Nikhef

Technical projects

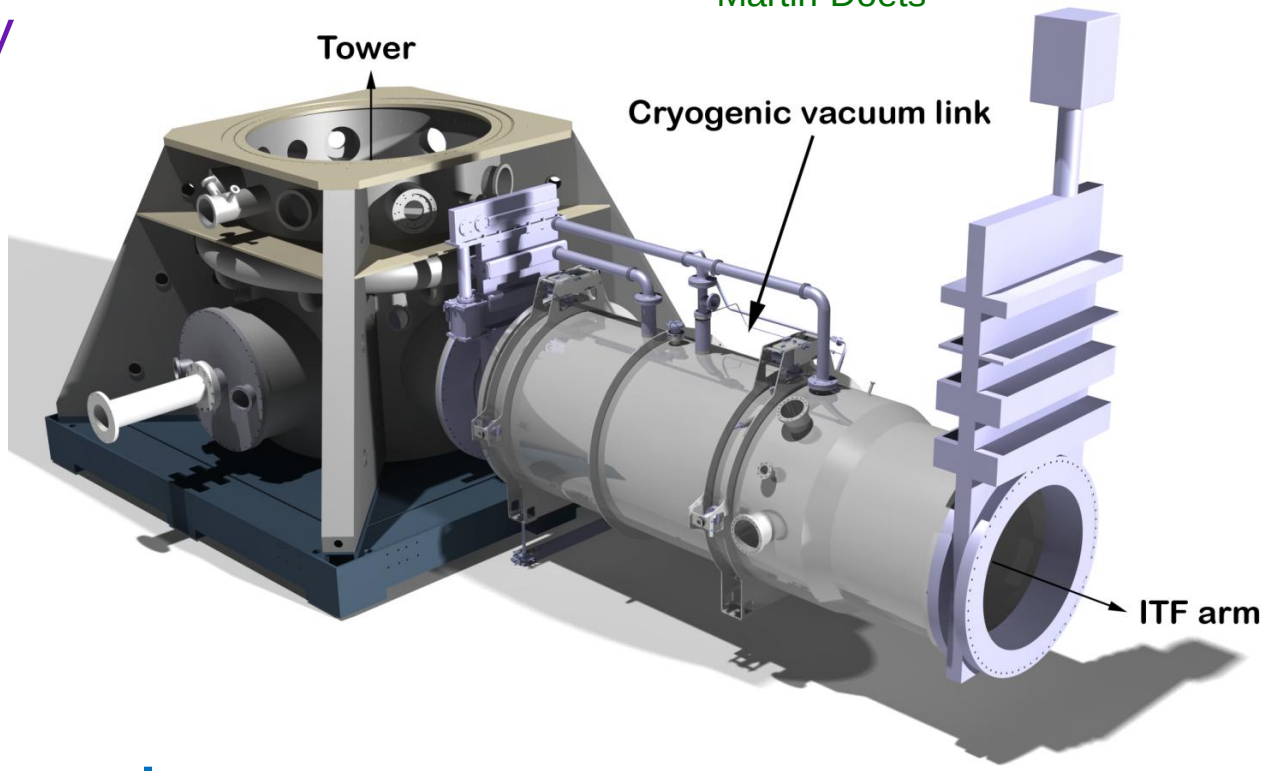
- Cryolinks
- Linear alignment
- IMC end mirror
- Phase camera
- Seismic suspensions

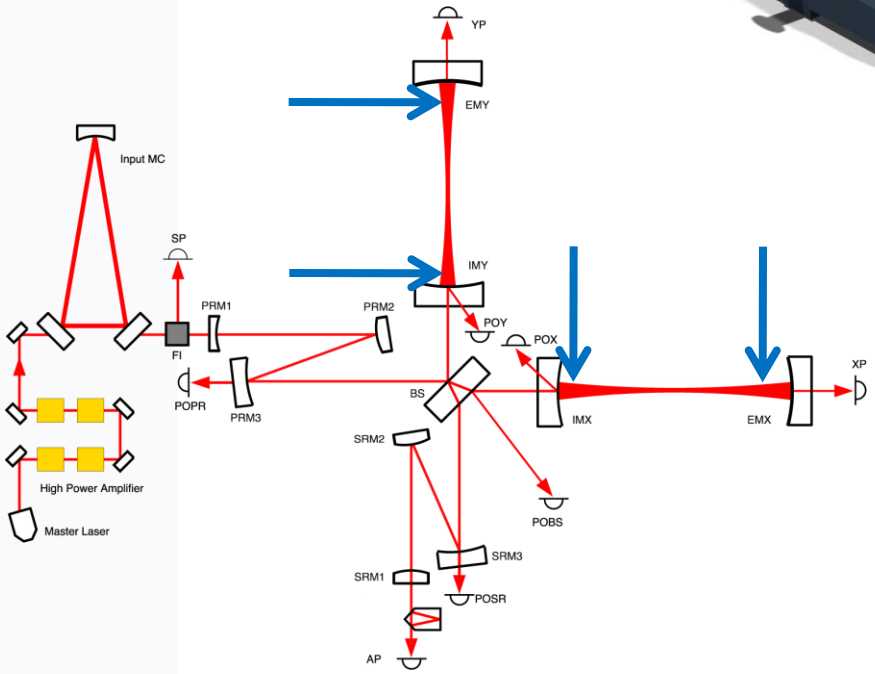
Jo van den Brand, Nikhef

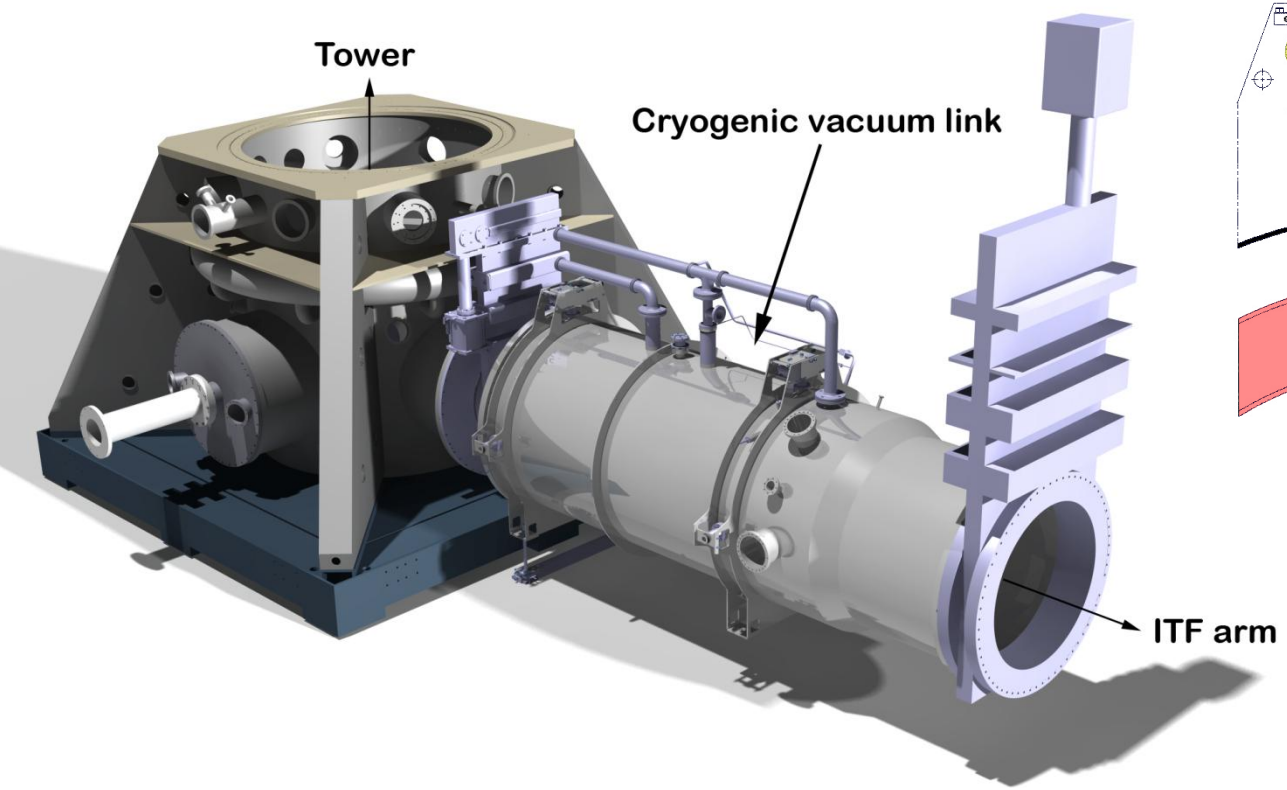
CRYOLINKS

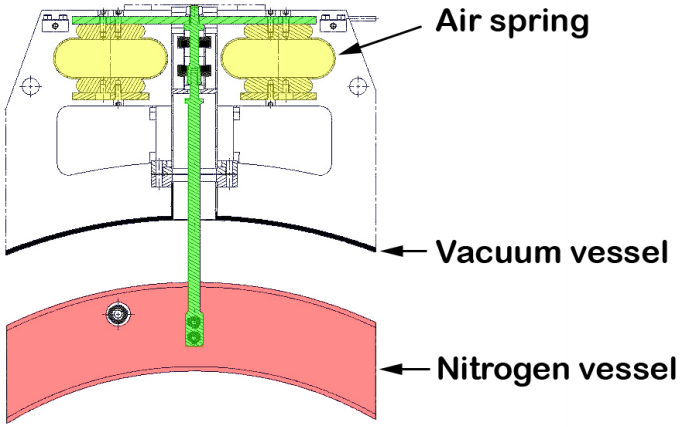
Martin Doets

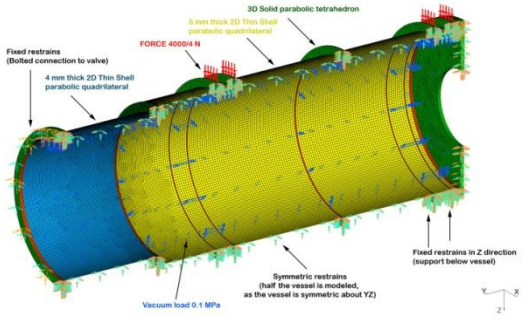
- Links (4) for AdV
  - Separate arms from towers
  - 10^{-9} mbar
  - Freeze water

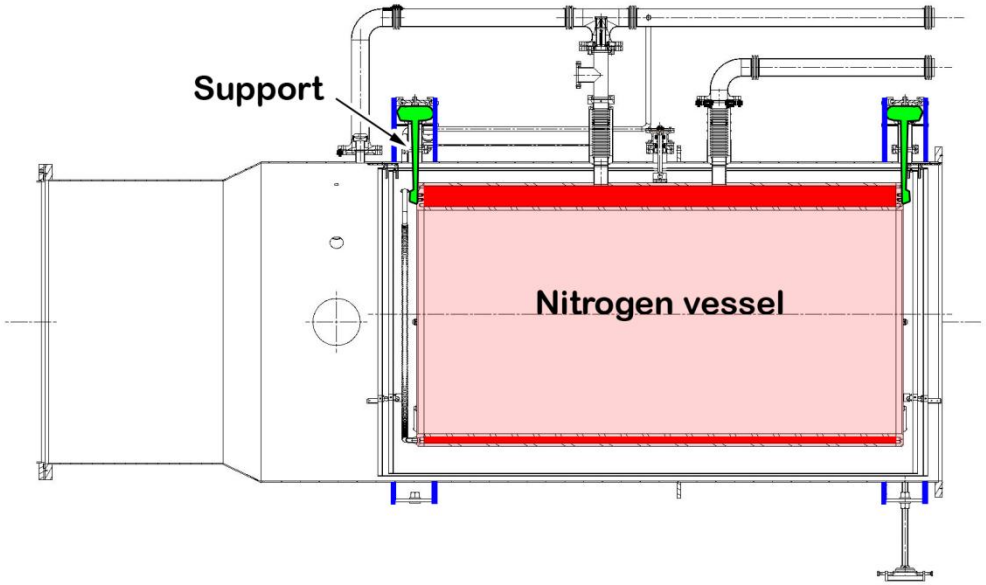


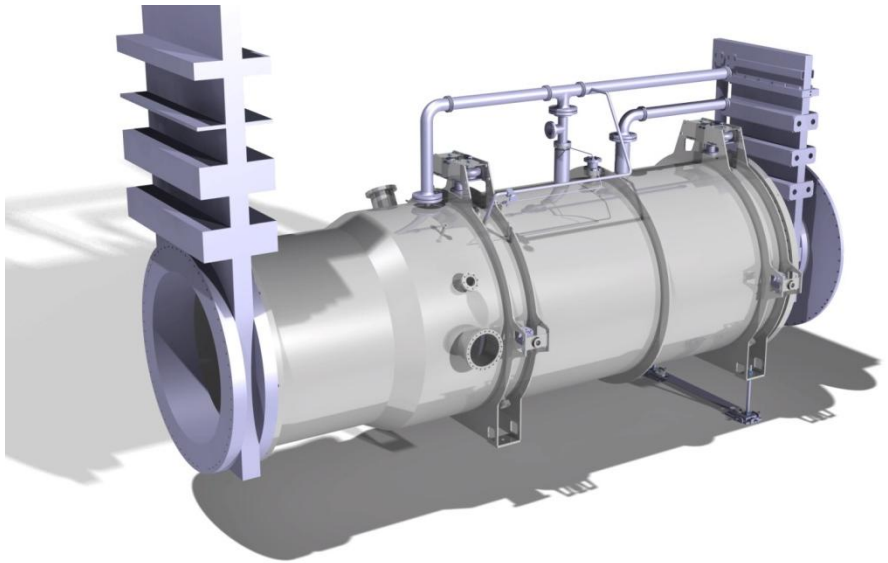



Tower
Cryogenic vacuum link
ITF arm


Air spring
Vacuum vessel
Nitrogen vessel


3D Solid parabolic tetrahedron
5 mm thick 2D Thin Shell parabolic quadrilateral
FORCE 4000/4 N
Fixed restrains (Bolted connection to valve)
4 mm thick 2D Thin Shell parabolic quadrilateral
Fixed restrains in Z direction (support below vessel)
Symmetric restrains (half the vessel is modeled, as the vessel is symmetric about YZ)
Vacuum load 0.1 MPa

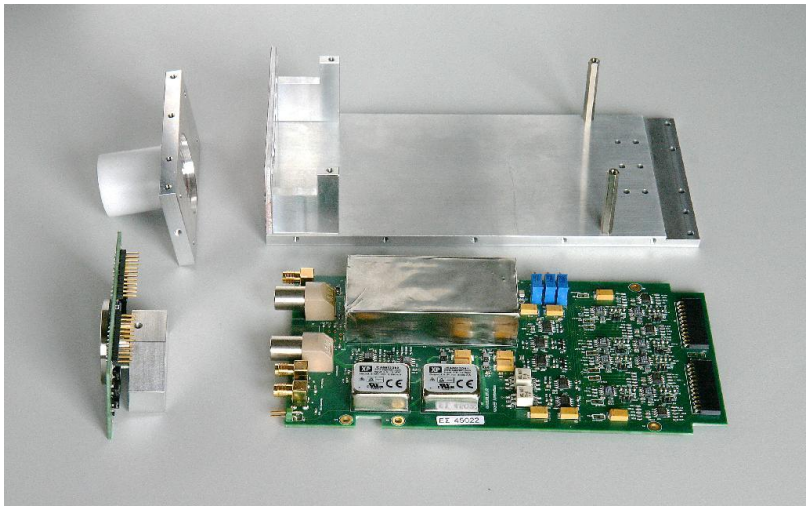

Support
Nitrogen vessel

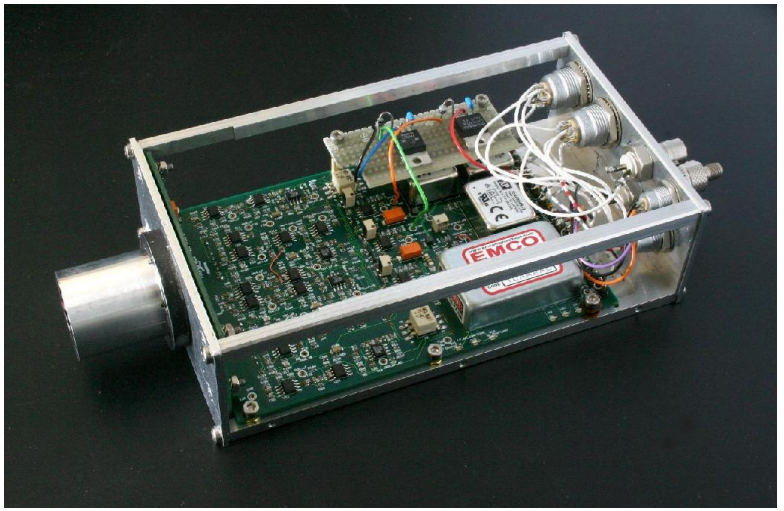


Linear alignment

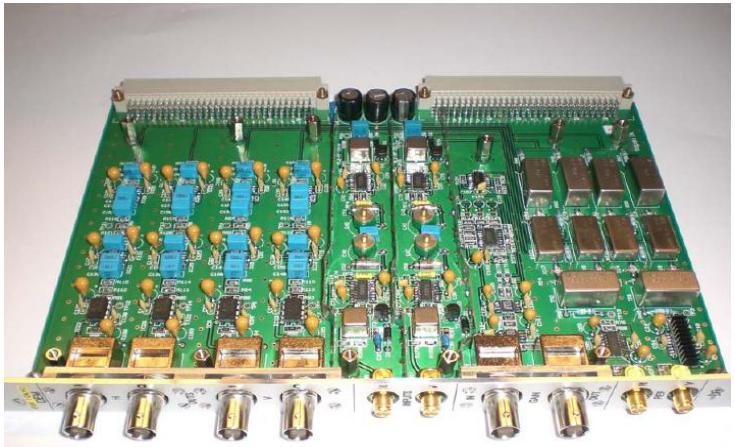
Henk Groenstege, Nikhef
Han Voet, VU University Amsterdam

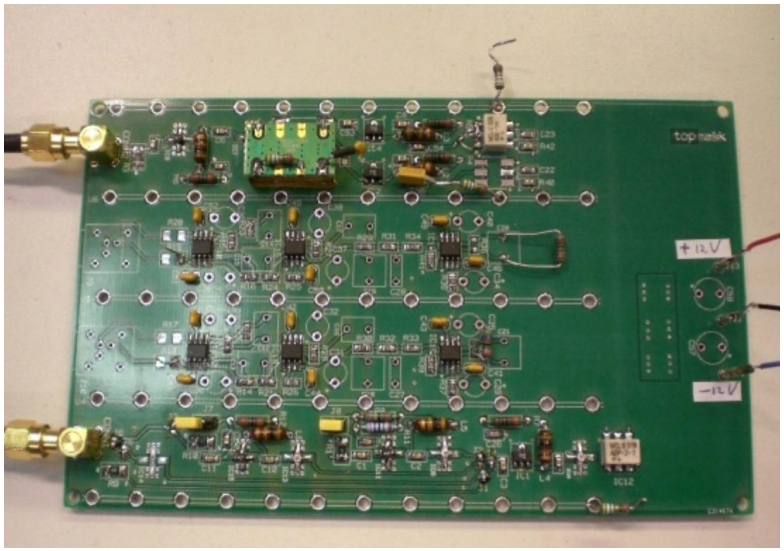
Quadrant photodiode front-ends





Demodulator boards
Prototype for AdV: 2 – 120 MHz

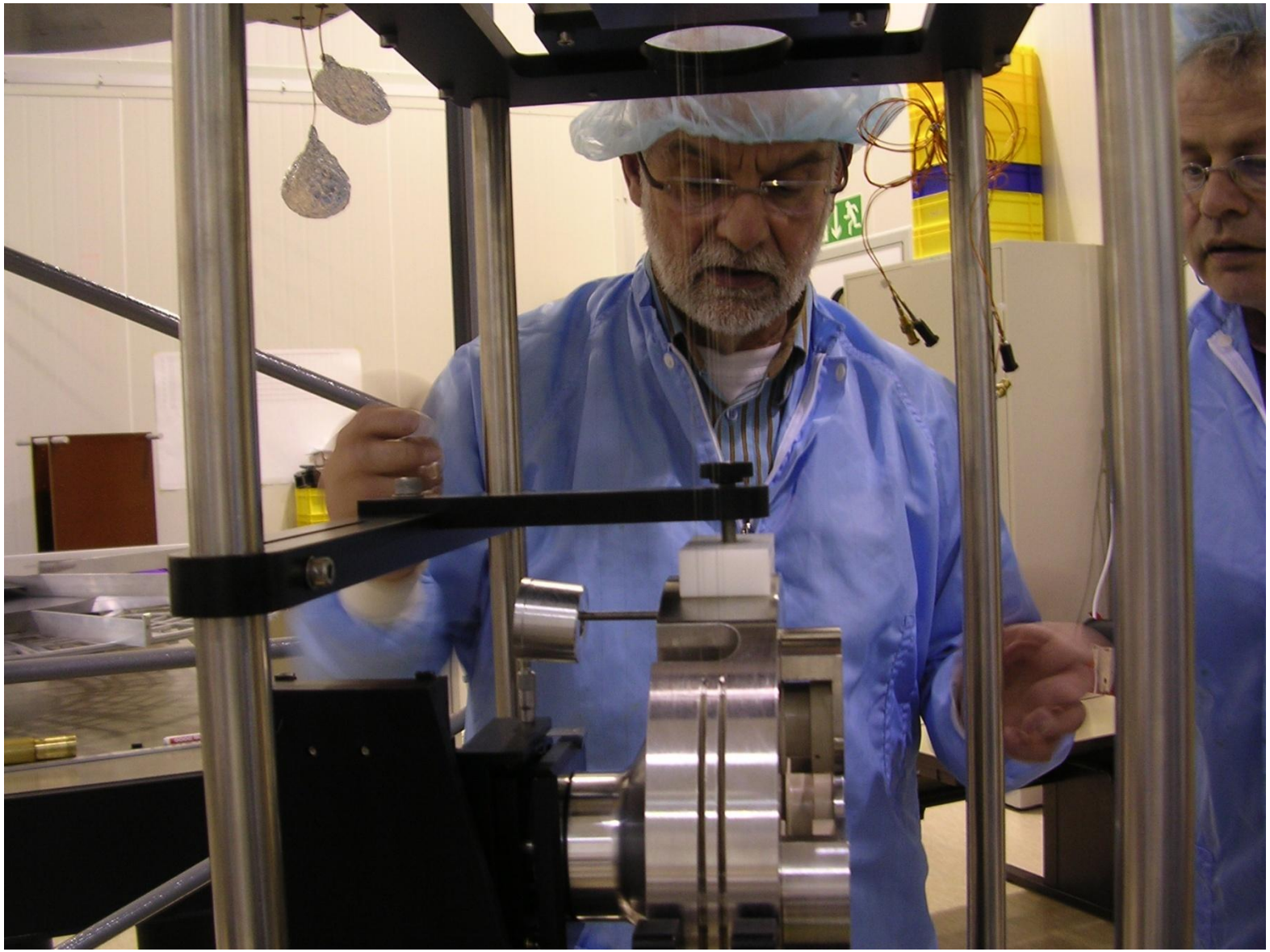




IMC end mirror made at Nikhef

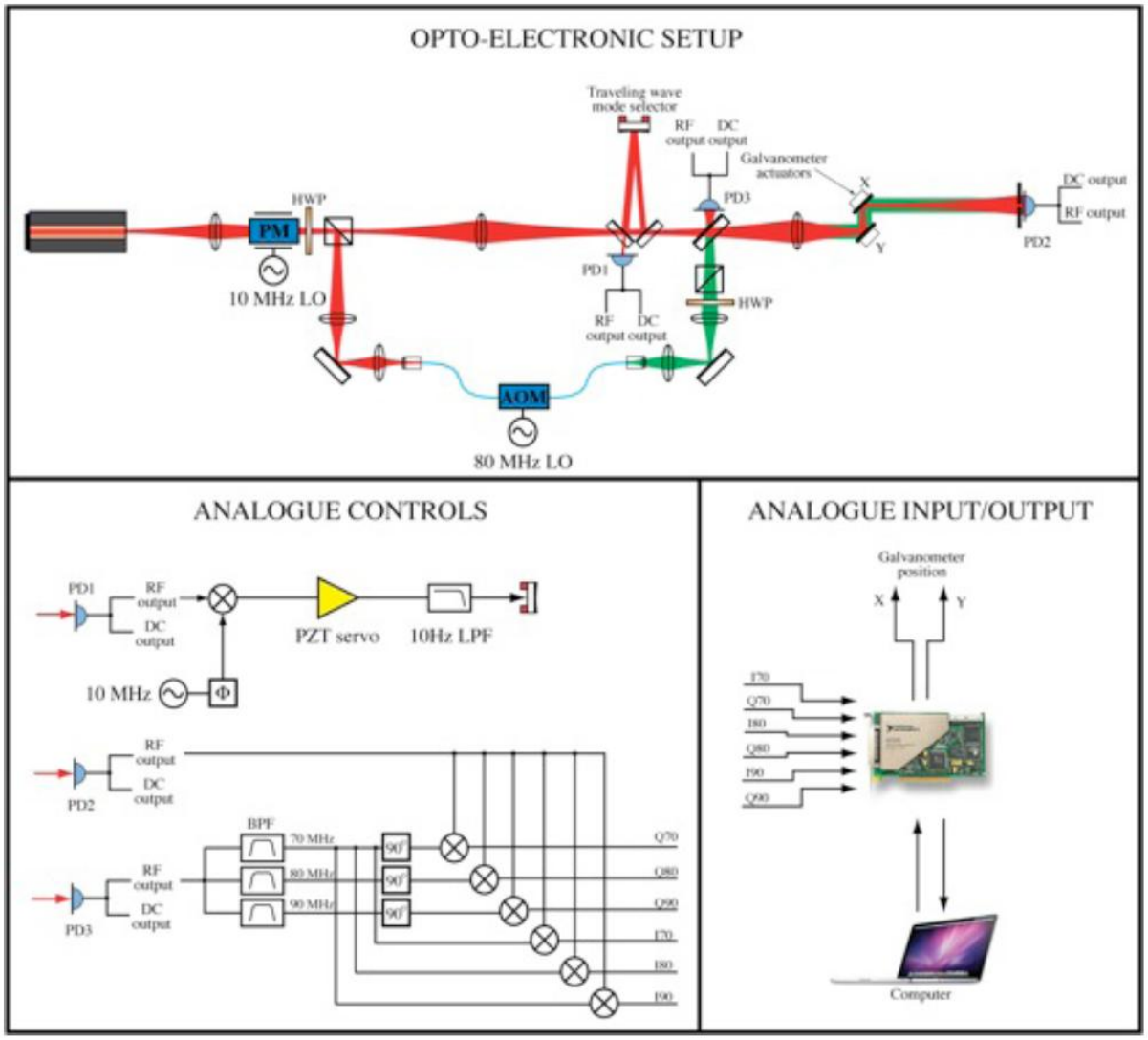
Moveable mirror (30 mm) with counter weight

IMC end mirror made at Nikhef



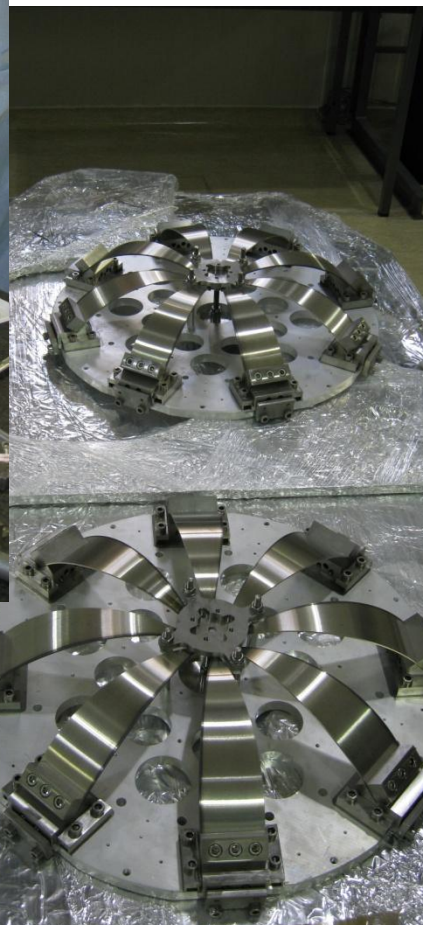
Phase camera (2) for AdV

David Rabeling, Nikhef



Optical tables suspensions

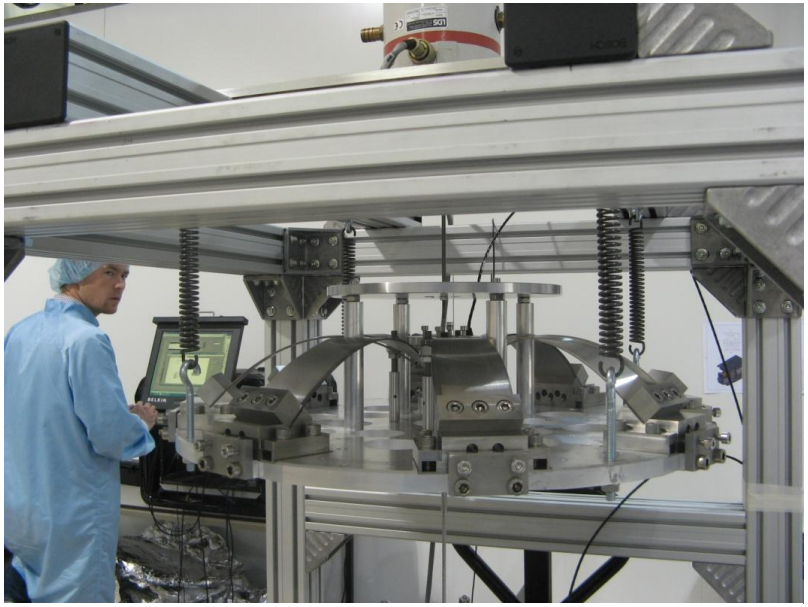
- Assembly
  - Nikhef cleanroom
  - Completed

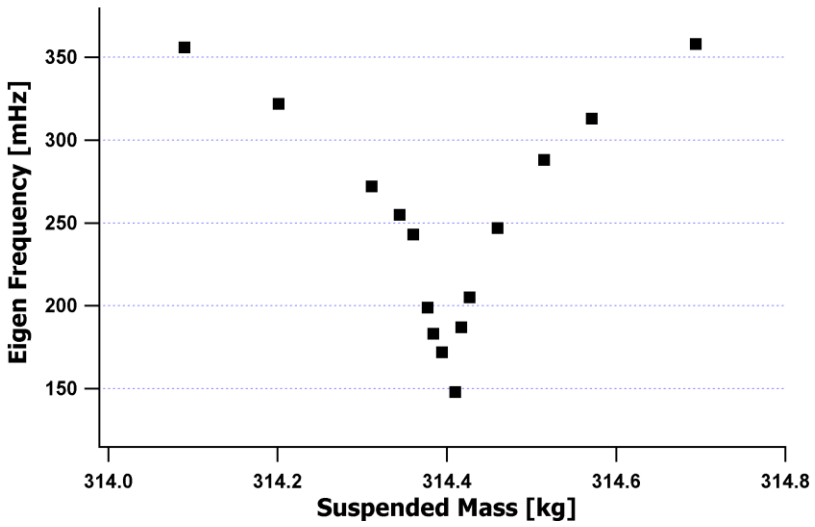


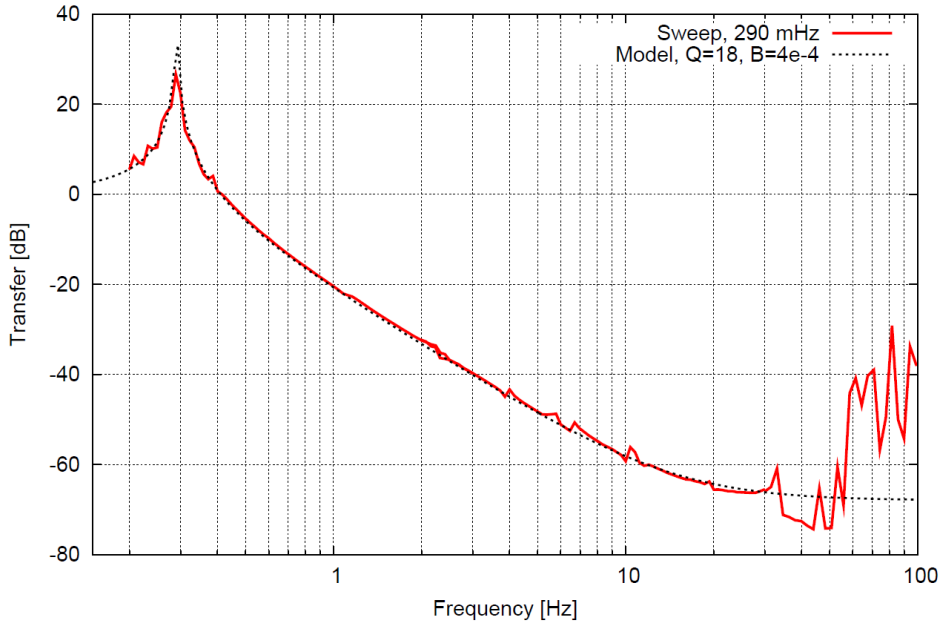
Frans Mul
Willem Kuilman
Michiel Jaspers
Gerrit Brouwer
Mark Beker
Mathieu Blom

GAS ISOLATION PERFORMANCE

- Transfer function
  - 60 dB above 10 Hz
  - Achieved > 65 dB at 20 Hz
  - Precise loading
    - Weigh components on bench
    - Decided on frequency setting: 400 mHz
  - Quality factor decreases at low frequency

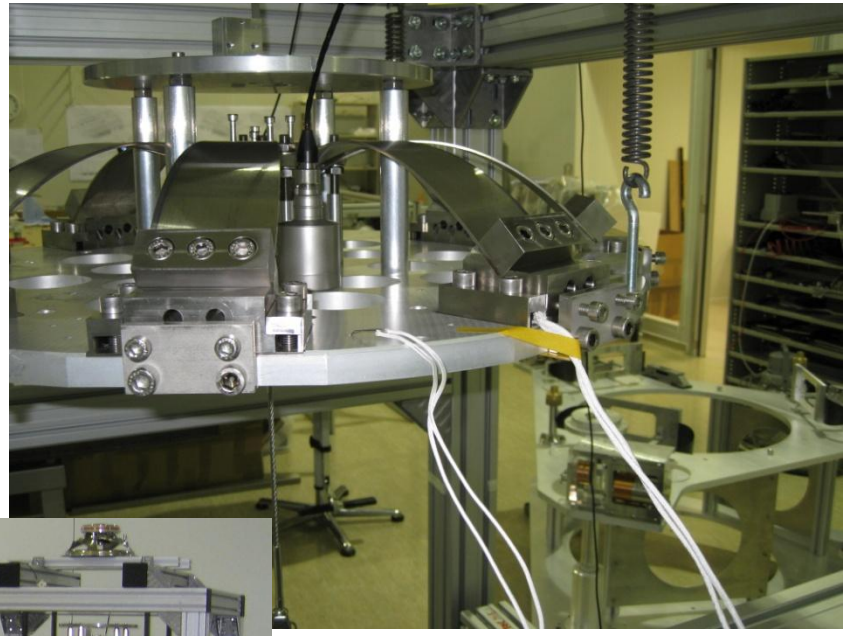






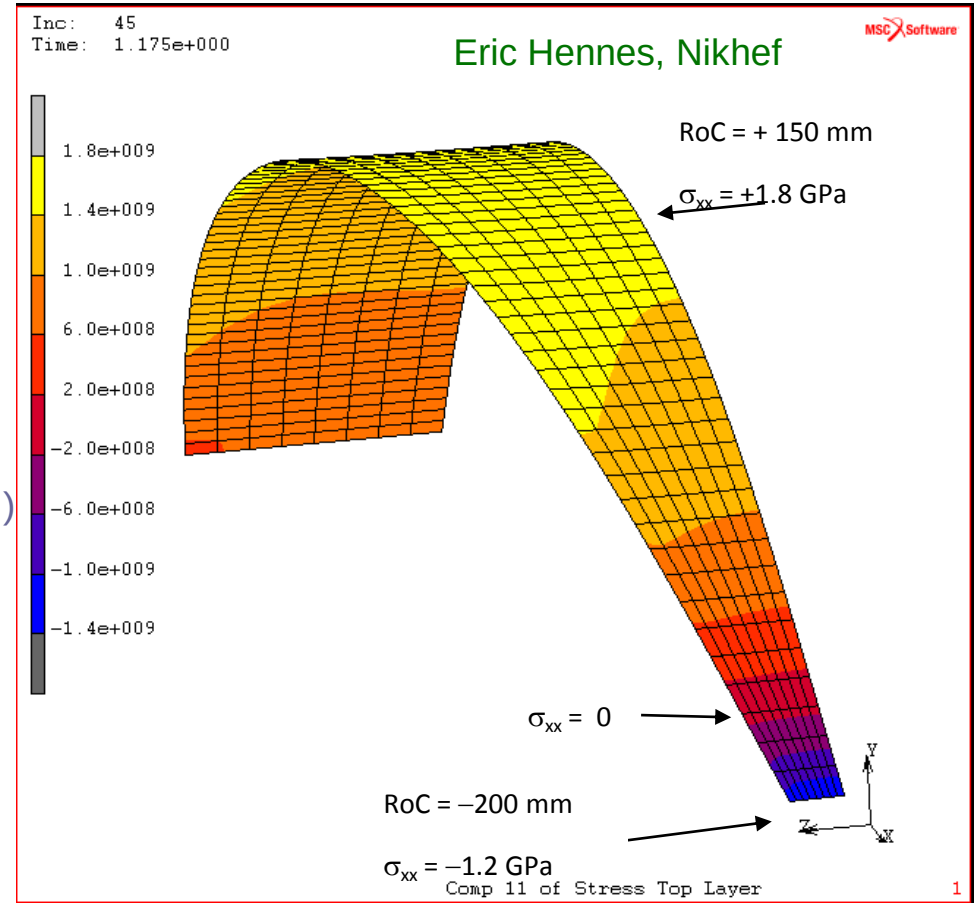
GAS TESTS

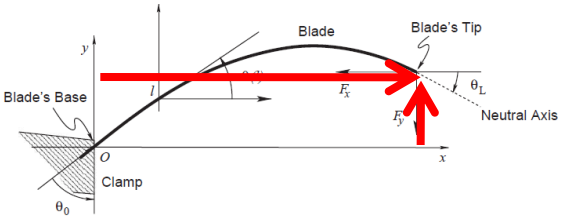
- Temperature dependence
  - Cleanroom: 16 to 24.2 degrees C
  - Measure
    - Vertical displacement
    - Resonance frequency
- Creep studies



FEA studies

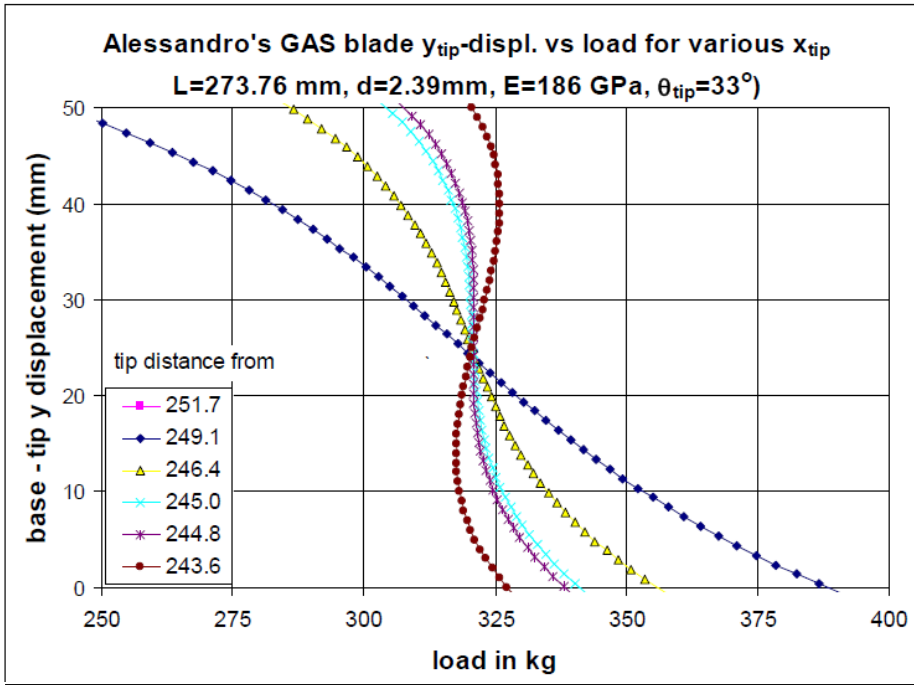
- FEA results
  - Stress distribution
    - Poisson ratio 0.32
    - Width distribution
    - Average stress 1.4 GPa
    - High surface stress
  - Compare FEA to data
    - Temperature stability (cleanroom!)
    - Strain gauges, tensile tests
    - Frequencies, positions
    - Safety aspects
    - Stress corrosion
  - Discuss with experts
    - ESA, Marine
    - Albert Einstein Institute, Caltech, Pisa, …
- Affect GAS design

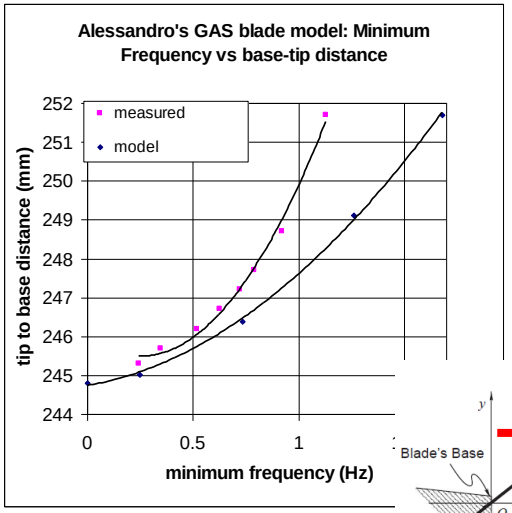


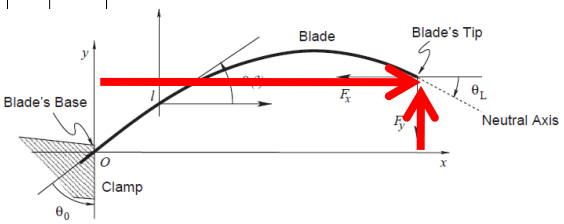


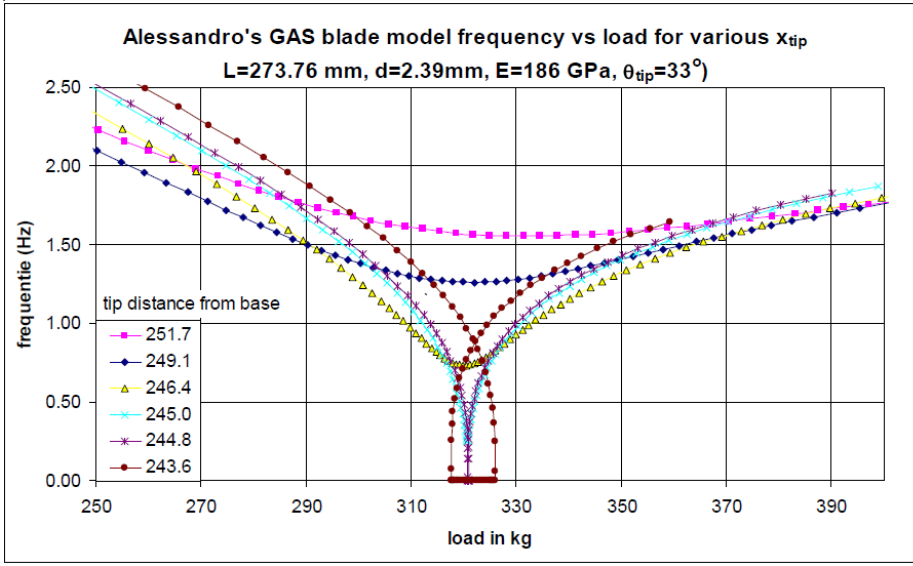
FEA STUDY: TUNING PROCEDURE

- Tuning procedure predictions
  - Base-tip distance vs load
    - For various x values
    - Optimum predicted at x = 244.8 mm
  - Frequency vs load
    - For various x values
    - Tune x to > 244.8 mm
    - Tune within few tenth's of mm



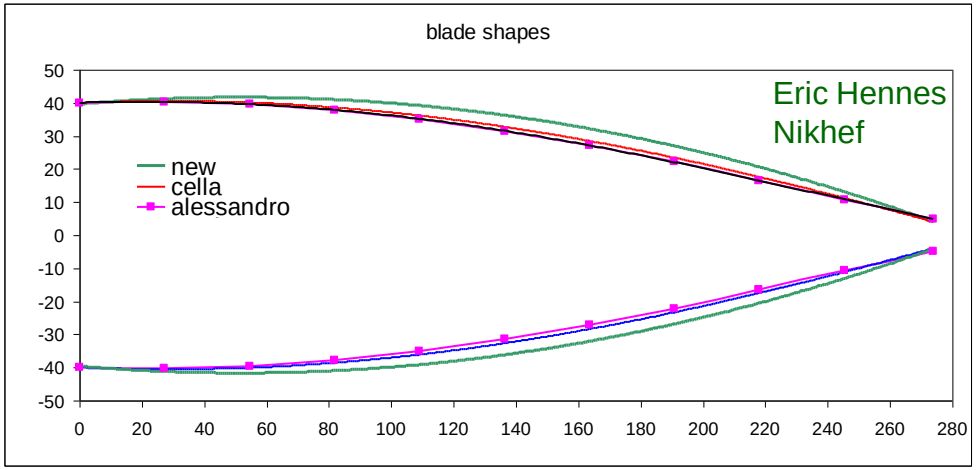


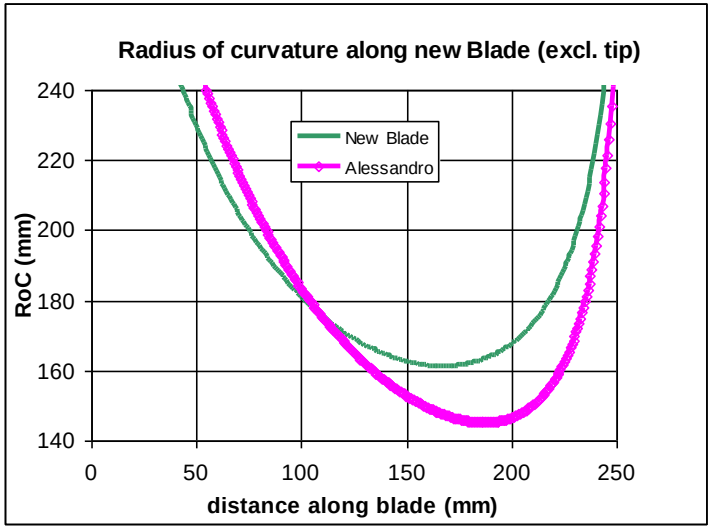


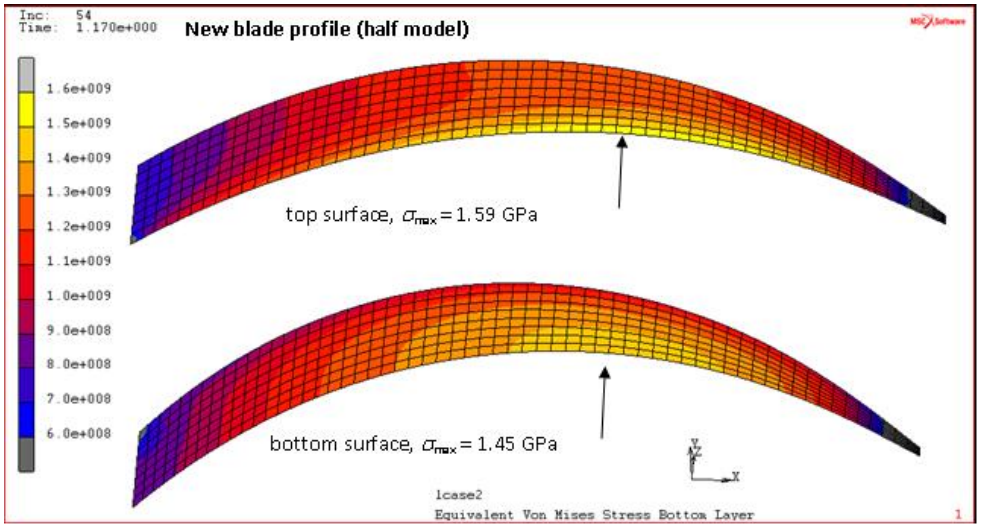


FEA STUDY: BLADE SHAPES

- Blade shape optimization
  - Shape for LCGT under study
    - Check with prototypes
    - 12% stress reduction
    - Work in progress



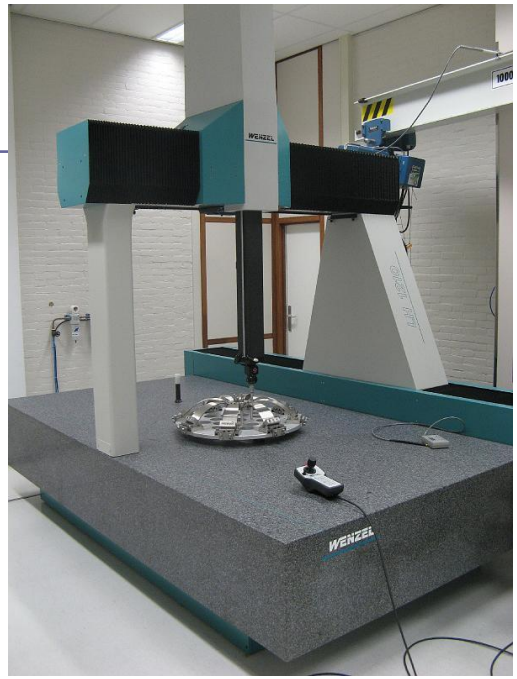


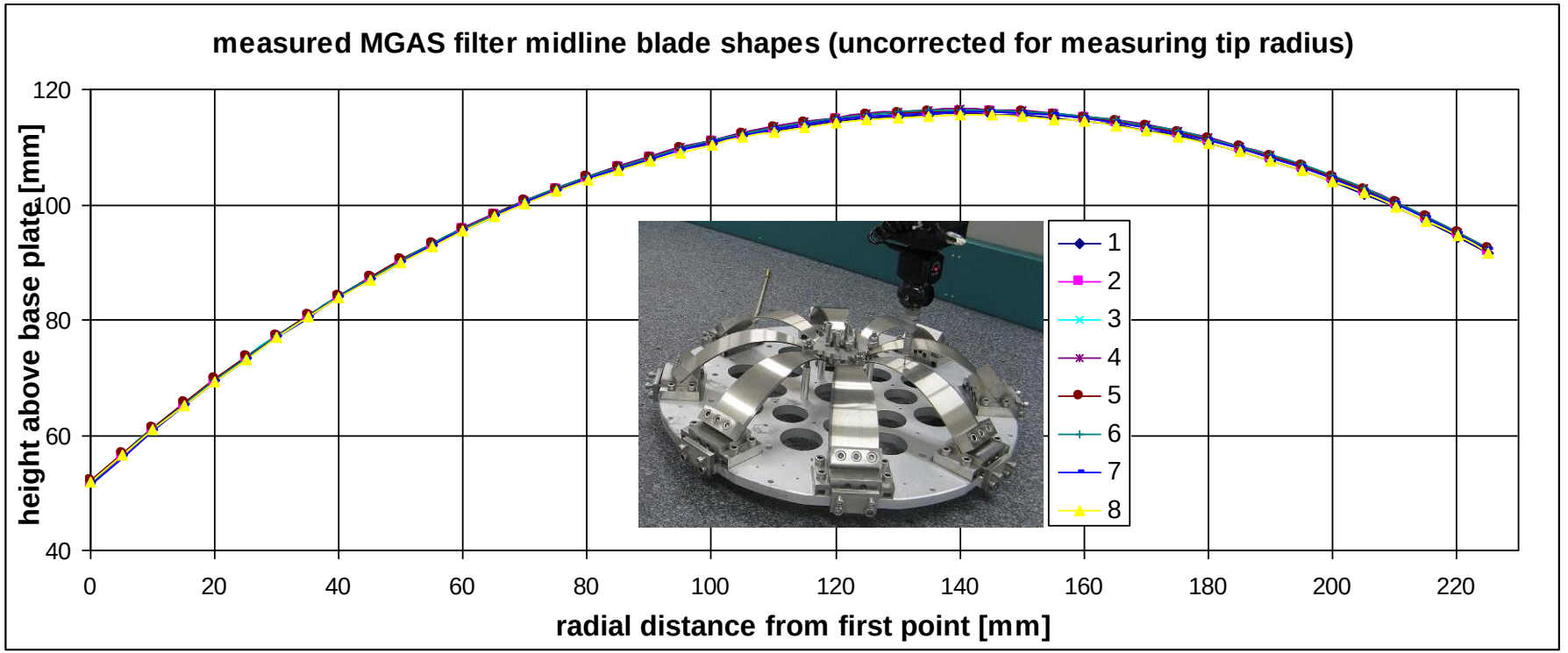


GAS PROFILE

Berend Munnicke
Eric Hennes, Nikhef

- GAS blade shapes
  - 3D measuring machine
    - First results (to be corrected for tip radius of probe)
    - About 1 mm differences between the eight blades
    - Small tilt of the keystone?
    - Implications for H/V coupling?

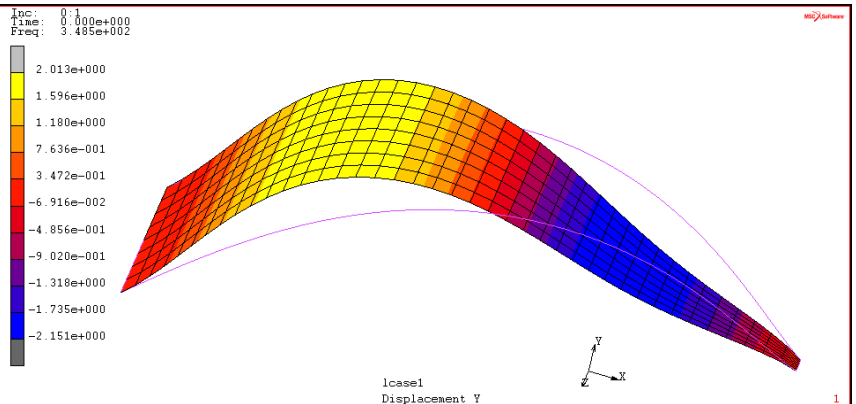


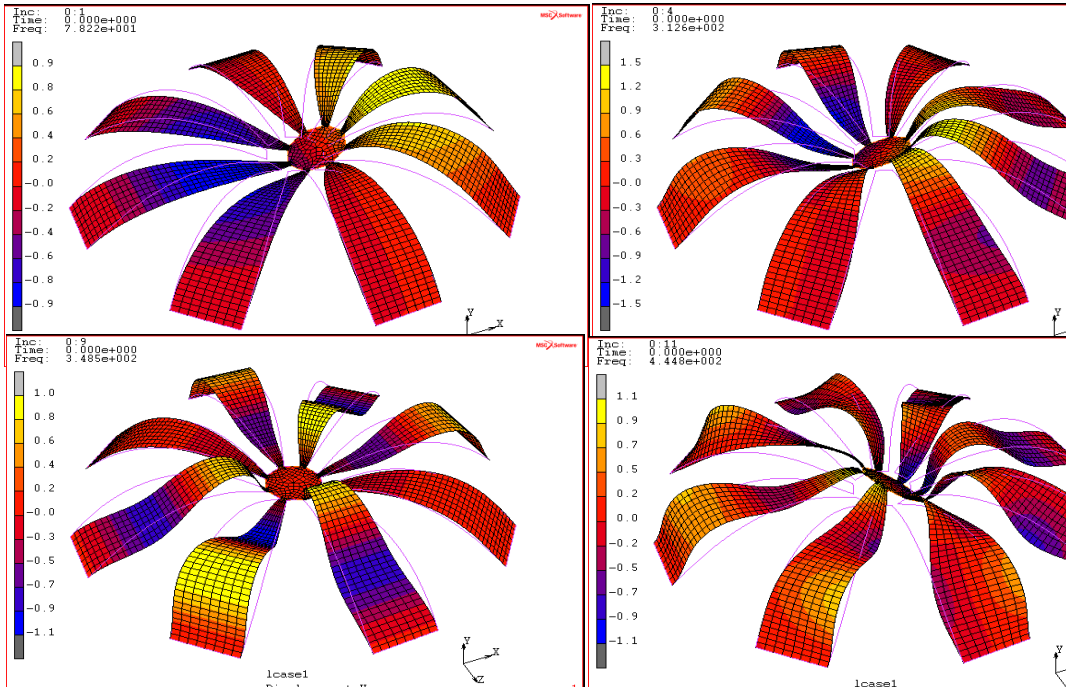


GAS BLADE: MODAL ANALYSIS

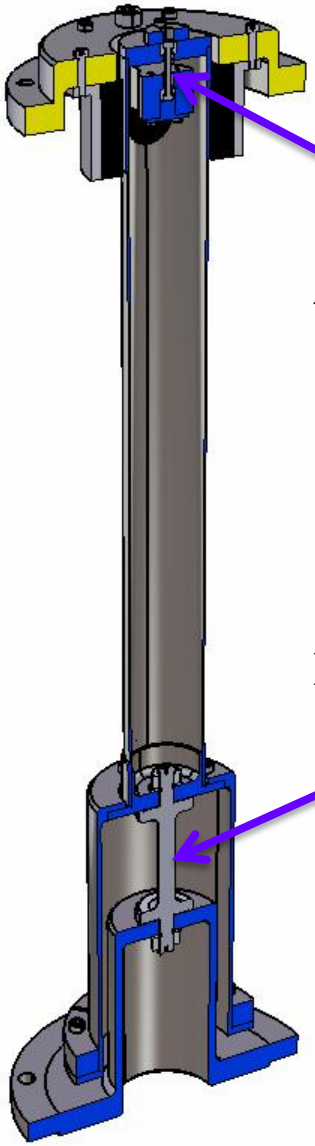
Eric Hennes
Nikhef

- GAS blade rigidly connected to free-moving keystone (0.5 kg)
  - 80 Hz for two translational/rotational modes
  - 300 Hz for two keystone rotational modes (about horizontal axis)
  - 350 Hz for eight internal blade modes (zero rotation and displacement of keystone)
  - 445, 500 and 720 Hz: two modes, including blade twist
- GAS blade rigidly connected to keystone
  - Keystone can be considered fixed for EIB-SAS
    - First modal shape at 350 Hz
    - Under stress at 325 Hz
    - For Virgo MAS at 105 Hz



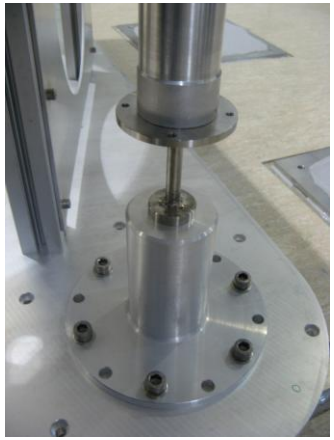


IP assembly

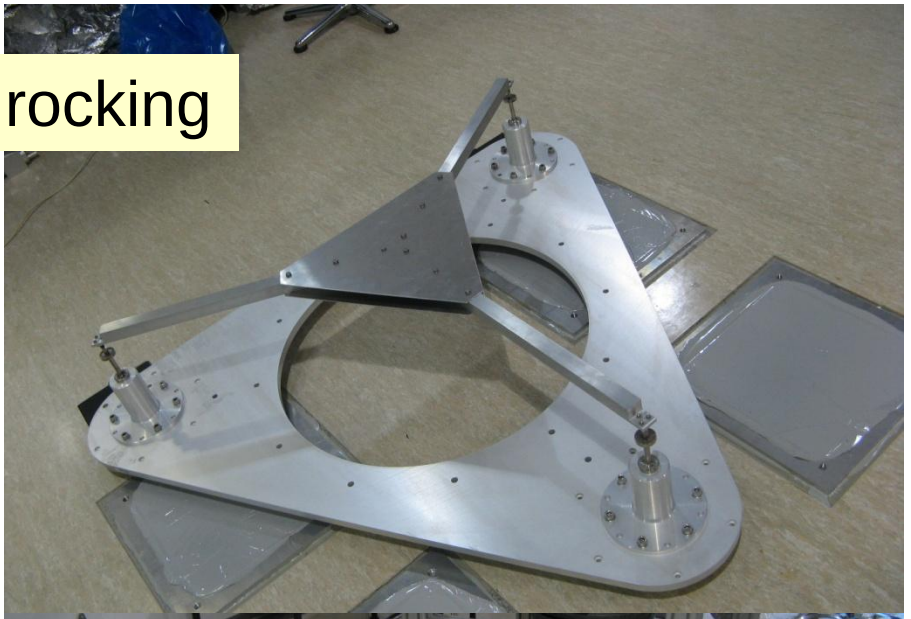


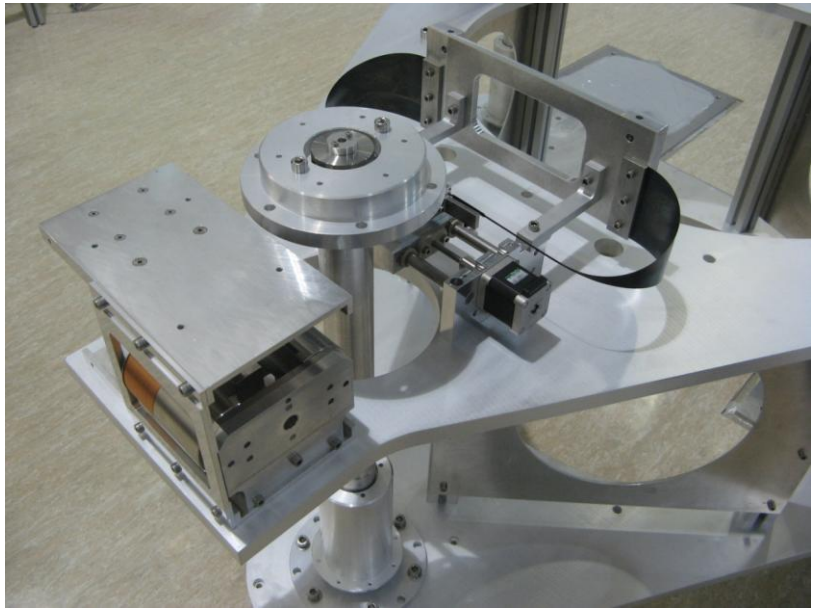
Small flex joint

Main flex joint



Tool to minimize rocking

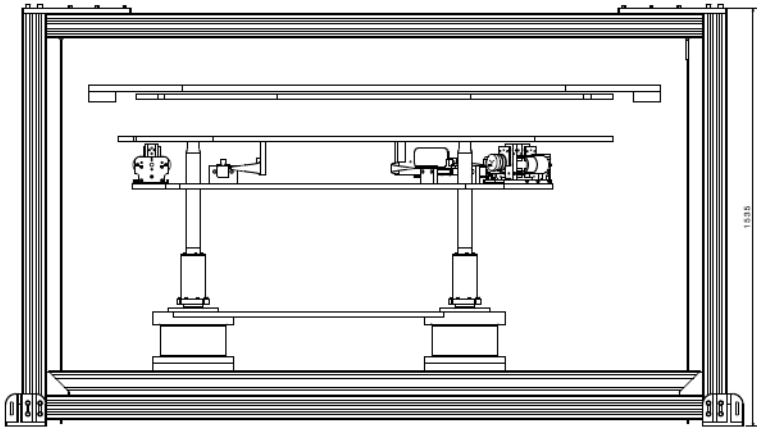


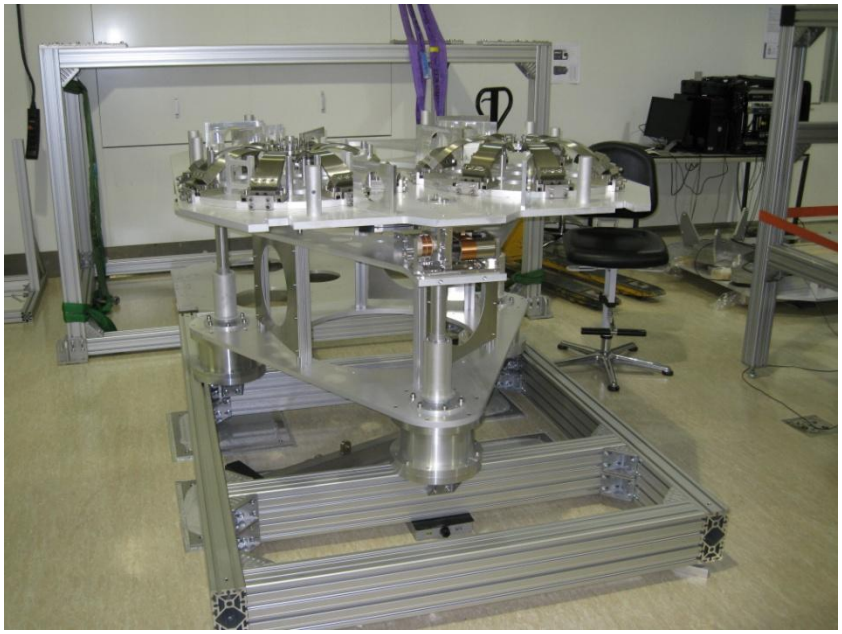


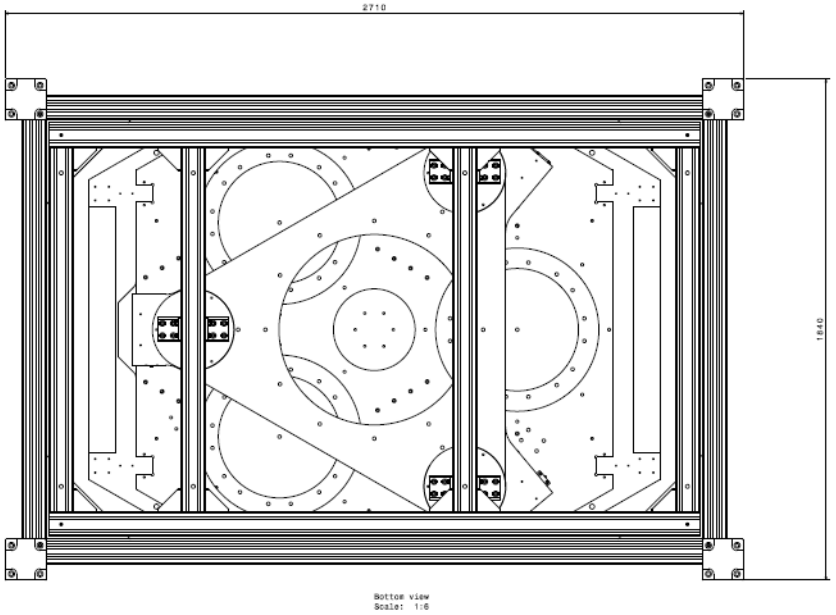
IP tuning

Gert Jan Mul

- IP tuning set-up
  - Frame completed
  - Suspend EIB-SAS
  - Shaker, accelerometers
- Tune IP counterweight
  - Improve horizontal transfer function
  - Measure transfer functions



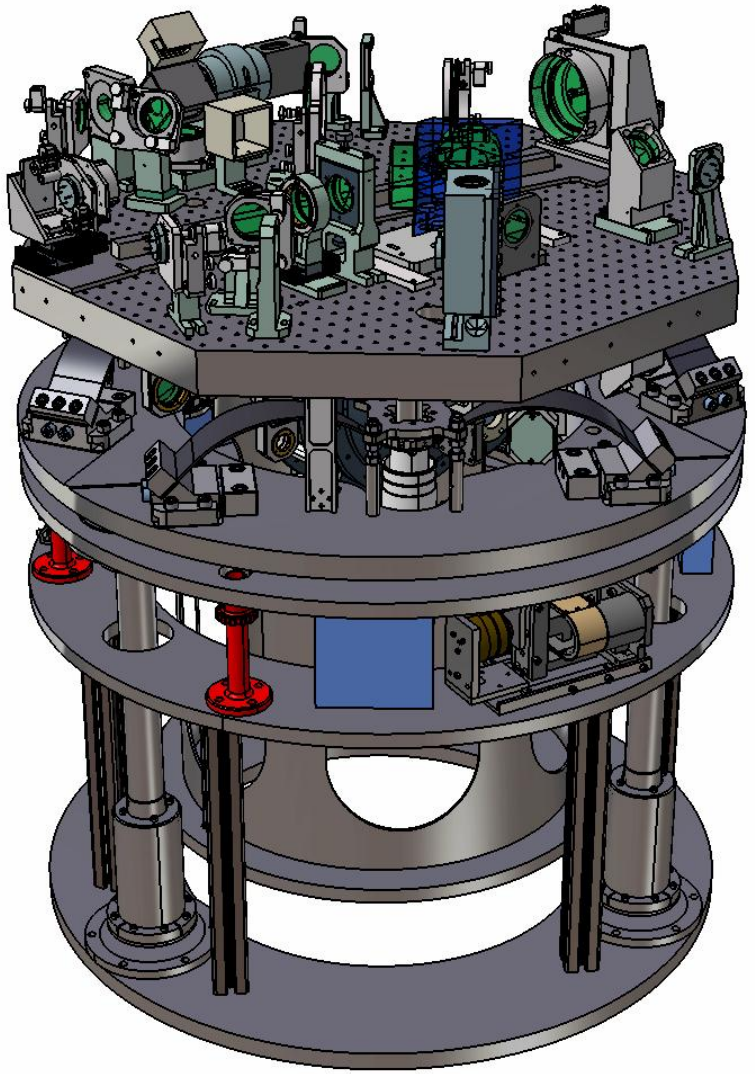




Internal bench suspension tables

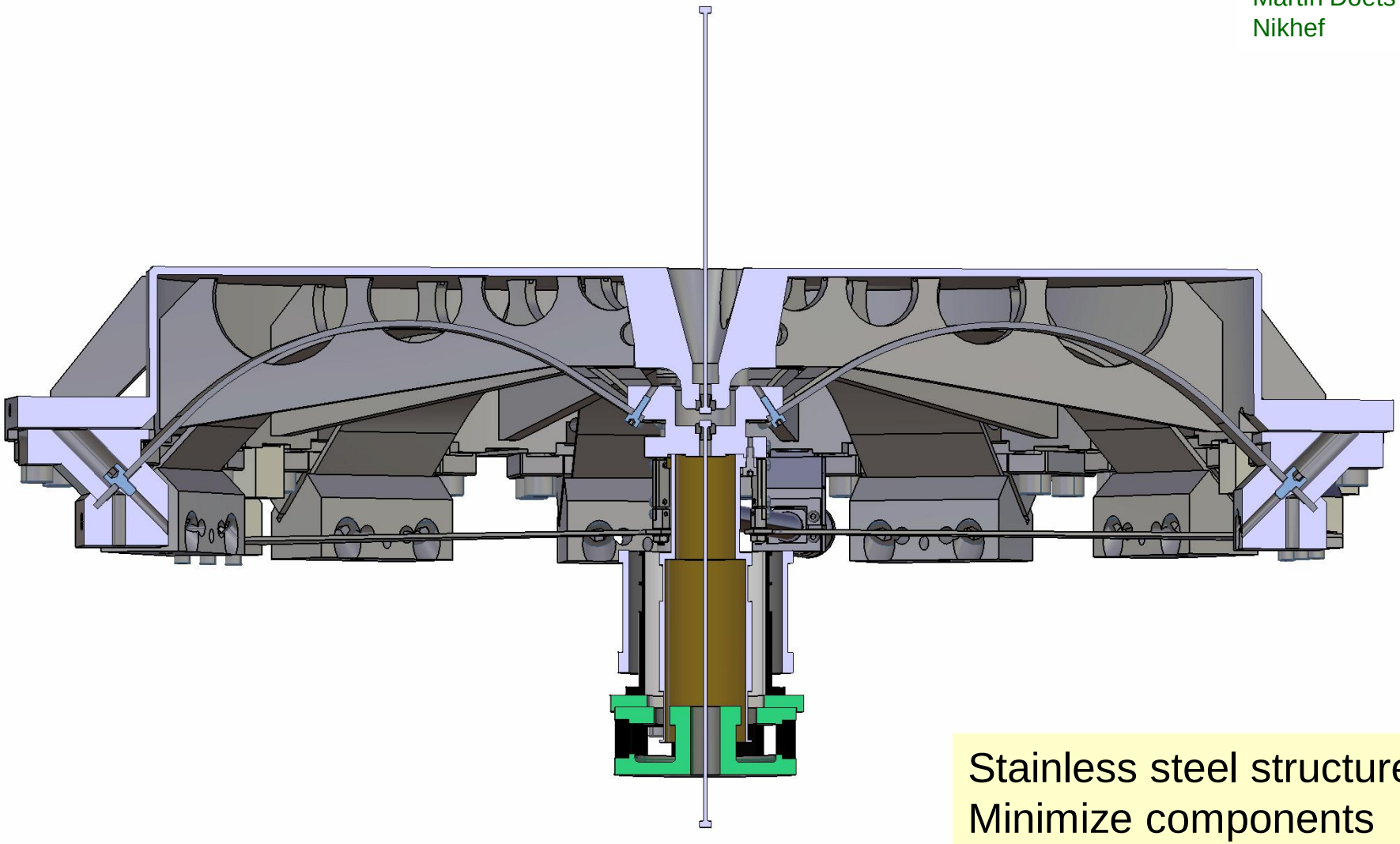
A. Bertolini, AEI
F. Mul, Nikhef

- Attenuation
  - Horizontal: IP and wires
    - 127 dB (1 fm/rtHz) at 10 Hz
  - Vertical: GAS springs
    - 3 sets of 2 blades
    - Tilt stability
  - Vertical – horizontal coupling
    - 1% yields 1 pm/rtHz residual vertical
    - No wands needed
- Criteria and procedures needed
  - GAS systems, short IP legs
    - AdV specs on displ/tilt noise needed
  - Optical paths
    - Layout and access, lower IB
    - Freeze specs ASAP
  - Control issues
    - Sensors, cabling, vacuum separation



GAS as chain element

Martin Doets
Nikhef



Stainless steel structure
Minimize components

Drum mode at 350 Hz

GAS as chain element

Settle on design (2010)
Construct 2 filters
Test in Q1 2011: characterize 6 dofs

Tests in collaboration with LCGT?

Martin Doets
Nikhef