Background
Crushing rock particles to fine sizes (typically below 150 µm) is an essential preparatory step for the recovery of valuable minerals from the rock ores. The process is highly energy intensive and energy inefficient, and the mining industry is under increasing pressure to reduce its energy consumption and improve the disposal of the fine particle tailings from its mineral recovery plants.

One of the key levers in this quest is to reduce the amount of milling and grinding before the initial flotation recovery process. This has in turn led to significant interest in ‘coarse recovery’ technologies that can achieve high recovery rates at top sizes around 350 – 500 µm, rather than the 100 - 180 µm used in most existing flotation plants. However, these coarse recovery plants are generally intolerant of ultra-fine particles (typically below 50 µm), and the recovery performance can be significantly improved if the majority of the ultra-fine material is removed and treated separately. The separate treatment of ultra-fines also significantly simplifies the problem of tailings disposal, so there is a multiplied benefit from solving this challenge.

Comminution Reimagined is developing a low energy, dry grinding technology that is ideally suited to feed a coarse recovery plant. However, removing the ultra-fines from the product stream will be key to achieving improved recovery and adoption of the new mill. The company is interested in investigating the efficiency of a cross air flow to remove such fines, and on understanding the impact of various devices and parameters (e.g. chamber geometry, air flow rates, use of baffles and flow guides, introduction of rotating elements, flow impact of the crushing elements themselves).

The company has built a simple test chamber with precise measurement capabilities and would like to offer a Masters student with an interest in applied fluid dynamics and aerodynamics the opportunity to undertake a very interesting and potentially highly impactful project to understand the flow dynamics and optimize the geometry of the test chamber. The project will be based at the company’s laboratory in Gothenburg and the student will be expected to sign a non-disclosure agreement.

The company envisages implementing the optimized design into their pilot milling machine immediately on completion of the proposed project.

Objective
The aims of the project are to:

1) Understand the air flows and the interactions between the air and the crushed rock particle stream.
2) Understand the effect of different separation chamber geometries and flow control devices, and specifically how the mill fracture elements can be utilized to improve the energy-efficient extraction of ultra-fine particles.
3) Recommend and design an improved chamber geometry, and quantify its effectiveness relative to the current design.
The project will apply the scientific method to structured evaluation and development of a viable solution pathway to improve air flow.

1) A literature review on the relevant fluid dynamics and existing fine particle separation and scalping methods.
2) Designing a simple, ‘configurable’ separation chamber geometry to enhance the existing equipment (the company will ensure that the manufacture is expedited).
3) Perform CFD-based topology optimization in comsol to generate key design features.
4) Specifying the detailed test procedures, measurements and analyses.
5) Mapping the air flows in this chamber with and without the ore stream. Currently, the envisaged methods include video of smoke trails and measurements of pressures and flow rates at selected locations in the system (measurement equipment capable of high sampling rates can be provided if needed).
6) Measuring the efficiency of the extraction of the ultra-fine particles on a limited set of test geometries and conditions.
7) Recommending design improvements to the existing pilot mill based on the results of the above tests.
8) Implement a design change and quantify the change in performance.

The ideal candidate/candidates will have an understanding of mechanical design and CAE development. They should have a key interest in applied mechanics and happy working across many disciplines. Insight into optimization and minerals processing industry is seen as a merit but not essential.

The supervisor for the project will be Gauti Asbjörnsson (gauti@chalmers.se) and the examiner will be Magnus Evertsson (magnus.evertsson@chalmers.se).