



Automation of Finite Element Analysis on the example of high-pressure injection valve Andrzej Ziombra

Gasoline Systems

1

GS/ECC-SI-Ziombra | 22.05.2015 | 15_0207 | © Robert Bosch GmbH 2015. Alle Rechte vorbehalten, auch bzgl. jeder Verfügung, Verwertung, Reproduktion, Bearbeitung, Weitergabe sowie für den Fall von Schutzrechtsanmeldungen.



BOSCH

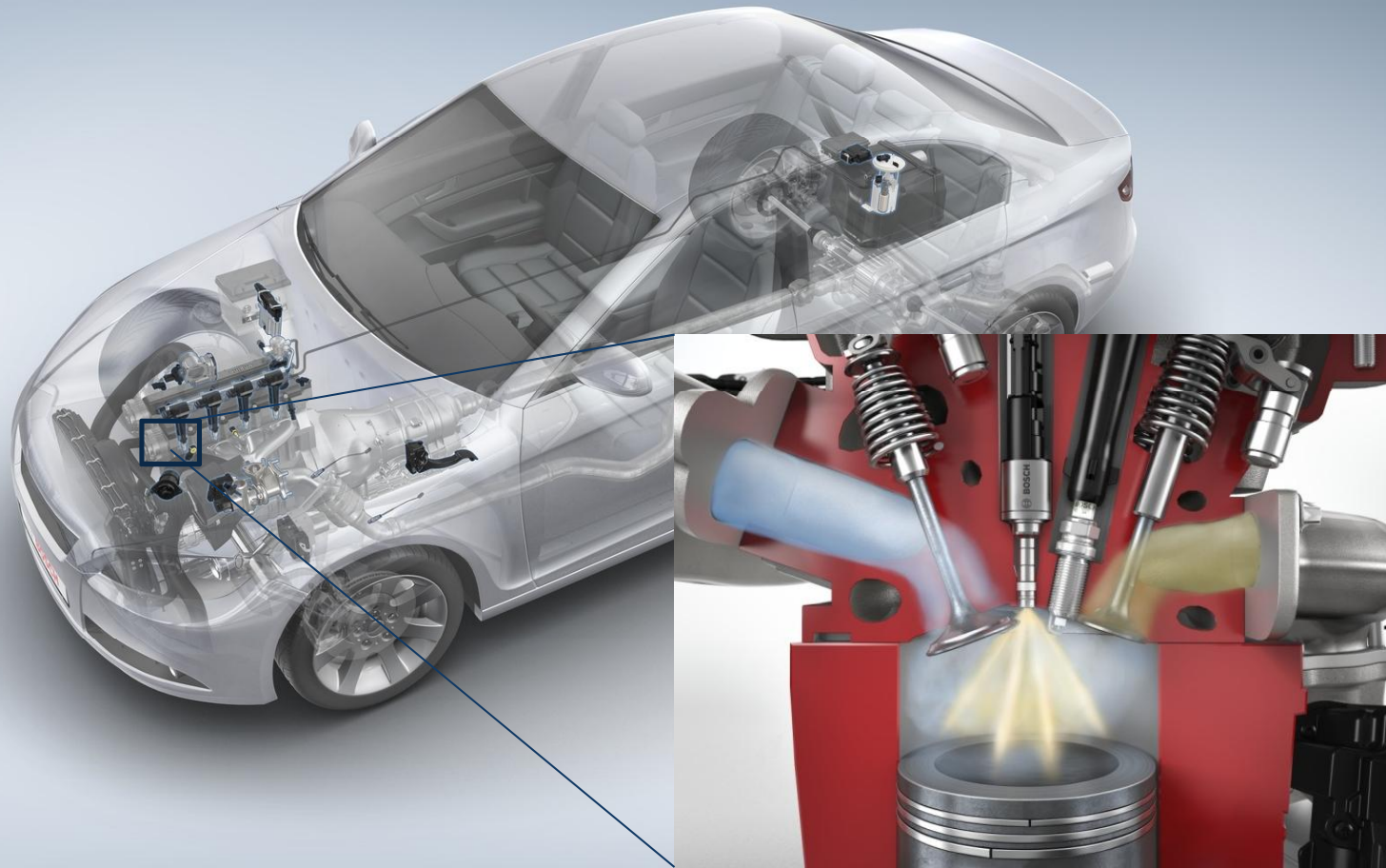
Bosch - Four business sectors



Gasoline Systems



Gasoline Systems - Direct Injection



Gasoline Systems

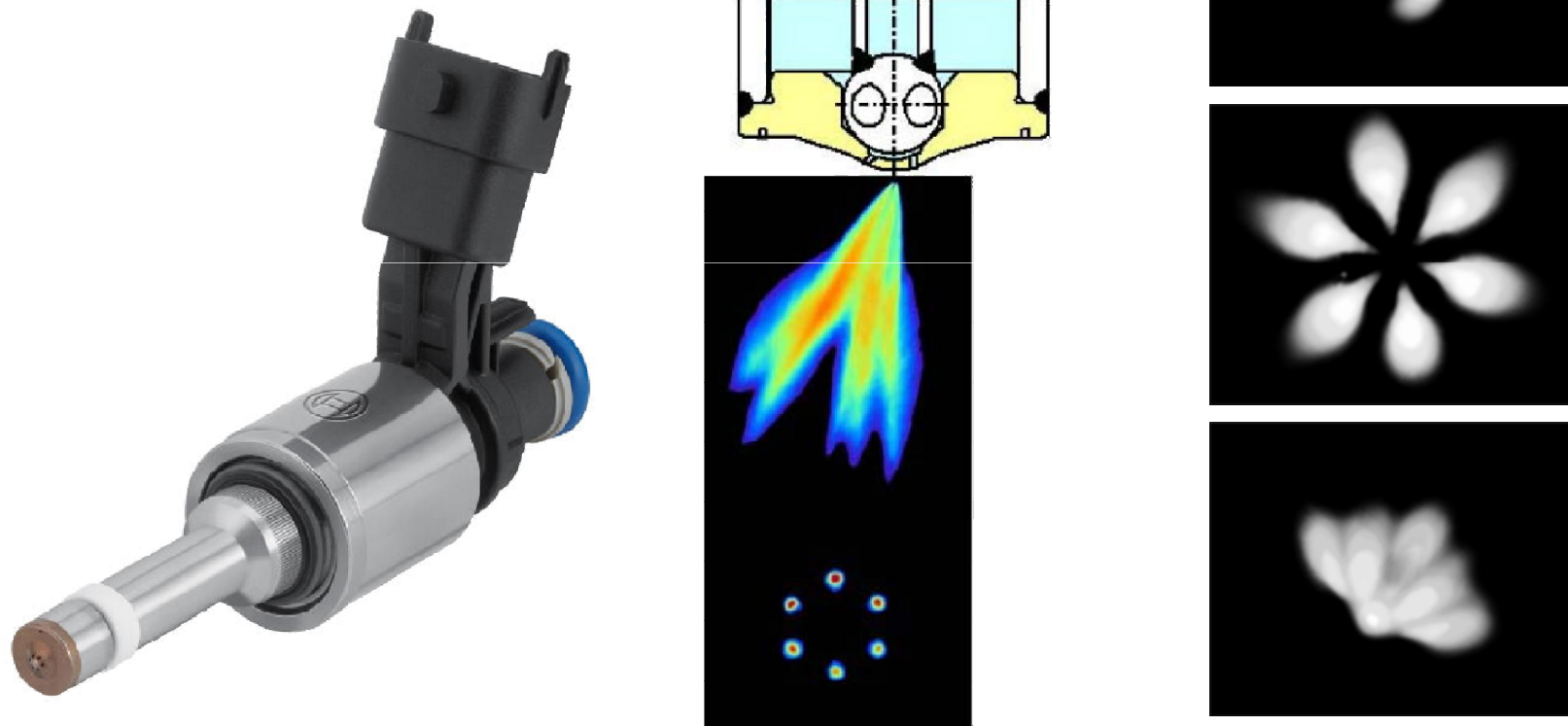


Contents

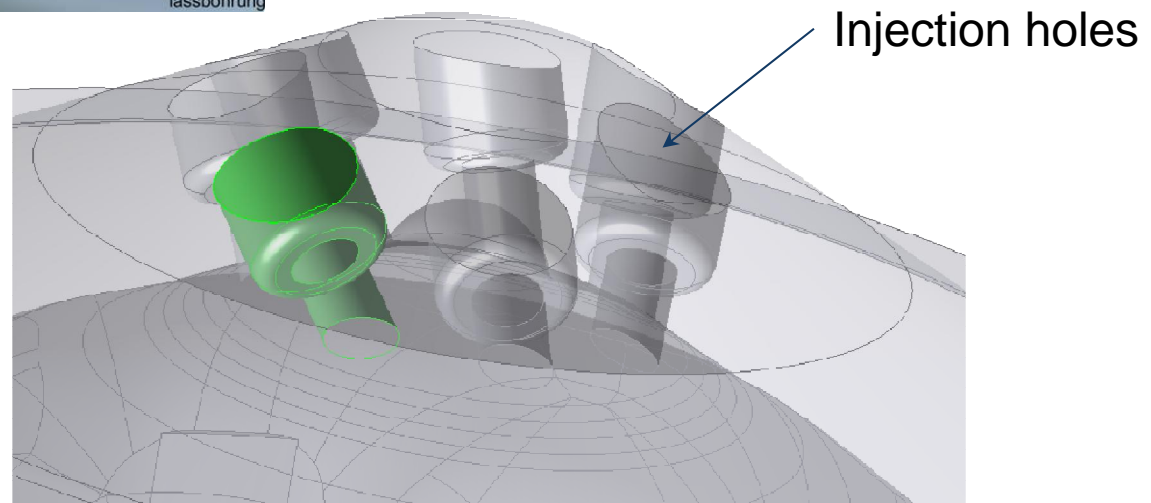
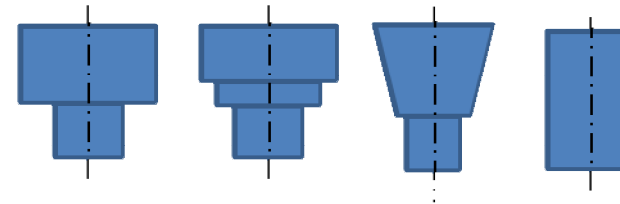
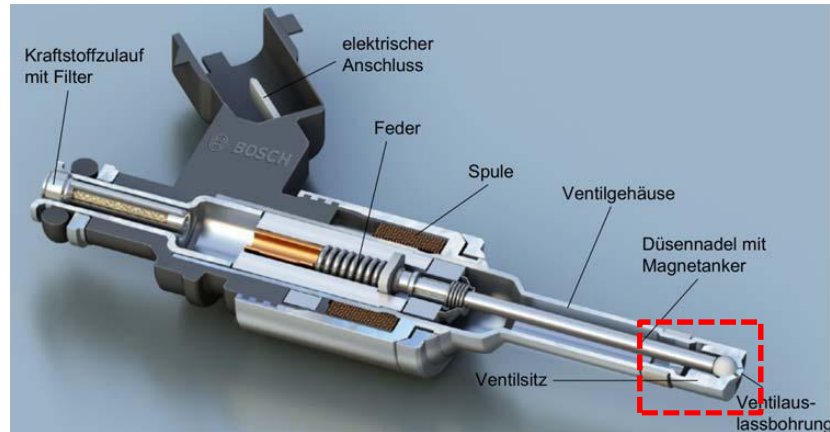
- Ø High-pressure injector HDEV 5 - brief introduction
- Ø The challenge
- Ø Model description
- Ø Process overview
- Ø The method – journaling and scripting
- Ø Post processing
- Ø Summary and outlook



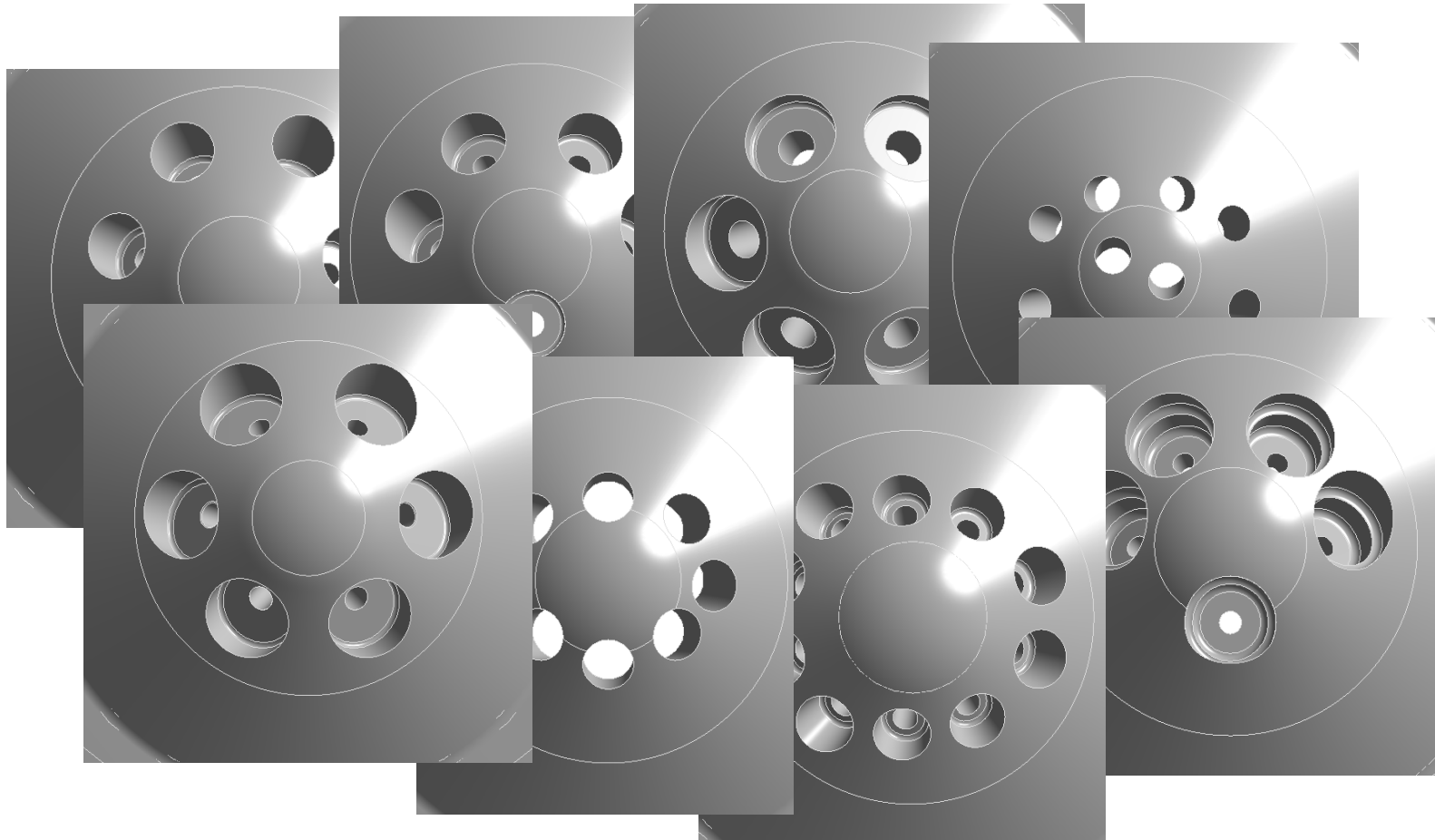
High-pressure injector - HDEV5 Variability of spray form



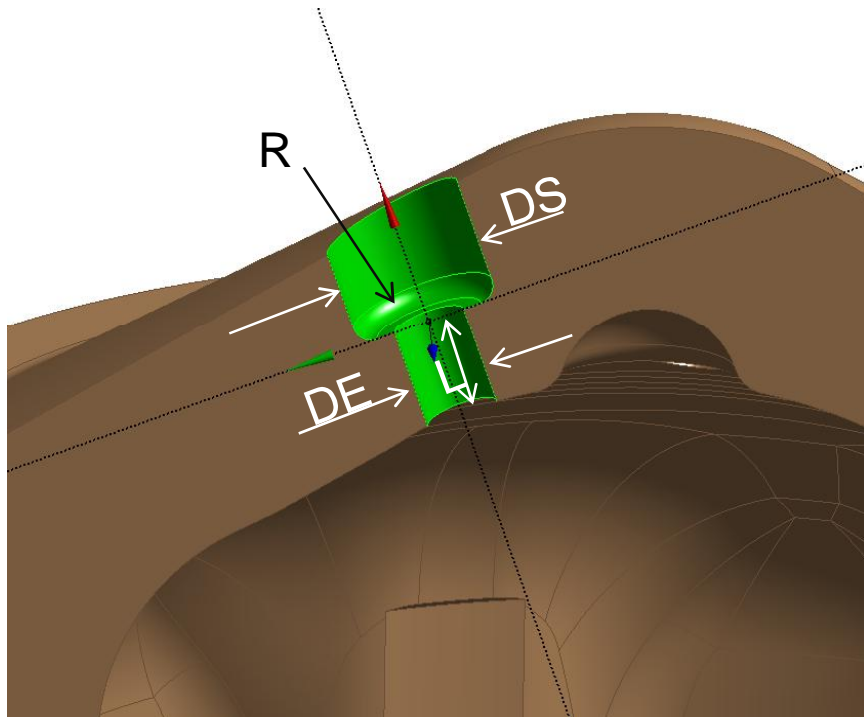
High-pressure injector - HDEV5



HDEV - Variants of injection holes

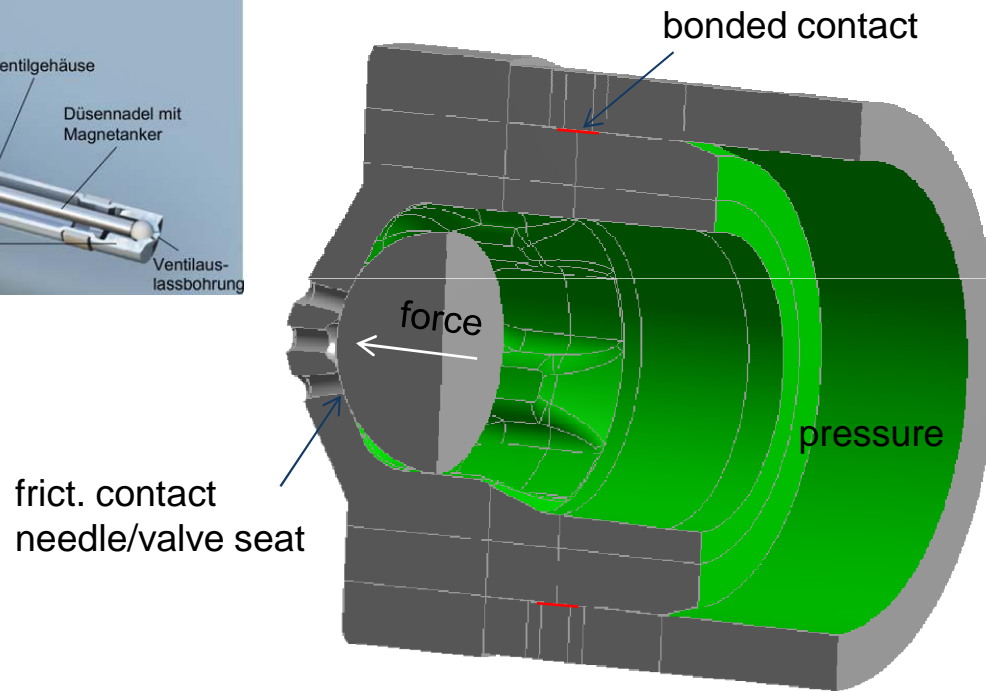
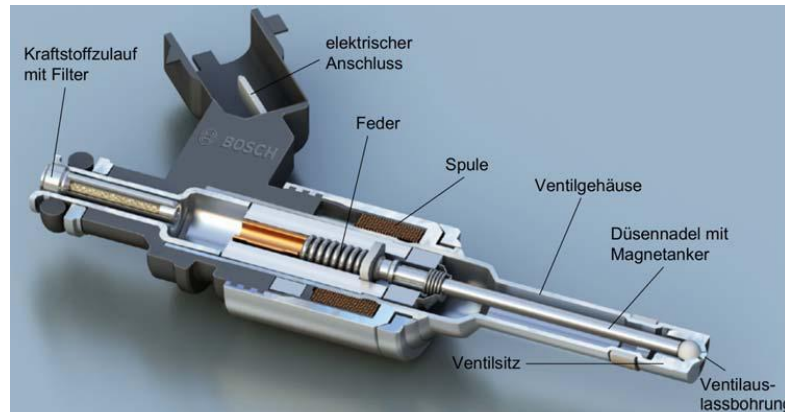


The challenge : 300+ design variants per annum

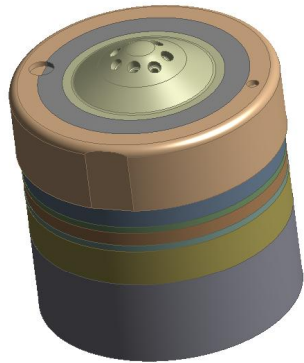


DS – pre-stage diameter
DE – injection hole diameter
L – length of injection hole
R – rounding radius of pre-stage

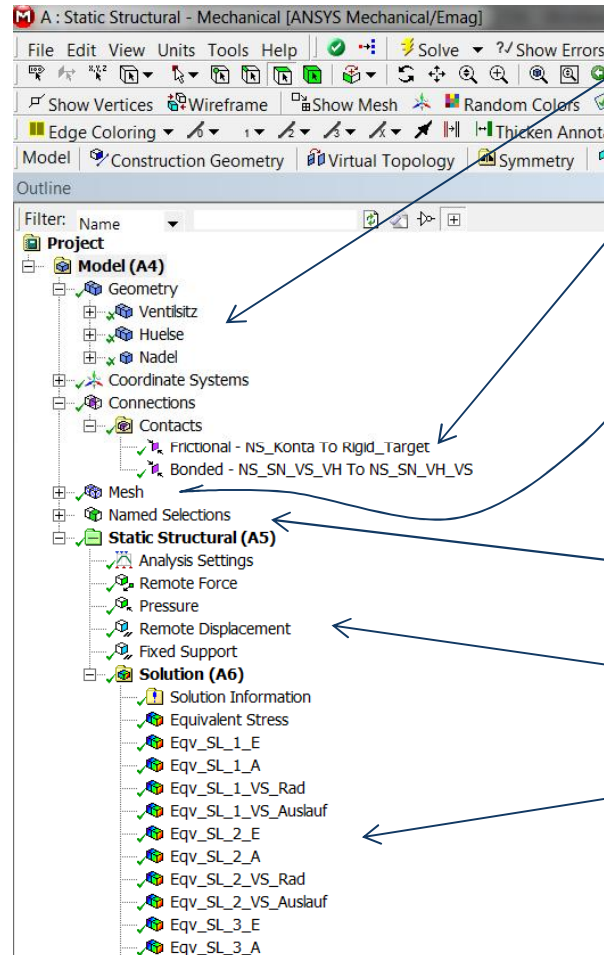
HDEV 5 - FE Model



HDEV5 - FE Model creation

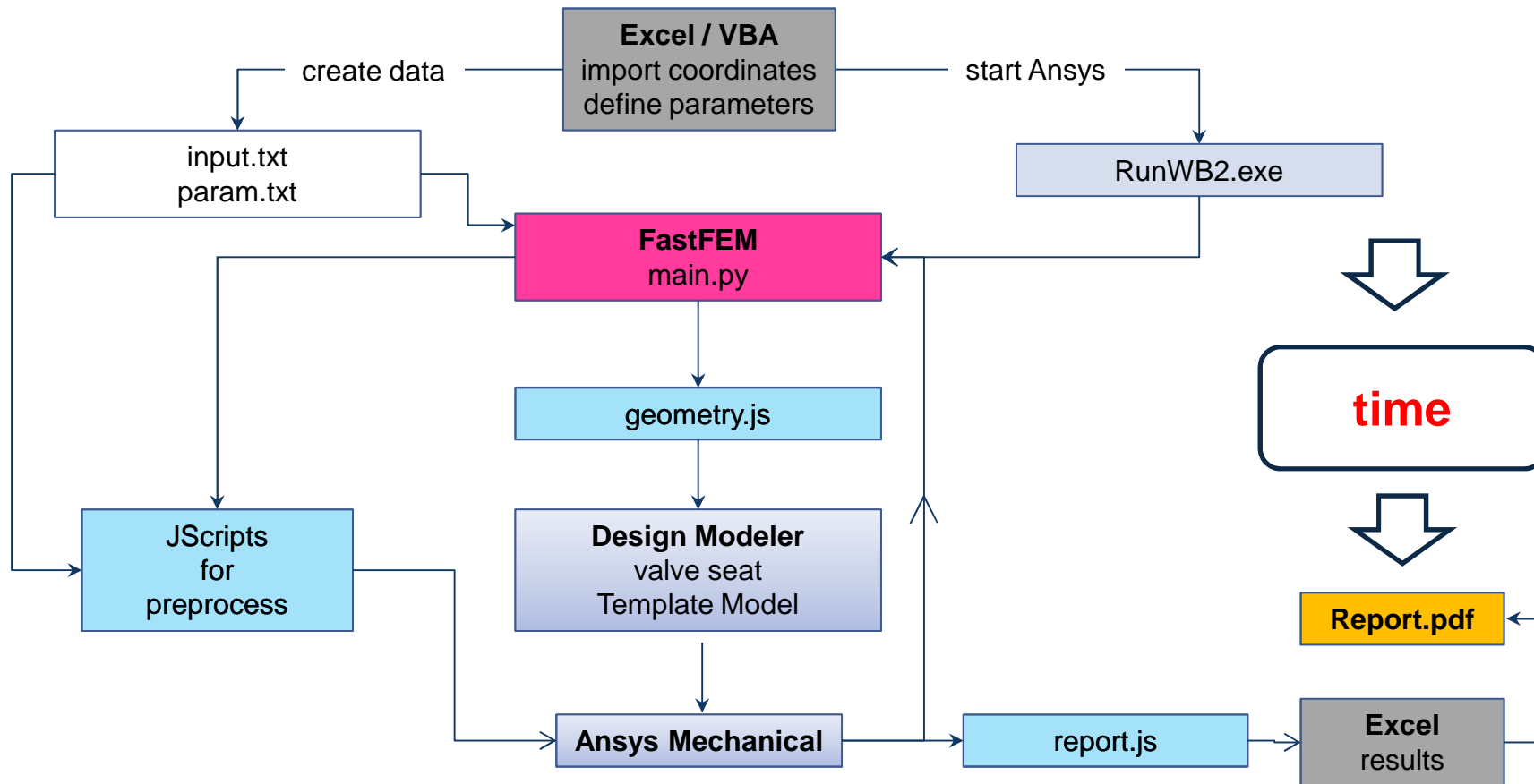


- read in geometry
- divide volumes
- create sets



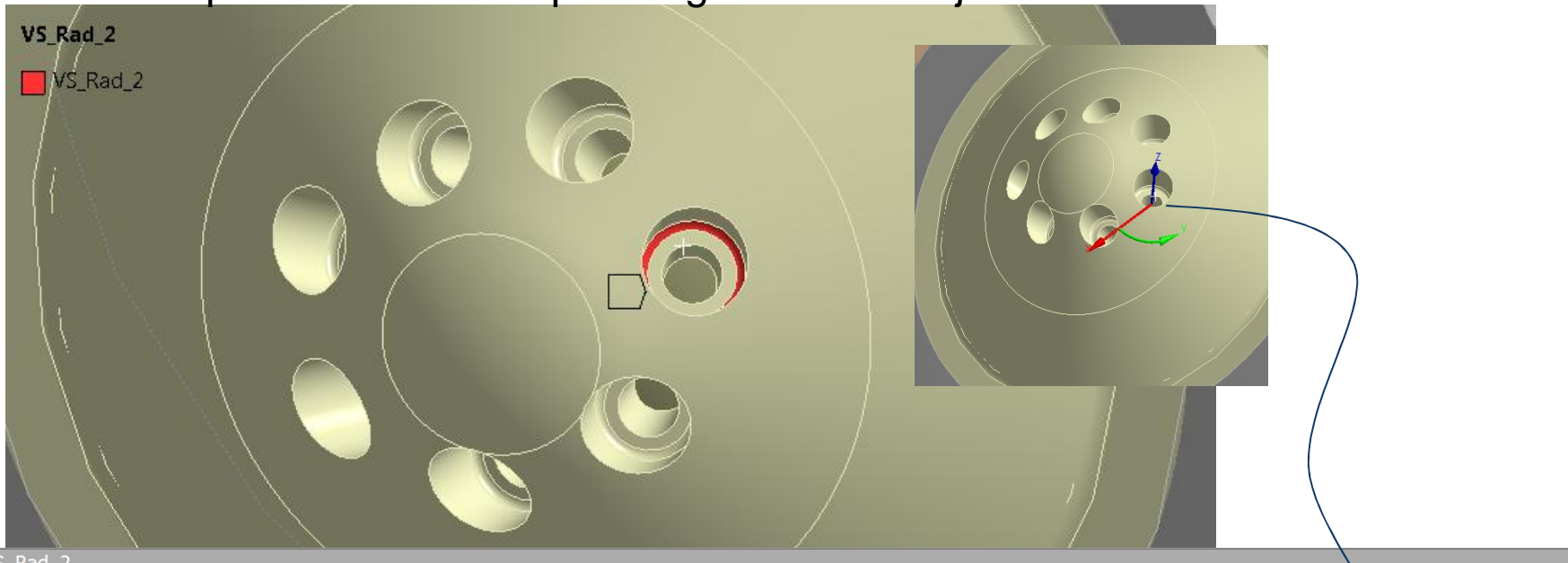
- assign materials to parts
- create contacts and their settings
- assign mesh settings to volumes, surfaces, lines
- create sets
- define loads and BCs
- create results sets for evaluation

Flow chart



How it is possible?

It is all about sets – named selections required for contacts, mesh, loads, a.s.o.
An example: create set for pre-stage radius of injection hole No.2 :



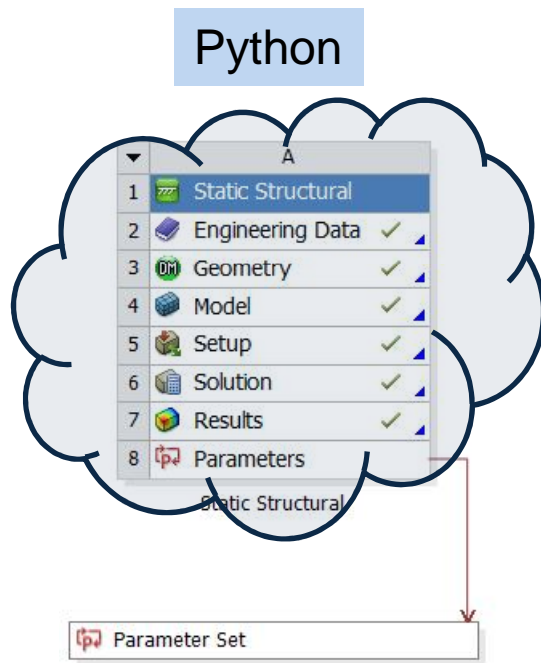
VS_Rad_2

VS_Rad_2

VS_Rad_2

Generate									
	Action	Entity Type	Criterion	Operator	Units	Value	Lower Bound	Upper Bound	Coordinate System
<input checked="" type="checkbox"/>	Add	Face	Type	Equal	N/A	Torus	N/A	N/A	N/A
<input checked="" type="checkbox"/>	Filter	Face	Location Z	Range	mm	N/A	-1.	1.	Batch_3_Pts2
<input checked="" type="checkbox"/>	Filter	Face	Location X	Less Than	mm	0.1	N/A	N/A	Batch_3_Pts2

Journal in WB



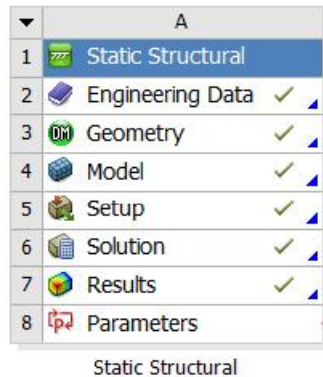
```

10 design_ = "x_Uentilsitz" # valve seat basis
11 TemplateDir = "x_Template"
12 # read in parameters
13 f = open(workingDir + "param.txt","r")
14 variante = int(f.readline()) # variation of injection holes
15 nr_loecher = int(f.readline())
16 f.close()
17 myPath = """"var title =new String("x_change") ;""""
18 Open(FilePath = TemplateDir + "Uentilsitz.wbpj")
19 system1 = GetSystem(Name="SYS")
20 geometry = system1.GetContainer(ComponentName="Geometry")
21 Save(FilePath="C:\\FF25\\Simulation\\" + title + "\\\" +title + ".wbpj", Overwrite=True)
22 # function for checking if there are any Free DM licenses
23 check_DM_lic()
24 # create geometry
25 geometry.Edit()
26 script1=open("C:\\FF25\\Skripte\\geometry.js", 'r')
27 geometry.SendCommand(Command = myPath + script1.read())
28 script1.close();
29 geometry.Exit()
30 Save()
31 #
32 ## create FE model
33 def main ():
34     component2 = system1.GetComponent(Name="Model")
35     component2.Refresh()
36     model1 = system1.GetContainer(ComponentName="Model")
37     ## create FE model
38     model1.Edit()
39     script2 = open('C:\\Fastfem2_5\\Skripte\\mechanical2.js', 'r')
40     model1.SendCommand(Command = myPath + script2.read())
41     component2 = system1.GetComponent(Name="Model")
42     component2.Refresh()
43     model1 = system1.GetContainer(ComponentName="Model")
44     script2.close()
45     model1.Exit()
46     #
47     component3 = system1.GetComponent(Name="Setup")
48     component4 = system1.GetComponent(Name="Solution")
49     component3.Update(AllDependencies=True)
50     tmpSetup = system1.GetComponent(Name="Setup")
51     cStateSetup = GetComponentState(tmpSetup)
52     #
53     if cStateSetup.State.ToString() != "UpToDate":
54         f = open(workingDir + "Error_Model.txt","a")
55         f.write("There is an error in the model")
56         f.close()
57         return()
58     try:
59         component4.Update(AllDependencies=True)
60     except:
61         f = open(workingDir + "Error_Solution.txt","a")
62         f.write("solution is unconverged or there is an error in the model")
63         f.close()
64         return()
65     component5 = system1.GetComponent(Name="Results")
66     component5.Update(AllDependencies=True)
67     model1.Edit()
    
```


Scripts in Ansys WB

```
var PF1 = agb.FPoint(agc.FPointConstruction, agc.FPointCoordinateFile);  
PF1.Name = "BoxPoints";  
PF1.CoordinateFile = quelle_"input.txt";  
agb.Regen();  
//
```

```
// delete default contacts  
//  
var conta_DS.Tree.FirstActiveBranch.ContactRegions;  
count_conta = conta_DS.Count;  
  
for (var ic=1; ic<=count_conta; ic++) {  
  
DS.Script.changeActiveObject(conta_DS(ic).ID);  
  
DS.Tree.CanDeleteItems();  
DS.Tree.DeleteItems();  
bHandleNodeClick = true;  
DS.EnableRefreshParameters = true;  
}  
}
```



JavaScript

Parameter Set

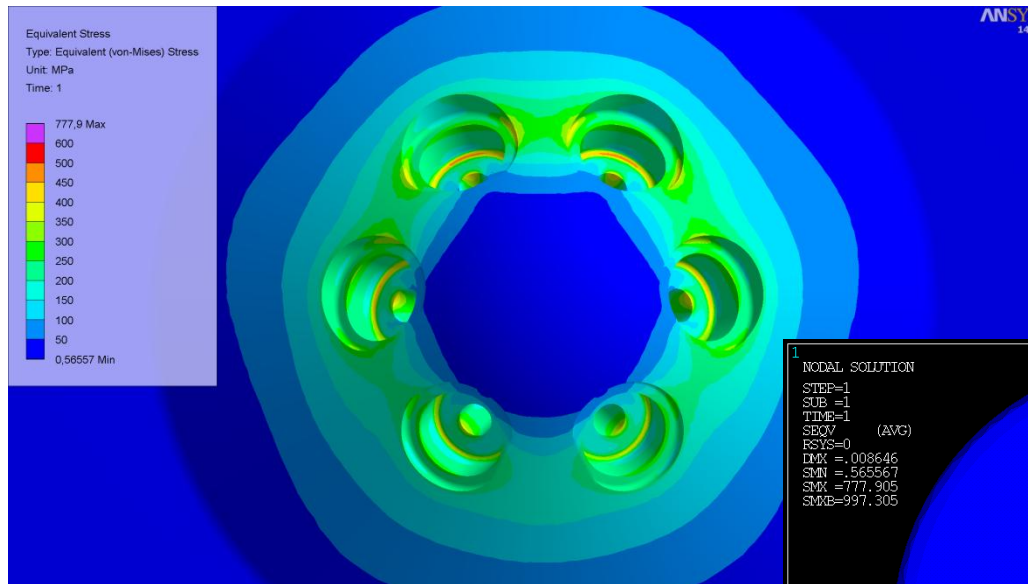
```
currEnvi = branch.Environment; //  
command = currEnvi.AddCommandEditor();  
  
msg = " ? APDL CODE " + param1 + "\n" +  
"/GRAPH,FULL \n" +  
"/RGB,INDEX, 0, 0, 0, 0 \n" +  
"/RGB,INDEX, 60, 60, 60,13 \n" +  
"/RGB,INDEX, 80, 80, 80,14 \n" +  
"/RGB,INDEX,100,100,100,15 \n" +  
  
command.Text += msg;  
DS.Script.FillTree();
```

APDL code
in JavaScript

examples of JavaScript code

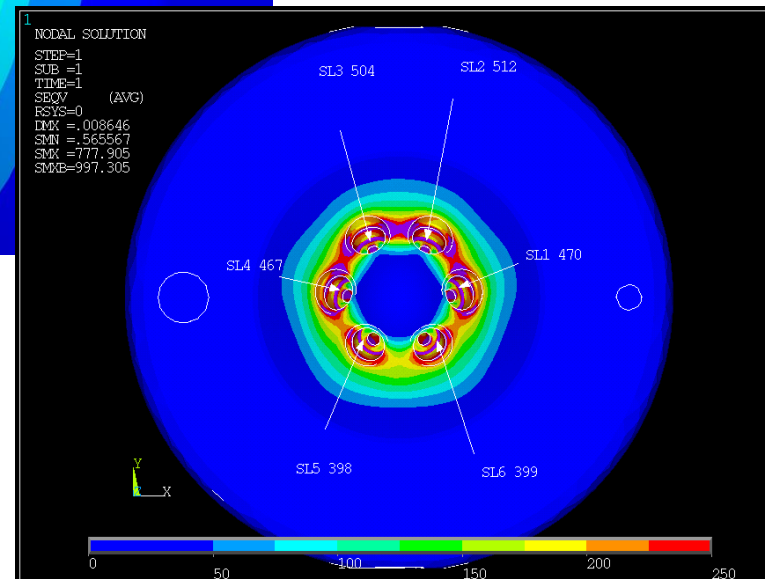


Postprocessing

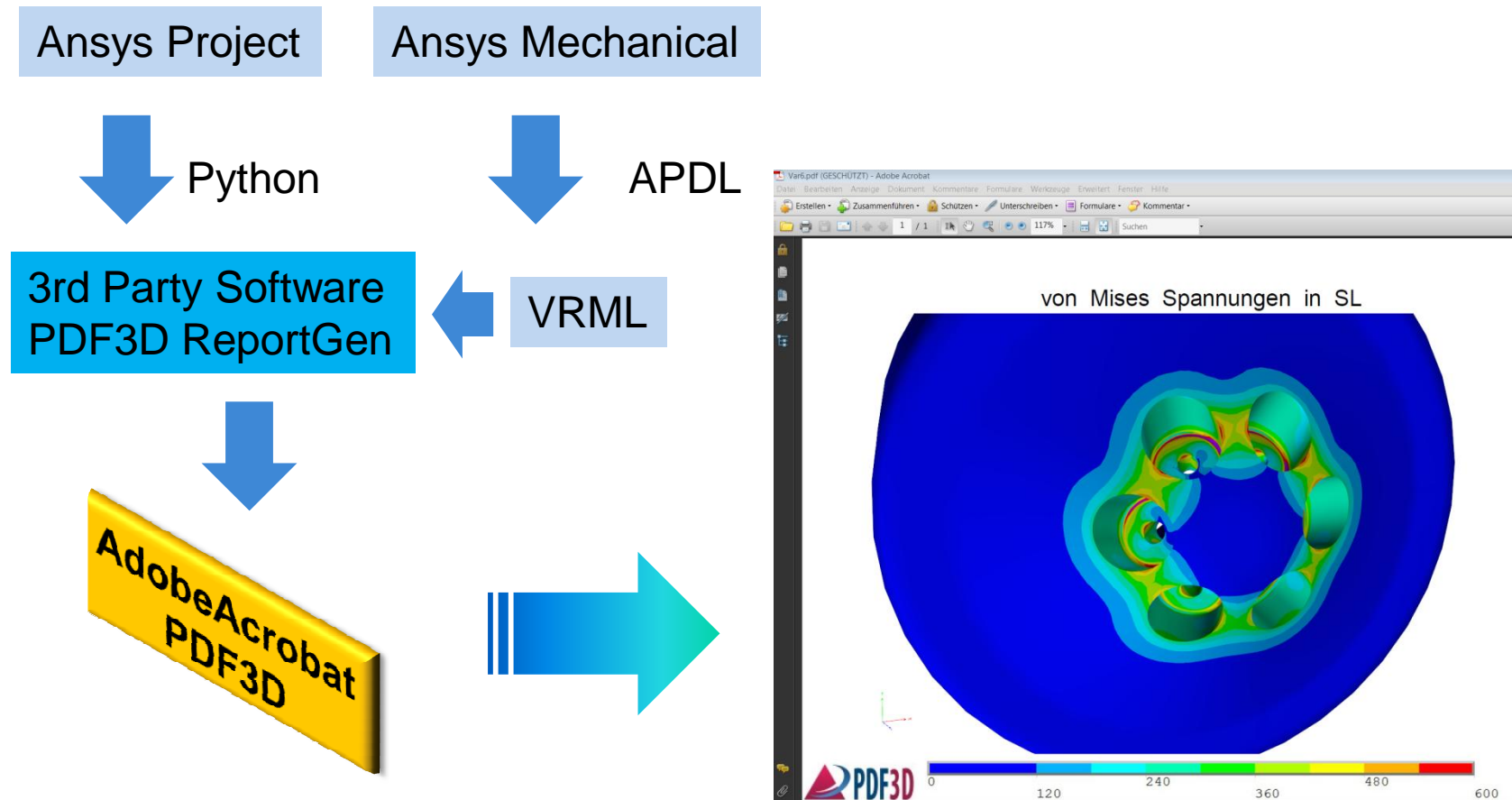


- User defined plots, legend, views
- Figure generation
- Annotations only with APDL
- Parametric results

```
DS.Script.doInsertSolutionEquivalentStress(1)
ListView.ActivateItem("Scoping Method");
ListView.ItemValue = "Named Selection";
ListView.ActivateItem("Named Selection");
ListView.ItemValue = "SL_" + (k-1).toString() + "_E" ;
ListView.ActivateItem("Display Time");
ListView.ItemValue = j ;
ListView.ActivateItem("Maximum")
ListView.SelectedItem.IsChecked = "true" ;
```



Connecting external programs - PDF3D



Summary

- ü Standardization of the process
- ü Best practice incorporated
- ü Relief of simulation engineer from standard routines
- ü Reduction of errors
- ü Time/Costs reduction
- ü Parameters enabled for optiSLang (optimization)
- ü Tool for non simulation engineers



Thank you for your attention

