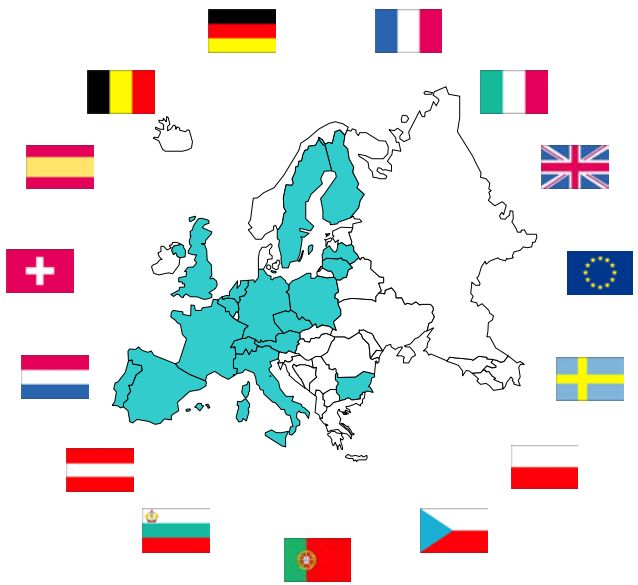
Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

SIXTH FRAMEWORK PROGRAMME

3st Meeting on DM2 ECATS Feasibility Study of EUROTRANS: Integrated Project on European Transmutation



CEA, Saclay France

June 23, 2005

Domain DM2 ECATS

Technical Work Program Proposal

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3rd ECATS Meeting – Feasibility Study -
CEA/INSTS – Saclay, France
23rd of June, 2005

Content

1. **Review of and Comments to the Original Proposals i.e. considering the RACE program, the SAD facility and the YALINA facility**

2. **Rational to achieve a sound overall structure of ECATS and definition of the work packages**

3. **Presentation of the proposed programme**

4. **Necessary next steps**

5. **Resources and Budget Allocation**
   – A First Preliminary Proposal -

Original Proposals

RACE program related proposal by P. Granget, CEA and D. Beller, Idaho State University (Appendix A)

SAD program related proposal by V. Shvetsov, JINR with contributions from W. Gudowski, KTH and C. Broeders, FZK (Appendix B)

YALINA program related proposal by H. Ait Abderahim and P. Baeten, SCK-CEN with remarks from H. Kiyavitskaya, JINPRS (Appendix C)

SAD program related proposal by E. Gonzales and D. Villamarin, CIEMAT (Appendix D)

Offer by I. Matveenko from IPPE in Russia to consider the use of the critical facilities BFS-1/2 for testing

RACE program related proposal – Task/Subtask structure -

Validation of:	Full coupling of real ADS components	Physics and kinetics of an external-source driven subcritical core at ~0 power	Dynamics and experimental techniques of an ADS at power with feedbacks	High energy neutrons propagation	Power/beam current relation validation	Operations at power (start-up/shutdown /scram)
TRADE	YES	YES	YES	NO	YES	YES
RACE	NO	YES	YES	NO	YES	YES
SAD	YES	YES	NO (*)	YES	NO	NO
YALINA	NO	YES	NO	NO	YES	NO
MUSE	NO	YES	NO	NO	NO	NO

(*) YES, if power extended to ~100kW

RACE program related proposal – Task/Subtask structure -

- **T 2.1** : RACE - T experiments

  Subtask 2.1.1 : In-pile instrumentation and measurements (use of the TRIGA reactor at Casaccia as a test bed for instrumentation)

- **T 2.2**: Re-evaluation and extension of the design of the RACE facilities and experiments

  Subtask 2.2.1: Review and extension of core configurations

  Subtask 2.2.2: Target structural design (low and high power operation)

  Subtask 2.2.3: High power target cooling design and experimental validation

  Subtask 2.2.4: Support to the Review of shielding and radioprotection issues

RACE program related proposal – Task/Subtask structure -

- **T 2.3** : Support to Safety Analysis

Subtask 2.3.1: Support to the Review of control and safety system

Subtask 2.3.2: Core and System Transient Analysis

- Assessment of tools adequacy to the final sub-critical configurations by means of a computational benchmark.
- Assessment of tools on the critical experiments in the range of 30 kW to 100 kW
- Design analysis to assess the main safety issues on the final design: e.g. dynamic analysis of free reactivity transients; operational transients simulation to verify the effectiveness of the power control.

Subtask 2.3.3: Final Safety Analysis

RACE program related proposal – Task/Subtask structure -

- **T 2.4** : In-pile instrumentation, commissioning tests, and experiments

  Subtask 2.4.1: Support to the review of control and safety system (2.3.1 duplicate)
  Subtask 2.4.2: Low power phase experiments (LP; June 2005 to December 2007)
  Subtask 2.4.3: Experimentation at high power (HP; June 2007 to June 2009)

- **T 2.5**: Experiments interpretation and transposition to future ADS development : SAD, XT-ADS, EFIT

  Subtask 2.5.1 Analysis of the RACE - T experiments relative to MUSE 4
  Subtask 2.5.2 Interpretation of the RACE - LP phase
  Subtask 2.5.3 Interpretation of the RACE - HP phase
  Subtask 2.5.4 Transposition of RACE outcomes to XT-ADS and EFIT design

RACE program related proposal – Comments -

- The overall program proposal appears to be a one to one copy of the TRADE – PLUS program without special considerations of the possible impact of the new partner i.e. the US-DOE and Universities

- A clear commitment of the US to establish conditions for a successful completion of the RACE – HP phase is not reflected in the work program.

- Safety and licensing related issues have to remain solely in the responsibility of the partner in the US. Potential impact of the HP phase of the program on the attitude of licensing authorities needs to be clarified.

- Compared to the TRADE-PLUS program some reduction of the effort becomes necessary to get more flexibility to support the part of the program related to YALINA and SAD

SAD program proposal – Task Structure

1. Qualification of sub-criticality monitoring:
   ECATS will take special responsibility for this topic:

- Contributing to instrumentation
- Participation in experiments on BFS at IPPE
- Preparing theoretical foundations (if necessary) for modified/new techniques of sub-criticality monitoring
- Processing and interpretation of all experimental data
- Preparing final reports and publications with evaluation and recommendations (selection of the technique, out-selection of non-performing techniques)

SAD program proposal – Task Structure

2. Validation of generic dynamic behavior of an ADS in a wide range of sub-critical levels, sub-criticality safety margins and thermal feedback effects:

- Detail investigations of possible experiments to “simulate” dynamics of SAD without altering the design principles
- Implementation – if appropriate – of experimental techniques and participation in experiments
- Processing and interpretation of the data
- Report and recommendations

SAD program proposal – Task Structure

3. Validation of the core power/beam current relationship

- ECATS takes full responsibility for this package, designing necessary detection system, participation in experiments, processing and interpretation of data, final reports and evaluations

4. Start-up and shut-down procedures, Instrumentation validation and specific dedicated experimentation

- ECATS will be consultative partner. Full responsibility with the SAD-team. ECATS can contribute with instrumentation.

SAD program proposal – Task Structure

5. Interpretation and validation of experimental data, Benchmarking and code validation activities etc

ECATS takes full responsibility for this package in a close collaboration with the SAD team.

- ECATS is responsible for all simulations, code improvements, uncertainty analysis etc
- SAD-team guarantees necessary precision of all material, istopic and geometry data.

SAD program proposal – Task Structure

6. Qualification of the proton beam reliability and the beam transport line, Pb-Bi or Pb-spallation target design in association with relevant proton beam and the effects of spallation residues including that of polonium

- The SAD team is responsible for this task. ECATS makes assessment of the target design, benchmarks all data on different targets.
- Pre- and post-irradiation investigations done by the SAD team.
- ECATS can take responsibility (with UMM involvement) for measurements on bare targets, such as: beam heating power, radiation fields around the target with the use of dose meters and micro-dosimetric counters (for validation of calculations), time structures of the beam and the generated neutron field (original and with spectra modified by inserted moderators; also for testing the experimental equipment)
- In beam transport issues ECATS may give some evaluations and feedback.

SAD program proposal – Task Structure

7. Safety and licensing issues of different component parts as well as that of the integrated system as a whole

- The SAD-team is fully responsible. Transfer of all documents to ECATS. Assessment and analysis done by ECATS. Feedback to the SAD team.

8. Radiation shielding and radiation doses

- ECATS – co-partner (UMM group contributes to experiments). Simulations and interpretation of results, final report done by ECATS.

SAD program proposal – Comments

- The SAD program proposal follows closely the items of the shopping list of requests for experimental support presented at the 2nd ECATS meeting in Brussels
- A large part of the proposed program assumes that the facility will become operational well within the time period of the IP EUROTRANS. However, other parts of the program are concerned as well with items which will be investigated during preparation of the construction of the facility and for detailed design optimization.
- The provided program proposal is by far too sketchy. A relatively large effort becomes necessary to provide a similar level of detail and clarity about tasks and subtasks as in the other program proposals. Qualification of some of the tasks by E. Gonzales from CIEMAT was quite helpful to get a better insight into parts of the foreseen program.
- Task coordinators, responsible and/or participating organizations, time schedules, foreseen deliverables etc. have not yet been specified in sufficient detail. This needs to be corrected very quickly.

YALINA program proposal – Task Structure -

Task 2.1.1:Definition and characterisation of the different YALINA configurations in view of the investigation of the methodology for reactivity monitoring

Task 2.1.2: Investigation of the current-to-flux reactivity on-line monitoring technique

Task 2.1.3: Investigation of the interim calibration techniques used at beam trips for cross-checking of the current-to-flux on-line reactivity monitoring technique

Task 2.1.4 Investigation of full calibration techniques for kinetic parameters during loading/start-up procedures.

Task 2.1.5: Definition of a methodology for reactivity monitoring in ADS and definition of procedures for start-up, loading, operation and shut-down.

YALINA program proposal – Comments -

The program proposal provides a very coherent presentation of the case and of the rational behind the requested tasks.

However, it would help for a better defense of the requested experiments to shortly characterize the core configurations to be investigated in detail and more importantly to limit explicitly the number of variants to a minimum. (Task 2.1.1)

Considerations on the **Overall structure of the ECATS program**

- When all contributions provided by one facility to the program would be arranged in only one work package the risk increases that the working groups on the sites of the different facilities do not co-operate sufficiently closely with each other.

- Some of the proposals of tasks to be performed in the different facilities provide knowledge of similar nature. Therefore, it is mandatory to organise the working scheme in such a way that specialists of the different facilities are forced to co-operate nearly on a day to day basis.

- A work package should be defined such that the contributing scientists can continue their work even if one of the involved experimental facilities fail to provide the results on schedule due to what reason so ever.

Considerations on the **Overall structure of the ECATS program**

- Similar objectives to provide improved knowledge by the different experimental support programs have been taken as guideline for specifying the work package structure of the ECATS program.

- Whenever reasonable contributions from the different experimental programs to the same subject of interest have been combined in one work package thus forcing the teams to exchange their views and share intermediate results quickly and continuously during execution of the program

Work Packages of the ECATS program

- **WP 2.1: Qualification of sub-criticality monitoring and of the core power/beam current relationship.**
- **WP 2.2 Validation of the generic dynamic behaviour of an ADS in a wide range of sub-criticality levels and with consideration of thermal feedback effects.**
- **WP 2.3 Qualification of the design of the beam transport line and of the Pb-Bi or Pb- spallation target design approach**
- **WP 2.4 Evaluation of the impact of high energy protons and the fast neutron flux on damage of structures and on shielding issues**
- **WP 2.5 Collection of information about safety and licensing issues of different component parts as well as that of integral systems – Extrapolation to the XT-ADS and EFIT cases.**

ECATS program proposal of WP 2.1 – Task/Subtask structure -

- **Task 2.1.1** Zero power, CW YALINA experiments

Subtask 2.1.1.1:Definition and characterisation of the different YALINA configurations in view of the investigation of the methodology for reactivity monitoring

Subtask 2.1.1.2: Investigation of the current-to-flux reactivity on-line monitoring technique

Subtask 2.1.1.3: Investigation of the interim calibration techniques used at beam trips for cross-checking of the current-to-flux on-line reactivity monitoring technique.

Subtask 2.1.1.4 Investigation of full calibration techniques for kinetic parameters during loading/start-up procedures.

ECATS program proposal of WP 2.1 – Task/Subtask structure -

- **Task 2.1.2** Zero and low power, SAD experiments

  Subtask 2.1.2.1 Start-up experiments in the SAD facility using the (D-T) source
  Subtask 2.1.2.2 Experiments in the SAD facility using the 660 MeV proton accelerator

- **Task 2.1.3**: Definition of a methodology for reactivity monitoring in ADS and definition of procedures for start-up, loading, operation and shut-down.

Based on

- the experience gained with the different measurement techniques in various operational conditions,
- input from WP2.2 on feedback effects and operational experience procedures (RACE-T/LP and HP)
- operational constraints specified in DM1 DESIGN

procedures for start-up, loading, nominal operation and shut-down will be established.

ECATS program proposal of WP 2.2 – Task/Subtask structure -

- **Task 2.2.1** Experimental demonstration within the RACE Programme

  Subtask 2.2.1.1 RACET experiments

  Subtask 2.2.1.2 Re-evaluation and extension of the design of the RACE facilities

  Subtask 2.2.1.3 Support to the transient behaviour assessment

  Subtask 2.2.1.4 In-pile instrumentation, commissioning tests, experimental techniques development and validation

  Subtask 2.2.1.5 Experiments interpretation, code validation and transposition to future ADS development : SAD, XT-ADS, EFIT

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- **Task 2.2.2** Experimental demonstration within the SAD Programme

  Subtask 2.2.2.1 Validation of generic dynamic behavior of an ADS in a wide range of sub-critical levels, sub-criticality safety margins and thermal feedback effects

  Subtask 2.2.2.2 Interpretation and validation of experimental data, Benchmarking and code validation activities etc

ECATS program proposal of WP 2.3 – Task/Subtask structure -

- **Task 2.3.1** SAD target design evaluations
- **Task 2.3.2** SAD target materials investigations
- **Task 2.3.3** Validation of “radiological/radiation protection” calculations

Subtask structure is still to be provided

ECATS program proposal of WP 2.4 – Task/Subtask structure -

- **Task 2.4.1** Radiation shielding and radiation doses

The Task characterization is still to be provided in more detail as well as the subtask structure

ECATS program proposal of WP 2.5 – Task/Subtask structure -

- **Task 2.5.1** SAD safety analysis report and its feedback to XT-ADS and or EFIT

The Task characterization is still to be provided more precisely as well as the subtask structure if extrapolation of the SAD safety analysis report is felt necessary to be performed in detail

Necessary next steps

- Overall Approval of the proposed Work Package structure (small corrections/modifications on the level of Tasks/Subtasks should not be prevented)
- Nomination and approval of a (future) Domain Coordinator to assist the (interim) Domain Coordinator (JUK)
- Nomination and approval of Work Package Coordinators.
- Presentation of the intended general outline of the ECATS program to the Commission and appropriate consideration of the achieved feedback (to be done by JUK asap)

Necessary next steps

- Updating of the Task/Subtask description where necessary, preferentially when SAD project related Tasks are concerned
- Nomination of Task Coordinators and afterwards opening negotiations about active contributions by interested partners of the IP EUROTRANS (to be initiated by the interim and future Domain Coordinator)
- Formalization of the contacts to the partners outside the EC and evaluation of contractual matters potentially of concern (to be done by the IP Coordinator)
- Overall harmonization of the final program including allocation of resources and man power effort at the latest up to September 2005.

Concluding Remarks

- My very sincere thanks go to the colleagues who have prepared their individual program proposals in due time
- Though we have made considerable progress in establishing a reasonable work program for the ECATS Domain there is still a lot of work ahead of us.
- My best guess is that in minimum we still need about two months up to the time where we get a common approval of the overall program
- Nevertheless, the duration of the ECATS program should remain unchanged i.e. it should last four years. The then appearing difference to the final date of the work performed in the other Domains should be accepted.

Resources and Budget Allocation

(First preliminary proposal by D. Struwe FZK June 20th, 2005)

- Resources and budget allocation is still dominated by specification of the effort in man power, cost for delegation of personal to foreign sites and traveling cost to be provided by each of the participating organizations. Other cost aspects will arise due to the following reasons:

  At this stage, the European collaboration with the US foresees to provide our partners with:
  - loan of fission chambers and special fuel elements (ENEA)
  - loan of miniature (Φ1.5 mm; Φ4 mm; Piccolo micromegas) fission chambers (CEA)
  - loan of data acquisition equipment (CEA, ENEA)
  - effort in the area of data acquisition and interpretation (CEA, etc.)

- Similar cost aspects will appear when accepting to perform the experiments in the BFS facility or when part of the equipment for the PIE of the target material is to be provided by European partners.

Resources and Budget Allocation

- It is proposed to allocate upper limits of resources and budget to the different work packages on basis of a specific percentage of the whole sum which was originally foreseen to be used for the support of the TRADE –PLUS Domain of EUROTRANS (5.5M€ over four years).
- Upper limits for the different work packages should be selected dependent on the importance for the successful realization of the XT- ADS design and the amount of work involved.
- If the foreseen effort to be invested into the different tasks of the work packages exceeds the pre-specified upper limits it is recommended to reduce the respective work program accordingly.

Resources and Budget Allocation

- The actual program proposal contains several tasks and/or sub-tasks which can only be performed if either the SAD facility becomes operational as scheduled or if the extension of the RACE program to the high power operation option can be realized without being confronted by currently unknown difficulties.
  Therefore, it is proposed to allocate initially only 70 % of the whole budget to the different work packages.
- 30 % of the overall budget should be spent only as currently foreseen or otherwise if the construction of the concerned facilities and the execution of the tasks proceed as scheduled.
  This aspect will be evaluated at the latest two years after the start of the ECATS activities.
- After two years, the progress of the proposed program will be reviewed and it will be decided how to proceed. The situation is to be explained clearly and the then made proposals for a solution are to be presented to the governing council of the IP EUROTRANS for approval.

Resources and Budget Allocation

In relation to the importance of the different work packages for the successful realization of the XT – ADS and the amount of activities foreseen it is proposed to set the upper limit values as follows:

WP 2.1 Qualification of sub-criticality monitoring and of the core power/beam current relationship.

European partners	15 %
YALINA facility	5 %
SAD facility	0 %
subtotal	20 %

WP 2.2 Validation of the generic dynamic behaviour of an ADS in a wide range of sub-criticality levels and with consideration of thermal feedback effects.

support for the RACE program	30 %
support for the SAD program	5 %
subtotal	35 %

Resources and Budget Allocation

WP 2.3 Impact of high energy protons and neutrons respectively, on target and structures and on shielding issues
(Qualification of the design of the beam transport line and of the Pb-Bi or Pb- spallation target design approach)

support for the SAD program 5 %

(WP 2.4 Evaluation of the impact of high energy protons and the fast neutron flux on damage of structures and on shielding issues)

support for the SAD program 5 %

WP 2.4 Evaluation of licensing aspects deduced from RACE and SAD in view of XT-ADS necessities
(Collection of information about safety and licensing issues of different component parts as well as that of integral systems – Extrapolation to the XT-ADS and EFIT cases.)

support for the SAD program 5 %

total amount of the overall program 70 %

Resources and Budget Allocation

- Initially the responsibility for the appropriate distribution of the resources in between the tasks and the partners of a work package should be left preferentially with the respective WP coordinator keeping the Domain coordinator properly informed.
- When the final program has been established members of the ECATS feasibility study group should review the results and the coordinator of the feasibility study (J. Knebel, FZK) should evaluate together with the Domain coordinator whether the solution achieved is a fair compromise between the different interests and the necessities arising from the program proposal.
- In addition it should be evaluated whether the then achieved situation - due to good arguments – differs from the TRADE-PLUS program and to what extent.
- In specific cases appropriately small corrections could be envisaged as result of this review process.