MTF_Interp_Polar_Plots

September 23, 2015

In [1]:
```
import pandas as pd
import pickle
import seaborn as snb
import matplotlib.pyplot as plt
import numpy as np
%matplotlib inline
```

In [2]:
```
polar_halfs_dat = pd.read_pickle('MTFHalfPolar.p')
interp_halfs_dat = pd.read_pickle('MTFHalfInterp.p')
```

In [17]:
```
grouped_polar = polar_halfs_dat.groupby(['Soffset','Doffset'])

polar_halfs = {}
for a,b in grouped_polar:
    group = b[['xslice','yslice','zslice','xslice_radius','yslice_radius','zslice_radius'\
               ,'xslice_slope','yslice_slope','zslice_slope','mag','Soffset','Doffset']]
    polar_halfs[a] = {'means':group.groupby("mag").mean(),
                      'vars':group.groupby("mag").var(ddof=1),
                     'stds':group.groupby("mag").std(ddof=1)}

grouped_interp = interp_halfs_dat.groupby(['S','D'])

interp_halfs = {}
for a,b in grouped_interp:
    group = b[['X1','X2','X3','X4','Y1','Y2','Y3','Y4','Z1','Z2','Z3','Z4','mag','D','S']]
    interp_halfs[a] = {'means':group.groupby("mag").mean(),
                      'vars':group.groupby("mag").var(ddof=1),
                     'stds':group.groupby("mag").std(ddof=1)}
```

In [4]:
```
S1D1 = interp_halfs[(1,1)]['means']
avs_S1D1 = pd.DataFrame(columns=['X','Y','Z'])
avs_S1D1.X = S1D1[['X1','X2','X3','X4']].transpose().mean()
avs_S1D1.Y = S1D1[['Y1','Y2','Y3','Y4']].transpose().mean()
avs_S1D1.Z = S1D1[['Z1','Z2','Z3','Z4']].transpose().mean()

S1D1 = interp_halfs[(1,1)]['stds']
stds_S1D1 = pd.DataFrame(columns=['X','Y','Z'])
stds_S1D1.X = S1D1[['X1','X2','X3','X4']].transpose().mean()
stds_S1D1.Y = S1D1[['Y1','Y2','Y3','Y4']].transpose().mean()
stds_S1D1.Z = S1D1[['Z1','Z2','Z3','Z4']].transpose().mean()


S0D1 = interp_halfs[(0,1)]['means']
avs_S0D1 = pd.DataFrame(columns=['X','Y','Z'])
```

```
avs_S0D1.X = S0D1[['X1','X2','X3','X4']].transpose().mean()
avs_S0D1.Y = S0D1[['Y1','Y2','Y3','Y4']].transpose().mean()
avs_S0D1.Z = S0D1[['Z1','Z2','Z3','Z4']].transpose().mean()

S0D1 = interp_halfs[(0,1)]['stds']
stds_S0D1 = pd.DataFrame(columns=['X','Y','Z'])
stds_S0D1.X = S0D1[['X1','X2','X3','X4']].transpose().mean()
stds_S0D1.Y = S0D1[['Y1','Y2','Y3','Y4']].transpose().mean()
stds_S0D1.Z = S0D1[['Z1','Z2','Z3','Z4']].transpose().mean()

S1D0 = interp_halfs[(1,0)]['means']
avs_S1D0 = pd.DataFrame(columns=['X','Y','Z'])
avs_S1D0.X = S1D0[['X1','X2','X3','X4']].transpose().mean()
avs_S1D0.Y = S1D0[['Y1','Y2','Y3','Y4']].transpose().mean()
avs_S1D0.Z = S1D0[['Z1','Z2','Z3','Z4']].transpose().mean()

S1D0 = interp_halfs[(1,0)]['stds']
stds_S1D0 = pd.DataFrame(columns=['X','Y','Z'])
stds_S1D0.X = S1D0[['X1','X2','X3','X4']].transpose().mean()
stds_S1D0.Y = S1D0[['Y1','Y2','Y3','Y4']].transpose().mean()
stds_S1D0.Z = S1D0[['Z1','Z2','Z3','Z4']].transpose().mean()

S0D0 = interp_halfs[(0,0)]['means']
avs_S0D0 = pd.DataFrame(columns=['X','Y','Z'])
avs_S0D0.X = S0D0[['X1','X2','X3','X4']].transpose().mean()
avs_S0D0.Y = S0D0[['Y1','Y2','Y3','Y4']].transpose().mean()
avs_S0D0.Z = S0D0[['Z1','Z2','Z3','Z4']].transpose().mean()

S0D0 = interp_halfs[(0,0)]['stds']
stds_S0D0 = pd.DataFrame(columns=['X','Y','Z'])
stds_S0D0.X = S0D0[['X1','X2','X3','X4']].transpose().mean()
stds_S0D0.Y = S0D0[['Y1','Y2','Y3','Y4']].transpose().mean()
stds_S0D0.Z = S0D0[['Z1','Z2','Z3','Z4']].transpose().mean()
```

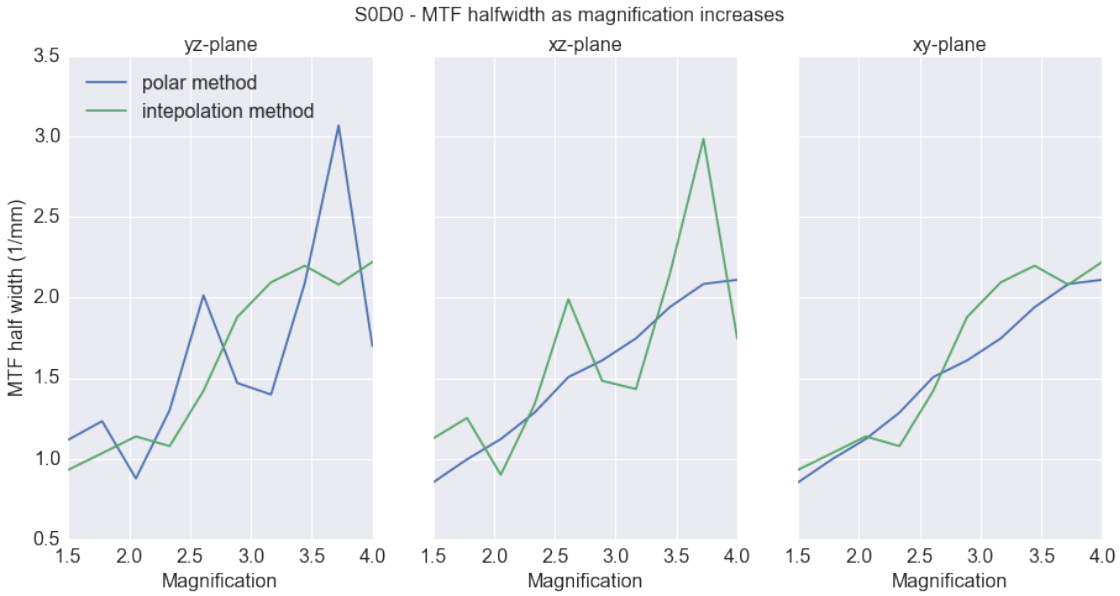
In [22]:
```
from scipy.optimize import curve_fit
mags = polar_halfs[(0,1)]['stds'].index

def recip(x,A,B):
    return A/x + B

def lin(x,A,B):
    return A*x + B

def reciplin(x,A,B,C,D):
    return A*np.exp(-B*x) + C*x + D

popt1_e, pcov = curve_fit(recip, mags.data.tolist(), polar_halfs[(1,0)]['means'].\
                          xslice.as_matrix())
popt2_e, pcov = curve_fit(recip, mags.data.tolist(), polar_halfs[(1,0)]['means'].\
                          yslice.as_matrix())
popt3_e, pcov = curve_fit(recip, mags.data.tolist(), polar_halfs[(1,0)]['means'].\
                          zslice.as_matrix())

popt4_e, pcov = curve_fit(recip, mags.data.tolist(), avs_S1D0.X.as_matrix())
```

```
popt5_e, pcov = curve_fit(recip, mags.data.tolist(), avs_S1D0.Y.as_matrix())
popt6_e, pcov = curve_fit(recip, mags.data.tolist(), avs_S1D0.Z.as_matrix())

rmse_px10 = np.sqrt(np.mean((recip(np.array(mags.data.tolist()),*popt1_e)- \
                            polar_halfs[(1,0)]['means'].xslice.as_matrix())**2))
rmse_py10 = np.sqrt(np.mean((recip(np.array(mags.data.tolist()),*popt2_e)- \
                            polar_halfs[(1,0)]['means'].yslice.as_matrix())**2))
rmse_pz10 = np.sqrt(np.mean((recip(np.array(mags.data.tolist()),*popt3_e)- \
                            polar_halfs[(1,0)]['means'].zslice.as_matrix())**2))

rmse_ix10 = np.sqrt(np.mean((recip(np.array(mags.data.tolist()),*popt4_e)-avs_S1D0.\
                            X.as_matrix())**2))
rmse_ix10 = np.sqrt(np.mean((recip(np.array(mags.data.tolist()),*popt5_e)-avs_S1D0.\
                            Y.as_matrix())**2))
rmse_ix10 = np.sqrt(np.mean((recip(np.array(mags.data.tolist()),*popt6_e)-avs_S1D0.\
                            Z.as_matrix())**2))

popt1_l, pcov = curve_fit(lin, mags.data.tolist(), polar_halfs[(0,1)]['means'].\
                          xslice.as_matrix())
popt2_l, pcov = curve_fit(lin, mags.data.tolist(), polar_halfs[(0,1)]['means'].\
                          yslice.as_matrix())
popt3_l, pcov = curve_fit(lin, mags.data.tolist(), polar_halfs[(0,1)]['means'].\
                          zslice.as_matrix())

popt4_l, pcov = curve_fit(lin, mags.data.tolist(), avs_S0D1.X.as_matrix())
popt5_l, pcov = curve_fit(lin, mags.data.tolist(), avs_S0D1.Y.as_matrix())
popt6_l, pcov = curve_fit(lin, mags.data.tolist(), avs_S0D1.Z.as_matrix())

rmse_px01 = np.sqrt(np.mean((lin(np.array(mags.data.tolist()),*popt1_l)- \
                            polar_halfs[(0,1)]['means'].xslice.as_matrix())**2))
rmse_py01 = np.sqrt(np.mean((lin(np.array(mags.data.tolist()),*popt2_l)- \
                            polar_halfs[(0,1)]['means'].yslice.as_matrix())**2))
rmse_pz01 = np.sqrt(np.mean((lin(np.array(mags.data.tolist()),*popt3_l)- \
                            polar_halfs[(0,1)]['means'].zslice.as_matrix())**2))

rmse_ix01 = np.sqrt(np.mean((lin(np.array(mags.data.tolist()),*popt4_l)-avs_S0D1.\
                            X.as_matrix())**2))
rmse_iy01 = np.sqrt(np.mean((lin(np.array(mags.data.tolist()),*popt5_l)-avs_S0D1.\
                            Y.as_matrix())**2))
rmse_iz01 = np.sqrt(np.mean((lin(np.array(mags.data.tolist()),*popt6_l)-avs_S0D1.\
                            Z.as_matrix())**2))

popt1, pcov = curve_fit(reciplin, mags.data.tolist(), polar_halfs[(1,1)]['means'].\
                        xslice.as_matrix())
popt2, pcov = curve_fit(reciplin, mags.data.tolist(), polar_halfs[(1,1)]['means'].\
                        yslice.as_matrix())
popt3, pcov = curve_fit(reciplin, mags.data.tolist(), polar_halfs[(1,1)]['means'].\
                        zslice.as_matrix())

popt4, pcov = curve_fit(reciplin, mags.data.tolist(), avs_S1D1.X.as_matrix())
popt5, pcov = curve_fit(reciplin, mags.data.tolist(), avs_S1D1.Y.as_matrix())
popt6, pcov = curve_fit(reciplin, mags.data.tolist(), avs_S1D1.Z.as_matrix())

rmse_px11 = np.sqrt(np.mean((reciplin(np.array(mags.data.tolist()),*popt1)- \
```

```
                                polar_halfs[(1,1)]['means'].xslice.as_matrix())**2))
rmse_py11 = np.sqrt(np.mean((reciplin(np.array(mags.data.tolist()),*popt2)- \
                                polar_halfs[(1,1)]['means'].yslice.as_matrix())**2))
rmse_pz11 = np.sqrt(np.mean((reciplin(np.array(mags.data.tolist()),*popt3)- \
                                polar_halfs[(1,1)]['means'].zslice.as_matrix())**2))

rmse_ix11 = np.sqrt(np.mean((reciplin(np.array(mags.data.tolist()),*popt4)-avs_S1D1.\
                                X.as_matrix())**2))
rmse_iy11 = np.sqrt(np.mean((reciplin(np.array(mags.data.tolist()),*popt5)-avs_S1D1.\
                                Y.as_matrix())**2))
rmse_iz11 = np.sqrt(np.mean((reciplin(np.array(mags.data.tolist()),*popt6)-avs_S1D1.\
                                Z.as_matrix())**2))
```

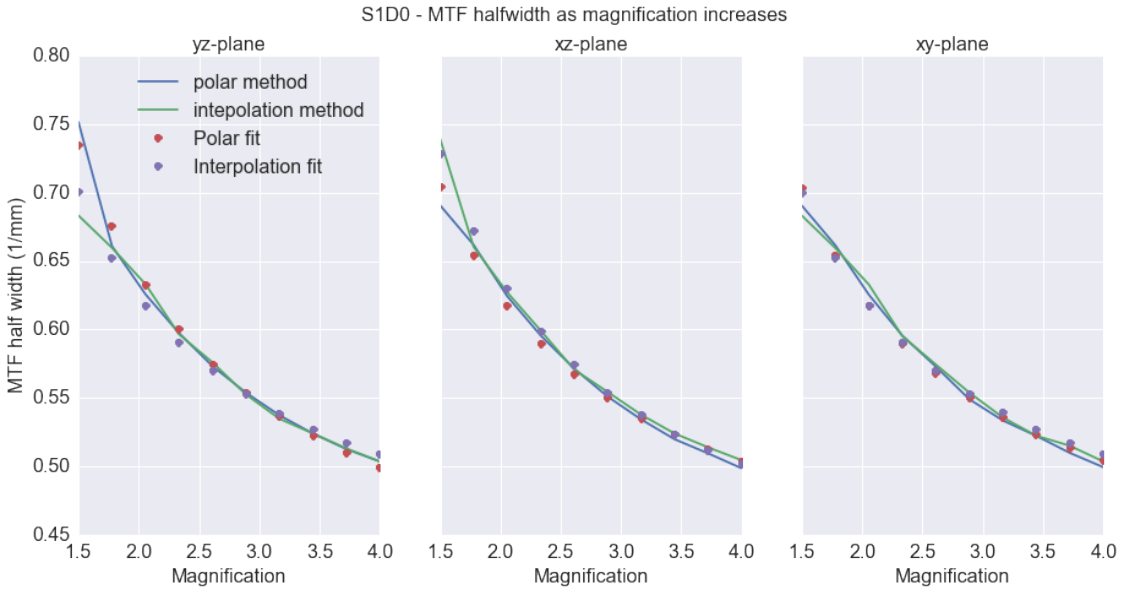
In [6]:
```
fig,(ax1,ax2,ax3) = plt.subplots(ncols=3,nrows=1,figsize = (15,7),sharey=True)

fig.suptitle('S0D0 - MTF halfwidth as magnification increases',fontsize=16)

polar_halfs[(0,0)]['means'].xslice.plot(ax=ax1,label='polar method',fontsize=16)
avs_S0D0.X.plot(ax=ax1,label = 'intepolation method',fontsize=16)
ax1.legend(loc=0,fontsize=16)
ax1.set_ylabel('MTF half width (1/mm)',fontsize = 16)
ax1.set_xlabel('Magnification',fontsize = 16)
ax1.set_title("yz-plane",fontsize = 16)
ax1.tick_params(axis='both', which='major', labelsize=16)

polar_halfs[(0,0)]['means'].yslice.plot(ax=ax2,label='polar method',fontsize=16)
avs_S0D0.Y.plot(ax=ax2,label = 'intepolation method',fontsize=16)
ax2.set_title("xz-plane",fontsize = 16)
ax2.set_xlabel('Magnification',fontsize = 16)
ax2.tick_params(axis='both', which='major', labelsize=16)

polar_halfs[(0,0)]['means'].zslice.plot(ax=ax3,label='polar method',fontsize=16)
avs_S0D0.Z.plot(ax=ax3,label = 'intepolation method',fontsize=16)
ax3.set_title("xy-plane",fontsize = 16)
ax3.tick_params(axis='both', which='major', labelsize=16)
ax3.set_xlabel('Magnification',fontsize = 16)
```

Out[6]:
```
<matplotlib.text.Text at 0x109f87a10>
```



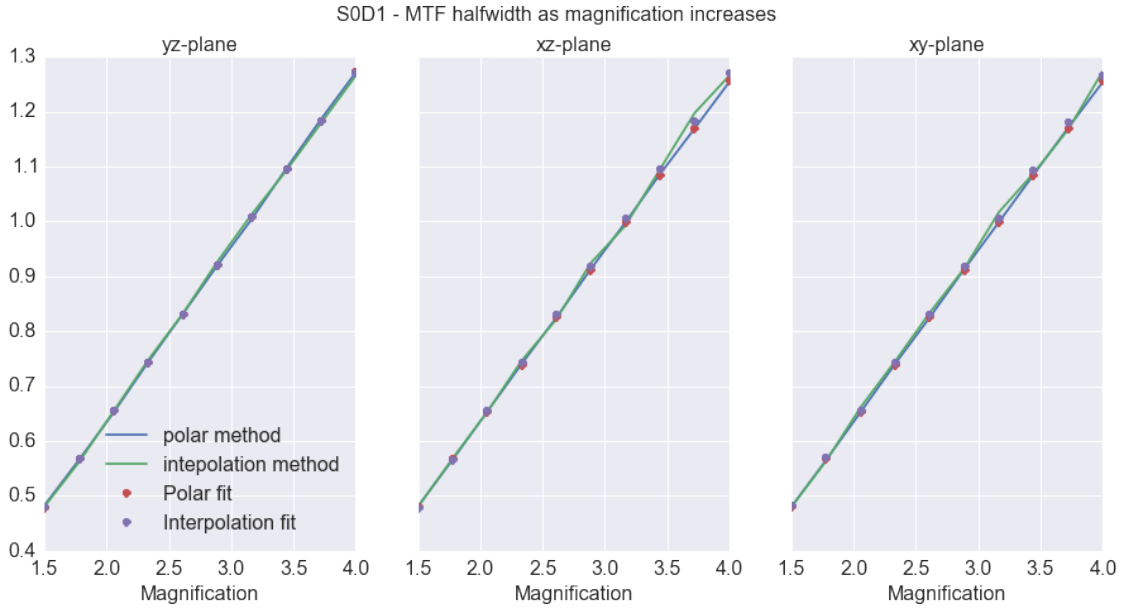
In [20]:
```
fig,(ax1,ax2,ax3) = plt.subplots(ncols=3,nrows=1,figsize = (15,7),sharey=True)

fig.suptitle('S1D0 - MTF halfwidth as magnification increases',fontsize=16)

polar_halfs[(1,0)]['means'].xslice.plot(ax=ax1,label='polar method',fontsize=16)
avs_S1D0.X.plot(ax=ax1,label = 'intepolation method',fontsize=16)
ax1.plot(mags.data.tolist(),recip(np.array(mags.data.tolist()),*popt1_e),'o' \
         ,label = 'Polar fit')
ax1.plot(mags.data.tolist(),recip(np.array(mags.data.tolist()),*popt4_e),'o' \
         ,label = 'Interpolation fit')
ax1.legend(loc=0,fontsize=16)
ax1.set_xlabel('Magnification',fontsize = 16)
ax1.set_title("yz-plane",fontsize = 16)
ax1.set_ylabel('MTF half width (1/mm)',fontsize = 16)
ax1.tick_params(axis='both', which='major', labelsize=16)

polar_halfs[(1,0)]['means'].yslice.plot(ax=ax2,label='polar method',fontsize=16)
avs_S1D0.Y.plot(ax=ax2,label = 'intepolation method',fontsize=16)
ax2.plot(mags.data.tolist(),recip(np.array(mags.data.tolist()),*popt2_e),'o' \
         ,label = 'Polar fit')
ax2.plot(mags.data.tolist(),recip(np.array(mags.data.tolist()),*popt5_e),'o' \
         ,label = 'Interpolation fit')
ax2.set_title("xz-plane",fontsize = 16)
ax2.set_xlabel('Magnification',fontsize = 16)
ax2.tick_params(axis='both', which='major', labelsize=16)

polar_halfs[(1,0)]['means'].zslice.plot(ax=ax3,label='polar method',fontsize=16)
avs_S1D0.Z.plot(ax=ax3,label = 'intepolation method',fontsize=16)
ax3.plot(mags.data.tolist(),recip(np.array(mags.data.tolist()),*popt3_e),'o' \
         ,label = 'Polar fit')
ax3.plot(mags.data.tolist(),recip(np.array(mags.data.tolist()),*popt6_e),'o' \
         ,label = 'Interpolation fit')
```

```
ax3.set_title("xy-plane",fontsize = 16)
ax3.set_xlabel('Magnification',fontsize = 16)
ax3.tick_params(axis='both', which='major', labelsize=16)
```



In [21]:
```
fig,(ax1,ax2,ax3) = plt.subplots(ncols=3,nrows=1,figsize = (15,7),sharey=True)

fig.suptitle('S0D1 - MTF halfwidth as magnification increases',fontsize=16)

polar_halfs[(0,1)]['means'].xslice.plot(ax=ax1,label='polar method',fontsize=16)
avs_S0D1.X.plot(ax=ax1,label = 'intepolation method',fontsize=16)
ax1.plot(mags.data.tolist(),lin(np.array(mags.data.tolist()),*popt1_l),'o' \
         ,label = 'Polar fit')
ax1.plot(mags.data.tolist(),lin(np.array(mags.data.tolist()),*popt4_l),'o' \
         ,label = 'Interpolation fit')
ax1.legend(loc=0,fontsize=16)
ax1.set_title("yz-plane",fontsize = 16)
ax1.set_xlabel('Magnification',fontsize = 16)
ax1.tick_params(axis='both', which='major', labelsize=16)

polar_halfs[(0,1)]['means'].yslice.plot(ax=ax2,label='polar method',fontsize=16)
avs_S0D1.Y.plot(ax=ax2,label = 'intepolation method',fontsize=16)
ax2.plot(mags.data.tolist(),lin(np.array(mags.data.tolist()),*popt2_l),'o' \
         ,label = 'Polar fit')
ax2.plot(mags.data.tolist(),lin(np.array(mags.data.tolist()),*popt5_l),'o' \
         ,label = 'Interpolation fit')
ax2.set_title("xz-plane",fontsize = 16)
ax2.set_xlabel('Magnification',fontsize = 16)
ax2.tick_params(axis='both', which='major', labelsize=16)

polar_halfs[(0,1)]['means'].zslice.plot(ax=ax3,label='polar method',fontsize=16)
avs_S0D1.Z.plot(ax=ax3,label = 'intepolation method',fontsize=16)
ax3.plot(mags.data.tolist(),lin(np.array(mags.data.tolist()),*popt3_l),'o' \
```

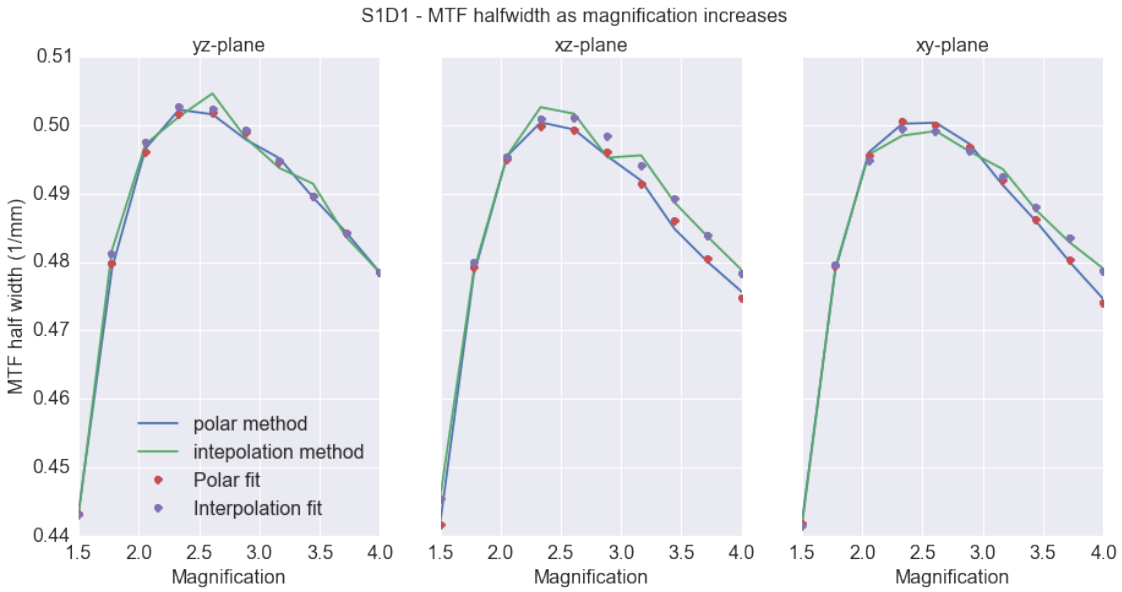
```
         ,label = 'Polar fit')
ax3.plot(mags.data.tolist(),lin(np.array(mags.data.tolist()),*popt6_l),'o' \
         ,label = 'Interpolation fit')
ax3.set_title("xy-plane",fontsize = 16)
ax3.set_xlabel('Magnification',fontsize = 16)
ax3.tick_params(axis='both', which='major', labelsize=16)
```



In [9]:
```
fig,(ax1,ax2,ax3) = plt.subplots(ncols=3,nrows=1,figsize = (15,7),sharey=True)

fig.suptitle('S1D1 - MTF halfwidth as magnification increases',fontsize=16)

polar_halfs[(1,1)]['means'].xslice.plot(ax=ax1,label='polar method',fontsize=16)
avs_S1D1.X.plot(ax=ax1,label = 'intepolation method',fontsize=16)
ax1.plot(mags.data.tolist(),reciplin(np.array(mags.data.tolist()),*popt1),'o' \
         ,label = 'Polar fit')
ax1.plot(mags.data.tolist(),reciplin(np.array(mags.data.tolist()),*popt4),'o' \
         ,label = 'Interpolation fit')
ax1.legend(loc=0,fontsize=16)
ax1.set_ylabel('MTF half width (1/mm)',fontsize = 16)
ax1.set_xlabel('Magnification',fontsize = 16)
ax1.set_title("yz-plane",fontsize = 16)
ax1.tick_params(axis='both', which='major', labelsize=16)

polar_halfs[(1,1)]['means'].yslice.plot(ax=ax2,label='polar method',fontsize=16)
avs_S1D1.Y.plot(ax=ax2,label = 'intepolation method',fontsize=16)
ax2.plot(mags.data.tolist(),reciplin(np.array(mags.data.tolist()),*popt2),'o' \
         ,label = 'Polar fit')
ax2.plot(mags.data.tolist(),reciplin(np.array(mags.data.tolist()),*popt5),'o' \
         ,label = 'Interpolation fit')
ax2.set_title("xz-plane",fontsize = 16)
ax2.tick_params(axis='both', which='major', labelsize=16)
```

```
        ax2.set_xlabel('Magnification',fontsize = 16)

        polar_halfs[(1,1)]['means'].zslice.plot(ax=ax3,label='polar method',fontsize=16)
        avs_S1D1.Z.plot(ax=ax3,label = 'intepolation method',fontsize=16)
        ax3.plot(mags.data.tolist(),reciplin(np.array(mags.data.tolist()),*popt3),'o' \
                 ,label = 'Polar fit')
        ax3.plot(mags.data.tolist(),reciplin(np.array(mags.data.tolist()),*popt6),'o' \
                 ,label = 'Interpolation fit')
        ax3.set_title("xy-plane",fontsize = 16)
        ax3.tick_params(axis='both', which='major', labelsize=16)
        ax3.set_xlabel('Magnification',fontsize = 16)
```

Out[9]: <matplotlib.text.Text at 0x10a2b5fd0>




```
In [10]: S1D0 = polar_halfs[(1,0)]['means'].xslice_radius.apply(lambda x:np.abs(x-30)/30).as_matrix()
         S0D1 = polar_halfs[(0,1)]['means'].xslice_radius.apply(lambda x:np.abs(x-30)/30).as_matrix()
         S1D1 = polar_halfs[(1,1)]['means'].xslice_radius.apply(lambda x:np.abs(x-30)/30).as_matrix()

In [11]: mags = polar_halfs_dat.mag.unique()
         fig,ax = plt.subplots(ncols=1,nrows=1,figsize = (10,7))
         ax.plot(mags,S1D0,'g*-',label="S1D0")
         ax.plot(mags,S0D1,'r*-',label="S0D1")
         ax.plot(mags,S1D1,'m*-',label="S1D1")

         ax.legend(loc=0,fontsize=16)
         ax.set_title("Relative error in Radius - Magnification",fontsize = 16)
         ax.set_ylabel("Relative Error (%)",fontsize = 16)
         ax.tick_params(axis='both', which='major', labelsize=16)
         ax.set_xlabel("Magnification",fontsize = 16);
```


Relative error in Radius - Magnification
Relative Error (%)
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
1.5
2.0
2.5
3.0
3.5
4.0
Magnification
S1D0
S0D1
S1D1

In [ ]: