	FM3				
	August 10, Wednesday	**Time (minutes)**	**Attendance**		
	Morning e-Poster			09:45-10:30	
	Morning Oral Session			10:30-12:00	
	FM 3-1 (Room 103)				
	Nicolas Martinet	15+5	on-site	Introduction to cosmic shear and the meeting	
	Marika Asgari	15+5	on-site	Cosmic Shear Analyses with KiDS: past, present and future	
	Hironao Miyatake	15+5	on-site	Weak Lensing Cosmology from Subaru Hyper Supreme-Cam Survey	
	Axel Guinot	15+5	on-site	Weak Lensing analysis of the 3,600deg2 of the CFIS-UNIONS data	
	Afternoon Oral Session 1			13:30-15:00	
	FM 3-2 (Room 103)				
	Mijin Yoon	15+5	on-site	Cosmic shear reanalysis of KiDS-1000 with metacalibration shape catalog	
	Harry Johnston	15+5	on-site	Forecasting gains in (4-6)x2pt large-scale structure analyses with spectroscopic-photometric galaxy cross-correlations	
	Tilman Troester	15+5	on-site	Can beyond ΛCDM models address the S8 tension? Extended cosmology analysis of the Kilo-Degree Survey	
	Alexandra Amon	15+5	virtual	Cosmology from DES Y3 weak lensing	
	Break			15:00-15:15	
	Afternoon Oral Session 2			15:15-16:45	
	FM 3-3 (Room 103)				
	Renee Hlozek	25+5	on-site	CMB tensions and systematics	
	Sherry Suyu	25+5	on-site	Tensions in Cosmology: H0 measurements	
	All	30	both	Discussion	
	Afternoon e-Poster			16:45-17:30	
	August 11, Thursday				
	Morning e-Poster			09:45-10:30	
	Morning Oral Session			10:30-12:00	
	FM 3-4 (Room 103)				
	Jia Liu	25+5	virtual	Higher-Order Statistics with Stage IV surveys	
	Matteo Cataneo	15+5	on-site	On the road to percent accuracy: The Reaction Way	
	Pierre Fleury	15+5	on-site	Cosmic shear from Einstein rings	
	Kyle Finner	15+5	on-site	NIRWL: Identifying Systematics in Near-infrared Weak-lensing Measurements with CANDELS/HST	
	Afternoon Oral Session 1			13:30-15:00	
	FM 3-5 (Room 103)				
	Sungwook E Hong	15+5	on-site	Weak-lensing Mass Reconstruction of Galaxy Clusters with a Convolutional Neural Network	
	Alessio Spurio Mancini	15+5	virtual	COSMOPOWER: Deep Learning – accelerated cosmological inference from next-generation surveys	
	Chris Hirata	15+5	virtual	Nancy Grace Roman Space Telescope	
	Francois Lanusse	15+5	virtual	Weak Lensing with the Rubin Observatory LSST	
	Break			15:00-15:15	
	Afternoon Oral Session 2			15:15-16:45	
	FM 3-6 (Room 103)				
	Hendrik Hildebrandt	15+5	virtual	Cosmic shear with the ESA/NASA Euclid space mission	
	Jun Zhang	15+5	virtual	Shear Measurement Strategy in CSST	
	All	40	both	Discussion	
	Angus Wright	10	on-site	Closing	

Stats for 19 participants

##################
Genders:

	F	M
invited speakers (accepted)	5	6
contributed speakers	1	7

##################
Countries:

France	3
UK	4
Japan	2
Germany	4
Netherlands	1
Canada	1
USA	2
Korea	1
China	1

##################
Invited speakers:
Marika Asgari
Hironao Miyatake
Alexandra Amon
Renee Hlozek
Sherry Suyu
Jia Liu
Matteo Cataneo
Chris Hirata
Francois Lanusse
Hendrik Hildebrandt
Jun Zhang

##################
Session chairs:
Angus Wright
Nicolas Martinet
Marika Asgari
Alessandro Maraio
Anna Niemiec

##################
Around 30 in-person participants on average
at sessions, with others on-line.

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Consensus Cosmic Shear in the 2020s: Focus Meeting Summary

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ABSTRACT

Executive Summary

The 2022 IAU General Assembly in Busan, Korea, was host to Focus Meeting 3 "Consensus Cosmic Shear in the 2020s". The meeting was focussed on bringing together members of the cosmological community, particularly those from the field of weak-lensing cosmic-shear, in a collaborative effort to discuss persistent discrepancies in the estimates of cosmological parameters from various probes, and to reach a consensus regarding the optimal methods of analysis for the next generation of cosmic-shear analyses. In this regard alone, the meeting was an overwhelming success. The meeting was attended by 19 speakers (11 invited, 8 contributed), representing research institutes in 9 countries, and included representatives from the Kilo Degree Survey (KiDS), the Dark Energy Survey (DES), the Hyper-Suprime Camera Survey (HSC), the Deep Lens Survey (DLS), the Ultraviolet Near-Infrared Optical Northern Survey (UNIONS), the *Euclid* Consortium, the Rubin Observatory Legacy Survey of Space and Time (LSST), the Chinese Space Station Optical Survey (CSSOS), the *Nancy G. Roman* Observatory, the *Planck* Collaboration, the Atacama Cosmology Telescope (ACT) collaboration, and the H_0 Lenses in COSMOGRAIL's Wellspring (H0LiCOW) collaboration. Invited speakers were evenly split in terms of gender expression, academic seniority, and geographic location. Additionally, the meeting specifically allocated over one third of available time to audience interaction, where all participants (speaker or otherwise) were encouraged to contribute to a lively and engaging discourse covering a wide range of topics.

The meeting was centered around three fundamental questions:

1. Is there trust within the community regarding the veracity of cosmological parameters measured by ongoing Stage-III cosmological surveys?
2. Is there consensus within the community regarding the likely origin (or origins) of the so-called S_8-tension?
3. Does the community feel that cosmological analyses are in need of better astrophysical models/understanding in the lead-up to Stage-IV surveys?

In order to answer these questions, the meeting engaged speakers from all ongoing Stage-III cosmological surveys, all planned (and in-preparation) Stage-IV Surveys, and from other ongoing cosmological surveys (specifically regarding CMB and distance ladder measurements).

Trust in Stage-III Analyses

With regards to the first question, the meeting attendees were somewhat undecided. Compelling presentations by each of the Stage-III surveys regarding the accuracy and robustness of their findings (particularly under the influence of numerous astrophysical and non-astrophysical systematic effects) certainly inspired confidence in the work currently being undertaken. Particular emphasis was made on the conservative nature of ongoing work, whereby each survey restricts their analyses considerably, to samples which (they argue) are well calibrated and understood: HSC utilise only galaxies brighter than $i = 24$, DES only analyse scales where they believe (for example) baryonic effects have little-to-no influence, and KiDS excludes all parts of colour-magnitude space where they believe redshift calibration to be unreliable. Furthermore, additional presentations demonstrated the robustness of current and future methods of analysis, suggesting that current and future Stage-III cosmological parameters would be robust to methodological systematics. This is achieved through the use of (for example) multiple shape-measurement methods, multiple statistics for data-vector construction, multiple codes for likelihood evaluation, and multiple methods of posterior inference and parameter estimation.

Nonetheless, despite these excellent presentations and extensive discussions, there was still an air of caution among the attendees (including those who had just presented such compelling evidence for the analyses robustness). Group consensus seemed to suggest that residual minor differences between the values of S_8 reported by the surveys, despite (nominally) being statistically insignificant, were enough to instil uncertainty in the minds of the community. In a lively discussion, the overwhelming agreement, from both members of the cosmic-shear community and outside observers, was that only through comprehensive joint analyses of all Stage-III surveys would the community be convinced of the accuracy and precision of currently available studies. The discussion ended on a somewhat curious note, though, when a disagreement between the results of previous and ongoing joint studies was raised: previous efforts to analyse KiDS and DES data with joint analysis choices led to *less* agreement rather than more, however recently published work from the LSST DESC indicated that a reanalysis of HSC, DES, and KiDS data with their Stage-IV pipeline produced better agreement between the surveys than has been pre-

sented independently. The cause of this apparent disagreement is currently unknown.

The Origin of the S_8 tension

The S_8 tension refers to the tendency of late-time probes of large-scale structure growth to measure the Universe as being less-clumpy than is predicted by a ΛCDM universe extrapolated from the cosmology inferred from the CMB. This tension was naturally a focus of discussion within the meeting.

With regards to the meeting's second primary question, the meeting attendees were far more concrete and unified in their views. When asked whether the meeting attendees thought that there was consensus on the origin of the S_8 tension, all attendees voted firmly in the negative. Furthermore, during a live-but-secret poll of the attendees their beliefs of the origin of the S_8 tension, the organisers were very interested to note that attendees were most likely to indicate "(possibly unknown) systematics in my area of study" as their best-guess-origin for the tension, followed closely by "new early-universe physics". Further discussion on this topic suggested that attendees tendency to attribute the tension firstly to systematics in their own area of study was driven by their deeper knowledge of exactly how analysis is performed in their field. As one attendee simply expressed: "I know how the sausage is made".

Presentations and discussions around the origin of the S_8 tension focussed on three primary areas: systematic effects in cosmic-shear measurements, systematic effects in CMB measurements, and the prospect of new early Universe physics. Systematic effects in cosmic shear had been well discussed as part of the first question, and so naturally much discussion fell to the latter two possibilities.

Extremely informative and illuminating presentations of CMB analysis methodologies and systematic biases were presented, again giving strong evidence for the fidelity of previous and ongoing CMB studies. This naturally led to a discussion of what modifications to the ΛCDM model would be required to resolve the S_8 tension while not modifying the observables from either the CMB nor low-redshift. Interestingly, it was demonstrated that few late-time modifications to the cosmological model are able to resolve the S_8 tension. Furthermore, it was further argued that *no* late-time modification to the cosmological model would be able to simultaneously resolve both the H_0 and S_8 tensions. This conclusion specifically led the meeting to the conclusion that only new early-universe physics was likely to provide a reasonable model-based resolution to the S_8 tension, and subsequently led to this option scoring highly in our secret poll.

Better Astrophysical Models & Understanding

The third key question of the meeting was more forward-focussed than the previous two, primarily asking the community whether or not there was sufficient confidence in the currently employed astrophysical models that are utilised in cosmological analyses.

As a preface to the discussion of the adequacy of fundamental astrophysical models, presentations were made that demonstrated how the community would squeeze ever-increasing amounts of data from current and future surveys. New statistics (particularly those probing higher-orders of the shear field) and new analysis methods (such as machine-learning acceleration of likelihood evaluations) will invariably make future cosmological surveys even more statistically powerful (per unit-area per unit-depth) than their predecessors: estimates from the Stage-IV consortia suggest 1% and 0.1% constraints on w_0, w_a and σ_8 respectively are entirely possible, provided systematic effects are controlled adequately.

This lead to the natural discussion about whether the treatment of astrophysics in cosmic-shear analyses is sufficient for next-generation analyses. After a considerable debate, the attendees were largely in agreement that Stage-IV surveys would require a somewhat fundamental shift in the way that they treat astrophysics: no longer can astrophysical models be treated as a nuisance and marginalised over, but rather the community would be best served by endeavouring to jointly understand the evolution of dark matter and baryons. Our datasets implore us to not analyse future surveys as cosmologists and astrophysicists independently, but rather together as one community.

Consensus?

The goal of the meeting was to bring together members of the cosmological community in an effort to reach a consensus regarding optimal methods of analysis for the next generation of cosmic-shear surveys. We proposed three key questions, and the meeting attendees largely concluded that:

1. the community was not-yet entirely confident in the results of Stage-III surveys (but that this confidence could be bolstered by joint analyses);
2. the community overwhelmingly did not agree on the origin of the S_8 tension; and
3. the community agreed that future surveys would require a more holistic approach to astrophysical systematics.

We, the organisers, crudely graded these three conclusions regarding consensus as "maybe", "no", and "yes", and gave the overall question of 'is there consensus in cosmic shear?' a grade of 50%: a pass.

However there was one final discussion that the organisers felt warranted comment, which surrounded the question of how we, as a community of cosmologists working both collaboratively *and* competitively, would be best served while undertaking the next generation of surveys. The community is keenly aware of the dangers of confirmation bias, herd mentality, and the requirements of having redundant methods to verify results. Continuation of the highly independent core analyses that were undertaken by Stage-III experiments, for these reasons, is paramount. However, given the community's skepticism around the results of Stage-III cosmological parameters, there is also a growing opinion that improved collaboration between Stage-IV teams will be crucial to realising the full potential of the surveys. Thus collaboration, despite competition, is crucial: independent pipelines and results must not come at the cost of communication and transparency.

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Kyle Finner, Pierre Fleury, Axel Guinot, Hendrik Hildebrandt, Chris Hirata, Renee Hlozek, Sungwook E Hong, Harry Johnston, Francois Lanusse, Jia Liu, Alessio Spurio Mancini, Hironao Miyatake, Sherry Suyu, Tilman Troester, Mijin Yoon, and Jun Zhang.