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Czech Technical University in Prague
Faculty of Civil Engineering 土木工程学院
Department of Microenvironmental and Building Services Engineering
微环境和建筑服务工程系

Seminar

讲座

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Indoor Environment in Energy Efficient Buildings

节能建筑的室内环境

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Federation of European Heating, Ventilation and Air-conditioning Associations

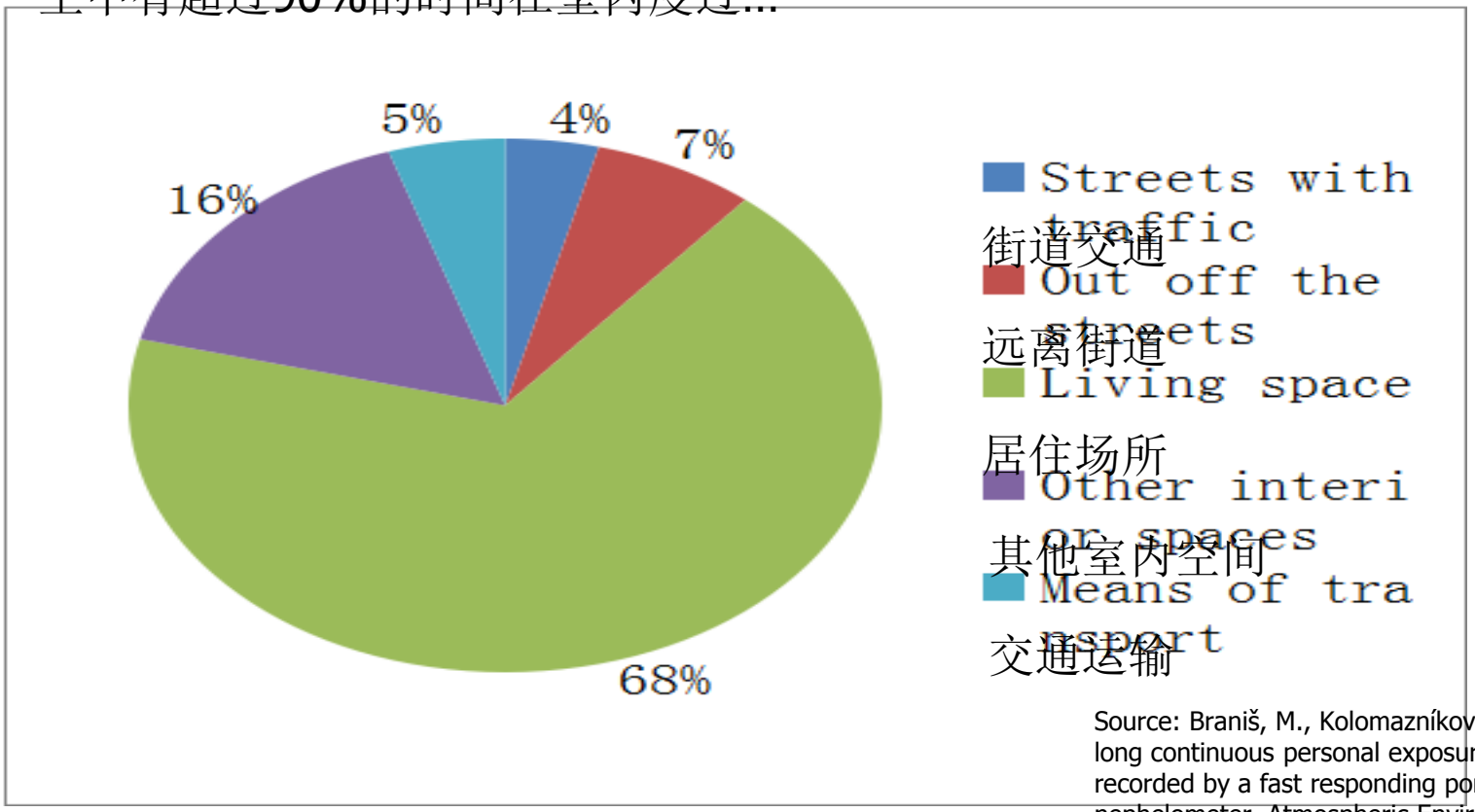
欧洲供暖、通风与空调协会

Indoor environmental quality
室内环境质量

Indoor Environment of Buildings
建筑的室内环境

Up to 90 % of our life we spend indoors… (SZÚ 2012)

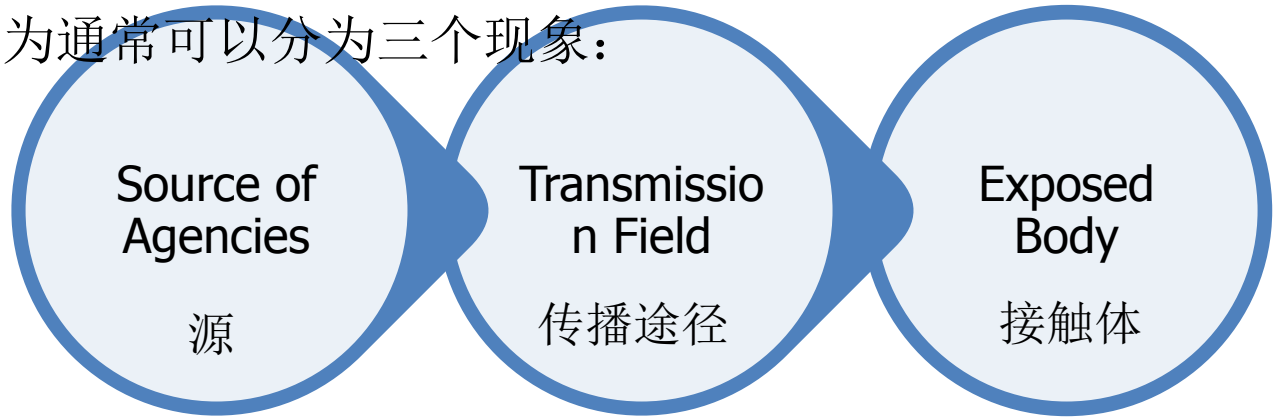
一生中有超过90%的时间在室内度过…



Source: Braniš, M., Kolomazníková, J. (2010) Year-long continuous personal exposure to PM2.5 recorded by a fast responding portable nephelometer. Atmospheric Environment 44(24): 2865-2872

Indoor Environment of Buildings
建筑的室内环境

- The indoor environment is the environment inside buildings. It is generally a physical reality that surrounds a living organism with which it interacts and which contributes to his physical condition constantly.
- It can be generally considered as a set of three phenomena, which are:
- 室内环境是建筑内的环境。 它通常是有机生物体周围的物理条件，并且二者之间相互作用与影响的结果。
- 它被认为通常可以分为三个现象：



Agencie *: homogeneous component of physical reality, creating flows and affecting exposed body* 物理现实中均质的组分；产生流动和影响接触体

Exposed Body*: human, animal, plant, machine or other entity responding to environment* 人体，动物，植物，机器或者其他与环境有关的实体

Agencie	Transmission Field	Exposed Body (Part)
Toxic substances(有毒物质)	Air(空气)	respiratory tract(呼吸道), skin
Aerosols(气溶胶)	Air	respiratory tract, skin(皮肤)
Mikrobes(细菌)	Air	respiratory tract, digestive tract(消化道), skin
Odours(恶臭气体)	Air	respiratory tract(呼吸道)
Water vapor (水蒸气)	Air	respiratory mucosa(呼吸道粘膜), skin
Heat(热)	Air, contact bodies(接触体)	respiratory tract, skin
Light(光)	Space(空间)	Visual system(视觉系统)
Acoustics waves(声波)	Air	Auditory system(*听觉系统*)
Ionizing radiation(电离辐射)	Space	internal organs without feedback(无反馈的内脏)
Ions in the air(空气中的离子)	Air	respiratory tract
Static(静电)	Space	skin
Other electromagnetic waves(其他电磁波)	Space	internal organs without feedback

Indoor Environment of Buildings
建筑的室内环境

- Ind. Environment influences:
  室内环境的影响：
  - Health 健康
  - Productivity 生产力
  - Comfort 舒适

J. Adam Huggins for The New York Times 26.7.2007

Indoor Environment of Buildings
建筑的室内环境 =

Internal Microclimate
内部的微气候 =

Indoor Environment (IE)
室内环境

Perception of IE
室内环境的认知

- Reaction of organism to the environment:
  有机体对环境的反应：
  - efforts to eliminate adverse effects in order to achieve **comfort** 努力消除负面影响以达到舒适
    - Conscious – e.g. taking a sweater on, closing window, running blinds 自觉行为-即，穿衣服，关窗，调整百叶
    - Subconscious – e.g. sweating, shaking, eye accommodation 潜意识的-即，流汗，颤抖，眼睛调节
  - Short-term X long-term effects
    短期与长期的影响

Environmental Comfort

环境的舒适性

„State of mind expressing satisfaction with the environment“

(Fanger 1970 - ASHRAE)

„精神状态表达了对环境的满意程度“

„Feeling of well being physically and mentally“ (European passive solar handbook)

„感觉良好是身体和精神上的感觉“

„Indoor environmental quality is related to coexistence of thermal comfort, visual comfort, indoor air quality and acoustic comfort.“ (Rehva Guidebook 13)

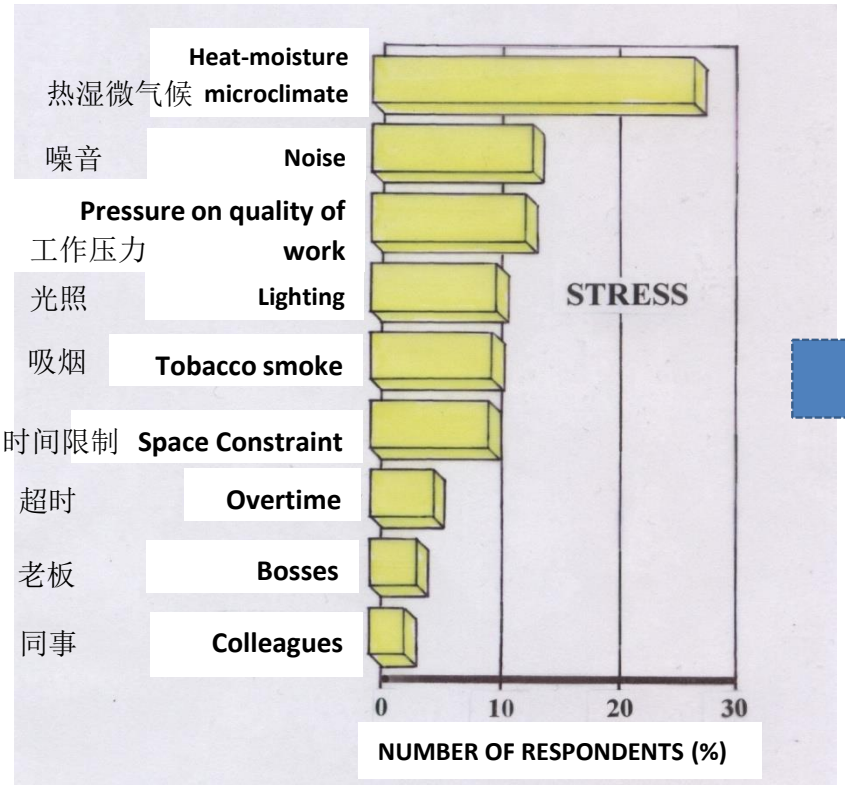
„室内环境质量是有关热舒适，视觉舒适，室内空气质量和声舒适的共存“

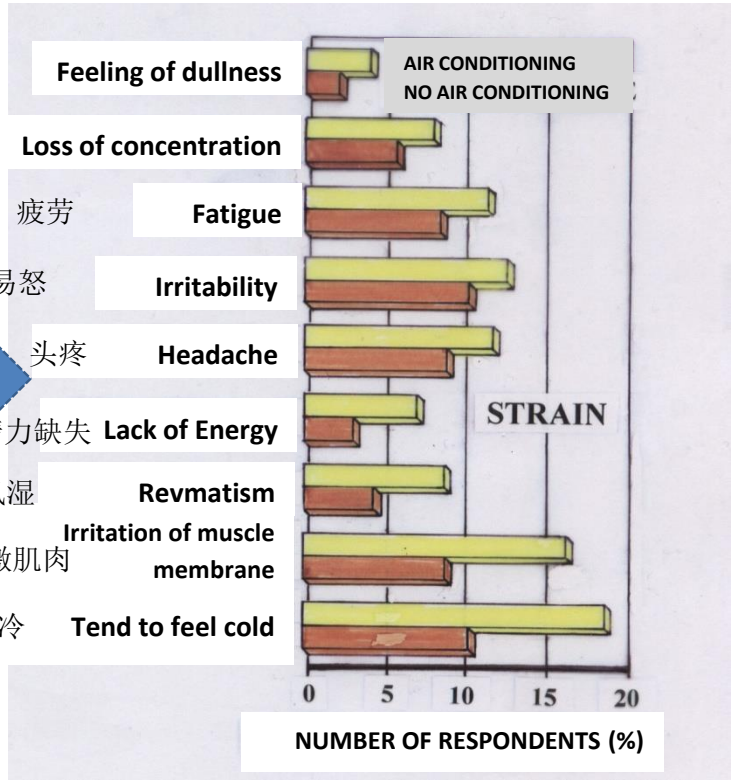
Indoor Environment

室内环境

Stress - evokes a response of the organism - **strain**

压力-唤起一个有机体的反应-**紧张**





Factors forming the resulting state of the environment

形成环境最终状态的因素

Physical factors of the environment 环境的物理条件

- Temperature 温度
- Humidity 湿度
- Air velocity 风速
- Air quality 空气品质
- Lighting 光照
- Noise 噪音
- Radiation 辐射
- Space 空间

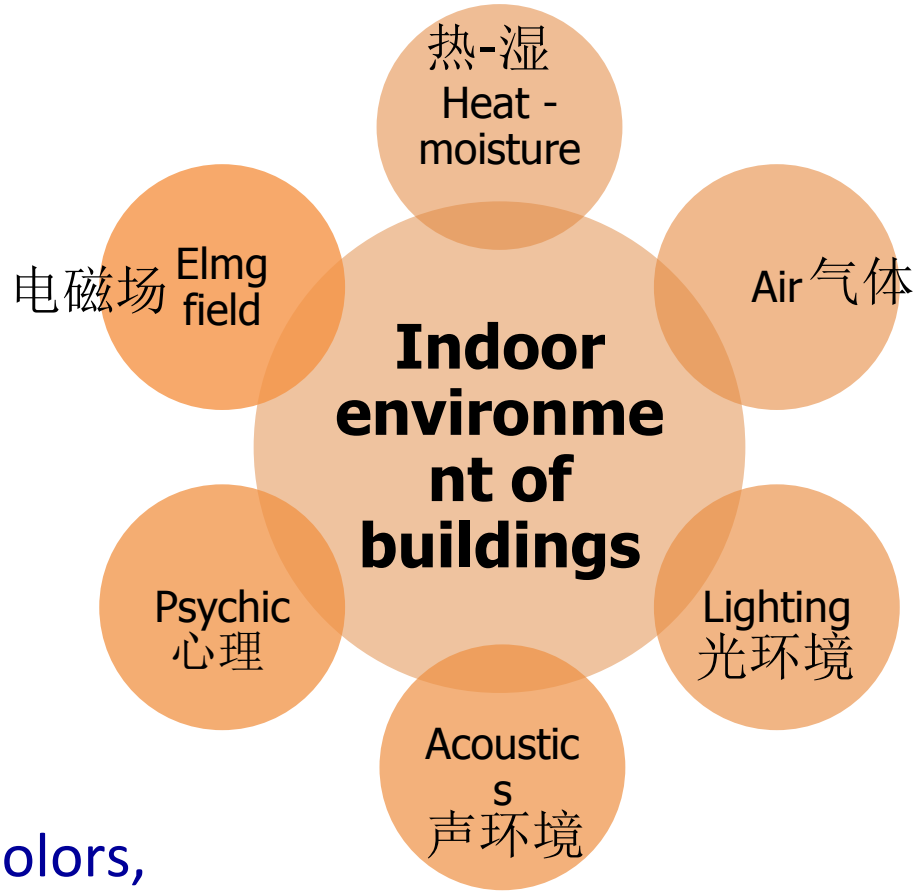
Factors of the organism 有机体的因素

- *Age* 年龄
- *Sex* 性别
- *Rhythmicity - breathing, heart rate, body temperature, menstrual cycle ...* 节律性，如：呼吸，心跳，体温，月经
- *Psychological factors - state of mind, introvert / extrovert ...* 心理因素：如，思维状态，内向/外向
- *Biological processes - digestion, sleep, work, rest, sex ...* 生物进程：消化，睡眠，工作，休息，性

Indoor Environment of Buildings
建筑的室内环境

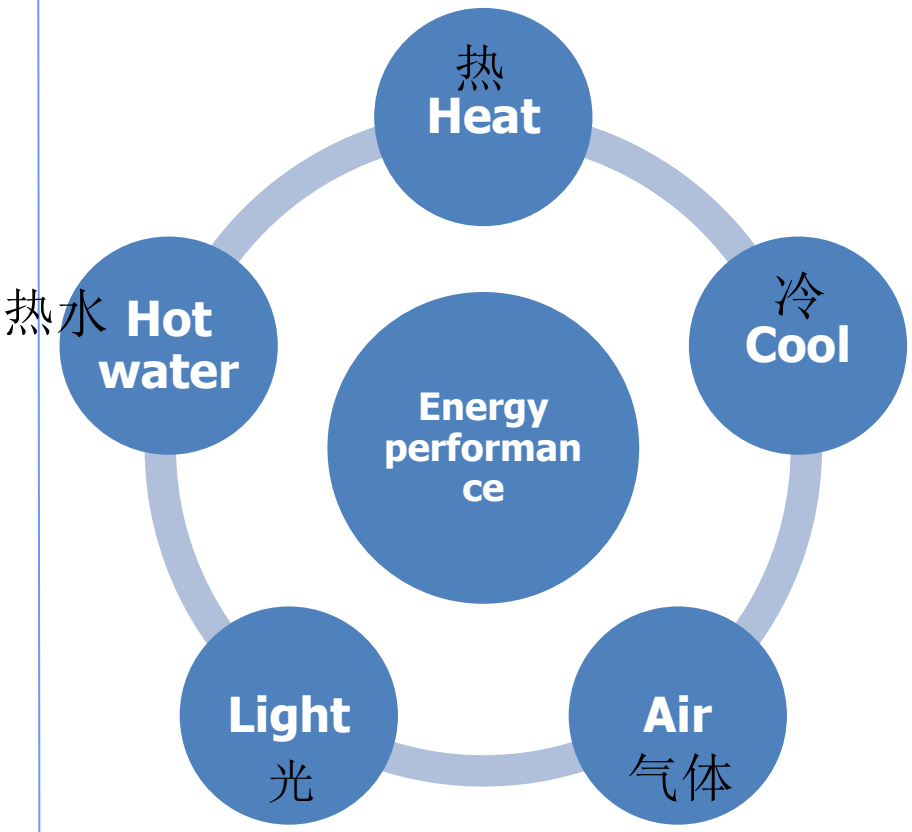
Components of IE 构成元素：

- **Heat - moisture** 热-湿
- **Air quality** 空气品质
  - **gases** 气体
  - **aerosols** 气溶胶
  - **microorganisms** 微生物
- **Acoustics** 声环境
- **Lighting** 光环境
- **Electro -static, -ion, -magnetic, ionizing and radiation field** 电磁场
- **Psychological comfort** (colors, surfaces, architecture ...) 心理因素



Source : Jokl 1986

Energy performance of building
建筑的能效表现

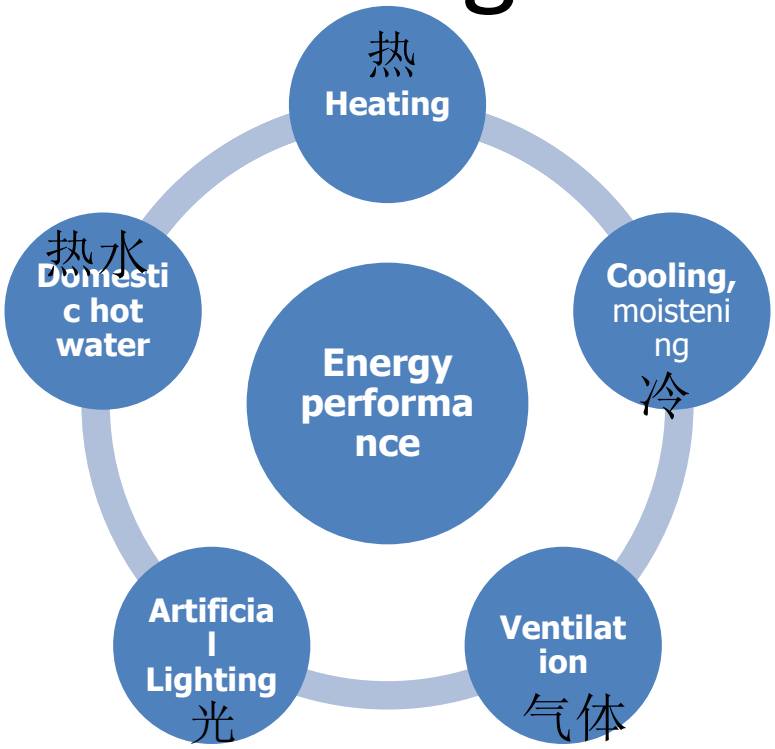


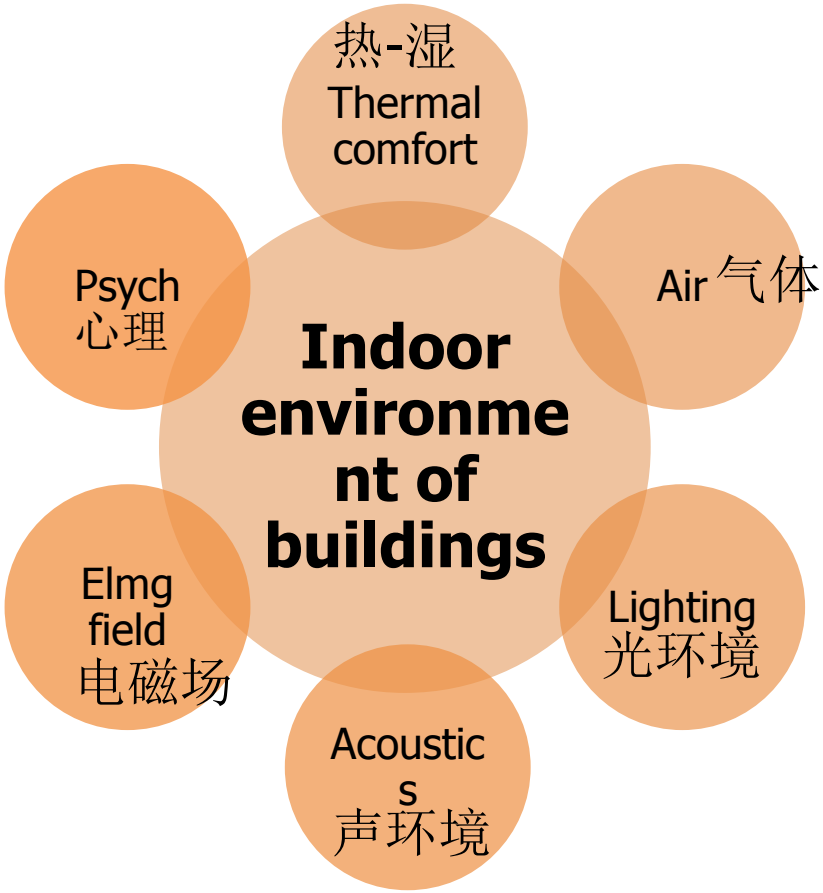
… means the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, **inter alia**, energy used for:

- **–Heating**
- **–Cooling**
- **–Ventilation**
- **–Hot water**
- **–Lighting….**

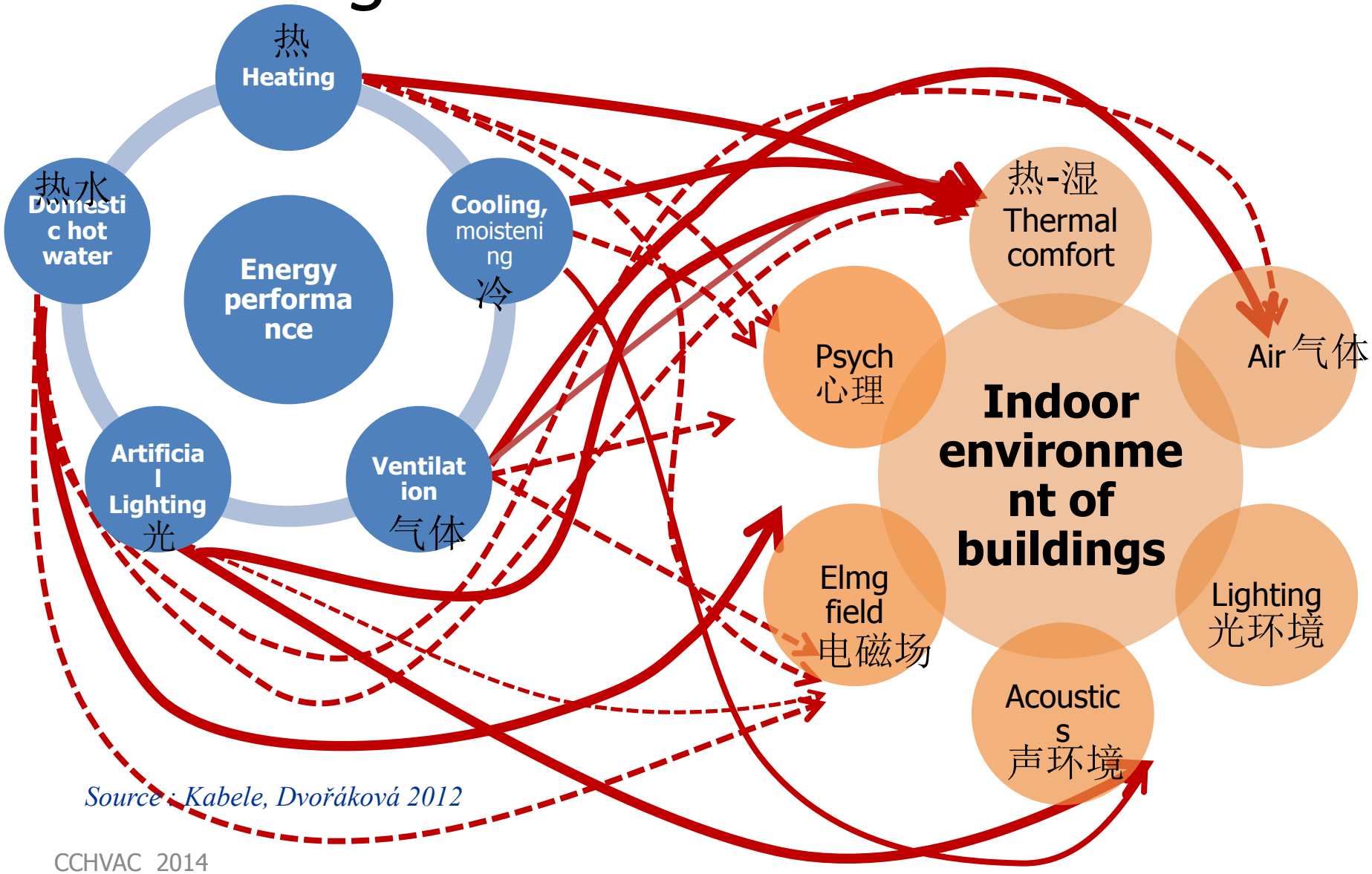
Source: DIRECTIVE 2010/31/EU

Building and Indoor Environment...





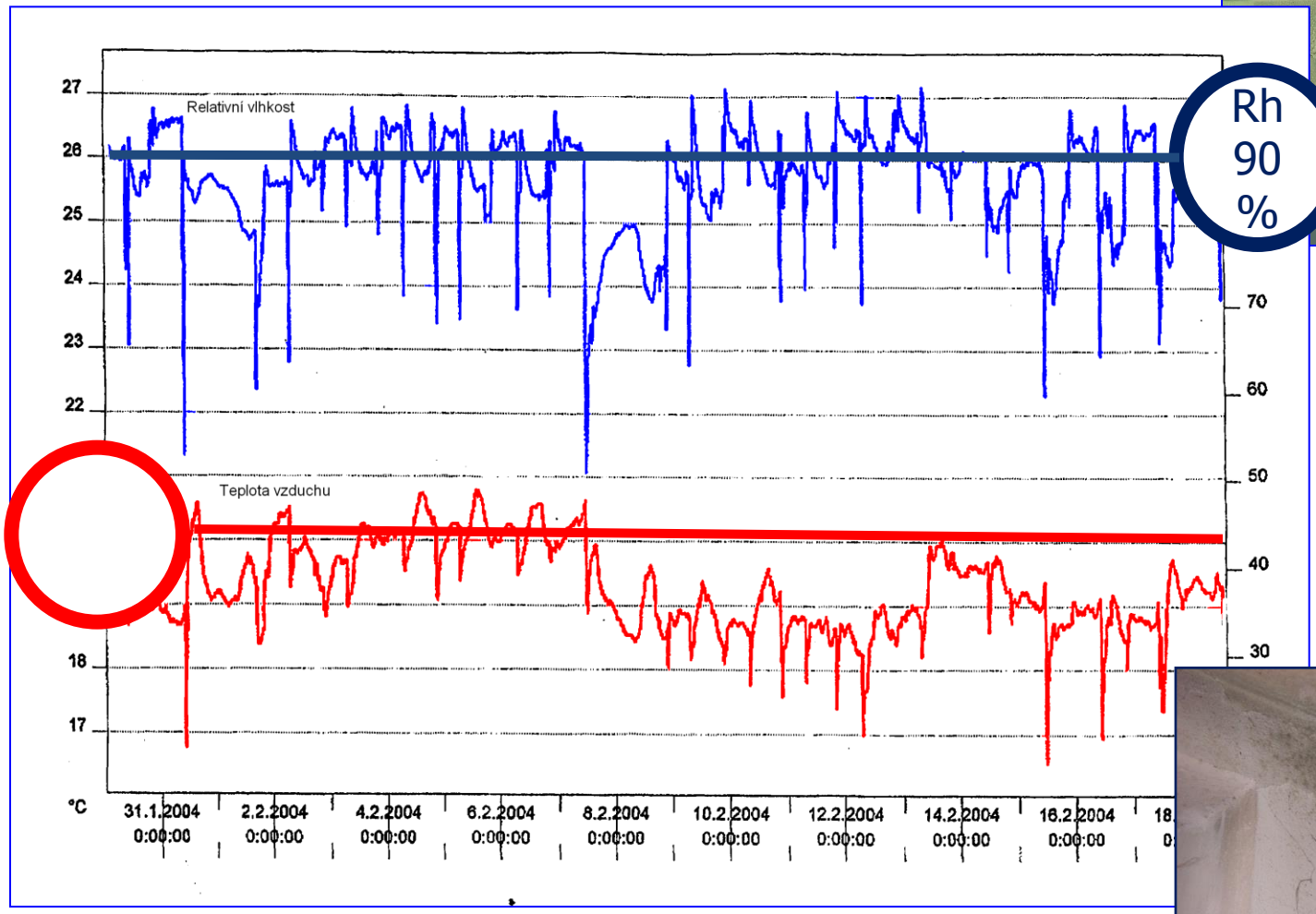
Building and Indoor Environment...



Source : Kabele, Dvořáková 2012

例子：“能源意识”用户行为的结果：

Example: a consequence of "energy conscious" user behavior



Source : Kabele 2006

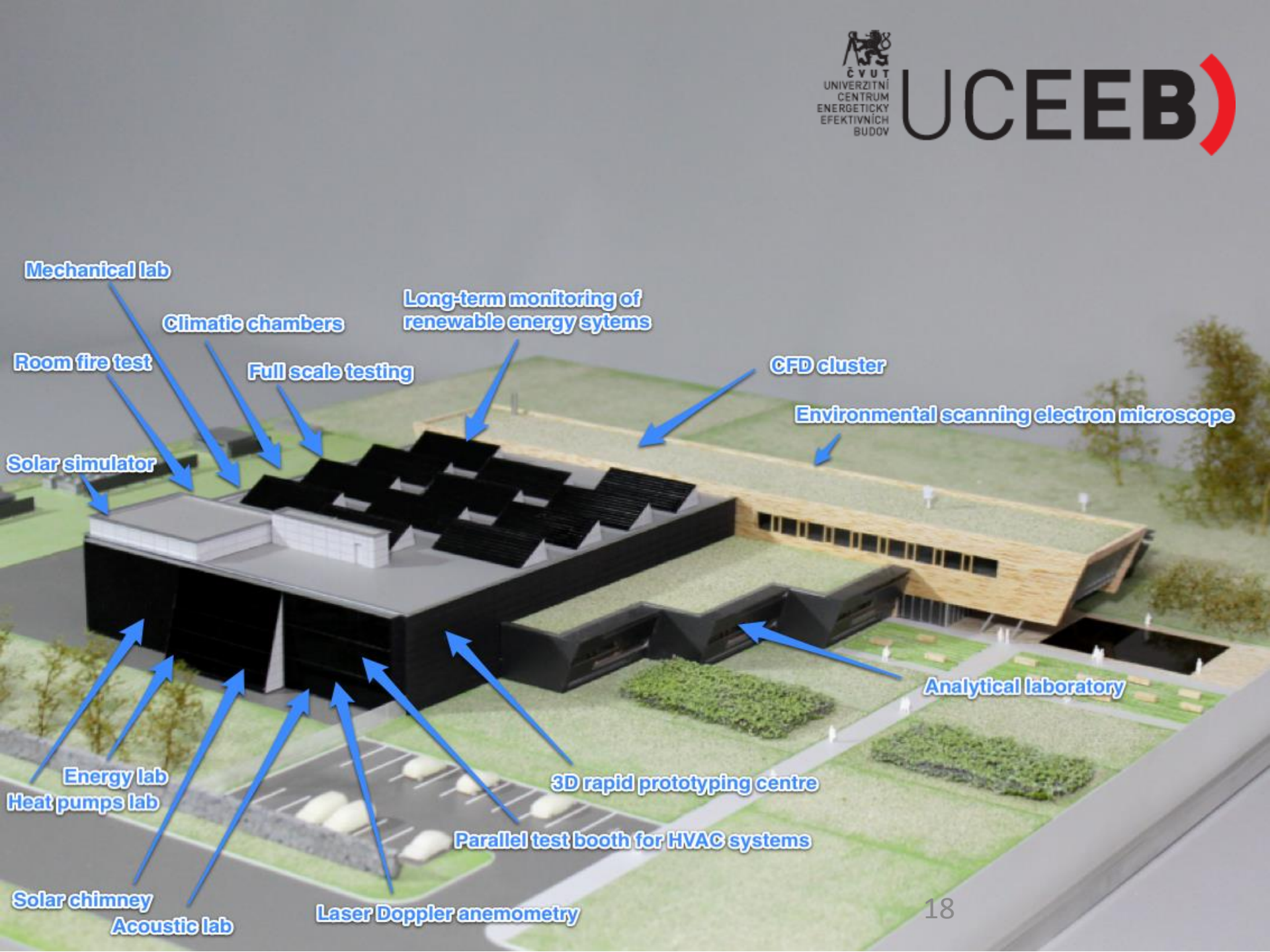
RESEARCH
研究

大学建筑节能研究中心，是捷克技术大学布拉格分校的一个跨学科的研究机构。 主要关注与环保高能效的建筑并提供健康的室内环境。

University Centre for Energy Efficient Buildings (UCEEB) *is an interdisciplinary research facility of the Czech Technical University in Prague. The main focus is on environmental friendly energy efficient buildings providing healthy indoor environment.*

ČVUT UNIVERZITNÍ CENTRUM ENERGETICKY EFEKTIVNÍCH BUDOV

UCEEB



Research groups
研究小组：

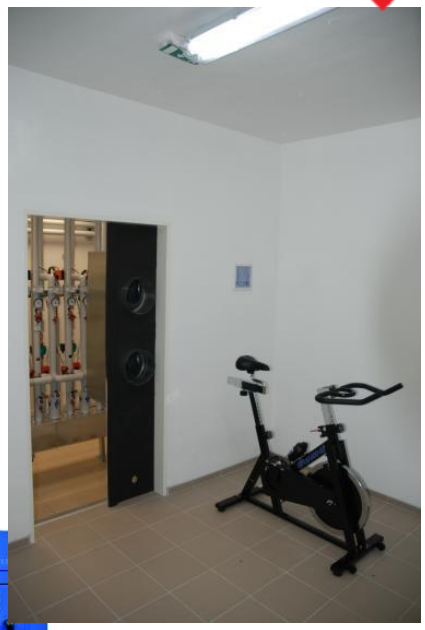
- Architecture and interaction of buildings with environment
  建筑，环境与建筑的相互影响
- Energy systems of buildings
  建筑的能源系统
- **Quality of indoor environment**
  室内空气品质
- High performance building materials and structures
  高性能的建筑材料
- Monitoring, diagnostics and smart control of buildings
  建筑的监测、诊断与智能控制

Quality of indoor environment

室内空气品质

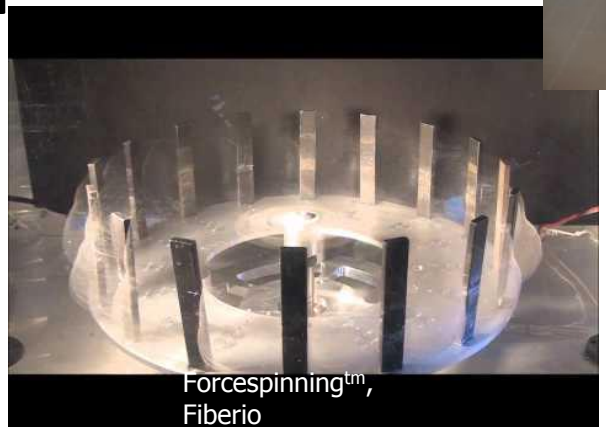
- **Lab of IEQ**

  室内空气品质实验室



- **Lab of advanced nanomaterials**

  纳米材料实验室



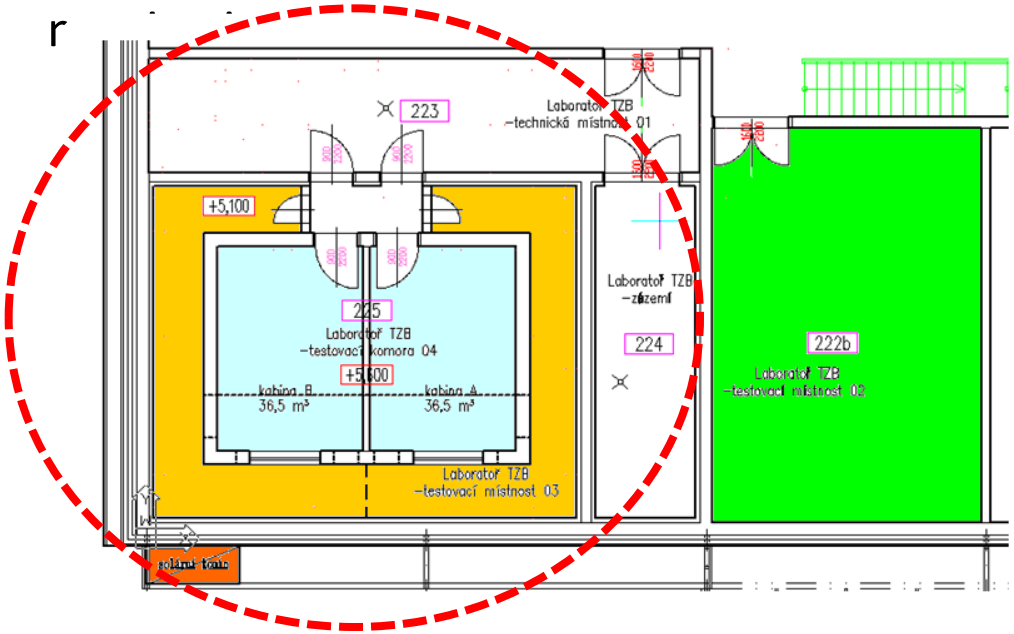
- **Lab of intelligent personal healthcare**

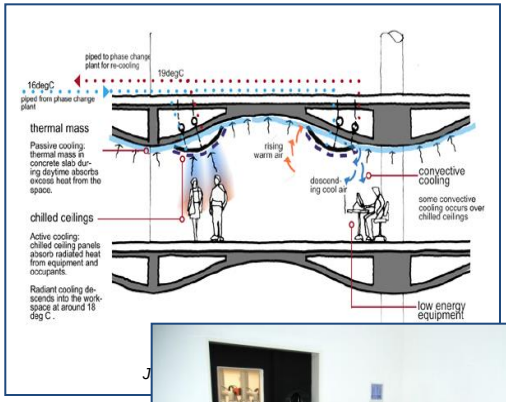
  智能个人健康护理实验室

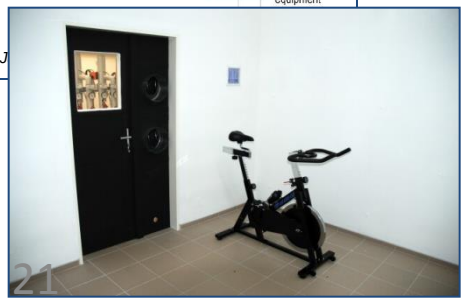
Quality of indoor environment 室内空气品质

LABORATORY OF IEQ

- **Parallel test booth** for IEQ systems testing. Box in box system - two identical chambers 4 x 5 x 3 m in the climatic box chamber with controlled thermal conditions simulating ambient (-20 ° C up to +40 ° C). Optimisation and full-scale testing of low energy heating, cooling and ventilation systems in different environmental conditions. Monitoring temperature, humidity, CO_2, VOC, PIV anemometry for air distribution pattern visualisation. Indoor environmental comfort and air quality r



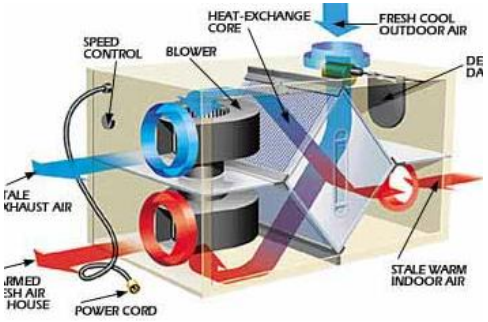


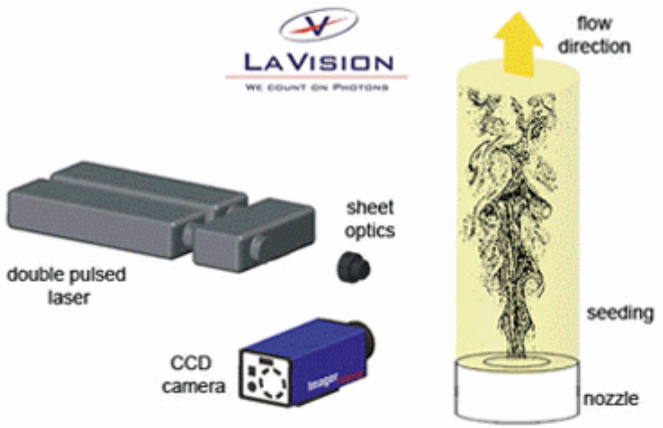


Quality of indoor environment 室内空气品质

LABORATORY OF IEQ

- **Lab of hybrid ventilation** with solar chimney for advanced low energy ventilation systems development and testing. 混合送风实验室
- **Test bed for small air-handling** units with monitoring system. Testing of heat recovery units, filters, fans, exchangers efficiency and optimisation 小型空气处理实验床
- **Particle Image Velocimetry**激光离子测速技术
- **Themal manikin** 暖体假人





Quality of indoor environment

LABORATORY OF IEQ

Czech Technical University in Prague
Faculty of Civil Engineering
Department of Microenvironmental and Building Services Engineering

Thank you for your attention

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