Vjezba 3: polumjer laserskog snopa

http://sail.zpf.fer.hr/laserlab/spotsize.nb

Postupno zaklanjanje profila snopa:

Snaga (relativna jedinica) u detektoru koja odgovara pomacima zaslona od 50 μm:

```
In[1]:= y = {56.7, 56.6, 56.6, 56.5, 56.4, 56.3, 56.1, 55.7, 55.0, 54.1, 52.7, 51.2,
           49.1, 46.3, 42.9, 39.0, 34.8, 30.7, 26.2, 21.8, 17.8, 14.8, 11.5, 8.2,
           6.2, 4.4, 3.1, 2.2, 1.6, 1.1, 0.8, 0.6, 0.5, 0.4, 0.3, 0.3, 0.3, 0.3};
```

Polozaji zaslona u μm su relativna velicina pa ih mozemo proizvoljno generirati:

```
In[2]:= npts = Length[y];
        h = 50 Range[npts];
```

Maksimalna apsolutna pogreska se pridruzuje na osnovu specifikacije mjernog uredjaja (pogreska skale):

```
In[4]:= dy = Sqrt[(0.5)^2 + (0.01 y)^2];
```

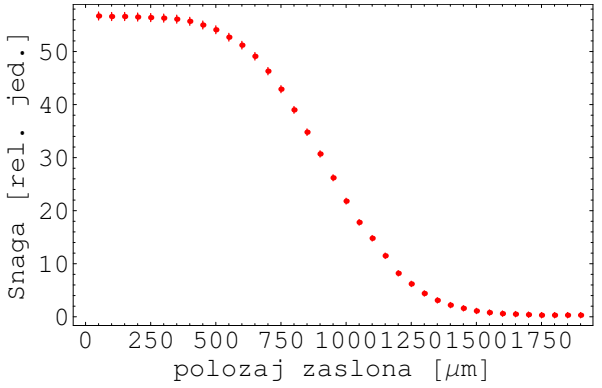
Uvodimo nekoliko pomocnih varijabli:

```
In[5]:= data = Transpose[{h, y, dy}];
        {h1, hN} = {First@h, Last@h};
        hrange = hN - h1;
```

Prikaz mjerenja:

```
In[8]:= fig1 = {Red, AbsoluteThickness[1/2], AbsolutePointSize[2],
          Point[{#[[1]], #[[2]]}] & /@ data,
          Line[{{#[[1]], #[[2]] - #[[3]]}, {#[[1]], #[[2]] + #[[3]]}}] & /@ data
         };
```

```
In[9]:= Show[Graphics@fig1, Frame → True,
         FrameLabel → {"polozaj zaslona [μm]", "Snaga [rel. jed.]"}];
```



Vrijednost parametra P_0 prema izrazu (3.10) iz uputa za vjezbu:

```
In[10]:= fitP0[h0try_, wtry_, data_] := Module[{hi, pi, di, qi},
           {hi, pi, di} = Transpose[data];
           qi = (1 - Erf[Sqrt[2] (hi - h0try) / wtry]) / 2;
           (pi / di).(qi / di) / (qi / di).(qi / di)
          ];
```

Funkcija S^2 definirana prema izrazu (3.9) uz vrijednost parametra P_0 izracunatu prema izrazu (3.10, funkcija fitP0):

```
In[11]:= S2fun[h0try_, wtry_, data_] := Module[{hi, pi, di, P0try, resi},
           {hi, pi, di} = Transpose[data];
           P0try = fitP0[h0try, wtry, data];
           resi = (pi - P0try (1 - Erf[Sqrt[2] (hi - h0try) / wtry]) / 2) / di;
           resi.resi
          ];
```

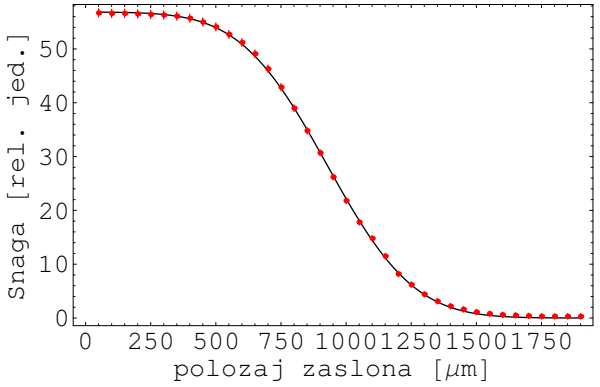
Pronalazimo minimum S^2 u odnosu na parametre h_0 i w:

```
In[12]:= {S2min, fitpars} = FindMinimum[S2fun[h0, w, data], {h0, h1 + hrange / 2}, {w, hrange / 2}]

Out[12]= {7.51279, {h0 → 927.148, w → 522.554}}
```

Prikaz mjerenja (crveno) i modela odredjenog metodom najmanjih kvadrata (crno):

```
In[13]:= {P0fit, h0fit, wfit} = {fitP0[h0, w, data], h0, w} /. fitpars;
         Plot[P0fit (1 - Erf[Sqrt[2] (h - h0fit) / wfit]) / 2,
           {h, h1, hN}, PlotStyle → {Black}, Frame → True, PlotPoints → 128, Epilog → fig1,
           FrameLabel → {"polozaj zaslona [μm]", "Snaga [rel. jed.]"}];
```



Procjena pogreske parametara h_0 i w (postupak nije opisan u uputama za vjezbu):

In[15]:=
```
dh0j = Sqrt[2 / D[(npts - 3) S2fun[h0, w, data] / S2min, {h0, 2}]] /. fitpars;
dwj = Sqrt[2 / D[(npts - 3) S2fun[h0, w, data] / S2min, {w, 2}]] /. fitpars;
ContourPlot[(npts - 3) S2fun[h0, w, data] / S2min,
 {h0, h0fit - 2 dh0j, h0fit + 2 dh0j}, {w, wfit - 2 dwj, wfit + 2 dwj},
 Contours → {(npts - 3) + 1.00, (npts - 3) + 2.30}, Axes → True,
 AxesOrigin → {h0fit, wfit}, ContourShading → False,
 FrameLabel → {"h₀ [μm]", "w [μm]"}, PlotPoints → 64];
```