

COST Action

Progress Review at 24 months

(28/11/2017 to 28/11/2019)

CA16212: Impact of Nuclear Domains On Gene Expression and Plant Traits

This report is submitted by the Action Rapporteur in fulfilment of the requirements of the rules for COST Action Management, Monitoring and Final Assessment and is confidential to the COST Association and the Management Committee of the Action.

Summaries

The main aim and objective of the Action is to

bring together research communities to foster integrative plant research aiming to decipher the inter-related regulatory processes interpreting the genome in model and crop species with particular emphasis on the role of nuclear domains in gene expression control

During its first two years the Action progressed the achievement of this as described below

INDEPTH has successfully gathered a large community of between 70 and 80 laboratories keen to collaborate and exchange knowledge & techniques in the exciting and new field of plant nuclear domains. From the hundred initial members representing 19 countries (2017), INDEPTH comprises now about 200 members from 32 countries (2019) including members of the International Plant Nucleus Consortium (IPNC) working on the plant nuclear envelope and periphery and members of the European Workshop of Plant Chromatin (EWPC) experts in the field of chromatin and transcription regulation. Visibility of this new network is improving thanks to a publicly available website (<https://www.brookes.ac.uk/indepth/>) and @COST_INDEPTH twitter account with 156 followers and more than 10K impressions per month.

In order to foster synergies in plant nuclear domain research in Plants, INDEPTH has organized 31 events in two years including 3 main meetings, 7 workshops, 3 dissemination meetings, 15 STSM and 3 training schools. Main meetings are an exciting place with the initiation of a large number of new collaborations between countries and recently initiated about 35 new collaborations between INDEPTH members involving 15 countries. INDEPTH improved the visibility and research quality of COST members through 13 peer-reviewed publications by INDEPTH members, 5 of them as open access publication supported by INDEPTH. STSM have been very successful, mostly involving young researchers at the PhD or Post-doctoral levels with promise to continue their careers in plant science. 8 previous collaborations were reinforced thanks to STSM. Finally, travel grants have proven to be essential for STSM and TS trainees and meeting attendees from ITCs, that could not afford to participate otherwise.

This improved visibility resulted in 8 successful grant applications linked to an Action topic of INDEPTH or involving collaboration between INDEPTH members and new grant proposals are being submitted including a new ITN network entitled EpiSeedLink bringing together 11 partners from 7 countries as well as industrial partners. Interaction with industrial partners in the fields of plant breeding, bio-informatics, microscopy and image analysis are promoted through dedicated workshops and active participation in training schools.

INDEPTH will continue its networking activities in offering a wide range of cross-sectorial and interdisciplinary training to attract a new generation of plant scientists working on plant nuclear organization with high multi-disciplinary skills.

The Rapporteur summarised the Action's major outcomes, impacts and successes as follows

The action has successfully implemented all suggested tasks described in the MoU for the action. Its impact is quite high both at the scientific level and the career development of young scientists. The delay in the implementation of certain tasks will definitely benefit from the active participation of more young and enthusiastic scientists. It is noteworthy that stakeholders from industry are actively involved in the implementation of the action. A point that needs immediate attention, since it raises a high risk in the implementation of the action, is the initiation of nuclear proteomics research approaches. Other than the last comment the whole action is properly implemented so far.

The Action Chair has described their plans for addressing issues identified in their report as follows

- Continue to enhance the expertise of INDEPTH community by promoting new knowledge & technologies not or poorly applied in plants through scientific meetings.
- Identify a Protein Protein Interaction (PPI) leader, collect published PPI datasets and integrate these into the IntAct database. Promote PPI approaches within INDEPTH.
- Collect image datasets and use the INDEPTH website as an entry point to the new 3D image repository. Use the Website to disseminate Open access protocols through a dedicated page.
- Continue to enhance public/industry links during the Eucarpia meeting (July 2020, Netherlands), the 20th International Sunflower Conference (June 2020, Serbia) and with the help of IPC partner at the Plant and Animal Genome Conference (January 2021).
- Promote synergies between model and cultivated plant species through training schools in chromatin organization technologies and Imaging (2020).
- Implement the new ITC/NNC transversal working group leads by Pr Ahmet Tek (Turkey) to allow new joint grant applications.
- Promote the use of INDEPTH material in Masters and PhD programs and promote ERASMUS+ exchanges between partners.
- Despite the fact that the UK is engaged in the process of leaving the European Union (Brexit), maintain the strong involvement of the UK partners who are a major driving force for INDEPTH.

The Rapporteur summarised the Actions's plans for addressing issues identified in the report

The proposed plans, IF more young scientists are involved to help with the implementation of the required tasks, are adequate for implementing the action in the remaining 2 years.

Achievement of MoU objectives, deliverables and additional outputs/ achievements

MoU objectives

The Action reported progress of the following objectives.

MoU objective	Level of progress	Rapporteur assessment
Provide a web site and an on-line open-access depository for INDEPTH data sets;	76 - 100%	CONFIRMED
Generate standardized protocols in 3D imaging of the nucleus (WG1), nuclear proteomics (WG2), chromatin domains (WG2), phenotyping during development & under stress conditions (WG3);	51 - 75%	NOT confirmed
Collect plant data sets in 3D imaging of the nucleus (WG1), nuclear proteomics (WG2), chromatin domains (WG2), phenotyping during development & under stress conditions (WG3);	26 - 50%	CONFIRMED
Perform analyses using the collected datasets to predict the nuclear protein interactome (WG4);	0 - 25%	NOT confirmed
Create new application tools such as new softwares (WG1, WG4), new bioinformatic pipelines to predict Protein Protein Interactions (PPI) (WG4) and periodicity and distribution patterns (WG4);	26 - 50%	CONFIRMED
Promote synergies between model and cultivated plant species;	51 - 75%	CONFIRMED
Develop opportunities for collaboration with industry, foster the transfer of knowledge between model and cultivated species and creation of intellectual property in image analysis.	26 - 50%	CONFIRMED
Promote sustainable interactions between industrial and public research with leading companies in microscopy, imaging software and plant breeding during Teaching Schools (TS), meetings, Short Term Scientific Missions (STSM) and round-table discussions;	26 - 50%	CONFIRMED
Welcome the participation of new Inclusiveness Target Countries (ITCs) and Near Neighbour Countries (NNCs) in INDEPTH activities;	76 - 100%	CONFIRMED
Promote gender equality and women leadership in this exciting field of research;	76 - 100%	CONFIRMED
Foster interdisciplinary training and career development for Early Career Investigators (ECIs) through their involvement in the organization of project activities and their participation in training events (TS and STSMs);	26 - 50%	CONFIRMED
Promote new ERASMUS agreements between partner universities;	26 - 50%	CONFIRMED
Integrate knowledge obtained from the project in Master and PhD training programmes of the academic partner organizations.	26 - 50%	CONFIRMED

Rapporteur assessment of the level of progress reported by the Action.

The Rapporteur did not confirm the level of progress reported by the Action for the following objectives as explained below.

MoU objective	Level of progress reported	Rapporteur's explanation
Generate standardized protocols in 3D imaging of the nucleus (WG1), nuclear proteomics (WG2), chromatin domains (WG2), phenotyping during development & under stress conditions (WG3);	51 - 75%	It is stated that the level of achievement of MoU objective is 51-75%. Though there are only 7 protocols published in the actions website. One would expect more and quite detailed protocols such as the ones published from CSHL or Nature Methods comparing methodologies and describing pitfalls and benefits for certain approaches. The protocols provided are not in a unified form, coming from different publications and labs and there is no sign of standardisation as described in the MoU.
Perform analyses using the collected datasets to predict the nuclear protein interactome (WG4);	0 - 25%	This is one of the most interesting and valuable objectives of the action, though there was not any progress made. A more robust and convincing plan for implementing this objective should be set forth.

Action explanation regarding MoU objectives reported as 25% or less achieved

The table below shows the Action's explanation and the Rapporteur's analysis thereof for any MoU objectives that the Action reported as 25% or less achieved.

MoU Objective that was reported as 25% or less achieved	Action's explanation	Rapporteur's analysis
Perform analyses using the collected datasets to predict the nuclear protein interactome (WG4);	This activity is directly linked to objective 3 and for that reason has not started. Once the PPI datasets will be collected and included into a database such as IntAct. A review publication promoting this activity will be led by the PPI leader. This will promote the dissemination of PPI approaches in the Plant community.	The justification is acceptable though publishing a review article is not acceptable since the objective included "analyses using the collected datasets to predict the nuclear protein interactome".

General Assessment of MoU objectives

The level of ambition of the MoU objectives is **Medium**.
Overall, **most MoU Objectives are progressing appropriately**.

Deliverables

The table below shows, for each deliverable, the delivery status reported by the Action and the Rapporteur's comment.

Deliverable	Month deliverable due	Delivery status	Rapporteur Comment
A review publication about "next challenges in plant microscopy"	12	Delivered	Excellent work, properly citing the EU COST action funding this programme. Published in a good journal appropriate for this kind of work.
Standardized protocols in "plant sample preparation" deposited on INDEPTH Website; a multi-authored publication	30	Not delivered, but expected before end of Action	More protocols, properly prepared with the appropriate details and discussing alternatives such as in the form of Nature Methods or CSHL Protocols should be published in the action's website. Currently the number and quality of protocols is insufficient.
Standardized protocols in "plant 3D imaging"	30	Delivered	Protocols should be more detailed discussing pitfalls and benefits for choosing certain approaches and not just a collection of experimental steps without any explanation. Otherwise the term standardised is not accomplished. Why these protocols are better compared to other individual's protocols.
Datasets of "3D images of plant nuclei" available to the public and education programs	36	Delivered	Indeed there is a database of images available to the public though the information provided as a description of each image is inadequate.
A review publication about "software benchmarking"	48	Not delivered, but expected before end of Action	The plan provided the Action Chair is adequately presented. The right persons are involved in preparing this review article and it is anticipated to be delivered in 2021 as described.
A review publication about the state-of-the-art to study "plant nuclear organization"	18	Not delivered, but expected before end of Action	There is already a publication available online, properly acknowledging COST support and the second submitted coauthored publication will potentially be available in 2020. The plans are adequately described and acceptable.
Standardized protocols in "plant proteomics" available to the public and education programs	24	Delivered	The protocols for plant proteomics, which will be available to the public and educational programs are not informative enough. It is rather a general protocol for proteomic analysis, which is not specifically

			prepared for plant scientists nor supports any standardisation.
Datasets of "plant nuclear proteome" and "plant nuclear compartments" available to the public and education programs	33	Not delivered, but expected before end of Action	The plans for properly implementing this task are described in sufficient detail. Apparently there was no experimental work performed regarding the elucidation of the plant nuclear proteome and the plans for addressing this issue the next two years are not convincing.
A multi-authored publication about relevant methods to investigate the plant nuclear compartments	33	Not delivered, but expected before end of Action	The publication in Cur. Opin. Plant Biol. is of high quality and properly acknowledging COST. The plans described are adequate and acceptable.
Standardized protocols in "-omics sample preparation and bioinformatics analysis"	48	Not delivered, but expected before end of Action	The plans for preparing standardised protocols for genomics experiments and their analysis are acceptable and based on expert participation in a Training School.
A review publication about "chromatin dynamics during plant response to stress"	18	Delivered	Deliverable completed. The coauthored publication properly cites COST action's support.
Standardized protocols in "plant phenotyping under stress"	30	Not delivered, but expected before end of Action	The plan for implementing this deliverable is adequately described and acceptable.
Standardized protocols in "plant phenotyping at specific developmental stages"	48	Not delivered, but expected before end of Action	If open access is achieved to the published protocols mentioned it will be a great progress for delivering the protocols.
Repository including INDEPTH 3D images and -omics data made publicly available	24	Delivered	The images, which are not 3D, are missing a proper description to be usable by the public. It is not obvious whether -omic data are available.
A joint publication about "periodicity and distribution pattern"	33	Not delivered, but expected before end of Action	The plans for implementing this kind of research and the joint publication are adequately described and deemed trustworthy based on the scientific quality of participants.
A joint publication about "PPI in plant proteome"; a validated PPI network in the plant nucleus	33	Not delivered, but expected before end of Action	In general, the proteomics part of the action and the characterisation of the plant nuclear proteome have not proceeded since the beginning of the action. The plans for addressing these shortcomings should be more specific providing the sufficient details otherwise the implementation of this task will be of very high risk.
A conceptual framework to predict functional compartments in the nucleus from PPI,	48	Not delivered, but expected before	It is clear from the description of the deliverable that a multi-

imaging, omics data at different levels (epigenetics, genetics, RNA, proteins) in plants		end of Action	authored publication will fulfil the specific task such as the integration of imaging and omics data for the prediction of nuclear functional compartments.
Publication of an article describing the INDEPTH COST-Action	6	Delivered	The deliverable has been completed. A nice publication in J Cell Sci is valuable regarding the kick-off meeting of the action.
Functional and Implemented Website with project description, protocols, news letter ...etc	6	Delivered	Deliverable completed. A really nicely prepared website has been constructed with adequate information for the public.
Definition and management of a Research Topic in line with the INDEPTH Action in a relevant journal such as Frontiers in Plant Science (or similar) as Guest Editor.	48	Not delivered, but expected before end of Action	The plans for implanting this task are adequately described and acceptable.

General Assessment of deliverables

The level of ambition of the deliverables is **medium**.
Overall, **most deliverables are progressing appropriately**.

Additional outputs / achievements

Co-authored Action publications

The Action reported 13 publications on the topic of the Action, co-authored by at least two Action participants from two countries participating in the Action. The full list of publications appears in Annex I.

The:

- **Quality** of the Action's co-authored publications is **excellent**.
All the publications are of high quality, in good journals and properly addressing COST's support.
- **Significance** of the Action's co-authored publications is **excellent**.
Almost all publications are of high significance for the field, therefore published in good journals.
- **Relevance** to the Action of the Action's co-authored publications is **excellent**.
All the publication are highly relevant to the action's objectives.
- **Quantity** of the Action's co-authored publications is **very good**.
13 publications have emerged so far from the participating groups but the number is expected to rise since more cooperative work will take place the next two years.

Projects and proposals resulting from Action activities

The Action reported the following projects resulting from Action activities involving at least one Action participant.

Title	Main proposer name	Funder
BioSunmulant	Geelen	Other EU - FACCE SURPLUS is an ERA-NET Cofund, formed in collaboration between the European Commission and a partnership of 15 countries in the frame of the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI).
Bet-hedging in plants - multi level analysis of seed dormancy variability - from single cell to population.	Swiezewski	National
A new model to study light-regulated seed germination	Mittelsten Scheid	Trans-national - National Research, Development and Innovation Office (NKFIH) – Austrian Science Fund (FWF)
Development of New Biopesticides for Seed Protection - ECOPEST	Miladinović	National
ChromaLight	Barnèche	Trans-national - France ANR-18-CE13-0004-01, Switzerland FNS
How plants respond to light cues - thinking on a novel route	Baroux	Trans-national - The VELUX FOUNDATIONS(VELUX)Project 1107

In addition the Action reported 2 proposals resulting from Action activities involving at least one Action participant, and for which the Action networking was necessary.

Relevance of the Action's proposals and/ or projects is **very good**.

Quantity of the Action's proposals and/ or projects is **very good**.

Other outputs / achievements

The table below shows the other outputs / achievements.

Other Output / Achievement reported by Action	Significance of the output
<p>STSM, Training schools and workshops have initiated or strengthened collaborations and are at the origin of new publications. Here are some examples:</p> <ul style="list-style-type: none"> • STSM #94763 Gianluca Teano (PhD student, France) was trained in C. Baroux's lab (Switzerland) in Feb 2018: <ul style="list-style-type: none"> ◦ Rutowicz, K., Lirski, M., Mermaz, B., Teano, G., Schubert, J., Mestiri, I., Kroteń, M.A., Fabrice, T.N., Fritz, S., Grob, S., et al. (2019). Linker histones are fine-scale chromatin architects modulating developmental decisions in Arabidopsis. <i>Genome Biol</i> 20, 1–22. ◦ A new publication between the two groups is in preparation with Gianluca Teano as first author. • STSM # 101329 Ariadna Picart-Piccolo (PhD Student, France) was trained in S. Grob's lab (Switzerland) in June 2018; collaboration between the two groups have already generated one accepted publication: <ul style="list-style-type: none"> ◦ Frederic Pontvianne and Chang Liu. (2020) Chromatin domains in space and their functional implications. <i>Current Opinion in Plant Biology</i>. <i>in press</i>. ◦ A research paper is in preparation between the two groups 	<p>Medium</p>
<p>A network of computing centers to support a public repository for 3D image of plant nucleus:</p> <p>The OMERO server at Florida University (FSU-OMERO) was first proposed as a new repository for 3D image of Plant nucleus by Pr Hank Bass during Workshop n°2 (July 2018) organized in Florence during the SEB annual meeting.</p> <p>This first workshop was the starting point for the organization of Workshop n°6 in Lisbon (Sept 2019) in which INDEPTH members were trained to OMERO by the Dundee's OMERO team.</p> <p>The second workshop attracted the interest of two new computing centers based in France (Université Clermont Auvergne) and in Cyprus (Cyprus Institute) which are now also implementing OMERO. The 3 computing centers are currently working to interconnect their OMERO servers. This network is expected to grow as</p>	<p>High</p>

<p>Oxford Brookes (UK) and ITQB Nova (Portugal) computing facilities are very keen to participate in this networking activity.</p> <p>As an unexpected result from the Action, it will undoubtedly allow to initiate new interactions between computing centers and contribute to the excellence of the Plant Science community by providing in the next two years new facilities for image storage for local users but also to the public worldwide. We expect that OMERO server facilities will boost our benchmarking activity of image softwares and provide new resources for training in Master courses.</p> <p>Web access for the repository: https://omero.bio.fsu.edu/webclient/userdata/?experiment=-1</p>	
<p>Improved expertise of Staff members through STSM and Training schools.</p> <ul style="list-style-type: none"> • New expertise used to train INDEPTH students through Training school n°1: STSM # 97200 Sophie DESSET (INSERM Engineer) learned the 3D RNA FiSH technique in Stefanie Rosa Lab (Sweden) in April 2018, practice the technology and set-up plants and protocols in another laboratory (France) in order to train the students with this innovative technology during the 3D FiSH training school in October 2018. • New expertise to apply innovative proteomic approaches through Training school n°2: 3 staff members from 3 different French institutes (Mathieu Ingouff, Aline Probst, Nathalie Picault) were trained to flow cytometry and nanoMS technology by the Olomouc center and bring this new expertise in their respective lab. 	<p>High</p>

The quality and quantity of the other outputs/ achievements was assessed as follows.

The importance of STSMs performed was high, though more STSMs would be expected to increase the networking impact of the action.

Impacts

The Action reported the following impacts (the short- to long-term scientific, technological, and / or socioeconomic changes produced by a COST Action, directly or indirectly, intended or unintended) that have resulted, or might result, from the Action.

Description of the impact	Type of impact	Timing of impact
<p>INDEPTH promoted interactions between industrial and academia through, workshop, Training Schools and new joined grant proposals.</p> <p>During the Training School n°1 in 3D FiSH (Oct 2018) the Stellaris company provided RNA FiSH protocols and probes and the Zeiss company (Germany) trained the trainees on LSM800 confocal microscope equipped with the Airyscan technology.</p> <p>During Workshop n°6 (Sept 2019) trainees interacted directly with developers of the OMERO team (UK).</p> <p>During Workshop n°7 (Dec 2019), the attendees of the third main meeting (100 attendees) interacted with industrial partners 3 industrial partners: KWS SAAT SE & Co. KGaA (Germany), Sequentia Biotech (Spain) and BIOVEGEN (Spain). This last workshop motivated one of the industrial partner (Sequentia Biotech) to participate to the next training school on omics analysis organized in France in 2020 and to participate in a joint project that will be submitted in January 14th, 2020 (ITN EpiSeedLink).</p> <p>One joint project between academia and Industry have been funded in 2019 (BioSunmulant; see section “project proposal”).</p>	<ul style="list-style-type: none"> • Scientific / Technological • Economic 	<p>Achieved</p>
<p>Validity, relevance and significance (in particular importance and timeliness) of the impact reported by the Action: Excellent organization of Training Schools with the participation of relevant stakeholders from the private sector.</p>		
<p>INDEPTH promotes bio-image analysis applied to the 3D plant nucleus.</p> <p>INDEPTH now offers an OMERO server (Deliverable 4 & 14) for (1) published datasets, (2) datasets for training purpose and (3) directories of unpublished results designed for specific teams working together. This will support the new INDEPTH community for the future, drastically change benchmarking activity (Deliverable 5), support training activity in bio-image analysis (Objective 13) and as an unexpected outputs is creating a new network activity between computing centers.</p>	<ul style="list-style-type: none"> • Scientific / Technological • Societal 	<p>Achieved</p>
<p>Validity, relevance and significance (in particular importance and timeliness) of the impact reported by the Action: Indeed, an OMERO server is in place, though as previously commented the organization of the database would require additional information to be added.</p>		
<p>INDEPTH is creating a new plant scientist community working on plant nuclear organization with high multi-disciplinary skills.</p>	<ul style="list-style-type: none"> • Scientific / Technological 	<p>Foreseen five-to-ten years after the end of the Action</p>
<p>Validity, relevance and significance (in particular importance and timeliness) of the impact reported by the Action: Quite significant impact in the filed of nuclear organization with a focus in plant Biology.</p>		
<p>INDEPTH promotes young plant scientists' career development in offering a range of cross-sectorial and interdisciplinary training and scientific exchange activities through STSM to eventually enhancing their job opportunities.</p>	<ul style="list-style-type: none"> • Scientific / Technological • Societal 	<p>Foreseen by the end of the Action</p>
<p>Validity, relevance and significance (in particular importance and timeliness) of the impact reported by the Action: STSMs are organised with the participation of young scientists. Indeed, the impact is noteworthy for the development</p>		

of their careers and even more STSMs are expected to take place in the next two years.

The extent to which the Action has advanced the careers, skills and networks of researchers including ECIs (as described by the Action) is **excellent**.

Stakeholder engagement

During this first part of the Action, we mainly focused our attention to Journal editors to promote the scientific excellence of INDEPTH teams. Social dissemination platforms such as the GARNet blog, INDEPTH twitter account and INDEPTH Website news were used to reach the scientific community. Specific actions were achieved by direct interaction with the editors of Nucleus, Methods in Molecular Biology, Frontiers in Plant Science and the Journal of Experimental Botany. This will be continued with editors of leading journal in the field (Genome Biology, Nature Methods...). We also initiate Interaction with industrial partners: in plant breeding (Limagrain, KWS...) in bio-informatics (Sequentia), in microscopy (Zeiss, Nikon, Leica...) as well as leading groups developing open access platforms such as GALAXY, OMERO and IntAct teams. So far, INDEPTH did not plan specific actions in its annual work budget plan in order to disseminate COST Action missions and outputs notably towards young people. This could be achieved in the coming years by supporting the participation in local science popularization events such as "La Fête de la Science", the "Science Week", the "Fascination of Plants Day"... Finally, selected funding agencies will be contacted to promote Plant science on model as well cultivated species.

The Rapporteur recommended that the following stakeholders should also be engaged by the Action.

General assessment of impacts

The Action's impacts are best described as follows:

Multiple highly significant impacts are reasonably foreseen, at least one of which is already observed [Excellent]

Dissemination and exploitation of Action results (other than co-authored Action publications listed previously)

Dissemination

Dissemination meetings funded by the Action

The following Dissemination meeting(s) funded by the Action added value for the Action:

- Dissemination meeting 1 - ICAR 2018, 25-06-2018 - 29-06-2018, Finland
- NEUBIAS, 06-02-2019 - 08-02-2019, Luxembourg
- Dissemination meeting at the European Workshop Series on Plant Chromatin (EWPC), 13-06-2019 - 14-06-2019, Germany

Action website

<https://www.brookes.ac.uk/indepth/>

The:

- openness and user-friendliness of the Action website are excellent
- content of the Action website (programmes and minutes of all events present, all outputs/deliverables accessible from website) is excellent

The Action website was an effective means of disseminating the Action.

Rapporteur's comment on the website

Elegantly constructed website containing all the necessary information for disseminating the action's results. Compared with other similar websites a great job was done here.

Other dissemination activities

The following other dissemination activities reported by the Action were effective and added value

Item/activity	Participation of INDEPTH members to the 6th European Workshop on Plant Chromatin (EWPC); Cologne 13-14 June 2019 Session Chair: D. Schubert , Ortun Mittelsten Scheid, Valérie Gaudin, Claudia Köhler Speaker: Célia Baroux, Kalyani Krishna, Aline Probst, Inna Lermontova, Iva Mozgová, Rafal Archacki, Sandra Fonseca, Sebastian Marquardt, Sarah Farrona
Target Audience	This bi-annual meeting bring together most of the labs involved in EU countries working in Plant Chromatin field.
Outcome of the activity	Large dissemination of INDEPTH activities to a wider audience. More labs joined INDEPTH after this meeting
Hyperlink	https://www.mpijz.mpg.de/4864142/Final_program.pdf

Item/activity	Participation of INDEPTH members to the Annual meeting of the Society of Experimental Biology (SEB); Florence, 4-5 July 2018 Organization of a special session entitled "Functional organisation of the nuclear periphery" by INDEPTH WG1 leader Katja Graumann and STSM coordinator David Evans (Oxford Brookes University, UK) together with Roland Foisner (Medical University Vienna, Austria) INDEPTH Speakers: Myriam Charpentier (John Innes Centre, UK), Hank Bass (Florida State University, USA), Kentaro Tamura (Kyoto University, Japan), Christophe Tatout and Gwenaëlle Detourne (Université Clermont Auvergne, France) and Frederic Pontvianne (Université Perpignan, France).
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Target Audience	This annual meeting bring together a broad audience (Plant and animals) of up to 500 attendees coming worldwide.
Outcome of the activity	Large dissemination of INDEPTH activities to a wider audience. More labs joined INDEPTH after this meeting
Hyperlink	http://www.sebiology.org/events/event/seb-florence-2018/programme/cell-biology#functional

Exploitation activities

No exploitation activities were reported by the Action.

Assessment of Action dissemination and exploitation activities

The effectiveness of the Action's dissemination and exploitation approach (other than co-authored publications) is assessed as follows

The information provided regarding the dissemination and exploitation approach of the action adequately describes all relevant actions that took place to promote all activities.

Assessment of Action dissemination and exploitation activities

There were many highly effective Action activities focusing on dissemination of Action results [Excellent]

Other matters

Difficulties in implementing the Action

The Action Rapporteur made the following observations regarding difficulties in implementing the Action:

The Action Chair elegantly identifies the problems arising from the lack of proper participation to the action's activities. Though the Action Chair's suggestion to involve young scientists is probably the choice for circumventing the problems for the implementation of the action.

Emerging topics / developments in the field of the Action

The Action reported the following emerging topics / developments in the field of the Action.

- The following topics are in discussion for future actions - all are focused on plant eukaryotes and should be coordinated with actions focusing on animal models

Future COST Action: plant 4D nucleome - Integrating cytogenetic maps with molecular chromatin profiles - image data, image analysis and chromatin modeling

Future COST Action: Nuclear proteomics

Future COST Action: Chromatin-based integration of stress in plants - this is a biological aspect that distinguishes plants most from animals hence bears great promises of original findings

Exploratory workshop: Membraneless compartments in the nucleus (liquid liquid phase separation)
Conference or Workshop: Integrating plant organisms in existing nucleome initiatives

Communication with stakeholders and empowering influencers in the field will be key in ensuring our efforts lead to clear success stories and maintain enthusiasm- as well as the pool of experts- in Plant Science.

Publishing high impact publications on the online repositories is prioritized for the two next years, to enhance the recognition of the work and attract young scientists

Transfer knowledge to Master and PhD studies (INDEPTH experts in the field of chromatin and transcription regulation will now further develop knowledge and understanding of the way in which the nucleus regulate gene transcription through spatial organization of the genome).

The Action Rapporteur made the following comment on the emerging topics / developments in the field reported by the Action.

The Action Chair identified all the relevant emerging concepts in the field of plant 3D -omics. The suggested future developments are in agreement with the immediate needs in the field of plant biology.

Action Rapporteur

This Second Progress Report was submitted on 2020-02-19 by:
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Annex 1: List of publications

The Action reported 13 publications on the topic of the Action, co-authored by at least two Action participants from two countries participating in the Action.

Co-authored Action publications - peer-reviewed

Title	Depletion of KNL2 Results in Altered Expression of Genes Involved in Regulation of the Cell Cycle, Transcription, and Development in Arabidopsis
Authors	Anastassia Boudichevskaia ; Andreas Houben ; Anne Fiebig; Klara Prochazkova ; Ales Pecinka ; Inna Lermontova
DOI	doi:10.3390/ijms20225726
Type	Journal article
Published in	International Journal of Molecular Sciences
Published by	MDPI AG
ISSN	1422-0067
Subjects	Physical and Theoretical Chemistry; Inorganic Chemistry; Organic Chemistry; Spectroscopy; Molecular Biology; Catalysis; General Medicine; Computer Science Applications
Link	https://www.mdpi.com/1422-0067/20/22/5726/pdf
Title	Probing the 3D architecture of the plant nucleus with microscopy approaches: challenges and solutions
Authors	Tao Dumur; Susan Duncan ; Katja Graumann ; Sophie Dessel ; Ricardo S Randall ; Ortrun Mittelsten Scheid ; Dimiter Prodanov ; Christophe Tatout ; Célia Baroux
DOI	doi:10.1080/19491034.2019.1644592
Type	Journal article
Published in	Nucleus
Published by	Informa UK Limited
ISSNs	1949-1034 ; 1949-1042
Subject	Cell Biology
Link	https://www.tandfonline.com/doi/pdf/10.1080/19491034.2019.1644592
Title	Arabidopsis S2Lb links AtCOMPASS-like and SDG2 activity in H3K4me3 independently from histone H2B monoubiquitination
Authors	Anne-Sophie Fiorucci; Clara Bourbousse; Lorenzo Concia; Martin Rougée; Anne-Flore Deton-Cabanillas; Gérald Zabulon; Elodie Layat; David Latrassé; Soon Kap Kim; Nicole Chaumont; Bérangère Lombard; David Stroebel; Sophie Lemoine; Ammara Mohammad; Corinne Blugeon; Damarys Loew; Christophe Bailly; Chris Bowler; Moussa Benhamed; Fredy Barneche
DOI	doi:10.1186/s13059-019-1705-4
Type	Journal article
Published in	Genome Biology
Published by	Springer Science and Business Media LLC
ISSN	1474-760X
Links	http://link.springer.com/content/pdf/10.1186/s13059-019-1705-4

	<p>59-019-1705-4.pdf; http://link.springer.com/article/10.1186/s13059-019-1705-4/fulltext.html</p>
Title	Identification and characterization of genes encoding the nuclear envelope LINC complex in the monocot species <i>Zea mays</i>
Authors	Hardeep K. Gumber ; Joseph F. McKenna ; Amado L. Estrada; Andrea F. Tolmie; Katja Graumann; Hank W. Bass
DOI	doi:10.1242/jcs.221390
Type	Journal article
Published in	Journal of Cell Science
Published by	The Company of Biologists
ISSNs	0021-9533 ; 1477-9137
Subject	Cell Biology
Link	https://syndication.highwire.org/content/doi/10.1242/jcs.221390
Title	Cloning of the wheat Yr15 resistance gene sheds light on the plant tandem kinase-pseudokinase family
Authors	Valentina Klymiuk ; Elitsur Yaniv; Lin Huang ; Dina Raats ; Andrii Fatiukha ; Shisheng Chen; Lihua Feng; Zeev Frenkel; Tamar Krugman; Gabriel Lidzbarsky ; Wei Chang ; Marko J. Jääskeläinen ; Christian Schudoma ; Lars Paulin; Pia Laine; Harbans Bariana ; Hanan Sela ; Kamran Saleem; Chris Khadgi Sørensen; Mogens S. Hovmøller; Assaf Distelfeld; Boulos Chalhoub; Jorge Dubcovsky ; Abraham B. Korol; Alan H. Schulman ; Tzion Fahima
DOI	doi:10.1038/s41467-018-06138-9
Type	Journal article
Published in	Nature Communications
Published by	Springer Science and Business Media LLC
ISSN	2041-1723
Links	http://www.nature.com/articles/s41467-018-06138-9.pdf ; http://www.nature.com/articles/s41467-018-06138-9
Title	The H3 histone chaperone NASP SIM3 escorts CenH3 in Arabidopsis
Authors	Samuel Le Goff ; Burcu Nur Keçeli ; Hana Jeřábková ; Stefan Heckmann ; Twan Rutten ; Sylviane Cotterell ; Veit Schubert ; Elisabeth Roitinger ; Karl Mechtler ; F. Christopher H. Franklin ; Christophe Tatout ; Andreas Houben ; Danny Geelen ; Aline V. Probst ; Inna Lermontova
DOI	doi:10.1111/tpj.14518
Type	Journal article
Published in	The Plant Journal
Published by	Wiley
ISSNs	0960-7412 ; 1365-313X
Subjects	Plant Science; Genetics; Cell Biology
Links	https://onlinelibrary.wiley.com/doi/pdf/10.1111/tpj.14518 ;

	https://onlinelibrary.wiley.com/doi/full-xml/10.1111/tpj.14518
Title	DET1-mediated degradation of a SAGA-like deubiquitination module controls H2Bub homeostasis
Authors	Amr Nassrallah ; Martin Rougée; Clara Bourbousse; Stephanie Drevensek; Sandra Fonseca ; Elisa Iniesto ; Ouardia Ait-Mohamed; Anne-Flore Deton-Cabanillas; Gerald Zabulon; Ikhlaq Ahmed; David Stroebel; Vanessa Masson; Berangere Lombard; Dominique Eeckhout; Kris Gevaert; Damarys Loew; Auguste Genovesio; Cecile Breyton; Geert De Jaeger; Chris Bowler ; Vicente Rubio ; Fredy Barneche
DOI	doi:10.7554/eLife.37892
Type	Journal article
Published in	eLife
Published by	eLife Sciences Publications, Ltd
ISSN	2050-084X
Links	https://cdn.elifesciences.org/articles/37892/elifesciences/37892-v2.pdf ; https://cdn.elifesciences.org/articles/37892/elifesciences/37892-v2.xml
Title	Meeting report – INDEPTH kick-off meeting
Authors	Geraint Parry ; Aline V. Probst ; Célia Baroux; Christophe Tatout
DOI	doi:10.1242/jcs.220558
Type	Journal article
Published in	Journal of Cell Science
Published by	The Company of Biologists
ISSNs	0021-9533 ; 1477-9137
Subject	Cell Biology
Link	https://syndication.highwire.org/content/doi/10.1242/jcs.220558
Title	Chromatin dynamics during interphase and cell division: similarities and differences between model and crop plants
Authors	Ales Pecinka ; Christian Chevalier ; Isabelle Colas ; Kriton Kalantidis ; Serena Varotto ; Tamar Krugman ; Christos Michailidis ; María-Pilar Vallés; Aitor Muñoz; Mónica Pradillo
DOI	doi:10.1093/jxb/erz457
Type	Journal article
Published in	Journal of Experimental Botany
Published by	Oxford University Press (OUP)
ISSNs	0022-0957 ; 1460-2431
Subjects	Plant Science; Physiology
Link	http://academic.oup.com/jxb/advance-article-pdf/doi/10.1093/jxb/erz457/31057592/erz457.pdf
Title	The nuclear envelope in higher plant mitosis and meiosis
Authors	Monica Pradillo ; David Evans ; Katja Graumann
DOI	doi:10.1080/19491034.2019.1587277
Type	Journal article

Published in	Nucleus
Published by	Informa UK Limited
ISSNs	1949-1034 ; 1949-1042
Subject	Cell Biology
Link	https://www.tandfonline.com/doi/pdf/10.1080/19491034.2019.1587277
Title	The Chromatin-Associated Protein PWO1 Interacts with Plant Nuclear Lamin-like Components to Regulate Nuclear Size
Authors	Pawel Mikulski ; Mareike L. Hohenstatt ; Sara Farrona ; Cezary Smaczniak ; Yvonne Stahl ; Kerstin Kaufmann ; Gerco Angenent ; Daniel Schubert
DOI	doi:10.1105/tpc.18.00663
Type	Journal article
Published in	The Plant Cell
Published by	American Society of Plant Biologists (ASPB)
ISSNs	1040-4651 ; 1532-298X
Subjects	Plant Science; Cell Biology
Link	https://syndication.highwire.org/content/doi/10.1105/tpc.18.00663
Title	Linker histones are fine-scale chromatin architects modulating developmental decisions in Arabidopsis
Authors	Kinga Rutowicz; Maciej Lirski; Benoît Mermaz; Gianluca Teano; Jasmin Schubert; Imen Mestiri; Magdalena A. Kroteń; Tohnyui Ndinyanka Fabrice; Simon Fritz; Stefan Grob; Christoph Ringli; Lusik Cherkezyan; Fredy Barneche; Andrzej Jerzmanowski; Célia Baroux
DOI	doi:10.1186/s13059-019-1767-3
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Published in	Genome Biology
Published by	Springer Science and Business Media LLC
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Links	http://link.springer.com/content/pdf/10.1186/s13059-019-1767-3.pdf ; http://link.springer.com/article/10.1186/s13059-019-1767-3/fulltext.html
Title	Footprints of parasitism in the genome of the parasitic flowering plant Cuscuta campestris
Authors	Alexander Vogel ; Rainer Schwacke; Alisandra K. Denton; Björn Usadel ; Julien Hollmann ; Karsten Fischer; Anthony Bolger; Maximilian H.-W. Schmidt; Marie E. Bolger; Heidrun Gundlach ; Klaus F. X. Mayer ; Hanna Weiss-Schneeweiss; Eva M. Temsch; Kirsten Krause
DOI	doi:10.1038/s41467-018-04344-z
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Links

<http://www.nature.com/articles/s41467-018-04344-z.pdf>;
<http://www.nature.com/articles/s41467-018-04344-z>