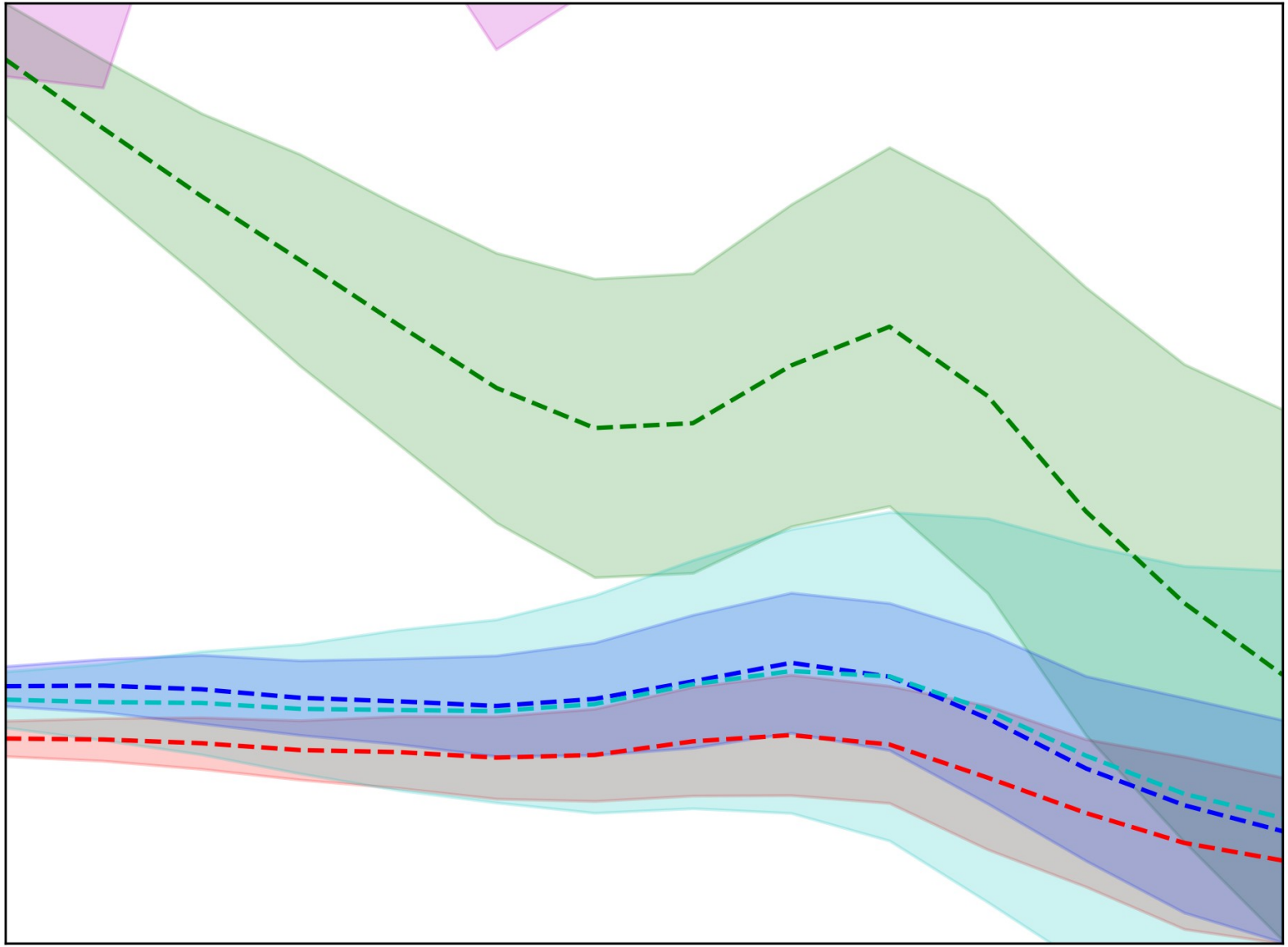
Using cross-correlations to recover the BAO peak in sparse spectroscopic surveys

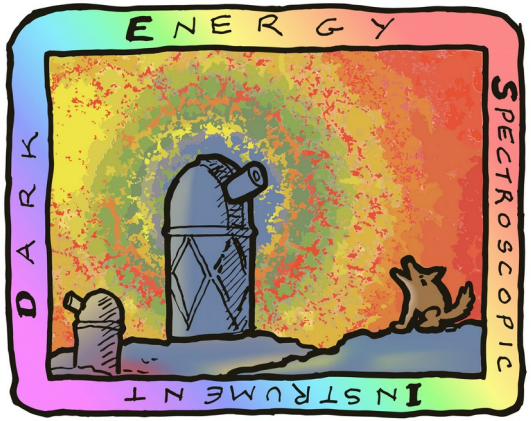
by **Christoph Saulder** (KASI)

8th Korea-Japan workshop on Dark Energy



Collaborators

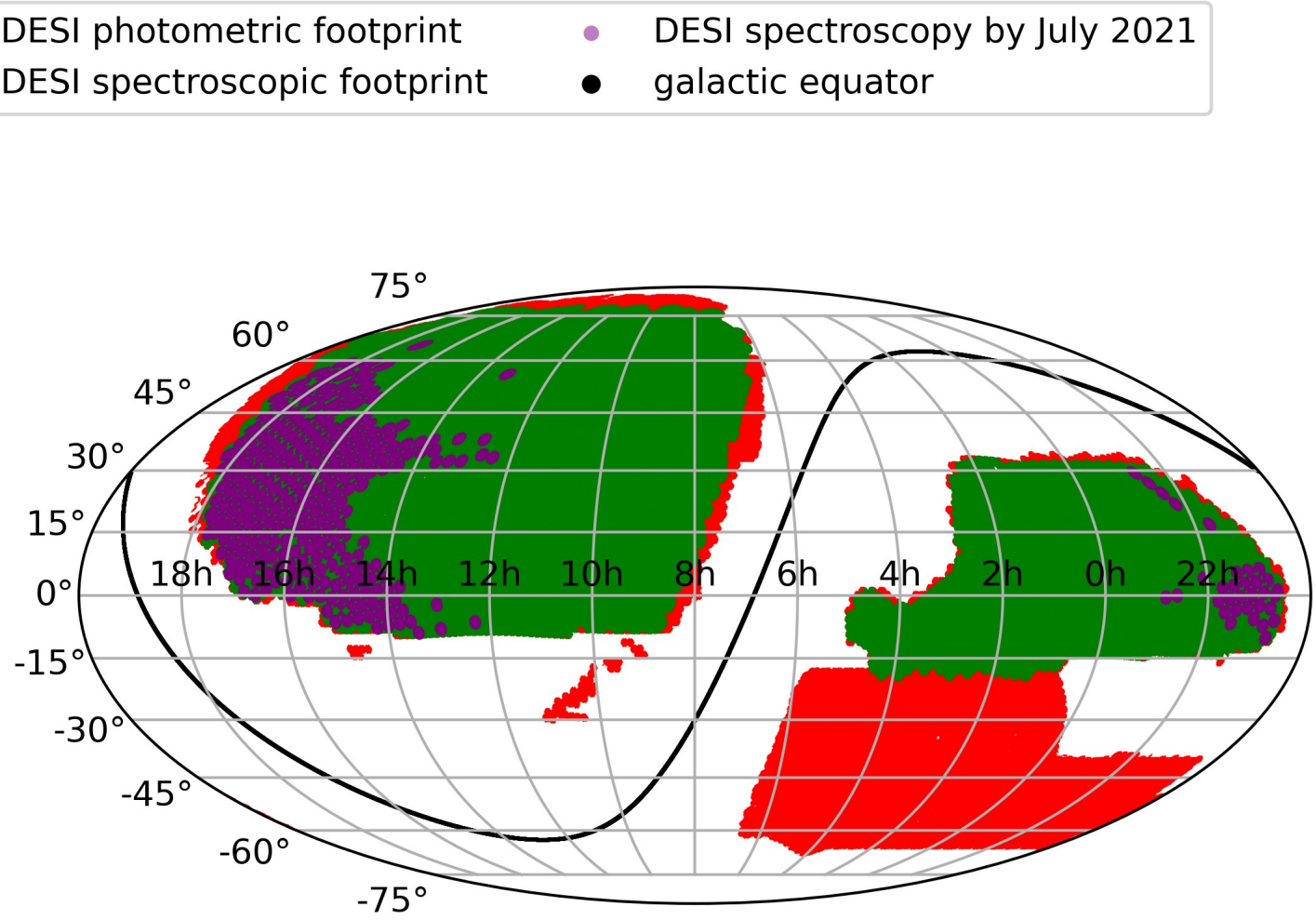
- Christoph Saulder (KASI)
- Yong-Seon Song (KASI)
- Minji Oh (formerly SJTU)
- Feng Shi (Xidian University)
- Yi Zheng (SYSU)



The Motivation

- Photometric survey get completed before spectroscopic surveys
- Spectroscopic surveys will usually be less complete than photometric surveys
- However photometric redshifts have huge error bars
- Depending on survey strategy for spectroscopic survey: first wide than deep or first deep than wide

DESI DA0.2 footprint



Our toy model

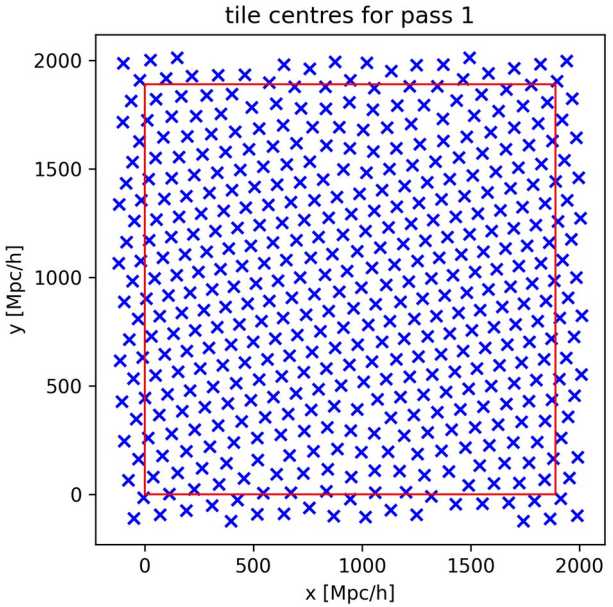
- DESI-like survey
- Photo-z uncertainty $\sigma_0 = 0.02$
- Current focus: LRGs around z=0.7
- Only one target class
- Fibre assignment based on DESI

Simulations

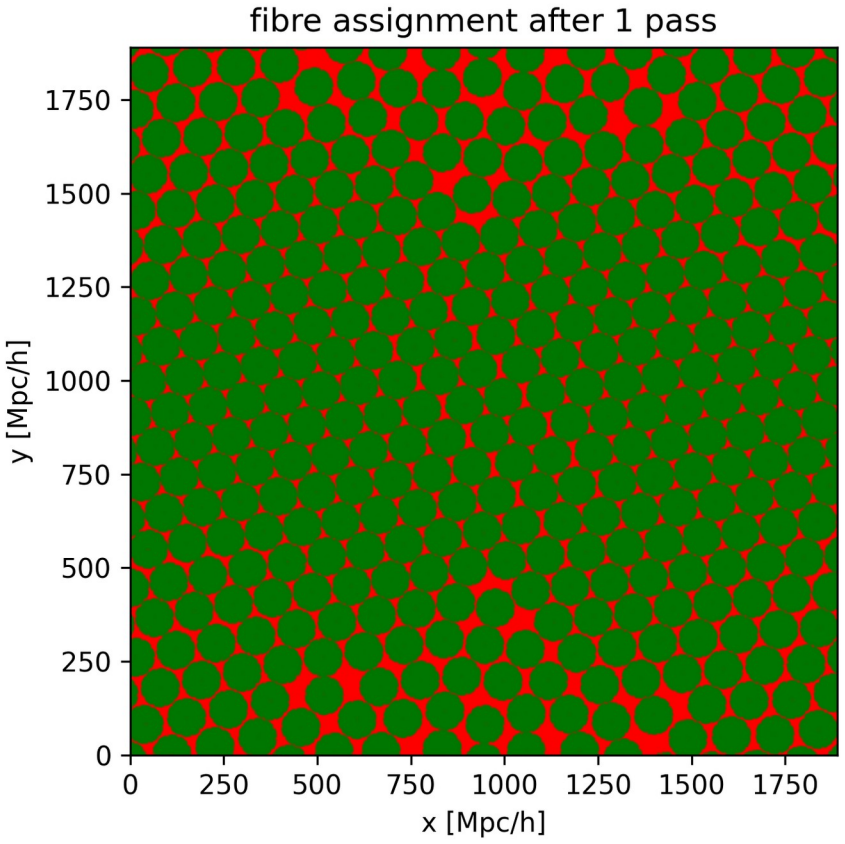
- 100 mocks with Planck cosmology
- Cubes with 1890 Mpc/h side length
- Halos identified using Rockstar
- Galaxies are painted using HOD models based on observations (currently only tested with the DESI LRG sample)

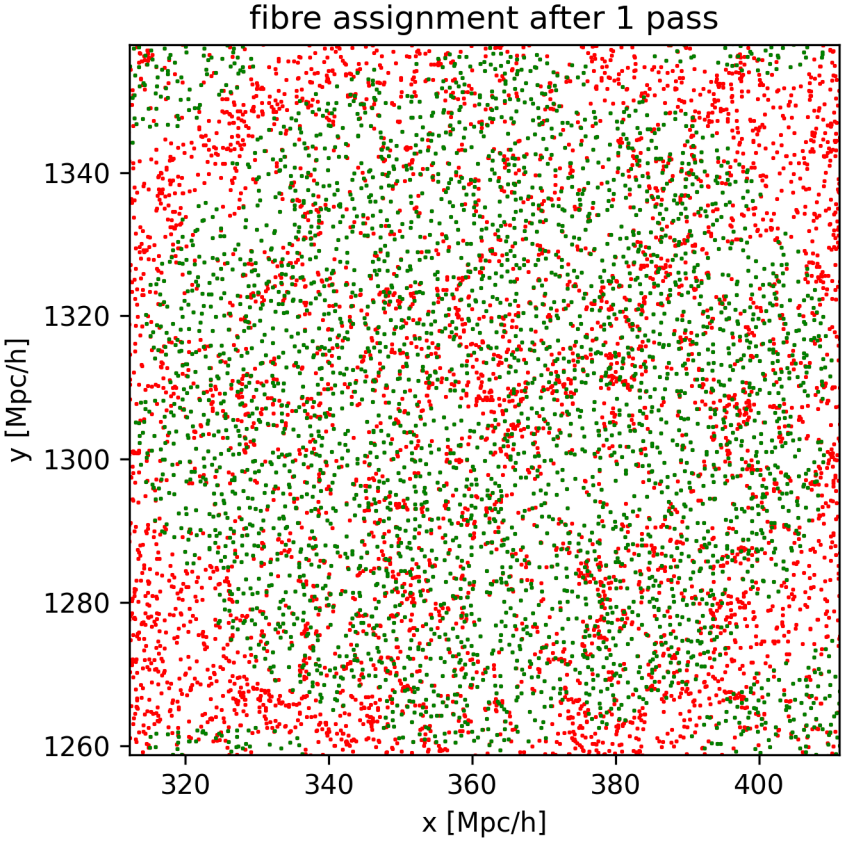
Fibre assignment

- Tiling strategy of DESI
- Comparing 1-pass with many passes
- Impact of fibre placements and completeness of the spectroscopic data



First pass


fibre assignment after 1 pass
y [Mpc/h]
x [Mpc/h]
0
250
500
750
1000
1250
1500
1750

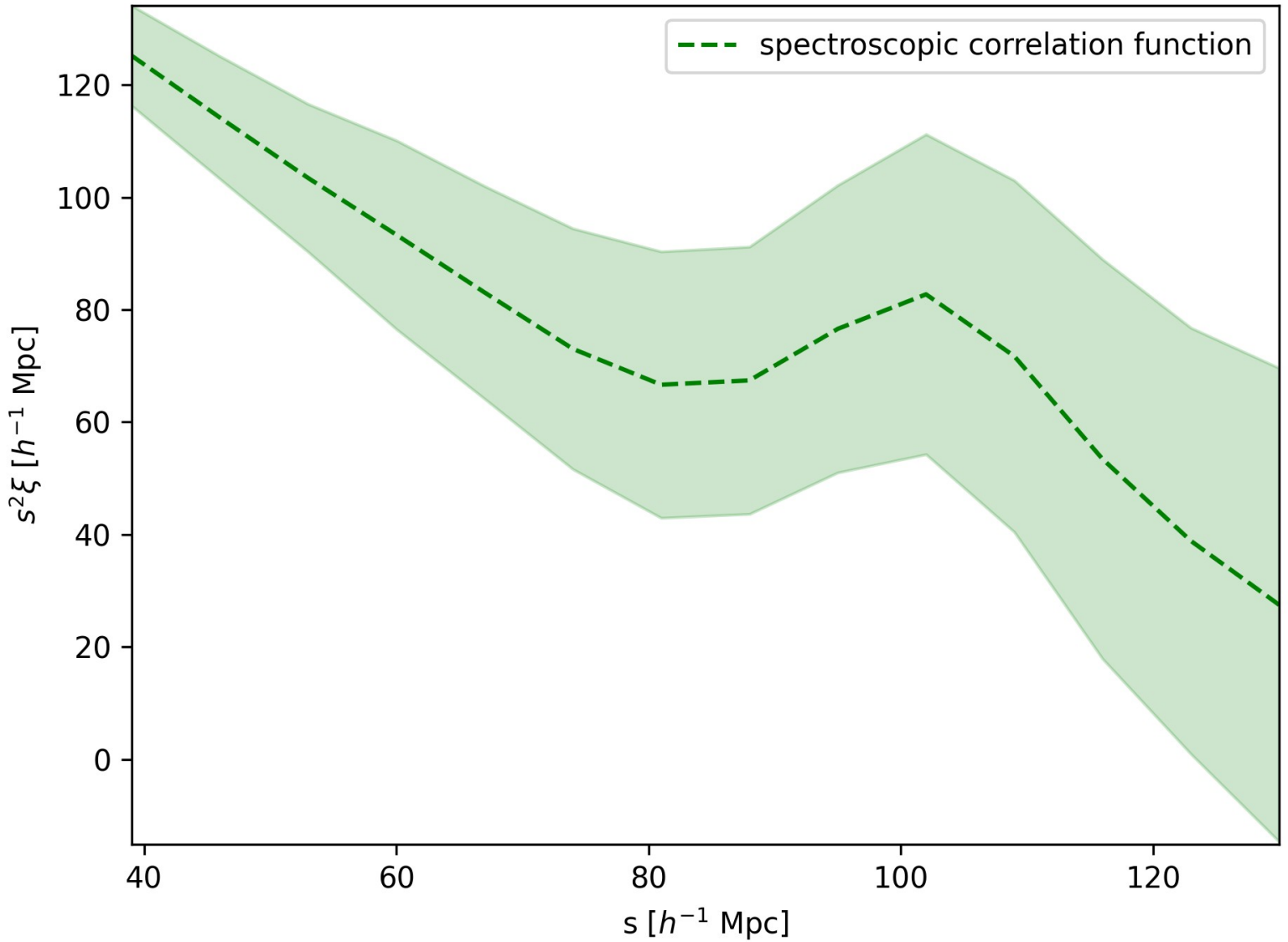

fibre assignment after 1 pass
y [Mpc/h]
x [Mpc/h]
1260
1280
1300
1320
1340
320
340
360
380
400

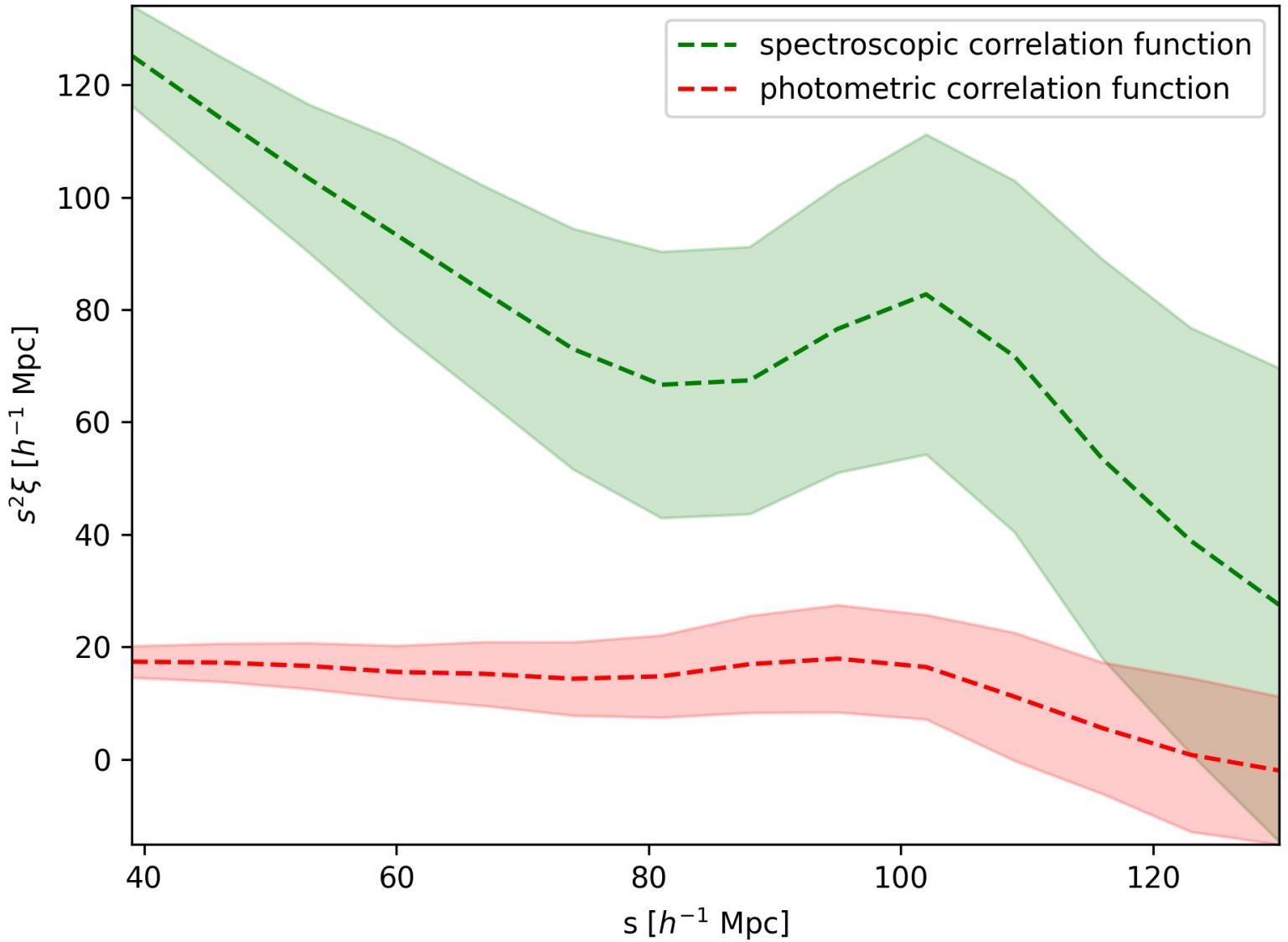
First pass

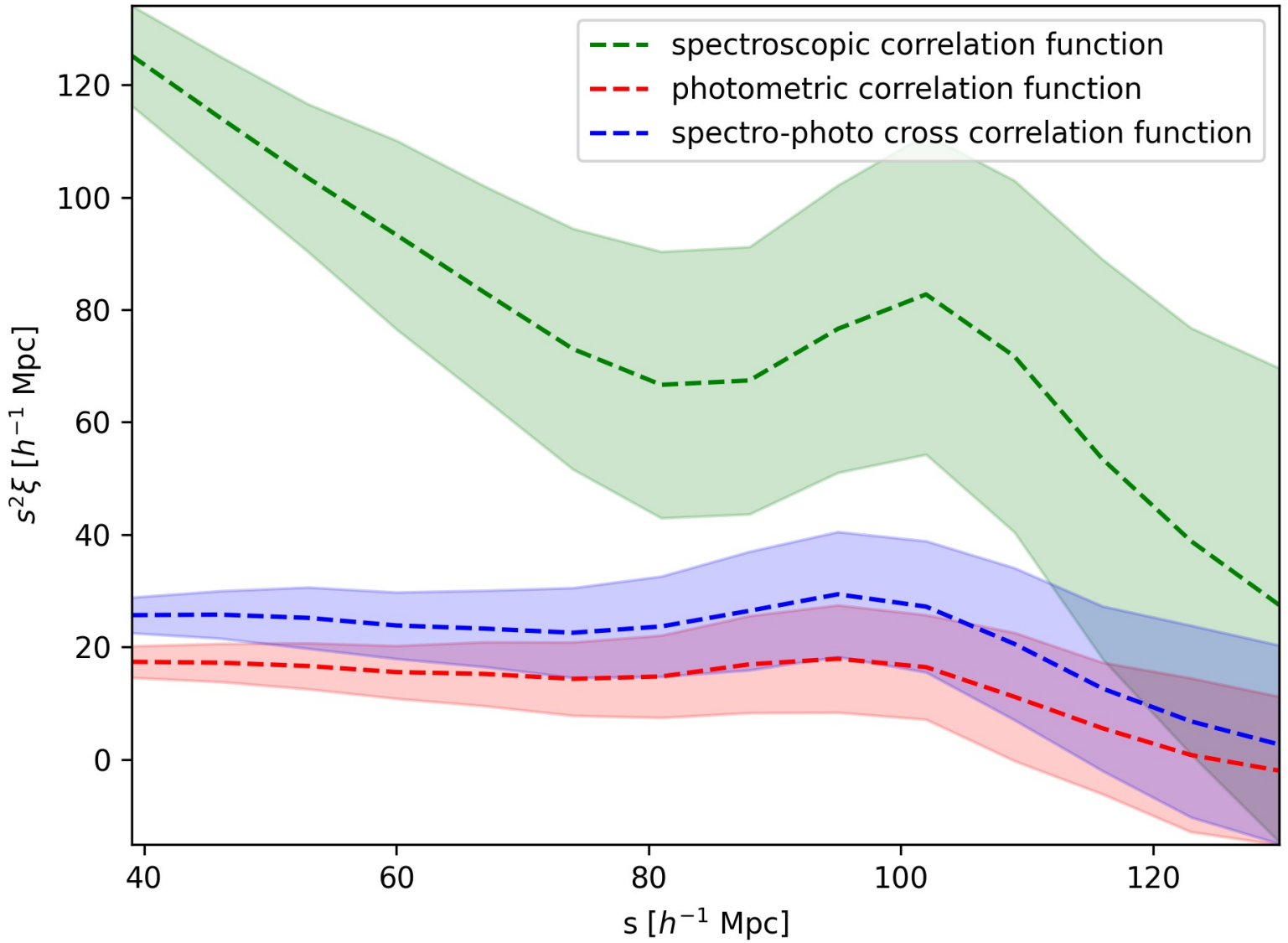
- Comparable to the current status of DESI and the first DESI main survey data release
- In simulation: about 40% of targets covered
- In observations: about 20% completeness after 1 pass for LRG, because broken fibres, sky and star fibres, competing other targets, ...

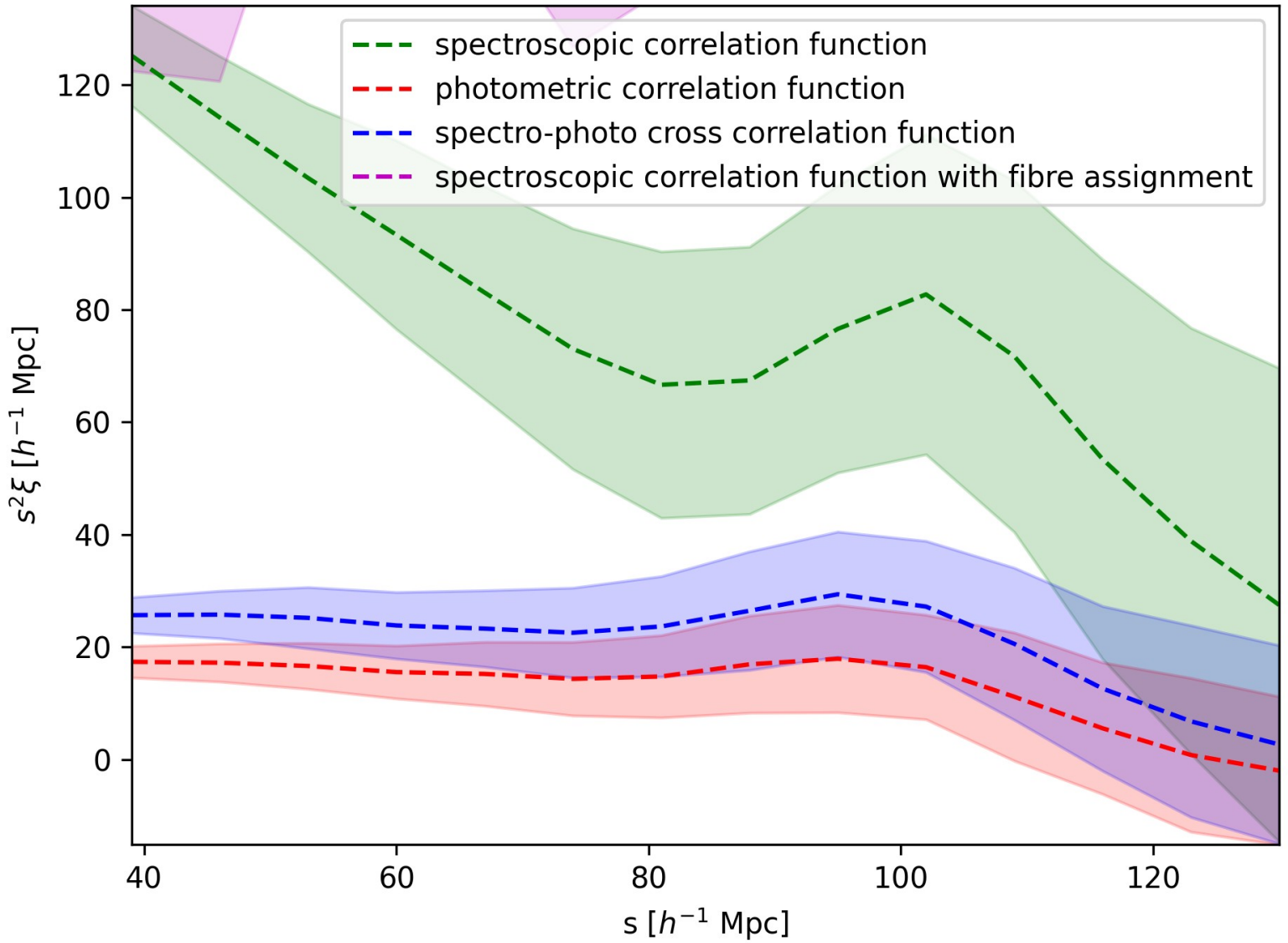
Large scale correlation function

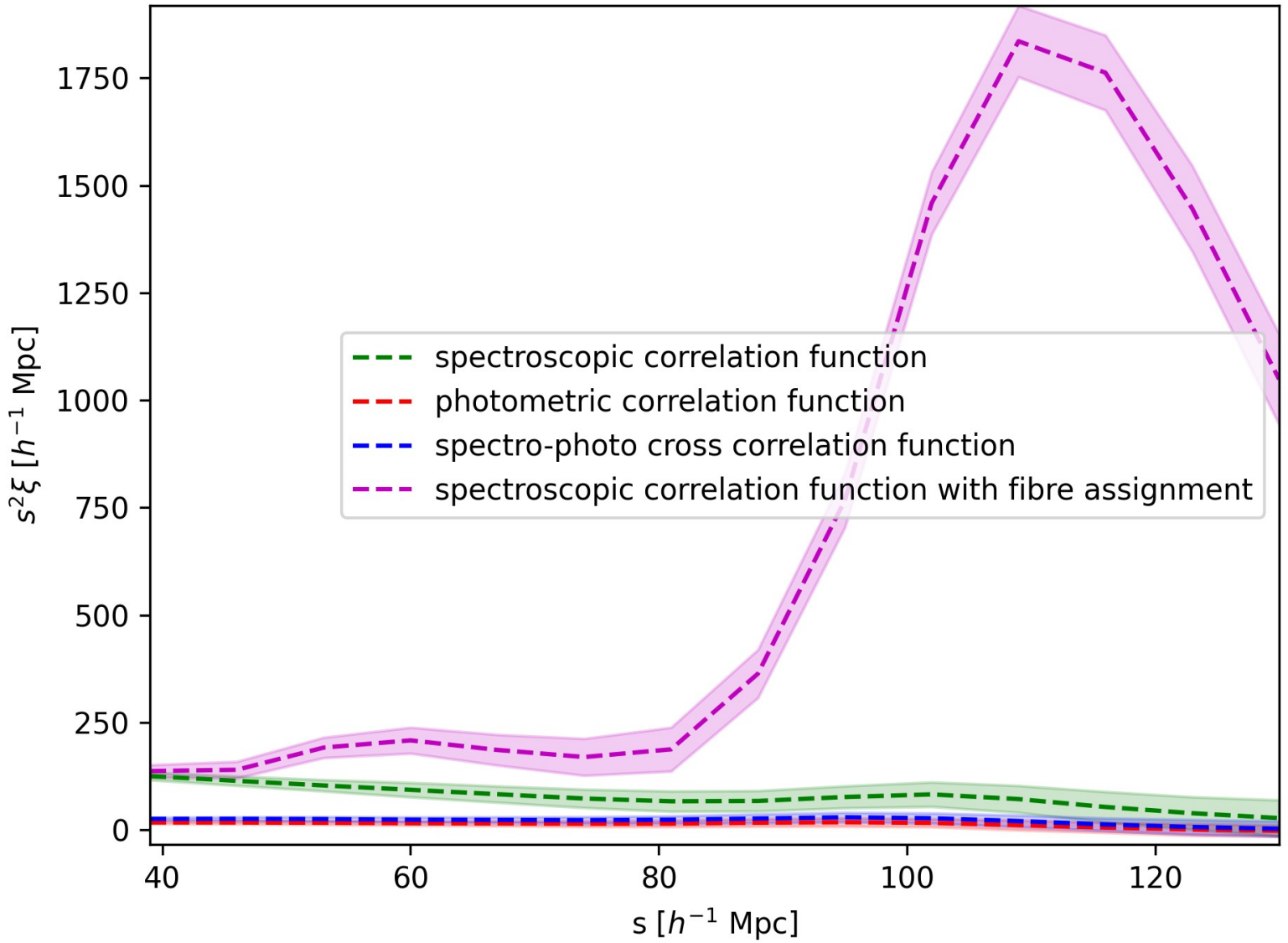
- Correlation function ξ(s,μ) around BAO peak
- Comparison between
  - Clean spectroscopic data
  - Photometric data
  - Cross-correlation spectro-photo data
  - Spectroscopic data after fibre assignment

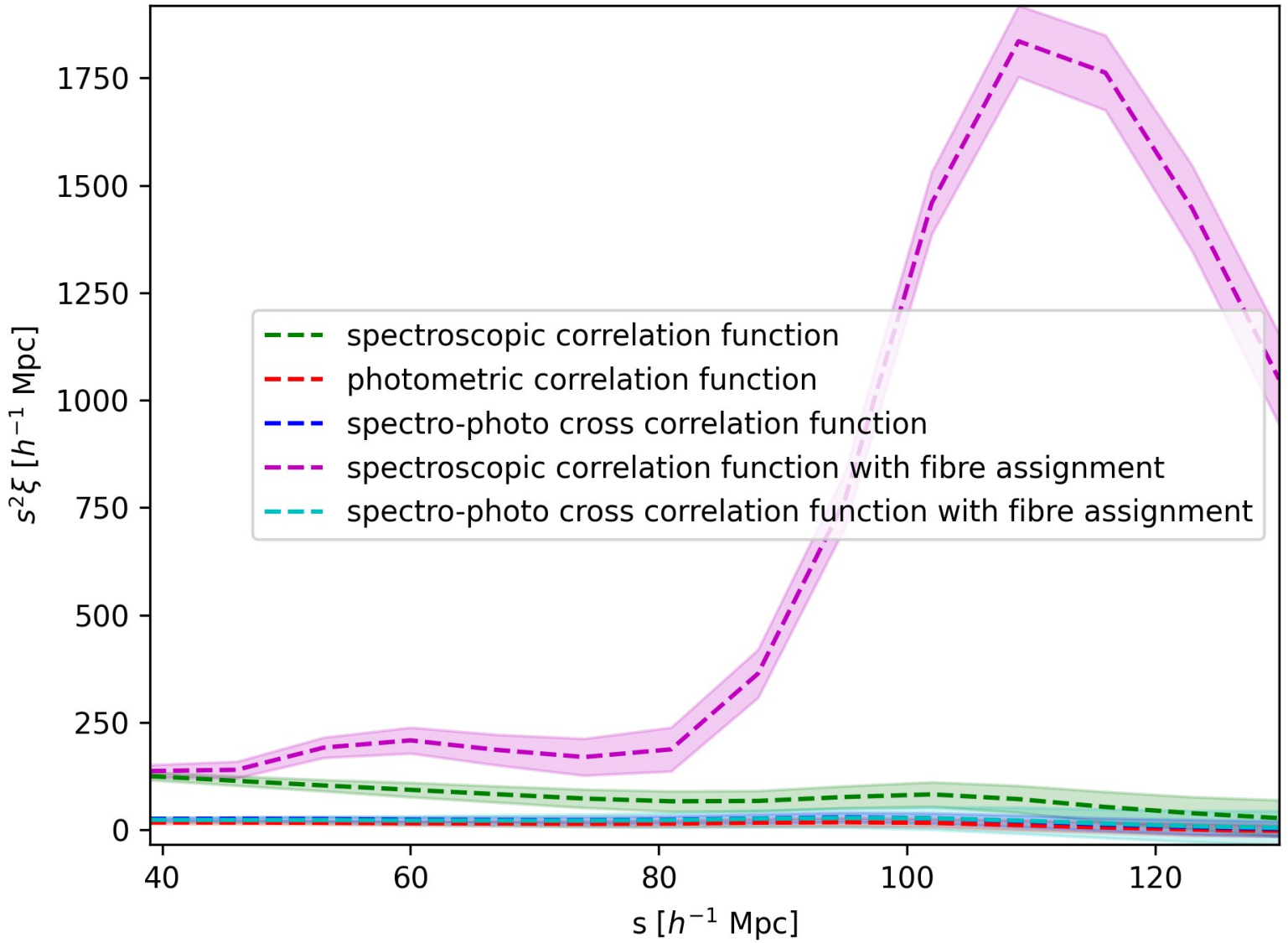

spectroscopic correlation function
120
100
80
60
40
20
0
$s^2\xi$ [h^{-1} Mpc]
40
60
80
100
120
s [h^{-1} Mpc]


spectroscopic correlation function
photometric correlation function
120
100
80
60
40
20
0
$s^2\xi$ [h^{-1} Mpc]
40
60
80
100
120
s [h^{-1} Mpc]


spectroscopic correlation function
photometric correlation function
spectro-photo cross correlation function
120
100
80
60
40
20
0
$s^2\xi$ [h^{-1} Mpc]
40
60
80
100
120
s [h^{-1} Mpc]


spectroscopic correlation function
photometric correlation function
spectro-photo cross correlation function
spectroscopic correlation function with fibre assignment
$s^2\xi$ [h^{-1} Mpc]
s [h^{-1} Mpc]
0
20
40
60
80
100
120
40
60
80
100
120


1750
1500
1250
1000
750
500
250
0
$s^2\xi$ [h^{-1} Mpc]
40
60
80
100
120
s [h^{-1} Mpc]
spectroscopic correlation function
photometric correlation function
spectro-photo cross correlation function
spectroscopic correlation function with fibre assignment


spectroscopic correlation function
photometric correlation function
spectro-photo cross correlation function
spectroscopic correlation function with fibre assignment
spectro-photo cross correlation function with fibre assignment
$s^2\xi$ [h^{-1} Mpc]
s [h^{-1} Mpc]
0
250
500
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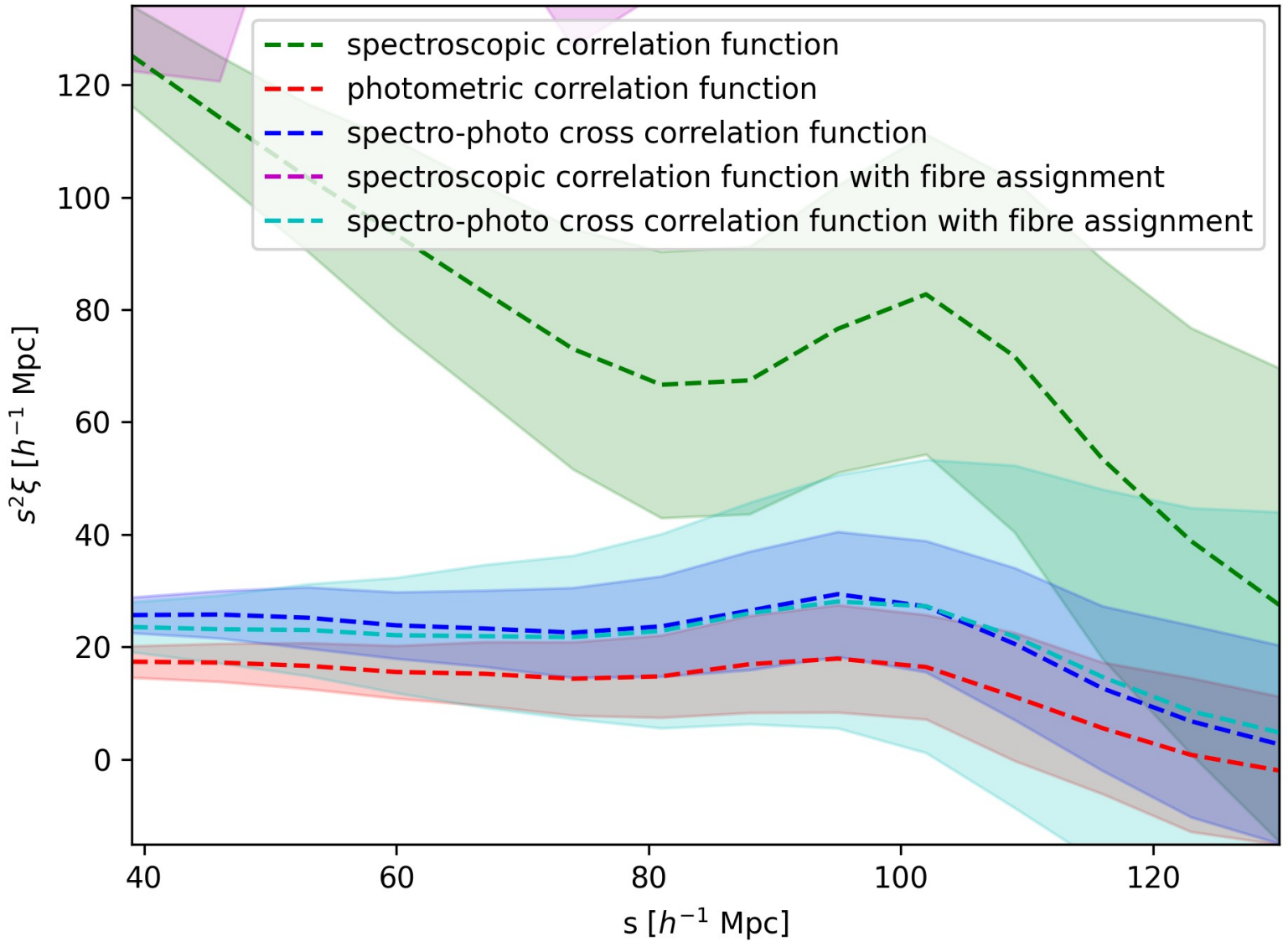
1750
40
60
80
100
120


spectroscopic correlation function
photometric correlation function
spectro-photo cross correlation function
spectroscopic correlation function with fibre assignment
spectro-photo cross correlation function with fibre assignment
$s^2\xi$ [h^{-1} Mpc]
s [h^{-1} Mpc]
0
20
40
60
80
100
120
40
60
80
100
120

Outlook

- More sophisticated toy models
- Considering possible other target classes
- Testing if a possible competitive probe to other techniques (such as PIP weights) for early DESI data
- Considering other future surveys (J-PAS, Euclid, LSST)

Summary

- Comparing auto- and cross-correlation function for photometric and spectroscopic LRG selection
- Cross-correlation can recover features, even if the spectroscopic data set is incomplete and biased due to fibre assignment
- Application for early DESI data (DA0.2)

QUESTIONS?

Thank you!
감사합니다 !
ありがとうございました!