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# Resilience for a scrap system in transition (RESIO)

- State-of-the-Art
- Project P2025-208972
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# Consortium

- Research Institutes
  - Swerim
  - LTU
- Industry partners
  - Foundry
    - Norrlandsgjuteriet
  - Recycling
    - Stena Recycling


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# Scrap as a system, not only a material

- Rapid fossil-free transition in Sweden
  - BF-BOF → H-DRI & EAF
- EAF capacity expands faster than scrap supply
- Scrap quality challenges grow:
  - More EoL scrap → Higher heterogeneity and tramp elements
- Key consequence:
  - Low-information scrap has limited usability,

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# Projects and continuity

Previous projects:
- OptiScrap
- PURESCRAP

What these established:
- Technical feasibility of LIBS-based analysis
- Industrial relevance

What RESIO adds:
- Real-world deployment
- Explicit system perspective

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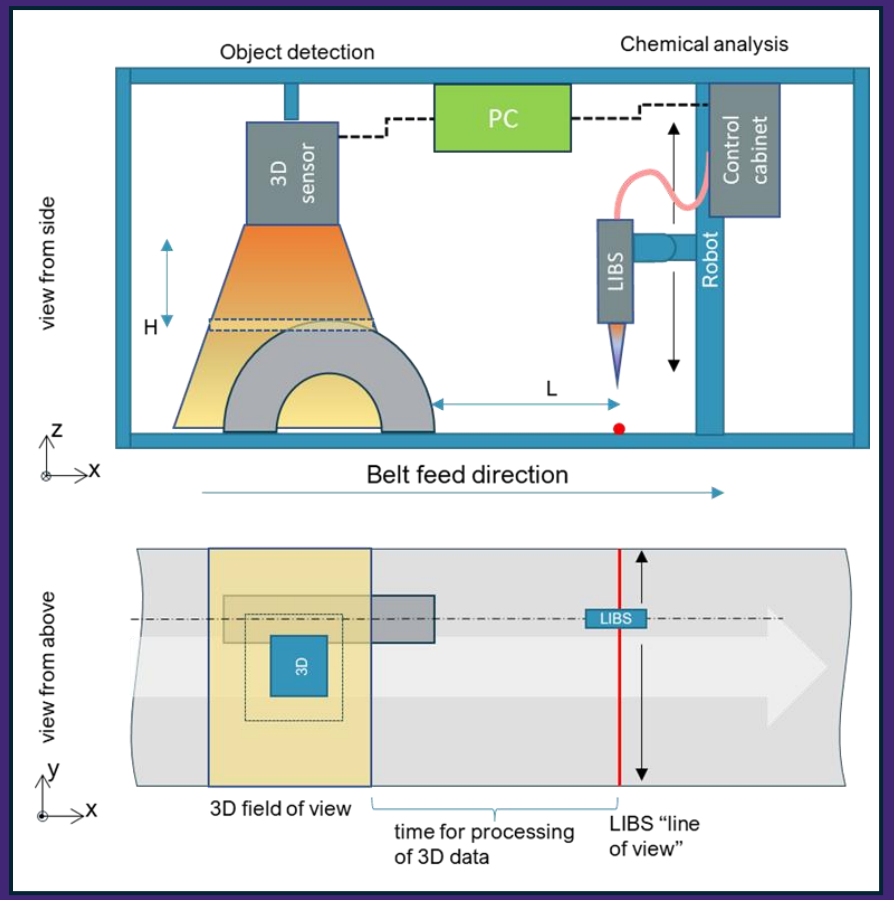
# In-Line LIBS as a system, not a sensor

- LIBS combined with:
  - 3D vision
  - Motion system
  - Automated evaluation
  - Pre-cleaning to deal with coatings

- Real-time evaluation and classification

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# Technical challenges

- Surface contamination (rust, paint)
- Calibration for unknown scrap
  - Unexpected signals can appear which causes spectral interference (e.g. Cu vs Ti)
- Throughput limited by:
  - Geometry detection
  - Focus stability
  - Conveyor speed

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# How scrap systems are analysed

- Scrap systems analysis methods:
  - Material Flow Analysis
  - Stock-flow & lifetime models
- Core variables:
  - Historic steel use
  - Product lifetime
  - Collection & recycling rates

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# What system-level analyses consistently show

- Scrap supply driven by historic production
- Long time lags dominate system behaviour
- Volumes increase slowly and predictably

System property:

*Long term supply is not affected by increased demand*

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# Demand moves faster than quality – Sweden feels it

- Steel demand responds rapidly to:
  - Economic activity
  - Policy and investment decisions

Sweden:

- High recycling efficiency
- Strong integration with EU scrap market
- Rapid H-DRI scale-up - earlier than most regions

Mismatch:

Scrap demand constraints move faster than supply quality/information improves

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# The ”Messy Mid-Term

- Existing research and models focus on
  - 2050 +
  - Near-equilibirum conditions

- But the transition period is characterized by:
  - Partial circularity
  - Overlapping production routs
  - Market and quality uncertainty

Evaluating interventions here reveals dynamics less covered in previous models

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# Key Take-Aways

Evaluating increased scrap characterisation provides insight into how the scrap systems behave during transition

What this information reveals:

- How information reshapes scrap usability
- How constraints manifest differently across actors during transitions
- Where system behaviour diverges from equilibrium models

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