TECHNISCHE UNIVERSITÄT DRESDEN

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Vacuum Technology WS 20/21 Virtually presented Lecture 1, Oct. 27 2020

Prof. Dr. Johann W. Bartha

Inst. f. Halbleiter und Mikrosystemtechnik
Technische Universität Dresden

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VIDEO CAMPUS SACHSEN

VT L01 a 13:59

About the instructor

CV: Johann W. Bartha

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Prof. Dr. Johann W. Bartha received a Diploma and PhD. degree in solid state physics at the University of Hannover, Germany. He was two years Post Doc at the IBM T. J. Watson Research Center Yorktown Heights, N. Y. were he investigated Metal Polyimide interfaces for applications in multi layer ceramic packaging. 1985 he joined the IBM German Manufacturing Technology Center (GMTC) at Sindelfingen Germany as staff member and became responsible for plasma based technologies in semiconductor processing as a senior staff member. 1994 he accepted a professorship at the University of Applied Sciences at Münster, Germany where he established a laboratory for micro manufacturing. 1999 he accepted a C4 professorship as head of the chair for Semiconductor Technology at the Dresden University (TUD). From March 2003 to April 2019 he was director of the Institute of Semiconductor- and Microsystems technologies at TUD and established a strong collaboration between Dresden University and the local semiconductor Industry. The research focus at his department was BEOL processing (PVD, ECD, CMP) including barrier characterization. He established in situ monitoring techniques for atomic layer deposition in the cleanroom lab. Since 4/2019 he is retired but continues acting as senior professor at IHM.

Prof. Bartha is member of the DPG (German physical society), and foundation member of the Silicon Saxony association. He was co-organizer of several international conferences in the field of microelectronics (IITC – International Interconnect Conference, European AEC/APC, ICPT 2007 – Int. Conf. on Planarization Technology, IWFIPT 2007, MRS Spring Symposium on CMP 2004 and 2010) and co-founder of the Dresden Summer School Microelectronics. He was non voting member in the board of the FhG-CNT until 2009 (a joint R&D organization of AMD, Qimonda and Fraunhofer) and was head of the NaMLab gGmbH scientific board (materials research company owned by TUD) until 2018.

L01

Further organizational stuff

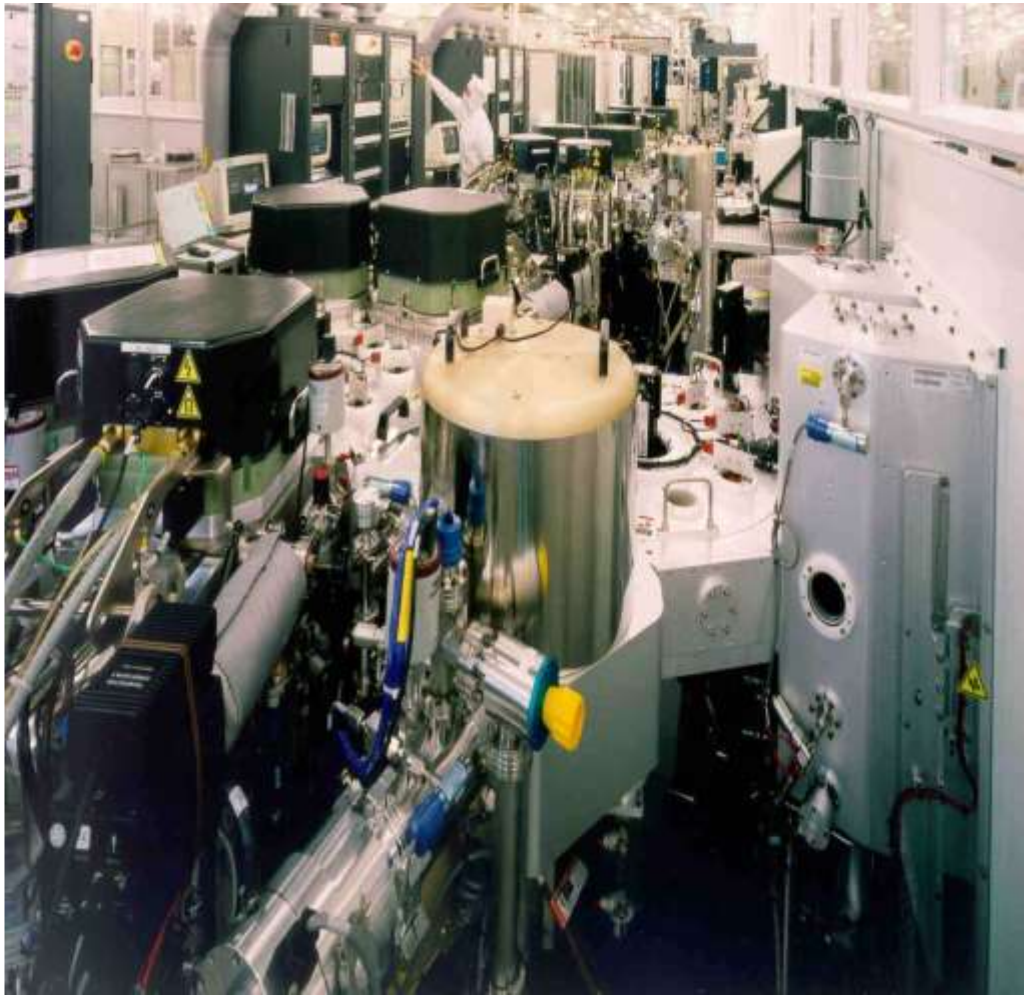
- **Literature:**
  I will distribute later a booklet (pdf) containing much of the content. I am not aware of a book, that matches with the lecture as assembled here.
- **Examination:**
  If the number of students to be examined exceeds 20 (currently the case!), the exam will be held as written test.
- **Consultation:**
  I will invite within the next few weeks to a consultation as ZOOM conference. In urgent cases do not hesitate to contact me via e-mail!

(Johann.Bartha@tu-Dresden.de)

0. Introduction

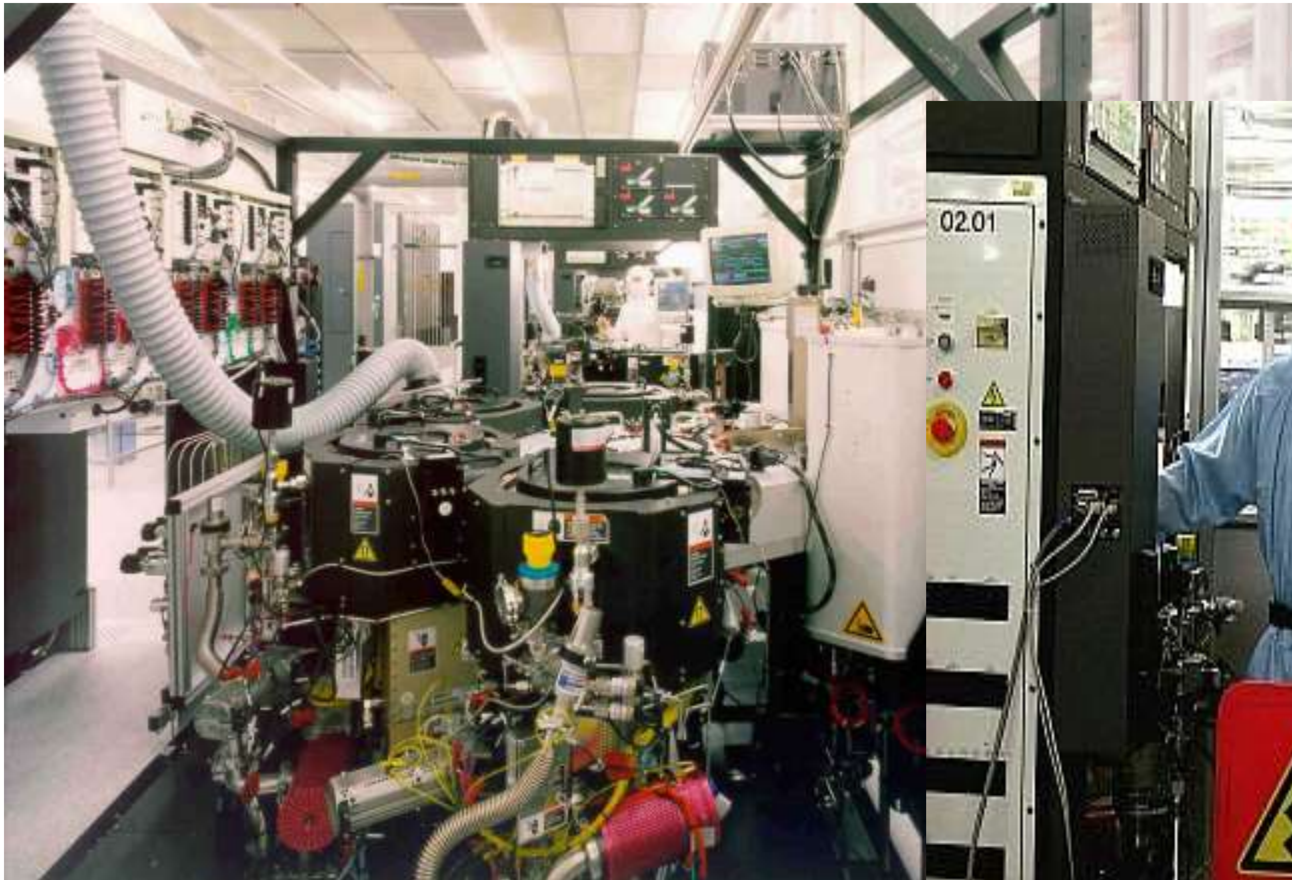
- Vacuum techn. & relation to semiconductor manufacturing
- some history
- back to manufacturing

IC - Production: Workplaces - IFD P200



LO1

Man & Production: Workplaces - IFD P200



LO1

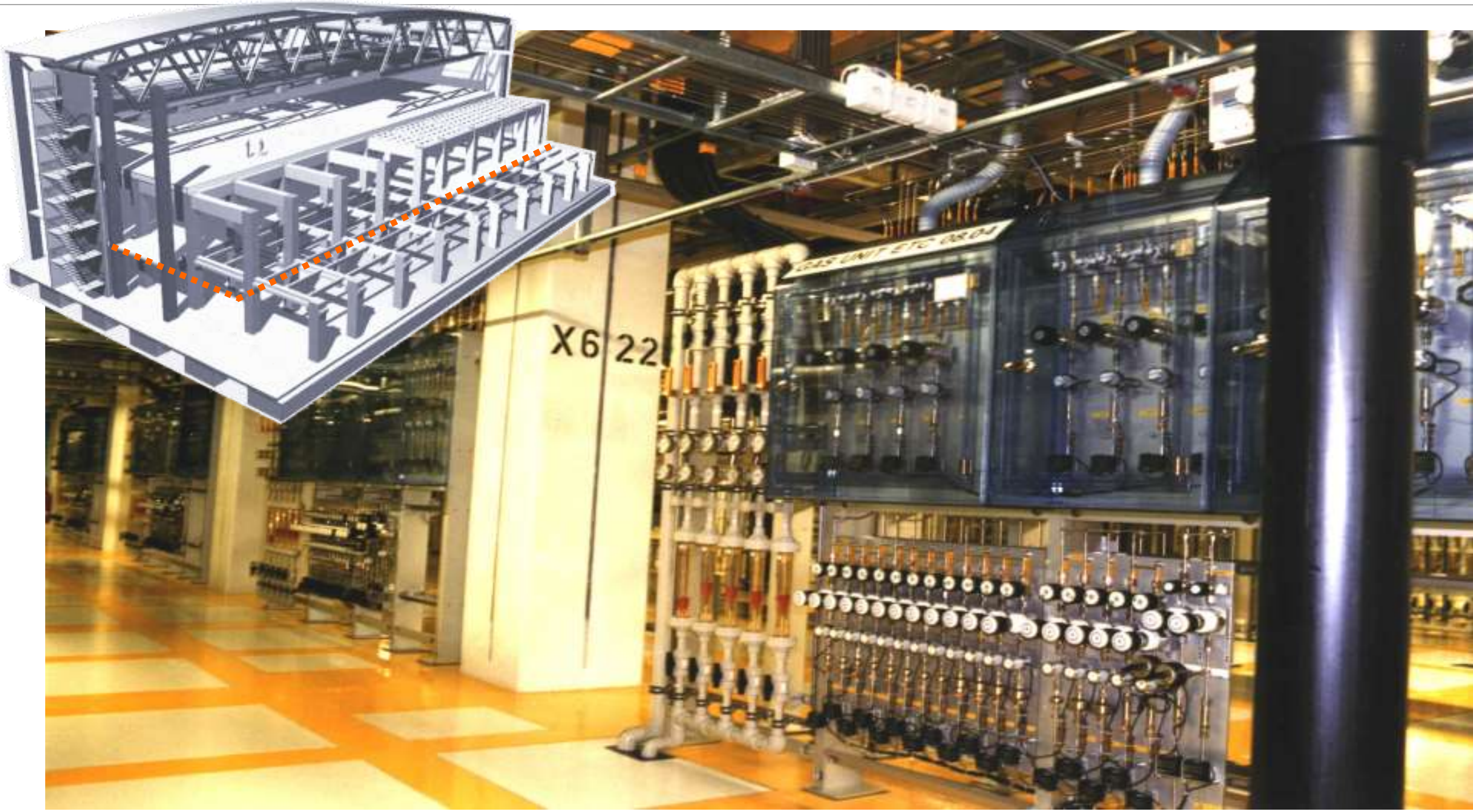
„OPEN“ - Cleanroom - IFD P200 - Production Bay

LO1

Cleanroom - Clean Subfab Area 5m high - Air Return

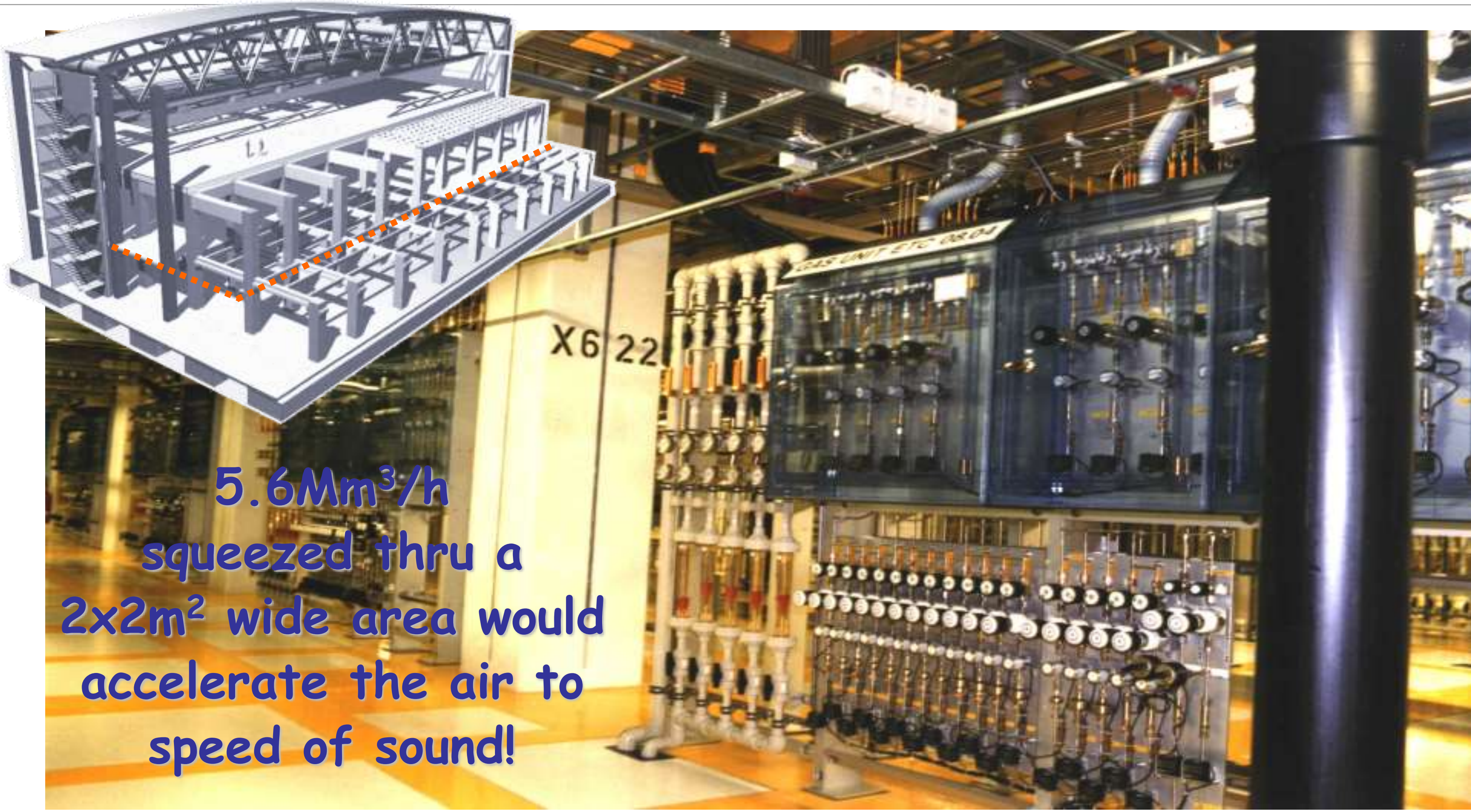
LO1

Cleanroom - Clean Subfab Area 5m high - Air Return



LO1

Cleanroom - Clean Subfab Area 5m high - Air Return



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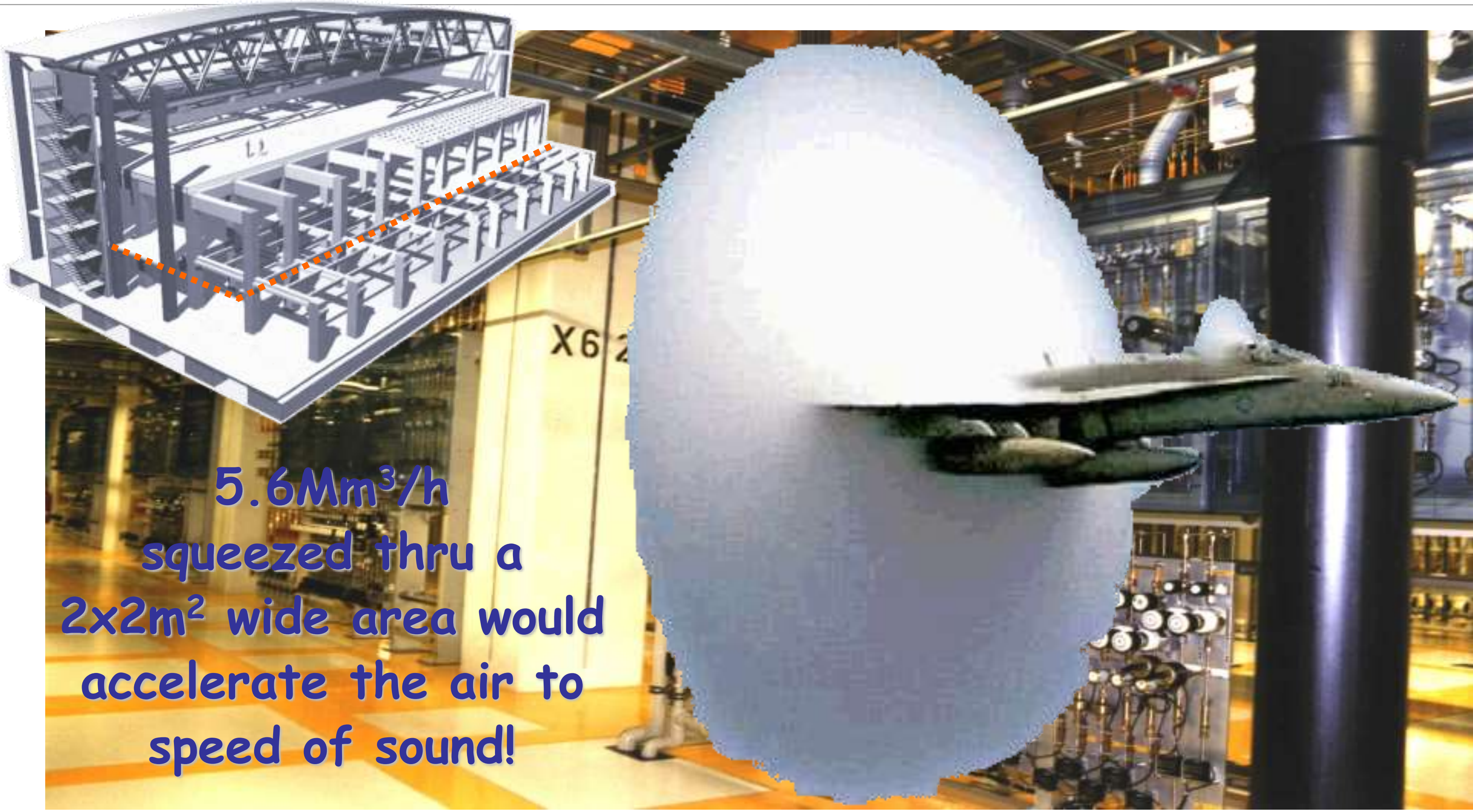
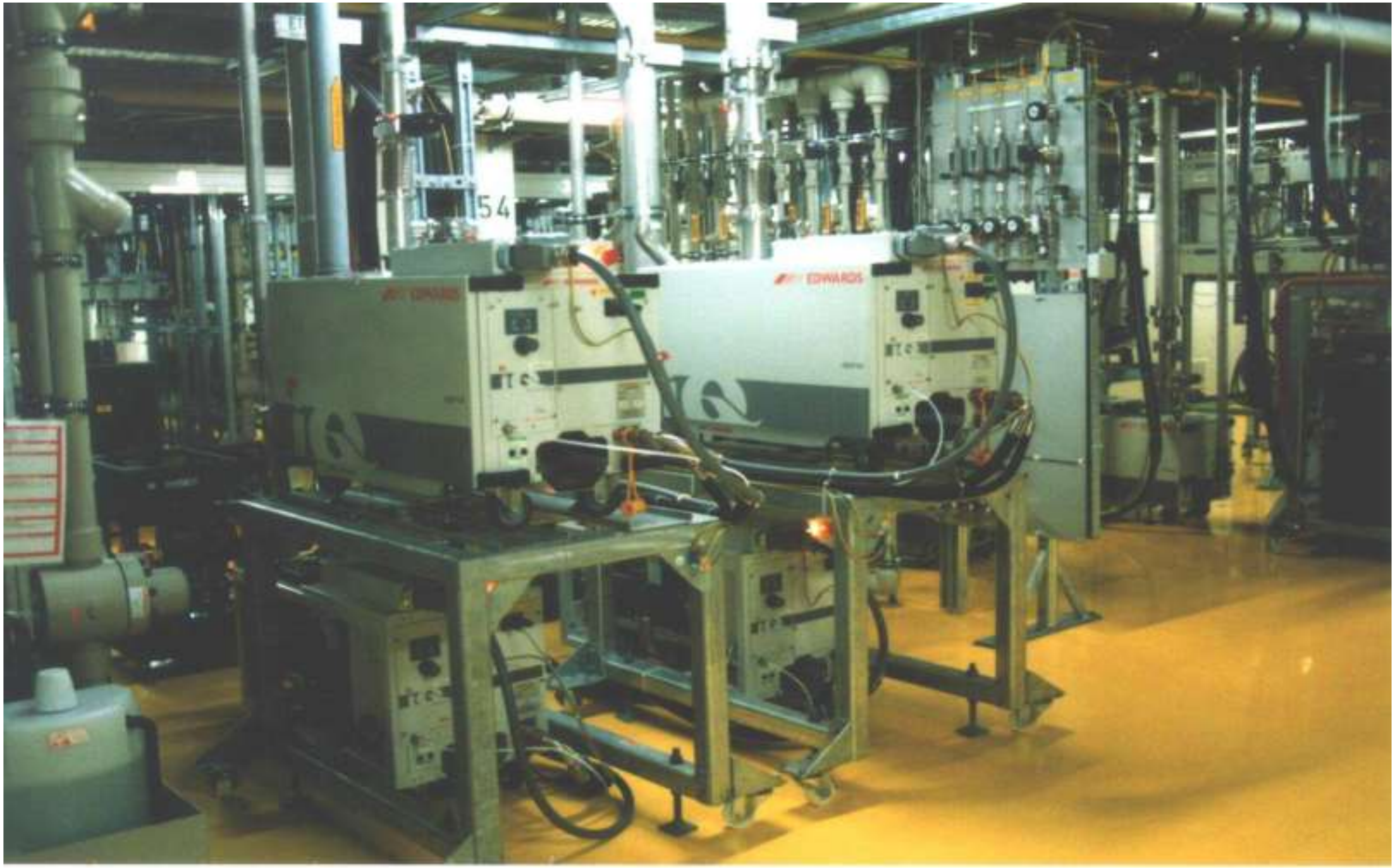
Cleanroom - Clean Subfab Area 5m high - Air Return



LO1

Cleanroom - Clean Subfab Area - Basement



LO1

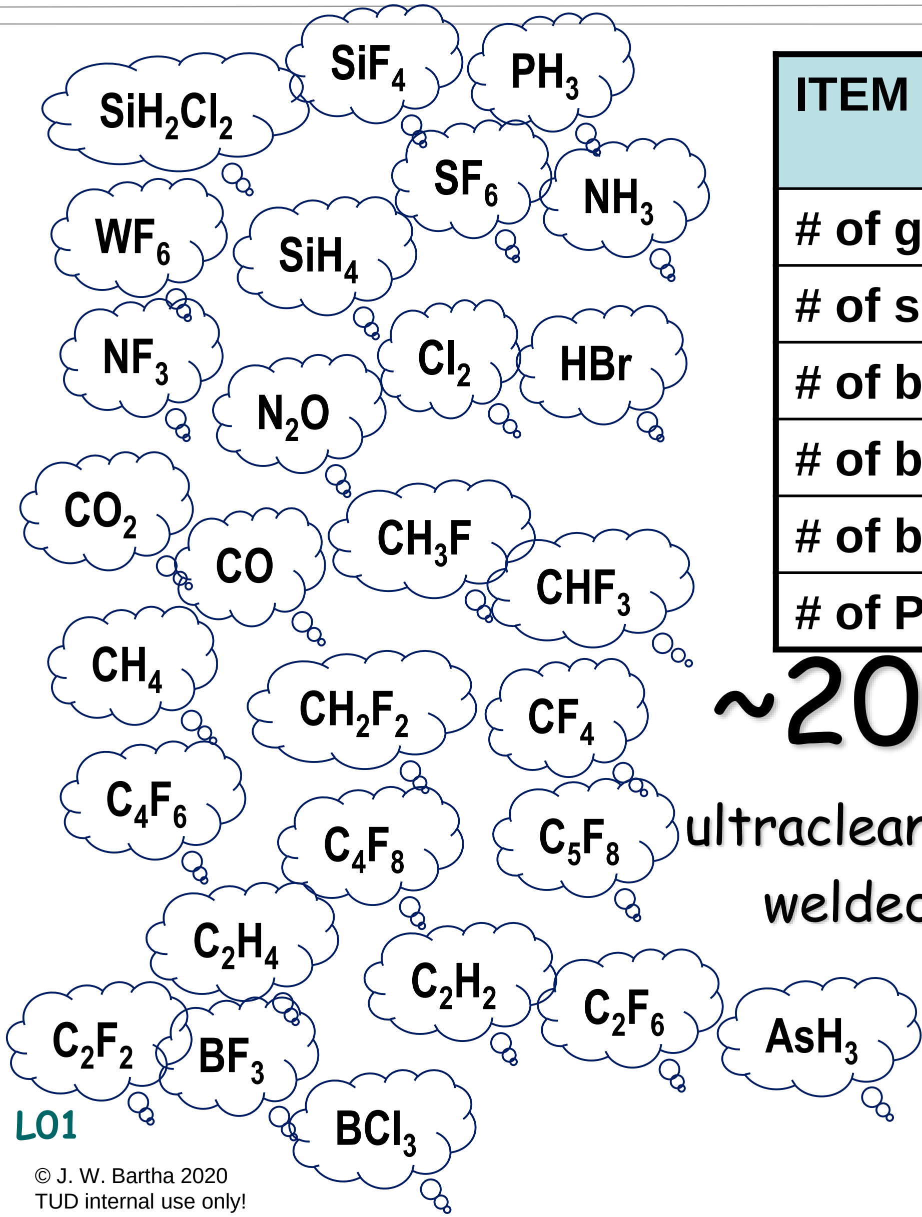
Wafer-Fab – Facilities – Bulk Gases

Bulk-Gas		Consumption m^3 / h
Nitrogen	N_2	10 000
Oxygen	O_2	300
Argon	Ar	60
Hydrogen	H_2	30
Helium	He	20

Courtesy of FAC

LO1

Wafer-Fab – Facilities – Special Gases



ITEM	200mm	300mm
# of gas cabinets	320	130
# of species	50	50
# of bottle exchanges / w	80	30
# of bottles	650	270
# of bottles in stock	680	20
# of PoUs	1300	800

~200km

ultraclean, specially welded piping


Courtesy of FAC

LO1

Back to the beginning of vacuum technology

VT L01 c 22:04

https://www.youtube.com/watch?v=h37XUBYYmjM&t=67s

L01

Otto von Guerike 1602 -1686

Vacuum Technology Today in microelectronics

VT L01 d 09:04

7:00 – 12:30

Outline of the lecture:

Chapters

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0. Introduction
1. Gas kinetic
2. Pressure Ranges
3. Vacuum technical terms
4. Vacuum generation
5. Pressure measurement

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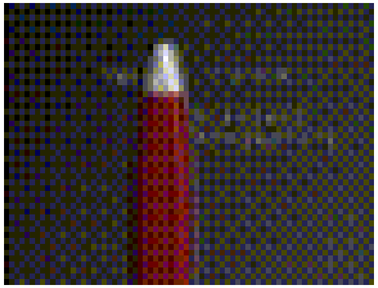

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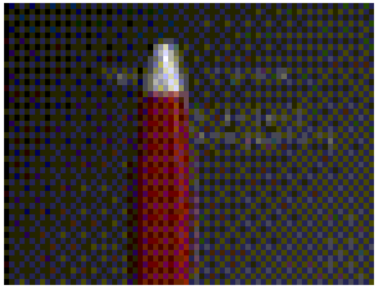

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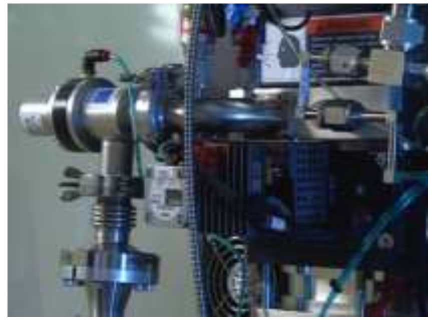

L01

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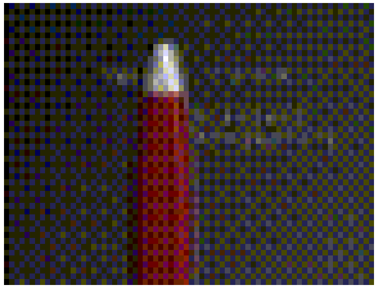

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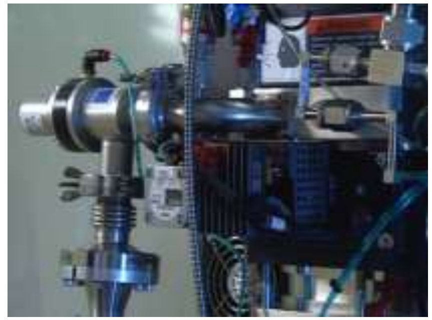

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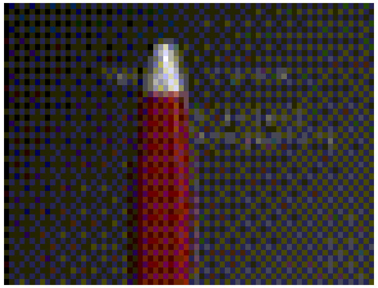

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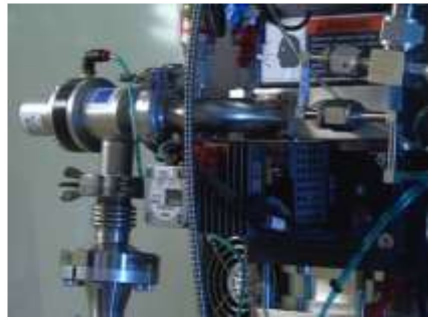

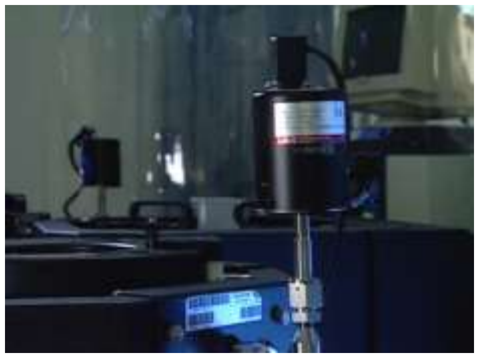

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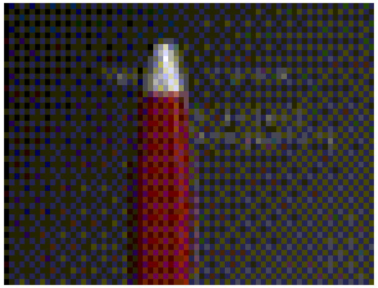

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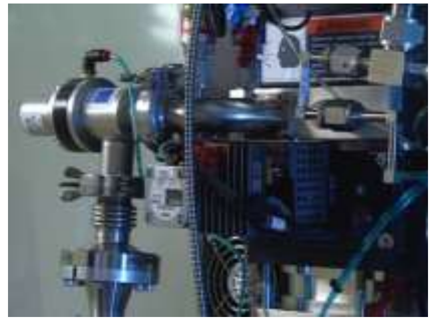
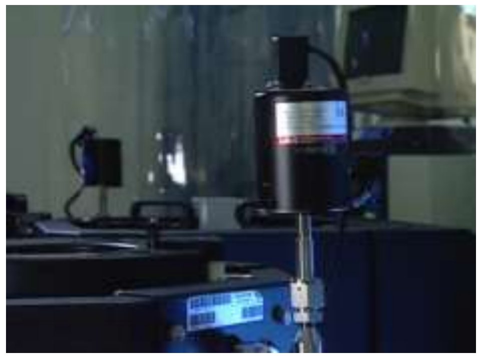




Chapters

0. Introduction

Air pressure as a force to the walls of an empty container -> Pressure = Force/Area

1. Gas kinetic

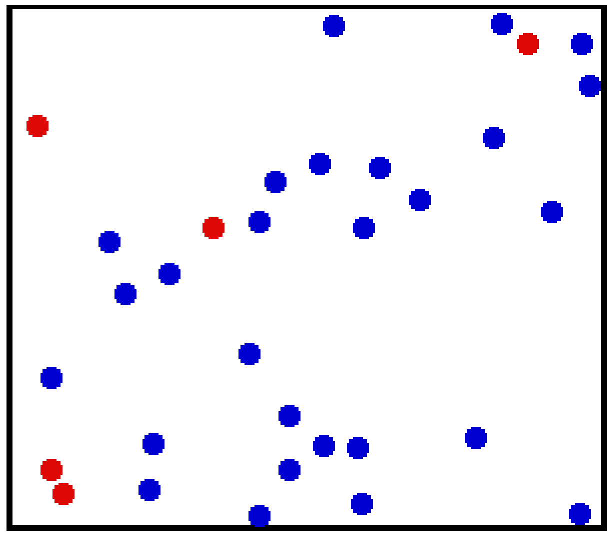
2. Pressure Ranges

3. Vacuum technical terms

4. Vacuum generation

5. Pressure measurement

Blackboard:
What is pressure?



LO1

Blackboard: What is pressure?

What is Pressure?
Unit → Pa (= N/m²)

Pressure = Force / Area
= (mass · accelleration) / Area
= mass · velocity change per time unit / Area
= (mass · times velocity change) / (time unit · Area)
= change in momentum / (time unit · Area)

phenomenologically ↓ kinetic ↙

$P = F / \Delta A = m \cdot a / \Delta A = (m \cdot \Delta v / \Delta t) / \Delta A = \Delta p / \Delta A \cdot \Delta t$

Pressure is
the "transfer" of momentum to a wall per time- and area unit

What is Pressure?
Unit is Pa (=N/m²)

↓

L01

What is Pressure?
Unit is Pa (=N/m^2)

↓

Pressure = Force / Area

What is Pressure?
Unit is Pa (=N/m²)

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Pressure = Force / Area

= mass · accelleration / Area

LO1

What is Pressure?
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= mass · (velocity change per time unit) / Area

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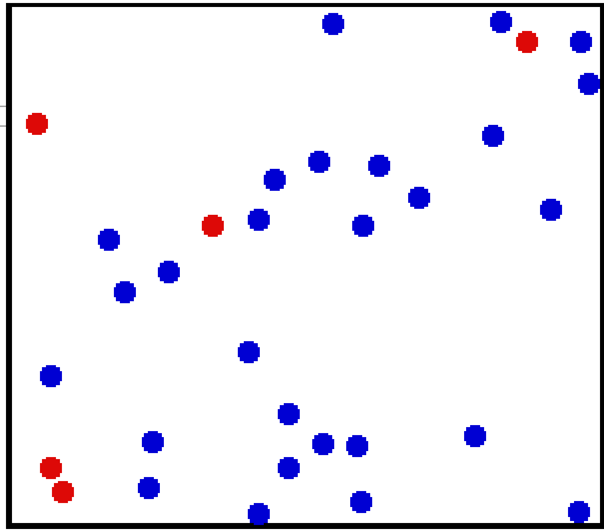

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LO1

Blackboard:
New way of understanding the gas properties:

New way of understanding
the gas properties:

approximations

- Gas particles are spheres
- no forces except when collide
- movement independent from each other
- isotropy (no special direction)
- law of conservation • energy & momentum

- velo ity of ·ndividual particles changes frequently
due to colisions

LC.

New way of understanding the gas properties:

Model approximations

- **Gas particles are spheres of atomic dimension**
- **no forces except when collide**
- **movement independent from each other**
- **isotropy (no special direction)**
- **law of conservation of energy and momentum holds**
- **velocity of individual particles changes frequently due to collisions**

L01

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»Wissen schafft Brücken.«

LO1