LuminaLED Cleanroom Lab

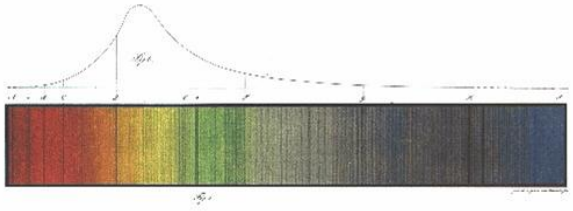
Dedicated R&D Cleanroom for the TOP LED technology solutions regarding future solid state lighting devices

Tuesday, 25th October 2011
Venue: Manufuture 2011 Conference, Wroclaw, Poland

Fraunhofer IPA

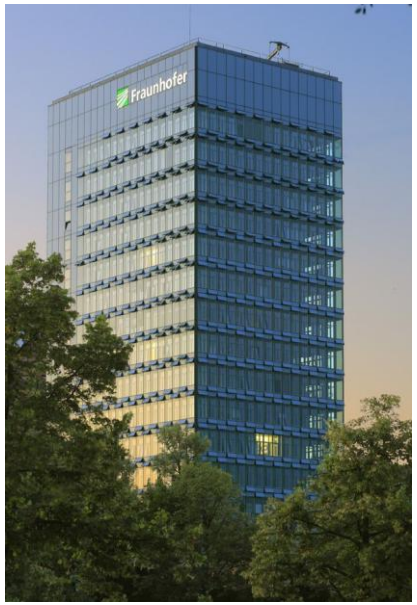
The Fraunhofer-Gesellschaft
Inspiration: Joseph von Fraunhofer (1787-1826)

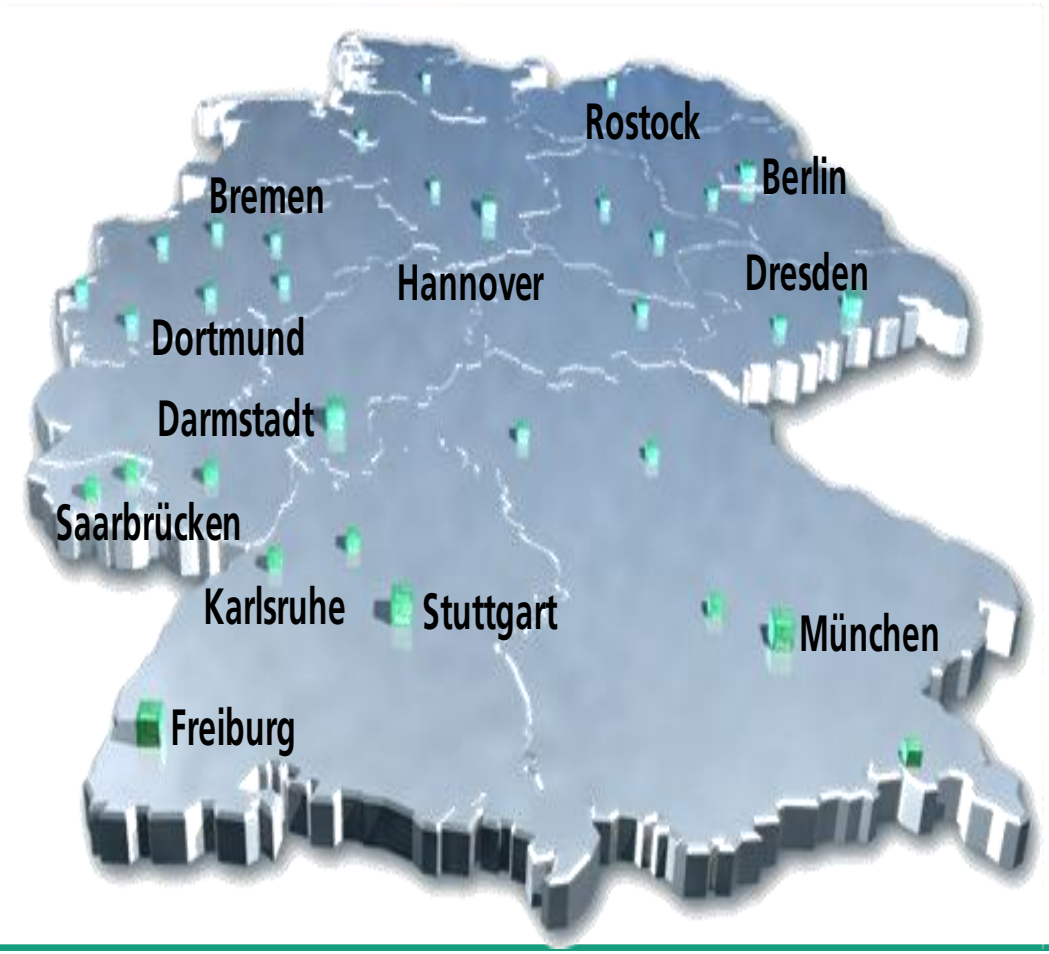
- **Researcher**:
  Discovery of »Fraunhofer Lines«
  in the sun spectrum
- **Inventor**:
  New methods of lens processing
- **Entrepreneur**:
  Head of Royal Glass Factory



The Fraunhofer-Gesellschaft
Head offices in Munich, Germany

- 59 institutes at more than 40 locations
- 17,500 employees
- 1.6 billion € budget





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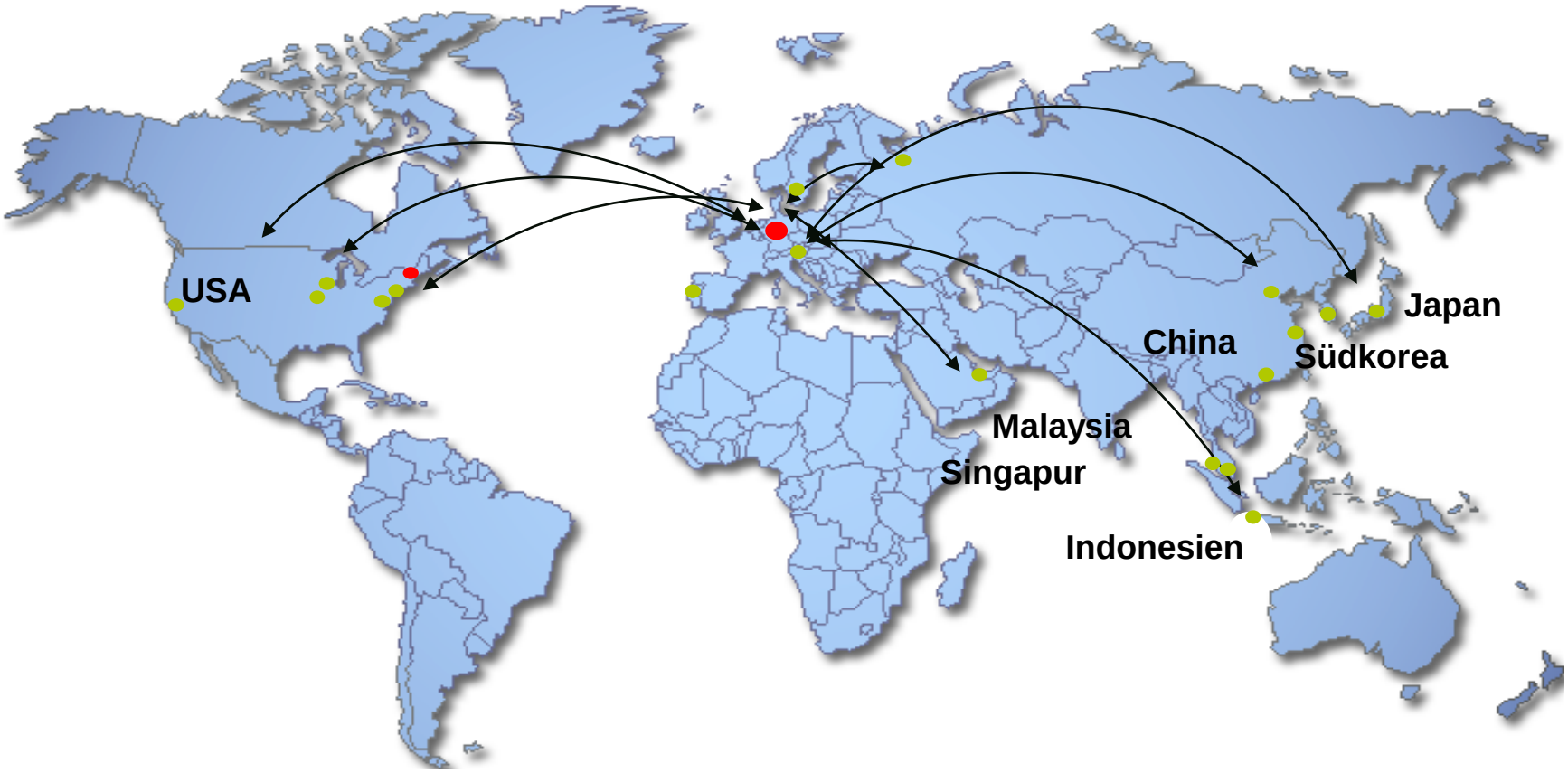
Fraunhofer Research Units Worldwide



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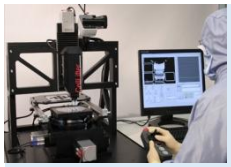
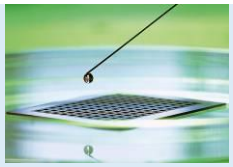
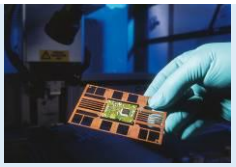
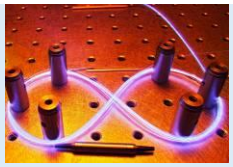
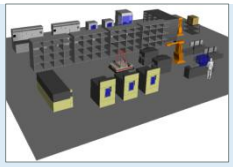
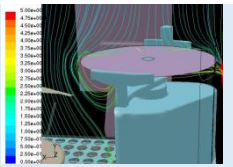
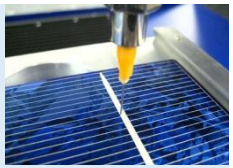
Fraunhofer IPA:
Linking Science and Industry

Universität Stuttgart IF
Institut für Industrielle Fertigung und Fabrikbetrieb

Universität Stuttgart ISW
Institut für Steuerungstechnik der Werkzeugmaschinen und Fertigungseinrichtungen

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Commerce & Industry

Higher education → Research → Development → Realization → Application

Fraunhofer IPA, Stuttgart, Germany

- **Specific laboratories for automization & equipment technology for**
  - Printing technologies
  - Medical Devices
  - Bio, Pharmaceutics, Life Science
  - Digital Facroty (GEM-Lab)
- **Surface technologies**
  - Coating Technology
  - Plating Technology
  - Additive Manufacturing
- **Research for pigments and lacquers**
- **Ultraclean Technologies and Micromanufacturing**
  350 m² Cleanrooms, ISO Classes 1-7
- **Development of automization concepts**
  - Development industrial robots
  - Service robots / assembly
  - Orthopaedics
  - CNT laboratories
  - Assessment systems

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Dept. „Ultraclean Technology and Micromanufacturing“ at a glance

- **Applied research** and development in cleanroom manufacturing
- More than **25 years** of experience and know-how
- 43 scientists and 30 students
- Our customers:
  - **Manufacturers** of miniaturized and contamination critical **products**
  - Device and **equipment manufacturers** in the field of clean, micro and nano productions
  - Cleanroom **planners** and production suppliers

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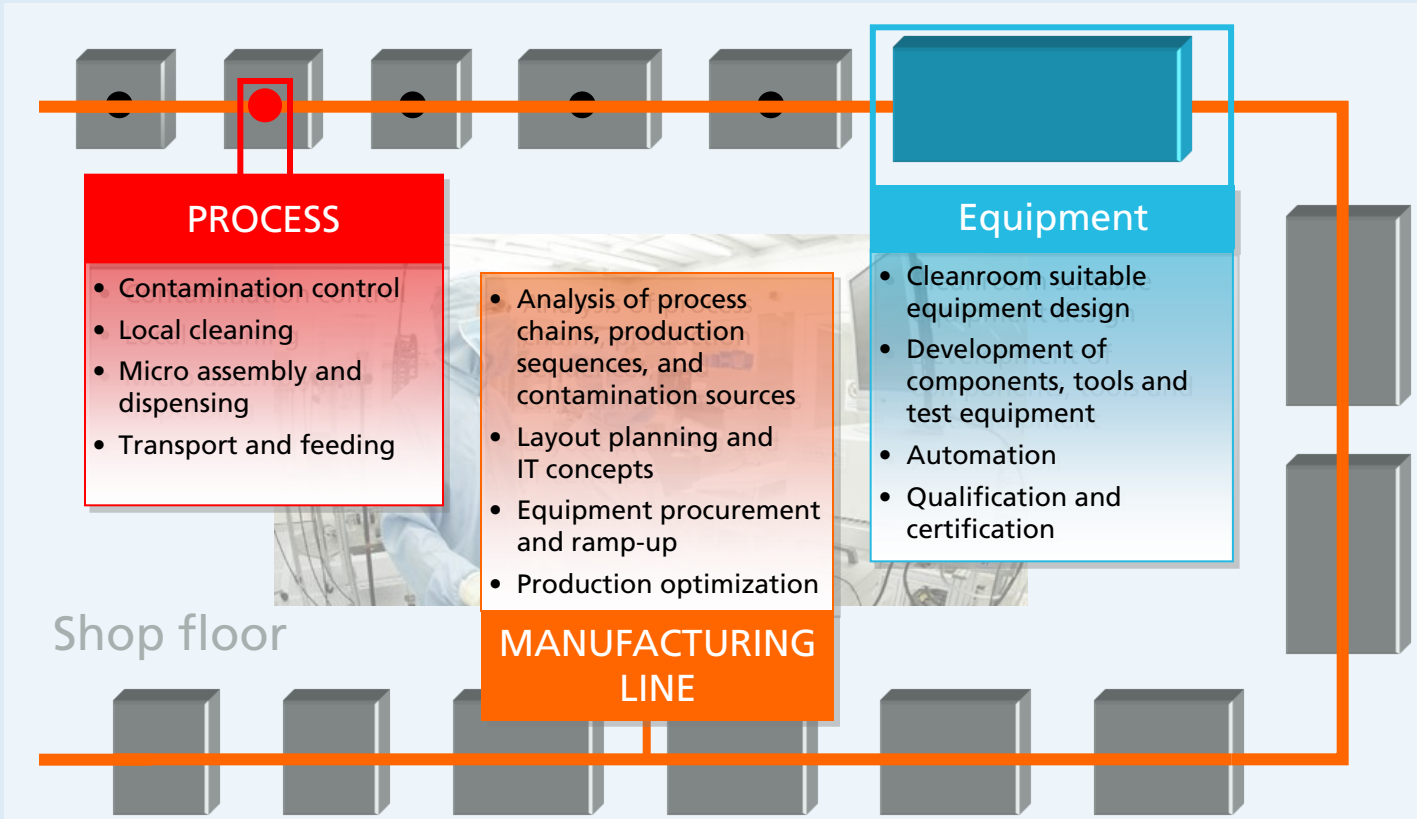
Our services



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Our infrastructure

LABORATORIES

- Cleanrooms ISO 1-7
- Sterile area S1 laboratory
- PV lab
- Micro assembly laboratory
- Simulation laboratory
- Electronic laboratory

MEASUREMENT AND TEST TECHNOLOGY

- Particle detection
- 2D and 3 D microscopes
- Conditioning cabinet
- Micro sensor systems
- LabView based measuring station
- Material test bench
- NanoPhotonics, CNC, ellipsometer, contact angle

SOFTWARE

- Layout and CAD software: Solidworks, Pro-Engineer, ANSYS FLUENT, EAGLE, Heidi
- MES: FactoryWorks, Fab300, MES frameworks
- Simulation: Automod, Autosched, Technomatics
- CASE-Tools: IBM Rose, Enterprise Architect, Codebeamer, Miro.BAS
- Analysis tools / APC: LabView, MATLAB, Catalyst
- Equipment integration: FabConnect, In-house development
- Equipment control: Beckhoff, Siemens

EQUIPMENTS

- Laser structuring equipments (Eximer, …)
- 2D and 3D cleaning equipments (CO_2, laser, plasma, ultra and mega sonic)
- Micro dispensing and micro assembly systems (Sysmelec, Adept)
- Hardening systems (UV technology, heating cabinet, heat radiator)

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Project specific tasks: LuminaLED Lab 1

Realization of adapted cleanroom environment

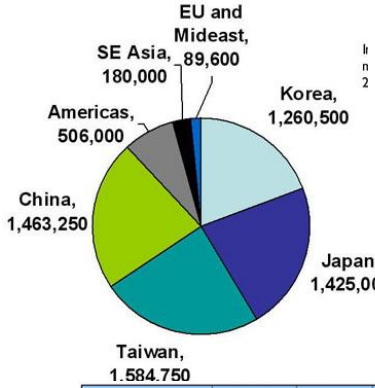




Advantages of LEDs

- LEDs are increasingly used for lighting
  - lower energy consumption
  - longer lifetime
  - improved robustness
  - smaller size
  - faster switching
  - greater durability and reliability
- ➢ LED production is a **fast growing market** with a high potential for innovative developments.

consumer LED lamps



Installed capacity in wafers per month (in 2" equivalents, 4Q-2011, forecast)

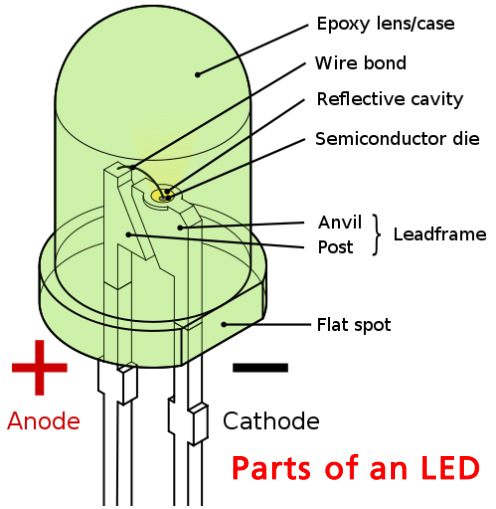
Country/Region	2010	2011	2012
Europe & Mideast	2	2	
China	12	18	13
Americas	1	1	
SE Asia			2
Taiwan	2	3	
Korea		2	
Japan	2	1	
Grand Total	19	27	15

LED Fabs Start Operation

courtesy: http://semi.org/node/36821

Fraunhofer IPA specific project tasks 1/2

- LEDs are semiconductor light sources
- production sensitive in regard of **contamination**:
  - Particles, ESD, AMC
- production as well as research and development in this field relies strongly to suitable **clean production concepts**:
  - consisting of a clean production environment (cleanroom)
  - clean production equipment
  - clean logistic/personnel flows & clean processes
  - product tracking systems
    - LIMS – **L**aboroatory **I**nformation **M**anagement **S**ystem



Parts of an LED

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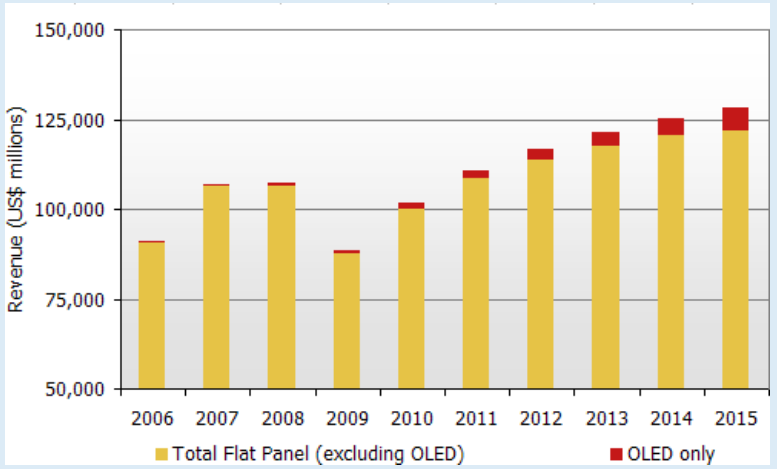
Fraunhofer IPA specific project tasks 2/2

- Main project goals:
  - realize **competitive** and **future-proof clean environment** for **research & pilot production**
  - cleanroom with **all subcategories** to be realized (incl. pipings, electricity, hardware components, cleanroom walls, ceilings etc.)
  - development and implementation of **manufacturing concept** (incl. material management, equipment management and process control)
  - cleanroom to be **ready-for-use** after project duration of **10 months**
  - cleanroom to be build up in a way that all **existing facilities, supply systems and components** (walls, gas, water, electricity, etc.) **will be used** as much as possible
  - **turnkey cleanroom** solution: reflecting and even **exceeding current state of the art**
- For future demands (e.g. **OLED production)**: area of highest cleanliness level of **ISO class 1** with laminar flow to be build up

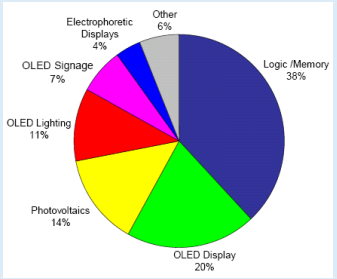
Outlook to the future:
ISO Class 1 cleanroom for OLED challenges

- Global market forecast OLED lighting: multibillion dollar market within few years (~ **37% growth per year**)
- Organic Photovoltaics:
  Still a market in starting position

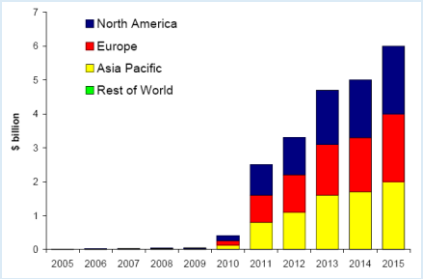
- Market shares in IDTechEx study:
  330 billion US$ in 2027
- Most important markets
  - Logic / Memory
  - OLED-Display
  - Photovoltaics



Displaysearch; OLED revenue 2015: 6 billion $



IDTechEx study



International OLED market forecast

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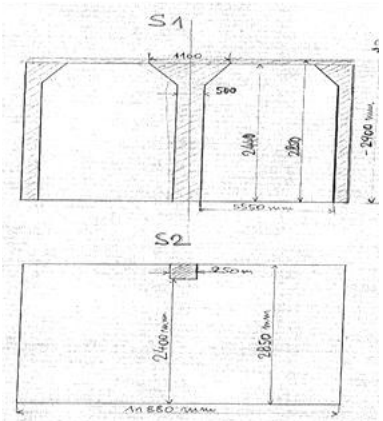
Key Players within LuminaLED

- **Microelectronica S.A.**
  - business idea, product, customers
- **ASM International N.V.**
  - Equipment (e.g. wirebonder, assembly, encapsulation)
- **Fraunhofer IPA** (Dept. Ultraclean technolog and micromanufacturing)
  - conception, layout, building infrastructure, material flow, material engineering, cleaning technologies, COO, MES-systems layout, lot & product tracking, contamination control, determination of LED-efficiencies , qualification and certification of installed cleanrooms

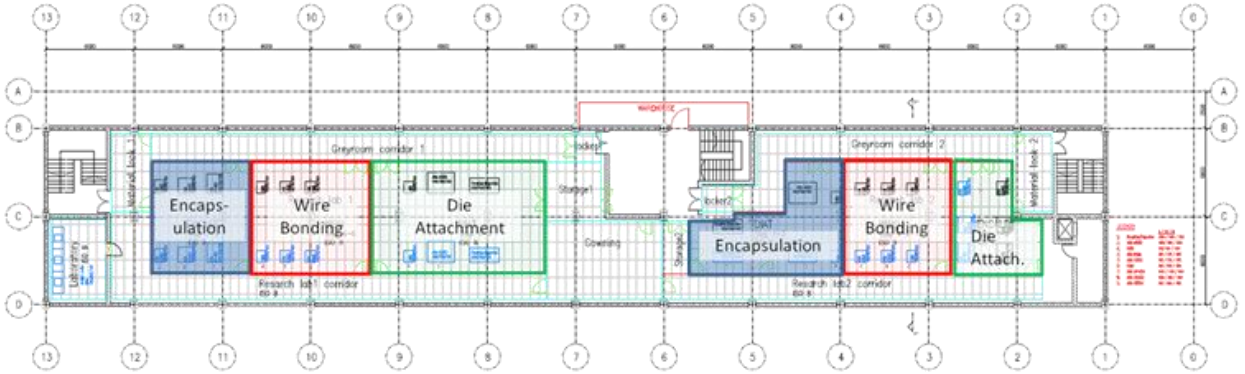
Project data

- Project name and number: LuminaLED #1015/2010
- Project description:
  Setting-up the LED Laboratory for the National Car Industry
- Financing Authority:
  EU Structural Funds through Romanian Authority for Research
- Project dimension: around 17 million €
  - Required financing from EU: around 10 million €
  - Co-financing: around 7 million €
- Market targeted: car industry manufacturer (Renault, Dacia etc.)
- product: back side lamp of the car
  (for current and future electrical vehicle)
- technology LED: SMD, K2, ceramic

Starting point;
Manual sketches, conceptual & rough planning

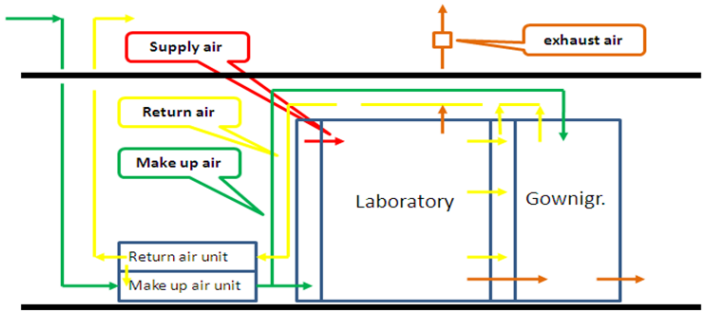


Manual sketches



Conceptual planning “cleanroom modules”

“as-built” situation



Rough planning “air handling”

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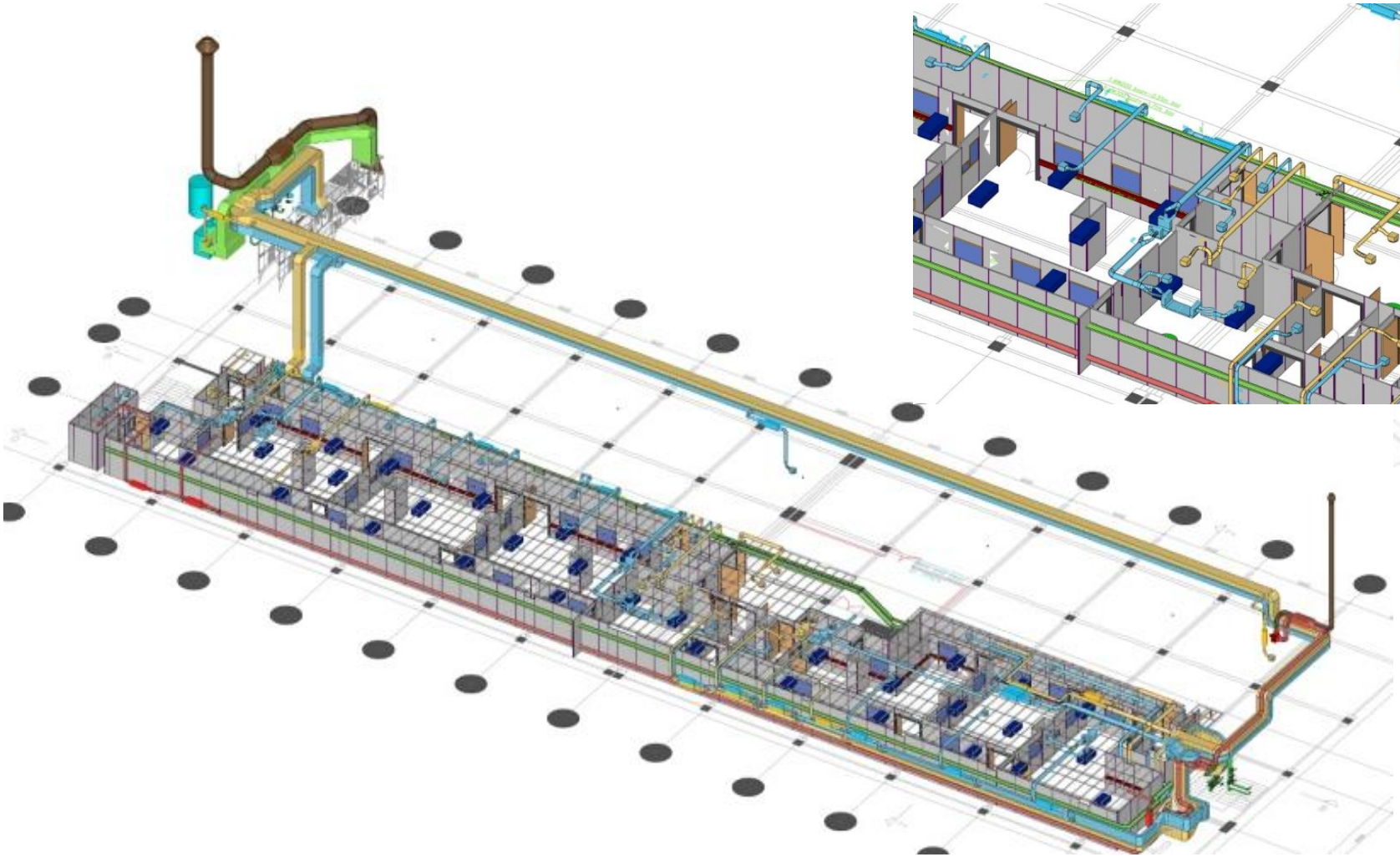
Realization; cleanroom ready-for-use: 700 m² ISO 8 & 40 m² ISO 1



Conclusion

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- possible “problem solver” that brings latest research results to industry
- **applied research**:
  - SMEs (as they can’t afford research equipment of their own)
  - companies in new technological fields
- **transfers latest research results** into industry
  - newest production technology into applications
  - lifting regional production facilities to higher level
- **LuminaLED project**
  - starting point for ongoing / further collaboration