



# NTNU

Innovation and Creativity

## Technical support and Equipment in Process Metallurgy

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SiManTi 3.10.2013

# Technical support and equipment in Process Metallurgy

- Technical support at IMT
- Technical services at NT faculty
- Equipment in process metallurgy
  - Lab scale, small scale, pilot
  - NTNU, Sintef
- Procedure when running experiment
- Wiki database for equipment

# Technical support at IMT

- 15 technical employee at IMT
- 7 in Alfred Getz vei (Agv)
- 8 in Kjemi blokk II (KII)
- [Technical staff IMT](http://www.ntnu.edu/mse/employees/technical-staff)  
<http://www.ntnu.edu/mse/employees/technical-staff>

# Engineer in process metallurgy

- High temperature equipment : graphite tube furnaces, induction furnaces...
- Crushing/sieving lab
- Instrumentation : thermocouple (K,S,B and C), MFC, datalogger...
- Diverse lab consumables : crucibles, tube, hoses...
- Room responsible : HSE

# Electron microscope laboratories

## Senior Engineer Morten P. Raanes

- Electron probe micro-analyser EPMA
- [EM Lab](#)
- <http://www.material.ntnu.no/lab/material/booking.php>



## Senior Engineer Yingda Yu

- Scanning electron microscope SEM
- Transmission electron microscopy TEM
- Liquid nitrogen



## Staff engineer Torild Krogstad

- XRD
- Etching lab
- GD-MS, Glow discharge mass spectroscopy
- ICP-MS, inductive coupled plasma
- **Chemical**, [Eco Online](https://innsida.ntnu.no/wiki/-/wiki/Norsk/Stoffkartotek)  
<https://innsida.ntnu.no/wiki/-/wiki/Norsk/Stoffkartotek>
- **Gas**
- Metallography lab



## Senior Engineer Trygve Schanche

- Metallography lab Agv and KII
- Sample preparation
- Heat treatment
- Cutting
- Microscope
- Hardness measurement

## Staff engineer Pål Chr. Skaret

- Mechanic testing
- Hydraulic press
- Rolling and torsion
- Officices
- PC
- Telephon
- **Access card**
  - Risk assement
  - Room access requisition
  - K:\imt\HMS

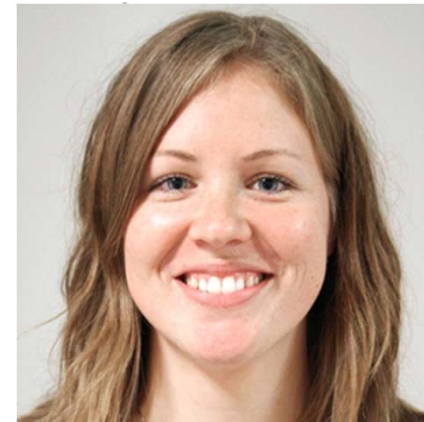


## Staff engineer Harald Holm

- Electric and electronic support
- [Safety representative](#) Agv
- <https://innsida.ntnu.no/wiki/-/wiki/English/Safety+representative>
- PC
- Keys

## Staff engineer Gunn Torill Wikdahl

- HSE coordinator
- New PhD ? Get HSE course
- [HMS at NT faculty](#)
- <https://innsida.ntnu.no/wiki/-/wiki/Norsk/HMS+ved+NT>
- [K:\imt\HMS](#)



## Staff engineer Solveig Jonassen

- [Simple purchases](#)
  - Supplier agreement
  - E-requisition
  - <https://innsida.ntnu.no/bestille>
- Chemical storage, EcoOnline KII
- Room access





- Senior Engineer Eli Beate Larsen
  - Technical staff leader IMT, Thermic analysis, Cold isostatic press



- Senior Engineer Elin H. Albertsen
  - Carbon lab, hazard waste

- Staff Engineer Magnus B. Følstad
  - electrochemical laboratories



- Staff Engineer Pei Na Kui
  - Furnaces KII, glove box, spray pyrolyse lab

- Staff Engineer Kjell Røkke
  - Gas central system KII, Light microscope



- Senior Engineer Julian Tolchard
  - XRD and SEM in KII

# Technical services at the NT faculty

- Glass Blowing Workshop
  - Realfagbygget DU3
- Mechanical/Engineering Workshop
  - Realfagbygget DU3
- IT and Instrumentation Service
  - Realfagbygget C2
- Order work from innsida / mine bokmerker / NT Fak.
- [Order work at NT workshop](http://www.nt.ntnu.no/adm/Verksted/)  
<http://www.nt.ntnu.no/adm/Verksted/>
- [Description of the workshops](http://www.ntnu.no/nt/om-oss/verksteder)  
<http://www.ntnu.no/nt/om-oss/verksteder>

# Glass Blowing Workshop

Manager: Astrid Salvesen



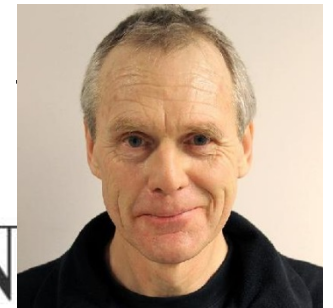
- Glass equipment manufacturing and repair. Special design.
- Various qualities of glass and materials:
  - Borosilicate glass (Duran glass)
  - Quarts ( $\text{SiO}_2$ )
  - Ceramic materials
  - Noble metals (gold, platinum and various alloys)
- Machining: diamond sawing, drilling, grinding and polishing

# Mechanical/Engineering Workshop

Manager: Harald Snekvik



- Construction, development, modification, repair and maintenance of apparatus and equipment using machining techniques
  - Machining of various materials (high alloy qualities of steel, plastic materials, wooden materials, etc).
  - **Graphite (Aksel Alstad)**, coke, boron-nitride and various composite materials
  - Modern CNC turning lathes and milling machines. EDM equipment (spark erosion). Welding (traditional and plasma), soldering, etc
- Competence on high vacuum technology
- Technical calculations and drawings (AutoCad) according ISO and DIN standards

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# Equipment for metallurgy and mineral research

## Type of equipment

- *Characterisation*
- *Standardised tests*
- *Laboratory tests*
- *Small scale tests*
- *Pilot scale tests*
- *Industrial measurements*

## Types of research

- *Mineralogy*
- *Ore dressing*
- *Powder technology*
- *Ferroalloy production*
- *PV Si production*
- *PV Si characterisation*
- *Alloy characterisation*

# Graphite tube furnaces

- Inert or reducing atmosphere
- Up to 2500°C
- Various features :
  - Weighting device
  - Gas lance
  - Quenching chamber
  - Translation of crucible
  - Off gas measurement
- Crucible size
  - Up to  $\text{Ø}45\text{od} \times 70$
  - Resina  $\text{Ø}60/52 \times 100$



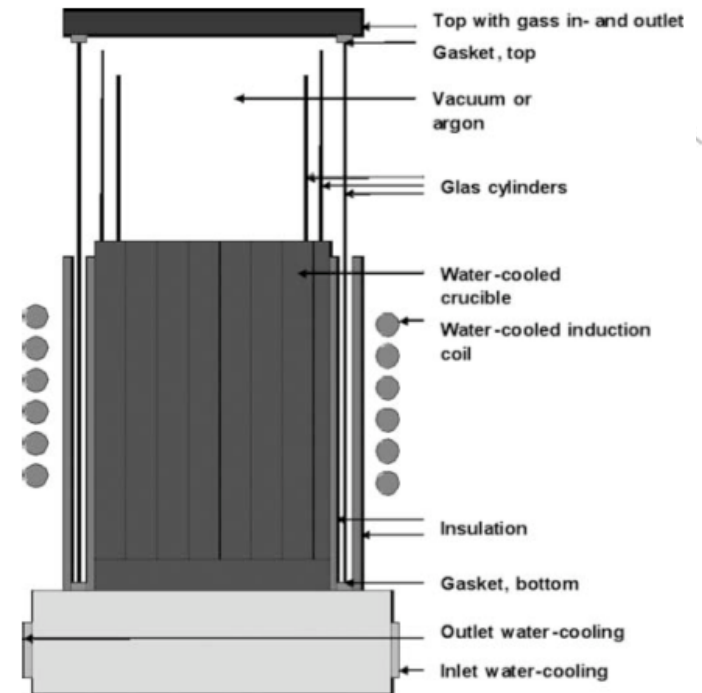
# Vacuum induction furnace “Blue furnace”

- Temperature limit: 2000°C
- Manual heating control
- Crucible size
  - OD Ø80mm (normally)
  - Height 160mm, max 200mm
- Gas purging
- Sampling
- Crucible visible through glass



# Cold Crucible induction furnace

- 75 kVA high frequency power generator (750 kHz)
- Multi wavelength pyrometer FAR FMP2
- Evacuating system with possibility of purging gas
- Freeze lining
- Work possibilities with very corrosive slags
- 300-500g



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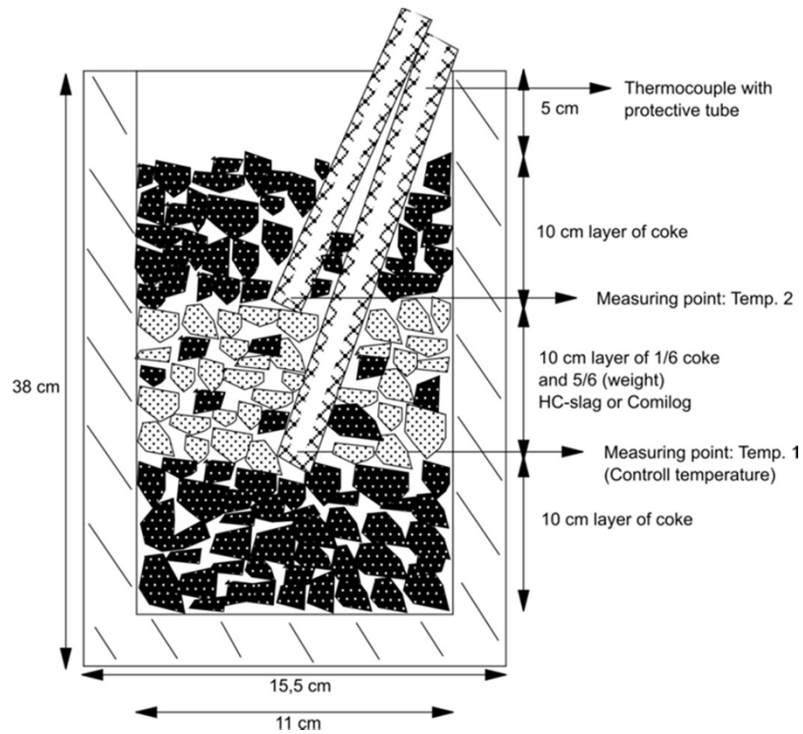


# IF75 - Induction furnace

- Small scale smelting apparatus
- Investigation of reactant behaviour at different temperatures
- Volume of approx. 6 dm<sup>3</sup>
- Graphite crucible
  
- 75kW
- 3kHz



# IF75 experiment example



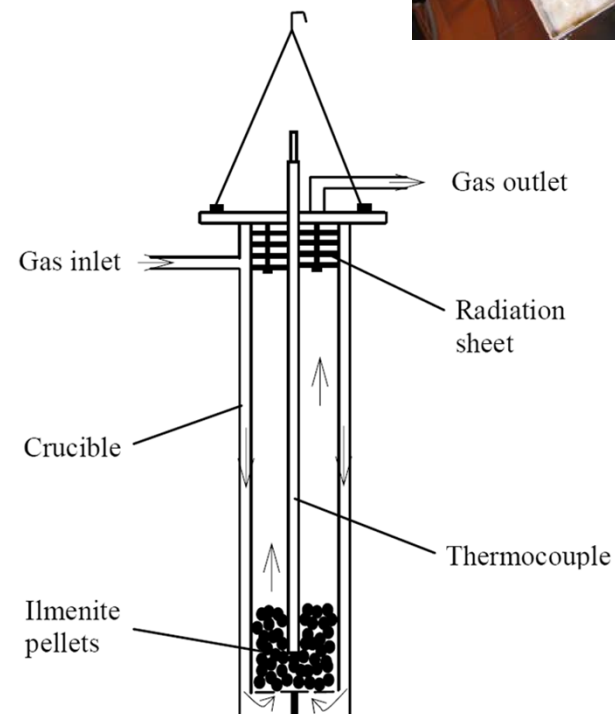
# Sample preparation lab

- Crushing
- Sieving
- Ultrasound bath
- Drying cabinet
- Pelletizing
- Mixing



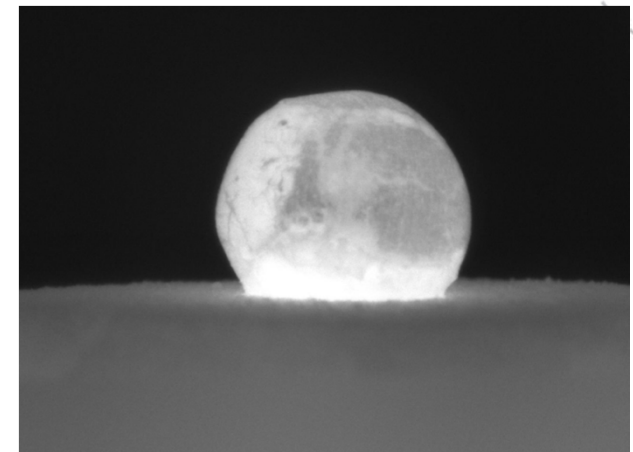
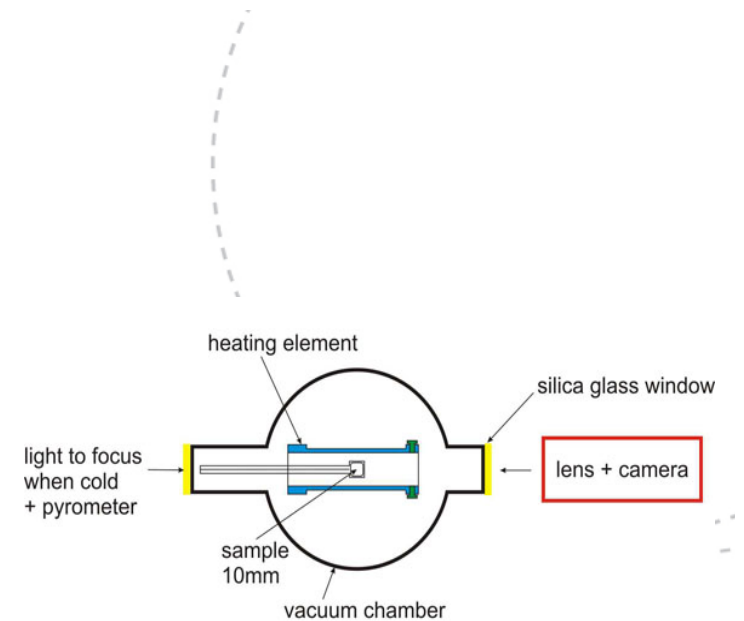
# DisVarDri furnace

- Sintef – Shawn Wilson, Edith Thomassen
- Simulation of DRI shaft.
- Controlled gas inlet and temperature
- Online weight and gas composition measurement (IR)
- $T_{\max} = 1200^{\circ}\text{C}$
- Sample 300g

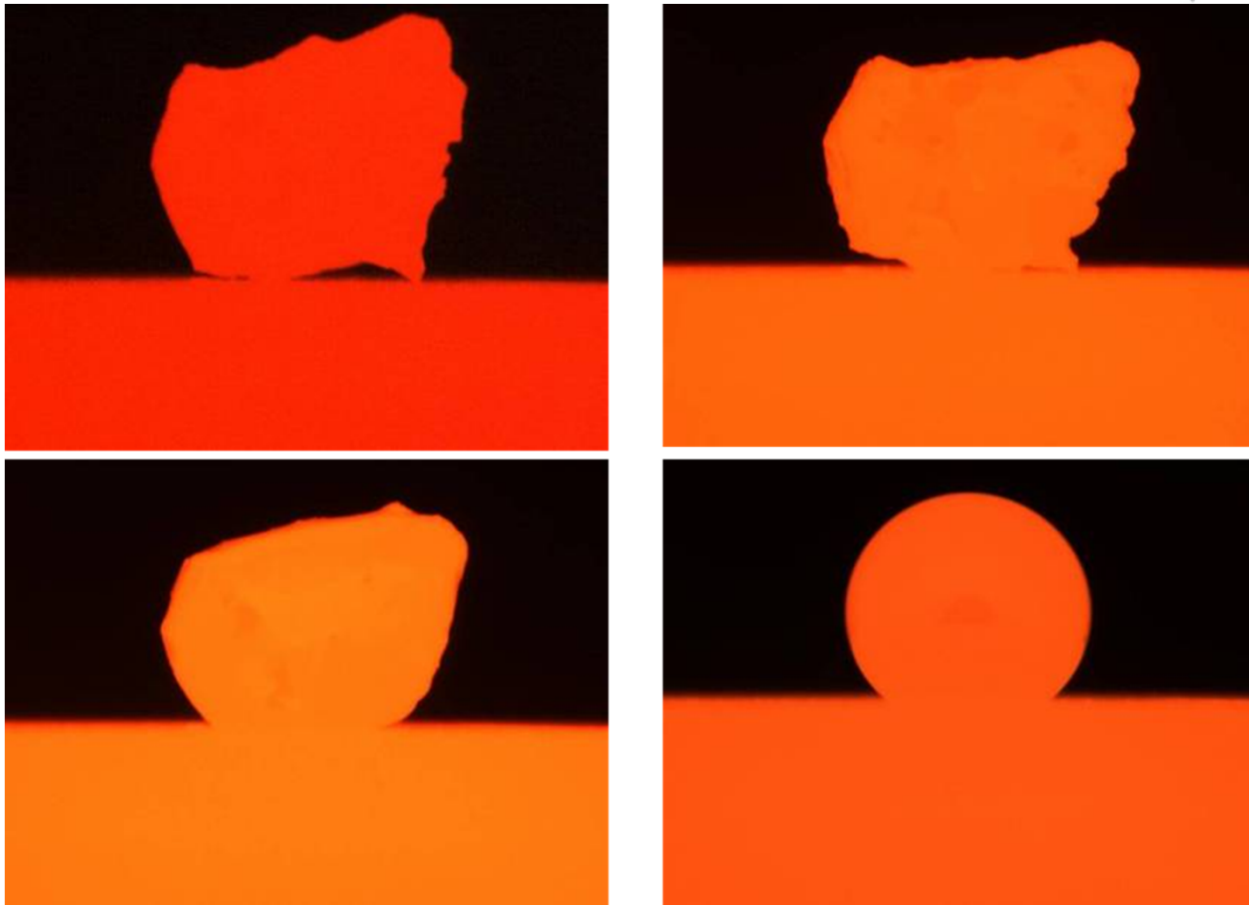


# Wettability furnace

- Sintef – Tone Anzjøn
- Measurement of the contact angle of a liquid drop on a 10mm diameter substrate
  - The wetting angle
  - The melting point
  - The reactivity between different materials
- Heating rate up to 1600°C in 1 minute
- Atmosphere : vacuum, inert or reducing
- Maximum temperature 2400°C



## Melting behaviour at increasing temperature



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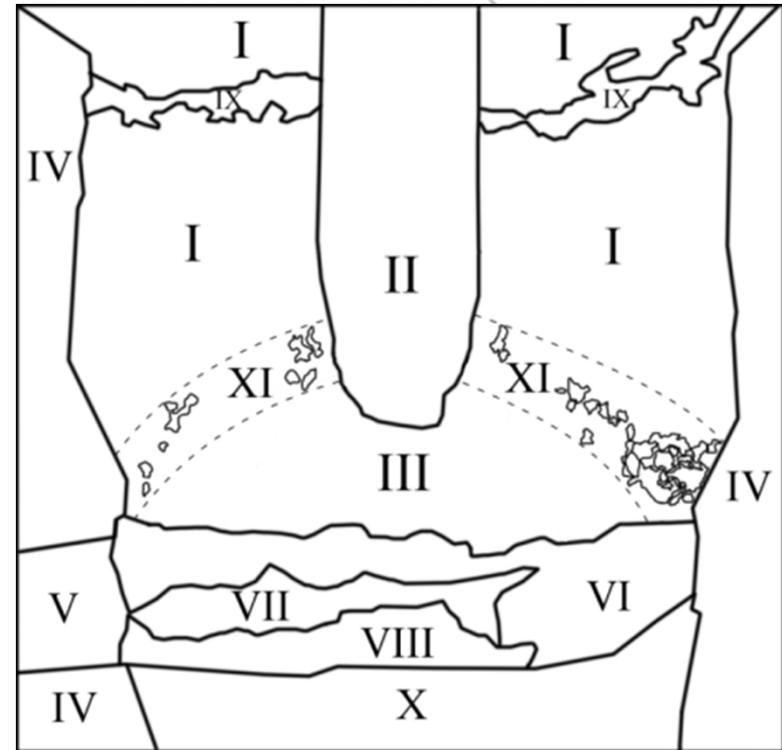
# Pilot scale Si-production in 160kW single phase furnace

- Sintef – Steinar Prytz
- 440 kVA power supply
- Possible to operate at different frequencies:
  - 25, 50, 75, or 100 Hz AC
- Automatic logging of power supply parameters and gas temperature.
- Opportunities for :
  - Off gas analysis (CO, CO<sub>2</sub>, O<sub>2</sub>, NO, NO<sub>2</sub> and SO<sub>2</sub>)
  - Material balance
  - Energy balance



# Pilot furnace

## Post experimental investigations



Samples for Microprobe, SEM and chemical analysis



# How do I run experiment ?

- Agree with your supervisor and write the **risk assessment**
- Get room access. Pål Skaret and room responsible
- Purchase through the ordering system:
  - Consumables. Delphine Leroy. **Remember long delivering time !**
  - **Register chemical**. Torild Krogstad. **No storage in the office !**
  - Gas. Torild Krogstad. 2 days delivering time.
- Working hours : 8:00 to 16:00, Monday to Friday
  - Contact supervisor and room responsible for late work
- Indicate what your doing on lab board
- **Mark your samples**
- **Tidy after yourself**

# Important documents in the lab

<b>Safety card (vernekort)</b>	Bills at entrances showing names of the Head of dept, HSE-coordinator, safety representative
<b>Room card (romkort)</b>	Bills outside entrances to laboratories showing vital information on safety issues to fire fighters and others
<b>Apparatus card (apparatorkort)</b>	Bills situated by the instruments telling who is responsible, what to do in emergency situations, etc.
<b>Operating instructions (driftsinstruks)</b>	How to perform a working task or using an instrument. Copies available in the lab.
<b>Risk assessments (risikovurderinger)</b>	Documentation of risks. Copies available in the lab.
<b>Safety data sheets (sikkerhetsdatablad)</b>	Safety information on dangerous substances. Copies available in the lab.

Good luck with your experiments !