

**Vysoké učení technické v Brně
Fakulta strojního inženýrství
Ústav výrobních strojů, systémů a robotiky**

Komplexní měření součásti na souřadnicovém měřicím stroji

Příloha bakalářské práce **Možnosti měření geometrické přesnosti obrobku**

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Datum: 16. 5. 2011

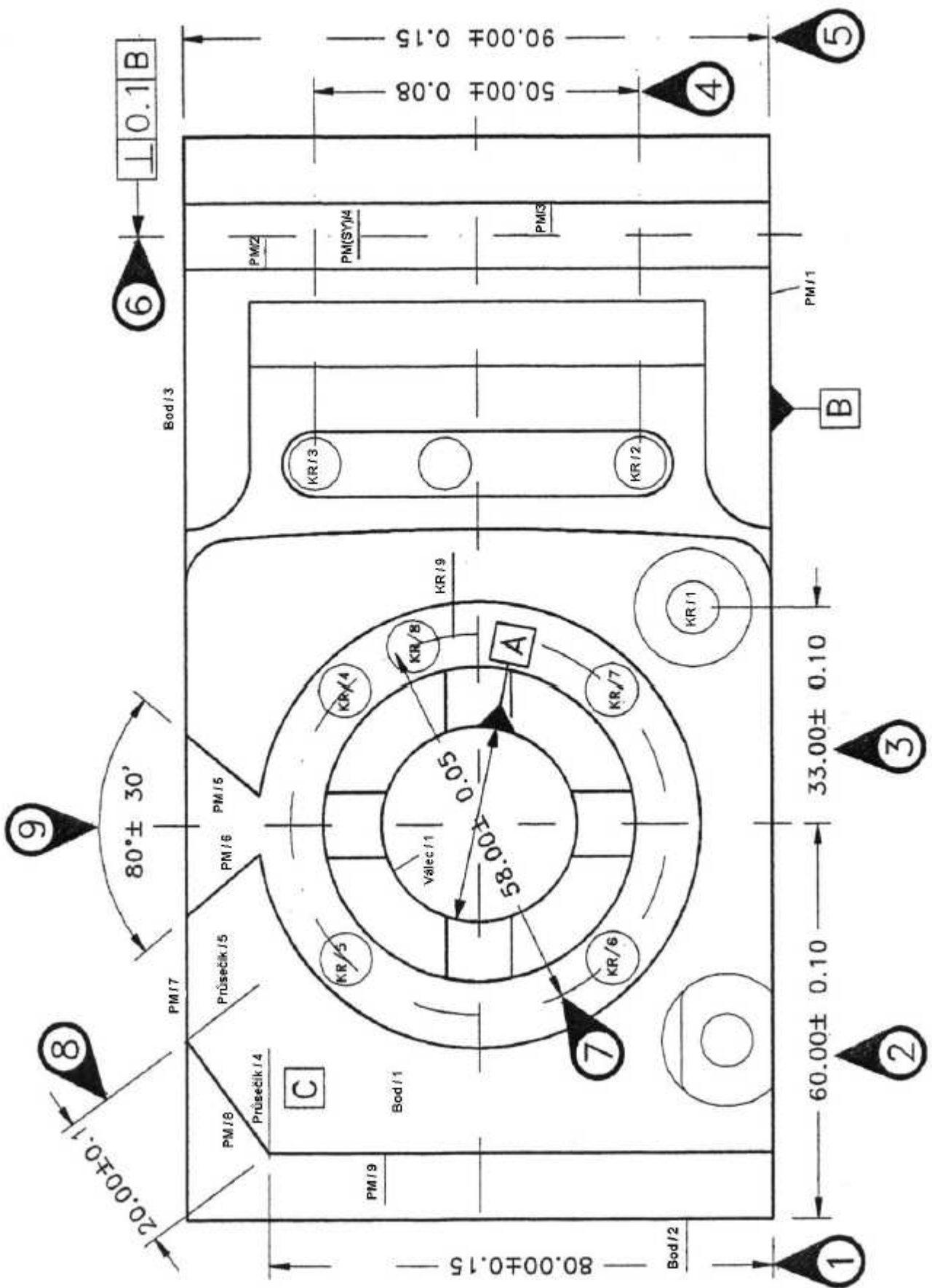
Místo měření: Renishaw, spol. s r. o.
Olomoucká 85
627 00 Brno, Česká republika

Datum měření: 2. 3. 2011

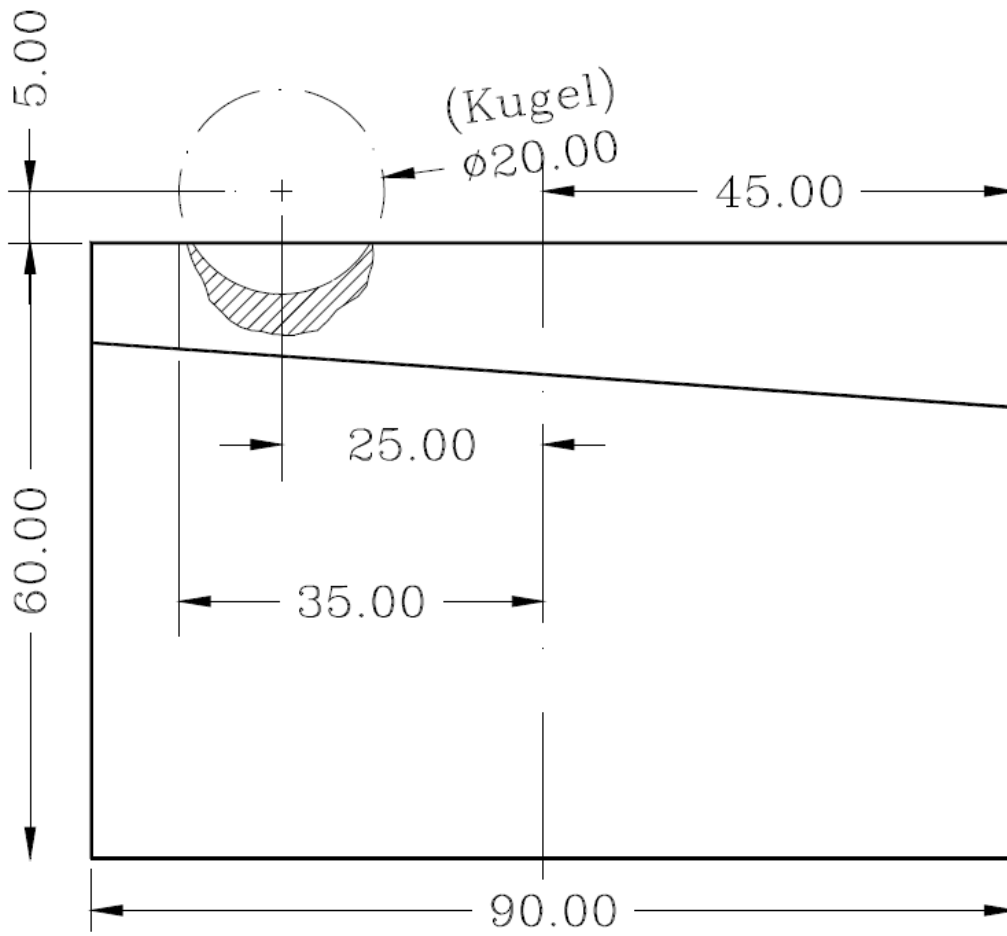
Použité přístroje:

- Souřadnicový měřicí stroj DEA Swift
- Snímací systém
 - Hlavice sondy Renishaw PH10M
 - Skenovací sonda Renishaw SP25M
 - Modul doteku sondy Renishaw SM25-1
 - Snímací dotek (snímací kulička o průměru 5 mm, užitečná pracovní délka 21 mm)
- Universal CMM Controller Renishaw UCC2
- Servo Power Amplifier SPA 2
- Kalibrační koule (ø 25 mm, výška 95 mm)
- Přípravky k upnutí součásti
- PC (software - Renishaw Modus 1.3, UCC Server)

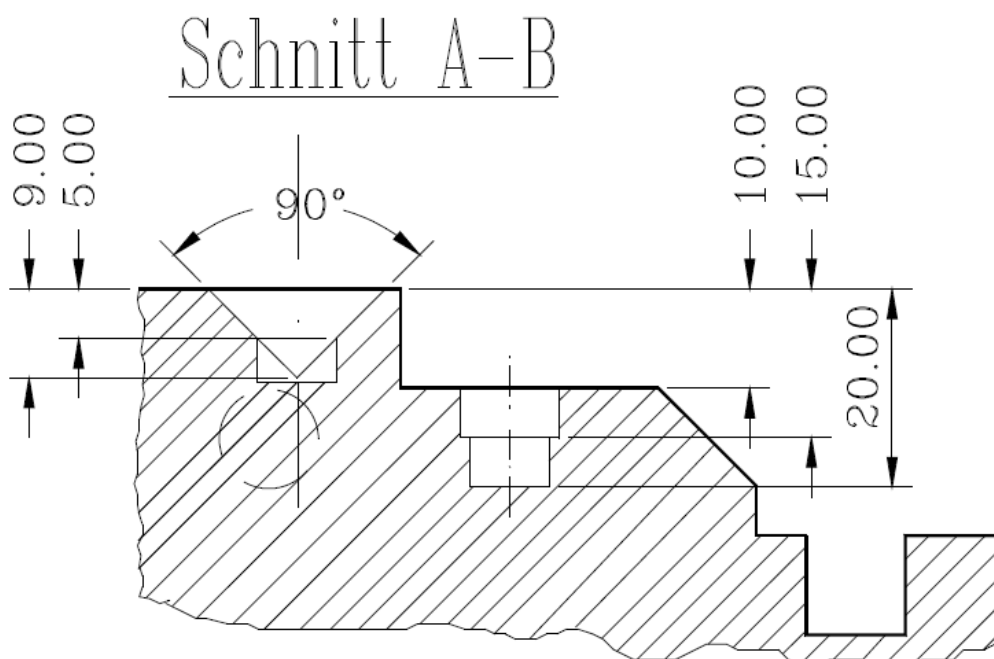
Výkresy součásti:



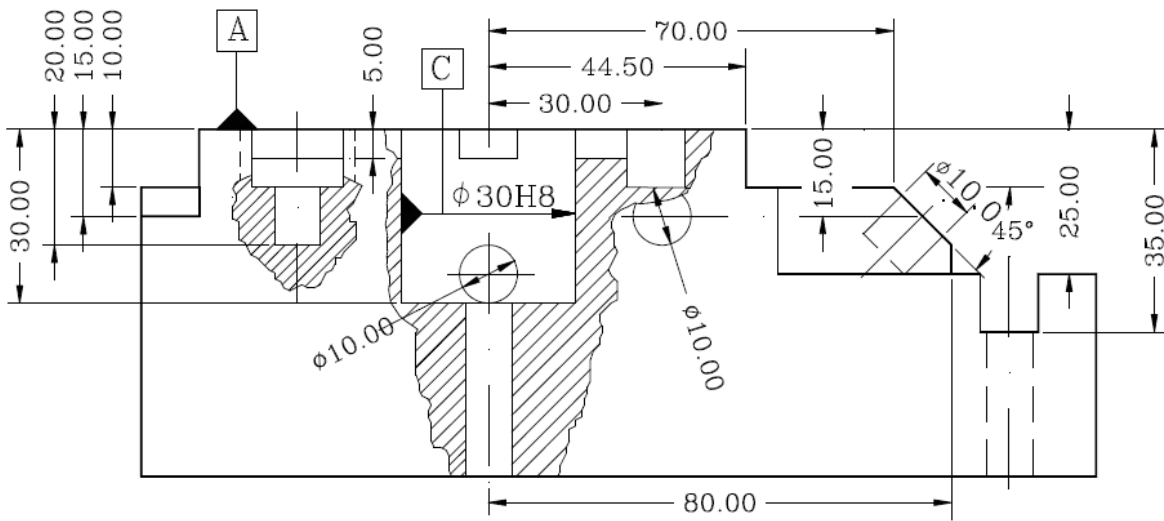
Bokorys (Y-Z)



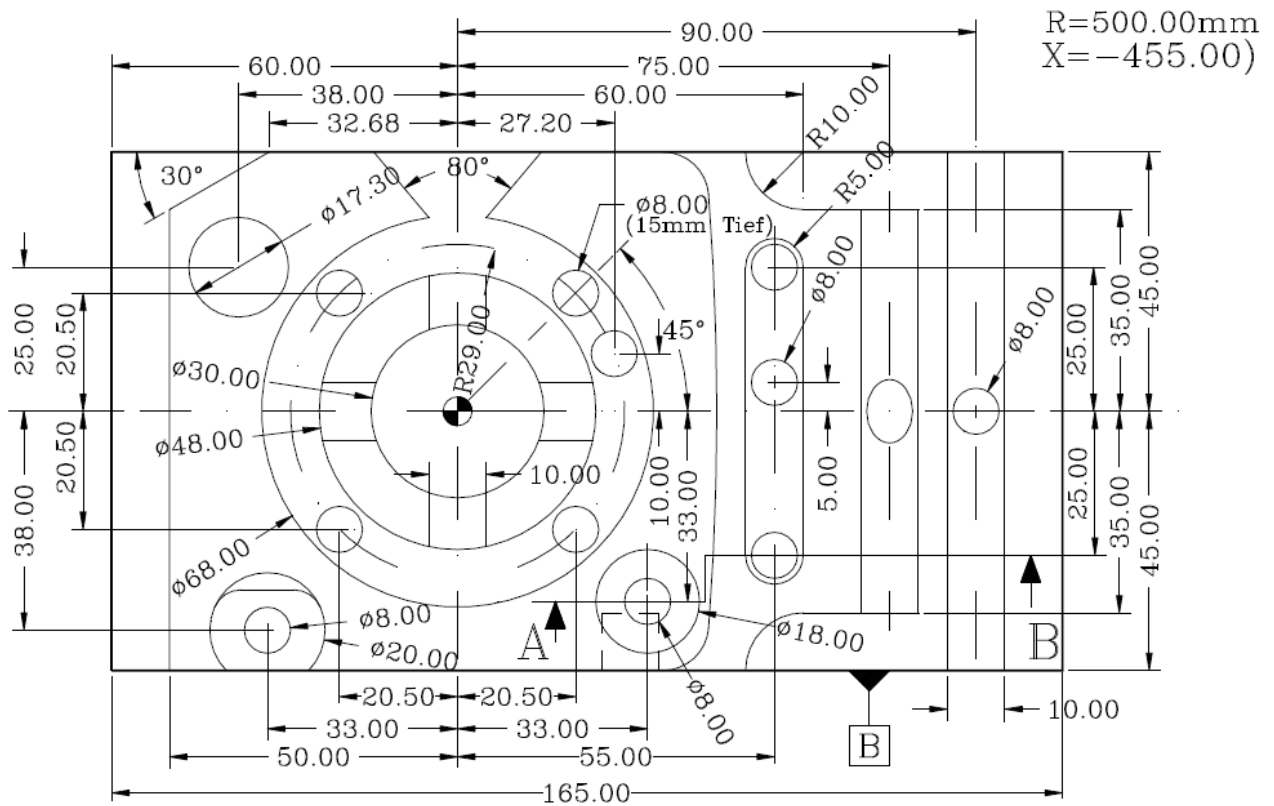
ŘEZ A-B



Nárys (Z-X)



Púdorys (X-Y)



Postup:

1. Studie výkresů součásti
2. Vhodné sestavení snímacího systému (tj. hlavice sondy, sondy, modulu a doteku)
3. Spuštění PC, přívodu vzduchu, stroje a dalších potřebných zařízení
4. Spuštění programu UCC Server
5. Vytvoření stroje a snímacího systému v programu UCC Server
6. Ustavení kalibrační koule na desku stroje a její vytvoření v programu UCC Server
7. Kalibrace snímacího systému
8. Vhodné ustavení měřené součásti na žulovou desku stroje
9. Spuštění programu Renishaw Modus
10. Základní nastavení nového programu a výběr doteku
11. Postavení souřadného systému (vyrovnání)
12. Vyvolání modelu a synchronizace souřadných systémů
13. Měření
14. Konstrukce potřebných prvků pomocí změřených
15. Vyhodnocení a tvorba jednoduchého protokolu měření
16. Ukončení měření a vypnutí všech zařízení

Měřicí program:

\$\$sablonu programu.....

```
DMISMN/'Mereni - blok',05.2
FILNAM/'Mereni - blok',05.2
DV(0)=DMESWV/'13,1,2,214'
UNITS/MM,ANGDMS,TEMPC
DECPL/ALL,DEFAULT
V(0)=VFORM/ALL
DISPLY/TERM,V(0),STOR,DMIS,V(0)
SNSET/APPRCH,5
SNSET/CLRSRF,15
SNSET/DEPTH,0
D(0)=DATSET/MCS
MODE/MAN
T(CORTOL_X1)=TOL/CORTOL,XAXIS,-0.1,0.1
T(CORTOL_Y1)=TOL/CORTOL,YAXIS,-0.1,0.1
T(CORTOL_Z1)=TOL/CORTOL,ZAXIS,-0.1,0.1
T(DIAM_1)=TOL/DIAM,-0.1,0.1
```

\$\$zakladni nastaveni + vyvolani a vyber doteku.....

```
SNSET/APPRCH,2
SNSET/CLRSRF,10
SNSET/RETRCT,2
SNSET/SEARCH,2
```

```
RECALL/SA(Tool_1.1.21.5.A0.0-B0.0)
```

```
SNSLCT/SA(Tool_1.1.21.5.A0.0-B0.0)
```

\$\$mereni zakladen a postaveni souradneho systemu.....

```
TEXT/OPER,'Najed 10 mm nad stred kulove plochy !'
```

```
F(nulovy_bod)=FEAT/POINT,CART,0,0,0,0,0,1
MEAS/POINT,F(nulovy_bod),0
ENDMES
```

```
D(air_souradny_system)=TRANS/XORIG,FA(nulovy_bod),YORIG,FA(nulovy_bod),ZORIG,FA(nulovy_bod)
```

```
$$<MEAS_CYLNDR name = "valec_1">
```

```
MODE/PROG,MAN
```

```
F(valec_1)=FEAT/CYLNDR,INNER,CART,24.922,38.322,-19.005,0.009,-0.006,-1,30.023
```

```
MEAS/CYLNDR,F(valec_1),8
```

```
GOTO/CART,23.864,40.572,-0.002
```

```
GOTO/CART,25.078,40.706,-24.078
```

```
PTMEAS/CART,25.161,53.304,-23.945,-0.013,-1,0.006
```

```
PTMEAS/CART,9.991,39.335,-24.079,0.998,-0.069,0.009
```

```
PTMEAS/CART,23.83,23.324,-24.206,0.076,0.997,-0.005
```

```
PTMEAS/CART,39.874,40.059,-24.047,-0.993,-0.118,-0.008
```

```
GOTO/CART,26.286,40.028,-13.954
```

```
PTMEAS/CART,35.666,48.789,-13.84,-0.719,-0.695,-0.002
```

```
PTMEAS/CART,14.085,48.788,-13.876,0.719,-0.695,0.01
```

```
PTMEAS/CART,13.126,29.011,-14.056,0.783,0.622,0.003
```

```
PTMEAS/CART,37.192,29.766,-13.994,-0.82,0.572,-0.011
```

```
GOTO/CART,25.056,40.195,11.637
```

```
ENDMES
```

```
$$<\MEAS_CYLNDR = valec_1>
```

```
$$<MEAS_LINE name = "PM_1">
```

```
MODE/PROG,MAN
```

```

F(PM_1)=FEAT/LINE,UNBND,CART,69.526,67.513,-38.786,0,0.978,-0.208,1,0,0
MEAS/LINE,F(PM_1),2
GOTO/CART,81.977,9.376,11.636
GOTO/CART,81.977,5.879,-25.688
PTMEAS/CART,69.526,5.813,-25.683,1,0,0
GOTO/CART,92.336,125.593,-25.688
GOTO/CART,92.256,129.293,-51.31
PTMEAS/CART,69.526,129.227,-51.893,1,0,0
GOTO/CART,74.121,129.293,21.975
GOTO/CART,62.338,55.027,21.974
ENDMES
$$<\MEAS_LINE = PM_1>

```

```

$$<MEAS_PLANE name = "ROVINA_1">
MODE/PROG,MAN
F(ROVINA_1)=FEAT/PLANE,CART,30.328,37.221,-9.16,-0.008,-0.002,1
MEAS/PLANE,F(ROVINA_1),6
PTMEAS/CART,62.363,54.926,-8.867,-0.008,-0.002,1
PTMEAS/CART,62.759,21.771,-8.914,-0.008,-0.002,1
PTMEAS/CART,33.701,-4.893,-9.197,-0.008,-0.002,1
PTMEAS/CART,-9.503,13.836,-9.528,-0.008,-0.002,1
PTMEAS/CART,-9.329,63.141,-9.451,-0.008,-0.002,1
PTMEAS/CART,41.909,74.263,-9.007,-0.008,-0.002,1
GOTO/CART,41.884,74.359,18.276
ENDMES
$$<\MEAS_PLANE = ROVINA_1>

```

```

DATDEF/FA(ROVINA_1), DAT(C)
DATDEF/FA(PM_1), DAT(B)
DATDEF/FA(valec_1), DAT(A)
D(souradny_system)=DATSET/DAT(C),ZDIR,ZORIG,DAT(B),YDIR,DAT(A),XORIG,YORIG

```

\$\$synchronizace s modelem.....

```

DID(blok_model)=DEVICE/STOR,'C:\Documents and Settings\Administrator\My
Documents\Michal\Kucharka_MODUS\Modely\sampleblock.sab'
OPEN/DID(blok_model),CAD,VENDOR,'ACIS'
G(blok_model_ALL)=GEOM/DID(blok_model)
EQUATE/DA(souradny_system),CADCS,DID(blok_model),'Default'
EQUATE/DA(souradny_system),CADCS,DID(blok_model),-1,0,0,0,-1,0,0,0,1,0,0,60

```

\$\$,.....mereni.....

```

$$<MEAS_LINE name = "PM_2">
MODE/PROG,MAN
F(PM_2)=FEAT/LINE,UNBND,CART,0.036,84.776,-30.023,1,0,-0.008,0,1,0
MEAS/LINE,F(PM_2),2
GOTO/CART,-36.258,92.512,26.989
GOTO/CART,-36.772,89.971,-29.649
PTMEAS/CART,-36.863,84.776,-29.715,0,1,0
GOTO/CART,36.924,89.853,-30.263
PTMEAS/CART,36.835,84.776,-30.331,0,1,0
ENDMES
$$<\MEAS_LINE = PM_2>

```

```

$$<MEAS_LINE name = "PM_3">
MODE/PROG,MAN
F(PM_3)=FEAT/LINE,UNBND,CART,-2.237,94.766,-29.863,-1,0,0.008,0,-1,0
MEAS/LINE,F(PM_3),2
PTMEAS/CART,35.252,94.766,-30.177,0,-1,0
GOTO/CART,-39.714,89.87,-29.624
PTMEAS/CART,-39.605,94.766,-29.551,0,-1,0
GOTO/CART,-39.423,89.165,6.882
ENDMES
$$<\MEAS_LINE = PM_3>

```

```
$$<MEAS_LINE name = "PM_5">
MODE/PROG,MAN
F(PM_5)=FEAT/LINE,BND,CART,-36.585,6.155,-4.773,-42.694,11.243,-4.73,0,-1,0
MEAS/LINE,F(PM_5),2
GOTO/CART,-56.13,-4.005,-4.666
PTMEAS/CART,-36.185,6.217,-4.625,-0.915,-0.399,-0.054
PTMEAS/CART,-42.631,11.601,-4.573,-0.913,-0.403,-0.057
GOTO/CART,-42.859,0.283,-4.782
ENDMES
$$<\MEAS_LINE = PM_5>
```

```
$$<MEAS_LINE name = "PM_6">
MODE/PROG,MAN
F(PM_6)=FEAT/LINE,BND,CART,-39.367,-3.617,-4.915,-45.056,-8.403,-4.851,0,-1,0
MEAS/LINE,F(PM_6),2
PTMEAS/CART,-36.488,-5.903,-5.062,-0.996,0.064,0.056
GOTO/CART,-46.656,-8.78,-4.799
PTMEAS/CART,-40.423,-8.735,-5.013,-0.991,-0.124,0.053
GOTO/CART,-62.993,-3.795,-4.67
ENDMES
$$<\MEAS_LINE = PM_6>
```

```
$$<MEAS_LINE name = "PM_7">
MODE/PROG,MAN
F(PM_7)=FEAT/LINE,UNBND,CART,-44.998,18.98,-29.025,0,-0.99,0.141,-1,0,0
MEAS/LINE,F(PM_7),2
GOTO/CART,-57.045,89.738,-38.051
PTMEAS/CART,-44.998,89.388,-39.07,-1,0,0
GOTO/CART,-50.17,89.481,6.625
GOTO/CART,-61.72,-51.197,6.915
GOTO/CART,-61.938,-51.232,-18.902
PTMEAS/CART,-44.998,-51.459,-18.976,-1,0,0
GOTO/CART,-52.642,-41.068,-2.834
ENDMES
$$<\MEAS_LINE = PM_7>
```

```
$$<MEAS_LINE name = "PM_8">
MODE/PROG,MAN
F(PM_8)=FEAT/LINE,UNBND,CART,-40.056,-41.124,-4.525,0,-1,-0.003,-1,0,0
MEAS/LINE,F(PM_8),2
SNSET/APPRCH,4
SNSET/SEARCH,4
GOTO/CART,-54.46,-39.548,-4.503
PTMEAS/CART,-40.056,-35.955,-4.508,-1,0,0
PTMEAS/CART,-40.056,-46.135,-4.541,-1,0,0
GOTO/CART,-41.128,-59.77,-4.585
ENDMES
$$<\MEAS_LINE = PM_8>
```

```
$$<MEAS_LINE name = "PM_9">
MODE/PROG,MAN
F(PM_9)=FEAT/LINE,UNBND,CART,6.03,-49.648,-5.025,1,0,-0.008,0,-1,0
MEAS/LINE,F(PM_9),2
PTMEAS/CART,-27.926,-49.648,-4.742,0,-1,0
GOTO/CART,39.764,-56.935,-5.375
PTMEAS/CART,40.119,-49.648,-5.31,0,-1,0
GOTO/CART,39.3,-76.917,-5.344
ENDMES
$$<\MEAS_LINE = PM_9>
```

```
$$<MEAS_LINE name = "PM_10">
MODE/PROG,MAN
F(PM_10)=FEAT/LINE,UNBND,CART,1.181,-59.775,-19.036,-1,0,0.008,0,-1,0
MEAS/LINE,F(PM_10),2
```

```
GOTO/CART,39.182,-76.937,-19.408
PTMEAS/CART,40.201,-59.775,-19.363,0,-1,0
GOTO/CART,-37.865,-67.692,-18.779
PTMEAS/CART,-37.709,-59.775,-18.71,0,-1,0
GOTO/CART,-37.591,-72.585,30.5
ENDMES
$$<\MEAS_LINE = PM_10>
```

```
SNSET/APPRCH,1
SNSET/RETRCT,1
SNSET/SEARCH,1
```

```
$$<MEAS_CIRCLE name = "KR_1">
MODE/PROG,MAN
F(KR_1)=FEAT/CIRCLE,INNER,CART,32.975,33.07,-6.211,0,0,1,7.978
MEAS/CIRCLE,F(KR_1),4
GOTO/CART,33.425,33.142,26.965
GOTO/CART,33.082,33.097,-6.213
PTMEAS/CART,33.171,37.054,-6.211,-0.049,-0.999,0
PTMEAS/CART,36.953,33.367,-6.211,-0.997,-0.075,0
PTMEAS/CART,33.201,29.088,-6.211,-0.057,0.998,0
PTMEAS/CART,28.998,32.762,-6.211,0.997,0.077,0
GOTO/CART,32.662,32.705,6.478
ENDMES
$$<\MEAS_CIRCLE = KR_1>
```

```
$$<MEAS_CIRCLE name = "KR_2">
MODE/PROG,MAN
F(KR_2)=FEAT/CIRCLE,INNER,CART,24.988,54.947,-17.488,0,0,1,7.958
MEAS/CIRCLE,F(KR_2),4
GOTO/CART,24.315,58.739,6.511
GOTO/CART,24.975,55.346,-17.51
PTMEAS/CART,21.016,55.184,-17.488,0.998,-0.06,0
PTMEAS/CART,24.817,58.922,-17.488,0.043,-0.999,0
PTMEAS/CART,28.962,55.144,-17.488,-0.999,-0.05,0
PTMEAS/CART,25.166,50.972,-17.488,-0.045,0.999,0
GOTO/CART,25.474,54.559,-7.855
GOTO/CART,-24.543,55.14,-7.44
ENDMES
$$<\MEAS_CIRCLE = KR_2>
```

```
$$<MEAS_CIRCLE name = "KR_3">
MODE/PROG,MAN
F(KR_3)=FEAT/CIRCLE,INNER,CART,-25.003,54.805,-16.896,0,0,1,7.974
MEAS/CIRCLE,F(KR_3),4
GOTO/CART,-25.234,54.588,-16.893
PTMEAS/CART,-25.05,58.792,-16.896,0.012,-1,0
PTMEAS/CART,-21.029,55.125,-16.896,-0.997,-0.08,0
PTMEAS/CART,-24.827,50.822,-16.896,-0.044,0.999,0
PTMEAS/CART,-28.981,54.538,-16.896,0.998,0.067,0
GOTO/CART,-25.182,54.456,12.272
ENDMES
$$<\MEAS_CIRCLE = KR_3>
```

```
$$<MEAS_CIRCLE name = "KR_4">
MODE/PROG,MAN
F(KR_4)=FEAT/CIRCLE,INNER,CART,-20.501,20.387,-11.881,0,0,1,7.962
MEAS/CIRCLE,F(KR_4),4
GOTO/CART,-19.941,20.203,11.839
GOTO/CART,-20.424,20.176,-11.881
PTMEAS/CART,-20.322,24.364,-11.881,-0.045,-0.999,0
PTMEAS/CART,-24.477,20.603,-11.881,0.999,-0.054,0
PTMEAS/CART,-20.79,16.417,-11.881,0.073,0.997,0
PTMEAS/CART,-16.524,20.23,-11.881,-0.999,0.039,0
GOTO/CART,-20.46,20.428,-3.554
```

GOTO/CART,-10.053,27.5,-2.604

ENDMES

\$\$<\MEAS_CIRCLE = KR_4>

\$\$<MEAS_CIRCLE name = "KR_8">

MODE/PROG,MAN

F(KR_8)=FEAT/CIRCLE,INNER,CART,-9.925,27.153,-12.213,0,0,1,7.971

MEAS/CIRCLE,F(KR_8),4

GOTO/CART,-10.131,27.3,-12.216

PTMEAS/CART,-9.962,31.138,-12.213,0.009,-1,0

PTMEAS/CART,-5.947,27.395,-12.213,-0.998,-0.061,0

PTMEAS/CART,-9.702,23.173,-12.213,-0.056,0.998,0

PTMEAS/CART,-13.901,26.877,-12.213,0.998,0.069,0

GOTO/CART,-10.184,26.801,6.97

GOTO/CART,20.693,20.928,6.72

ENDMES

\$\$<\MEAS_CIRCLE = KR_8>

\$\$<MEAS_CIRCLE name = "KR_7">

MODE/PROG,MAN

F(KR_7)=FEAT/CIRCLE,INNER,CART,20.488,20.499,-12.543,0,0,1,7.97

MEAS/CIRCLE,F(KR_7),4

GOTO/CART,20.41,20.904,-12.573

PTMEAS/CART,20.536,24.484,-12.543,-0.012,-1,0

PTMEAS/CART,24.463,20.782,-12.543,-0.997,-0.071,0

PTMEAS/CART,20.669,16.518,-12.543,-0.046,0.999,0

PTMEAS/CART,16.517,20.168,-12.543,0.997,0.083,0

GOTO/CART,20.336,21.355,8.048

GOTO/CART,20.318,-21.204,8.107

ENDMES

\$\$<\MEAS_CIRCLE = KR_7>

\$\$<MEAS_CIRCLE name = "KR_6">

MODE/PROG,MAN

F(KR_6)=FEAT/CIRCLE,INNER,CART,20.49,-20.456,-12.252,0,0,1,7.97

MEAS/CIRCLE,F(KR_6),4

GOTO/CART,20.324,-20.8,-12.249

PTMEAS/CART,20.46,-16.471,-12.252,0.007,-1,0

PTMEAS/CART,24.463,-20.145,-12.252,-0.997,-0.078,0

PTMEAS/CART,20.829,-24.426,-12.252,-0.085,0.996,0

PTMEAS/CART,16.516,-20.744,-12.252,0.997,0.072,0

GOTO/CART,20.254,-20.794,9.508

GOTO/CART,-21.75,-19.767,9.857

ENDMES

\$\$<\MEAS_CIRCLE = KR_6>

\$\$<MEAS_CIRCLE name = "KR_5">

MODE/PROG,MAN

F(KR_5)=FEAT/CIRCLE,INNER,CART,-20.501,-20.577,-12.51,0,0,1,7.963

MEAS/CIRCLE,F(KR_5),4

GOTO/CART,-21.163,-20.386,-12.511

PTMEAS/CART,-20.857,-16.612,-12.51,0.089,-0.996,0

PTMEAS/CART,-16.524,-20.396,-12.51,-0.999,-0.045,0

PTMEAS/CART,-20.267,-24.552,-12.51,-0.059,0.998,0

PTMEAS/CART,-24.473,-20.853,-12.51,0.998,0.069,0

GOTO/CART,-20.604,-20.882,25.958

ENDMES

\$\$<\MEAS_CIRCLE = KR_5>

T(10)=TOL/CIRLTY,0.1

T(Kruhovitost)=TOL/CIRLTY,0.1

T(Soustrednost)=TOL/CONCEN,0.1,FA(ROZT_KR_9)

\$\$<MEAS_CIRCLE name = "kruznice">

MODE/AUTO,PROG,MAN

F(kruznice)=FEAT/CIRCLE,INNER,CART,0,0,-8,0,0,1,30

```

$$<CONSTRAINT type="RAY" base=(0.000,0.000,-8.000) direction=(0.000,0.000,1.000) offset = 24.626>
GOTO/CART,0,0,16.626
$$<\CONSTRAINT>
MEAS/CIRCLE,F(kruznice),200
PTMEAS/CART,15,0,-8,-1,0,0
PTMEAS/CART,14.993,0.471,-8,-1,-0.031,0
PTMEAS/CART,14.97,0.942,-8,-0.998,-0.063,0
PTMEAS/CART,14.933,1.412,-8,-0.996,-0.094,0
PTMEAS/CART,14.882,1.88,-8,-0.992,-0.125,0
PTMEAS/CART,14.815,2.347,-8,-0.988,-0.156,0
PTMEAS/CART,14.734,2.811,-8,-0.982,-0.187,0
PTMEAS/CART,14.639,3.272,-8,-0.976,-0.218,0
PTMEAS/CART,14.529,3.73,-8,-0.969,-0.249,0
PTMEAS/CART,14.404,4.185,-8,-0.96,-0.279,0
PTMEAS/CART,14.266,4.635,-8,-0.951,-0.309,0
PTMEAS/CART,14.113,5.081,-8,-0.941,-0.339,0
PTMEAS/CART,13.947,5.522,-8,-0.93,-0.368,0
PTMEAS/CART,13.766,5.957,-8,-0.918,-0.397,0
PTMEAS/CART,13.572,6.387,-8,-0.905,-0.426,0
PTMEAS/CART,13.365,6.81,-8,-0.891,-0.454,0
PTMEAS/CART,13.145,7.226,-8,-0.876,-0.482,0
PTMEAS/CART,12.911,7.636,-8,-0.861,-0.509,0
PTMEAS/CART,12.665,8.037,-8,-0.844,-0.536,0
PTMEAS/CART,12.406,8.431,-8,-0.827,-0.562,0
PTMEAS/CART,12.135,8.817,-8,-0.809,-0.588,0
PTMEAS/CART,11.852,9.194,-8,-0.79,-0.613,0
PTMEAS/CART,11.558,9.561,-8,-0.771,-0.637,0
PTMEAS/CART,11.252,9.92,-8,-0.75,-0.661,0
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PTMEAS/CART,10.607,10.607,-8,-0.707,-0.707,0
PTMEAS/CART,10.268,10.935,-8,-0.685,-0.729,0
PTMEAS/CART,9.92,11.252,-8,-0.661,-0.75,0
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PTMEAS/CART,9.194,11.852,-8,-0.613,-0.79,0
PTMEAS/CART,8.817,12.135,-8,-0.588,-0.809,0
PTMEAS/CART,8.431,12.406,-8,-0.562,-0.827,0
PTMEAS/CART,8.037,12.665,-8,-0.536,-0.844,0
PTMEAS/CART,7.636,12.911,-8,-0.509,-0.861,0
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PTMEAS/CART,6.81,13.365,-8,-0.454,-0.891,0
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PTMEAS/CART,5.957,13.766,-8,-0.397,-0.918,0
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PTMEAS/CART,4.635,14.266,-8,-0.309,-0.951,0
PTMEAS/CART,4.185,14.404,-8,-0.279,-0.96,0
PTMEAS/CART,3.73,14.529,-8,-0.249,-0.969,0
PTMEAS/CART,3.272,14.639,-8,-0.218,-0.976,0
PTMEAS/CART,2.811,14.734,-8,-0.187,-0.982,0
PTMEAS/CART,2.347,14.815,-8,-0.156,-0.988,0
PTMEAS/CART,1.88,14.882,-8,-0.125,-0.992,0
PTMEAS/CART,1.412,14.933,-8,-0.094,-0.996,0
PTMEAS/CART,0.942,14.97,-8,-0.063,-0.998,0
PTMEAS/CART,0.471,14.993,-8,-0.031,-1,0
PTMEAS/CART,0,15,-8,0,-1,0
PTMEAS/CART,-0.471,14.993,-8,0.031,-1,0
PTMEAS/CART,-0.942,14.97,-8,0.063,-0.998,0
PTMEAS/CART,-1.412,14.933,-8,0.094,-0.996,0
PTMEAS/CART,-1.88,14.882,-8,0.125,-0.992,0
PTMEAS/CART,-2.347,14.815,-8,0.156,-0.988,0
PTMEAS/CART,-2.811,14.734,-8,0.187,-0.982,0
PTMEAS/CART,-3.272,14.639,-8,0.218,-0.976,0
PTMEAS/CART,-3.73,14.529,-8,0.249,-0.969,0
PTMEAS/CART,-4.185,14.404,-8,0.279,-0.96,0
PTMEAS/CART,-4.635,14.266,-8,0.309,-0.951,0

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PTMEAS/CART,-5.081,14.113,-8,0.339,-0.941,0
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PTMEAS/CART,-8.817,12.135,-8,0.588,-0.809,0
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PTMEAS/CART,-9.561,11.558,-8,0.637,-0.771,0
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PTMEAS/CART,-11.852,9.194,-8,0.79,-0.613,0
PTMEAS/CART,-12.135,8.817,-8,0.809,-0.588,0
PTMEAS/CART,-12.406,8.431,-8,0.827,-0.562,0
PTMEAS/CART,-12.665,8.037,-8,0.844,-0.536,0
PTMEAS/CART,-12.911,7.636,-8,0.861,-0.509,0
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PTMEAS/CART,-13.947,5.522,-8,0.93,-0.368,0
PTMEAS/CART,-14.113,5.081,-8,0.941,-0.339,0
PTMEAS/CART,-14.266,4.635,-8,0.951,-0.309,0
PTMEAS/CART,-14.404,4.185,-8,0.96,-0.279,0
PTMEAS/CART,-14.529,3.73,-8,0.969,-0.249,0
PTMEAS/CART,-14.639,3.272,-8,0.976,-0.218,0
PTMEAS/CART,-14.734,2.811,-8,0.982,-0.187,0
PTMEAS/CART,-14.815,2.347,-8,0.988,-0.156,0
PTMEAS/CART,-14.882,1.88,-8,0.992,-0.125,0
PTMEAS/CART,-14.933,1.412,-8,0.996,-0.094,0
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PTMEAS/CART,-14.993,0.471,-8,1,-0.031,0
PTMEAS/CART,-15,0,-8,1,0,0
PTMEAS/CART,-14.993,-0.471,-8,1,0.031,0
PTMEAS/CART,-14.97,-0.942,-8,0.998,0.063,0
PTMEAS/CART,-14.933,-1.412,-8,0.996,0.094,0
PTMEAS/CART,-14.882,-1.88,-8,0.992,0.125,0
PTMEAS/CART,-14.815,-2.347,-8,0.988,0.156,0
PTMEAS/CART,-14.734,-2.811,-8,0.982,0.187,0
PTMEAS/CART,-14.639,-3.272,-8,0.976,0.218,0
PTMEAS/CART,-14.529,-3.73,-8,0.969,0.249,0
PTMEAS/CART,-14.404,-4.185,-8,0.96,0.279,0
PTMEAS/CART,-14.266,-4.635,-8,0.951,0.309,0
PTMEAS/CART,-14.113,-5.081,-8,0.941,0.339,0
PTMEAS/CART,-13.947,-5.522,-8,0.93,0.368,0
PTMEAS/CART,-13.766,-5.957,-8,0.918,0.397,0
PTMEAS/CART,-13.572,-6.387,-8,0.905,0.426,0
PTMEAS/CART,-13.365,-6.81,-8,0.891,0.454,0
PTMEAS/CART,-13.145,-7.226,-8,0.876,0.482,0
PTMEAS/CART,-12.911,-7.636,-8,0.861,0.509,0
PTMEAS/CART,-12.665,-8.037,-8,0.844,0.536,0
PTMEAS/CART,-12.406,-8.431,-8,0.827,0.562,0
PTMEAS/CART,-12.135,-8.817,-8,0.809,0.588,0
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PTMEAS/CART,-11.252,-9.92,-8,0.75,0.661,0
PTMEAS/CART,-10.935,-10.268,-8,0.729,0.685,0
PTMEAS/CART,-10.607,-10.607,-8,0.707,0.707,0

PTMEAS/CART,-10.268,-10.935,-8,0.685,0.729,0
PTMEAS/CART,-9.92,-11.252,-8,0.661,0.75,0
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PTMEAS/CART,-8.817,-12.135,-8,0.588,0.809,0
PTMEAS/CART,-8.431,-12.406,-8,0.562,0.827,0
PTMEAS/CART,-8.037,-12.665,-8,0.536,0.844,0
PTMEAS/CART,-7.636,-12.911,-8,0.509,0.861,0
PTMEAS/CART,-7.226,-13.145,-8,0.482,0.876,0
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PTMEAS/CART,-4.635,-14.266,-8,0.309,0.951,0
PTMEAS/CART,-4.185,-14.404,-8,0.279,0.96,0
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PTMEAS/CART,-3.272,-14.639,-8,0.218,0.976,0
PTMEAS/CART,-2.811,-14.734,-8,0.187,0.982,0
PTMEAS/CART,-2.347,-14.815,-8,0.156,0.988,0
PTMEAS/CART,-1.88,-14.882,-8,0.125,0.992,0
PTMEAS/CART,-1.412,-14.933,-8,0.094,0.996,0
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PTMEAS/CART,-0.471,-14.993,-8,0.031,1,0
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PTMEAS/CART,0.471,-14.993,-8,-0.031,1,0
PTMEAS/CART,0.942,-14.97,-8,-0.063,0.998,0
PTMEAS/CART,1.412,-14.933,-8,-0.094,0.996,0
PTMEAS/CART,1.88,-14.882,-8,-0.125,0.992,0
PTMEAS/CART,2.347,-14.815,-8,-0.156,0.988,0
PTMEAS/CART,2.811,-14.734,-8,-0.187,0.982,0
PTMEAS/CART,3.272,-14.639,-8,-0.218,0.976,0
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PTMEAS/CART,4.185,-14.404,-8,-0.279,0.96,0
PTMEAS/CART,4.635,-14.266,-8,-0.309,0.951,0
PTMEAS/CART,5.081,-14.113,-8,-0.339,0.941,0
PTMEAS/CART,5.522,-13.947,-8,-0.368,0.93,0
PTMEAS/CART,5.957,-13.766,-8,-0.397,0.918,0
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PTMEAS/CART,7.226,-13.145,-8,-0.482,0.876,0
PTMEAS/CART,7.636,-12.911,-8,-0.509,0.861,0
PTMEAS/CART,8.037,-12.665,-8,-0.536,0.844,0
PTMEAS/CART,8.431,-12.406,-8,-0.562,0.827,0
PTMEAS/CART,8.817,-12.135,-8,-0.588,0.809,0
PTMEAS/CART,9.194,-11.852,-8,-0.613,0.79,0
PTMEAS/CART,9.561,-11.558,-8,-0.637,0.771,0
PTMEAS/CART,9.92,-11.252,-8,-0.661,0.75,0
PTMEAS/CART,10.268,-10.935,-8,-0.685,0.729,0
PTMEAS/CART,10.607,-10.607,-8,-0.707,0.707,0
PTMEAS/CART,10.935,-10.268,-8,-0.729,0.685,0
PTMEAS/CART,11.252,-9.92,-8,-0.75,0.661,0
PTMEAS/CART,11.558,-9.561,-8,-0.771,0.637,0
PTMEAS/CART,11.852,-9.194,-8,-0.79,0.613,0
PTMEAS/CART,12.135,-8.817,-8,-0.809,0.588,0
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PTMEAS/CART,12.665,-8.037,-8,-0.844,0.536,0
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PTMEAS/CART,13.766,-5.957,-8,-0.918,0.397,0
PTMEAS/CART,13.947,-5.522,-8,-0.93,0.368,0
PTMEAS/CART,14.113,-5.081,-8,-0.941,0.339,0
PTMEAS/CART,14.266,-4.635,-8,-0.951,0.309,0

PTMEAS/CART,14.404,-4.185,-8,-0.96,0.279,0
PTMEAS/CART,14.529,-3.73,-8,-0.969,0.249,0
PTMEAS/CART,14.639,-3.272,-8,-0.976,0.218,0
PTMEAS/CART,14.734,-2.811,-8,-0.982,0.187,0
PTMEAS/CART,14.815,-2.347,-8,-0.988,0.156,0
PTMEAS/CART,14.882,-1.88,-8,-0.992,0.125,0
PTMEAS/CART,14.933,-1.412,-8,-0.996,0.094,0
PTMEAS/CART,14.97,-0.942,-8,-0.998,0.063,0
PTMEAS/CART,14.993,-0.471,-8,-1,0.031,0
ENDMES
OUTPUT/FA(kruznice),TA(CORTOL_X1),TA(CORTOL_Y1),TA(DIAM_1),TA(Kruhovitost)
\$\$<\MEAS_CIRCLE = kruznice>

GOTO/CART,0,0,33.596

\$\$konstrukce prvku.....

F(PM_7a)=FEAT/LINE,UNBND,CART,-44.998,18.98,0,0,-1,0,0,0,1
CONST/LINE,F(PM_7a),PROJLI,FA(PM_7),FA(ROVINA_1)

F(PM_8a)=FEAT/LINE,UNBND,CART,-40.056,-41.124,0,0,-1,0,0,0,1
CONST/LINE,F(PM_8a),PROJLI,FA(PM_8),FA(ROVINA_1)

F(PM_9a)=FEAT/LINE,UNBND,CART,6.03,-49.648,0,1,0,0,0,0,1
CONST/LINE,F(PM_9a),PROJLI,FA(PM_9),FA(ROVINA_1)

F(PM_5a)=FEAT/LINE,UNBND,CART,-39.601,9.408,0,1,0,0,0,0,1
CONST/LINE,F(PM_5a),PROJLI,FA(PM_5),FA(ROVINA_1)

F(PM_6a)=FEAT/LINE,UNBND,CART,-39.621,-9.543,0,-1,0,0,0,0,1
CONST/LINE,F(PM_6a),PROJLI,FA(PM_6),FA(ROVINA_1)

F(Prusecik_4)=FEAT/POINT,CART,-40.056,-49.648,-4.603,0,0,1
CONST/POINT,F(Prusecik_4),INTOF,FA(PM_8a),FA(PM_9a)

F(Prusecik_5)=FEAT/POINT,CART,-42.527,-150.733,-4.854,0,0,1
CONST/POINT,F(Prusecik_5),INTOF,FA(PM_7a),FA(PM_8a)

F(ROZT_KR_9)=FEAT/CIRCLE,INNER,CART,-0.006,-0.045,-12.308,0,0,1,58
CONST/CIRCLE,F(ROZT_KR_9),BF,FA(KR_4),FA(KR_5),FA(KR_6),FA(KR_7),FA(KR_8)

F(SYM_PR_4)=FEAT/LINE,UNBND,CART,-1.1,89.771,-29.943,1,0,0,0,1,0
CONST/LINE,F(SYM_PR_4),MIDLI,FA(PM_2),FA(PM_3)

F(SYM_PR_4a)=FEAT/LINE,BND,CART,0,89.771,0,80,89.771,0,0,0,1
CONST/LINE,F(SYM_PR_4a),PROJLI,FA(SYM_PR_4),FA(ROVINA_1)

F(PM_1a)=FEAT/LINE,UNBND,CART,44.494,29.075,0,0,1,0,0,0,1
CONST/LINE,F(PM_1a),PROJLI,FA(PM_1),FA(ROVINA_1)

\$\$vyhodnoceni.....

T(1)=TOL/DISTB,NOMINL,80,-0.15,0.15,XAXIS,AVG
OUTPUT/FA(PM_1),FA(Prusecik_4),TA(1)

T(2)=TOL/DISTB,NOMINL,60,-0.1,0.1,YAXIS,AVG
OUTPUT/FA(PM_10),FA(valec_1),TA(2)

T(3)=TOL/DISTB,NOMINL,33,-0.1,0.1,YAXIS,AVG
OUTPUT/FA(valec_1),FA(KR_1),TA(3)

T(4)=TOL/DISTB,NOMINL,50,-0.08,0.08,XAXIS,AVG
OUTPUT/FA(KR_2),FA(KR_3),TA(4)

T(5)=TOL/DISTB,NOMINL,90,-0.15,0.15,XAXIS,AVG

OUTPUT/FA(PM_1),FA(PM_7),TA(5)

T(7)=TOL/DIAM,-0.05,0.05

OUTPUT/FA(ROZT_KR_9),TA(7)

T(8)=TOL/DISTB,NOMINL,20,-0.1,0.1,PT2PT,AVG

OUTPUT/FA(Prusecik_4),FA(Prusecik_5),TA(8)

T(9)=TOL/ANGLB,80,-0:30,0:30,XYPLAN

OUTPUT/FA(PM_5a),FA(PM_6a),TA(9)

UNITS/MM,ANGDEC,TEMPC

T(6)=TOL/ANGLB,90,-0.1,0.1,XYPLAN

OUTPUT/FA(SYM_PR_4a),FA(PM_1a),TA(6)

GOTO/CART,-24.812,-37.879,8.682

PAUSE

ENDFIL

Výsledky měření:

02-Mar-2011 09:25		Mereni - blok				Strana 1	
(mm)	MERENÁ	JMENOVIČÁ	D-TOL	H-TOL	ODCHYLKA	GRAFIKA	CHYBA
Kružnice:kružnice							
osa X	-0.002	0.000	-0.100	+0.100	-0.002	---*---	
osa Y	0.019	0.000	-0.100	+0.100	0.019	---+*--	
Prumer	30.010	30.000	-0.100	+0.100	0.010	---*---	
Kruhovitost	0.077			0.100		+--*-	
Prímka:PM_1--Bod:Prusecik_4							
Délka Xprn.	79.930	80.000	-0.150	+0.150	-0.070	--*+---	
Prímka:PM_10--Válec:valec_1							
Délka Yprn.	59.770	60.000	-0.100	+0.100	-0.230	<---+---	-0.130
Válec:valec_1--Kružnice:KR_1							
Délka Yprn.	33.081	33.000	-0.100	+0.100	0.081	---+*-	
Kružnice:KR_2--Kružnice:KR_3							
Délka Xprn.	49.972	50.000	-0.080	+0.080	-0.028	--*+---	
Prímka:PM_1--Prímka:PM_7							
Délka Xprn.	89.916	90.000	-0.150	+0.150	-0.084	-*-+---	
Kružnice:ROZT_KR_9							
Prumer	57.934	58.000	-0.050	+0.050	-0.066	<---+---	-0.016
Bod:Prusecik_4--Bod:Prusecik_5							
Délkaprn.	19.930	20.000	-0.100	+0.100	-0.070	-*-+---	
Prímka:PM_5a--Prímka:PM_6a							
Úhel XY	79:51:59	80:00:00	-00:30:00	+00:30:00	-00:08:01	--*+---	
Prímka:SYM_PR_4a--Prímka:PM_1a							
Úhel XY	89.838	90.000	-0.100	+0.100	-0.162	<---+---	-0.062
Cas 11 min 23 sek. nOK v tol:10 mimo:3 Konec protokolu							

Fotodokumentace:



Obr.1: DEA Swift



Obr.2: Kalibrační koule



Obr.3: Renishaw Servo Power Amplifier SPA 2



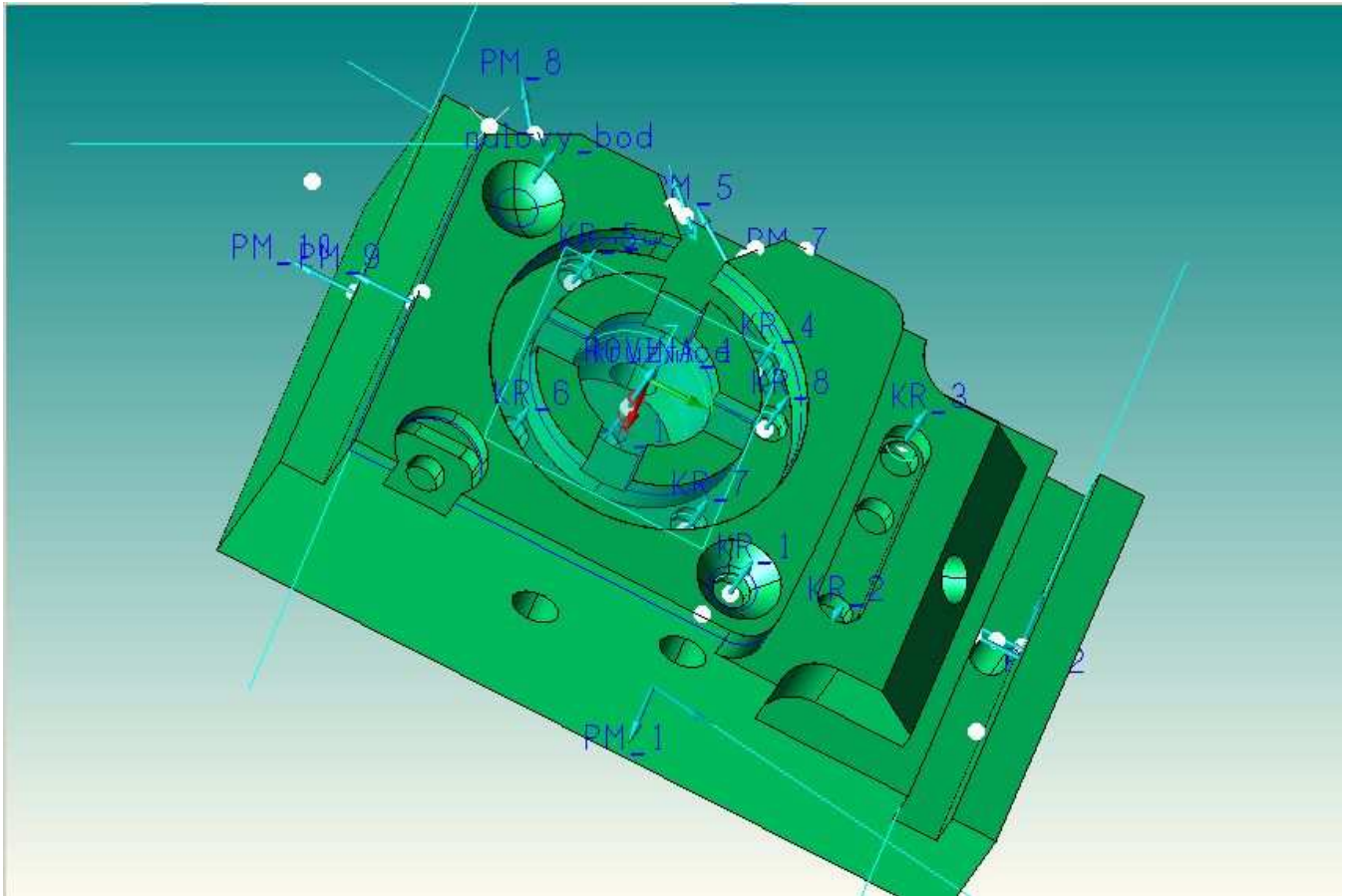
Obr.4: Snímací systém Renishaw



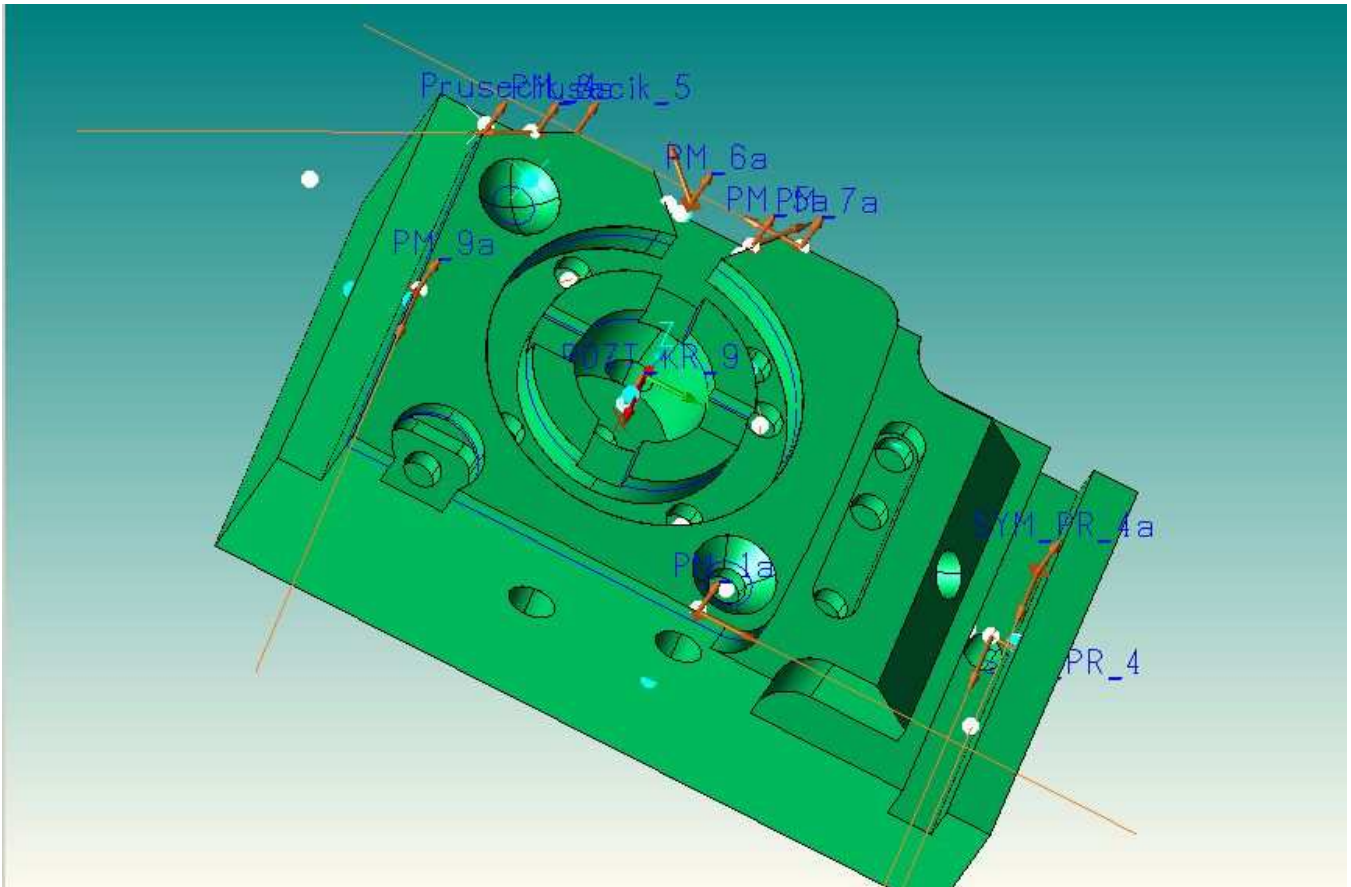
Obr.5: Upnutí součásti na žulové desce



Obr.6: Renishaw Universal CMM Controller UCC 2

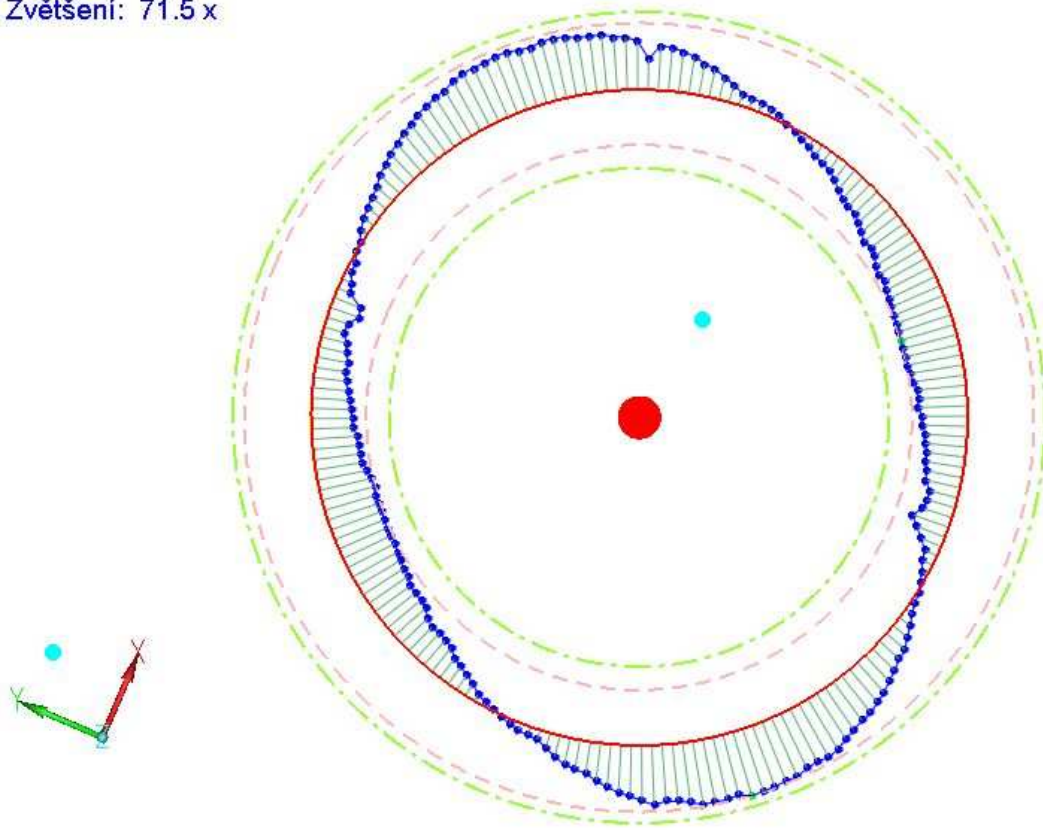


Obr.7: Znázorněné měřené prvky na modelu součásti



Obr.8: Znázorněné konstruované prvky na modelu součásti

Zvětšení: 71.5 x



Obr.9: Kružnice skenovaná pomocí 200 bodů

Vysvětlivky k Obr. 9:

Červená – kružnice jmenovitých hodnot

Zelená – kružnice hodnot dolních a horních tolerancí (mezikružší je tolerančním polem)

Modrá – jednotlivé snímané body a jejich odchylky

Růžová – kružnice opsaná maximální naměřené hodnotě a vepsaná minimální naměřené hodnotě

Závěr:

Hlavním cílem této přílohy bakalářské práce *Možnosti měření geometrické přesnosti obrobku* je poukázat na důležité náležitosti a postupy při měření na souřadnicovém měřicím stroji. Dále pak má tato příloha dokazovat, že se autor prakticky setkal s tímto způsobem postprocesního měření, jež je částečnou náplní jeho výše uvedené bakalářské práce. Ve výsledku vyšlo ze 13 tolerovaných prvků 10 prvků v toleranci a 3 mimo toleranci.