



676401 – ETN-FPI

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***Optical Foundations of Full-Parallax Imaging***

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**Abstract:**

Report on the second Training School of the Network, “Training school on optical foundations of full-parallax imaging”, organized at University of Valencia 12<sup>th</sup> - 15<sup>th</sup> September 2016.



*Photos: Robert Bregovic*

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## Summary

The second ETN-FPI network's training event, "Training school on optical foundations of full-parallax imaging" was organized at University of Valencia 12th – 15th of September 2016.

The aim of this school was to provide all ETN-FPI network members with the necessary background of the optical aspects of full-parallax imaging and display. The course began with an introduction to matrix paraxial optics (also named as ABCD formalism), which helped to explain straightforwardly the image formation capacity of lenses and of combination of lenses. In the afternoon session, some experiments designed for the easy understanding of law of lenses were performed in the Laboratory of the Faculty of Physics.

The second-day of the course was, again, divided into the morning and the afternoon sessions. In the morning session, multi-view systems were analyzed in terms of ABCD formalism. Different geometries for the lightfield capture were compared. Also, the aperture and field limitation were explained for a general optical system, and particularized for multi-view systems. In the afternoon session, the students implemented in the Laboratory some fundamental optical instruments. Also, the magnification and the field limitation were measured and understood.

Morning session of third day was devoted to explain the wave theory of image formation. To this end propagation of wavefields through converging lenses was analyzed and concepts of PSF, spatial resolution, OTF and frequency cut-off were understood. In the afternoon session, the students carried out in the Laboratory some fundamental experiments of spatial-frequencies filtering in optical imaging instruments.

On the last-day of the course, the morning session was devoted to modern microscopy techniques based on full-parallax concept. In the afternoon session the students were guided to a tour through the 3DID Lab, where the last achievements of the Lab were explained and demonstrated.

Most network members stayed together in a hotel in the downtown easily connected with the School venue. In the evenings, they participated to social activities to encourage bonding as a team and the development of personal relationships with the newcomers.

After the school, notes from most of the lectures were published online as a permanent learning resource for network members and also for the wider community: <http://www.full-parallax-imaging.eu/TS2/schedule>



Eleven of the network's already recruited Early Stage Researchers attended to the second training school (see Annex 1 "Participants").

All ESRs had a complementary MSCA-ITN info on the current issues with network Coordinator Atanas Gotchev (TUT), project managers Robert Bregovic (TUT) and Maria Salomaa (TUT) on Monday 12th September at 17:30.

## Program and teaching material

### Day 1: Monday 12<sup>th</sup> September: Matrix formulation of Geometrical Optics.

#### Theory session.

**Instructor:** Manuel Martínez-Corral (University of Valencia)

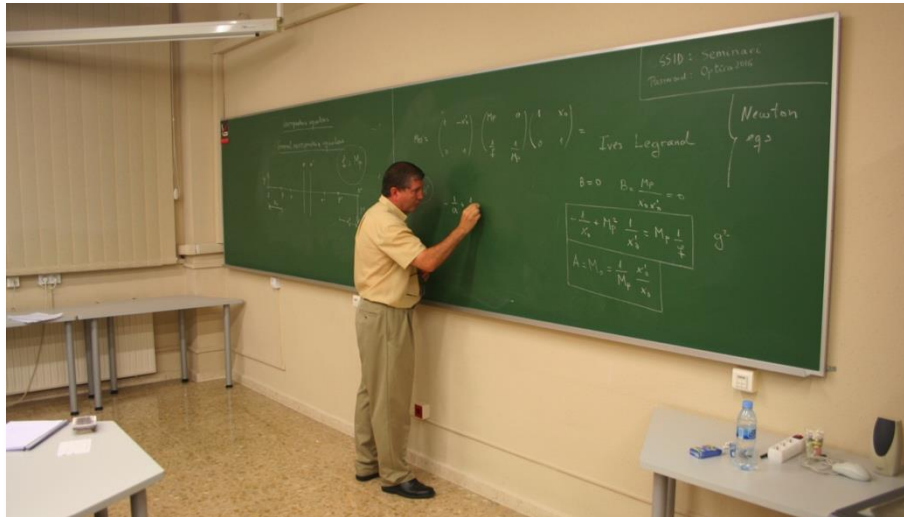
**Contents:** Matrix formulation of Geometrical Optics. The concept of ABCD matrix. Matrix of propagation and of refraction. ABCD matrix between conjugated planes. Transposition of ABCD matrices.

[Handy notes of the Session](#)

#### Laboratory session.

**Instructor:** Juan-Carlos Barreiro (University of Valencia)

**Contents:** Refraction through a plane-parallel plate. Total-internal reflection. Verification of law of lenses: image position and magnification.



### Day 2: Tuesday 13<sup>th</sup> September: Geometrical-optics theory of multi-view systems.

#### Theory session.

**Instructor:** Manuel Martínez-Corral (University of Valencia)

**Contents:** ABCD formalism and the lightfield description. Multi-view systems analyzed in terms of ABCD formalism. Limitation of aperture and field.

[Handy notes of this Session](#)

#### Laboratory session.

**Instructor:** Juan-Carlos Barreiro and Adrián Dorado (University of Valencia)

**Contents:** Implementation of fundamental optical instruments: microscope and telescope. Measurement of magnification and field limitation.

[Laboratory guide: The Microscope](#)

[Laboratory guide: The Telescope](#)



**Day 3: Wednesday 14<sup>th</sup> September: Wave theory of image formation.**

**Theory session.**

**Instructor:** Genaro Saavedra (University of Valencia)

**Contents:** The plane wave and the spherical wave. The wave propagation explained as linear superposition of spherical waves. Propagation of waves through converging lenses. Propagation through telecentric optical systems. Image formation analyzed in terms of wave optics: the concepts of PSF, spatial resolution, OTF and frequency cut-off.



**Laboratory session.**

**Instructor:** Juan-Carlos Barreiro and Genaro Saavedra (University of Valencia)

**Contents:** Light diffracted through periodic screens. Optical filtering of selected frequency content of different 2D objects. Implementation of a catadioptric stereo camera.

**Day 4: Thursday 15<sup>th</sup> September:** 3D microscopy techniques bases on full-parallax concept.

**First talk.**

**Instructor:** Jin Swoger (Center for Genomic Regulation, Barcelona)

**Title:** Multidimensional Mesoscopic Biological Imaging.



**Second talk.**

**Instructor:** Emilio Sánchez-Ortiga (Imperial College, London)

**Title:** Challenges in 3D microscopy.

**Laboratory session.**

**Instructor:** Genaro Saavedra

**Contents:** Guided tour into the 3D Imaging and Display Lab.



**Teachers**

Manuel Martinez-Corral (University of Valencia).  
Genaro Saavedra-Tortosa (University of Valencia).  
Juan-Carlos Barreiro-Hervás (University of Valencia).  
Adrián Dorado Vide (University of Valencia).  
Emilio Sánchez-Ortiga (Imperial College).  
Jim Swoger (Center for Genomic Regulation, Barcelona)

**Feedback**

The eleven Early Stage Researchers, who attended the training event, responded to UVEG’s feedback questionnaire after the training school. On the scale from 1 to 5, the quality of content (QoC) of all the lectures scored 4.5 points and the quality of presentation (QoP) scored 4.0. There was a good balance among all the lectures, so that all of them obtained scores in the neighborhood of 4.0. Also, though some find the work bit too time-consuming, the Laboratory sessions obtained very good scores as well: 4.3 QoC and 4.1 QoP. Overall, the venue (4.0) and the social programme (4.3) of the training school were also appreciated by ESRs.

In the “Free comments” section the ESRs especially appreciated the efforts of the teachers and the passion they put in the transmission of their knowledge. The also thought that participation of senior researchers and post-doc students of the host institution to the training school was very beneficial, and the ESRs could also learn from them. However, some of them found that the schedule was quite tight, particularly in regard to Laboratory work.

In general, the ESRs found the school very useful for their future work in the network, and appreciated good communication and organization of the event.





**Annex 1: Participants**

Scrofani	Gabriele	University of Valencia (ESR)
Ansari	Amir	University of Valencia (ESR)
Palmieri	Luca	University of Kiel (ESR)
Gao	Yuan	University of Kiel (ESR)
Kaspiris	Christos	Newcastle University (ESR)
Ahmad	Waqas	Midsweden University (ESR)
Li	Yongwei	Midsweden University (ESR)
Gama	Filipe	Tampere University of Technology (ESR)
Morechini	Sergio	Tampere University of Technology (ESR)
Doronin	Oleksii	Holografika (ESR)
Ardebili	Daniel	Raytrix (ESR)
Hong	Seokmin	University of Valencia
Sola Pikabea	Jorge	University of Valencia
Tolosa Ruiz	Angel	University of Valencia
Bregovic	Robert	Tampere University of Technology
Read	Jenny	Newcastle University
Olsson	Roger	Midsweden University
Gotchev	Atanas	Tampere University of Technology
Suominen	Olli	Tampere University of Technology
Sahin	Erdem	Tampere University of Technology
Akpinar	Ugur	Tampere University of Technology
Ziegler	Matthias	Fraunhofer IIS Germany