MARIE CURIE HOST FELLOWSHIP FOR THE TRANSFER OF KNOWLEDGE
TOK
Annex I
"Description of Work"

PART A: CONTRACT DETAILS AND OBJECTIVES

1: **Full Title:** *DETERMINISTIC AND STOCHASTIC DYNAMICS, FRACTALS, TURBULENCE*

Short Title (i.e. Project Acronym): SPADE2

2: **Proposal Number: 14508**

Contract Number:

3: **Start Date:** 01/09/2005 **Duration of the project:** 48 Months

4: **Contractors and Place(s) of Implementing the Project**

The Co-ordinator and other Contractors listed below shall be collectively responsible for execution of work defined in this Annex:

The Co-ordinator

1. Institute of Mathematics of the Polish Academy of Sciences IM PAN established in Poland

Other training partners

2. The University of Warwick U. Warwick established in Great Britain;
3. Universite Pierre et Marie Curie Paris 6 established in France;
4. Scuola Normale Superiore di Pisa SNS Pisa established in Italy;
5. L'Institut National de Rechcerche en Informatique et en Automatique INRIA established in France;
6. Christian-Albrechts Unversitaet zu Kiel CAU Kiel established in Germany.

5: **Project Overview**

The aim of SPADE 2 is to reinforce in Poland the existing and to establish new areas of modern mathematics of primary importance, through developing research collaboration with best world experts and obtaining top quality training. This will contribute to the position of Warsaw in particular IMPAN as a leading mathematical centre in Europe and to the development of ERA.

The subject of SPADE2 is interdisciplinary: methods of dynamical systems, 1,2, finite and infinite dimensional, the study of regularities and long time behaviour of solutions for some PDE's, as Navier-Stokes Eq., and fractal nature of arising attractors.

Applications include fractals (data compression, signal transmission), flows in blood vessels, population dynamics, tomography. More specifically, areas and methods include:

- 1D-dynamics, real and complex, Iterated Function Systems (IFS) as a kernel of higher dimension phenomena (hyperbolic, non-uniformly hyperbolic, dominated splitting), dimensions and measures on metric attractors and basins, Multifractal Spectra of Lyapunov exponents, entropy, dimensions.
- Infinite-dimensional systems. 2D (Navier-Stokes Eq.), 3D thin domains attractors
- Scaling limits in physical processes. Dimensions and scaling exponents for the 2D models like percolation, Ising model, self avoiding random walk, etc. There are expected advances in the models like diffusion limited aggregation (a generic model of fractal growth) or random matrices (of major importance in studying disordered media).
- Stochastic Processes. Evolution equations with impulsive noise. Stochastic Burgers and Navier – Stokes equations. Stochastic equations for spin systems and bond markets. Bellman equations and stochastic maximum principle for controlled evolution equations. Random environment and turbulence. Stochastic equations on manifolds.
- Methods of Function Spaces: Sobolev Spaces, Gerrey classes functions of bounded variation, analysis of singularities of measures, singular integrals and harmonic analysis. Wavelet methods. (Degenerate) quasiconformal methods in holomorphic dynamics and PDE’s.

The corresponding Tasks are topics in

1. Dynamical Systems, Fractals
2. Partial Differential Equations, turbulence, asymptotics
3. Stochastic Processes, scaling limits.
4. Methods of Function Spaces.

The priorities in the project are the visits of top specialists from abroad giving series of lectures, and seminars with the participation of researchers and PhD students from IM PAN and other institutions. A special interdisciplinary ToK SPADE2 weekly seminar will be organized.

The partners of IM PAN for outgoing visits are the universities: Warwick, Paris 6, CAU Kiel, and research institutes SNS Pisa, INRIA Institute at Rocquencourt ("Projet Fractale").

The activities of ToK will be widely advertised through Web pages with abstracts of lectures and seminars, bulletins e-mailed to registered participants and PhD students. Some ToK survey lectures and courses will be published in Banach Center Publications. Openings of positions and vacancies will be published on the web page and adequate European bulletins.

The programme will be managed by the Coordinator, Feliks Przytycki and Scientific Committee, which will include the Coordinator, Task Coordinators and Recruitment Committee, advised by International Advisory Board, in cooperation with the Training Partners Scientists-in-Charge. Yearly and Final reports will be prepared according to the milestones plan (CPF form A9).

PART B: IMPLEMENTATION

1. Description of the transfer of knowledge

- **Scientific objectives and contribution to the advance of capabilities of the applicant, by research fields/tasks.**

1. Dynamical systems. Many investigations will be encompassed by the general Thom-Smale-Palis programme, to study typical dynamics and prove that in many situations most of the space consists typically of basins of attraction to periodic motions, to describe separating chaotic sets and study changes of the patterns with changing parameters.
In 1D real iteration the Density of Hyperbolicity has been proved recently in Warwick, opening new perspectives due to new methods, in particular function theory, quasi-conformal methods, see theme 4. In complex case (rational, entire or meromorphic) the problem is still open, attracting attention of leading specialists and will be of high interest by SPADE2. Related is the problem of Local Connectedness of the Mandelbrot set (MLC), demanding better understanding of the renormalizations. Julia (chaotic) sets will be investigated from combinatorial and geometric measure theory point of view. Top Polish researchers in 1D iteration, who emigrated will be involved (Misiurewicz, Nowicki, Swiatek, Graczyk, Urbanski). The group working in population dynamics (Katowice) with the use of 1D and stochastic processes methods will get a new impetus in studies of blood cells, small scale (fractal) structures.
In higher dimensions the theory of limit sets of IFS is emerging, especially in non-conformal case (solenoids). (Self) intersecting Cantor sets are of this nature. They appear in the parameter space in the homoclinic tangency bifurcation (Palis, Yoccoz, Moreira). M. Rams will coordinate ToK at IMPAN in this area. In applications of IFS there is expected a benefit from the cooperation with INRIA "projet fractale"
It is planned to join recent fast progress in the theory of dominated splitting, generalising hyperbolic (or Anosov) systems and other typical properties of Lyapunov spectra, in cooperation with the Brasilian, French and Portuguese schools, and in understanding equilibria, in particular SRB (Sinai-Ruelle-Bowen) measures and their multifractal spectra on invariant sets (attractors), in particular in fluid dynamics, see theme 2. It is also planned to join KAM theory and Arnold diffusion investigation.

2. PDE's, turbulence, asymptotics. Many features of the physical phenomenon of turbulence in fluid flows can be explained rigorously in the frame of the theory of infinite dimensional dynamical systems. there is an interest in finite dimensionality of the flow of two-dimensional Navier-Stokes (NS) fluid (e.g. on two dimensional torus), the axially symmetric flows and three dimensional NS fluid in thin 3-D domains. The number of degrees of freedom of such flows is connected to the Hausdorff dimension of the global attractor. Dimension estimates given in terms of the Grashof number correspond to the Kraichnan and Kolmogorov dissipation lengths that concern classical descriptions of turbulence. There is also an interest in such close problems as long time behaviour of solutions of semi-linear evolution equations, regularity of solutions in Gevrey classes, the study of models of pattern formation, blood motions and plane motions.
With the help of foreign experts it is planned to examine the regularity to NS in different geometries and symmetries. There will be also included the NS motions in pipes with large velocity which could model the motion of blood in vessels. There will be also developed further the method of re-summation of formal solutions and apply it to nonlinear evolution equations such as semi-linear heat, KdV and shallow water equations.

3. Stochastic Processes.
Scaling limits in physical processes. The Tok is planned in scaling limits of percolations in relation with SLE_K, applied to dimension of Brownian frontiers, or selfintersections (O. Schramm, W. Werner, S. Rohde, S. Smirnov). Another topic, is DLA, deterministic and stochastic models, random matrices (Kanyon, Johansson, Carleson, Makarov*)*

There is an intention to continue our study of qualitative properties of solutions to *stochastic differential equations* (ordinary and partial) driven by Wiener and impulsive, i.e. Levy noise. In particular their long time behaviour, existence of invariant measures and attractors, ergodicity, large deviation estimates, exit probabilities and large noise asymptotic. Those properties are important for understanding models which appear naturally in fluid mechanics as a description of the dynamics of a fluid under influence of a random exeternal force and turbulence. In particular stochastic Navier-Stokes, Euler and Burgers equations and Anderson models in two or three dimensional regions. Turbulent transport is another ToK topic, this includes anomalous scaling and intermittency in the Krauchnian model, phase transition, IFS methods, multifractal spectra of random attractors. Random media. There is expected to collaborate on turbulence with K. Gawedzki (Lyon), S. Ola (Paris) Bernard, Kupiainen, Horva. The theory of Dirichlet processes and forms can be useful for constructing solutions to equations with irregular coefficients. Collaboration with University of Bielefeld (M. Röckner), should be very fruitful.
Intensively studied are distributed *control systems both deterministic and stochastic*. The analytic methods developed in our Institute (S. Peszat and J. Zabczyk) for uncontrolled models would be applicable here. It is planned to collaborate on control of flexible and reaction-diffusion systems with Pisa, (G. Da Prato) and Detroit (J.L. Menaldi) and Trento (L.Tubaro). In particular we would like to learn the theory of backward stochastic equations with its relation to the stochastic maximum
Stochastic differential geometry, in particular stochastic equations on manifolds, construction of a Gaussian measure on infinitely dimensional manifolds (loop spaces), are important, yet a little neglected subjects in Poland. They have fascinating applications and directly related to sub-Riemannian geometry. We would like to learn how those theorie are related to physics of strings.
4. Methods of Function Spaces. A remarkable progress was achieved in the last few years around the fast developing subject of wavelet expansions. It is planned to develop wavelet methods in numerical solutions of differential equations and non-linear approximation – collaboration with A. Shadrin (Cambridge). The connections between the measure theory, non-linear functional analysis and the theory of differentiation of functions, including functions on infinitely dimensional spaces, received a lot of attention in recent years – it is planned to collaborate with D. Preiss (University College London) in this domain. Theory of spaces of smooth fuctions (non-reflexive Sobolev spaces, spaces of functions of bounded variation, anisotropic spaces) require deeper study and further development. This includes multidimensional Fourier and wavelet analysis, approximation by splines in the spaces of smooth functions, embedding and trace theorems (V. Kolyada), isomorphic properties of function spaces and their dependence on smoothness and domain, singular integral operators on Sobolev spaces, the use of interpolation in the study of PDEs; Sobolev spaces on metric measure spaces. Developement of quasi-conformal (or degenerated quasi-conformal) methods in holomorphic dynamics and PDEs; application to inverse problems, impedance tomography and nonlinear equations (K. Astala, P. Koskela, T. Iwaniec).

♦ Tasks, scientists, organisations.

The ToK programme is divided into four linked tasks according to research fields. Listed (in brackets) are the names of local researchers involved in the tasks. In square brackets are listed some foreign scientists potentially involved in the project.
1. Deterministic Finite Dimensional Dynamical Systems. (F. Przytycki, M. Rams, R. Rudnicki, M. Wojtkowski, A. Zdunik, J. Kotus);
• Real 1-D dynamics and complexification, analytic and combinatorial theory, geometric measures, multifractal point of view [A. Douady, J. Graczyk - Orsay; J.-Ch. Yoccoz, College de France, S. van Strien, O. Kozlovski - U. Warwick, G. Levin – Jerusalem, G. Swiatek-Penn State, K. Astala, P. Koskela, P, Mattila –U. Helsinki, X. Buff – Bordeaux, K.L. Petersen, B. Branner – Copenhagen, M. Shishikura –Kyoto, J. Rivera-Letelier -Antofagasta] ;
• Hyperbolic and dominated splitting, non-uniform hyperbolicity: Lorentz and Henon attractors, Sinai-Ruelle-Bowen measures, homoclinic tangency bifurcations, limit sets for non-conformal iterated function systems, selfintersecting Cantor sets [M.Benedicks - KTH Stockholm, J. Palis, M. Viana, H. Pujals - IMPA Rio de Janeiro; S. Luzzatto – IC London, V. Baladi - Paris 6, J. Schmeling - U Lund; K. Simon - Tech. Uni. Budapest]. (Also topics in

hamiltonian and geodesic systems, chaos between quasi-periodic motions. [S. Kuksin - Edinburgh (also Task 2); P. Le Calvez - Paris 13; H. Eliasson: Paris 6; A. Chenciner -Paris 6, J. Llibre, C. Simo - Barcelona, R. de La Llave - Texas; Marmi - SNS Pisa.].

2. Partial Differential Equations, turbulence, asymptotics. (W. Zajączkowski, G. Łukaszewicz, J. Rencławowicz, T. Regińska, G. Łysik).

- Infinite dimensional dynamical systems and lubrication theory. Atractors, SRB-measures, mixing [G. Raugel, R. Teman – Paris 6, J. C. Robinson – U Warwick, G. Bayada – INSA, Lyon, A. Kupiainen –U. Helsinki, J. Bricmont –Lourain, V. Baladi – Paris 6];
- Equations of viscous fluids: existence and regularity for Navier-Stokes [G. Raugel, M. Cannone, Y. Meyer - Paris, P. Penel - Toulon, M. Wiegner - RWTH Aachen, H. Beirao da Veiga - Pisa, A. Sequieira - Lisbon, R. Salvi – Milan, W. Schroeder - RWTH Aachen, I. Neustupa, M. Pokorny - Prague];
- Evolution equations, asymptotics, [T. Gramchev - Cagliari U., W. Balser – U. Ulm];

3. Stochastic processes. (A. Lasota, T. Komorowski, S. Peszat, R. Rudnicki, L. Stettner, J. Zabczyk)

- Scaling limits and conformal invariance of physical processes, percolation and superprocesses, diffusion limited aggregation, Schramm-Loewner evolution, random matrices [W. Werner, R. Kanyon - Paris-Sud, R. Tribe - U. Warwick, C. Muller - Rochester, K. Burdzy - Seattle, K. Gawedzki – ENS Lyon, Carleson, Benedics, K. Johansson –KTH Stockholm, S. Smirnov KTH & Geneve];
- Stochastic evolution equations and turbulence. Properties of solutions: [G. Da Prato (SNS, Pisa),B. Maslowski and J. Seidler (Prague), Z. Brzezniak (Hull), W. Hoh and M. Röckner (Bielefeld), E. Priola (Torino)]. Special equations: [R. Tribe and S. Assing (Warwick), L. Mytnik (Haifa), C. Mueller (Rochester), F. Russo (Paris XIII)]. Turbulence: [K. Gawedzki (ENS Lyon), F. Flandoli (Pisa), Z. Brzezniak (Hull), D. Bernard (CEA Saclay), M. Olivier (IU Bremen)].
- Stochastic control of distributed parameter systems. Dynamic programming: [G. Da Prato (SNS Pisa), S. Cerrai (Florence)]. Stochastic maximum principle: [G. Tessitore and M. Fuhrman (Milano), F. Gozzi (Rome), R. Buckhdan (Brest),), B. Oksendal (Oslo)]
- Stochastic geometry: [D. K. Elworthy (Warwick), Y. Gliklikh (Voronez), and Y. Le Jan (Paris Sud)] Subriemanian geometry – singularities [M. Zhitomirski], at IMPAN: B. Jakubczyk, S. Janeczko.

4. Methods of Function Spaces. (Z. Ciesielski, A. Kamont, P. Mankiewicz, P. Wojtaszczyk, A. Pełczyński, M. Wojciechowski);

- Isomorphic properties of function spaces, interpolation, singular integrals, Carnot-Caratheodory spaces [G. Pisier – Paris 6, Garcia-Cuerva – U. Autonoma Madrid, V. Kolyada – U. Karlstat, Brudnyj, Shwartzman - Technion Jerusalem, P. Jones - Yale, P. Mueller - Linz , Vogt -WUP, M. Roginskaya – Goteborg, D. Preiss, M. Csörnyei – UCL, G. Alberti -Pisa, A. Volberg -Paris6];
- Wavelets and approximation, unconditional structures, non-linear methods [A. Shadrin - Cambridge, DeVore, N. Kalton - Columbia Mo., Terenzi - Milano];
- Elliptic Partial Differential Equations and quasi-conformal mappings [K. Astala, T. Iwaniec, P. Koskela, G. Martin (New Zeland)] (B. Bojarski, P. Hajlasz, A. Kałamajska, P. Strzelecki)

♦ Research method and workplan

1. A special multidisciplinary TOK SPADE2 weekly seminar will be organized. The accent will be on mathematical methods present in all the tasks.

2. IMPAN has been organising seminars and lectures regularly for many years. They have been attracting an audience from the whole Poland with many talks given by foreign specialists. The incoming researchers will reinforce these seminars. Some seminars will be newly organised or reorganised, to fit better the needs of the programme. Below is the list of existing seminars, which will be hopefully reinforced, due to the programme. In square brackets are indicated the leaders of the seminars. Most of these events takes and will take place at IMPAN, attracting also students from Warsaw Technical University (which is nearby)

and Warsaw University. Some of them will be organized at Maths Department of Warsaw University.

3. General seminars:

- Population dynamics (all the Tasks, Katowice/Warsaw) [R.Rudnicki, A. Lasota]
- Dynamical systems (Task 1, in relation with 2,3) [H. Żołądek, A. Zdunik, F. Przytycki, K. Barański]
- Partial Differential Equations (Task 2) [B. Bojarski, W. Zajączkowski, G. Łysik, G. Łukaszewicz, Z. Peradzyński]
- Stochastic Processes (Task 3) [J. Zabczyk, Sz. Peszat, T. Komorowski]
- Functional Analysis (Task 4) [A. Pełczyński, Cz. Bessaga, W. Żelazko, S. Rolewicz, M. Wojciechowski, S. Kwapień, R. Latała and others]
- Spectral Theory of Differential Operators (Tasks 2, 4, Kraków branch) [J. Janas]
- Approximation Theory (Tasks 2, 4, Gdańsk branch [Z. Ciesielski, A. Kamont, T. Figiel]
- Population Dynamics Seminar, Katowice branch (Task 1, 2, 3) [R. Rudnicki]

4. Some specific seminars (existing or planned):

- Analytic theory of differential equations (Task 2)[G. Łysik, H. Kołakowski]
- Geometric Theory of Sobolev spaces (Task 4) [, P. Strzelecki, A. Kałamajska]
- Wavelet bases in function spaces (Task 4) [P. Wojtaszczyk]
- Navier-Stokes Equations (Task 2) [W. Zajączkowski]
- Low dimensional dynamics and Holomorphic iteration (Task 1) [J. Kotus, F. Przytycki, A. Zdunik, M. Rams]

Several (1-semester or longer) courses or series of advanced lectures given by the visiting scientists involved in ToK will be provided. We mention only some of them:

- Homoclinic tangency bifurcations (Task 1)
- Point processes and their applications (Task 3.)
- Evolution equations (all Tasks)
- Unconditionality of spline bases (Task 4)

Scientists involved in the ToK will give short courses and survey lectures at mathematical weekend seminars (national), Banach Center research schools, summer schools and workshops (international).

5. Tutoring

Tutoring related to the courses will be delivered by the visiting scientists, to local young researchers (in order that the young participants and tutors master the topic).

♦ **<u>Indicative breakdown of experienced researchers</u>**

The TOK fellowship undertakes to provide a minimum of 46 person-months for Experienced Researchers and 66 person-months for More Experienced Researchers (total 112) whose appointment will be financed by the contract.
The total number of person-months hosted at IM PAN will be minimum 66, and the total number of outgoing staff to the partner organizations will be minimum 46 person-months. Quantitative progress, with reference to the table contained in Part C and in conformance with relevant contractual provisions, will be monitored regularly.

	Hosted experienced researchers to be financed by the contract		Total (a+b)
	Experienced researchers (person-months) (a)	More experienced researchers (person-months) (b)	(c)
1. IMPAN	30	36	66
2. U. Warwick	4	9	13
3. Paris 6	4	9	13
4. SNS Pisa	2	6	8
5. INRIA	4	2	6
6. CAU Kiel	2	4	6
TOTAL	46	66	112

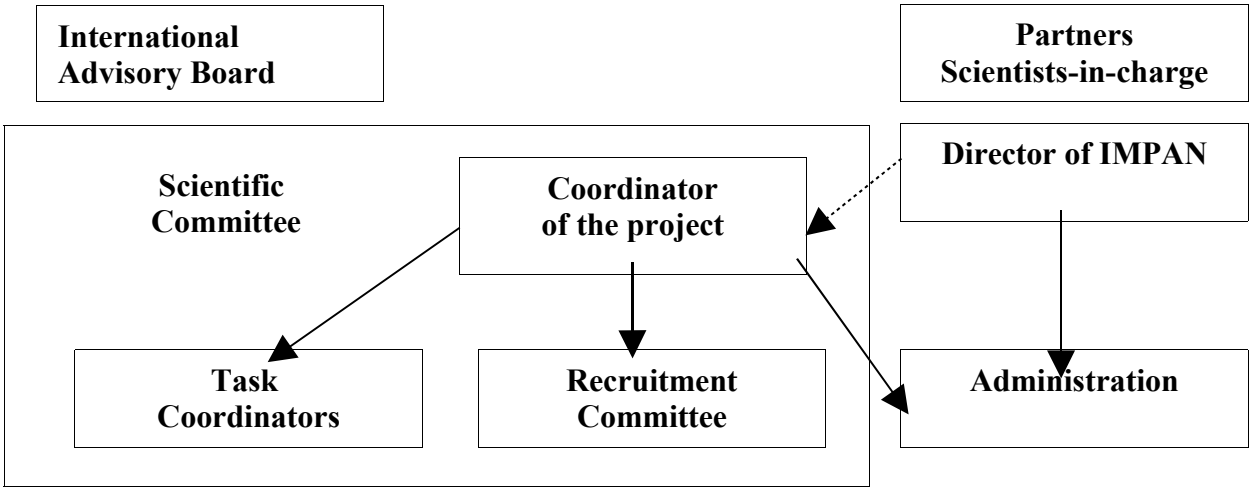
Schedule Each of the 4 tasks will have 2 semesters of more concentrated work, including seminars, courses and lectures. However since the tasks are closely interrelated, the activities of each task will continue during the whole life of the programme (and beyond). They will be combined with (usually preceded by) basic courses by local staff for students at Warsaw University and Warsaw University of Technology and PhD students from IMPAN. These will prepare the students for participation in more advanced activities delivered by the ToK guests. Planning 66 person/months visits of experienced and more experienced researchers during the programme, it is expected o have 2 visitors from abroad at one time. They can lead or co-lead 2 seminars and together with local students and local researchers they will create a critical mass to achieve significant results. 46 person/months of visits in training partners institutions will provide each task a possibility of two or three 1-semester (2-6 months) visits.
SPADE2 will be accompanied by Polish Ministry of Science individual and small team's grants.
Yearly reports will be provided according to contract deliverables, see CPF form A9. There is planned a midterm international workshop to present scientific progress and discuss plan for the remaining 2 years
Supporting of the experienced researchers with practical matters relating to their mobility. To increase the availability of top experts in the field and ensure the continuity of long-term research collaboration, several of short-term visitors should be offered split fellowships. IMPAN owns a number of mini-apartments that can be rented to short-term guest upon demand. The long-term guests will have no problem finding an appropriate accommodation in Warsaw, and will be assisted in it by IMPAN administration. The planned total number of visitors might slightly increase or decrease depending on the availability and performance of the fellows.

Milestones and deliverables, see CPF A9, Section B3 in this Annex and CPF A4b.

2. Management

Proposed management and organisational structure

The organisational and management structure of the project is illustrated on the following chart:



1. The scientific committee (which includes Tasks Coordinators and Recruitment Committee) decides about general priorities, the choice of topics and methods to be transferred and the general splitting of means among the tasks. It makes suggestions to the coordinator and task coordinators. It evaluates the yearly progress in the ToK programme.

2. The coordinator, Feliks Przytycki (his scientific assistant is Grzegorz Łysik), is responsible for the execution of the ToK programme. The coordinator directly communicates with the Director of IMPAN and EU institutions. He collaborates with the Scientific Committee (in particular with the task coordinators) in:

(a) selecting the candidates at IMPAN for the secondments, in the cooperation with the partners scientists-in-charge;

(b) organising the transfer of methods, learned during the secondments, after return to Poland;

(c) selecting the subject and time and advertising the visiting positions at IMPAN in the ToK programme, with the help of the technical staff.

The coordinator is responsible for **financial decisions** made in the ToK programme and takes care of all administrative and financial matters (offices, accommodation) using the administration structure of IMPAN. He also collaborates in these matters with the training partner organisations

3. The Tasks 1 - 4 are coordinated by **the task coordinators** chosen among scientists involved in the project. These will be tentatively: Task 1: M. Rams, Task 2: W. Zajączkowski, Task 3: J. Zabczyk, Task 4: M. Wojciechowski. They are subordinated to the coordinator of the project. They organise visits (timetable, selection of topics) communicating with scientists-in-charge from the partner organisations. On the IMPAN side they fix the content and timetable of seminars, lectures and workshops connected with the ToK project. They report periodic research and training progress to the Scientific Committee.

4. The International Advisory Board, IAB (consisting of distinguished scientists) will be established to ensure the maximal possible efficiency and help to indicate the best experts possibly involved in the transfer of knowledge.

5. The Recruitment Committee will select the candidates and propose the **appointments** to the coordinator, who in case of doubts asks for additional consultations in Scientific Committee, partners scientists-in-harge and International Advisory Board.

It demands recommendation letters and asks experts for the opinions with <10 years of experience researchers.

More experienced researchers (experts) will be selected carefully by the Scientific Committee upon suggestions by tasks coordinators (and advised by IAB) basically from the list in Part 1, square brackets, and will get personal invitations.

Monitoring and reporting
The execution of the Project will be monitored and evaluated yearly by the Scientific Committee in collaboration with the partner scientists-in-charge. The scientific and training progress (measured e.g. by publications, attracted students etc.) will be reported to the EU commission by the Coordinator in Periodic Activity Report, as well as Periodic Management Report and Financial Statement. The Final Report will be submitted in a similar procedure.

A part time employment of a technical secretary in charge of the project is planned, in particular in charge of the technical preparation of an e-bulletin, and creating and maintaining the web page.

Advertising
The SPADE2 project will be advertised on the web page of IMPAN as well as in the European Newsletter, where the vacancies for experienced and more experienced researchers will be published. We shall also send posters to the main universities in Europe. Local seminars and lectures are advertised by posters, web page and e-mails sent to interested participants. The ToK successes and events will be advertised on CORDIS web page, too.
A bulletin of SPADE2 is planned to be issued and sent to the participants regularly.

Equal opportunities
To attract women researchers a help with housing, finding school, kindergarten etc. will be provided with an appropriate advertising.
An additional advertising through personal connections of involved IMPAN personnel will attract researchers from less favoured regions.

3. Indicators of Progress and Success

3.1 Quantitative Indicators of progress and success to be used to monitor the project

3.1.1 Research Activities

In reporting on progress with the implementation of its research plan the fellowship will provide information and data on the following:

- organisation of, or participation in, presentations to external specialist workshops and conferences (number, dates, places, title of event)
- individual and joint publications and pre-publications, directly related to the work undertaken within the contract (number, references)
- patents or patent applications directly related to the contract (number, references)
- development of new scientific and/or industrial collaborations (number, references)

3.1.2 Transfer of knowledge activities

When reporting on progress with the implementation of its ToK Plan the host fellowship organisation will provide information and data on the following:

- the rate of recruitment of experienced researchers and also where appropriate for each partner (ratio person-months filled/offered)
- the nature and justification for adjustments, if any, to the original overall number of person-months for experienced researchers as well as the breakdown, where necessary, of this overall number among other partners (see table contained in Part C)
- the time and duration of each individual appointment. the number and level of involvement of senior researchers directly associated with the supervision of the recruited experienced researchers (at each partner)

- attendance at fellowship meetings, workshops and conferences by the experienced researchers (number, names, place, date)
- organisation of training events (e.g. training workshops/seminars) at individual partner sites (number, attendees' names, place, date)

3.2 Qualitative Indicators of progress and success to be used to monitor the project

3.2.1 Research Activities

In reporting on progress with the implementation of its research plan the host fellowship organisation will provide information and data on the following:

- general progress with research activities programmed at individual and partnership level
- highlights on more particularly innovative developments (novel concepts, approaches, methods and / or products)
- nature and justification for adjustments, if any, to the original research work plan and/or timetable
- scientific community recognition of the fellowship research contribution (awards, invitation to conferences, …)

3.2.2 Transfer of knowledge activities

In reporting on progress with the implementation of its training plan and ToK the fellowship will provide information and data on the following:

- highlights on the exploitation of the "complementarities" between the training partners
- nature and justification for adjustments, if any, to the original ToK plan and/or timetable (e.g. opportunities for new collaborations)
- level of satisfaction of the experienced researchers (e.g. as expressed in response to questionnaires)

3.2.3 Management

In reporting on progress with its management the participant will provide information and data on the following:

- effectiveness of the "internal" communication and decision making between the co-ordinator and the experienced researchers, including feedback processes
- effectiveness of the recruitment strategy of the fellowship in terms of equal opportunities (including gender balance) and open competition at international level

PART C: CONTRACT DELIVERABLES

Proposal Number	14508	Proposal Acronym	SPADE2

Overall Indicative Project Deliverables

	Incoming Researchers						Outgoing Researchers					
	Experienced Researchers (4-10 years)			Experienced Researchers (>10 years)			Experienced Researchers (4-10 years)			Experienced Researchers (>10 years)		
	Full-time Person Months	Indicative number of researchers	Stipend (%)	Full-time Person Months	Indicative number of researchers	Stipend (%)	Full-time Person Months	Indicative number of researchers	Stipend (%)	Full-time Person Months	Indicative number of researchers	Stipend (%)
1	30	7	20%	36	9	17%						
2							4	1	0%	9	3	0%
3							4	1	0%	9	3	0%
4							2	1	0%	6	2	0%
5							4	2	0%	2	1	0%
6							2	1	0%	4	2	0%
Sub-Total	30	7		36	9		16	6		30	11	

Research Classified as Laboratory-base Yes/No	NO
Contribution to the research/transfer of knowledge calculated on Fixed amount (F) or Real expenses (R)	F

PART D: COMMUNITY CONTRIBUTION

Proposal Number1	14508	Proposal Acronym[2]	SPADE2

Overall Maximum Community Contribution

Year	Eligible expenses for the activities carried out by the researchers					Eligible expenses related to the activities of the host organisations				Maximum EC contribution
	A	Transnational Mobility		D	E	F	G	H	I	
	Monthly Living Allowance	B Travel Allowance	C Mobility Allowance	Career Exploratory Allowance	Participation expenses of the eligible researchers	Research/ training/transfer of knowledge	Management and Audit Certification	Overheads	Other types of eligible expenses	
	Costs (in euros)	Costs (in euros)	Costs (in euros)	Costs (in euros)	Costs (in euros)	Costs (in euros)	Costs (in euros)	Costs (in euros)	Costs (in euros)	(in euros)
1	96669	5250	12684	0	0	12750,00	4332,63	12735,30		144421
2	151382	8250	21708	2000	0	18600,00	6870,15	20194,07		229005
3	178565	8250	24185	2000	0	20700,00	7950,64	23370,07		265021
4	91722	4750	12331	0	0	12750,00	4135,30	12155,27		137843
5	0	0	0	0	0	0,00	0,00	0,00		0
6	0	0	0	0	0	0,00	0,00	0,00		0
Total	518338	26500	70909	4000	0	64800,00	23288,72	68454,72	0,00	776291