



# International Workshop on **We**earable **R**obotics

**WeRob General Chair:** Prof. José L. Pons

**WeRob Co-chair & Coordinator for US and Canada:** Prof. José L. Contreras-Vidal

**Coordinator for Europe:** Prof. Herman van der Kooij

**Coordinator for Asia-Pacific:** Prof. Seong-Whan Lee

**Coordinator for South and Central America:** Prof. Rogelio Soto

**Organizers:** Neural Rehabilitation Group, Cajal Institute, Spanish National Research Council (CSIC), Cullen College of Engineering at the University of Houston, Tecnológico de Monterrey (ITESM) and University of Twente.



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**Major Sponsors:** TIRR Memorial Hermann & Korea University.



**Platinum Sponsors:** Wearable Robotics, OSSUR, EksoBionics and ReWalk.



**Gold Sponsors:** Technaid, REX Bionics and BrainProducts.



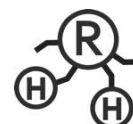
**European Projects:** Balance, BioMot, CYBERLEGS, EXO-LEGS, H2R, SYMBITRON



CYBERLEGS



EXOLEGS



## Workshop Program

|               | Sunday, 14       | Monday, 15                                                                                                                                  | Tuesday, 16                                                                | Wednesday, 17                                                      | Thursday, 18                                                                         |
|---------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 08.30 - 09.00 |                  | General Introduction and <b>Opening session</b>                                                                                             |                                                                            |                                                                    |                                                                                      |
| 09:00 - 10:30 |                  | <b>Session 1.1:</b><br>Clinical Application Scenarios for WRs (I)<br><br><b>Plenary lecture:</b><br>Prof. Y Sankai and Demonstration of HAL | <b>Session 2.1:</b><br>Benchmarking, Regulatory and Funding aspects of WRs | <b>Session 3.1:</b><br>Clinical Application Scenarios for WRs (II) | <b>Session 4.1:</b><br>Translational and Industrial/Market Challenges/ Opportunities |
| 10:30 - 11:00 |                  | Coffee Break & Exhibitions                                                                                                                  |                                                                            |                                                                    |                                                                                      |
| 11:00 - 13:00 |                  | Session 1.1                                                                                                                                 | Session 2.1                                                                | Session 3.1                                                        | Session 4.1                                                                          |
| 13:00 - 14:30 |                  | Lunch                                                                                                                                       |                                                                            |                                                                    |                                                                                      |
| 14:30 - 16:00 |                  | <b>Session 1.2:</b><br>Neural Interfacing with WRs                                                                                          | <b>Session 2.2:</b><br>Design Challenges of WRs                            | Free Time                                                          | <b>Session 4.2:</b><br>Advanced Control Methods for WRs                              |
| 16:00 - 16:30 |                  | Poster Session, Coffee Break & Exhibitions                                                                                                  |                                                                            |                                                                    | Poster Session, Coffee Break & Exhibitions                                           |
| 16:30 - 18:00 |                  | Session 1.2                                                                                                                                 | Session 2.2                                                                |                                                                    | Session 4.2                                                                          |
| 20:00         | Welcome cocktail |                                                                                                                                             |                                                                            | Gala dinner                                                        |                                                                                      |

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| <b>Monday, 15th Morning</b> | <b>Session 1.1: Clinical Application Scenarios for Wearable Robots (I)</b><br><b>Session Chairs: J.L. Pons and M. Molinari</b>                                               |
| <b>8:30 – 09:00</b>         | General Introduction and Opening session (J.L. Pons)                                                                                                                         |
| <b>9:00 – 10:00</b>         | Joint SSNR and WeRob Plenary lecture: Prof. Y. Sankai and Demonstration of HAL                                                                                               |
| <b>10:00 – 10:10</b>        | <a href="#">Demonstration Ekso Bionics™</a>                                                                                                                                  |
| <b>10:10 – 10:30</b>        | Invited Talk: G. Francisco, H2 NeuroExo: A Clinical Study in Post-stroke Gait Rehabilitation                                                                                 |
| <b>10:30 – 11:00</b>        | Coffee Break & Exhibitions                                                                                                                                                   |
| <b>11:00 – 11:20</b>        | Invited Talk: Dr. A. Gil-Agudo, HNPT, Toledo, Spain                                                                                                                          |
| <b>11:20 – 11:40</b>        | Invited Talk: Dr. M. Molinari, Fondazione Santa Luzia, Rome, Italy                                                                                                           |
| <b>11:40 – 13:00</b>        | Panel discussion “What can be learnt from past pilot clinical experience with WR for rehabilitation?” Participants: G. Francisco, A. Gil, Ekso Bionics, ReWalk, Rex Bionics. |

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| <b>Monday, 15th Afternoon</b> | <b>Session 1.2: Neural Interfacing with WRs</b><br><b>Session Chairs: J. Del R. Millán and J.L. Contreras-Vidal</b>                                                                                                      |
| <b>14:30 – 14:35</b>          | Introduction by Prof. J. Del R. Millán and Prof. J.L. Contreras-Vidal                                                                                                                                                    |
| <b>14:35 – 14:55</b>          | Invited talk: Prof. Seong-Whan Lee, Korea University                                                                                                                                                                     |
| <b>14:55 – 15:15</b>          | Invited talk: Prof. Sankai, Tsukuba University and Cyberdyne, Japan*                                                                                                                                                     |
| <b>15:15 – 15:35</b>          | Invited Talk: Prof. Jose Contreras-Vidal, University of Houston, TX                                                                                                                                                      |
| <b>15:35 – 16:00</b>          | Invited Talk: Prof. D. Farina, University Medical Center Göttingen, Germany                                                                                                                                              |
| <b>16:00 – 16:30</b>          | Poster Session, Coffee Break & Exhibitions                                                                                                                                                                               |
| <b>16:30 – 16:50</b>          | Invited Talk: Prof. J. del R. Millán, EPFL, Switzerland                                                                                                                                                                  |
| <b>16:50 – 17:10</b>          | Invited talk: Prof. J.M. Azorín, UMH, Spain, Neural interfacing in the Biomot EU project                                                                                                                                 |
| <b>17:10 – 17:20</b>          | Oral presentation: Atila Kilicarslan, Robert G. Grossman and Jose Luis Contreras-Vidal, EEG-based Control of a Multi-Functional Lower-Body Exoskeleton for SCI Patients: Mobility, Brain Plasticity and Health Benefits. |
| <b>17:20 – 17:30</b>          | Oral presentation: Stanisa Raspopovic, Francesco Maria Petrini, Jacopo Carpaneto and Silvestro Micera, Restoring the sensory feedback into the bidirectional prosthetic control                                          |
| <b>17:30 – 17:45</b>          | Concluding Remarks and Discussion                                                                                                                                                                                        |
| <b>17:45 – 18:00</b>          | <a href="#">Demonstration of NeuroRex by Rex Bionics Ltd</a>                                                                                                                                                             |

| ID           | <b>Poster session</b><br><b>Monday, 15<sup>th</sup> Afternoon</b><br><b>16:00 – 16:30</b>                                                                                                                                                                                                                                                                                                                                        |
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| <b>PO-1</b>  | Alexandre Verney, Boris Moriniere, Neil Abroug, Philippe Garrec, Catherine Bidard, Yann Perrot, Andriy Yelisyyev, Tetiana Aksenova, Serpil Cokgungor, Jérémy Pradal, Napoleon Torres-Martinez, Thomas Costecalde, Michael Foerster, Fabien Sauter, David Ratel, Guillaume Charvet, Corinne Mestais and Alim-Louis Benabid. "CLINATEC BCI platform : Controlling EMY exoskeleton by the mean of ECoG-recording implants WIMAGINE" |
| <b>PO-2</b>  | Basilio Lenzo, Alessandro Filippeschi, Emanuele Ruffaldi, Antonio Frisoli, Fabio Salsedo and Massimo Bergamasco. "ALEX, a new exoskeleton for power assist and motor learning"                                                                                                                                                                                                                                                   |
| <b>PO-3</b>  | Thomas Bulea, Diane Damiano and Hyung-Soon Park. "Cortical Activity during Walking: Developing Brain Machine Interfacing Targets for Neurorehabilitation"                                                                                                                                                                                                                                                                        |
| <b>PO-4</b>  | David Jose Ramirez Arroyo and Arys Carrasquilla Batista. "Servo Control Device for Quadraplegic Wheelchair Activated by Neural Signal"                                                                                                                                                                                                                                                                                           |
| <b>PO-5</b>  | Kai Henning Koch and Katja Mombaur. "ExoOpt - a tool for evaluating exoskeleton designs using model-based optimization"                                                                                                                                                                                                                                                                                                          |
| <b>PO-6</b>  | Magdo Bortole, Fangshi Zhu, Anusha Venkatakrishnan, Zachary Hernandez, José Luis Pons and José Luis Contreras-Vidal. "H2 NeuroExo: Integration of the H2 Lower Body Powered Exoskeleton and Mobile Brain Monitoring to Improve Gait Rehabilitation"                                                                                                                                                                              |
| <b>PO-7</b>  | Louis Flynn, Francesco Giovacchini, Luka Ambrozic, Maja Gorsic, Marko Munih, Virginia Ruiz-Garate, Jean-François Collard, Renaud Ronsse, Raffaele Molino-Lova, Federica Vannetti, Joost Geeroms, Rene Jimenez-Fabian, Bram Vanderborght, Dirk Lefeber and Nicola Vitiello. "Introduction to CYBERLEGS: Hardware and Control"                                                                                                     |
| <b>PO-8</b>  | Josep María Font-Llagunes, Urbano Luguís, Francisco Romero, Daniel Clos, Francisco Javier Alonso and Javier Cuadrado. "Design of a Patient-Tailored Active Knee-Ankle-Foot Orthosis to Assist the Gait of Spinal Cord Injured Subjects"                                                                                                                                                                                          |
| <b>PO-9</b>  | Eloy Urendes Jimenez, Guillermo Asín Prieto, María Gómez Jiménez, Ramón Ceres Ruiz and José L. Pons. "An integrated lower limb exoskeleton and body weight support system: design and implementation"                                                                                                                                                                                                                            |
| <b>PO-10</b> | Maria Gomez, Cristina Lopez de Subijana, Eloy Urendes and Enrique Navarro. "Validation of a Marker Model for Gait Analysis with Wearable Exoskeletons"                                                                                                                                                                                                                                                                           |
| <b>PO-11</b> | Gurvinder Virk, Usman Haider, I Nyoman Indrawibawa, Rakesh Krishnan and Nauman Masud. "EXO-LEGS for the Future Ageing Society"                                                                                                                                                                                                                                                                                                   |
| <b>PO-12</b> | Conor Walsh. "Mobility Enhancing Soft Exosuits"                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>PO-13</b> | Philippe Garrec. "Mechanical design optimization to improve force transfer in electrically actuated exoskeleton"                                                                                                                                                                                                                                                                                                                 |

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| <b>Tuesday, 16th Morning</b> | <b>Session 2.1: Benchmarking, Regulatory and Funding aspects of WRs</b><br><b>Session Chairs: J. Veneman and D. Torricelli</b>                                                                                                                                                                                                                                                                                                                                                           |
| <b>9:00 – 9:20</b>           | Dr. J. Veneman, Tecnia, Spain. Title: “Benchmarking of bipedal functions in humanoids, exoskeletons and humans”                                                                                                                                                                                                                                                                                                                                                                          |
| <b>9:20 – 9:40</b>           | Mr. F. Thorsteinsson, Ossur, Iceland. Title: “Standards and regulations for prosthetics”                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>9:40 – 10:00</b>          | Prof. G. Virk, KTH Royal Institute of Technology, Sweden. Title: “Safety requirements for wearable robots”                                                                                                                                                                                                                                                                                                                                                                               |
| <b>10:00 – 10:20</b>         | Prof. R. Riener, ETH Zurich, Switzerland. Title: “The Cybathlon: A Competition that Promotes the Development of Assistive Devices”                                                                                                                                                                                                                                                                                                                                                       |
| <b>10:30 – 11:00</b>         | Coffee Break & Exhibitions                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>11:00 – 11:20</b>         | Daofen Chen, Program Manager NINDS-NIH, Title: “Funding aspects in Wearable robots”                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>11:20 – 12:00</b>         | Presentations from ongoing EU projects: <ul style="list-style-type: none"> <li>- Diego Torricelli (H2R project). Title “A translational approach for benchmarking human-like locomotion”</li> <li>- Alexander Schubert (Koroibot project). Title “Key performance indicators for humanoid walking motions defined in the Koroibot project”</li> <li>- Antonio del Ama (Biomot project). Title “A general framework for establishing benchmarks of wearable lower limb robots”</li> </ul> |
| <b>12:00 – 12:45</b>         | Panel discussion chaired by: J. Veneman and D. Torricelli.<br>Participants: F. Thorsteinsson, G. Virk, R. Riener, D. Chen                                                                                                                                                                                                                                                                                                                                                                |
| <b>12:45 – 13:00</b>         | <a href="#">Demonstration CSIC-Technaid S.L., H2 exoskeleton, Prof. J.L. Pons and J.O. Roa</a>                                                                                                                                                                                                                                                                                                                                                                                           |

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| <b>Tuesday, 16th Afternoon</b> | <b>Session 2.2: Design Challenges of Wearable Robots</b><br><b>Session Chairs: H. Van der Kooij and J. González</b>                                                                                  |
| <b>14:30 – 14:40</b>           | Introduction by Prof. H. Van der Kooij and Dr. J. González                                                                                                                                           |
| <b>14:40 – 15:00</b>           | Prof. H. van der Kooij, University of Twente, The Netherlands*                                                                                                                                       |
| <b>15:00 – 15:10</b>           | European Project Symbitron**                                                                                                                                                                         |
| <b>15:10 – 15:30</b>           | Dr. Philippe Garrec, CEA LIST, France*                                                                                                                                                               |
| <b>15:30 – 15:40</b>           | European Project Balance**                                                                                                                                                                           |
| <b>15:40 – 16:00</b>           | Prof. R. Riener, ETH, Zurich, Switzerland*                                                                                                                                                           |
| <b>16:00 – 16:30</b>           | Poster Session, Coffee Break & Exhibitions                                                                                                                                                           |
| <b>16:30 – 16:50</b>           | Prof. D. Lefeber, VUB, Belgium*                                                                                                                                                                      |
| <b>16:50 – 17:10</b>           | Oral presentation: Joost Geeroms, Louis Flynn, Rene Jimenez-Fabian, Bram Vanderborght and Dirk Lefeber, “Overview of the design and operating principles of the CYBERLEGS alpha and beta prostheses” |

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| <b>17:10 – 17:30</b> | Prof. C. Walsh, Harvard, USA*                                |
| <b>17:30 – 17:45</b> | Concluding Remarks and Discussion                            |
| <b>17:45 – 18:00</b> | <a href="#">Demonstration CEA ABLE arm, Alexandre Verney</a> |

\*Each speaker will have 15min to make their presentation and 5min for questions.

\*\* European projects will have 10minutes for presenting. This short presentation should be to raise awareness about the project and the work that is being done in the context of design challenges. Therefore it should be very general.

| <b>ID</b>    | <b>Poster session<br/>Tuesday, 16th Afternoon<br/>16:00 – 16:30</b>                                                                                                                                        |
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| <b>PO-14</b> | Joan Lobo-Prat, Alje G. Dunning, Mariska M. H. P. Janssen, Arjen Bergsma and Peter N. Kooren. "Flexextension A-Gear: Progress of Developing a Natural Arm Support for Duchenne Patients"                   |
| <b>PO-15</b> | Seungnam Yu, Changsoo Han and Ilje Cho. "Proposal of a Simple Structure for the Wearable Robot System Dedicated to the Backpack Carrying Task"                                                             |
| <b>PO-16</b> | Daegeun Park, Dae-Young Lee, Hyunki In and Kyu-Jin Cho. "Wearable Passive Arm Weight Bearing Device to assist people with disability using Permanent Magnets"                                              |
| <b>PO-17</b> | Álvaro Costa, Eduardo Iáñez, Andrés Úbeda, Daniel Planelles, Enrique Hortal and Jose M. Azorin. "Frequency and Number of Neighbors Study for Attention Level Classification Using EEG Signals"             |
| <b>PO-18</b> | No-Sang Kwak, Klaus-Robert Müller and Seong-Whan Lee. "Wearable Lower Limb Exoskeleton Control based on SSVEP"                                                                                             |
| <b>PO-19</b> | Kevin Hollander, Jeffrey Ward and Thomas Sugar. "Comparison of Exoskeleton Ankle Assistance to Downhill Walking Energetics and Biomechanics"                                                               |
| <b>PO-20</b> | Vijaykumar Rajasekaran, Joan Aranda and Alicia Casals. "Interaction based adaptive walking using a wearable exoskeleton"                                                                                   |
| <b>PO-21</b> | Svetlana Grosu, Carlos Rodriguez-Guerrero, Victor Grosu, Bram Vanderborght and Dirk Lefeber. "Friction Identification of Cable-Conduit Actuation System for Exoskeleton Orthoses"                          |
| <b>PO-22</b> | Francisco Resquin, Fernando Brunetti, Jaime Ibáñez, Aikaterini Koutsou and José Luis Pons. "Upper Limb Hybrid Control Architecture implemented in the Framework of the HYPER Project"                      |
| <b>PO-23</b> | Guillermo Asín Prieto, Eloy J. Urendes, Juan A. Gallego, Juan C. Moreno and José L. Pons. "Monitoring stability of gait on exoskeletons based on proprioceptive information"                               |
| <b>PO-24</b> | Masashi Sekine, Jacobo Fernandez-Vargas, Natsuki Hayata, Nthatheni Norman Nelufule and Wenwei Yu. "A Hybrid Lightweight Shoulder Prosthesis with an Antagonistic Mechanism by Pneumatic Elastic Actuators" |
| <b>PO-25</b> | Bumkee Lee, Seung-Keun Ahn and Dohyung Lim. Evaluation of Potential Feasibility of Use of New Moving System developed for Rehabilitation Gait Training Assistance                                          |

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| <b>Wed, 17th Morning</b> | <b>Session 3.1: Clinical Application Scenarios for Wearable Robots (II)</b><br><b>Session Chairs: M. Molinari, J. López-Coronado and J.L. Pons</b>                                                                                                                                                                   |
| <b>9:00 -9:05</b>        | Introduction by M. Molinari and J.L. Pons                                                                                                                                                                                                                                                                            |
| <b>9:05 – 9:30</b>       | Invited talk: Prof. A. Esquenazi, John Otto Haas Chair and Professor<br>Department of PM&R & Chief Medical Officer, MossRehab                                                                                                                                                                                        |
| <b>9:30 – 09:50</b>      | Invited Talk: Prof. Z. Rymer, Rehabilitation Institute of Chicago                                                                                                                                                                                                                                                    |
| <b>09:50 – 10:10</b>     | Invited Talk: Prof. V. Dietz, Balgrist University Hospital, Zurich, Switzerland                                                                                                                                                                                                                                      |
| <b>10:10 – 10:30</b>     | Oral presentation: Arun Jayaraman, Hideaki Takahashi, Chaitanya Mummidisetty and William Rymer, Randomized Control Trial Comparing Walking Task Specific Training with Stride Management Assist (SMA) Device vs. Functional Task Specific training on Functional Walking Ability in Outpatient Stroke Rehabilitation |
| <b>10:30 – 11:00</b>     | Coffee Break & Exhibitions                                                                                                                                                                                                                                                                                           |
| <b>11:00 – 11:25</b>     | Oral presentation: Jane Nitschke and Klaus Röhl, Comparison of the therapy with the Exoskeletons Rewalk, Ekso and HAL                                                                                                                                                                                                |
| <b>11:25 – 11:45</b>     | Oral presentation: Heidi Witteveen, Edwin van Asseldonk and Herman van der Kooij, Sensory Substitution to Enhance Balance in Wearable Exoskeletons                                                                                                                                                                   |
| <b>11:45 – 12:30</b>     | Panel discussion “Application Scenarios and clinical challenges in a roadmap for rehabilitation with WR”, chaired by M. Molinari and J.L. Pons.<br>Participants: A. Esquenazi, Z. Rymer, V. Dietz, J. Nitschke                                                                                                       |
| <b>12:30 – 12:45</b>     | Demonstration: Honda Exoskeleton                                                                                                                                                                                                                                                                                     |
| <b>12:45 – 13:00</b>     | Demonstration: “Bidirectional hand prosthesis that restores the feelings to user”. Stanisa Raspopovic, EPFL.                                                                                                                                                                                                         |

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| <b>Thurs, 18th Morning</b> | <b>Session 4.1: Translational and Industrial/Market Challenges/Opportunities</b><br><b>Session Chairs: F. Thorsteinsson, R. Raya</b> |
| <b>9:00 - 9:10</b>         | Introduction by Mr, Thorsteinsson and Dr. R. Raya                                                                                    |
| <b>9:10 – 9:40</b>         | Mr. M. Oddsson (Ossur, Iceland) - "Power Knee – from concept to commercial product"                                                  |
| <b>9:40 – 10:10</b>        | Dr. D. Gaebler (RIC, Chicago) - "Robots to the Rescue. Assisting Evaluation and Treatment Outcomes"                                  |
| <b>10:10 – 10:30</b>       | Amitt Goffer – “Wearable Exoskeletons: Limitations and Challenges”                                                                   |
| <b>10:30 – 11:00</b>       | Coffee Break & Exhibitions                                                                                                           |
| <b>11:00 – 11:15</b>       | <a href="#">Demonstration ReWalk exoskeleton - Amitt Goffer</a>                                                                      |
| <b>11:15 – 11:35</b>       | Mr. R. Csuhaj (Brain Products, Germany) - "How a research idea can become a product - example of Brain Products' actiCAP Xpress"     |

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| <b>11:35 - 11:55</b> | Mr. A. Espinosa (GTEC, Austria) - "BCI applications on the international market"                                                                             |
| <b>11:55 - 12:15</b> | Silvia Rohner, Alejandro Melendez Calderon and Ingo Kirchoff. "Industrial design requirements for wearable robots – recomendations from EXO-Legs consortium" |
| <b>12:15 - 12:35</b> | Dr. E. Rocon (CSIC, Spain) - "CP Walker Robotic Platform for Gait Rehabilitation and Training in Patients with CP"                                           |
| <b>12:35 - 12:55</b> | José L. Pons (CSIC, Spain) - "Pediatric exoskeletons"                                                                                                        |
| <b>12:55 - 13:00</b> | Concluding Remarks and Discussion                                                                                                                            |

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| <b>Thurs, 18th Afternoon</b> | <b>Session 4.2: International consensus on Advanced Control Methods for Wearable robots</b><br><b>Session Chairs: N. Vitiello and J. Moreno</b> |
| <b>14:30 - 14:40</b>         | Introduction by N. Vitiello and J.C. Moreno                                                                                                     |
| <b>14:40 - 15:00</b>         | Invited talk #1, D. Reinkensmeyer, UC Irvine – "Strategies for maximizing latent control of wearable robots"                                    |
| <b>15:00 - 15:20</b>         | Invited talk #2, T. Boaventura, J. Buchli, ETH Zürich – "Floating base rigid body inverse dynamics for transparent behaviour in exoskeletons"   |
| <b>15:20 - 15:40</b>         | Invited talk #3, K. Ohno, S. Shimoda, RIKEN, Behavior coordination between human and prosthetic devices                                         |
| <b>15:40 - 16:00</b>         | Invited talk #4, G. Virk, KTH Royal Inst of Tech, EXO-LEGS Project                                                                              |
| <b>16:00 - 16:30</b>         | Poster Session, Coffee Break & Exhibitions                                                                                                      |
| <b>16:30 - 16:50</b>         | Invited talk #5, J.C. Moreno, CSIC, BioMot project                                                                                              |
| <b>16:50 - 17:10</b>         | Invited talk #6, N. Vitiello, Scuola Superiore Sant'Anna, CYBERLEGS Project                                                                     |
| <b>17:10 - 17:30</b>         | Discussion chaired by N. Vitiello and J.C. Moreno                                                                                               |
| <b>17:30 - 17:45</b>         | Conclusions, N. Vitiello, J.C. Moreno                                                                                                           |
| <b>17:45 - 18:00</b>         | Demonstration ALEX exoskeleton                                                                                                                  |



| ID           | <b>Poster session</b><br><b>Thursday, 18<sup>th</sup> Afternoon</b><br><b>16:00 – 16:30</b>                                                                                                              |
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| <b>PO-27</b> | Jing Ye, Yo Kobayashi and Masakatsu G. Fujie. “Gait Phase Estimation Based on a Pelvis Assist Robot for Gait Rehabilitation of Hemiplegic Stroke Survivors”                                              |
| <b>PO-28</b> | Cory Meijneke, Wietse van Dijk and Herman van der Kooij. “Regulating Support Torque around the Ankle during Walking with the Achilles Exoskeleton”                                                       |
| <b>PO-29</b> | Virginia Ruiz Garate, Jean-Francois Collard and Renaud Ronsse. “Bio-inspired Model for Walking Assistance”                                                                                               |
| <b>PO-30</b> | Wansoo Kim, Heedon Lee, Donghwan Lim, Jungsoo Han and Changsoo Han. “Development of the Hanyang Exoskeleton Assistive Robot (HEXAR) to Enhance Lower Body Strength”                                      |
| <b>PO-31</b> | Florin Dzeladini, Andrew Pennycott, Etienne Burdet and Auke Ijspeert. “Benefits of a Neuromuscular Model for Symbiotic Man-Machine Exoskeleton Control Accounting for Patient Impairment Specificity”    |
| <b>PO-32</b> | Haoyong Yu, Gong Chen, Zhao Guo and Wei Shen Wong. “Design and Evaluation a Novel Portable Knee–Ankle-Foot Robot”                                                                                        |
| <b>PO-33</b> | Michael Tucker, Olivier Lamercy and Roger Gassert. “A Remotely Actuated Knee Perturbator for Human Knee Impedance Estimation”                                                                            |
| <b>PO-34</b> | Branko Brackx, Victor Grosu, Carlos Guerrero, Bram Vanderborght and Dirk Lefeber. “ALTACRO: Design of the Gait Rehabilitation Robot”                                                                     |
| <b>PO-35</b> | Hyun-Dae Yang, Jun-Young Jung and Hyun-Sub Park. “Design of the Size Adjustment Process-less Lower Limb Exoskeleton Robot For the Stroke”                                                                |
| <b>PO-36</b> | Jong-Won Lee, Hyo-Gon Kim, Jaeho Jang, Hyun-Sub Park and Sangdeok Park, Human Behavior Inspired Control Strategy for Lower Extremity Exoskeleton                                                         |
| <b>PO-37</b> | Ana Cecilia Villa Parra, Denis Delisle Rodríguez, Leonardo Broche-Vázquez, Teodiano Bastos-Filho, Roberto Sagaró and Anselmo Frizera-Neto, Proposal of an Assisted-Motion System for Gait Rehabilitation |
| <b>PO-38</b> | Keun-Tae Kim, Atila Kilicarslan, Jose L. Contreras-Vidal and Seong-Whan Lee, Classification of Left and Right Leg Movement Intentions using EEG Signals from Subjects using a Lower Body Exoskeleton     |
| <b>PO-39</b> | Bongsu Kim and Ashish Deshpande. “Mechanical Design of A Wearable Robot for Upper Body Rehabilitation”                                                                                                   |
| <b>PO-40</b> | Thomas Sugar and Jason Kerestes. “Developing Exoskeletons to Enhance Running Speed”                                                                                                                      |