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Excellence in Simulation Technologies for Aeronautics

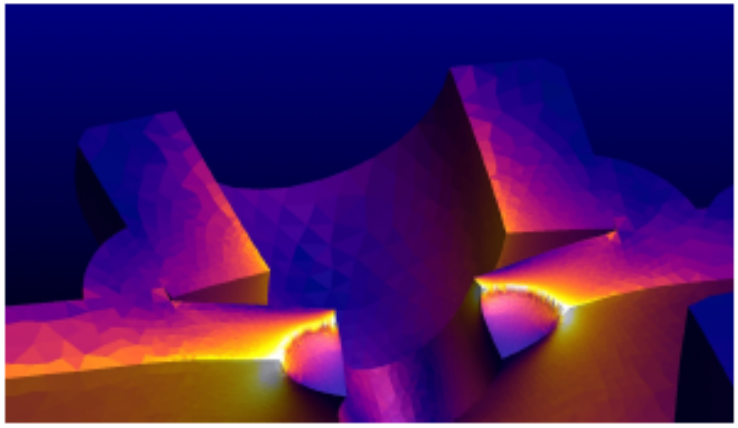
Structural design analysis - Fatigue

Arnaud Francois and Marc Duflot
Multiscale Material Modeling – Cenaero

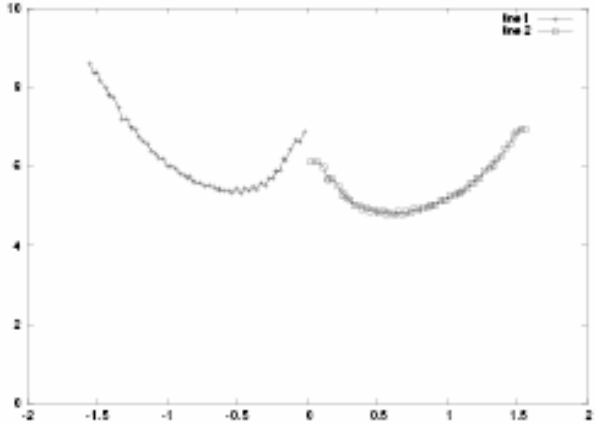
XFEM Crack propagation

Crack propagation with XFEM

The XFEM uses the same mesh for each step of the propagation.
So, no human intervention needed and easy to make a simulation with a large number of steps.
Moreover, easy to do multi-crack problems
See movie



Von Mises stress



Stress intensity factor

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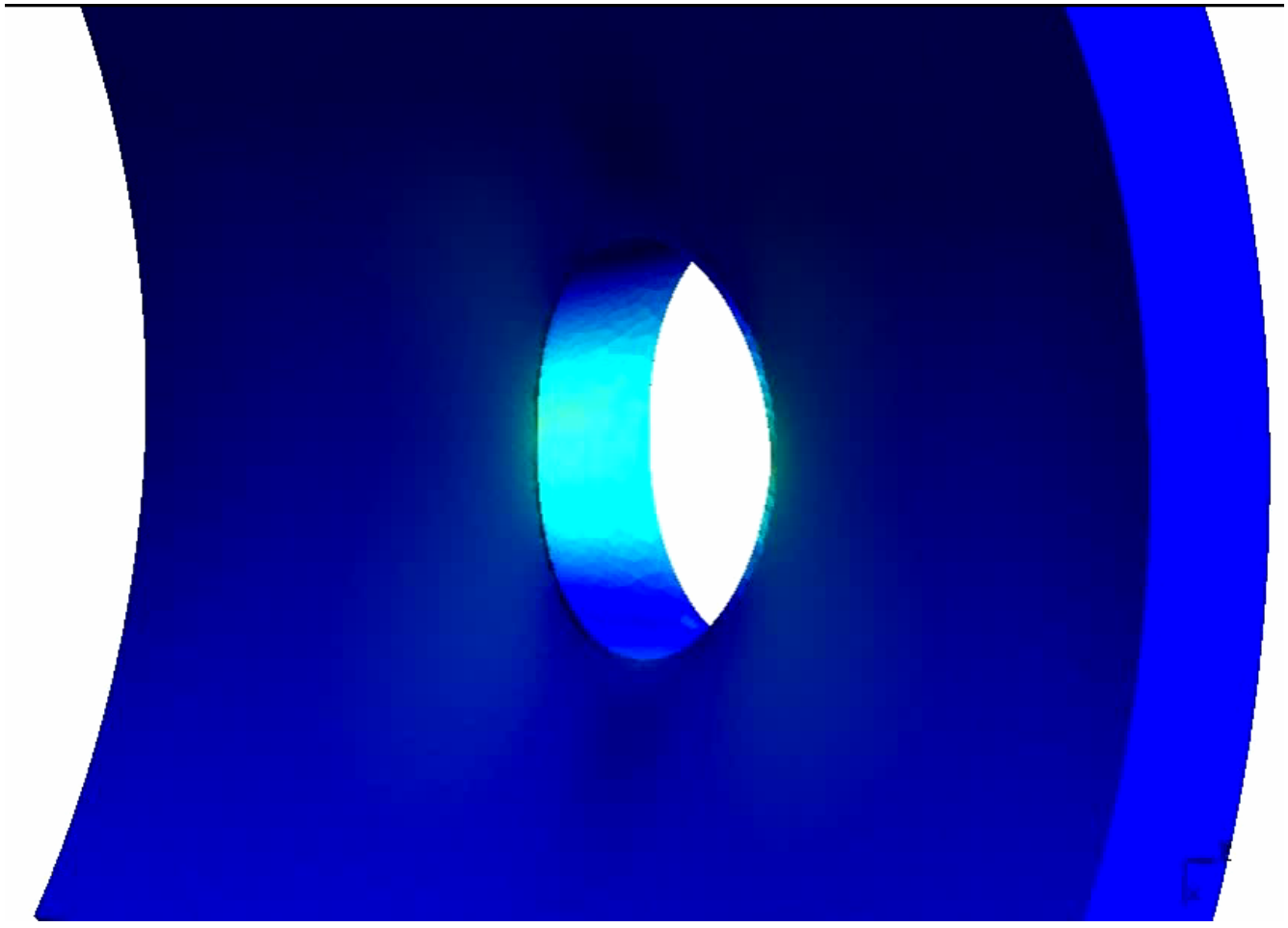
XFEM Crack propagation



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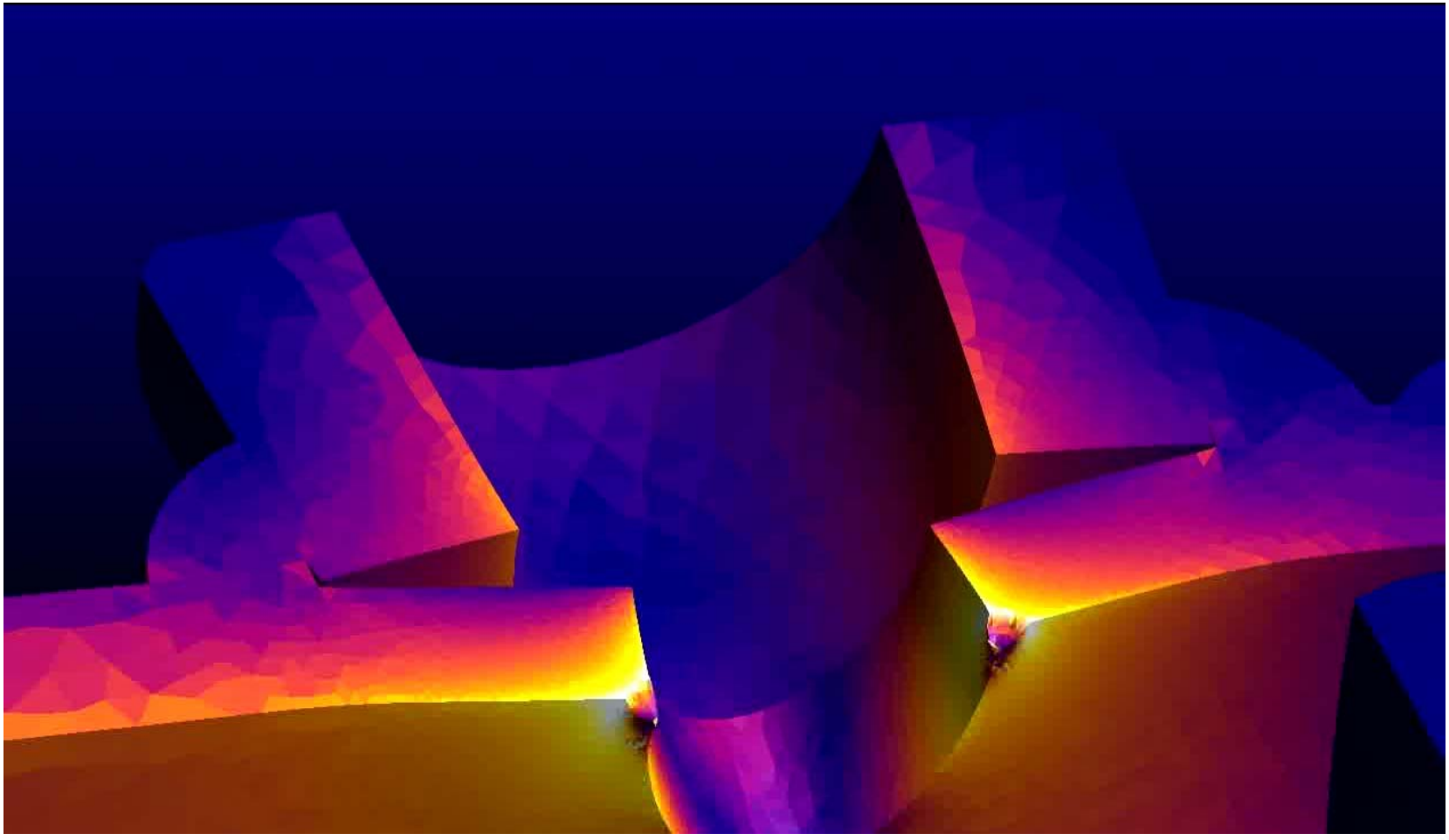
XFEM Crack propagation



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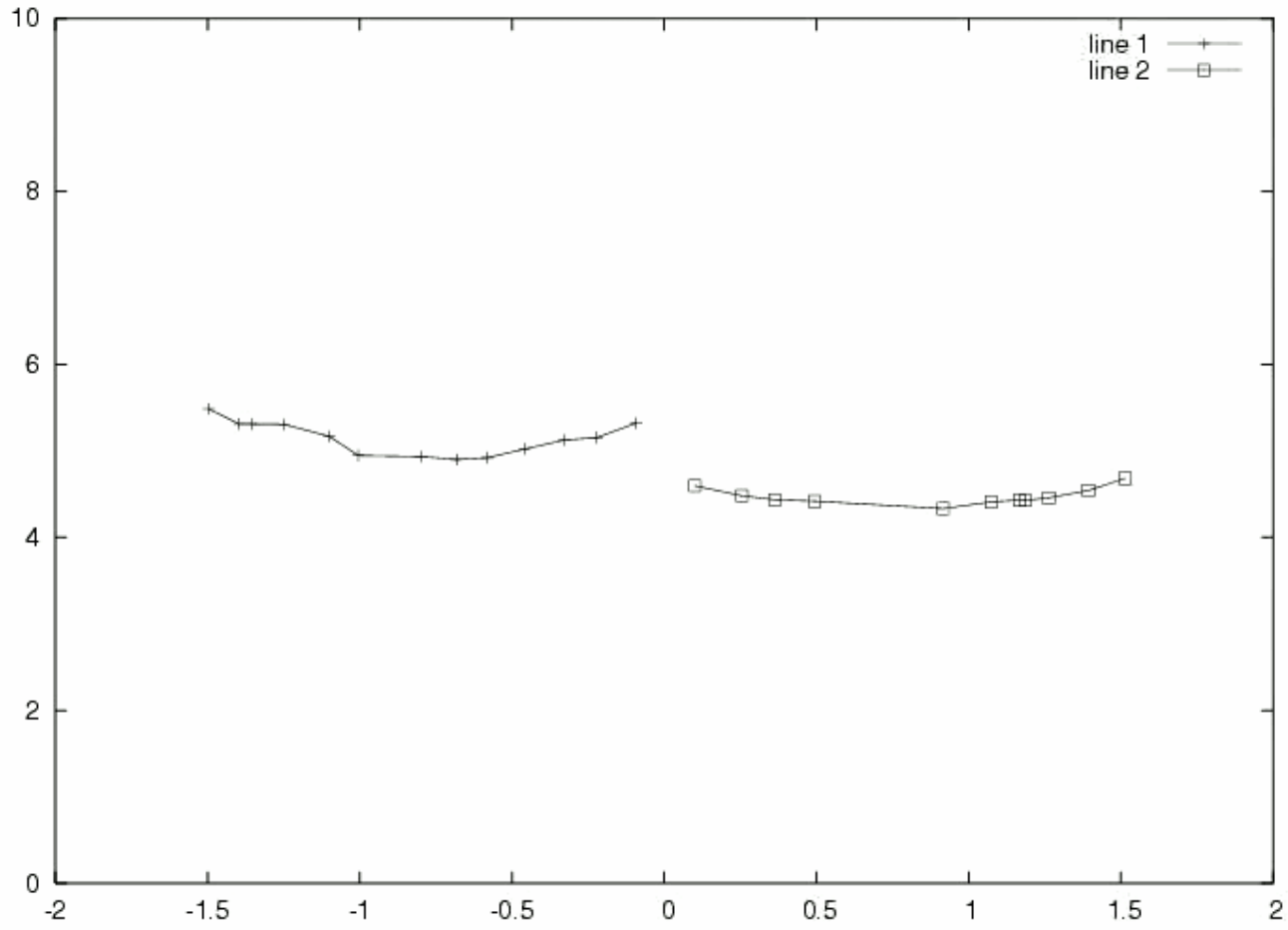
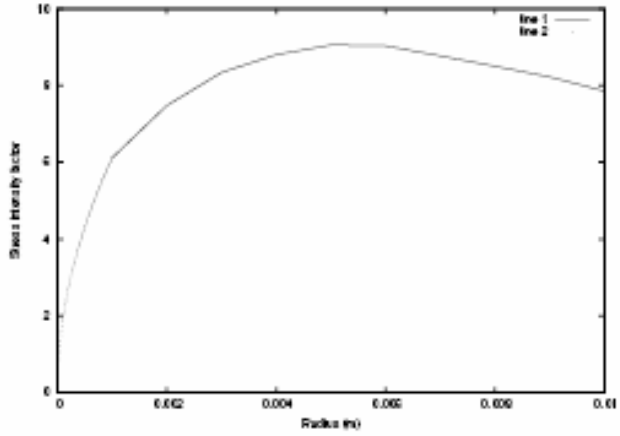
XFEM Crack propagation



XFEM Crack propagation

Crack propagation — Discussion



The same conclusions as with the FEM analysis holds.
When the crack reaches the welding, a part of the hoop stress is sustained by the welding and the oil port.
Are we sure of the free displacement condition between the oil port and the main cylinder?

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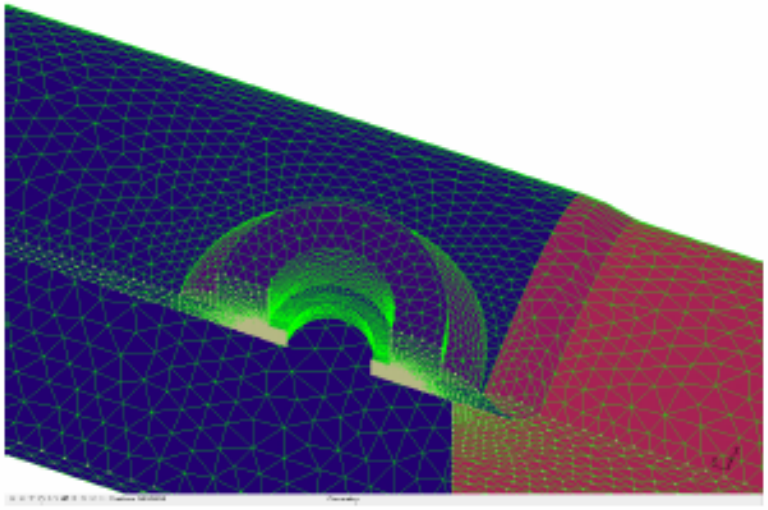
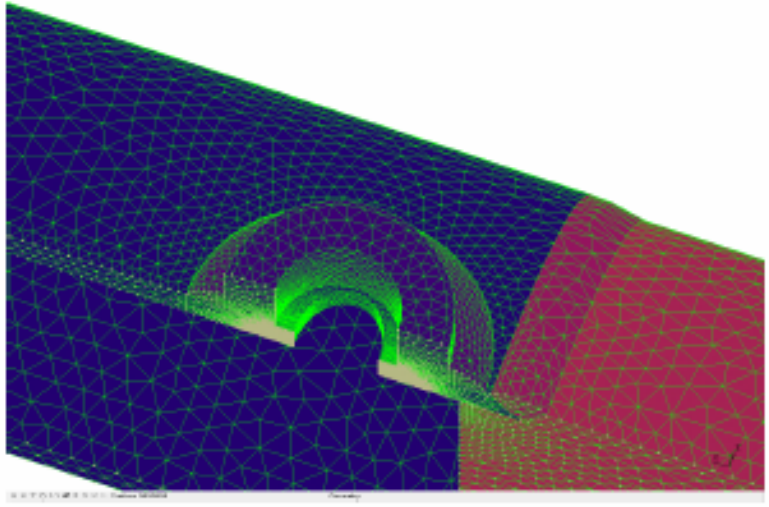
XFEM Crack propagation

Elliptical hole

In our theoretical analysis last year, we demonstrate that the inner pressure create hoop stress in the cylinder and that there is stress concentration at the hole.



Circular hole



Elliptical hole

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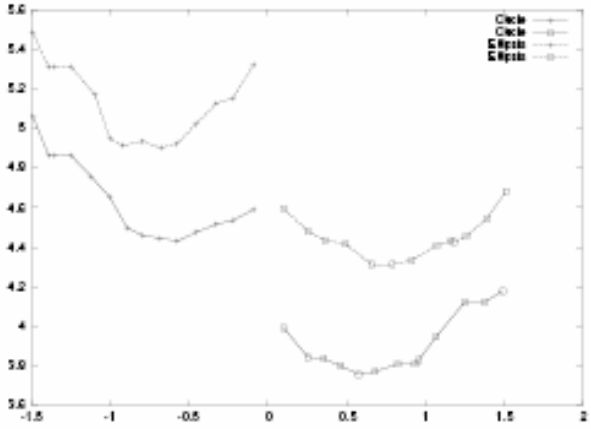
XFEM Crack propagation

SIF for the suggested elliptical hole

Results for the numerical simulation for a crack with radius 1 mm



As expected, SIF is 10% lower. For the optimal ellipsis, probably less.

Depending on the material (Paris exponent), we can expect a large increase in the cylinder lifetime. → Experiment?

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