

COST

Domain Committee "Forests, their Products and Services
(FPS)"

COST Action FP1005

Start Date May 11, 2011

*Fibre suspension flow modelling: a key for
innovation and competitiveness in the pulp &
paper industry*

MONITORING PROGRESS REPORT

Reporting Period: from 01 January 2012 – 31 December 2012

This Report is presented to the relevant Domain Committee.
It contains three parts:

- I. Management Report** prepared by the COST Office/Grant Holder
- II. Scientific Report** prepared by the Chair of the Management Committee of the Action
- III. Previous versions of the Scientific Report;** i.e., part II of past reporting periods

The report is a "cumulative" report, i.e. it is updated annually and covers the entire period of the Action.

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter II.D. Self evaluation.

Based on the monitoring results, the COST Office will decide on the following year's budget allocation.

Executive summary (max.250 words):

During the report period, which encompasses the second half of GP2 and the first half of GP3, the following objectives were successfully achieved:

- (1) Strengthening links with Action MP0806 "Particles in Turbulence".
- (2) Improving the website: it now includes a "Knowledge Base" section with freely-available data repositories from experiments and simulations of fiber suspension flows, and a "Job

Opportunities" section.

- (3) Organizing one joint MC/WG meeting in Udine (Italy), attended by 30 delegates. The meeting included the 6th Workshop of ERCOFTAC's SIG on "Fiber Suspension Flows": 18 presentations (available at <http://www.fp1005.cism.it/>) were given on the latest research activities carried out by Action participants (currently, 150 scientists from 17 COST countries and 5 institutions from 3 non-COST countries).
 - (4) Organizing a Training School on "*Non-Spherical Particles and Aggregates in Fluid Flows*" (36 trainees, http://www.fp1005.cism.it/pages/FP1005_ts2013cism.html)
 - (5) Organizing the International Conference "*Particles in turbulence*" jointly with Action MP0806 (>80 presentations, <http://mp0806.cineca.it/eindhoven/>) and the 1st Symposium on "Dispersed two-phase flows: Dispersion, deposition and agglomeration" (<http://multiphase-flows.olympic.in/>)
 - (6) Empowering STSMs: 11 STSMs were approved during GP2, 5 STSMs have been approved in the first half of GP3 (4 of which to ESRs or scientists less than 40 years old).
- Plans for 2014 include: one MC/WG meeting in June, organized jointly with the NORDITA Programme "*Dynamics of Particles in Flows: Fundamentals and Applications*" (website: <http://agenda.albanova.se/conferenceDisplay.py?confid=3280>), two training schools (one on collective particle dynamics in Italy in May, and one on particle characterization and flow monitoring in Portugal in June), and submission of joint project proposals for Horizon2020.

I. Management Report prepared by the COST Office/Grant Holder

I.A. COST Action Fact Sheet

- **COST Action FP1005** - Fibre suspension flow modelling: a key for innovation and competitiveness in the pulp & paper industry
- **Domain** Forests, their Products and Services (FPS)

- **Action details:**

CSO Approval: 2/12/ 2010
Entry into force: 20/01/2011

End date: 10/5/2015
Extension: -----

- **Objectives** TO PROMOTE AND DISSEMINATE VALIDATED COMPUTER MODELLING AND SIMULATION TECHNIQUES IN PAPERMAKING INDUSTRY.

- **Parties:** list of countries and date of acceptance

Austria 09/03/2011	Greece (date)	Poland 31/01/2011
Belgium (date)	Hungary (date)	Portugal 20/01/2011
Bulgaria (date)	Iceland (date)	Romania 25/08/2011
Croatia (date)	Ireland (date)	Serbia (date)
Cyprus (date)	Israel 21/11/2011	Slovakia (date)
Czech Rep. (date)	Italy 20/01/2011	Slovenia 12/07/2011
Denmark 01/03/2013	Latvia (date)	Spain 20/01/2011
Estonia (date)	Lithuania (date)	Sweden 10/05/2011
Finland 21/01/2011	Luxembourg (date)	Switzerland 06/04/2011
FYR of Macedonia (date)	Malta (date)	Turkey (date)
France 21/01/2011	Netherlands 31/01/2011	United Kingdom 20/01/2011
Germany 20/01/2011	Norway 06/04/2011	

- **Intentions to accept:** -

- **Other participants:**

University of British Columbia - Pulp and Paper Centre, Canada
University of Sao Paulo - Polytechnic School, Brazil
Sunny College of Environmental Science and Forestry, USA
Wesleyan University, USA
University of California at Davis, USA

Chair: Cristian Marchioli, International Center for Mechanical Sciences (CISM), P.zza Garibaldi 18, 33100 Udine (Italy), +39 0432 558006, marchioli@uniud.it, marchioli@cism.it

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Science Officer:
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Administrative Officer:
Cassia Azevedo fps@cost.eu

- **Action Web site:** <http://www.fp1005.cism.it/>

- **Grant Holder Representative:** Antonio Vinicio Turello (Legal Representative)
Mario Pezzetta (Financial Representative)

cism@cism.it

- **Working Groups:** (list of WGs and names and affiliations of participants)

WG1: Experimental techniques for fibre suspension flows

WG1 Leader: Juha Salmela (FI)

Members of WG: Afshin Abasi Hoseini (NO), Wolfgang Bauer (AT), Marina Camplo (IT), Alessandro Capone (IT), Asaf Cohen (IL), Carla Cotas (PT), René Delfos (NL), René Eckhart (AT), Axel Eckman (SE), Jouni Elfvingren (FI), Benjamin Fabry (DE), Pedro Faia (PT), Paul Krochak (SE), Mathias Kvik (SE), Masato Irota (SE), Ari Jasberg (FI), Paulo Ferreira (PT), Fredrik Lundell (SE), Anni Karppinen (FI), Arttu Miettinen (FI), Janne Poranen (FI), Fernando Rosa (PT), Jean-Claude Roux (FR), Martine Rueff (FR), Lilach Sabban (IL), William Sampson (UK), Salaheddine Skali-Lami (FR), Alfredo Soldati (IT), Bartek Stawicki (NL), René van Hout (IL), Angeles Blanco (ES), Bogomil Breznik (SI), Florin Ciolacu (RO), Petronela Nechita (RO), Enrico Calzavarini (FR), Pentti Saarenrinne (FI), Mattia Simeoni (IT), Johanna Liukkonen (FI), Antti Koponen (FI), Sanna Haavisto (FI), Nejc Zakrajsek (SI), Sergej Medved (SI), Jari Käyhkö (FI), Patrick Huber (FR), Vera Rutar (SI), Erik Dahlquist (SE), Carlos Negro (ES), Tomas Visktrom (FI), Greg Voth (USA), James Olson (CAN), Robert Powell (USA)

WG2: Predicting pulp behaviour with single-phase models

WG2 Leader: Maria Graça Rasteiro (PT)

Members of WG: Andreas Anzel (DE), Matthaus Babler (SE), Angeles Blanco (ES), Bogomil Breznik (SI), Florin Ciolacu (RO), Gaetano d'Avino (IT), Marco de Corato (IT), Gaetano de Monaco (IT), Elena De La Fuente (ES), Paulo Ferreira (PT), Fernando Garcia (PT), Patrick Huber (FR), Jari Käyhkö (FI), Paul Krochak (SE), Pier Luca Maffettone (IT), Amin Moosaie (DE), Carlos Negro (ES), Song Won Park (BRA), Robert Powell (USA), Bandaru Ramarao (USA), Jean-Claude Roux (FR), Martine Rueff (FR), Vera Rutar (SI), Khurram Shahzad (IT), Salaheddine Skali-Lami (FR), Anna Trubetskaya (DK), Roland Zelm (DE)

WG3: Modelling fibre suspension flows with multi-phase models

WG3 Leader: Bendiks Boersma (NL)

Members of WG: Gustav Amberg (SE), Helge Andersson (NO), Jean Regis Angilella (FR), Andreas Anzel (DE), Dariusz Asendrych (PL), Mustafa Barri (NO), Matthaus Babler (SE), Luca Brandt (SE), Enrico Calzavarini (FR), Sergio Chibbaro (FR), René Delfos (NL), Minh Do-Quang (SE), Pascal Fede (NL), Christoph Goniva (AT), Harald Grossmann (DE), Jari Hämäläinen (FI), Mohammed Khalij (FR), Gregorz Kondora (PL), Timo Kuntzsch (DE), Matias Kvik (SE), Cristian Marchioli (IT), Jan Matheas (DE), Jean-Pierre Minier (FR), Gilmar Mompean (FR), Amin Moosaie (DE), Christopher Nilsen (NO), James Olson (CAN), Rafik Ouchene (FR), Michael Reeks (UK), Francesco Picano (SE), William Sampson (UK), Gaetano Sardina (SE), Alfredo Soldati (IT), Martyin Sommerfeld (DE), Erik Svenning (SE), Anne Tanière (FR), Heiko Thoemen (CH), Berend Van Wachem (UK), Tomas Vikstrom (SE), Michael Wilkinson (UK), Nejc Zakrajsek (SI), Lihao Zhao (NO)

I.B. Management Committee member list

Name	Country	E-mail
Wolfgang BAUER	Austria	wolfgang.bauer@tugraz.at
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Berend VAN WACHEM	United Kingdom	b.van-wachem@imperial.ac.uk

I.C. Overview activities and expenditure

(2nd GP) Budget

Total Action Budget: 112,700 €

Remaining Action Commitment: 31,455.11 €

Meetings

Meeting Type	Date	Place						Cost	Total
Joint MC/WG Meeting	24-26 October 2012	PFI-NTNU Trondheim						20211.16	20211.16
Joint MC/WG Meeting	06-08 March 2013	Univ. of Coimbra						11823.92	32035,08

STSM

Beneficiary	Date		Place		Cost	Total
	From	To	From	To		
Cristian Marchioli	16/07/12	11/08/12	International Center of Mechanical Sciences, Udine (IT)	NTNU Trondheim (NO)	1900.00	1900.00
Mike Reeks	23/07/12	11/08/12	University of Newcastle (UK)	University of Udine (IT)	1400.00	3300.00
Sergio Chibbaro	16/07/12	13/08/12	Université Pierre et Marie Curie, Paris (FR)	International Center of Mechanical Sciences, Udine (IT)	2100.00	5400.00
Francesco Picano (ESR)	01/10/12	02/11/12	KTH, Stockholm (SE)	TUe, Eindhoven (NE)	1950.00	7350.00
Sanna Haavisto (ESR)	12/01/13	09/02/13	VTT, Jyväskylä (FI)	UC Davis (CA, USA)	2492.00	9842.00
Juha Salmela (ESR)	12/01/13	26/02/13	VTT, Jyväskylä (FI)	UC Davis (CA, USA)	1596.00	11438.00
Jure Ravnik (ESR)	25/02/13	22/03/13	University of Maribor, Maribor (SI)	University of Udine (IT)	1731.00	13169.00
Rui Silva (ESR)	12/04/13	14/06/13	Univ. Coimbra, Coimbra (PT)	KTH, Stockholm (SE)	2270.00	15439.00
Pedro Faia	04/05/13	12/05/13	Univ. Coimbra, Coimbra (PT)	KTH, Stockholm (SE)	1995.00	17434.00
Hugo Costa (ESR)	04/05/13	12/05/13	Univ. Coimbra, Coimbra (PT)	KTH, Stockholm (SE)	1995.00	19429.00
Jari Kolehmainen (ESR)	22/05/13	16/06/13	Tampere Univ. Technology, Tampere (FI)	University of Udine (IT)	1700.00	21129.00

Schools

Title	Date	Place				Cost	Total
Non-spherical particles and aggregates in fluid flows	17-21 June 2013	CISM, Udine (IT)	Trainees			13200.00	13200.00
			Trainers			4283.65	17483.65
			LOS			0.00	-
			Total				17483.65

Others

Title	Cost	Total
FSAC	10597.16	10597.16

Action Total : 81,244.89

II. Scientific Report prepared by the Chair of the Management Committee of the Action, describing results achieved during the Action operation in this period, in no more than 3 pages (the report is “cumulative”). All items listed in Sections A, B, and C, below, must be addressed.

Additional documentation such as extended scientific reports, proceedings of workshops, seminars or conferences may be provided separately as an annex to this report, and should be referenced in the report.

II.A. Innovative networking

- *Innovative knowledge resulting from COST networking through the Action. (Specific examples of Results vs. Objectives)*

During the report period, innovative knowledge has been provided both in the area of numerical simulations of fiber suspensions and in the area of experimental measurements.

As far as numerical simulations are concerned, COST networking through the Action proved beneficial in improving current understanding of the following aspects:

- (i) Development of a new software for simulation of dilute and semi-dilute suspensions of finite-size fibres in turbulence, based on the Discrete Element Method (DEM) code LIGGGHTS coupled with a Lagrangian fibre tracking code. The code can take into account inter-particle and particle-wall collision events.
- (ii) Development of new lift force models and new fibre-wall interaction models for the simulation of fibre dispersion in turbulence.
- (ii) Statistical characterization of the relative translational and rotational motion between rigid fibers and local fluid for the reference case of turbulent channel flow, which resulted in new data repositories added to the Knowledge Base.
- (iii) Evaluation of the effect of dynamic viscosity in the boundary layer on the simulation of concentrated pulp suspensions (e.g. Eucalyptus pulp suspensions)

From the experimental side, COST networking allowed significant advancements in:

- (i) characterization of particle size and particle concentration effects on turbulence modification in semi-dilute suspensions through velocity measurements using Magnetic Resonance Imaging (MRI), UPV or Particle Image Velocimetry (PIV) techniques.
- (ii) measurements of fiber suspensions flow behavior using simultaneously Electrical Impedance Tomography (EIT) and MRI for industrial/process monitoring purposes.

The advancements just highlighted were achieved through collaborations developed within the Action and finalized during the MC/WG meetings (not pre-existing) and have brought to ERS's applications for 9 approved STSMs in the period January-December 2013. Results from such collaborations have also lead to scientific publications in peer-reviewed journals and contributions to international conferences.

- *Significant scientific breakthroughs as part of the COST Action. (Specific examples)*

The main scientific breakthrough of the Action obtained during the report period has been the addition of new data repositories relative to industrially-relevant test problems and obtained from experimental measurements and numerical simulations. Collected data have been made freely available to interested users through the public access-free Knowledge Base stored on the Action's website. Test problems include dilute fiber suspensions (in particular: slip velocity and rotation statistics obtained from numerical simulations of fiber motion in fully-developed channel flow, and orientation statistics

from experimental measurements of fiber motion past a backward facing step), as well as dense suspensions: PIV-based velocity measurements at the head-box slice channel and NMR-based (Nuclear Magnetic Resonance) velocity measurements in a pipe. Quite recently new collaborative test-case measurements of pressure losses in polymer and fiber laden flows have been set up, with the participation of 6 different groups from WG1 and WG2 (see Annex 1). It is expected that users of different experimental methods will exploit our access-free Knowledge Base to compare their methods in specific flow problems, while users of different modelling approaches can carry out comparison of numerical solutions. Users of experimental methods and CFD models include specialist from universities or research institutes, but also specialists from industry and consulting companies.

- *Tangible medium term socio-economic impacts achieved or expected. (Specific examples)*

As already highlighted in the previous MPR, one socio-economic impact that may be expected from the improvement of CFD methodologies applied to pulp and paper making industry is a significant reduction of the energy consumption required by pulp and paper manufacturing. Currently, the pulp and paper industry is one of the most energy-intensive process industries, as also recognized by the Specific Programme for Horizon 2020. Suspensions of elongated fibers are at the basis of pulp and paper production, where mechanical properties of the final product depend on the mass and orientation distributions of the fibers. Better CFD modelling capabilities would certainly lead to improved design, optimized process operations and, in turn, huge energy savings. Reduction of energy demand from energy-intensive industries would have a beneficial impact of tantamount importance on EU countries in the current frame of worldwide economical crisis.

- *Spin off of new EC RTD Framework Programme proposals/projects. (List)*

There has been no spin off of new EC RTD Framework Programme proposal so far.

- *Spin off of new National Programme proposals/projects. (List)*

There has been no spin off of new National Programme proposal so far.

II.B. Inter-disciplinary networking

- *Additional knowledge obtained from working with other disciplines within the COST framework. (Specific examples)*

During the report period, the Action has benefited substantially from the mutual input of disciplinary expertise in computational and experimental fluid mechanics. As already pointed out in the first report (see attachment) cross-fertilization allowed by inter-disciplinary networking has favoured the development of modelling techniques for predicting adequately the behaviour of pulp suspensions in the dilute and semi-dilute regimes. In these regimes, state-of-the-art CFD approaches can be complemented by new finite-size techniques which allow fully-resolved simulation of the flow around individual fibers: these techniques may reproduce very accurately the local interaction between turbulence and fibers, thus providing a perfect background for model development at coarser spatial resolutions. Standard CFD can also benefit from new experimental techniques (alternative to classic optical techniques) based on NMR, Tomography, Ultrasonic Doppler Velocimetry, or Particle Tracking Velocimetry (PTV) and available within the Action. One of the test problems currently under investigation involves precisely the combined use of experimental techniques, finite-size techniques and point-particle techniques (based on Euler-Euler and Euler-Lagrange approaches)

to benchmark the relative performance of these tools and establish their range of applicability.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts. (Specific examples)*

The level of inter-disciplinarity comprised within the Action is still strengthening thanks to the contribution of new participants in each working group. Current level of inter-disciplinarity is in fact granting significant improvements in terms of scientific and technical knowledge of fiber suspension flows, as demonstrated for instance by the number of joint publications from Action participants.

As far as CFD is concerned, the expertise covers all areas from DNS to LES to RANS based numerical approaches, Euler-Euler and Euler-Lagrange methods, as well as finite-size simulation approaches that have complemented point-particle simulation approaches. Recently, new experts of stochastic modelling have started collaborating with WG3 members to strengthen the competences of Action participants in the area of theoretical modelling of fibre suspensions. As far as experiments are concerned, new measurements techniques based on NMR and Tomography have now routinely become available to the Action's scientific community. Examples of applications where Action FP1005 can provide significant scientific impact through inter-disciplinary networking are:

- Polymer and textile industries
- Fibre based insulation materials
- Reduction of CO₂ emission in coal-fired
- Fibre-induced drag reduction in turbulent flows.

Moreover, modelling the rheological properties of pulp suspension may also be of help for predicting behavior of suspensions commonly encountered in food processing or cosmetics.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts. (Specific examples)*

During the report period, meetings and workshops have been organized with the precise aim of strengthening the interaction among the different disciplines currently comprised within the Action. It appears that current level of inter-disciplinarity and inter-discipline networking has reached sufficient maturity to produce socio-economic impact provided that scientific knowledge can be effectively transferred to industry. To facilitate such knowledge transfer, a new working group (led by Action participants that are in daily contact with industry) has been created with the precise aim of bridging the gap between scientists and industrial practitioners, namely between fundamental scientific knowledge and practical problems.

II.C. New networking

- *Additional new members joining the Action during its life.*

During the report period, the Action had:

- one new country (Denmark) represented in the MC (current number of countries: 17)
- one new MC member (Anna Trubetskaya, DK)
- one MC member replacement (Prof. Martin Sommerfeld for Prof. Altmann)
- one new MC substitute (Marina Campolo for Italy)
- no new COST Participant subject to MoU acceptance

- *Total number of individual participants involved in the Action work. (Number of participants. Give % of female and of Early Stage Researcher participants)*
The total number of participants currently involved in the Action work is 115 (was 113). The percentage of female participants is 14% (was 13.3%). This percentage has been quite stable over the years and seems difficult to increase due to the scarce involvement of female researchers in fields of relevance for the Action (notably technology, engineering and mathematics, where the estimated percentage of female scientists is about 10%).
The percentage of ESR is around 32% (was around 28%). The slight increase in percent figures wrt the previous report period is due to the involvement of new young researchers who attended the training school.

- *Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools. In addition, justification should be provided if fewer than 4 STSMs were carried out during the year.*
Involvement of ERSs in the Action can be summarized as follows:
 - Involvement in Action management: the WG1 leader (Juha Salmela) and the WG3 deputy leader (Janne Poranen) are ESRs
 - Involvement in STSMs: a total of 21 STSMs have been approved so far (5 in GP1, 11 in GP2, 5 in GP3), 13 beneficiaries are ESRs, 4 beneficiaries are less than 40 years old.
 - Involvement in Training Schools: The training school on “Experimental techniques for fiber suspension flows” held in June 2012 was organized by at-that-time ESRs (Lundell, Salmela) and was attended by 13 ESRs from COST countries and 3 ESRs from non-COST countries.

- *Involvement of researchers from outside of COST Countries. (Number of participants from non-COST Countries approved by the CSO. Give % of such participants from countries with reciprocal agreements. Specify their contribution)*
Currently we have 5 participants from 3 non-COST countries that have been already approved by the CSO:
 - University of British Columbia (UBC) – Pulp and Paper Centre, Canada: UBC is one of the leading universities worldwide conducting research in the field of fiber suspension flows in all focus areas covered by the Action. In particular, UBC contributes with measurements and simulations of yield stress fluids in a range of natural and industrial settings.
 - University of Sao Paulo (USP) - Polytechnic School, Brazil: USP contributes with measurements of fibre and bubble flows for experimental techniques used for fibre suspension analysis and will develop models for multiscale multiphysics flow of fibres in water. In particular, USP will simulate pulp chest agitation.
 - University of California Davis (UCDavis) - Department of Chemical Engineering & Materials Science, USA: UCDavis will contribute in the development of NMR (Nuclear Magnetic Resonance) imaging viscometers and implementation of NMR imaging techniques to measure flows of opaque suspensions.
 - Wesleyan University (WU), USA: WU will contribute in the area of experimental tracking of rotational and translational motion of anisotropic particles in fluid flows. WU can provide time-resolved experimental measurements of the motion of small rod-like particles in turbulent flow, which allow measurement of orientation and position of rods using Lag-

rangian particle tracking with images from multiple high speed cameras in dilute flows.

- SUNY College of Environmental Science and Forestry (SUNY) - Empire State Paper Research Institute, USA: SUNY contributes in developing sophisticated DEM-based (Discrete Element Method) simulations of fibrous suspensions

The percentage of participants from non-COST countries with reciprocal agreements is 0%.

- *Advancement and promotion of scientific knowledge through publications and other outreach activities. (Number of publications and other outreach activities that resulted from COST networking through the Action. Complete list should be given in an annex)*

During the report period, advancement and promotion of scientific knowledge has been promoted through the following publications:

- Papers published in international peer-reviewed journals:

1. C. Marchioli, A. Soldati "Rotation statistics of fibers in wall shear turbulence", *Acta Mechanica*, **224** (2013), 2311-2330.
2. L. Zhao, H. Andersson, J.J.J. Gillissen "On inertial effects of long fibers in wall turbulence: concentration, orientation and fibers stresses", *Acta Mechanica*, **224** (2013), 2375-2384.
3. F. Zhao, B.G.M. van Wachem "Direct numerical simulation of ellipsoidal particles in turbulent channel flow", *Acta Mechanica*, **224** (2013), 2331-2358.
4. R. van Hout, L. Sabban, A. Cohen "The use of high-speed PIV and holographic cinematography in the study of fiber suspension flows" *Acta Mechanica*, **224** (2013), 2263-2280.
5. E.J. Tozzi, D.M. Lavenson, M.J. McCarthy, R.L. Powell "Effect of fiber length, flow rate, and concentration on velocity profiles of cellulosic fiber suspensions" *Acta Mechanica*, **224** (2013), 2301-2310.

- Papers submitted international peer-reviewed journals:

1. L. Zhao, C. Marchioli, H. Andersson "Slip velocity of rigid fibers in wall-bounded turbulence", *Phys. Fluids*, Accepted for Publication
2. C.A.F. Ventura, F.A.P. Garcia, P.J.T. Ferreira, M.G. Rasteiro, "Modelling pipe friction loss of pulp fibre suspensions" Part. Sci. Tech. Submitted (2013).

- Conference papers:

1. F. Lundell "Fluid vs. particle inertia: motions of non-spherical particles in shear" 1st Symposium on Dispersed Two-Phase Flows, ICNAAM 2013, Rhodes (Greece), September 21-27, 2013.
2. A. A. Hoseini, Z. Zavareh, F. Lundell, and H. I. Anderson "Fiber tracking algorithm in combined PIV/PTV measurement of fiber suspension flow" 1st Symposium on Dispersed Two-Phase Flows, ICNAAM 2013, Rhodes (Greece), September 21-27, 2013.
3. C. Marchioli and A. Soldati "Rotation statistics of rigid fibers in turbulent channel flow" 1st Symposium on Dispersed Two-Phase Flows, ICNAAM 2013, Rhodes (Greece), September 21-27, 2013.
4. J. Ravník, C. Marchioli, M. Hriberšek, and A. Soldati "On shear lift force modelling for non-spherical particles in turbulent flows" 1st Symposium on Dispersed Two-Phase Flows, ICNAAM 2013, Rhodes (Greece), September 21-27, 2013.
5. J.-C. Roux and J.-F. Bloch "Lubrication theory explains the modification of fiber properties in the refining process" 1st Symposium on Dispersed Two-Phase Flows, ICNAAM 2013, Rhodes (Greece), September 21-27, 2013.
6. C. Marchioli "FPS COST Action FP1005 - Fibre suspension flow modelling: A key for innovation and competitiveness in the pulp & paper industry" APS/DFD Meeting, Pittsburgh (USA), November 23-25, 2013.

7. C. Marchioli "On the rotation of rigid fibers in wall shear turbulence" APS/DFD Meeting, Pittsburgh (USA), November 23-25, 2013.

More are in preparation and will be included in the next monitoring progress report.

Outreach Activities:

- Publication of 5 papers in the October 2013 Special Issue on "Anisotropic Particles in Turbulence" of Acta Mechanica, published by Springer (see list above and Annex 2)
- Action FP1005 has co-organized the 1st Symposium on "Dispersed Two-Phase Flows: Dispersion, Deposition and Agglomeration" (21-27 September 2013, Rodos Palace Hotel, Rhodes, Greece) as part of the 11th International Conference of Numerical Analysis and Applied Mathematics (ICNAAM – 2013). Symposium website: <http://multiphase-flows.olympic.in/program.html>
- Action FP1005 has co-organized the 6th Workshop of ERCOFTAC's Special Interest Group on "Fiber Suspension Flows" (see Annex 3)
- *Activities and projects with COST network colleagues.*
During the report period Action FP1005 has organized a joint International Conference on "Particles in turbulence" (July 1-5, 2013, Eindhoven, The Netherlands), together with COST Action MP0806 (see also Annex 4). The conference was attended by more than 80 participants, and all presentations can be downloaded from the conference website: <http://mp0806.cineca.it/eindhoven/>. Action MP0806 has now ended, so current efforts are also devoted to finding new COST networks colleagues.
- *The capacity of the Action members to raise research funds.*
On February 20, 2014 a joint MC/WG meeting has been organized to select collaborative project proposals for submission to the first Horizon 2020 calls (the first deadlines being scheduled between the end of March and the beginning of April 2014). The selected projects focus on the following research topics:
 - *Development of new materials and fibres from cellulose: Creating a textile yarn from pulp or MFC*
 - *Dry pulp techniques for papermaking (including non-wovens)*
 - *Flocculation in shear flow turbulence: From complex Interactions to limitations in papermaking*
 One of the MC members (M. G. Rasteiro, University of Coimbra) was awarded a grant by FCT (Portuguese Science Foundation) for the research project "Using CFD to Model Fibre Suspensions Flows - FIBERFLOW", submitted under the auspices of COST Action FP1005.

II.D. Self evaluation

The main successes of Action FP1005 can be summarized as follows:

- Establishment of a stable and active European scientific community in the field of fiber suspension flows, with a specific twist towards pulp- and paper-making applications
- Effective working groups activity and efficient networking among participants (especially ESRs) through meetings, workshops, STSMs and training schools
- Production of the a large freely-available data repository from selected test problems in each focus area of the Action
- Successful dissemination of expertise, scientific research areas and activities covered by Action participants through Special Issues in peer-reviewed journals, organization and participation to international conferences and workshops

Drawbacks:

The only drawback experienced within Action FP1005 during the report period is, again, the scarce involvement of industrial representatives. It is quite difficult to get feed-back from industrial counterparts, especially the big ones from northern European countries. It is equally difficult to have industrial representatives attending the Action's workshops and meetings. To stimulate the interest of industrialists in the Action, a new "Knowledge Transfer" working group, led by those Action participants that are employed in the papermaking industry and/or are in closer contact with industries, has been created. This new WG aims at (1) transferring scientific knowledge produced within the Action to industrial practitioners, making them aware of the latest developments in CFD applied to papermaking and (2) advertising all events organized by the Action to foster industrial participation.

Key difficulties:

- As in the past years, the main difficulty is concerned with industrial involvement in the Action activities. As already highlighted in the previous reports, the gap between the extremely complex problems of pulp- and paper-making processes and the simplified problems that can be solved through simulations and experiments is still significant. As a result, industries still do not perceive CFD as crucial for improving design of papermaking mills. The main focus of the Action during the report period has been to narrow down such gap by improving current models and experimental techniques, so that these can be of practical use for the industry.

III. Previous scientific report(s)



APC 2013 FP1005
MPR.pdf

IV. Annexes

Annex 1: Guidelines for the collaborative test-case measurements on pressure loss evaluation in polymer and fiber laden flows



proposal.pdf

Annex 2: Special Issue on “Anisotropic Particles in Turbulence” on Acta Mechanica



SI.pdf

Annex 3: Scientific Programme of the International Conference “Particles in turbulence” (Eindhoven, July 1-5, 2013)



book-abstracts-eindhoven.pdf

Annex 4: Scientific Programme of the 6th Workshop of ERCOFTAC's Special Interest Group on “Fiber Suspension Flows”



final-programme.pdf

Annex 5: Scientific Programme of the 1st Symposium on “Dispersed Two-Phase Flows: Dispersion, Deposition and Agglomeration”



program_symposium_V2.pdf

Annex 6: Reports from previous MC/WG meetings (for dissemination)



Newsletter_CIEPQPF_Jul2013.pdf

Newsletter of the Chemical Process Engineering and Forest Products Research Centre



b95_fin.pdf

Scientific report on the 4th SIG42 Workshop for the ERCOFTAC Bulletin (June 2013)