# Exoskeleton Legs for Elderly Persons

# EXO-LEGS


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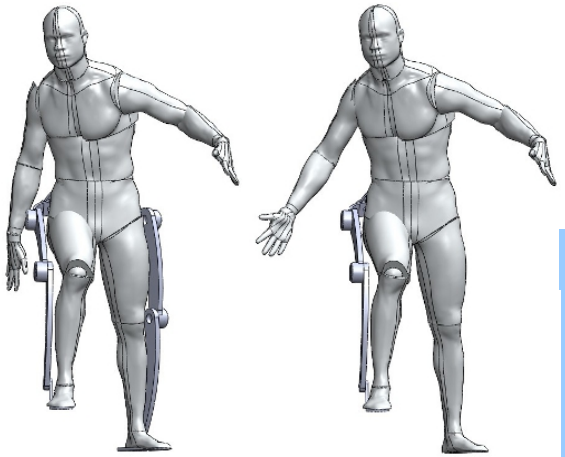


**36 months**
**4.55M€ (2.77M€)**

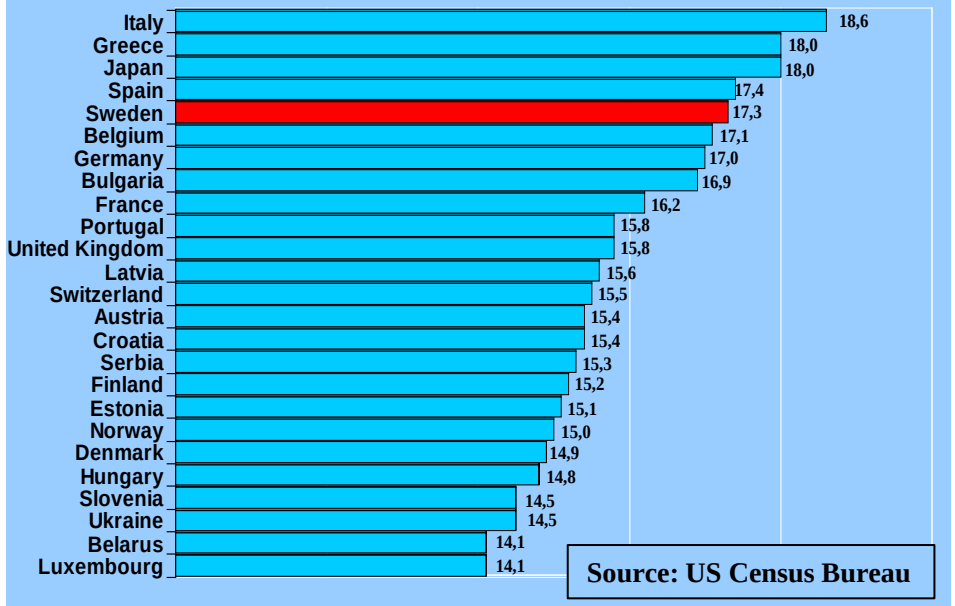
## Partners

1. **University of Gävle (UGAV), Sweden**
2. **Karlsruhe Institute of Technology (KIT), Germany**
3. **Universidad Politecnica de Cartagena (UPCT), Spain**
4. **Chas Blatchford & Sons Limited (CBSL), UK**
5. **Hocoma AG (HOAG), Switzerland**
6. **Gigatronik Technologies GmbH (GIGA), Germany**
7. **MRK Systeme GmbH (MRK), Germany**
8. **Projecto Control Montaje SL (PCM), Spain**
9. **Mobile Robotics Sweden AB (MRSA), Sweden**
10. **Gävle kommun (GAKO), Sweden and sub-partners**

# Why assistive exoskeletons are needed?

- Global increase in elderly population
  - More than 2 billion >65 in the world by 2050
  - 3 carers/elder ⇨ reducing to 2 carers/elder
  - Sweden: 17.3% ⇨ 30% over 60 yrs old
- Growing elderly population needs greater healthcare services
  - Exponentially increasing care costs
  - Care staff numbers reducing leading to more stressed personnel
- Situation is unsustainable and likely to break down soon. Viable alternatives allowing the elderly to remain in their own homes for as long as possible with good quality of life are urgently needed ⇨ Ambient Assistive Living (AAL)
- Maintaining personal mobility is central to healthy & active daily living
  - Wheel chairs, rollators are currently the only solutions but are limited in their effectiveness
  - Exoskeletons offer suitable alternatives

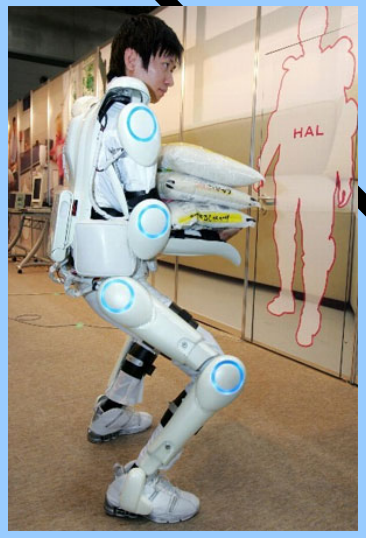
Population percentage of >65 years (≈2004) in world's top 25 "oldest countries"

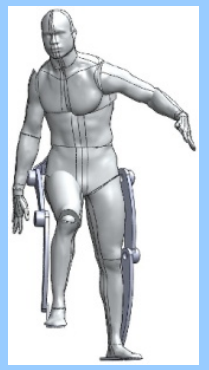



# Our Vision

- HiG's research in physical assistive exoskeletons are aimed at developing new mobility aids to help elderly people move around for normal daily motion tasks.

Develop, test and commercialise from simple single joint assistive device to lower-body to full-body exoskeletons



# What will EXO-LEGS do?

- Will develop new mobility aids to help elderly people for basic daily motion tasks
- EXO-LEGS will develop 3 exoskeletons
  - **Basic exoskeleton**: Standing, sit-to-stand, straight walking, walking with rollator
  - **Standard exoskeleton**: Basic + up/down stairs, walking and turning, bending down, crouching, walking on ramps, stepping over objects
  - **Deluxe exoskeleton**: Standard + speed walking, walking on uneven ground, walking on slippery ground, exercising, using leg to open door
- Engagement with end users
  - Currently 87 end users from Sweden, Germany, UK, Spain, Switzerland
- Prototypes designed and tested in the labs
- Final solutions validated by elderly end users in 5 target countries
- Commercialisation to follow

**Few exoskeleton devices developed around the world**

**HAL, Cyberdyne, Japan**

**REX, Rex Bionics, NZ**

**ReWalk, Argo Medical, Israel**

**First lower-body exoskeleton device developed at Högskolan i Gävle.**

# • Key issues

**Technical**

1. **Stability (walking, stairs, sit-stand, etc)**
2. **Fall detection & alleviation**
3. **Communications for**
   - **Relatives/carers to seek support**
   - **Alarms / technical support**
   - **Homing function**

**Commercial**

1. **Business plan**
2. **PR programme**
3. **Affordability**
4. **Service model**

**User acceptance**

1. **Don/doff ability**
2. **Wearability, ease of use**
3. **Fit range of human sizes**
4. **Added value over wheelchair**

**Regulatory**

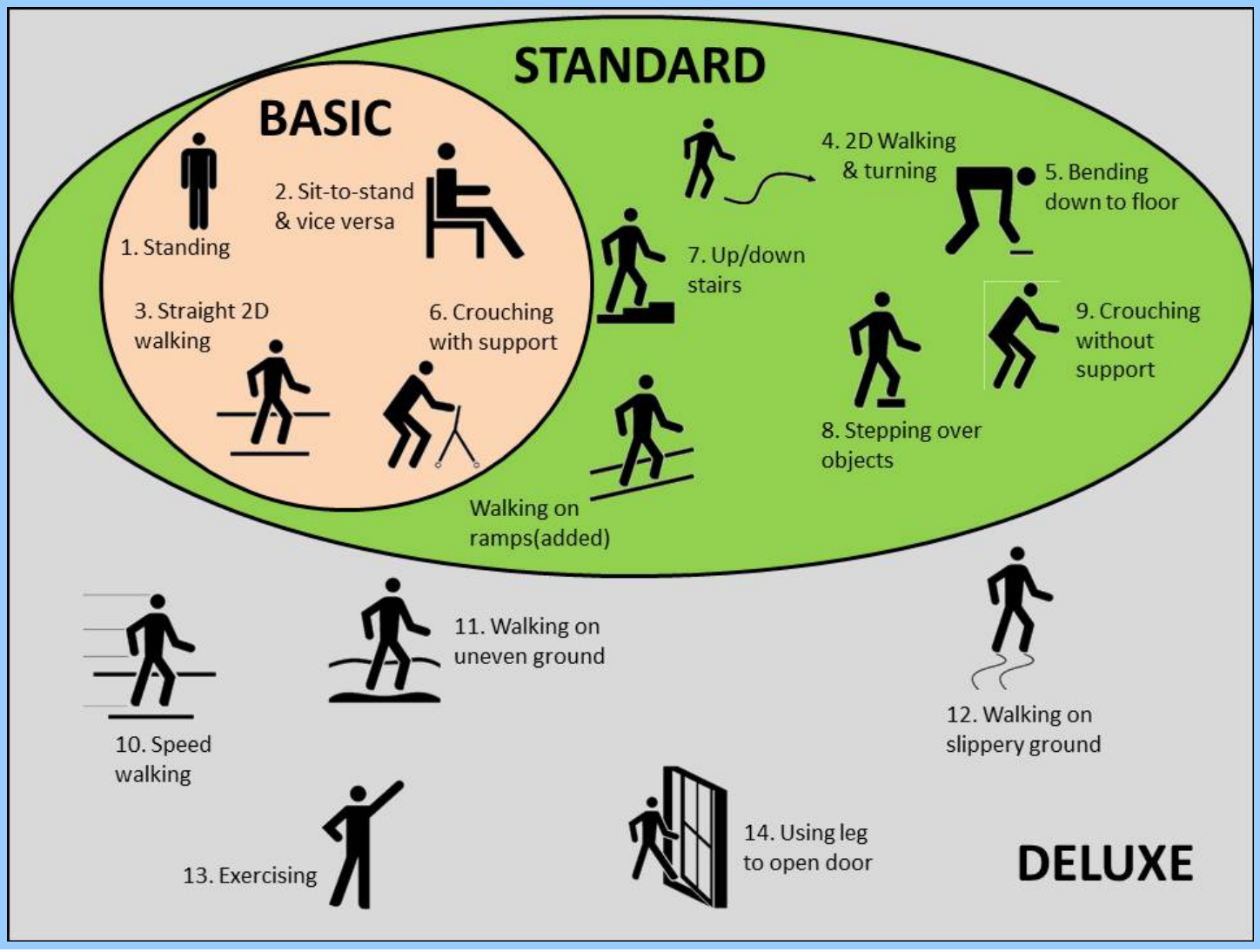
1. **ISO/IEC safety compliance**
2. **Weather proof**

# Detailed work plan for EXO-LEGS

- WP1: End users and scenarios (UGAV)
- WP2: Exoskeleton components (UPCT)
- WP3: System integration, testing and validation (KIT)
- WP4: Pilot test beds (GAKO)
- WP5: Commercialisation (CBSL)
- WP6: Project management (UGAV)

# WP1: EEUG exoskeleton requirements

- 47 completed Q1s: Results for B, S & D exoskeletons



Level 1 Ethical Approval awarded December 2013

# EXO-LEGS Level 2 Ethical Process

EEUG Member declares interest in EXO-LEGS user tests

Initial Information and briefing

Completes, signs and submits the mobility self assessment request

EEUG testing Informed Consent Form signed

Medical Assessment

OK

Further Review

Unsuitable for EEUG testing

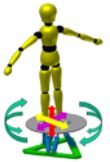
Decline Request

Exit

Schedule Test

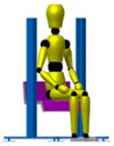
## Test 1- Balance Test

1. Briefing and demonstratio
2. Doubt clearance
3. Trial Test 1 and final OK
4. Test 1 begins on agreemen



## Test 2- Sit-to-stand Test

1. Demonstration and briefin
2. Doubt clearance
3. Trial Test 2 and final OK
4. Test 2 begins on agreement



## Test 3- Straight Walking

1. Demonstration and briefing
2. Doubt clearance
3. Trial Test 3 and final OK
4. Test 3 begins on agreement

Schedule another test?

YES

NO

Feedback

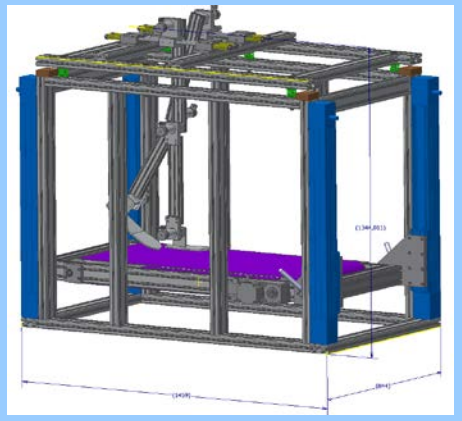
Feedback

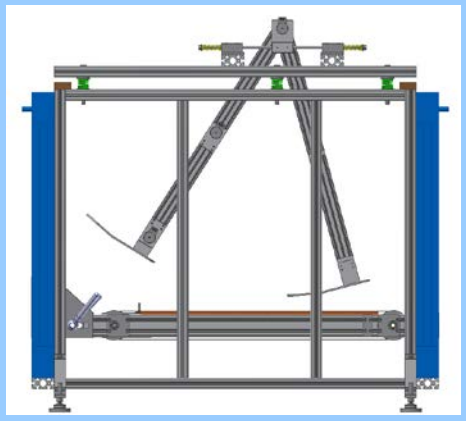
# WP2: Exoskeleton components

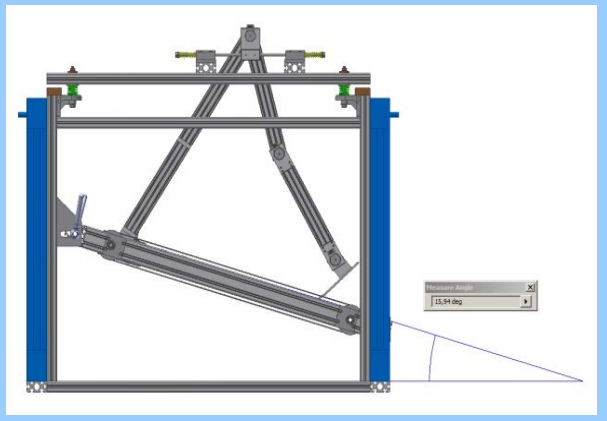
- Detailed technical and non-technical work to design, develop and build the different components for the exoskeletons. The work will comprise the following elements:
  - Theoretical modelling and simulation (standing, sit-to-stand and stand-to-sit, straight walking)
  - Mechanical design and construction, materials
  - Sensors, actuators and controls
  - User interface
  - Experimental rigs

# WP2: Straight walking rigs

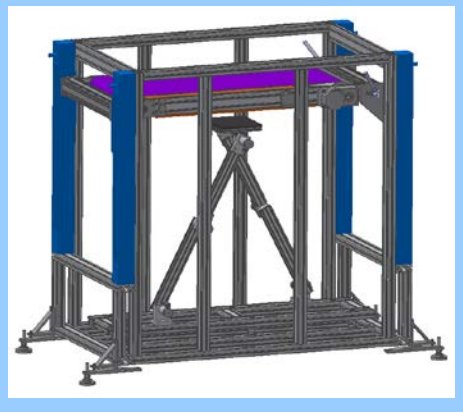
## Rig 1: Single support

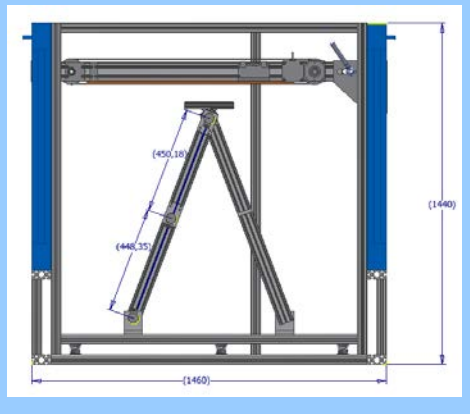


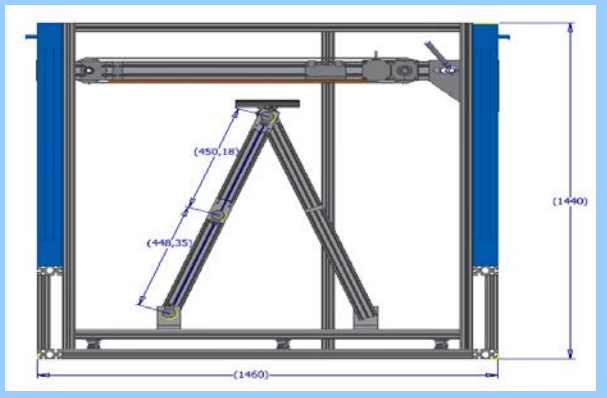




## Rig 2: Double support

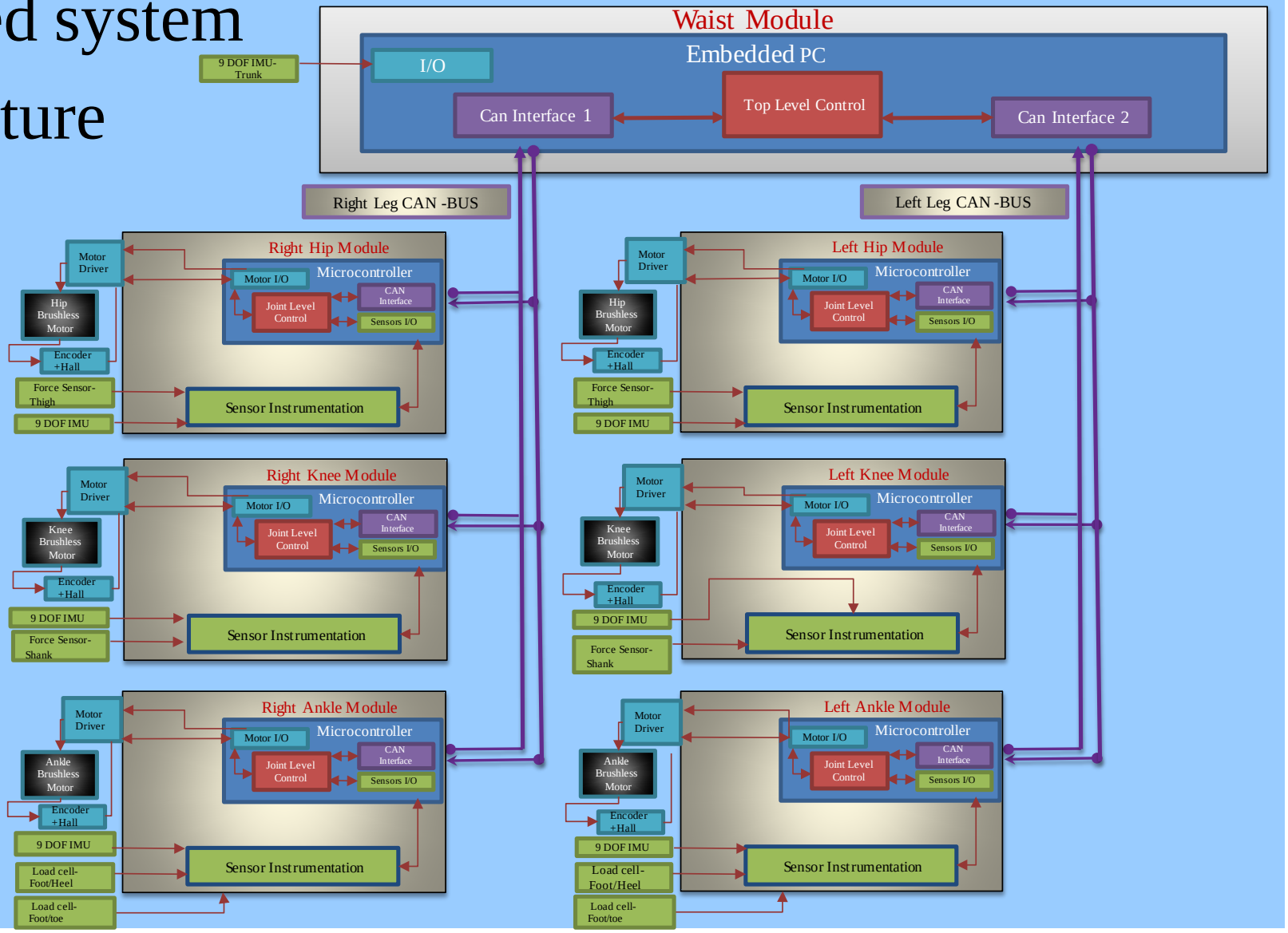




# WP3: System integration

## Proposed system architecture



# WP4: Pilot test beds (GAKO)

- WP4 will design and agree details of the pilot test beds and testing procedures.
- Set up and implement the EXO-LEGS test beds:
  - Sweden: Several test beds in Gävle, Sandviken and Hudiksvall; e.g. Edsbacka care home with ≈25 elderly persons
  - Germany: Geriatric Center Karlsruhe, Dept of ev. Diakonissenkrankenhaus Karlsruhe-Rüppur;
  - Spain: San José y San Enrique, Cieza and Fundación Hospital de Parapléjicos, Toledo
  - Switzerland: Several possible; e.g, out-patient care Center Helios Klinik Zihlschlacht (HKZ), Sulgen having 90 beds
  - UK: Several CBSL care facilities can be used

**Edsbacka, Enganga, Sweden**

**SJySE, Cieza, Spain**

**PhdP, Toledo, Spain**

**HZK, Sulgen, Switzerland**

# WP5 Commercialisation

- Target customers

| Customer A & B | Customer C | Customer D | Customer E | Customer F |
|---|---|---|---|---|
|  |  |  |  |  |
| Active & slightly disabled private elderly person | Elderly care organisation | Rehabilitation institution | Health Insurance | Research/Univ |

- SWOT analysis
- Business plans being formulated

# Conclusions

- Ageing society + not enough carers + raising costs ⇨ Need for assistive technology rising
- Assistive mobility exoskeletons could offer an effective and affordable solution
- EXO-LEGS exoskeletons: Basic, Standard and Deluxe being specified, designed, built, tested and commercialised
- Role of End Users is vital to success of R&D