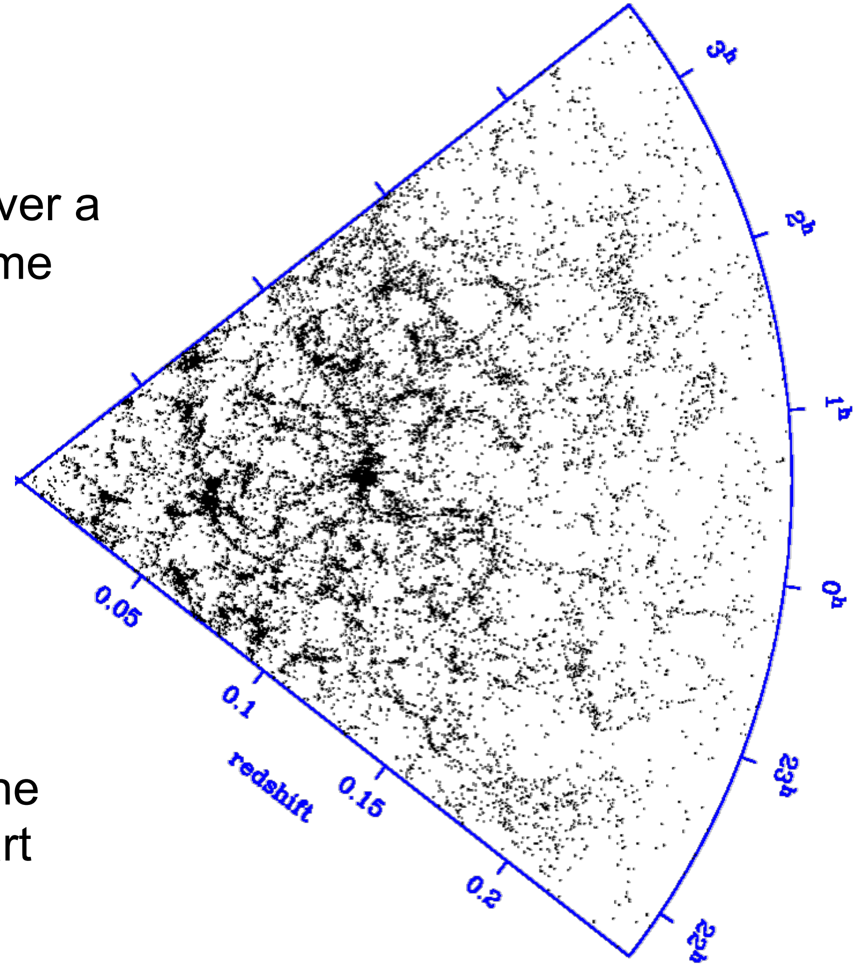
# Galaxy Clustering Calibrations

Will Percival

# Galaxy Clustering

- Need angular galaxy positions
- Need galaxy redshifts

For lots of galaxies over a large volume

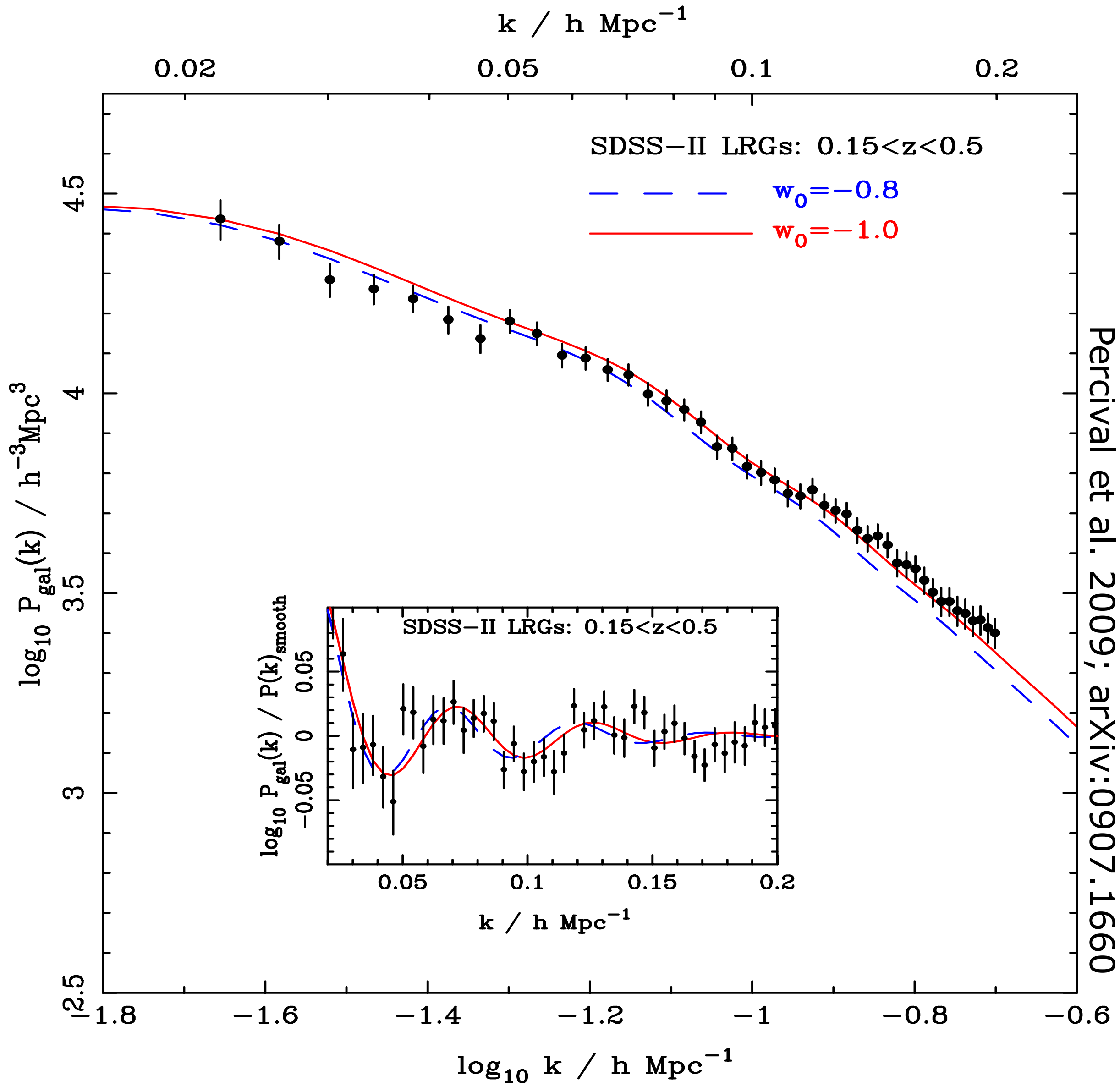



- Need to understand population
  - angular completeness
  - radial completeness
  - radial/angular fluctuations

This is the hard part

- Then can go from a density field to an overdensity field, and measure statistics

# Current power spectrum knowledge

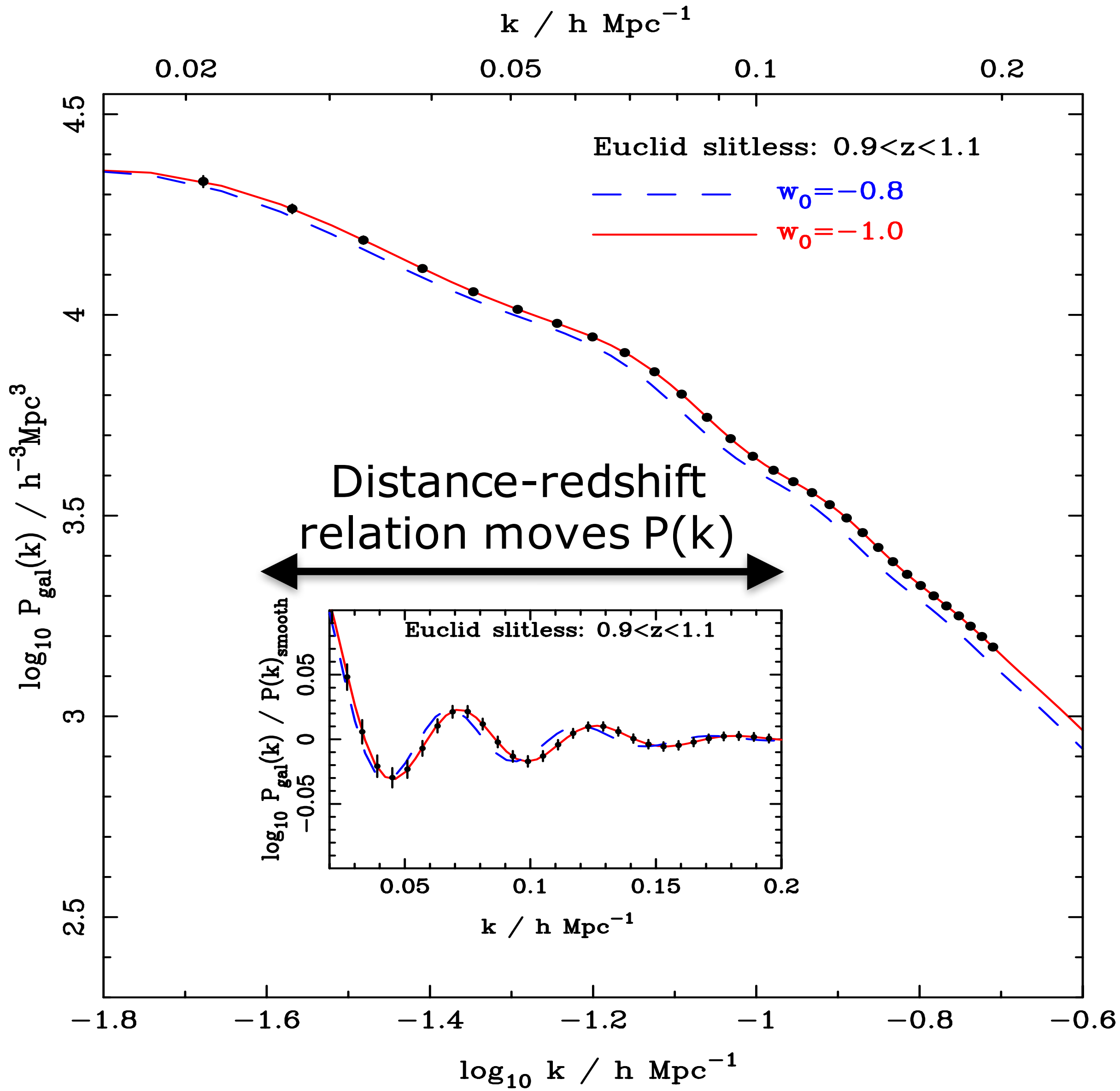



Percival et al. 2009; arXiv:0907.1660

# Power spectrum from Euclid spectro-survey



One of five redshift slices, assuming the slitless baseline at z~1



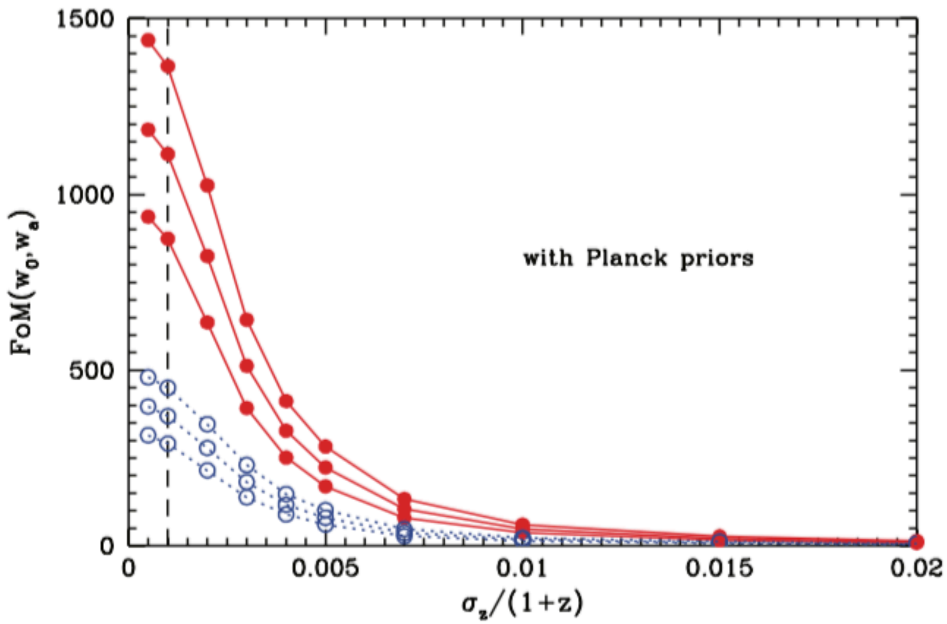
# Level 1 requirements
# (from SciRD issue 7, 10/8/15)

# Redshift calibration



R-GC.1-3 Measured redshifts should have a standard deviation around their true values of $\sigma(z)<0.001(1+z)$, with the exception of catastrophic redshift failures whose fraction is limited by R-GC.1-10.

T-GC.1-3 Increased redshift errors impact on the measured clustering signal by reducing the clustering signal in the radial direction (RD16, RD18). The DETF Figure-of-merit for BAO constraints saturates for redshift accuracies better than this requirement, as shown in Fig. 2 of RD17. (Wang et al. 2010, MNRAS 409 737)



# Redshift calibration



R-GC.1-4 Measured redshifts should have a systematic offset <1/5 of the standard deviation given in R-GC.1-3, with the exception of catastrophic redshift failures whose fraction is limited by R-GC.1-10.

T-GC.1-4 The requirement limits the skewness of the redshift distribution: If the distribution is too skewed our statistical analysis will become highly non-Gaussian.

R-GC.1-12 The expected difference between the means of the true and observed redshift distributions, including all galaxies within the sample (ie including both good redshifts, and catastrophic failures), should be known to the 0.1 per cent level within each redshift bin of width 0.1.

T-GC.1-12 If our estimates of the redshifts are systematically wrong, then our recovered distance-redshift relation will be offset. This requirement matches this offset to the recovered precision of the Euclid measurement, predicted as in RD16.

➔ Wavelength calibration

# Knowledge of purity



R-GC.1-10 The fraction of catastrophic redshift failures (galaxies whose measured redshifts do not fit within the distribution given by R-GC.1-3) should be less than f=0.2 (20%).

T-GC.1-10 Contamination of the sample will reduce the clustering strength. If the fraction of redshift failures in our sample of galaxies is f, then we define the `purity' as (1-f). For random contaminants, the clustering strength is multiplied by the purity squared, so a low purity reduces the signal strength and makes the BAO feature harder to measure.

R-GC.1-11 The fraction of catastrophic redshift failures (galaxies whose measured redshifts do not fit within the distribution given by R-GC.1-3) should be known to 1%.

T-GC.1-11 Knowing the purity we can recover the true amplitude of clustering.

➔ Purity calibration / Deep field

# Non-cosmological density fluctuations



R-GC.1-13 For galaxies that meet the flux limit specified by R-GC.2.1-1, with good redshifts as defined by R-GC.1-3 within the redshift range in R-GC.1-5, the rms fluctuation in galaxy counts within patches of 0.5 $deg^2$ area induced by flux calibration errors shall be less than 1.0%.

T-GC.1-13 BAO and RSD measurements across the line of sight can be affected by spurious fluctuations in the galaxy counts. This requirement is set at a level of 20% of the expected cosmological signal, at a scale approximately corresponding to the instrument field-of-view. Fluctuations between galaxy counts within circular regions depend on an integral over the correlation function on larger scales. This requirement therefore limits a set of spurious fluctuations including those on the projected BAO scale, which varies (with redshift) from 1 to 5 degrees. We assume that the power spectrum of spurious fluctuations is relatively smooth, so the spurious signal is not concentrated on the BAO scales.

➔ Relative spectro-photometric calibration

# Level 2 requirements (from SciRD issue 7, 10/8/15)

# Wavelength calibration (from redshift error)



R-GC.2.1-7 After calibration, the maximum error in the measured position of a spectral feature shall be less than 25% of one resolution element.

T-GC.2.1-7 This requirement corresponds to $f<R\Delta z$, and follows from the requirements on redshift accuracy ($\Delta z<0.001$, equivalent to R-GC.1-3) and resolution ($R=380$, equivalent to R-GC.2.1-5). This is a requirement placed on the accuracy of the wavelength calibration and the redshift measurement method, such that, together with the requirements on the spectral resolution R and the line sampling f, we can meet the L1 requirement on the redshift accuracy and systematic limit for any single galaxy.

# Calibration Deep field (from purity)

R-GC.2.1-10 A NISP spectroscopic subsample, with the same selection criteria as that of the spectroscopic galaxy sample chosen from the Wide survey, containing more than 140,000 galaxies shall be provided with purity >99%.

T-GC.2.1-10 Such a subsample, which could be provided by multiple exposures over a deep field, observed with similar conditions to the Wide survey, is necessary for the calibration of the NISP spectroscopic data.

# Spectrophotometry (from density fluctuations)



R-GC.2.1-12 Within patches of 0.5 $deg^2$ area distributed over the whole survey, fluctuations in the zero-point of the flux limit shall be smaller than 0.7% rms.

T-GC.2.1-12 The relationship between galaxy counts and flux limit is a ratio of approximately 1.5.

R-GC.2.1-13 After all calibrations, the absolute spectrophotometric error of the NISP-S shall be $< 5.0\%$.

T-GC.2.1-13 This goal ensures that the spectrophotometric flux limit for the wide survey as required in R-GC.2.1-1, is reached.

# Calibration Deep Field Requirements
# (proposed in EUCL-POR-DCR-8-001, submitted)

# Purity Calibration Deep field



R-DS.2.2-10 A NISP spectroscopic subsample, with the same selection criteria as that of the spectroscopic galaxy sample chosen from the Wide survey, containing more than 160,000 galaxies shall be provided with purity >99%

1% in each of 4 categories

↓

$N_i$=10,000

$N_{TOT}$=40,000 spurious redshifts

↓

160,000 correct redshifts (purity=20%)

↓

Area = 160,000/3900=41deg$^2$

# Purity Calibration Deep field



R-DS.2.2-14 At least 10 sets of wide-like visits, matching the integration time, dither pattern, and observational time-sequence of the Wide field survey strategy, containing at least 40 spectroscopic exposures in total, shall be performed in the NISP spectroscopic channel, each set of wide-like visits covering the same areas, for a total of at least 41 $deg^2$

Assuming each obs gives independent sample, chance of missing gal in N obs is (1-0.45)^N, where 0.45 is the completeness fraction

↓

use >99% of galaxies for calibration
(0.55)^N<0.01=> N>7.7

↓

Independent sample too conservative
round up to 10 passes

# Purity Calibration Deep field



R-DS.2.2-15 The 10 wide-like visits required by R-DS.2.2-14 should each have an orientation of the reference grism that is at least 10deg away from all others.

R-DS.2.2-** The 40 exposures required by R-DS.2.2-14 with independent directions within each wide-like visit (currently 30 orientations), should each have an orientation of dispersion that is at least 5 deg away from all others.

R-DS.2.2-** There should be no contiguous gap in the angular coverage of the dispersion directions between 0 and 360 deg larger than 30 deg.

R-DS.2.2-** After any year of the survey in the mission, the fraction of the area of the deep survey covered to a depth containing at least 8 wide-like visits, should be at least 80% of the fractional area of the Wide covered. [e.g. when 7500deg$^2$ (50%) of the Wide has been observed, at least 16deg$^2$ (40deg$^2$*0.5*0.8) of the deep survey should have been observed covered by at least 8 overlapping wide-like visits.