In [99]:
```
from plotting import *
%matplotlib inline
# get simulation
self = loadpickle('pickles/RVInformationGP')
```

Measuring the 3σ mass of one temperate Earth-sized planet

In [307]:
```
ind = 1451
print 'Orbital period = %.3f days'%self.Ps_med[ind]
print 'Planet radius = %.3f Earth radii'%self.rps_med[ind]
print 'Planet mass = %.3f Earth masses'%self.mps_med[ind]
print 'J = %.3f'%self.Jmags_med[ind]
print 'Stellar effective temperature = %i K'%self.Teffs_med[ind]
```

```
Orbital period = 26.300 days
Planet radius = 1.292 Earth radii
Planet mass = 2.660 Earth masses
J = 10.270
Stellar effective temperature = 3284 K
```

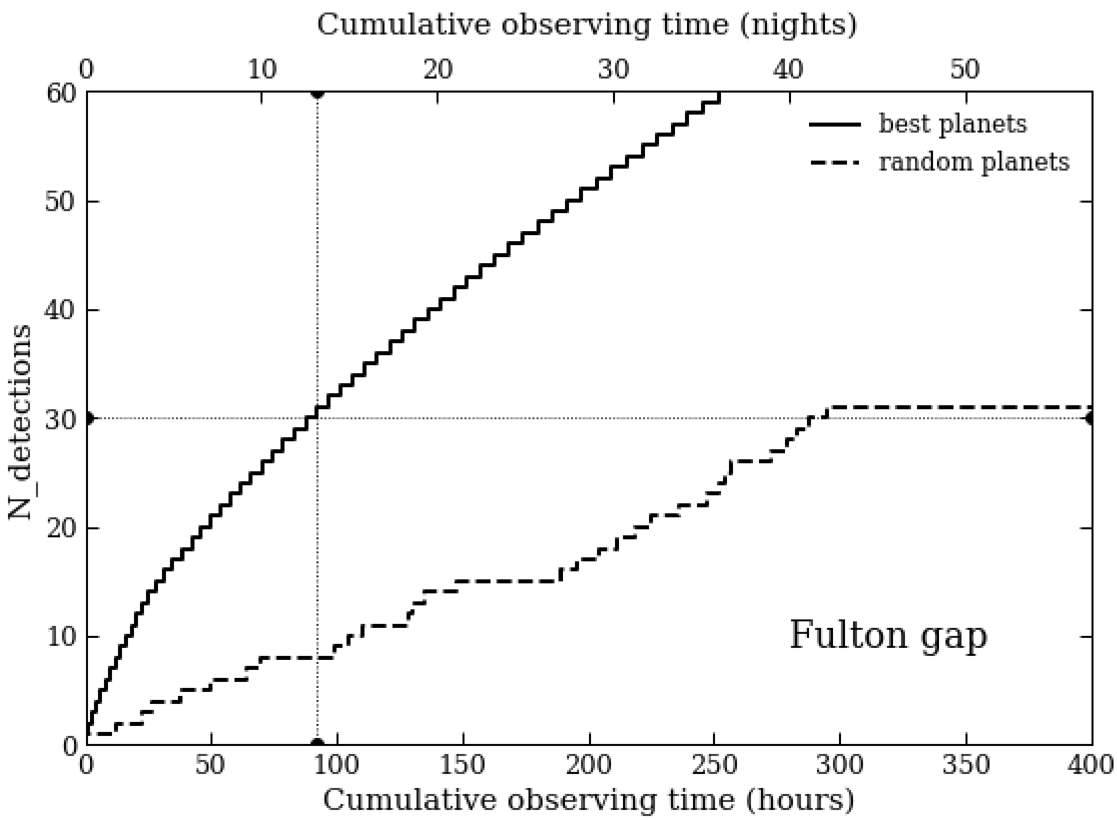
In [308]:
```
print 'Exposure time = %.2f minutes'%self.texps_med_N[ind]
print 'RV precision = %.2f m/s'%self.sigmaRV_phot_med_N[ind]
print 'Median effective RV rms = %.2f m/s'%self.sigmaRV_eff_med_N[ind]
print 'Median number of RV measurements required = %.1f'%self.NrvGPs_med_N[i
print 'Total observing time = %.1f hours (i.e. %.1f nights)'%(self.tobsGPs_r
tobs_WP2 = self.tobsGPs_med_N[ind]
```

```
Exposure time = 10.00 minutes
RV precision = 2.98 m/s
Median effective RV rms = 7.86 m/s
Median number of RV measurements required = 248.8
Total observing time = 41.5 hours (i.e. 5.9 nights)
```

Measuring the 3σ mass of the 30 'best' planets around the Fulton gap

In [309]:
```
N = 30
g = (self.rps_med >= 1.5) & (self.rps_med <= 2)
tobs = np.append(0, np.cumsum(np.sort(self.tobsGPs_med_N[g])))
tobs2 = np.append(0, np.cumsum(self.tobsGPs_med_N[g]))
Ndet= np.arange(tobs.size)
fig = plt.figure(figsize=(9,6))
ax1 = fig.add_subplot(111)
ax1.plot(tobs, Ndet, 'k-', lw=2, drawstyle='steps', label='best planets')
ax1.plot(tobs2, Ndet, 'k--', lw=2, drawstyle='steps', label='random planets'
ax1.axhline(N, ls=':', lw=.8), ax1.axvline(tobs[Ndet==N], ls=':', lw=.9)
tobs_WP2 = np.append(tobs_WP2, tobs[Ndet==N])
ax1.set_xlim((0,4e2)), ax1.set_ylim((0,60)), ax1.legend(loc='upper right', f
ax1.set_xlabel('Cumulative observing time (hours)'), ax1.set_ylabel('N_detec
ax1.text(.7, .15, 'Fulton gap', transform=ax1.transAxes, fontsize=18)
ax2 = ax1.twiny()
ax2.set_xlim((0,4e2/7)), ax2.set_xlabel('Cumulative observing time (nights)'
```

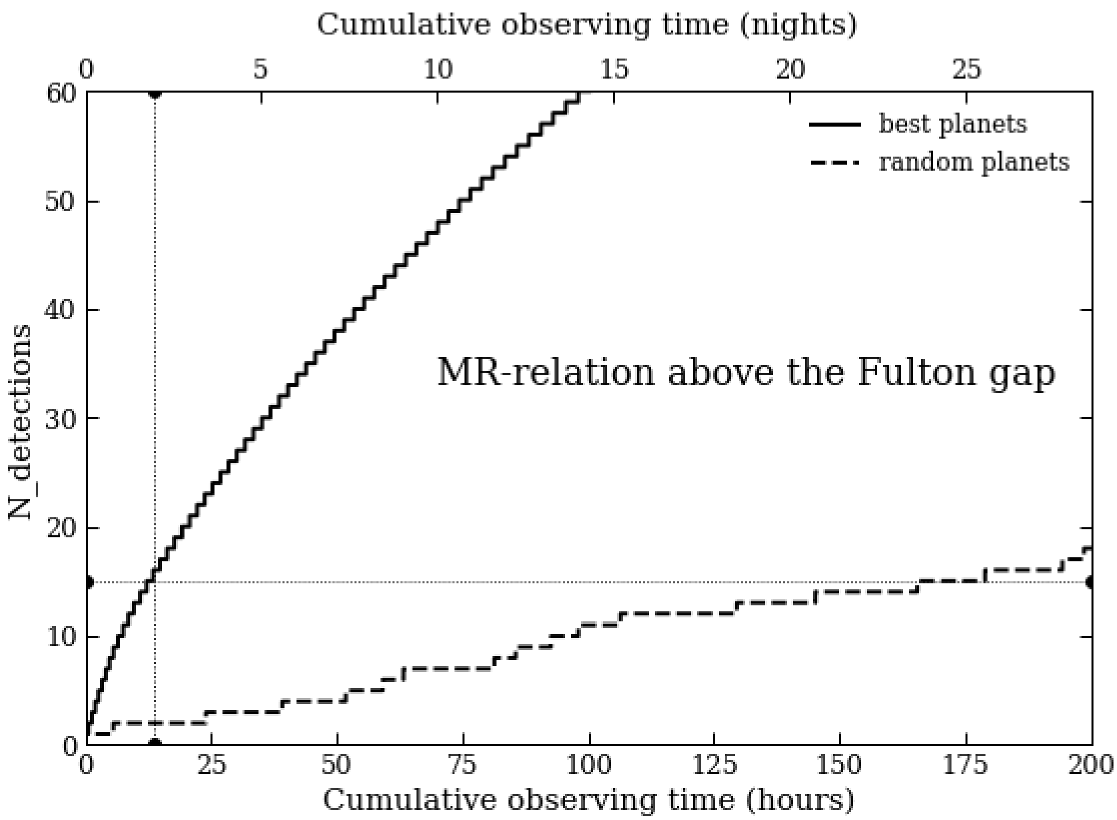
Out[309]: ((0, 57.142857142857146), <matplotlib.text.Text at 0x1a1e1fdf90>)



Extending the MR relation with 15 planets with $r_p \in [2, 4]R_\oplus$

In [310]:
```
N =15
g = (self.rps_med > 2) & (self.rps_med <= 4)
tobs = np.append(0, np.cumsum(np.sort(self.tobsGPs_med_N[g])))
tobs2 = np.append(0, np.cumsum(self.tobsGPs_med_N[g]))
Ndet= np.arange(tobs.size)
fig = plt.figure(figsize=(9,6))
ax1 = fig.add_subplot(111)
ax1.plot(tobs, Ndet, 'k-', lw=2, drawstyle='steps', label='best planets')
ax1.plot(tobs2, Ndet, 'k--', lw=2, drawstyle='steps', label='random planets'
ax1.axhline(N, ls=':', lw=.8), ax1.axvline(tobs[Ndet==N], ls=':', lw=.9)
tobs_WP2 = np.append(tobs_WP2, tobs[Ndet==N])
ax1.set_xlim((0,2e2)), ax1.set_ylim((0,60)), ax1.legend(loc='upper right', f
ax1.set_xlabel('Cumulative observing time (hours)'), ax1.set_ylabel('N_detec
ax1.text(.35, .55, 'MR-relation above the Fulton gap', transform=ax1.transAx
ax2 = ax1.twiny()
ax2.set_xlim((0,2e2/7)), ax2.set_xlabel('Cumulative observing time (nights)'
```

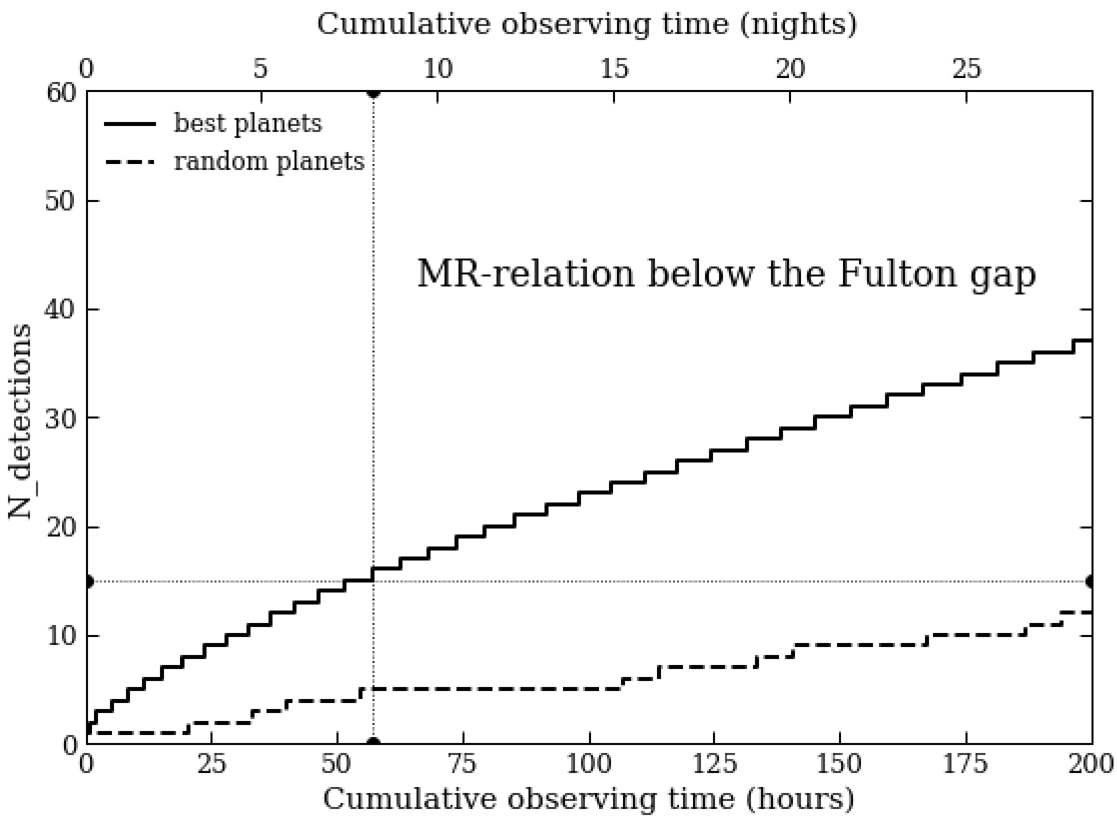
Out[310]:
```
((0, 28.571428571428573), <matplotlib.text.Text at 0x1a1e469110>)
```



Extending the MR relation with 15 more planets with $r_p \leq 1.5 R_\oplus$

In [311]:
```
g = (self.rps_med <= 1.5)
tobs = np.append(0, np.cumsum(np.sort(self.tobsGPs_med_N[g])))
tobs2 = np.append(0, np.cumsum(self.tobsGPs_med_N[g]))
Ndet= np.arange(tobs.size)
fig = plt.figure(figsize=(9,6))
ax1 = fig.add_subplot(111)
ax1.plot(tobs, Ndet, 'k-', lw=2, drawstyle='steps', label='best planets')
ax1.plot(tobs2, Ndet, 'k--', lw=2, drawstyle='steps', label='random planets'
ax1.axhline(N, ls=':', lw=.8), ax1.axvline(tobs[Ndet==N], ls=':', lw=.9)
tobs_WP2 = np.append(tobs_WP2, tobs[Ndet==N])
ax1.set_xlim((0,2e2)), ax1.set_ylim((0,60)), ax1.legend(loc='upper left', fo
ax1.set_xlabel('Cumulative observing time (hours)'), ax1.set_ylabel('N_detec
ax1.text(.33, .7, 'MR-relation below the Fulton gap', transform=ax1.transAxe
ax2 = ax1.twiny()
ax2.set_xlim((0,2e2/7)), ax2.set_xlabel('Cumulative observing time (nights)'
```

Out[311]: ((0, 28.571428571428573), <matplotlib.text.Text at 0x1a1e6c30d0>)



Measuring the 3σ mass of TRAPPIST-1b

From separate calculations assuming an RV activity rms equal to the photon-noise limited RV precision of TRAPPIST-1 with SPIRou (4.51 m/s)

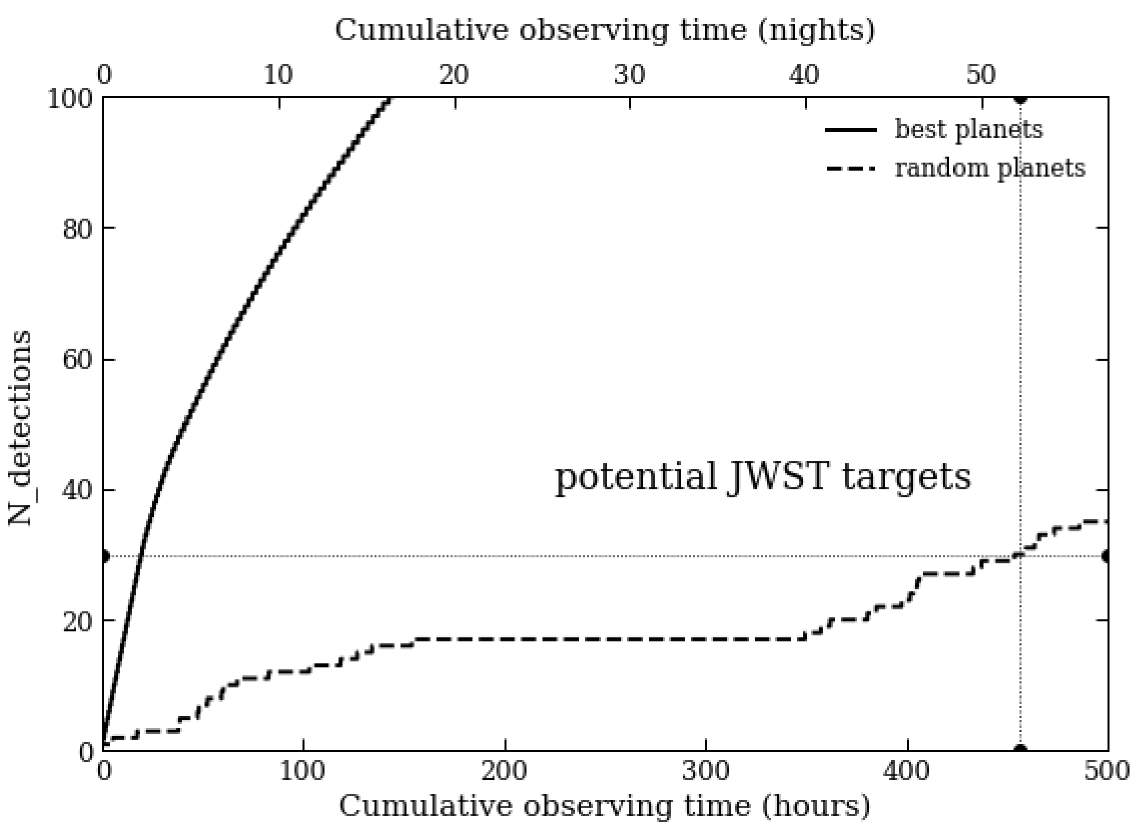
In [312]:
```
print 'Exposure time = 10.00 minutes'
print 'RV precision = 4.51 m/s'
print 'Number of RV measurements required = 234.1'
print 'Total observing time = 39.0 hours (i.e. 5.6 nights)'
tobs_WP2 = np.append(tobs_WP2, 39.017)
```

```
Exposure time = 10.00 minutes
RV precision = 4.51 m/s
Number of RV measurements required = 234.1
Total observing time = 39.0 hours (i.e. 5.6 nights)
```

Measuring the masses of (random) potential JWST targets with $J < 10$

In [313]:
```
g = (self.Jmags_med < 10)
tobs = np.append(0, np.cumsum(np.sort(self.tobsGPs_med_N[g])))
tobs2 = np.append(0, np.cumsum(self.tobsGPs_med_N[g]))
Ndet= np.arange(tobs.size)
fig = plt.figure(figsize=(9,6))
ax1 = fig.add_subplot(111)
ax1.plot(tobs, Ndet, 'k-', lw=2, drawstyle='steps', label='best planets')
ax1.plot(tobs2, Ndet, 'k--', lw=2, drawstyle='steps', label='random planets'
tobs_remaining = 7e2 - tobs_WP2.sum()
Njwst = int(Ndet[abs(tobs2-tobs_remaining)==np.min(abs(tobs2-tobs_remaining)
tobs_WP2 = np.append(tobs_WP2, tobs_remaining)
ax1.axhline(Njwst, ls=':', lw=.8), ax1.axvline(tobs_remaining, ls=':', lw=.9
ax1.set_xlim((0,np.ceil(tobs_remaining/1e2)*1e2)), ax1.set_ylim((0,1e2)), ax
ax1.set_xlabel('Cumulative observing time (hours)'), ax1.set_ylabel('N_detec
ax1.text(.45, .4, 'potential JWST targets', transform=ax1.transAxes, fontsiz
ax2 = ax1.twiny()
ax2.set_xlim((0,4e2/7)), ax2.set_xlabel('Cumulative observing time (nights)'
```

Out[313]: ((0, 57.142857142857146), <matplotlib.text.Text at 0x1a1e9197d0>)



In [314]:
```
: 'We detect %i random potential JWST targets in %.1f hours (i.e. %.1f nights
```

```
We detect 30 random potential JWST targets in 456.6 hours (i.e. 65.2 nigh
ts)
```

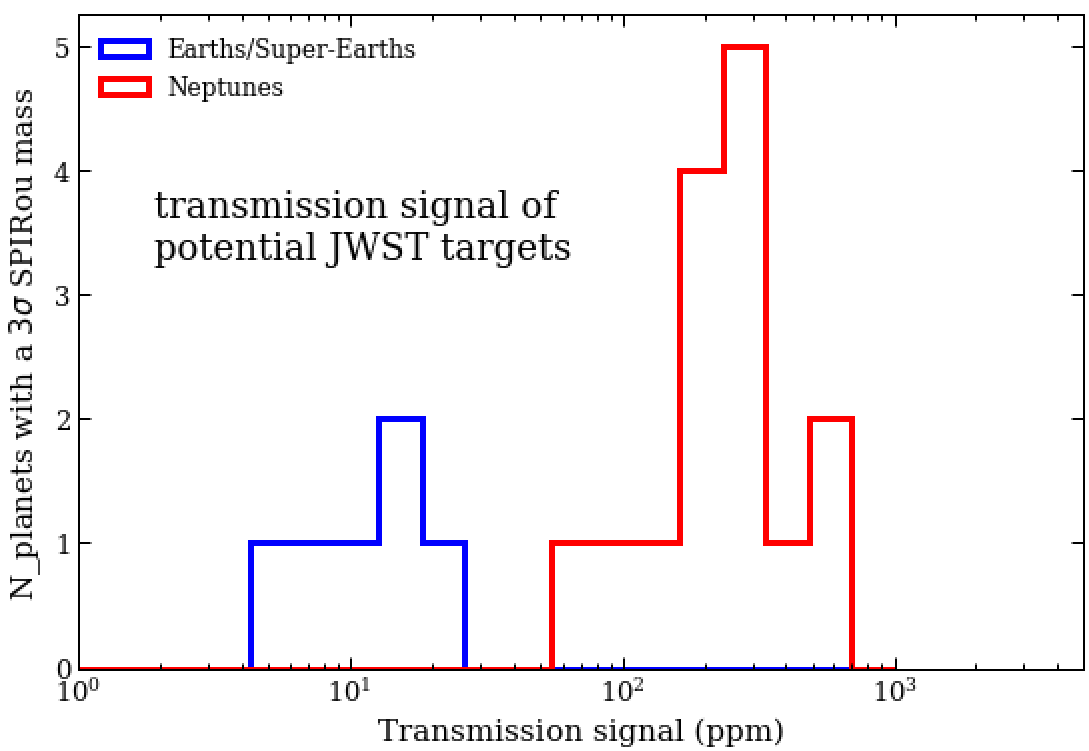
Plot histogram of the detected potential JWST targets:

In [315]:
```
ıals
ɔs, rps = self.Teffs_med[g][:Njwst], self.Rss_med[g][:Njwst], self.Ps_med[g][
:vs.Rsun2m(Rss)/(2*rvs.AU2m(rvs.semimajoraxis(Ps,Mss,mps))))
.size)

.transmission_spectroscopy_depth(Rss, mps, rps, Tps, mus)
5))

ɔpm[g1], bins=np.logspace(0,3,20), histtype='step', color='b', lw=3, label='E
 <= 4)
ɔpm[g2], bins=np.logspace(0,3,20), histtype='step', color='r', lw=3, label='N
.xlim((0,5e3)), plt.legend(loc='upper left', fontsize=12)
ɔn signal (ppm)'), plt.ylabel('N_planets with a $3\sigma$ SPIRou mass')
ıission signal of\npotential JWST targets', transform=ax1.transAxes, fontsize
```

Out[315]: <matplotlib.text.Text at 0x1a1eb4d0d0>



In [316]:
```
labels = ['1 temperature Earth-sized planet','30 planets at the Fulton gap',
for i in range(tobs_WP2.size):
    print 'Measuring %s requires %.1f hours (i.e. %.1f nights).'%(labels[i],
print 'Total observing time = %.1f hours (i.e. %.1f nights)'%(tobs_WP2.sum()
```

```
Measuring 1 temperature Earth-sized planet requires 41.5 hours (i.e. 5.9 nights).
Measuring 30 planets at the Fulton gap requires 92.3 hours (i.e. 13.2 nights).
Measuring 15 planets above the Fulton gap requires 13.5 hours (i.e. 1.9 nights).
Measuring 15 planets below the Fulton gap requires 57.1 hours (i.e. 8.2 nights).
Measuring TRAPPIST-1b requires 39.0 hours (i.e. 5.6 nights).
Measuring 30 JWST follow-up targets requires 456.6 hours (i.e. 65.2 nights).
Total observing time = 700.0 hours (i.e. 100.0 nights)
```