SERVICES & FACILITIES ANNUAL REPORT - FY April 2010 to March 2011

SERVICE	FUNDING	AGREEMENT	ESTABLISHED as S&F	TERM
Accelerator Mass Spectrometry (AMS) Laboratory			2008	5 years

TYPE OF SERVICE PROVIDED:

The Scottish Universities Environmental Research Centre (SUERC) Accelerator Mass Spectrometry (AMS) Laboratory supports the UK environmental science community, and others, with ultrasensitive measurements of long-lived radionuclides operating as natural chronometers. Radiocarbon-dating is the most common analysis but processed-sample ^{10}Be/Be, ^{26}Al/Al and ^{36}Cl/Cl ratios can also be determined to $<1\times10^{-15}$, thereby accessing ages from the contemporary to millions of years ago in the so-called atmo-, hyrdo-, litho-, cyro- and bio-spheres. ^{41}Ca and ^{129}I are also measured infrequently.

The Laboratory operates two modern electrostatic accelerators, a general purpose 5 MV tandem and a bi-polar 250 kV single-ended machine, for reliable and quick radiocarbon measurement capability in particular. Supporting stable isotope ratio measurements, i.e. sample δ^{13}C or chlorine concentration determination with 'spiked' carrier, are also available at additional cost. The SUERC AMS group operating the spectrometers includes physicists and a technician, as well as applications scientists with backgrounds in geology, environmental archaeology and volcanology for good intercourse with our users.

Since opening in 2002 the AMS Laboratory has been serving UK science in a variety of arrangements, but essentially the Laboratory is at the centre of a web of partner sample-feeder chemistry laboratories, including other NERC Facilities, that typically prepare samples for AMS for the end-user. Much work is commissioned by the local NERC Cosmogenic Isotope Analyses Facility (CIAF) and NERC Radiocarbon Facility (Environment) but NERC also sponsors AMS by grants and via the British Geological Survey and the British Antarctic Survey, sometimes using other sample preparation laboratories. Indeed, several UK chemistry laboratories including the CIAF have been established predicated on access to the SUERC AMS Laboratory. Finally, other actors (including national heritage organisations) obtain measurements on a PAYG basis via possibly yet other further chemistry laboratories.

The AMS Laboratory also pursues its own development and applications science. The Laboratory is at the vanguard of the pursuit of AMS at the low ion-energy limits of the technique; the Laboratory well competes with the best laboratories internationally that operate larger instruments by undertaking even heavy-ion AMS by gas-stripping ion charge and avoiding the deleterious effects of high-charge Coulomb explosion and stripper-foil ion straggling. The AMS Laboratory also works with its partner sample-chemistry laboratories to maintain and develop joint capabilities.

ANNUAL TARGETS AND PROGRESS TOWARDS THEM

The AMS Laboratory achieved NERC Recognised Facility status in 2008 in recognition of the Laboratory's facility-to-Facilities role and to promote NERC-supported access to the accelerators. For instance, projects that might otherwise compromise access for others because of project large size compared with established NERC capacity might be undertaken via third-party sample preparation facilities. Indeed, the submitted project (typically the AMS Laboratory makes a supporting linked Je-S submission) average size thus far is over 200 analyses, which is nearly comparable with the CIAF annual capacity; as per the appendix by the end of 2010 there have been 21 proposals (by the most inclusive measure, including one resubmission) by 16 principle investigators from eight universities. It is, however, difficult to analyses the totally of AMS Laboratory effort including the not explicitly Recognised Facility programme since many of our users are indirect. It is, however, difficult to analyses the totally of AMS Laboratory effort, including the not explicitly Recognised Facility programme, since our project involvement can be indirect via partner laboratories. However, there is a recent trend to larger projects and the first ~1000 AMS measurements proposal has just been submitted.

SCORES AT LAST REVIEW (each out of 5)		Date of Last Review:		
Need	Uniqueness	Quality of Service	Quality of Science & Training	Average
The AMS Laboratory is yet to be reviewed				

CAPACITY of HOST ENTITY FUNDED by S&F	Staff & Status	Next Review (March)	Contract Ends (31 March)
%	Prof Stewart Freeman, Dr Sheng Xu, Dr Philippa Ascough, Mr Richard Shanks, and Mr Drew Dougans collectively apply and develop the technology	2013	

FINANCIAL DETAILS: CURRENT FY						
Total Resource Allocation £k	Unit Cost £k			Capital Expend £k	Income £k	Full Cash Cost £k
	Unit 1	Unit 2	Unit 3			
FINANCIAL COMMITMENT (by year until end of current agreement) £k						
2010-11	2011-12	2012-13	2013-2014	2014-2015		

STEERING COMMITTEE	Independent Members	Meetings per annum	Other S&F Overseen

APPLICATIONS: DISTRIBUTION OF GRADES (current FY — 2010/11)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*								
Other academic								
Students								
Pilot								
TOTAL								
APPLICATIONS: DISTRIBUTION OF GRADES (per annum average previous 3 financial years —2007/2008, 2008/2009 & 2009/2010)								
	α5	α4	α3	α2	α1	β	R*/Pilot	Reject
NERC Grant projects*								
Other Academic								
Students								
Pilot								
TOTAL								

PROJECTS COMPLETED (current FY – 2010/11)							
	α5	α4	α3	α2	α1/β	R*/Pilot	Not Graded
NERC Grant projects*	**The AMS Laboratory is yet to complete any projects as a Recognised Facility**						
Other Academic							
Students							
Pilot							

Project Funding Type (current FY – 2010/11) (select one category for each project)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students		NERC C/S	Other	NERC Grant*	PhD Students		NERC C/S	Other
		NERC	Other				NERC	Other		
						Unknown				
Project Funding Type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)										
Grand Total	Infrastructure					PAYG				
	Supplement to NERC Grant *	PhD Students		NERC C/S	Other	NERC Grant*	PhD Student		NERC C/S	Other
		NERC	Other				NERC	Other		
						N/A				

User type (current FY – 2010/11)(include each person named on application form)				
Academic	NERC Centre/Survey	NERC Fellows	PhD Students	Commercial
Unknown				
User type (per annum average previous 3 financial years - 2007/2008, 2008/2009 & 2009/2010)				
Academic	NERC Centre/Survey	NERC Fellows	PhD Students	Commercial
N/A				

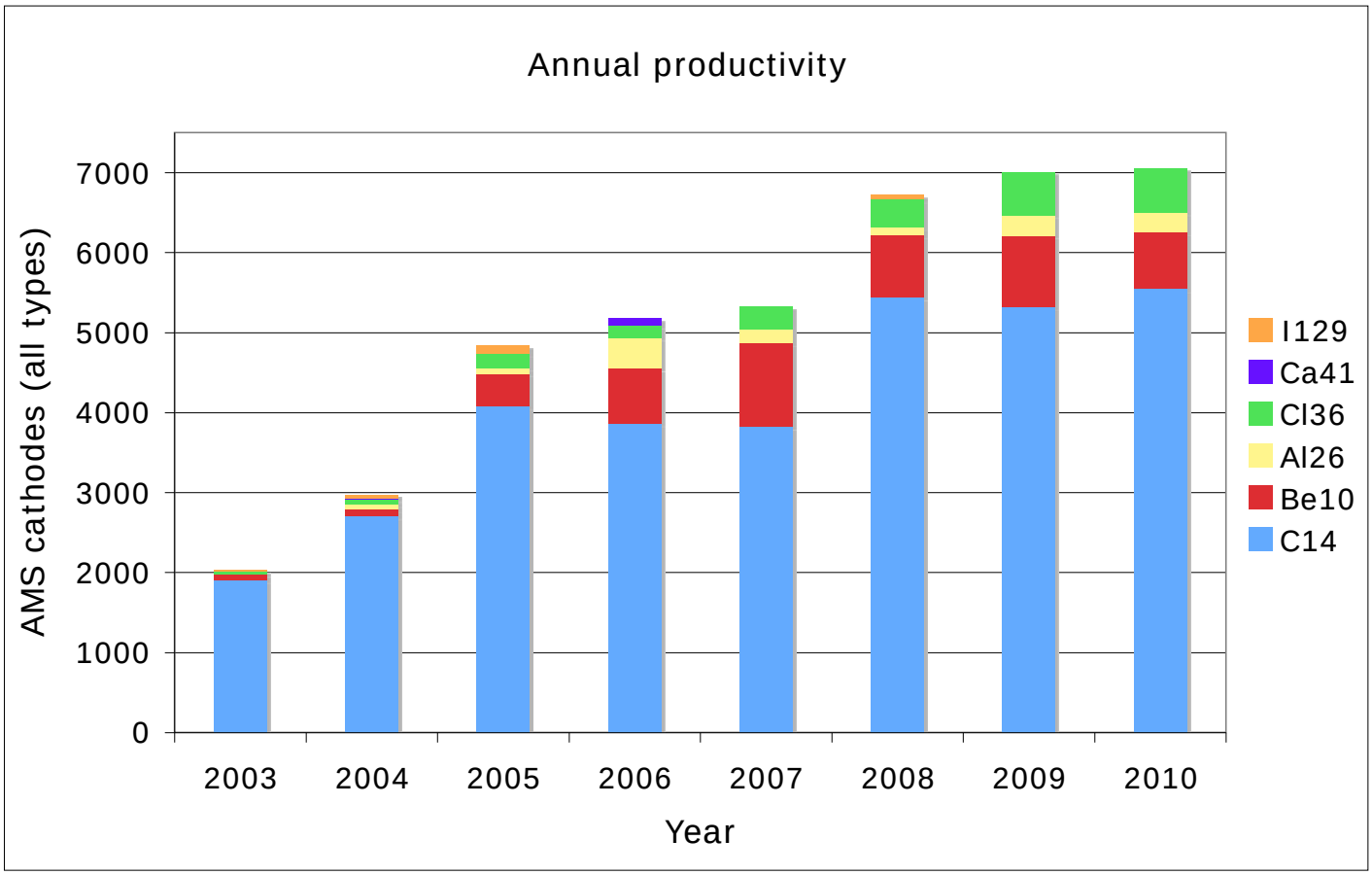
OUTPUT & PERFORMANCE MEASURES (current year)										
Publications (by science area & type) (calendar year 2010)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
There have been 26 peer-reviewed publications across NERC science areas and physics										
Distribution of Projects (by science areas) (FY 2010/11)										
Grand Total	SBA	ES	MS	AS	TFS	EO	Polar			
The AMS Laboratory is yet to complete any projects as a Recognised Facility										
OUTPUT & PERFORMANCE MEASURES (per annum average previous 3 years)										
Publications (by science area & type) (Calendar years 2007, 2008 &2009)										
SBA	ES	MS	AS	TFS	EO	Polar	Grand Total	Refereed	Non-Ref/ Conf Proc	PhD Theses
There have been on average 13 annual peer-reviewed publications across NERC science areas and physics										
Distribution of Projects (by science areas) (FY 2007/2008, 2008/2009 & 2009/2010)										
Grand Total	SBA	ES	MS	AS	TFS	EO	Polar			
N/A										

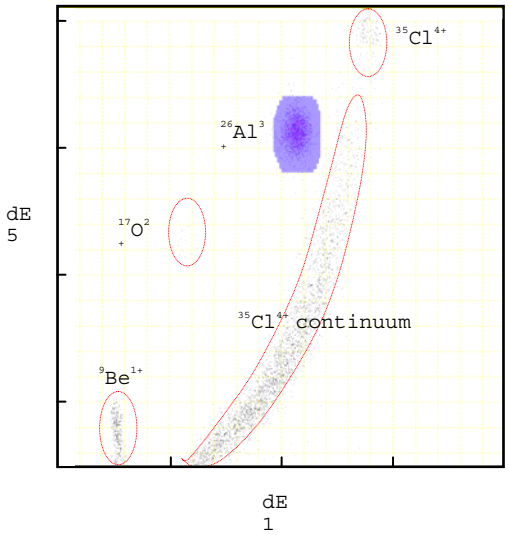
Distribution of Projects by NERC strategic priority (current FY 2010/11)							
Grand Total	Climate System	Biodiversity	Earth System Science	Sustainable Use of Natural Resources	Natural Hazards	Environment, Pollution & Human Health	Technologies
The AMS Laboratory is yet to complete any projects as a Recognised Facility							

**Combined Responsive Mode and Directed Programme grants*

NOTE: All metrics should be presented as whole or part of whole number NOT as a %

OVERVIEW & ACTIVITIES IN FINANCIAL YEAR (2010/11):

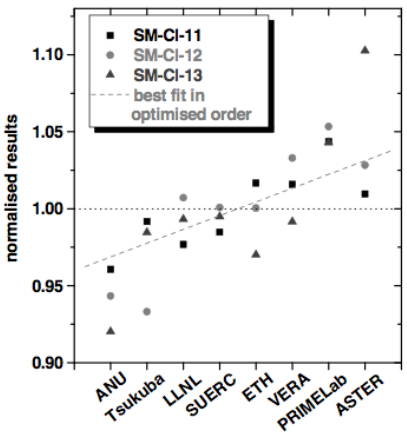




The histogram shows that productivity trends continue with in excess of 7,000 samples of all species, including development work with the local NERC Facilities, etc., being measured in 2010 for the second year running. This confirms the AMS Laboratory and partner chemistry-laboratories as the most productive such facility in Europe. Cosmogenic (so-called) radionuclide use (essentially the other-than-blue) is gradually increasing whereas there is a clear impact of adding a second spectrometer in 2007 for extra radiocarbon measurement capacity.

AMS Laboratory academic activity also goes well with accelerating publication record and numerous presentations; conference scientific-advisory-panel-service complimented a strong showing at the 12th International Conference on AMS in Wellington, New Zealand, March 2011. In particular, using the thinnest-yet SiN detector windows we have identified ^{35}Cl (possibly from $^{12}C^{35}Cl^{-}$ dissociating before the accelerator) as an unlikely interference to $^{26}Al^{3+}$ measurement. The detector spectrum of a deliberately adulterated sample shows that SUERC Al-AMS remains robust but this may explain occasional unphysical results elsewhere, i.e. what is sometimes considered an easy measurement is in fact a difficult one.

In contrast, technically challenging ^{36}Cl-AMS is routine with even the relatively small SUERC 5 MV spectrometer. The graph, from S. Merchel et al, *Ultra-trace analysis of 36Cl by accelerator mass spectrometry: an interlaboratory study*. Anal Bioanal Chem (2011) DOI 10.1007/s00216-011-4979-2, shows that the AMS Laboratory is very self-consistent and the most in agreement with international interlaboratory consensus values.

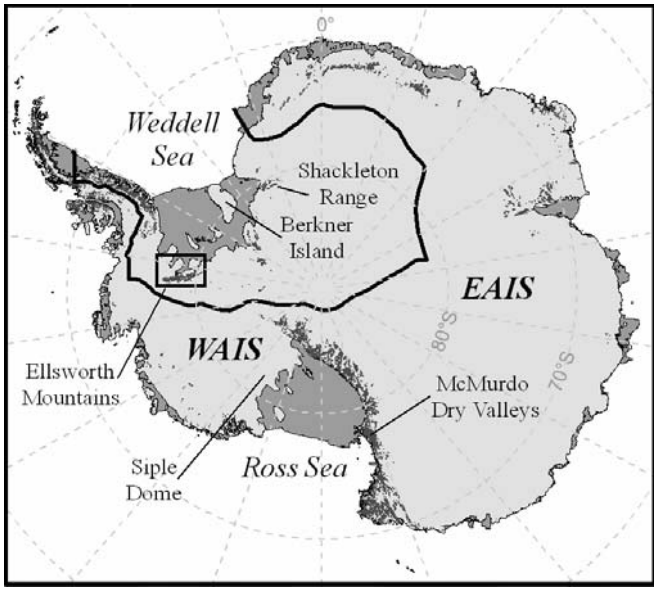


However, the departure of colleagues has been disruptive: physicist Dr Klaus Wilcken has joined the Australian Nuclear Science and Technology Organisation, but is replaced by Mr Richard Shanks from the University of Strathclyde; Dr Henrik Rother is now a Professor of Quaternary Geology at the Ernst-Moritz-Arndt Universität Greifswald and his replacement is pending.

Visitors in the past year have included sundry users and students, and most recently the 2011 meeting of the European Earth Surface Processes Group.

SCIENCE HIGHLIGHTS:

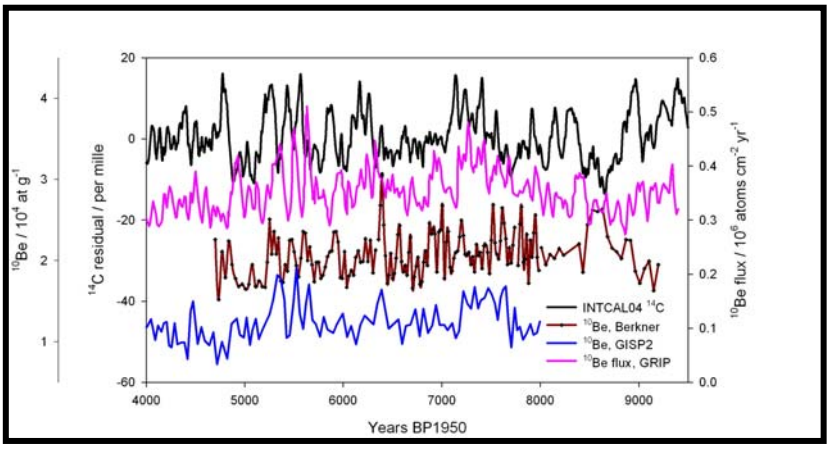
The AMS Laboratory has been active in collaborations studying the West Antarctic Ice Sheet (WAIS) that is much marine-grounded and climate-sensitive. In turn the WAIS is hypothetically a source of sufficient additional melt water to significantly alter the global environment past and future. However, *Deglacial history of the West Antarctic Ice Sheet in the Weddell Sea embayment: Constraints on past ice volume change*, M.J. Bentley et al, Geology 38 (2010) 411-414 uses new geomorphologic data and a numerical ice sheet model to reconstruct the ice sheet in the Weddell Sea at the Last Glacial Maximum. The volume of this ice would have added between 1.4 and 2.0 m to postglacial sea-level rise and would not have been sufficient to contribute significantly to meltwater pulse 1A, a rapid rise in sea level ~14,200 yr ago. Seemingly the water source was elsewhere.



The ice sheet's past extent was derived from measurements of accumulated cosmogenic radionuclides produced *in situ* since exposure of erratic boulders and mountain bedrock; the photograph shows sampling of deeply weathered Alpine Ridge surfaces (^{10}Be/ ^{26}Al > 4 million years old) in the Ellsworth Mountains. Related grant-funded studies are on-going.

A different type of record is retained in the remaining ice itself.

Cosmogenic ^{10}Be has been depth-profiled in the Berkner Island ice core with Prof Eric Wolff and Dr Robert Mulvaney of the British Antarctic Survey, and others. This low-altitude high-deposition-rate record compliments others near and far permitting the distinction of signals local, continental and global. The exemplar graph compares the high-resolution Berkner Island profile with Greenland cores in the vicinity of the 8.2 kyrs global cooling and sea level rise event. The profiles record variation in solar activity that modulates radionuclide production and reconciliation of the radiocarbon and radioberyllium signals continues.



FUTURE DEVELOPMENTS/STRATEGIC FORWARD LOOK

The increasing workload is a challenge for a changing group and aging technology. Our principle instrument is nearly ten years old but, with NERC assistance, is being refurbished to address wear and to equip it for a second decade's operation. This is expected to take two years beginning with the accelerator charging system (housed within the cream-coloured pressure vessel) in 2011. The spectrometer was originally specified with diverse capabilities including a second ion source capable of accommodating small gas samples (in photograph background), but such measurements are slow, and consequently expensive and rare, and the increasing demand is better served by source conversion to a higher-sample-capacity ion source instead.(Gas sample running will be an option on the second smaller instrument.) Finally, although we have had success in modifying the rare-isotope particle detector for improved performance, further gains depend on a new design still under consideration.