Switzerland
- Vadim Dudnikov (Ion sources), R. Webber (HINS), Fermilab, P.O. Box 500, Batavia, IL 60510-0500, USA;
- Ibon Bustinduy, ESS Bilbao, Parque Tecnológico Bizkaia, Laida Bidea, Edificio 207 B Planta Baja. 48160 Derio (España)
- Mats Lindroos(Accelerator division), ESS Lund,St Algatan 4, Box 176, Lund, Sweden, 221 00
- Saeed Assadi (Laserwire and diagnostics), Oak Ridge National Laboratory, P.O. Box 2008 MS-6477, Oak Ridge, TN 37831-6477

Annex G – Public outreach

Accelerator physics in general generated a considerable amount of public interest recently (LHC) and FETS as a generic project provides many opportunities for public outreach. For example, colleagues from Huddersfield University have produced a DVD on the European Spallation Source (ESS), presented by Sir Patrick Stewart, and an article on ADSR was recently published in the Mail on Sunday and elsewhere. FETS is already part of ISIS outreach programme that will also include possible upgrades to ISIS in outreach in this area. In addition, as the UK has become involved in the ESS we plan to engage with the public in this area as well.

The task “future of FETS” will cover a large range of possible applications for FETS as an R&D facility. This will be provide many opportunities to extend the public outreach to areas such as cancer therapy and the production of molybdenum 99 (Mo99). This will be publicised in the oncology, medical physics and wider medical communities via conference presentations and journal articles. Since this issue is a significant concern for the Department of Health, it may also be possible to exploit their resources for public outreach.

Similarly, steps will be taken to publicise the ADSR-related work (FFAG extension, high power linac). It is expected that the level of interest, and the frequency of reports in various media (conferences and workshops, articles in academic and popular science journals, seminars, etc.) will increase. In order to publicise our work to the wider community, FETS will have a small group to co-ordinate outreach activities and look for outreach opportunities. Some ideas are still in the planning stage, but we have made contacts with a number of teachers who are interested in this idea.