
ECO Mocks Catls Documentation

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This is the documentation for the [ECO Mocks Catalogue](#) repository. In here, you will find the structure and functions used in this repository, as well as information regarding the three different surveys.

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CHAPTER 1

Mock Catalogues

This is a brief overview of the different aspects of the synthetic catalogues produced for ECO RESOLVE-A and RESOLVE-B surveys

For a **more** comprehensive discussion on how the synthetic mocks were created, you can read the [ECO and Resolve Synthetic Catalogue](#) guide.

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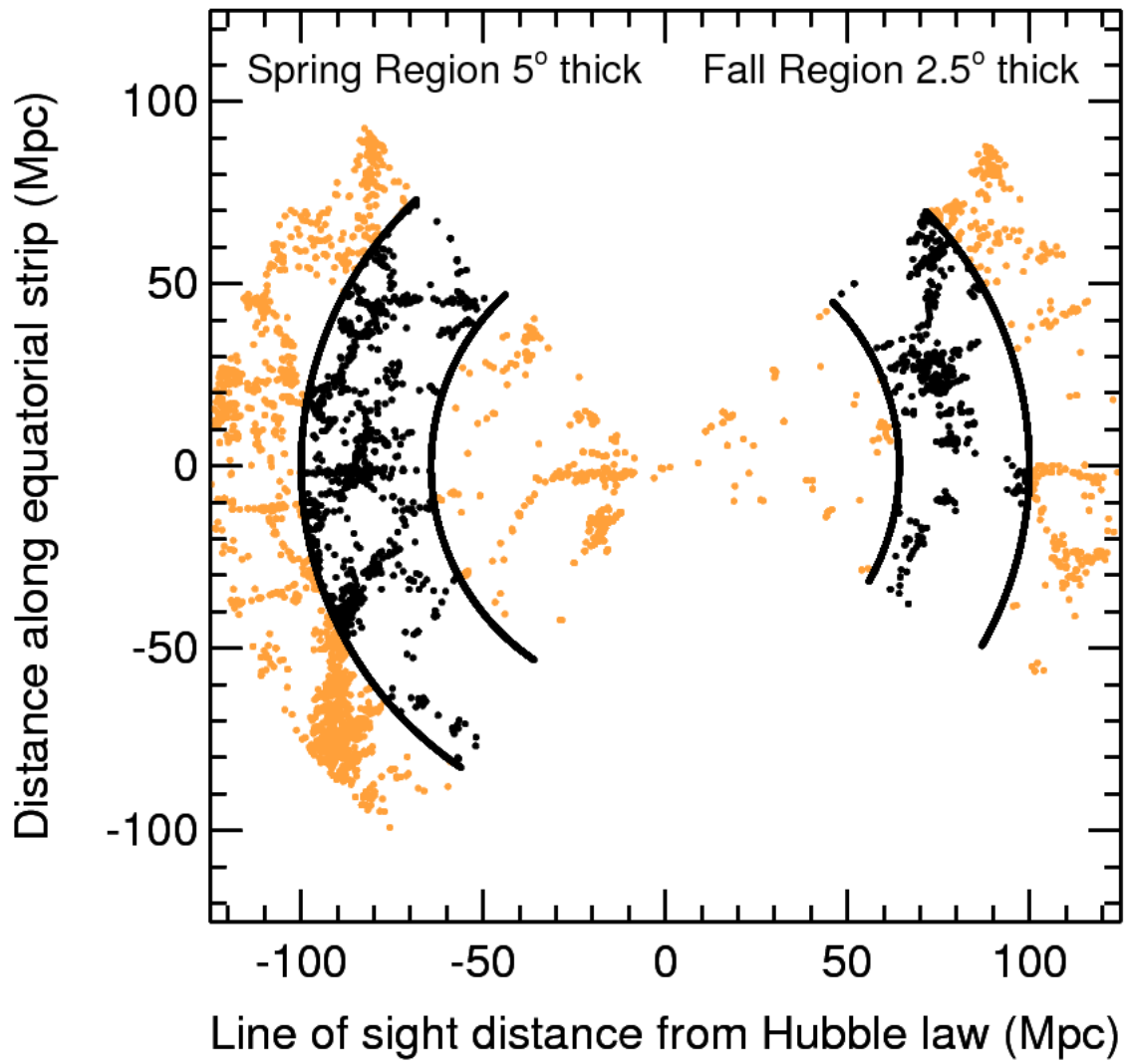
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1.1 ECO and RESOLVE

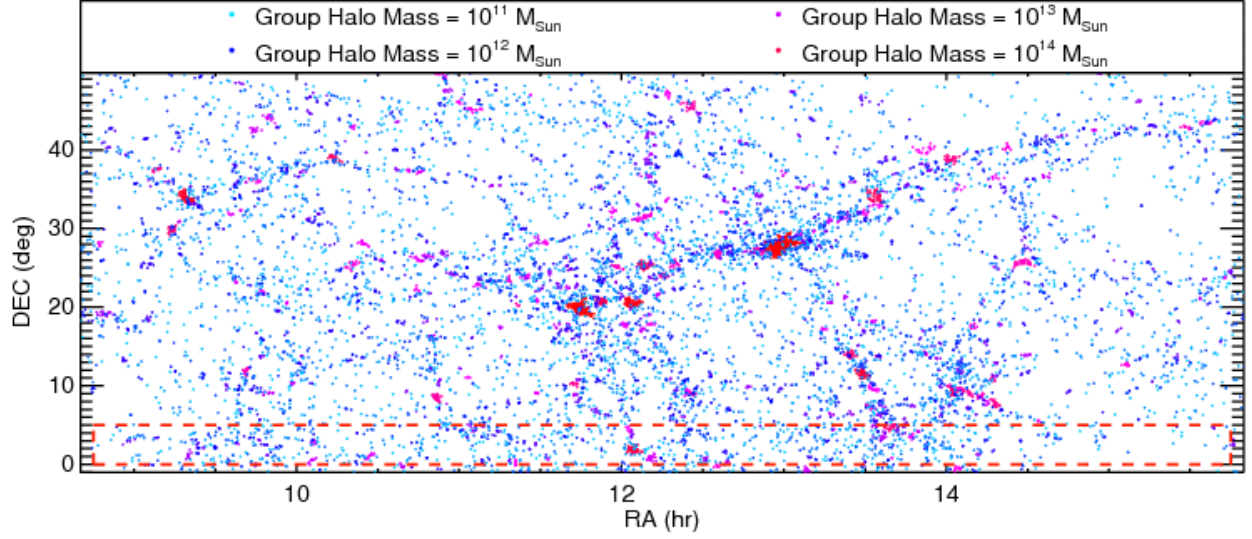
We construct a set of synthetic (mock) catalogues that have the same geometries as the **Environmental COntext** (ECO), **RESOLVE-A**, and **RESOLVE-B** galaxy surveys.

REsolved Spectroscopy Of a Local VolumeE (RESOLVE) is a volume-limited census of stellar, gas, and dynamical mass as well as star formation and merging within >50,000 cubic Mpc of the nearby cosmic web, reaching down to the dwarf galaxy regime and up to structures on tens of Mpc scales such as filaments, walls, and voids.

The Environmental COntext (ECO) catalog around RESOLVE is a much larger, purely archival data set with pipelines and methods matched to RESOLVE, enabling statistically robust analyses of environmental trends and calibration of cosmic variance.



This shows the right-ascension (RA) and declination (DEC) of galaxies in RESOLVE-A and RESOLVE-B galaxy redshift surveys.



RESOLVE-A (footprint demarcated by red dashed lines) embedded within ECO (entire plot showing current footprint, with ECO-B in preparation)

For more information on how the data for the different galaxy surveys were taken, go to the [Main ECO](#) and [RESOLVE](#) website.

1.2 Constructing catalogues

We design the *synthetic* catalogues to have the exact same geometries and redshift limits as those of the ECO, RESOLVE-A, and RESOLVE-B galaxy surveys.

This is a summary of the values used to create the synthetic galaxy catalogues. These catalogues are taking a *buffer* regions, which is an *extra* buffer region along the *cz* (velocity) direction in redshift-space.

Survey	RA (deg)	RA range	DEC (deg)	DEC range	zmin	zmax	Vmin (km/s)	Vmax (km/s)	Dist (Mpc)
A	(131.25, 236.25)	105.0	(0, +5)	5	0.00844	0.0249	2532	7470.	(25.32, 70.02)
B	(330.0 , 45.0)	75.0	(- 1.25, +1.25)	2.5	0.01416	0.024166	4250	7250.	(42.5 , 72.5)
ECO	(130.05, 237.45)	107.4	(-1, +49.85)	50.85	0.00844	0.0249	2532	7470.	(25.32, 70.02)

The next table provides the number of synthetic catalogues per cubic box of $L = 180 \text{ Mpc}/h$, where $h = 1$.

Survey	Number Mocks
A	59
B	104
ECO	8

In order to run the *Friends-of-Friends* (FoF) algorithm and put galaxies into galaxy groups, we have to choose a set of **linking lengths**. The set of linking lengths used for this analyses are

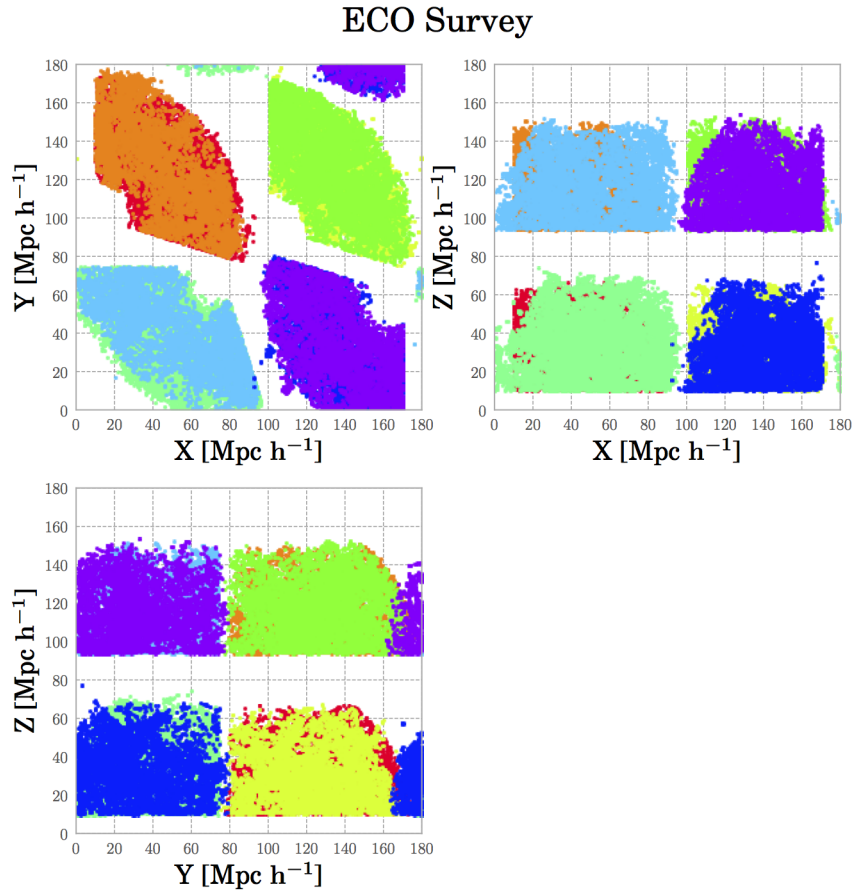
Table 1: FoF Group-finding parameters

l_{perp}	l_{para}
0.07	1.1

Note: The units for the linking lengths are in terms of the mean inter-galaxy separation of the simulation.

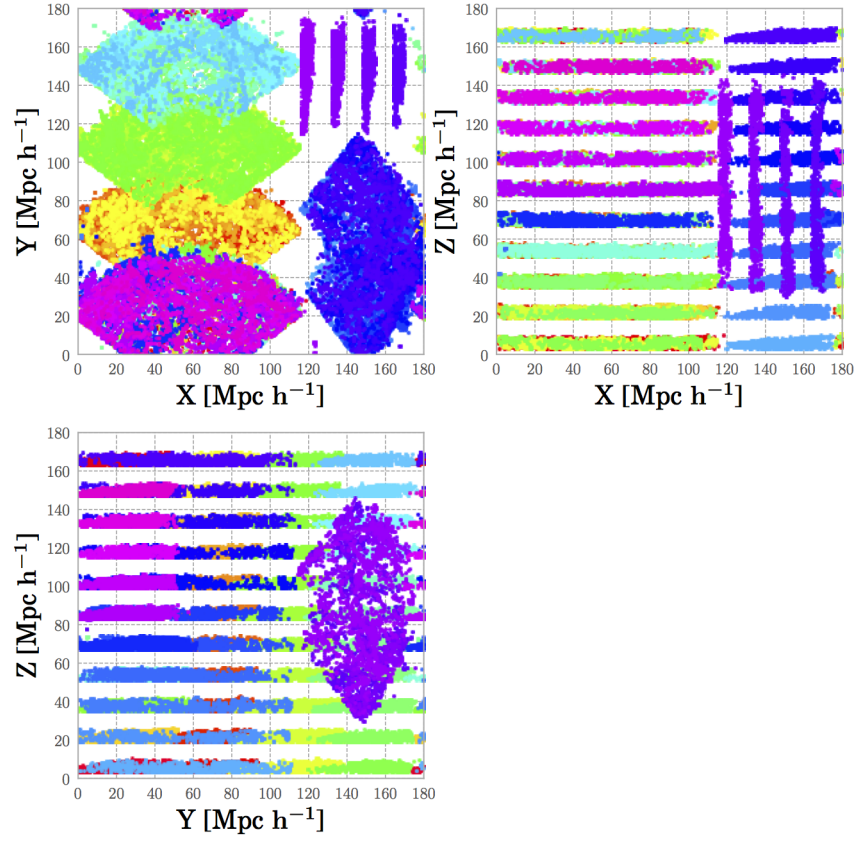
1.3 Distribution of catalogues in simulation box

In order to maximize the number of catalogues per simulation, we have to fit as many catalogues as we can, while keeping a distance of ~ 10 Mpc/h between catalogues. We chose this distance of 10 Mpc/h in order to avoid using the same galaxy for different catalogues, and also to make the catalogues as independent from each other as possible.



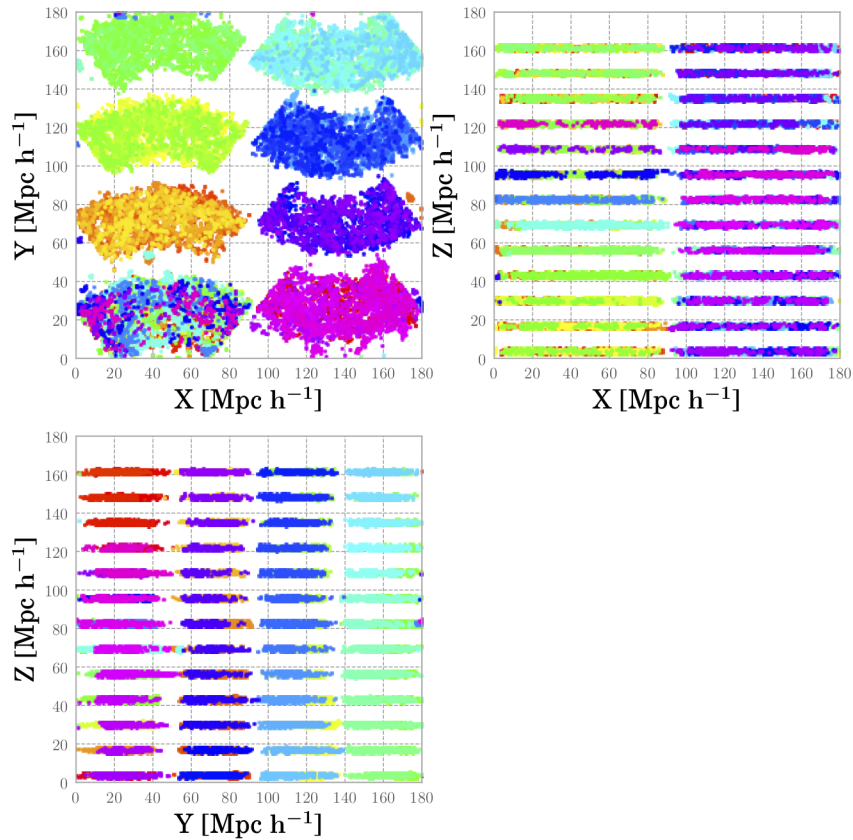
This figure shows how the catalogues for ECO surveys are organized within the simulation box used for this analysis.

RESOLVE A



And this figure shows the distribution of synthetic **RESOLVE-A** catalogues in the simulation box!

RESOLVE B



Finally, this figure shows the Cartesian representation of the positions of galaxies in the **RESOLVE-B** survey.

1.4 Downloading and reading in data from catalogues

The mock catalogues are located at http://lss.phy.vanderbilt.edu/groups/data_eco_vc/Mock_Catalogues/.

These catalogues can be downloaded as *tar* files, and be read by the Python package *Pandas*.

After having downloaded your file, you can read them in the following way:

```
#!/usr/bin/env python

import pandas as pd
import os

def reading_catls(filename, catl_format='.hdf5'):
    """
    Function to read ECO/RESOLVE catalogues.

    Parameters
    -----
    filename: string
        path and name of the ECO/RESOLVE catalogue to read

    catl_format: string, optional (default = '.hdf5')
```

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    type of file to read.
    Options:
        - '.hdf5': Reads in a catalogue in HDF5 format

Returns
-----
mock_pd: pandas DataFrame
    DataFrame with galaxy/group information

Examples
-----
# Specifying `filename`
>>> filename = 'ECO_catl.hdf5'

# Reading in Catalogue
>>> mock_pd = reading_catls(filename, format='.hdf5')

>>> mock_pd.head()

```

	x	y	z	vx	vy	vz	\
0	10.225435	24.778214	3.148386	356.112457	-318.894409	366.721832	
1	20.945772	14.500367	-0.237940	168.731766	37.558834	447.436951	
2	21.335835	14.808488	0.004653	967.204407	-701.556763	-388.055115	
3	11.102760	21.782235	2.947002	611.646484	-179.032089	113.388794	
4	13.217764	21.214905	2.113904	120.689598	-63.448833	400.766541	

	loghalom	cs_flag	haloid	halo_ngal	...	cz_nodist	vel_tot	\
0	12.170	1	196005	1	...	2704.599189	602.490355	
1	11.079	1	197110	1	...	2552.681697	479.667489	
2	11.339	1	197131	1	...	2602.377466	1256.285409	
3	11.529	1	199056	1	...	2467.277182	647.318259	
4	10.642	1	199118	1	...	2513.381124	423.326770	

	vel_tan	vel_pec	ra_orig	groupid	M_group	g_ngal	g_galtype	\
0	591.399858	-115.068833	215.025116	0	11.702527	1	1	
1	453.617221	155.924074	182.144134	1	11.524787	4	0	
2	1192.742240	394.485714	182.213220	1	11.524787	4	0	
3	633.928896	130.977416	210.441320	2	11.502205	1	1	
4	421.064495	43.706352	205.525386	3	10.899680	1	1	


```

    halo_rvir
0    0.184839
1    0.079997
2    0.097636
3    0.113011
4    0.057210
"""
## Checking if file exists
if not os.path.exists(filename):
    msg = '`filename`: {0} NOT FOUND! Exiting..'.format(filename)
    raise ValueError(msg)
## Reading file
if catl_format=='.hdf5':
    mock_pd = pd.read_hdf(filename)
else:
    msg = '`catl_format` ({0}) not supported! Exiting...'.format(catl_
↪format)
    raise ValueError(msg)

```

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```
    return mock_pd

def main():
    # Specifying filename
    filename = 'ECO_catl.hdf5'
    # Reading in ECO/RESOLVE catalogue
    mock_pd = reading_catls(filename)

if __name__ == '__main__':
    main()
```

1.5 Description of the *fields* in the catalogues

Each mock catalogues contains information about the **galaxy**, **group galaxy**, **host halo**, and more. We will denote *dark matter* as *DM*.

Note: The descriptions for the variables are somewhat long, so don't forget to scroll to the **right** to see *more*.

1.5.1 Main Galaxy Properties

Table 2: List of Parameters

Field	Description	Units
ra	Right Ascension	degrees
dec	Declination	degrees
cz	Velocity of the galaxy (** with redshift-space distortions)	km/s
M_r	r-band absolute magnitude of the galaxy	magnitudes
haloid	Dark matter halo ID, as taking from the simulation	None
loghalom	logarithmic value of the DM's mass	log(Msun/h) where h=1
halo_ngal	Total number of galaxies in DM halo. Number of galaxies in the mock may differ from this value	None
cs_flag	Type of galaxy. Halo central = 1, Halo satellite = 0	None
cz_nodist	Velocity of the galaxy (<i>without</i> redshift-space distortions)	km/s
dist_c	<i>Real</i> distance between halo's central galaxy and the galaxy.	Mpc/h with h=1
vel_tot	Total velu for peculiar velocity	km/s
vel_tan	Tangential component of the peculiar velocity	km/s
morph	Galaxy's morphology. 'LT': <i>Late Type</i> ; 'ET': <i>Early type</i> . Used either <i>goodmorph</i> (ECO) or <i>MORPH</i> (RESOLVE) keys. '-9999' if no matched galaxy	None
logmstar	Log value of galaxy's stellar mass. Used either 'rpgoodmstarsnew' (ECO) or 'MSTARS' (RESOLVE) keys in the files	log(Msun)
rmag	r-band <i>apparent</i> magnitude. Used either 'rpsmoothrestrmagnew' (ECO) or 'SMOOTHRESTRMAG' (RESOLVE) keys in the files.	magnitudes
umag	u-band <i>apparent</i> magnitude. Used either 'rpsmoothrestumagnew' (ECO) or 'SMOOTHRESTUMAG' (RESOLVE) keys in the files.	magnitudes
fsmgr	Stellar mass produced over last Gyr divided by pre-existing stellar mass from new model set. Used 'rpmeanssfr' (ECO) or 'MODELFSMGR' (RESOLVE) keys.	(1/Gyr)
survey_flag	Survey name, from which the properties of the real matched galaxy were extracted.	None
u_r	Color of the matched galaxy, i.e. (umag - rmag)	magnitudes
mhi	HI mass in galaxy. Used the <i>predicted</i> HI mass (matched to the ECO file, i.e. eco_wresa_050815.dat) and the key "MHI" (RESOLVE). To compute MHI masses using <i>ECO</i> , we used the formula: $10^{(MHI + \log mstar)}$	Msun
groupid	Group ID, to which the galaxy belongs after running <i>Berlind2006</i> FoF group finder.	None
g_ngal	Number of galaxies in a group of galaxies	None
halo_rvir	Virial radius of the DM halo, to which the galaxy belongs.	Mpc/h with $h = 1$.
M_group	Abundance matched mass of the galaxy group. This was calculated by assuming a monotonic relation between DM halo mass $\log M_{halo}$ and the group <i>total</i> luminosity. For RESOLVE-B, we used a modified version of the <i>ECO</i> group luminosity function.	Msun/h with $h = 1$
g_galtype	Type of galaxy. Group central = 1, Group satellite = 0	None

Note: The relationship between velocities (cz's) is the following: $(cz - cz_nodist)^2 + (vel_tan)^2 =$

(vel_tot)^2.

1.5.2 Halos Filaments

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This file includes data about the filaments found in the simulation box used for these synthetic catalogues.

The catalogue can be found at http://lss.phy.vanderbilt.edu/groups/data_eco_vc/Halo_Filaments/.

Table 3: List of Parameters - Halo Filaments

Field	Description	Units
Halo ID	Halo ID number for the given DM halo in the simulation box.	
log(MHalo)	Logarithmic value of the DM halo’s mass, as $\log(MHalo)$	$\log(M_{\text{sun}}/h)$ with $h = 1$
ID/Type	ID of the DM halo’s environment. ‘0’: Not in a filament; ‘1’: filament node; ‘2’: part of a filament skeleton; ‘3’: within a clode radius of a filament.	
Fil	ID of the halo’s filament. (-1 if not in a filament)	
Fil. Quality	Quality of the filament, i.e. probability that the filament is <i>real</i>	