ADAS-EU R(12)RE02

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Nigel Badnell, Martin O'Mullane, Francisco Guzmán, Luis Menchero and Alessandra Giunta

Review 2

8 Feb 2012

Workpackages : 26-5-2, 27-1*, 27-2*, 28-1*, 28-2*
Category : DRAFT

Review 2

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Abstract: *Review of reporting period: months 19-36*

Contents

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Chapter 1

Overview

In this middle period of the ADAS-EU project, the broad objectives for the period have largely been met. The international fusion programme, nonetheless, evolves and the specific needs from atomic physics modelling change and evolve with this. In particular, the momentum build-up with ITER is of note and its need for early support in the conceptual design phase for spectroscopic diagnostics. ADAS-EU was specifically mandated to support ITER and the European contribution to it, and has responded strongly to these needs. Dr. O'Mullane has carried almost the entire burden of this support, with frequent visits to the ITER site in France and direct participation in conceptual design reviews (see report DISSEM2 and the summaries therein, also the individual person entries in the six-monthly science reports SCIENCE4, SCIENCE5 and SCIENCE6). Another feature of the evolving European scene, has been the forming up into group projects, such as the Integrated Tokamak Modelling activity (ITM) under FP7, with participation of many European universities and laboratories from both the West and East of Europe. Then ADAS-EU support and point of contact has optimally been to ITM rather than to each university/laboratory separately. ADAS-EU has again responded in this middle period.

Another main part of dissemination is the ADAS-EU Courses. These were planned as annual events, linked in time and location to the ADAS Workshop. In 2010, the ADAS Workshop was held at Armagh Observatory in Northern Ireland, recognising ADAS connection with both fusion and astrophysics. It was then convenient to hold the 2nd ADAS-EU Course, scheduled for November 2010 within this reporting period, at EFDA-JET. A complexity has been the popularity of the ADAS training courses, but coupled to a wish to have them not only in Europe and also to have versions of them tuned to specific local interest. This is inspite of the fact that the ADAS-EU course, as original mandated, did allow for participation by any ADAS sponsored participant - not just European. A version of the ADAS-EU course, called ADAS-US and unfunded by ADAS-EU, was held at Auburn University, Alabama in July 2010. Then in 2011, the ADAS Workshop was held at Auburn University, Alabama, recognising the increasingly international nature of ADAS. The spin-off course ADAS-US was therefore held again at Auburn in October 2011. In the light of the paragraph below on academic underpinning of ADAS-EU, ADAS/ADAS-EU staff were very willing to contribute in this way. ITER Organisation was also enthusiastic to have a local, tailored version of the course. The ADAS-EU-ITER course was held at Cadarache in December 2010. The main ADAS-EU course for 2011, also within this reporting period, was planned to be held at RFX Padua in December 2011, but machine operations and consequent availability of RFX staff and resources induced a change of date to March 2012, falling outside this reporting period. The fourth and last of the ADAS-EU courses will be held also in 2012, in September along with the 17th ADAS Workshop at Cadarache. Details of these dissemination activities are in report DISSEM2.

The academic atomic physics underpinning of ADAS-EU, that is the production and making available of responsive fundamental atomic reaction cross-section data to feed into current plasma atomic models and spectroscopic diagnostic analysis, relies on the university academic activities of Professors Summers and Badnell, outwith their time committment to ADAS-EU. Badnell guides an international group of co-working scientists calculating key atomic reactions, which is probably the most productive in the world at this time. Loch, Ballance, Pindzola and Griffin at Auburn University, USA and Liang of Strathclyde University and the National Astronomical Observatories Beijing China deserve special mention. These data flow into the ADAS databases and thence into the ADAS-EU support action. The last eighteen months has been an outstanding period, with penetration into the most difficult atomic cases, such as tungsten for ITER, JET and AUG, as well as large scale production for simpler general systems. Summers, in the more applied atomic physics territory covered by ADAS, has guided the PhD work of Giunta and Nicholas, which completed in this period. Nicholas built and completed the advanced special feature spectroscopic analysis capability which has been provided for ADAS/ADAS-EU and is one of the main themes of ADAS-EU. Report PUBL2 is in essence the thesis of Nicholas. Giunta worked in the solar astrophysical area, analysing spectral measurements from the chromosphere/corona. A core part of Giunta work was the extended construction of the generalised-collisional-radiative (GCR) model for medium weight elements. Report PUBL5 is in essence the thesis of Giunta. Dr. Giunta has now joined the ADAS-EU/ADAS team (see section 1.1). This work, also supported by Badnell, is key to current fusion needs for highest quality modelling for species, such as argon and the iron group, and feeds directly into ADAS/ADAS-EU. The medium-weight element GCR work is on-going and a substantial and important extension to ADAS-EU theme 1. For this the new work packages 27-1 (level 1 and 2 AUTOSTRUCTURE/distorted wave, called AS/DW, collisional rate inclusion in ADAS), 27-2 (level 1 and 2 AS/DW mass data production), 28-1 (level 1 and 2 GCR ionisation) and 28-2 (level 1 and 2 GCR recombination) have been added to the ADAS-EU Project.

The OPEN-ADAS web site, which is the pathway for public domain release of data from ADAS-EU has proved very popular. There has been a very large number of users and downloads (The website is http://open.adas.ac.uk). A considerable problem occurred in mid-2011, when the OPEN-ADAS website was attacked and damaged by the frivolous actions of the so-called LutzSec group. This pointless exercise, since OPEN-ADAS is open, compromised user sign-in information and usage statistics. OPEN-ADAS had to be taken off-line for about two months for protective re-coding. This unexpected and arduous task was handled by Dr. O'Mullane in the absence of Dr. Whiteford - the original programmer. OPEN-ADAS is back in action, but without the sign-in and statistics aspects which were there before. Nonetheless, indications are that OPEN-ADAS remains very popular and is now seen as an essential resource world-wide. See report OPEN2 for further details.

As discussed in the previous review, a problem was created for implementation of some of the ADAS-EU plans by the unexpected, early departure of Dr. Alan Whiteford from the project. Dr. Whiteford was the intended person to direct the Electron Collision Working Party (ECWP). This activity was designed to assist and enable paths of communication between theoretical/computational atomic physicists calculating electron impact collisional cross-section data and the utilisation framework of ADAS-EU and ADAS. In October 2010, Professor Badnell of Strathclyde University, one of the leading such theorists in world, was freed up enough to assign 20% of his time to ADAS-EU and bring into play the ECWP. An extra report ECWP1 summarises its activity over the present reporting period. It is noted here, that Badnell was able to ccordinate substantial efforts on some of the most difficult cases in fusion, such as the ion W^{+20}, and to engage deeply with sub-contractors of ADAS-EU in the electron collision area. This has optimised benefit from sub-contractors. But particularly, Badnell and the ECWP have succeeded in breaking down some of these difficult problems such that we feel confident that the quality of content of the ADAS electron impact databases at the end of ADAS-EU will be unparalleled. The product and scientific detail of this work will enter particularly reports PUBL3 and PUBL5.

Six out of the eight planned ADAS-EU sub-contracts were placed in the first reporting period. Five of these delivered in the second half of 2011. The sixth had an agreed termination in a partly completed state. At this point in time, two sub-contracts remain unplaced and three-quarters of a sub-contract value was retained from sub-contract six. The delay in placing the last two stems from the late starting of ECWP and because further exploitation of the special feature infrastructure at this time could not be supported. The revised residual sub-contract intentions are detailed in section 1.3 below. The quality of delivery on the sub-contracts, although later than expected, and the effectiveness and relevance of their integration into the ADAS modelling has exceeded all expectations. The extra report SUBC1 gives more detail and includes copies of the completion reports.The sub-contracts were split between the electron collision side (for ionisation, recombination and excitation) and the ion collision side (for charge exchange recombination and beam excitation). For the latter, we now have sufficient information and consistency of data to forward model as far as tungsten as an impurity species in the core of ITER, in ionisation stages as high as W^{+60}. On the electron collision side, we now can model emission of tungsten as an inflowing neutral W^0, as a divertor species, such as W^{+20} and as a core species, such as W^{+44}.

The detailed reports due at this time have been assembled and are available as separate documents (see section 1.6. The titles and front pages are included in appendices for information. Attention is drawn to the PUBL series of reports. These contain the full scientific and computational application details of the main themes of ADAS-EU and are due for completion and publication towards the end of the ADAS-EU project. They are works 'in progress'. As a scientific work package item and its background theory are completed, the appropriate chapters and sections are written up in the relevant PUBL. They are available to the scrutinisers and the Governance Committee of ADAS-EU but should not be released further at this stage. Reference is made in the SCIENCE reports to sections of the PUBL documents which may be helpful or clarifying. It is noted that the work of ADAS-EU theme 5, which has proved more substantial than orginally expected, now has its own summative science and computational document PUBL6.

1.1 Staffing

As noted in REVIEW1, an emergency increase of assigned time to 40% FTE by Professor Summers was made from 1 Nov 2009, following the resignation of Dr. Whiteford. Also Dr. O'Mullane increased his time to 30% FTE. On 1 Oct 2010, Professor Summers reduced his assigned time to 20% and simultaneously Professor Badnell joined the ADAS-EU team at 20% FTE. Professor Badnell is based at the Department of Physics, University of Strathclyde and took over the direction of the ECWP.

On 1 Jan 2011, Professor Summers reduced his assigned time to 10% FTE and Dr O'Mullane increased his assigned time to 40%. This restored Professor Summers to the originally planned assignment of time in the late stages of ADAS-EU. Dr. O'Mullane has in effect now taken over the role of Dr. Whiteford.

A further year having elapsed, it was decided to seek to appoint another postdoctoral scientist on a two-year contract from 1 July 2011, the post to be funded 30% FTE from ADAS-EU and 70% by the ADAS project. The 30% from ADAS-EU comprises the 7 months of lost postdoctoral scientific input identified in REVIEW1 and will be used in the period up to 31 Dec. 2012. The position specification had both fusion and astrophysical components matching the funding ratio between ADAS-EU and ADAS and the ADAS obligations to both fusion and astrophysics.

The position was advertised. Details of the appointment processes and procedures are given in the report SETUP3. The quality of candidature for the position was outstanding. Two candidates were deemed appointable. The highest placed candidate, Dr. Alessandra Giunta, was offered and accepted the position. Her appointment dates from 1 Jul. 2011 as planned. Dr Giunta brings ideal talents to the project, already having connections with the MAST SuperX divertor planning team at CCFE Culham Laboratory. Dr Giunta will spend two days per week at Culham Laboratory and three days at Rutherford Appleton Laboratory.

With the postdoctoral positions now all filled, ADAS-EU has post-doctoral staff in place at IPP Garching, CEA Cadarache/ITER and CCFE Culham Laboratory/EFDA-JET.

1.2 Computation

The ADAS-EU project plan budgetted for a number of items of computer support equipment.

Laptops for the ADAS-EU postdoctoral staff, of sufficient power to carry the complete ADAS system, were required. These have allowed the ADAS-EU staff to function most effectively in their support and demonstration roles when visiting remote sites. Four machines were purchased in the last reporting period, but a fifth, along with necessary software, was purchased in the present period for Dr. Giunta. These machines individually came in below expected cost, so that the five machines (rather than the four originally expected) were within the budgetted limits.

Fixed servers, located and maintained at the Department of Physics, Strathclyde University, supply the web services, OPEN-ADAS and ADAS, provide the primary SVN and CVS archives of ADAS–EU and ADAS, and backup. The replacement and upgrading of these machines was anticipated as part of ADAS-EU and expected to be necessary at some point in the four year duration of ADAS-EU. Machine failure commenced in 2011, with lack of sufficient protective backup occuring in late 2011. The replacement plan was then put in motion. Also in late 2011, results on the more complex of the atomic physics background research tasks (this is funded independently of ADAS-EU) put into play as part of the ADAS-EU themes came to fruition. Especially, the influx studies for W^0, the dielectronic studies for medium-charge heavy ions such as W^{+20}, and the needs of advanced collisional-radiative modelling for heavy ion charge exchange with beams and for diatomic molecules (H_2 and H_2^+) identified a problem. This is the need for a a moderate power machine, but of very large memory assigned to each processor to pilot advanced models, in advance of their finalising and organising for massively parallel computer systems (but typically of modest attached memory per processor). It was decided in late 2011 that the requirements could be met by three moderate power, large backing store, machines as servers and one high capacity machine for pilot calculations. The details of the new

ADAS-EU/ADAS provision is detailed appendix A. The cost of the high capacity machine and the set of three servers were about equal and divided between ADAS-EU and ADAS consistent with the equipment plan and assigned budget of ADAS-EU.

It was noted in the overview that hacking caused problems for OPEN-ADAS and waste of staff time in 2011. It is also noted that the electrical services to the Department of Physics have been subject to unplanned interruptions and to voltage swings which trigger resets. These appear to be a feature of Scottish Power services at this time. Such unforwarned events can and do damage disk systems and were contributory to the failures discussed above. The new systems will be held in a rack system in a more protected enviroment, with central University backup (see appendix B).

1.3 Forward planning

From a scientific point of view, the main objective of the final period of ADAS-EU through to the end of 2012, is the summative developments of the main themes. This will be the scientific legacy of ADAS-EU which will be the completed documents PUBL1 - PUBL6 and the incorporation of their methods and results as codes and data within ADAS. On charge exchange with beams (PUBL1), we are confident that the fundamental database will be complete and at the precision levels needed for all current fusion devices and ITER through to its end. The completion of the derived, effective data for arbitrarily heavy species of receiver charge $>\sim 18$ requires the incorporation of the bundle-nl population model, driven by *adf42*. This task, to be completed by Summers, will follow the pattern of inclusion of the bundle-n model and difficulties are not anticipated. In essence, we believe that the theoretical inputs for all beam charge exchange spectroscopy will be available and complete by the end of ADAS-EU.

Theme 2, on special features and spectral analysis is complete from the point-of-view of the infra-structure. The creation of theoretical special feature constructs in ADAS for its exploitation is open-ended. The finishing point for ADAS-EU will be the complete driver data sets for the He-like/Li-like dielectronic satelllite line special feature. We are in a position to produce these routinely now, but the raw theoretical model and data needs to be refined with precison wavelengths for experimental spectroscopy. In the the final period, this modest completion and update should be done.

Theme 3 on heavy species went forward quickly and well, largely due to the efforts and PhD. work of Adam Foster. The last part of this theme was again, the open-ended lifting of the database from baseline, where possible, to so-called precision levels 1 and 2. In this respect, we have greatly exceeded expectations in finding convincing paths into the most difficult systems. In parallel with this and to somewhat less heavy systems, Alessandra Giunta has moved generalised-collisional-radiative (GCR) modelling forward strongly. Thus we can now envisage carrying this high precision modelling up to an beyond the iron period elements. Because of this, GCR has become a theme in its own right and PUBL5 added to the list of summative documents. These areas are tied closely to the activities of the Electron Collision Working Party (ECWP) and it is the ECWP which we really envisage growing and taking over from ADAS-EU after the end of 2012. ADAS-EU will leave the infrastructure for fusion and ECWP will refine it and connect it also with the infrastructure for astrophysical atomic analysis. Atomic physics for fusion and astrophysics should not be two separate things, but united following the philosophy of ADAS and its origins.

Development of theme 4 was initially led by Summers and Henderson, but was then taken over by Menchero when he moved into post for ADAS-EU. The theme was broadened by Summers and Henderson to cover the situation of mixed magnetic and electric fields rather than only a motional-Stark electric field. There is justification for this in the abiguities of experiment with respect to residual circular polarisation and meaningful observables. Menchero continued in this direction, but has exposed the limitations of perturbation theory (taken to 2nd order in the Stark field), especially if field ionisation rates are to be obtained at typical fusion neutral beam speeds. Menchero is followng the complex variable approach to obtaining an eigenstate basis for beam modelling. We shall continue forward in this direction with the theme, but it is a substantial task which we do not expect to be completed until the end of ADAS-EU.

The molecular theme, PUBL6, has been a much larger task than anticipated and is still further delayed from the estimate of REVIEW1. Completion of the reaction sets, filling the many gaps, was a slow process. Guzmán, leading this part, was also engaged with experiment plans at CEA Cadarache - a good and appropriate activity in ADAS-EU support terms. This has meant that the molecular collisional-radiative model is not yet in place, with the working version now expected around June 2012. This meant that the planned month's support by Prof. Janev of the molecular modelling could not be justified for 2011. This is now re-scheduled for the second half of 2012.

The completion of themes 4 and 6 and the associated PUBL4 and PUBL6 is now a priority. If residual staff funds remain in the last half-year of ADAS-EU, it may be appropriate for Summers to increase his ADAS-EU time from the current 10% to assist in these completions.

It is planned to reassign the remaining 2.75 of sub-contract monies, responding to the success of the completed sub-contracts and the opportunities created by some of them for extensions. These extension will exploit the methods previously developed and give very high return in database growth to ADAS. Thus it is planned to give extension contracts to ITPA, University of Vilnius and to Department of Physics, University of Mons-Hainaut. The plan, but delayed, sub-contract with Queen's University, Belfast will be put in place and target high power supercomputer R-matrix calculations of of the tungsten ions identified earlier in this report. Provided these sub-contacts are in place by the end of February 2012, completion in time for incorporation in the ADAS-EU PUBL series and the ADAS databases will be possible.

1.4 Finances

1.5 Publications

Publications in this period connected to ADAS-EU include works by Badnell ([1],[2], [3]), Giunta ([4], [5],[3]), Guzman ([6], [7], [8], [3]), Menchero ([3]), O'Mullane([9], [10], [11], [1], [12], [13], [14], [15], [16], [17], [18],[19], [3]) and Summers ([1], [5], [17], [10], [19], [3]). The references are to the bibliography of this review on pages 9 and 10. There are nineteen independent titles. Several of these publications have shared authorship

1.6 Reports

Reports available for release at this time comprise:

- SCIENCE4, SCIENCE5, SCIENCE6 (see Appendix A.1)
- OPEN2 (see Appendix A.2)
- SETUP3 (see Appendix A.3)
- DISSEM2 (see Appendix A.4)
- ECWP1, SUBC1, ITER1 (see Appendix A.5)

Reports in preparation, not for release at this time, comprise:

- PUBL1, PUBL2, PUBL3, PUBL4, PUBL5, PUBL6 (see Appendix A.6)

The frontispiece and contents pages only of the reports are given in the appendices. The full reports will placed on the ADAS-EU web site (www.adas-fusion.eu).

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Appendix A

Reports

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A.1 Reports: SCIENCE4, SCIENCE5, SCIENCE6

ADAS-EU R(10)SC04

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Martin O'Mullane, Francisco Guzman and Luis Menchero

Scientific progress report 4

April 13, 2012

Workpackages : 3-3, 4-1, 8-4, 9-1, 9-2, 9-3, 11-1, 26-1-4,S1, S4
Category : DRAFT

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ADAS-EU R(10)SC05

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Martin O'Mullane, Francisco Guzman and Luis Fernández-Menchero

Scientific progress report 5

February 3, 2012

Workpackages :
Category : DRAFT

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ADAS-EU R(10)SC06

ADAS-EU

ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Martin O'Mullane, Francisco Guzman, Luis Menchero and Alessandra Giunta

Scientific progress report 6

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Workpackages : 8-2, 8-3, 15-1, 15-2, 16-1, 16-2, 16-3, 26-1-6
Category : DRAFT

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A.2 Report: OPEN2

ADAS-EU R(12)OP02

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Martin O'Mullane, Francisco Guzman and Luis Menchero

OPEN-ADAS report 2

February 2012

Workpackages : 26-2-2
Category : PU

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A.3 Report: SETUP3

ADAS-EU R(12)SE03

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Nigel Badnell, Martin O'Mullane, Francisco Guzmán, Luis Menchero and Alessandra Giunta

ADAS-EU setup report 3

8 February 2012

Workpackages : 22-1-3, 22-2-3, 23-1-3, 23-2-3, 24-1, 25-1-3, 25-2-3, 26-3-3, S1, S5, S7
Category : DRAFT

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A.4 Report: DISSEM2

ADAS-EU R(11)DI02

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Martin O'Mullane, Francisco Guzman and Luis Menchero

Dissemination report 2

January 27, 2012

Workpackages : 20-1-2, 20-2-2, 21-1-2, 21-2-2, 26-4-2
Category : DRAFT

Contents

Preface

The report is the second of a series of three such reports, deliverable under the ADAS-EU project, which summarise dissemination of ADAS capabilities during the period.

H P Summers
January 27, 2012

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A.5 Report: ECWP1, SUBC1, ITER1

ADAS-EU R(12)SU01

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Nigel Badnell, Martin O'Mullane, Francisco Guzman,
Luis Menchero and Alessandra Giunta

**ECWP1: Electron Collision Working Party
Report 1**

20 Jan 2012

Workpackages : ??-??-??
Category : DRAFT – CONFIDENTIAL

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ADAS-EU R(12)SU01

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Nigel Badnell, Martin O'Mullane, Francisco Guzman,
Luis Menchero and Alessandra Giunta

SUBC1: Sub-contract specifications, deliverables, integration and analysis

18 Jan 2012

Workpackages : ??-??-??
Category : DRAFT – CONFIDENTIAL

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ADAS-EU R(12)SU03

ADAS-EU

ADAS for fusion in Europe

Grant: 224607

Martin O'Mullane

ITER1: ITER visits and support activities
Report 1

10 Feb 2012

Workpackages : 2-3 and 3-4

Category : DRAFT – CONFIDENTIAL

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A.6 Reports in development: PUBL1, PUBL2, PUBL3, PUBL4, PUBL5, PUBL6

ADAS-EU R(10)PU01

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Adam Foster, Martin O'Mullane and Hugh Summers

Charge exchange spectroscopy for fusion plasmas

17 June 2010

Workpackages : 2.34
Category : DRAFT

Contents

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ADAS-EU R(10)PU02

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Christopher Nicholas, Hugh Summers and Martin O'Mullane

PUBL2: Special features and spectral analysis for fusion plasmas

22 Jun 2010

Workpackages : 26-6-1
Category : DRAFT

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ADAS-EU R(09)01

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Hugh Summers, Adam Foster, Stuart Loch, Martin O'Mullane
and Allan Whiteford

Heavy species in fusion plasma modelling and spectral analysis

25 May 2010

Workpackages :
Category :

Contents

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ADAS-EU R(10)PU04

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Luis Fernández-Menchero, Stuart Henderson and Hugh Summers

PUBL4: Neutral Beam Emission: The Motional Stark Effect

01 Feb 2012

Workpackages : 26-6-4
Category : DRAFT – CONFIDENTIAL

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ADAS-EU R(10)PU05

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

Alessandra Giunta

Spectral analysis of the solar atmosphere at the chromosphere-corona boundary

August 24, 2010

Workpackages :
Category : DRAFT

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ADAS-EU R(12)PU06

ADAS-EU
ADAS for fusion in Europe

Grant: 224607

F. Guzmán

PUBL6: The ADAS molecular population model for fusion plasmas

1 Feb 2012

Workpackages : 26-6-6
Category : DRAFT – CONFIDENTIAL

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Appendix B

ADAS/ADAS-EU computing equipment review and status

ADAS/ADAS-EU/OPEN-ADAS Computer Resources

1. The provision of computer resources for ADAS-EU staff, central ADAS services, OPEN-ADAS web services, computational services for students and high performance computational facilities is financed from a mixture of ADAS funds, student support grants, ADAS-EU and department funds.

2. The present computer servers located at the University of Strathclyde:

Machine	Services	Status
ferro.phys.strath.ac.uk	/home/ file system	operational
	CVS, svn server	92% capacity
x-wing.phys.strath.ac.uk	access machine	failed hard disk
	general computation	
ripley.phys.strath.ac.uk	general computation	failed hard disk
open.adas.ac.uk	OPEN-ADAS server	operational

3. The University of Strathclyde provides infrastructure support and covers all internet bandwidth costs.

4. The ADAS-EU researchers have multi-place work locations and mobility is expected. The ability to to work effectively is enabled by providing software and sufficiently powerful laptop computers capable of running ADAS and complementary codes. This is backed up by ADAS specific servers housed at the University of Strathclyde.

5. In 2011 laptop computers were provided to ADAS-EU researcher Dr. A. Giunta and student Stuart Henderson. The specification:

Role	Model	CPU	Cache	Memory	Disk	Cost
Laptop	E640	Intel Core i5-560M 2.66Ghz	3Mb	8Gb	320Gb	£780.00 × 2

   Price is ex-VAT.

6. The gui of ADAS and much of the user programability of ADAS is provisioned via IDL, the Interactive Data Language from Exelis. This scientific programming language has an annual license fee. The ADAS group purchases 7 licenses per year split between 4 floating seats on the ADAS servers and node-locked licenses on laptops. The renewal cost in 2011 was £1267.83 (inc VAT) of which £423.00 was apportioned to the ADAS-EU budget.

7. The www.adas-fusion.eu domain name attracts an annual renewal fee of £17.99 (inc VAT).

8. Large scale calculations in support of ADAS-EU programmes and ADAS are carried out on various facilities:
   - JET Analysis Cluster at EFDA-JET.
   - HPC parallel systems at the University of Strathclyde.

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- HPC-FF, the High Performance Computing for Fusion which is part of the JuRoPA supercomputer (Jülich Research on Petaflop Architectures) a European supported programme with access for ADAS staff provided via CCFE, the UK Euratom Association.

9. In the past year a number of computer related issues have become matters of increasing concern:

   - The present ADAS computer infrastructure is nearing its end of life and two servers have suffered hard disk failure.
   - The hardware is not adequate to support the R-matrix repository plans.
   - The current backup provision is too ad-hoc a process for the increased scale of the ADAS activities.
   - The physical security of the computers can be compromised by estate re-allocation within the physics department.
   - ADAS-EU collaborations identified the need for a facility with large amounts of addressable memory. For the first few ionisation stages of the heavy species large memory serial calculations are required. This is against the trend of supercomputer centres where large number of CPUs with modest attached memory is the norm.

10. Following discussions the Physics Department will supply a server rack and housing in a secure location. Backup facilities to separate departmental and university NAS services can be purchased for a modest one-off fee of the order of £200/500Gb.

11. The following rack mounted servers have been ordered from Dell, one of the preferred suppliers to the university, satisfies the mid-term future needs of ADAS, ADAS-EU and OPEN-ADAS:

Role	Model	CPU	Cache	Memory	Disk	Cost
Computational node	R510	Intel Xenon X5650 6 core, 2.66Ghz	12Mb	96Gb	5 × 2Tb	£6221.52
Internet server	R310	Intel Xenon X3430 4 core, 2.4Ghz	8Mb	8Gb	4 × 2Tb	£2116.80 × 3

    Prices are ex-VAT. The R501 was delivered 11th January and the others are expected to arrive in February.

12. It was felt prudent to keep an off-site backup of the ADAS CVS repository, the ADAS-EU shared document repository and web-site and the OPEN-ADAS database. A 1Tb disk (£89.99. inc VAT ADAS budget) is kept at EFDA-JET for this purpose. We note that if is is required there may be greater problems than missing disks.

MO'M
Jan. 2011