

Satelitarne techniki pomiarowe

Wyznaczenie pozycji odbionika na podstawie obserwacji kodowych

materiały do ćwiczeń
aktualizacja: 13 maja 2014

Równanie pseudoodległości

$$PR = R(x_o^p, y_o^p, z_o^p) - \frac{x_s - x_o^p}{R^p} \Delta x - \frac{y_s - y_o^p}{R^p} \Delta y - \frac{z_s - z_o^p}{R^p} \Delta z + c \cdot \delta t$$

Macierz współczynników przy niewiadomych G ,

$$G = \begin{bmatrix} -\frac{x_s - x_o^p}{R^p} & -\frac{y_s - y_o^p}{R^p} & -\frac{z_s - z_o^p}{R^p} & 1 \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix}$$

$$L = \begin{bmatrix} PR - \sqrt{(x_s - x_o^p)^2 + (y_s - y_o^p)^2 + (z_s - z_o^p)^2} \\ \vdots \end{bmatrix}$$

$$[\Delta x \quad \Delta y \quad \Delta z \quad c\delta t]^T = (G^T G)^{-1} \cdot (G^T L)$$

Równanie pseudoodległości

$$PR = R(x_o^p, y_o^p, z_o^p) - \frac{x_s - x_o^p}{R^p} \Delta x - \frac{y_s - y_o^p}{R^p} \Delta y - \frac{z_s - z_o^p}{R^p} \Delta z + c \cdot \delta t$$

Macierz współczynników przy niewiadomych G ,

$$\rightarrow x_o^p = 0, \quad y_o^p = 0, \quad z_o^p = 0$$

$$G = \begin{bmatrix} -\frac{x_s - x_o^p}{R^p} & -\frac{y_s - y_o^p}{R^p} & -\frac{z_s - z_o^p}{R^p} & 1 \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix}$$

$$L = \begin{bmatrix} PR - \sqrt{(x_s - x_o^p)^2 + (y_s - y_o^p)^2 + (z_s - z_o^p)^2} \\ \vdots \end{bmatrix}$$

$$[\Delta x \quad \Delta y \quad \Delta z \quad c\delta t]^T = (G^T G)^{-1} \cdot (G^T L)$$

Dane

```
===== nr = 0 =====  
prn      X [m]      Y [m]      Z [m]      PR [m]  
  2    2517322.901    17217633.486    20369218.915    22246285.896  
 10   -9314838.898    19277369.505    15161206.529    24283583.211  
 12   11406344.544    18935412.559    14852148.501    21986550.835  
 14   21885259.963   -14864239.870     1407510.889    25191508.200  
 25   15054174.230     6979046.876    20721268.814    20359682.537  
 29   21560284.658   -1378445.354    15478568.916    20698916.801  
 31   8503922.509   -12358039.529    22114773.961    22251944.060
```

Rozwiązanie

```
rozwiązanie =  
  
    3973982.43334725  
    957529.651149071  
    4769447.50878022  
    299814.248291714  
  
BLH =  
  
    49.59      13.55   -84298.59  
  
rozwiązanie =  
  
   -493822.086291496  
   -103447.310753751  
   -471231.552634662  
   -452011.015369511  
  
BLH =  
  
    50.40      13.79   -769453.02  
  
rozwiązanie =  
  
   -8757.31763834099  
   -1530.29441661488
```

-5637.16428762093

-463098.995538579

BLH =

50.43 13.80 -779449.47

rozwiązanie =

-23.0494710745772

-0.519451240278158

-15.854584410456

-463113.287311285

BLH =

50.43 13.80 -779476.03

rozwiązanie =

-0.0752227454719332

-0.0212109415047053

-0.0524186560414819

-463113.33785289

BLH =

50.43 13.80 -779476.12

rozwiązanie =

-0.000148314577700148

3.05760977425962e-05

-0.000123360478028189

-463113.337932353

BLH =

50.43 13.80 -779476.12

pos =

```
3471379.90457528  
852551.505347099  
4292562.88473151  
-2004635.7257129
```

```
ans =
```

```
Columns 1 through 3:
```

```
18      50.4303803908948      13.798425020382
```

```
Column 4:
```

```
-779476.115434707
```

Iteracyjna metoda Hirvonena (geodezja wyższa)

Równanie
pseudoodległości

Przykład

$$N = \frac{a}{\sqrt{1 - e^2 \cdot \sin^2(B)}}$$

$$X = (N + H) \cos B \cos L$$

$$Y = (N + H) \cos B \sin L$$

$$Z = (N(1 - e^2) + H) \sin B$$

$$\operatorname{tg} L = \frac{Y}{X}$$

iteracyjnie

$$\operatorname{tg} B = \frac{(N(1 - e^2) + H)}{N + H}$$

$$a = 6\,378\,137,0 \text{ m}$$

$$\alpha^{-1} = 298,257\,223\,563$$

```
function[Ba,La,Ha]=hirvonen(X,Y,Z,a,e2);
j=1;
r = (X^2+Y^2)^(0.5);
B(j)=atan(Z/(r*(1-e2)));

while 1
    j = j+1;
    N(j) = Np(B(j-1),a,e2);
    H(j) = (r/cos(B(j-1)))-N(j);
    B(j) = atan(Z/(r*(1-(e2*(N(j))/(N(j)+H(j))))));

    if abs(B(j)-B(j-1))<(0.000001/206265) break; end;
end;

Ba = (B(j));
La = atan(Y/X);
Na = Np(Ba,a,e2);
Ha = (r/cos(Ba))-Na;
```


Równanie pseudoodległości

$$PR = R(x_o^p, y_o^p, z_o^p) - \frac{x_s - x_o^p}{R^p} \Delta x - \frac{y_s - y_o^p}{R^p} \Delta y - \frac{z_s - z_o^p}{R^p} \Delta z + c \cdot \delta t$$

Macierz współczynników przy niewiadomych G ,

$$\rightarrow x_o^p = 0, \quad y_o^p = 0, \quad z_o^p = 0$$

$$G = \begin{bmatrix} -\frac{x_s - x_o^p}{R^p} & -\frac{y_s - y_o^p}{R^p} & -\frac{z_s - z_o^p}{R^p} & 1 \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix}$$

$$L = \begin{bmatrix} PR - \sqrt{(x_s - x_o^p)^2 + (y_s - y_o^p)^2 + (z_s - z_o^p)^2} \\ \vdots \end{bmatrix}$$

$$[\Delta x \quad \Delta y \quad \Delta z \quad c\delta t]^T = (G^T G)^{-1} \cdot (G^T L)$$

Równanie pseudoodległości

$$PR = R(x_o^p, y_o^p, z_o^p) - \frac{x_s - x_o^p}{R^p} \Delta x - \frac{y_s - y_o^p}{R^p} \Delta y - \frac{z_s - z_o^p}{R^p} \Delta z + c \cdot \delta t$$

$+ I + T + \epsilon$ (różnice czasów)

Macierz współczynników przy niewiadomych G ,

$$G = \begin{bmatrix} -\frac{x_s - x_o^p}{R^p} & -\frac{y_s - y_o^p}{R^p} & -\frac{z_s - z_o^p}{R^p} & 1 \\ \vdots & \vdots & \vdots & \vdots \end{bmatrix}$$

$$L = \begin{bmatrix} PR - \sqrt{(x_s - x_o^p)^2 + (y_s - y_o^p)^2 + (z_s - z_o^p)^2} \\ \vdots \end{bmatrix}$$

$$[\Delta x \quad \Delta y \quad \Delta z \quad c\delta t]^T = (G^T G)^{-1} \cdot (G^T L)$$

Plik tekstowy [kliknij aby pobrać](#) – działa pod AdobeReader

```

----- nr = 0 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      2517322.901  17217633.486  20369218.915  22246285.896
 10      -9314838.898  19277369.505  15161206.529  24283583.211
 12      11406344.544  18935412.559  14852148.501  21986550.835
 14      21885259.963  -14864239.870  1407510.889   25191508.200
 25      15054174.230  6979046.876   20721268.814  20359682.537
 29      21560284.658  -1378445.354  15478568.916  20698916.801
 31      8503922.509   -12358039.529  22114773.961  22251944.060

----- nr = 1 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      2445903.544   17190599.804  20399463.618  22260768.404
  5      2807212.758   26332086.380   182591.996   25227329.761
 10      -9328342.150   19218272.588  15227776.743  24284300.302
 12      11406409.333  18991761.119  14780675.510  22007865.482
 14      21893000.907  -14860363.967   1311194.559  25215934.798
 25      15060961.053   7057759.767   20689967.035  20369696.583
 29      21514352.137  -1341281.243  15545955.477  20696984.428
 31      8578700.510   -12322773.259  22106304.053  22248964.419

----- nr = 2 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      2374332.139   17163640.476  20429327.658  22275344.634
  5      2797184.389   26332217.233   277320.274   25217041.691
 10      -9341963.784   19158945.169  15294044.363  24285123.403
 12      11406558.044   19047839.430  14708921.765  22029233.908
 14      21900441.543  -14856305.664   1214852.931  25240374.986
 25      15067875.307   7136341.151   20658268.507  20379795.762
 29      21468274.571  -1303896.637   15613044.933  20695130.198
 31      8653512.302   -12287661.618  22097418.605  22246080.475

----- nr = 3 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      2302610.002   17136756.506  20458810.437  22290014.287
  5      2787115.205   26332009.365   372043.195   25206783.087

```

10	-9355704.602	19099388.663	15360008.075	24286052.819
12	11406789.499	19103646.345	14636888.642	22050655.726
14	21907582.531	-14852063.684	1118487.862	25264828.157
25	15074916.322	7214789.343	20626173.848	20389980.052
29	21422053.593	-1266291.441	15679836.009	20693354.122
31	8728356.170	-12252705.256	22088117.813	22243292.717

----- nr = 4 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	2230738.456	17109948.887	20487911.364	22304776.982
5	2777003.868	26331462.956	466758.926	25196554.524
10	-9369565.395	19039604.492	15425666.568	24287088.725
12	11407102.513	19159180.728	14564577.520	22072130.811
14	21914424.538	-14847636.754	1022101.211	25289293.450
25	15082083.418	7293102.666	20593683.685	20400249.396
29	21375690.842	-1228465.570	15746327.437	20691656.120
31	8803230.397	-12217904.817	22078401.878	22240601.274

----- nr = 5 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	2158718.828	17083218.609	20516629.853	22319632.650
5	2766849.044	26330578.194	561465.639	25186356.764
10	-9383546.948	18979594.086	15491018.539	24288231.712
12	11407495.896	19214441.450	14491989.785	22093659.148
25	15089375.905	7371279.448	20560798.651	20410603.998
29	21329187.957	-1190418.950	15812517.952	20690036.578
31	8878133.260	-12183260.932	22068271.011	22238006.657

----- nr = 6 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	2086552.455	17056566.651	20544965.327	22334581.393
5	2756649.401	26329355.278	656161.504	25176190.790
10	-9397650.038	18919358.882	15556062.689	24289482.351
12	11407968.453	19269427.392	14419126.826	22115240.920
25	15096793.086	7449318.019	20527519.387	20421044.241
29	21282546.580	-1152151.517	15878406.299	20688495.916
31	8953063.036	-12148774.223	22057725.430	22235509.666

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----- nr = 7 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      2014240.679    17029993.988    20572917.215    22349622.821
  5      2746403.606    26327794.421      750844.689    25166057.112
 10     -9411875.433    18858900.323    15620797.728    24290840.783
 12     11408518.980    19324137.446    14345990.039    22136875.825
 25     15104334.253      7527216.718    20493846.542    20431570.033
 29     21235768.356    -1113663.216    15943991.224    20687034.144
 31      9028017.997   -12114445.301    22046765.362    22233110.583

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----- nr = 8 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      1941784.847    17003501.587    20600484.953    22364756.547
  5      2736110.331    26325895.844      845513.366    25155956.207
 10     -9426223.893    18798219.859    15685222.371    24292307.398
 12     11409146.270    19378570.511    14272580.823    22158563.640
 25     15111998.690      7604973.888    20459780.772    20442181.268
 29     21188854.930   -1074954.004    16009271.483    20685651.255
 31      9102996.415   -12080274.769    22035391.037    22230809.571

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----- nr = 9 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      1869186.317    16977090.408    20627667.982    22379982.491
  5      2725768.246    26323659.779      940165.705    25145888.688
 10     -9440696.172    18737318.948    15749335.340    24293882.558
 12     11409849.107    19432725.496    14198900.585    22180304.347
 25     15119785.672      7682587.875    20425322.742    20452878.197
 29     21141807.950   -1036023.848    16074245.835    20684347.527
 31      9177996.555   -12046263.219    22023602.699    22228607.188

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----- nr = 10 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      1796446.448    16950761.404    20654465.754    22395300.080
  5      2715376.026    26321086.470    1034799.876    25135855.105
 10     -9455293.014    18676199.054    15813135.362    24295566.348
 12     11410626.273    19486601.320    14124950.733    22202097.401
 25     15127694.464      7760057.032    20390473.121    20463660.499

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29	21094629.068	-996872.725	16138913.047	20683122.635
31	9253016.682	-12012411.233	22011400.594	22226503.307

----- nr = 11 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1723566.609	16924515.521	20680877.724	22410708.847
5	2704932.346	26318176.170	1129414.051	25125855.855
10	-9470015.154	18614861.649	15876621.174	24297358.764
12	11411476.540	19540196.909	14050732.684	22223942.481
25	15135724.323	7837379.720	20355232.589	20474528.092
29	21047319.935	-957500.622	16203271.891	20681976.501
31	9328055.058	-11978719.382	21998784.980	22224498.193

----- nr = 12 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1650548.175	16898353.697	20706903.355	22426208.892
5	2694435.883	26314929.145	1224006.401	25115891.815
10	-9484863.321	18553308.210	15939791.515	24299260.540
12	11412398.678	19593511.201	13976247.858	22245839.900
25	15143874.498	7914554.300	20319601.833	20485481.380
29	20999882.205	-917907.537	16267321.144	20680909.722
31	9403109.942	-11945188.230	21985756.119	22222592.638

----- nr = 13 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1577392.526	16872276.863	20732542.119	22441799.295
5	2683885.317	26311345.671	1318575.098	25105963.204
10	-9499838.234	18491540.222	16002645.134	24301271.410
12	11413391.449	19646543.142	13901497.679	22267788.910
25	15152144.227	7991579.143	20283581.544	20496519.714
29	20952317.534	-878093.478	16331059.591	20679921.586
31	9478179.591	-11911818.328	21972314.282	22220786.416

----- nr = 14 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1504101.048	16846285.944	20757793.491	22457480.024
5	2673279.330	26307426.033	1413118.314	25096070.675

10	-9514940.606	18429559.175	16065180.784	24303391.663
12	11414453.609	19699291.688	13826483.577	22289789.429
25	15160532.740	8068452.624	20247172.426	20507643.259
29	20904627.579	-838058.464	16394486.020	20679012.486
31	9553262.258	-11878610.218	21958459.749	22219079.932

----- nr = 15 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1430675.135	16820381.855	20782656.957	22473251.184
5	2662616.604	26303170.529	1507634.223	25086215.191
10	-9530171.138	18367366.568	16127397.226	24305622.039
12	11415583.911	19751755.805	13751206.987	22311841.850
25	15169039.260	8145173.123	20210375.185	20518852.455
29	20856813.999	-797802.524	16457599.229	20678182.930
31	9628356.196	-11845564.432	21944192.805	22217473.947

----- nr = 16 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1357116.187	16794565.507	20807132.006	22489112.506
5	2651895.825	26298579.467	1602120.996	25076397.522
10	-9545530.527	18304963.905	16189293.229	24307962.934
12	11416781.101	19803934.468	13675669.349	22333945.754
25	15177662.998	8221739.027	20173190.539	20530147.356
29	20808878.456	-757325.697	16520398.018	20677432.939
31	9703459.653	-11812681.491	21929513.744	22215968.772

----- nr = 17 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1283425.609	16768837.801	20831218.138	22505063.483
5	2641115.681	26293653.166	1696576.808	25066617.932
10	-9561019.458	18242352.697	16250867.564	24310414.450
12	11418043.918	19855826.660	13599872.107	22356100.902
25	15186403.159	8298148.729	20135619.209	20541527.841
29	20760822.611	-716628.032	16582881.196	20676762.396
31	9778570.877	-11779961.908	21914422.868	22214564.561

----- nr = 18 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1209604.811	16743199.631	20854914.858	22521103.612
5	2630274.863	26288391.955	1790999.833	25056876.789
10	-9576638.609	18179534.460	16312119.014	24312976.670
12	11419371.099	19907431.376	13523816.710	22378306.931
25	15195258.938	8374400.625	20097661.928	20552993.638
29	20712648.128	-675709.591	16645047.577	20676171.176
31	9853688.112	-11747406.184	21898920.486	22213261.380

----- nr = 19 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1135655.212	16717651.886	20878221.676	22537232.661
5	2619372.062	26282796.173	1885388.246	25047174.964
10	-9592388.650	18116510.717	16373046.366	24315649.754
12	11420761.372	19958747.620	13447504.612	22400563.742
25	15204229.521	8450493.120	20059319.432	20564544.850
29	20664356.671	-634570.442	16706895.981	20675659.387
31	9928809.601	-11715014.810	21883006.914	22212059.673

----- nr = 20 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	1061578.235	16692195.443	20901138.113	22553450.067
5	2608405.974	26276866.173	1979740.222	25037512.897
10	-9608270.242	18053282.998	16433648.414	24318433.707
12	11422213.463	20009774.404	13370937.271	22422870.877
25	15213314.087	8526424.624	20020592.467	20576181.243
29	20615949.907	-593210.668	16768425.234	20675226.899
31	10003933.585	-11682788.269	21866682.475	22210959.449

----- nr = 21 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	987375.309	16666831.175	20923663.694	22569755.693
5	2597375.297	26270602.314	2074053.938	25027891.058
10	-9624284.037	17989852.840	16493923.958	24321328.928
12	11423726.090	20060510.753	13294116.152	22445228.287
25	15222511.805	8602193.552	19981481.787	20587902.917
29	20567429.503	-551630.360	16829634.168	20674873.941
31	10079058.302	-11650727.030	21849947.502	22209961.188


```

----- nr = 22 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      913047.870  16641559.947  20945797.953  22586149.649
  5      2586278.729  26264004.969   2168327.571  25018310.426
 10     -9640430.679  17926221.783  16553871.805  24324336.119
 12     11425297.967  20110955.699  13217042.720  22467636.170
 25     15231821.837   8677798.327  19941988.150  20599710.291
 29     20518797.128   -509829.619  16890521.622  20674600.866
 31     10154181.988  -11618831.554  21832802.333  22209065.633

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----- nr = 23 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      838597.359  16616382.615  20967540.429  22602630.865
  5      2575114.975  26257074.521  2262559.298  25008771.039
 10     -9656710.804  17862391.375  16613490.772  24327454.815
 12     11426927.805  20161108.284  13139718.451  22490093.644
 25     15241243.333   8753237.377  19902112.324  20611602.638
 29     20470054.451   -467808.557  16951086.441  20674407.123
 31     10229302.879  -11587102.294  21815247.315  22208272.239

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----- nr = 24 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      764025.222  16591300.028  20988890.669  22619199.287
  5      2563882.738  26249811.362  2356747.298  24999273.799
 10     -9673125.038  17798363.171  16672779.677  24330685.474
 12     11428614.307  20210967.562  13062144.819  22512600.840
 25     15250775.440   8828509.135  19861855.084  20623580.162
 29     20421203.143   -425567.298  17011327.475  20674292.959
 31     10304419.207  -11555539.689  21797282.802  22207581.633

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----- nr = 25 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      689332.911  16566313.028  21009848.229  22635854.539
  5      2552580.727  26242215.897  2450889.750  24989819.222
 10     -9689673.999  17734138.730  16731737.350  24334028.413
 12     11430356.171  20260532.593  12984323.308  22535157.612

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25	15260417.291	8903612.043	19821217.212	20635642.863
29	20372244.875	-383105.973	17071243.582	20674258.448
31	10379529.203	-11524144.169	21778909.155	22206994.097

----- nr = 26 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	614521.886	16541422.447	21030412.668	22352804.535
5	2541207.654	26234288.540	2544984.834	24680615.230
10	-9706358.296	17669719.618	16790362.626	24037691.472
12	11432152.093	20309802.452	12906255.404	22257971.909
21	249993171.021	2372507.960	-8905497.510	25099718.703
25	15270168.014	8978544.547	19780199.496	20347998.771
29	20323181.320	-340424.727	17130833.624	20374511.260
31	10454631.097	-11492916.154	21760126.744	21906717.433

----- nr = 27 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	539593.609	16516629.113	21050583.556	22369632.901
5	2529762.231	26226029.717	2639030.731	24671248.177
10	-9723178.530	17605107.405	16848654.345	24041259.683
12	11434000.761	20358776.218	12827942.596	22280627.325
21	25029486.920	2393725.839	-8821625.744	25086632.522
25	15280026.728	9053305.100	19738802.733	20360232.106
29	20274014.151	-297523.714	17190096.472	20374636.488
31	10529723.116	-11461856.055	21740935.943	21906337.208

----- nr = 28 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	464549.551	16491933.843	21070360.467	22386547.740
5	2518243.176	26217439.861	2733025.624	24661925.976
10	-9740135.293	17540303.670	16906611.357	24044941.018
12	11435900.860	20407452.986	12749386.381	22303332.155
21	25059340.469	2414778.593	-8737586.669	25073552.399
25	15289992.545	9127892.162	19697027.727	20372551.050
29	20224745.042	-254403.097	17249031.002	20374841.971
31	10604803.487	-11430964.271	21721337.139	21906061.403

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----- nr = 29 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      389391.185  16467337.447  21089742.985  22403548.120
  5      2506649.208  26208519.420  2826967.694  24652648.810
 10     -9757229.166  17475309.995  16964232.517  24048735.423
 12     11437851.070  20455831.856  12670588.259  22326085.758
 21     25088930.646   2435667.084  -8653381.920  25060478.443
 25     15300064.565   9202304.199  19654875.289  20384955.133
 29     20175375.667   -211063.051  17307636.095  20375127.355
 31     10679870.435  -11400241.191  21701330.721  21905889.734

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----- nr = 30 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      314119.993  16442840.728  21108730.699  22420633.652
  5      2494979.050  26199268.850   2920855.127  24643417.320
 10     -9774460.725  17410127.968  17021516.688  24052643.106
 12     11439850.067  20503911.940  12591549.733  22348887.857
 21     25118256.436   2456392.184  -8569013.137  25047411.069
 25     15310241.883   9276539.683  19612346.235  20397444.237
 29     20125907.702   -167503.762  17365910.640  20375492.477
 31     10754922.183  -11369687.195  21680917.089  21905822.431

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----- nr = 31 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      238737.460  16418444.480  21127323.206  22437804.241
  5      2483231.427  26189688.618   3014686.107  24634232.195
 10     -9791830.535  17344759.183  17078462.739  24056664.198
 12     11441896.520  20551692.362  12512272.312  22371738.375
 21     25147316.832   2476954.769  -8484481.959  25034350.752
 25     15320523.585   9350597.094  19569441.393  20410018.518
 29     20076342.822   -123725.426  17423853.532  20375937.610
 31     10829956.953  -11339302.650  21660096.648  21905859.942

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----- nr = 32 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2      163245.077  16394149.490  21145520.109  22455059.287
  5      2471405.070  26179779.202   3108458.820  24625093.895
 10     -9809339.151  17279205.240  17135069.547  24060798.823

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12	11443989.096	20599172.252	12432757.510	22394636.941
21	25176110.832	2497355.724	-8399790.029	25021297.596
25	15330908.748	9424474.917	19526161.593	20422677.740
29	20026682.703	-79728.247	17481463.672	20376462.606
31	10904972.967	-11309087.916	21638869.813	21906002.309

----- nr = 33 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	87644.340	16369956.536	21163321.020	22472398.682
5	2459498.710	26169541.088	3202171.453	24616003.065
10	-9826987.121	17213467.743	17191335.995	24065047.209
12	11446126.456	20646350.754	12353006.842	22417583.533
21	25204637.447	2517595.938	-8314938.993	25008252.080
25	15341396.444	9498171.646	19482507.675	20435422.071
29	19976929.022	-35512.442	17538739.968	20377067.758
31	10979968.442	-11279043.341	21617237.005	21906249.960

----- nr = 34 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	11936.750	16345866.388	21180725.556	22489821.929
5	2447511.083	26158974.776	3295822.195	24606960.189
10	-9844774.984	17147548.303	17247260.974	24069409.456
12	11448307.258	20693227.019	12273021.832	22440577.792
21	25232895.690	2537676.311	-8229930.497	24995214.410
25	15351985.732	9571685.779	19438480.486	20448251.284
29	19927083.456	8921.760	17595681.334	20377752.805
31	11054941.598	-11249169.262	21595198.651	21906603.014

----- nr = 35 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-63876.184	16321879.810	21197733.344	22507329.095
5	2435440.928	26148080.775	3389409.235	24597966.366
10	-9862703.268	17081448.534	17302843.382	24073886.188
12	11450530.154	20739800.210	12192804.005	22463619.984
21	25260884.587	2557597.746	-8144766.191	24982185.638
25	15362675.668	9645015.823	19394080.880	20461165.800
29	19877147.681	53574.125	17652286.691	20378518.248
31	11129890.653	-11219466.007	21572755.188	21907062.245

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----- nr = 36 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -139792.952  16297997.555  21214344.016  22524920.307
  5     2423286.989  26136859.602   3482930.764  24589022.535
 10    -9880772.493  17015170.058  17358082.124  24078478.017
 12    11452793.794  20786069.500  12112354.892  22486710.345
 21    25288603.169   2577361.154  -8059447.726  24969166.417
 25    15373465.296   9718160.290  19349309.717  20474165.931
 29    19827123.375   98444.402   17708554.964  20379364.526
 31    11204813.823  -11189933.893  21549907.060  21907628.137

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----- nr = 37 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -215812.037  16274220.370  21230557.211  22542594.407
  5     2411048.010  26125311.788   3576384.973  24580128.540
 10    -9898983.172  16948714.499  17412976.111  24083184.282
 12    11455096.821  20832034.072  12031676.025  22509847.951
 21    25316050.474   2596967.454  -7973976.754  24956156.388
 25    15384353.654   9791117.701  19304167.865  20487250.934
 29    19777012.214   143532.336   17764485.088  20380290.975
 31    11279709.322  -11160573.227  21526654.715  21908300.336

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----- nr = 38 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -291931.915  16250548.994  21246372.576  22560351.109
  5     2398722.741  26113437.872   3669770.057  24571285.042
 10    -9917335.806  16882083.489  17467524.262  24088005.246
 12    11457437.876  20877693.119  11950768.946  22533032.574
 21    25343225.552   2616417.569  -7888354.933  24943156.085
 25    15395339.773   9863886.583  19258656.199  20500420.913
 29    19726815.877   188837.656   17820076.003  20381297.755
 31    11354575.366  -11131384.306  21502998.614  21909079.077

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----- nr = 39 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -368151.062  16226984.155  21261789.766  22578190.493

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5	2386309.937	26101238.405	3763084.209	24562493.197
10	-9935830.889	16815278.663	17521725.505	24092941.446
12	11459815.594	20923045.845	11869635.195	22556264.529
21	25370127.456	2635712.429	-7802583.919	24930166.308
25	15406422.674	9936465.469	19212775.602	20513676.197
29	19676536.040	234360.085	17875326.654	20382385.207
31	11429410.168	-11102367.415	21478939.221	21909965.047

----- nr = 40 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-444467.944	16203526.576	21276808.442	22596111.281
5	2373808.353	26088713.946	3856325.626	24553752.526
10	-9954468.903	16748301.663	17575578.772	24097991.985
12	11462228.609	20968091.464	11788276.321	22579542.579
21	25396755.252	2654852.974	-7716665.371	24917186.393
25	15417601.372	10008852.901	19166526.961	20527015.717
29	19626174.381	280099.332	17930235.995	20383552.339
31	11504211.942	-11073522.830	21454477.008	21910957.396

----- nr = 41 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-520881.024	16180176.970	21291428.272	22614114.317
5	2361216.752	26075865.067	3949492.505	24545064.746
10	-9973250.323	16681154.132	17629083.004	24103158.292
12	11464675.549	21012829.199	11706693.873	22602867.740
21	25423108.010	2673840.145	-7630600.950	24904217.803
25	15428874.873	10081047.427	19119911.173	20540440.693
29	19575732.576	326055.098	17984802.986	20384800.486
31	11578978.900	-11044850.817	21429612.456	21912057.691

----- nr = 42 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-597388.762	16156936.043	21305648.932	22632198.985
5	2348533.897	26062692.347	4042583.045	24536430.131
10	-9992175.616	16613837.723	17682237.149	24108440.353
12	11467155.036	21057258.286	11624889.409	22626239.649
21	25449184.810	2692674.894	-7544392.321	24891260.727
25	15440242.177	10153047.602	19072929.141	20553950.853

29	19525212.303	372227.073	18039026.591	20386129.469
31	11653709.253	-11016351.631	21404346.053	21913266.019

----- nr = 43 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-673989.611	16133804.492	21319470.106	22650364.723
5	2335758.557	26049196.378	4135595.446	24527849.333
10	-10011245.237	16546354.089	17735040.162	24113837.968
12	11469665.693	21101377.968	11542864.485	22649657.873
21	25474984.741	2711358.176	-7458041.147	24878315.314
25	15451702.274	10224851.990	19025581.774	20567545.860
29	19474615.237	418614.937	18092905.784	20387539.045
31	11728401.214	-10988025.516	21378678.292	21914582.242

----- nr = 44 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-750682.020	16110783.005	21332891.483	22668610.868
5	2322889.504	26035377.761	4228527.909	24519322.661
10	-10030459.633	16478704.890	17787491.006	24119350.982
12	11472206.136	21145187.503	11460620.667	22673121.945
21	25500506.898	2729890.954	-7371549.096	24865381.835
25	15463254.149	10296459.160	18977869.990	20581225.441
29	19423943.054	465218.358	18146439.544	20389028.922
31	11803052.991	-10959872.706	21352609.677	21916006.378

----- nr = 45 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-827464.432	16087872.262	21345912.761	22686936.458
5	2309925.516	26021237.107	4321378.639	24510849.721
10	-10049819.242	16410891.791	17839588.651	24124978.925
12	11474774.977	21188686.154	11378159.521	22696630.975
21	25525750.385	2748274.197	-7284917.836	24852460.058
25	15474896.777	10367867.689	18929794.713	20594988.845
29	19373197.431	512036.995	18199626.857	20390598.479
31	11877662.797	-10931893.426	21326140.716	21917537.805

----- nr = 46 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-904335.289	16065072.937	21358533.645	22705341.724
5	2296865.372	26006775.038	4414145.840	24502431.850
10	-10069324.492	16342916.460	17891332.073	24130722.339
12	11477370.827	21231873.199	11295482.618	22720185.269
21	25550714.316	2766508.881	-7198149.037	24839550.814
25	15486629.128	10439076.164	18881356.872	20608836.619
29	19322380.041	559070.496	18252466.715	20392248.324
31	11952228.841	-10904087.889	21299271.925	21919177.301

----- nr = 47 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-981293.025	16042385.691	21370753.847	22723826.885
5	2283707.858	25991992.186	4506827.718	24494070.374
10	-10088975.803	16274780.571	17942720.258	24136582.120
12	11479992.290	21274747.925	11212591.534	22743785.312
21	25575397.810	2784595.986	-7111244.373	24826655.062
25	15498450.161	10510083.175	18832557.407	20622769.358
29	19271492.560	606318.500	18304958.118	20393979.117
31	12026749.334	-10876456.298	21272003.830	21920925.842

----- nr = 48 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1058336.070	16019811.181	21382573.086	22742391.416
5	2270451.763	25976889.190	4599422.482	24485765.546
10	-10108773.583	16206485.800	17993752.197	24142558.216
12	11482637.970	21317309.628	11129487.848	22767430.587
21	25599799.998	2802536.499	-7024205.515	24813773.046
25	15510358.832	10580887.323	18783397.260	20636786.739
29	19220536.661	653780.635	18357100.070	20395790.548
31	12101222.483	-10848998.845	21244336.960	21922783.443

----- nr = 49 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1135462.852	15997350.052	21393991.090	22761034.822
5	2257095.880	25961466.705	4691928.342	24477518.008
10	-10128718.233	16138033.831	18044426.889	24148650.537
12	11485306.466	21359557.616	11046173.142	22791121.012

21	25623920.016	2820331.414	-6937034.141	24800905.252
25	15522354.087	10651487.215	18733877.384	20650888.633
29	19169514.017	701456.517	18408891.585	20397682.679
31	12175646.501	-10821715.714	21216271.855	21924750.108

----- nr = 50 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1212671.792	15975002.944	21405007.591	22779756.737
5	2243639.006	25945725.390	4784343.508	24469328.026
10	-10148810.144	16069426.348	18094743.341	24154859.102
12	11487996.372	21401491.208	10962649.004	22814856.237
21	25647757.010	2837981.730	-6849731.927	24788051.868
25	15534434.864	10721881.466	18683998.737	20665074.955
29	19118426.300	749345.753	18460331.682	20399655.455
31	12250019.595	-10794607.075	21187809.061	21926826.148

----- nr = 51 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1289961.308	15952770.485	21415622.331	22798557.190
5	2230079.943	25929665.918	4876666.196	24461196.808
10	-10169049.698	16000665.042	18144700.568	24161184.462
12	11490706.281	21443109.733	10878917.024	22838636.520
21	25671310.136	2855488.451	-6762300.552	24775213.506
25	15546600.095	10792068.700	18633762.283	20679346.057
29	19067275.182	797447.940	18511419.386	20401709.330
31	12324339.975	-10767673.090	21158949.129	21929012.130

----- nr = 52 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1367329.812	15930653.296	21425835.060	22817435.750
5	2216417.499	25913288.969	4968894.618	24453124.797
10	-10189437.265	15931751.607	18194297.590	24167626.755
12	11493434.783	21484412.530	10794978.796	22862461.517
21	25694578.554	2872852.590	-6674741.695	24762390.683
25	15558848.706	10862047.546	18583168.994	20693701.762
29	19016062.332	845762.665	18562153.730	20403844.101
31	12398605.851	-10740913.911	21129692.621	21931308.084

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----- nr = 53 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -1444775.715  15908651.991  21435645.532  22836391.771
  5     2202650.483  25896595.237  5061026.994  24445112.399
 10    -10209973.210  15862687.742  18243533.438  24174185.603
 12     11496180.462  21525398.949  10710835.920  22886330.687
 21     25717561.438  2890075.162   -6587057.040  24749583.371
 25     15571179.613  10931816.643  18532219.850  20708141.753
 29     18964789.421   894289.503   18612533.754  20406059.581
 31     12472815.433 -10714329.678  21100040.103  21933713.945

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----- nr = 54 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -1522297.422  15886767.173  21445053.512  22855425.293
  5     2188777.712  25879585.421   5153061.540  24437160.550
 10    -10230657.885  15793475.150  18292407.147  24180861.687
 12     11498941.902  21566068.352  10626489.996  22910244.425
 21     25740257.965   2907157.190  -6499248.269  24736792.426
 25     15583591.728  11001374.637  18480915.834  20722666.437
 29     18913458.116   943028.020   18662558.504  20408356.266
 31     12546966.930 -10687920.521  21069992.150  21936230.418

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----- nr = 55 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -1599893.332  15864999.437  21454058.769  22874535.436
  5     2174798.005  25862260.234   5244996.479  24429269.331
 10    -10251491.632  15724115.535  18340917.761  24187654.430
 12     11501717.682  21606420.109  10541942.631  22934201.936
 21     25762667.325   2924099.703  -6411317.066  24724017.735
 25     15596083.953  11070720.182  18429257.940  20737275.231
 29     18862070.084   991977.772   18712227.033  20410733.658
 30     4467516.705  -20724362.725  15661491.278  24304696.739
 31     12621058.554 -10661686.560  21039549.344  21938857.097

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----- nr = 56 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -1677561.845  15843349.370  21462661.082  22893722.276

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5	2160710.188	25844620.396	5336830.032	24421439.801
10	-10272474.787	15654610.608	18389064.333	24194564.390
12	11504506.379	21646453.604	10457195.433	22958203.454
21	25784788.715	2940903.733	-6323265.119	24711260.014
25	15608655.185	11139851.939	18377247.166	20751968.398
29	18810626.991	1041138.304	18761538.401	20413192.183
30	4493130.905	-20667927.825	15727077.231	24290151.822
31	12695088.515	-10635627.905	21008712.274	21941594.582

----- nr = 57 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1755301.351	15821817.549	21470860.236	22912985.118
5	2146513.091	25826666.638	5428560.425	24413672.113
10	-10293607.673	15584962.084	18436845.921	24201591.175
12	11507306.567	21686168.228	10372250.016	22982248.405
21	25806621.338	2957570.320	-6235094.115	24698519.263
25	15621304.312	11208768.580	18324884.518	20766745.524
29	18759130.502	1090509.150	18810491.674	20415731.437
30	4518925.924	-20611299.392	15792355.014	24275626.201
31	12769055.023	-10609744.654	20977481.536	21944442.644

----- nr = 58 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1833110.241	15800404.544	21478656.025	22932324.017
5	2132205.547	25808399.701	5520185.883	24405967.134
10	-10314890.606	15515171.678	18484261.592	24208735.377
12	11510116.818	21725563.387	10287107.997	23006336.979
21	25828164.411	2974100.510	-6146805.742	24685796.453
25	15634030.219	11277468.781	18272171.007	20781606.977
29	18707582.280	1140089.836	18859085.926	20418351.804
30	4544902.214	-20554479.015	15857323.316	24261120.913
31	12842956.291	-10584036.897	20945857.733	21947401.861

----- nr = 59 -----

prn	X [m]	Y [m]	Z [m]	PR [m]
2	-1910986.900	15779110.916	21486048.247	22951738.018
5	2117786.396	25789820.335	5611704.636	24398325.288
10	-10336323.890	15445241.113	18531310.421	24215996.495

12	11512935.698	21764638.493	10201770.995	23030468.457
21	25849417.155	2990495.351	-6058401.692	24673091.507
25	15646831.779	11345951.229	18219107.653	20796552.195
29	18655983.987	1189879.875	18907320.237	20421052.789
30	4571060.217	-20497468.289	15921980.834	24246635.673
31	12916790.530	-10558504.711	20913841.476	21950471.979

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----- nr = 60 -----
prn      X [m]      Y [m]      Z [m]      PR [m]
  2    -1988929.710  15757937.216  21493036.710  22971226.764
  5      2103254.482  25770929.300   5703114.914  24390747.004
 10    -10357907.821  15375172.112  18577991.489  24223374.543
 12    11515761.774  21803392.972  10116240.634  23054642.667
 21    25870378.801   3006755.901  -5969883.655  24660404.702
 25    15659707.862  11414214.618  18165695.481  20811581.144
 29    18604337.283   1239878.773  18955193.694  20423834.492
 30     4597400.368  -20440268.814  15986326.267  24232171.003
 31    12990555.954  -10533148.164  20881433.383  21953653.220

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