

# Evolution of Landing and Arresting Gear Simulation at Fokker Landing Gear

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20180504

See also: Siemens, Vienna, 2016, Design optimization of Landing Gear by Matlab driven VL-Motion models



*Fokker*

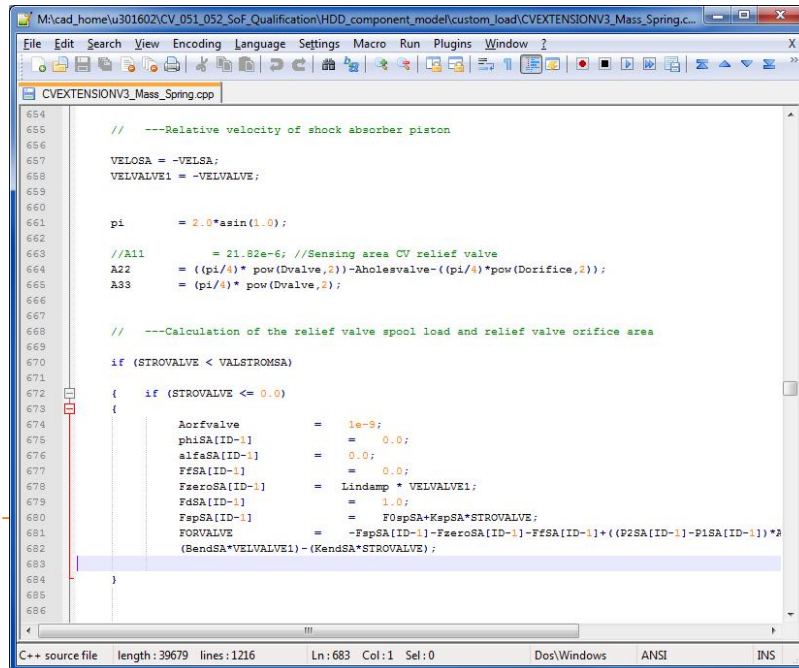
 GKN AEROSPACE

# AMESIM 1D HYDRAULICS/PNEUMATICS/...

## Mathematical $\beta$ modelling à Physical

### Past:

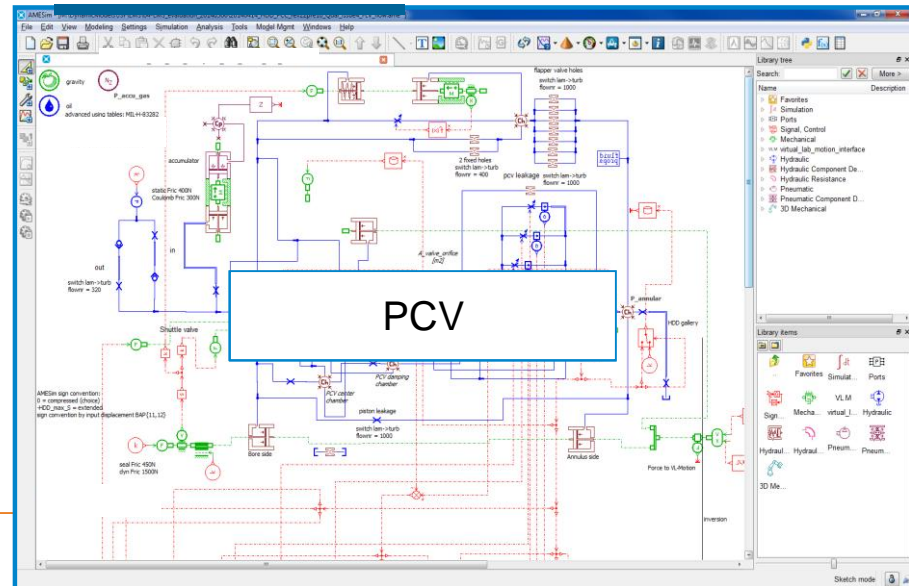
- § Free-body diagram à C-code
- § Tedious, error-prone, hard to evolve & to transfer the accumulated knowledge



```
654 // ---Relative velocity of shock absorber piston
655 VELOSA = -VELSA;
656 VELVALVE1 = -VELVALVE;
657
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659
660 pi = 2.0*asin(1.0);
661
662 //A11 = 21.82e-6; //Sensing area CV relief valve
663 A22 = ((pi/4)* pow(Dvalve,2))-Aholesvalve-((pi/4)*pow(Dorifice,2));
664 A33 = (pi/4)* pow(Dvalve,2);
665
666 // ---Calculation of the relief valve spool load and relief valve orifice area
667
668 if (STROVALVE < VALSTROMSA)
669 {
670   if (STROVALVE <= 0.0)
671   {
672     Aorfsvalve = 1e-9;
673     phiSA[ID-1] = 0.0;
674     alfaSA[ID-1] = 0.0;
675     FfSA[ID-1] = 0.0;
676     FzeroSA[ID-1] = Lindamp * VELVALVE1;
677     FdSA[ID-1] = 1.0;
678     FspSA[ID-1] = F0spSA+KspSA*STROVALVE;
679     FORVALVE = -FspSA[ID-1]-FzeroSA[ID-1]-FfSA[ID-1]+((P2SA[ID-1]-P1SA[ID-1])*A33
680     (BendSA*VELVALVE1)-(KendSA*STROVALVE);
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### Present:

- § GUI physical modelling
- § Software report in HTML
- § Easy, reliable, use of expert libs, easy model evolution & transfer of knowledge
- § FMU export



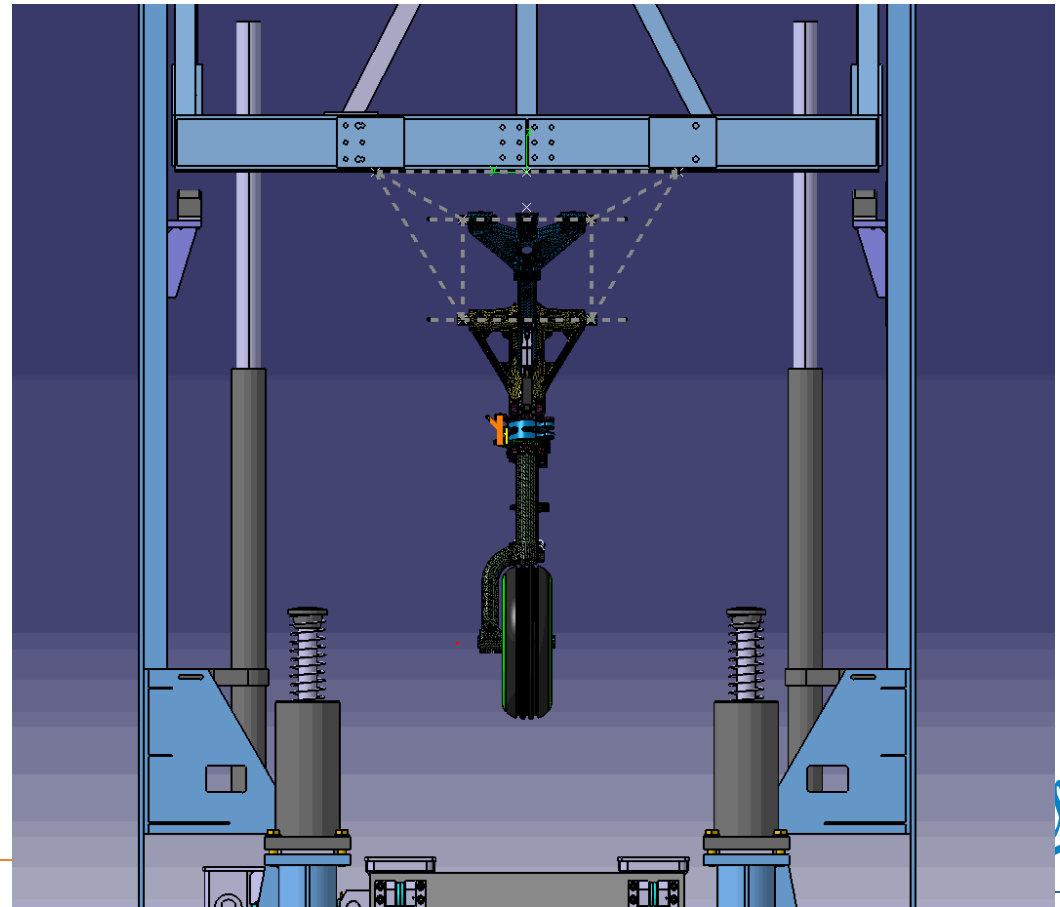
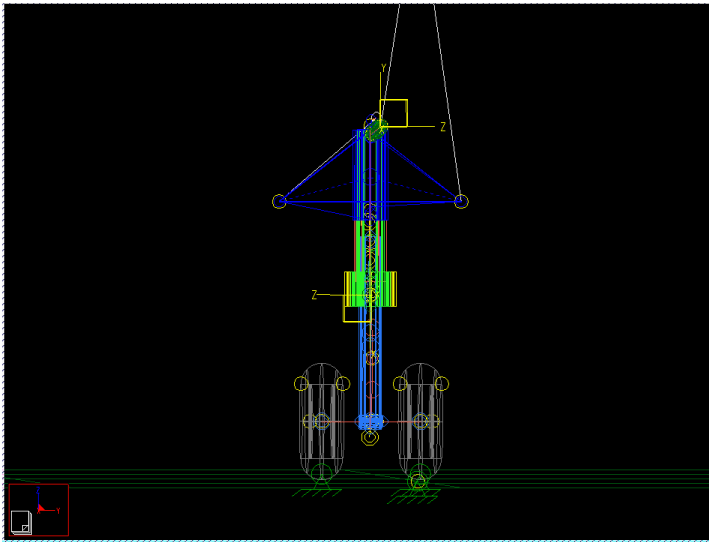
# VL-MOTION 3D MULTI-BODY DYNAMICS

## Flexibility options (Rigid / Beams / Modally Reduced)

Past:

- § Flexibility via beam models
- § Coupling 1D via compilation

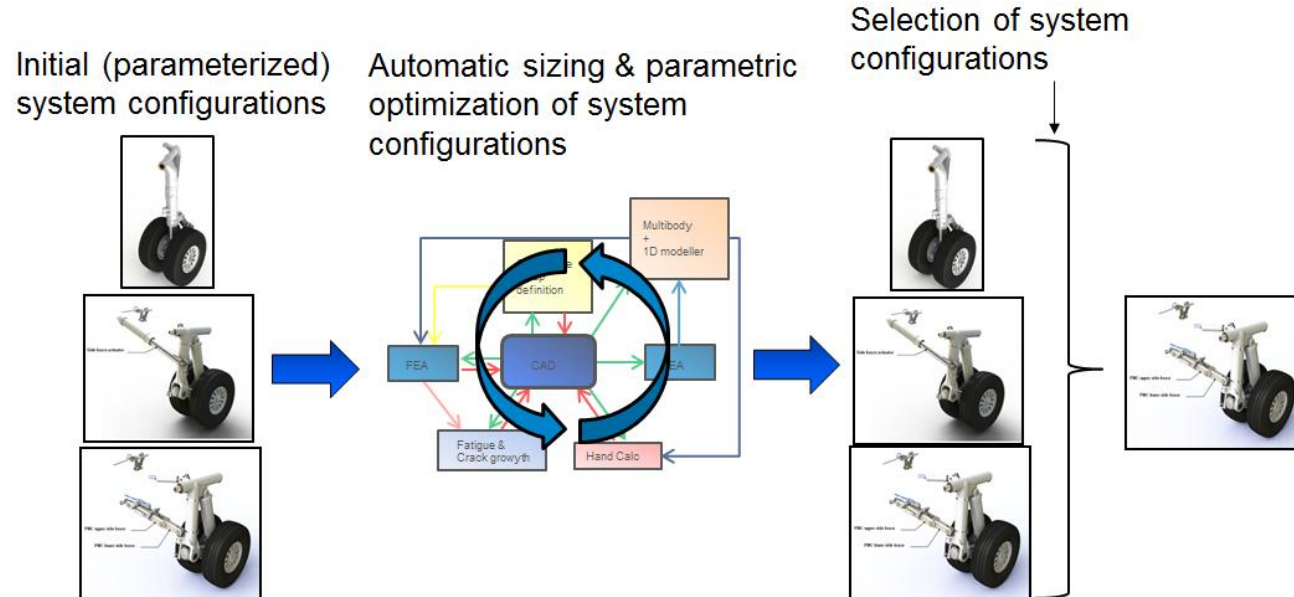
NH90 Shimmy example:



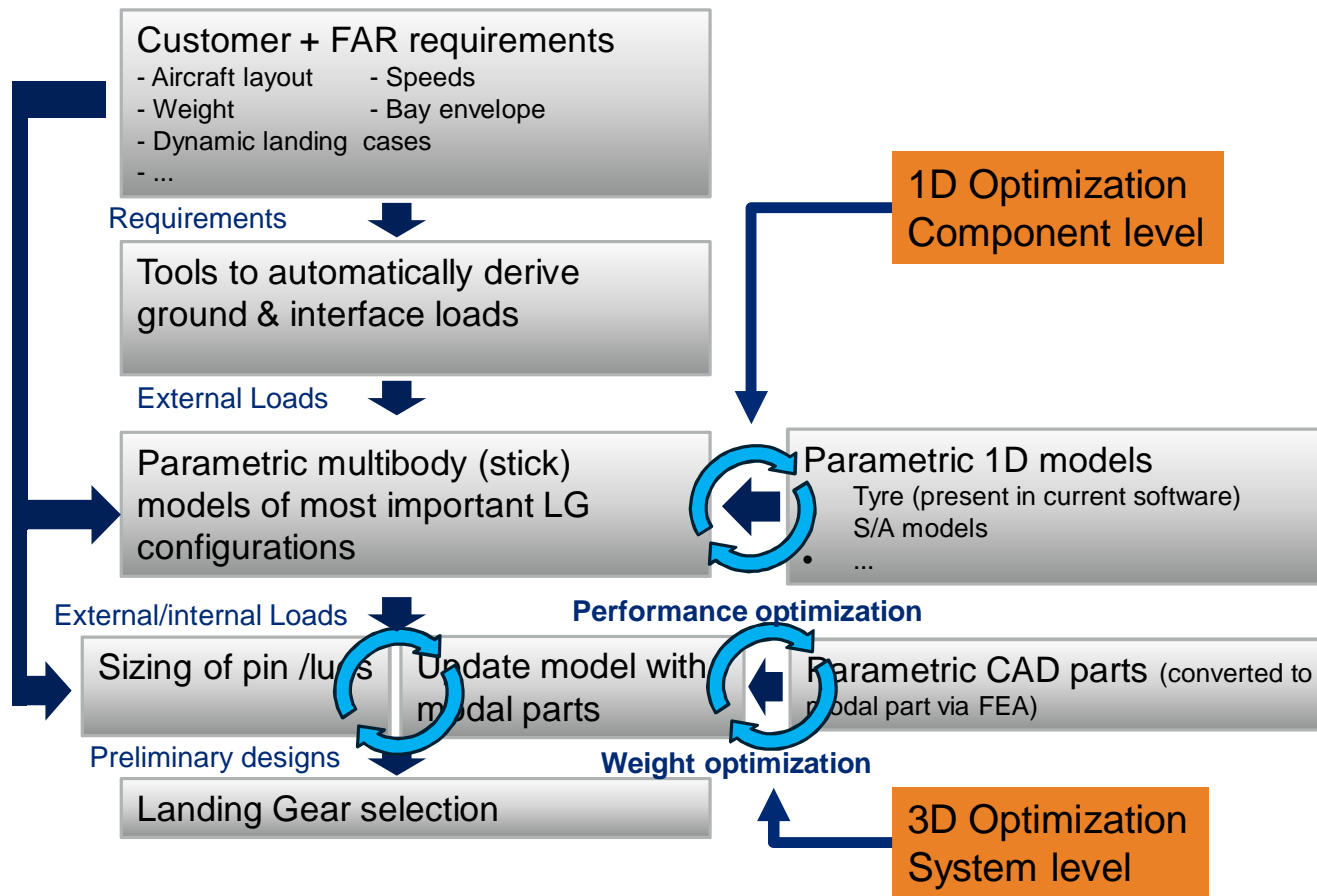
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# NEXT STEP: OPTIMIZATION OF THE DESIGN PROCESS

Create a tool to automatically size landing gear  
preliminary designs à proposal tool



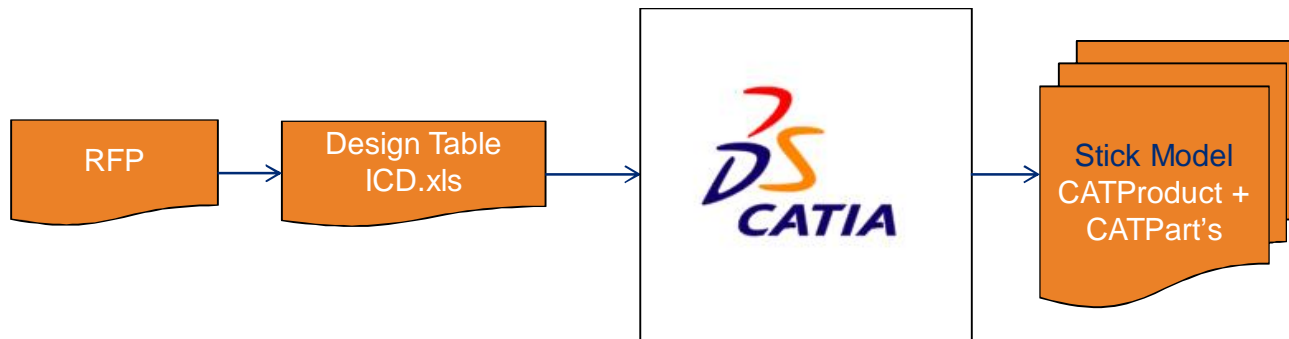
# SCHEMATIC STEPS IN THE OPTIMIZATION PROCESS



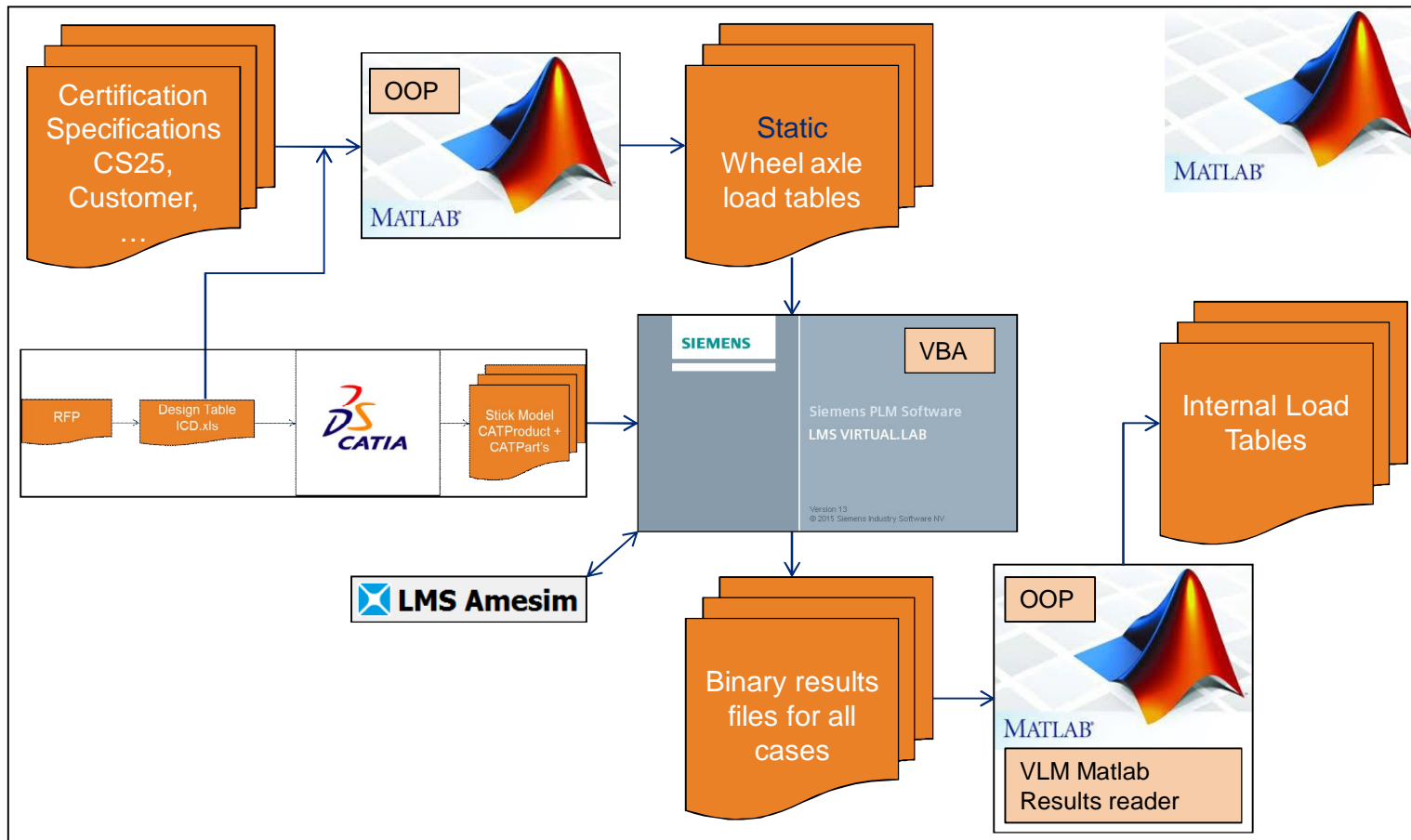
# MATLAB DRIVEN DESIGN TOOL

## Reuse of 3D CAD Effort à Stick Model

- § Stick model is built from a single Design Table (DT) xls file
- § Full parametric approach
- § Stick model + DT stored in Enovia

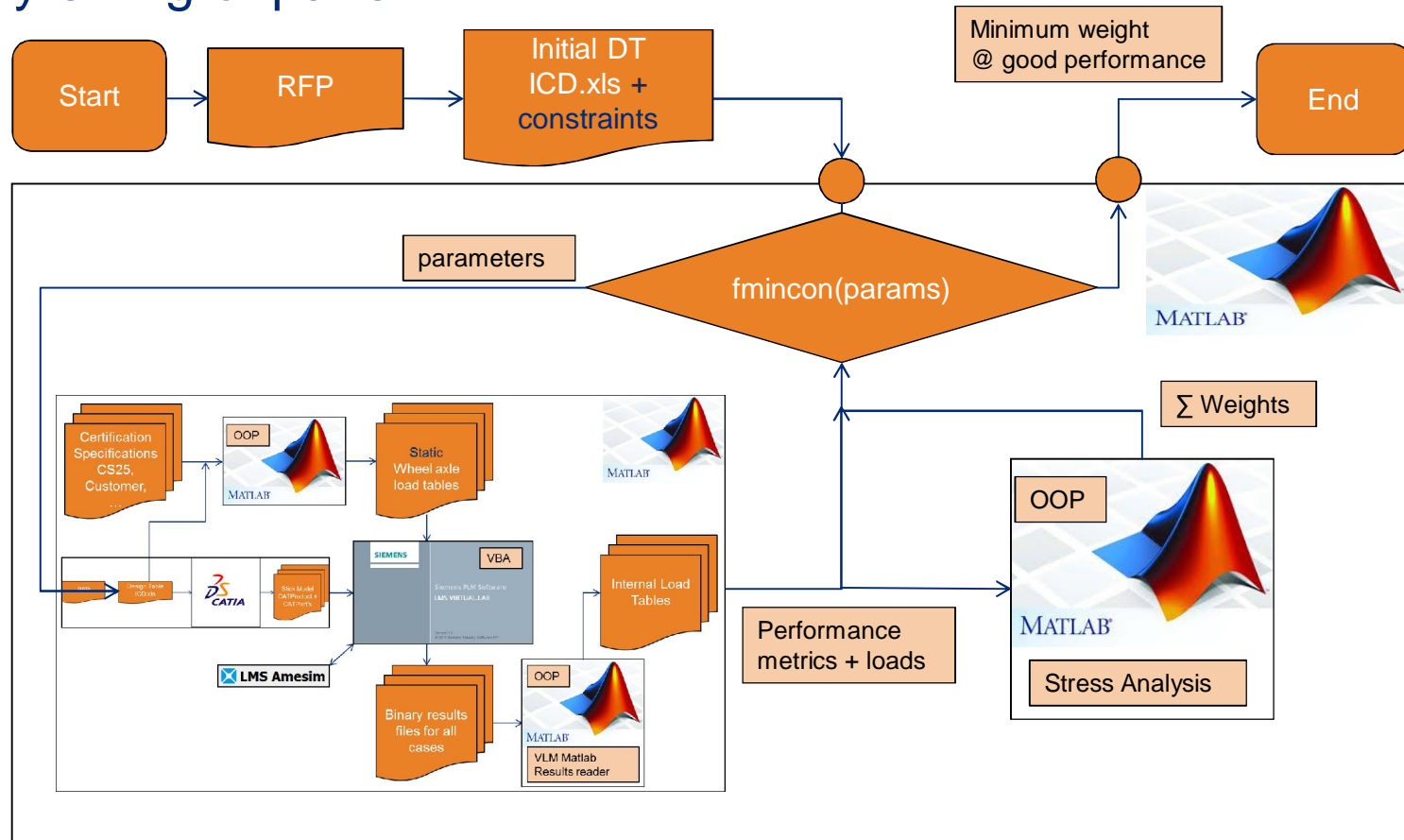


# EXTERNAL AND INTERNAL LOADS



# OPTIMIZATION

## Preliminary sizing of parts

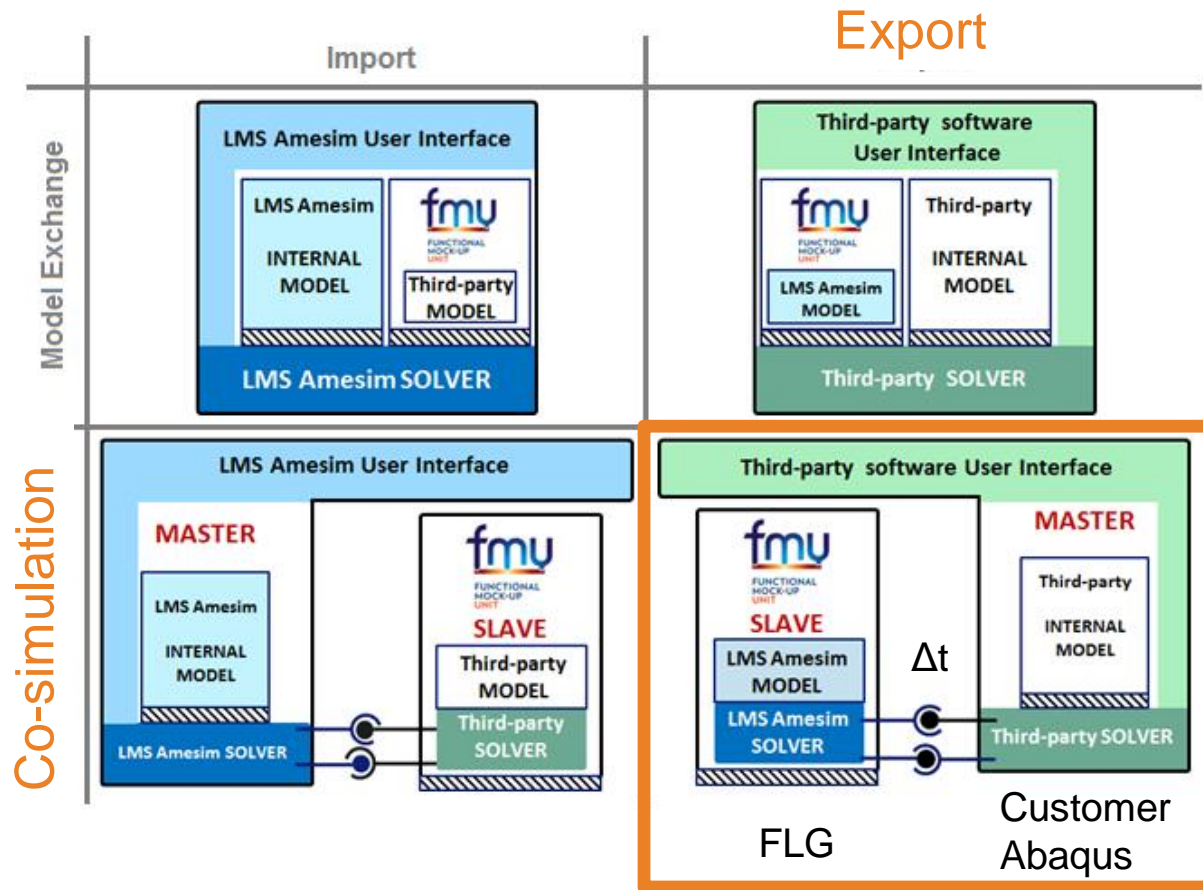




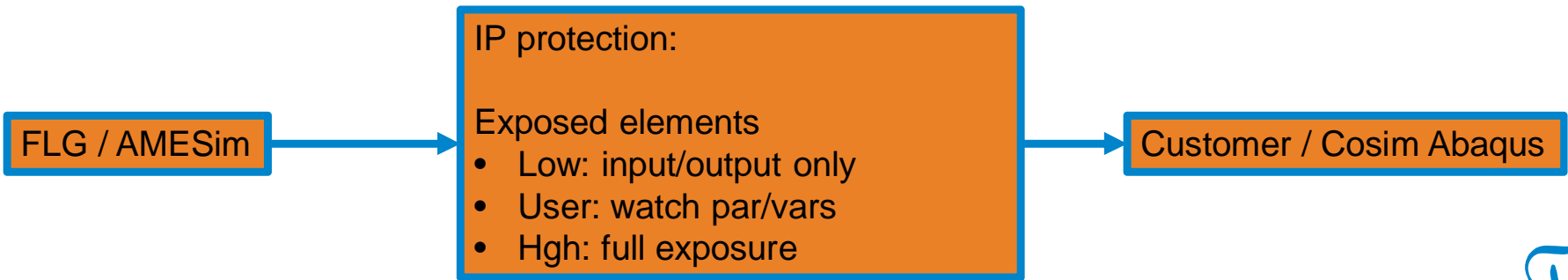
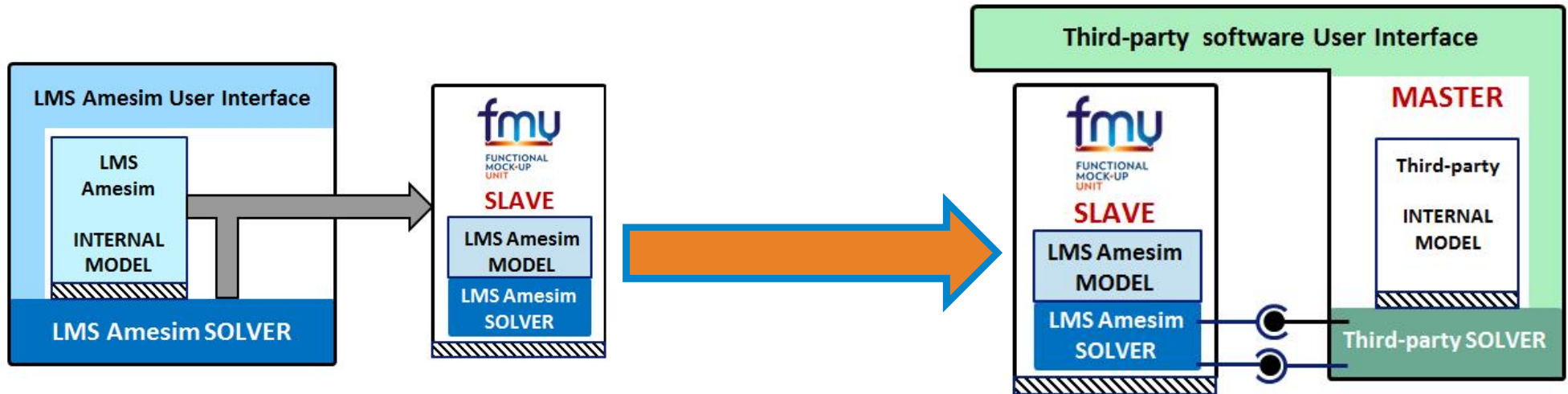
# CURRENT STATUS

- § Multidisciplinary Design Optimization for Flexible Systems
  - § Design based on single truth parameter file (Design, Stress, Dynamics)
  - § Modally reduced CAD parts
  - § Stress à Weight
  - § Performance
  - § Cost
- § Dynamic landing cases
- § Re-use of components via FLG libraries
  - § Submechanisms à **SimCenter?**
  - § Rigid stick models vs. parametrized flexible models
  - § Shock absorbers models (via cosim with AMESim)
- § Parametric CAD parts
  - § Parametric design in Catia à **SimCenter, NX/Catia import?**
  - § Automatically generated flexibility? à **SimCenter? NX Nastran**
- § Exporting the 1D model for our customers by FMU compilation

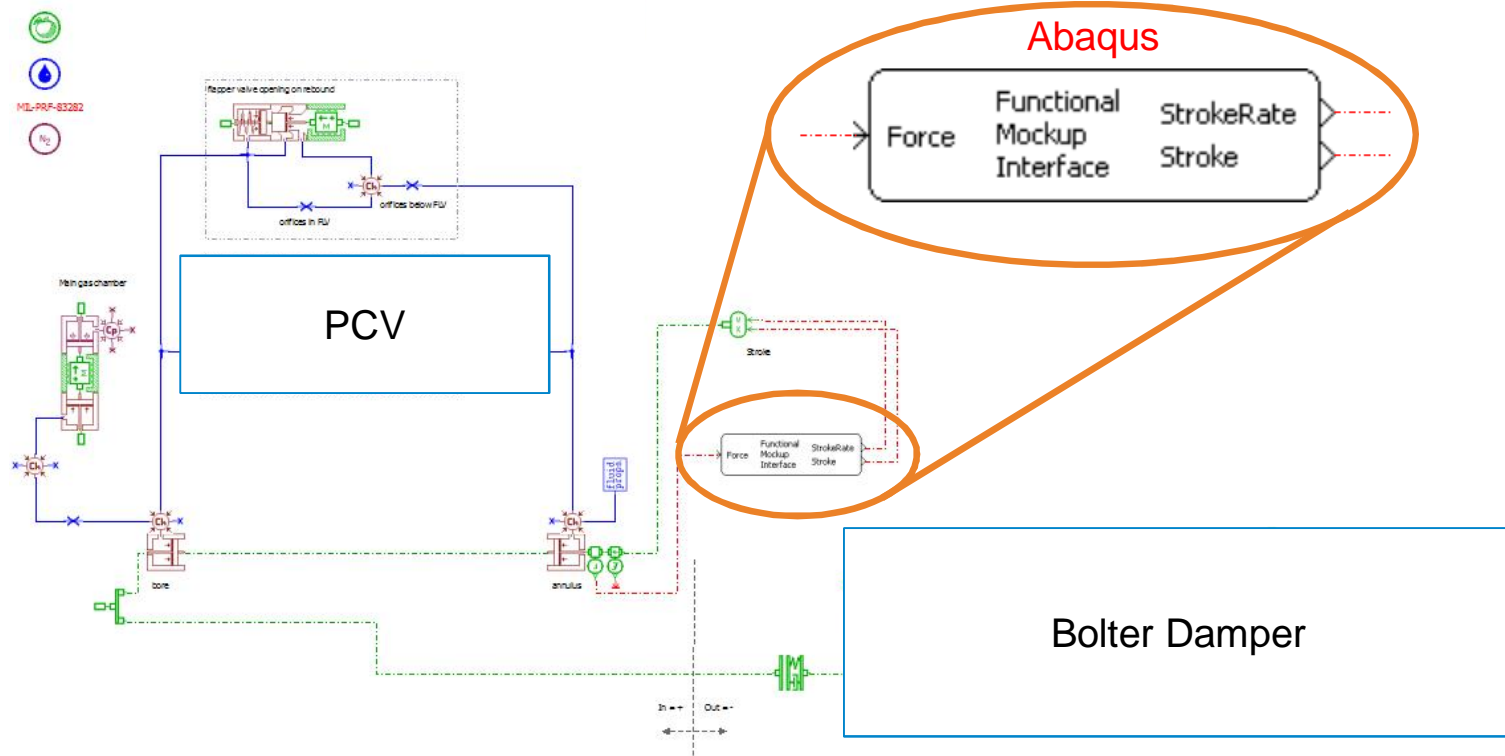
# POSSIBLE FMU INTERFACES/PROCESSES



# FMU COMPILATION AND THIRD PARTY COSIM USE

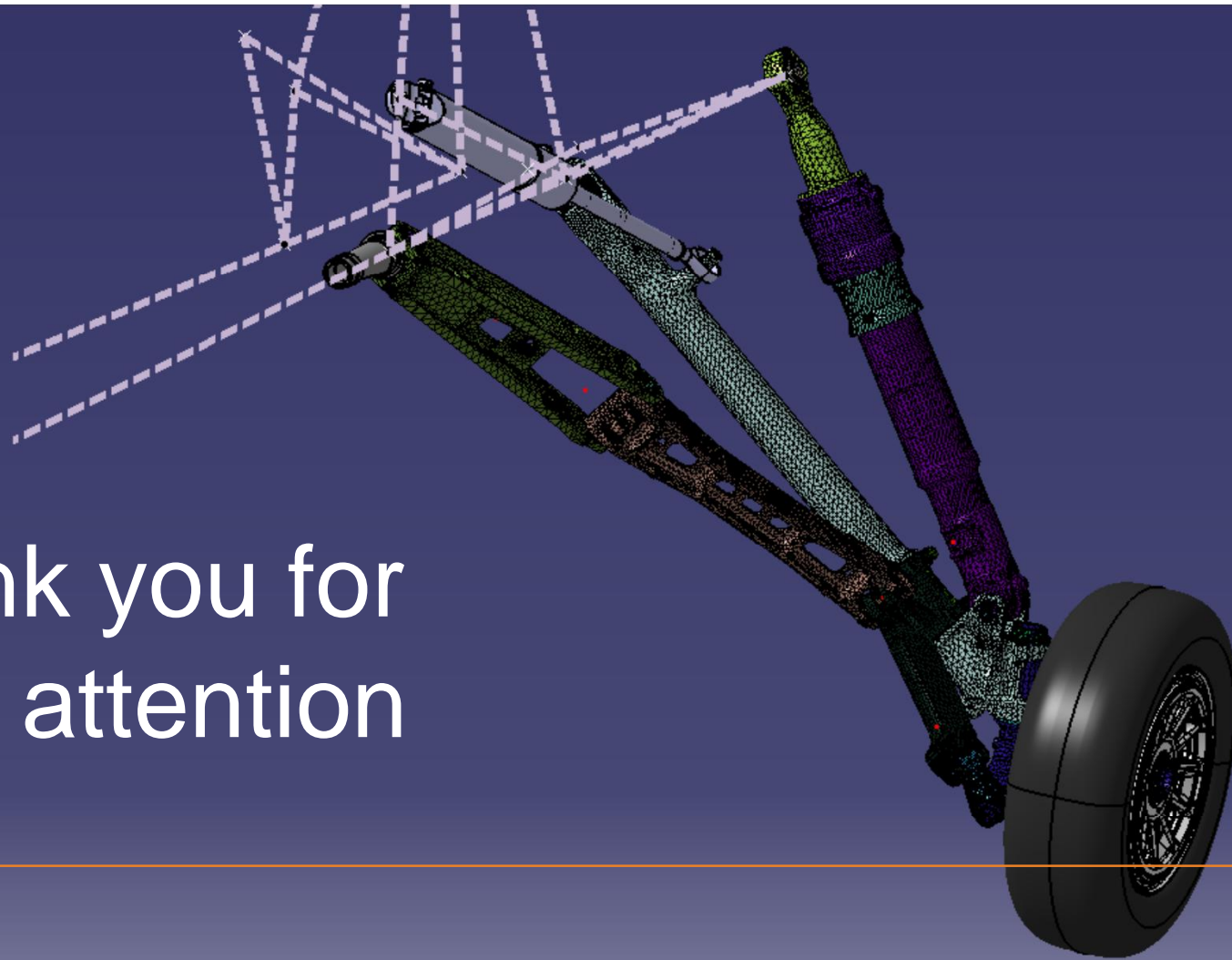


# AMESIM MODEL FMU INTERFACE BLOCK



# Thank you for Your attention

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