University of Hertfordshire

Our Galaxy SWG initial input to Cost Control

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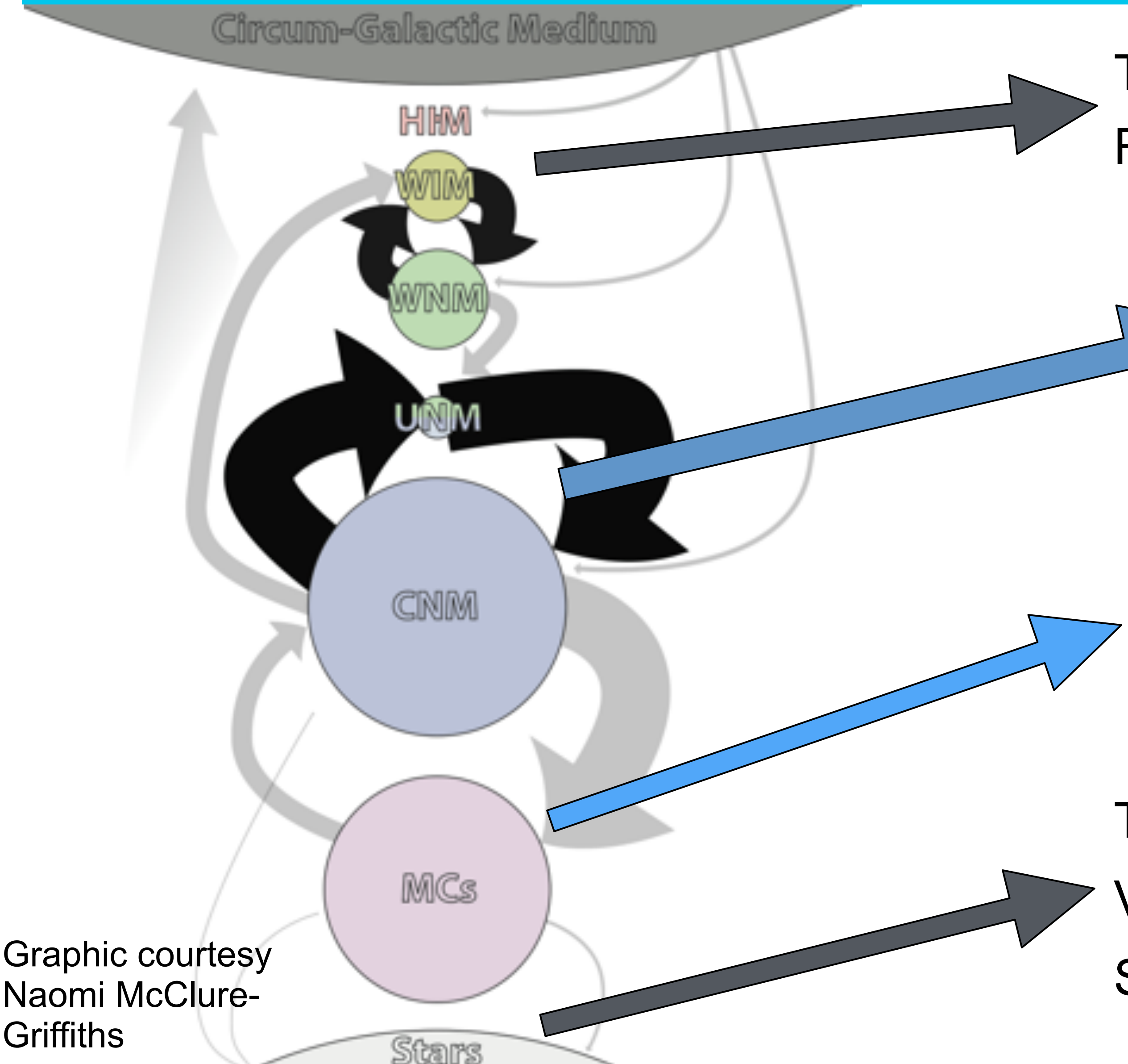
Uncovering the ecology of baryons



Graphic courtesy Naomi McClure-Griffiths

Thermal continuum from HII regions
Radio Recombination Lines

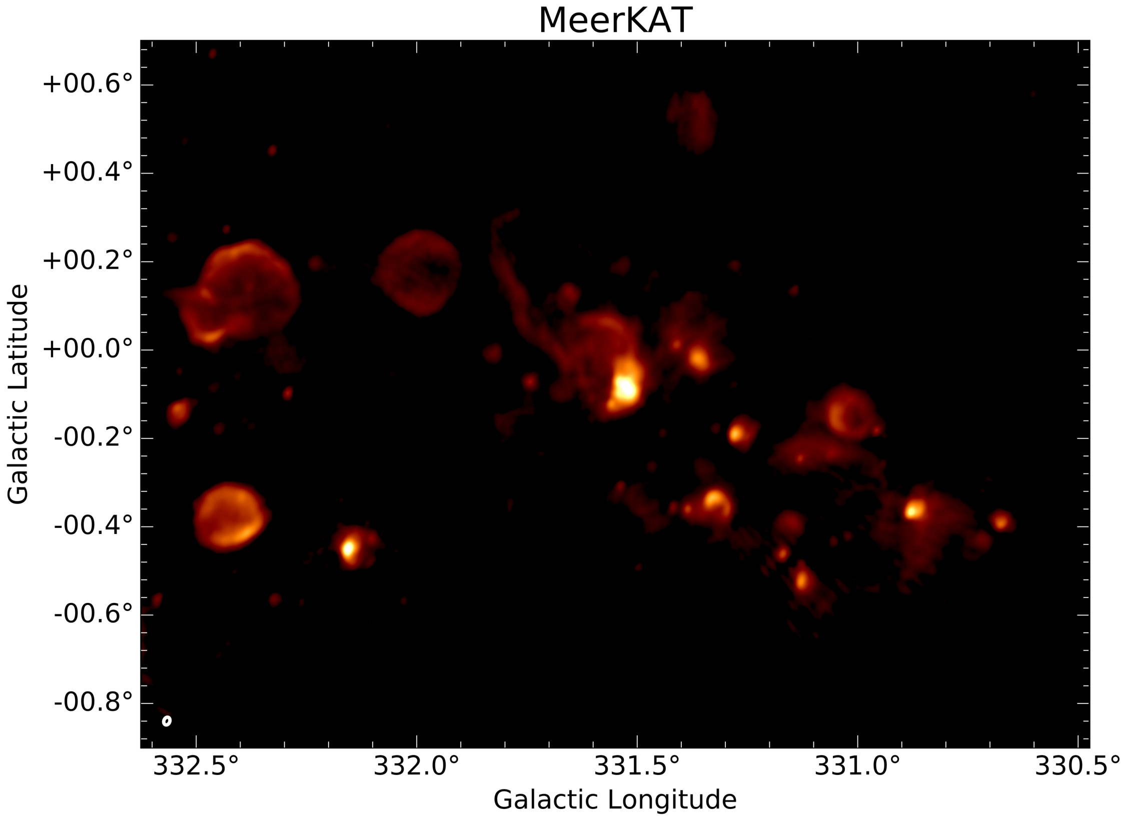
HI emission
HI absorption
HI tomography
Carbon Recombination Lines

H_2CO absorption
Thermal OH - CO dark gas

Thermal continuum from jets & winds
VLBI Tomography of young clusters
Stellar Radio astrophysics

Galactic Plane with MeerKAT-32

Tuesday's MeerKAT press release



Sharpest view of HII regions in the southern Galactic Plane

Data taken in 32k mode - investigating Radio Recombination Lines

SKA1 will make broadband RRL spectroscopy routine - 100s of lines per pixel in this image

General observations

Endorse broad approach of focusing on things that can be rolled back later and minimising science irretrievably lost

- “Fitted for but not with” - but infrastructure costs and beware “jam tomorrow”
- “Get the steel in the ground, compute can come later” - but need minimum acceptable level of SDP to start

Cost saving uncertainty

- Ongoing clarity really needed here

T_{obs} comes at a cost and cannot tend to infinity

- We should work hard to not lose commensality

Build an observatory not an experiment

- Frequency agility is key
- Do not lose attractiveness to outside investors

WS	Description	Alternate Design Description	MID COMM	Comment	Science Impact
5.39	INFRA_SA Renewable energy to outer dishes		MID	Applied to 9 outer dishes	1
5.34	Maximise use of code produced during Pre-Construction		COMM	GMRT, ASKAP, MeerKAT – further investigation (€12M claimed)	1
5.38	Simplify DDBH LOW		LOW		1
5.38	Simplify DDBH MID		MID		1
5.25.2	Reduce PSS-MID: A, 750 nodes to 500 nodes		MID	From 2 to 3 Beam/node	1
5.25.2	Reduce PSS-LOW: A, 250 nodes to 167 nodes		LOW	From 2 to 3 Beam/node	1
5.35	Reduce CBF-MID: Frequency Slice variant of CSP design	Reduce CBF-MID: MeerKAT-based design	MID	It is still possible to have the 5GHz full bandwidth at the cost of the other parametres. Therefore DSH is delivering the full bandwidth.	1
5.19	MID Frequency and Timing Standard (SaDT solution)	MID Frequency and Timing Standard (MeerKAT-based solution)	MID		1
5.19	MID SPF Digitisers (DSH solution)	MID SPF Digitisers (MeerKAT-based solution)	MID		1
5.26/5.29	LOW RPF: Early Digital Beam Formation	LOW RPF: Analogue Beam Formation	LOW		1
2	LOW: Log Periodic Antenna Design	LOW: Dipole Antenna Design	LOW	None of the current designs meet the L1 requirements	3
8	SDP- HPC: Deploy 200 Pflops (rather than 260 Pflops)		COMM	Science Risk to HPC-intensive objectives (lower allowed duty cycle)	2
5.24.3	Reduce Bmax MID to 120 km: A, remove 3 dishes, but keep infra to 150km		MID	Reduced number of dishes, prepare for dishes	2
5.24.2	Reduce Bmax MID to 120 km: B, remove infra, but add dishes to core		MID	(1.5 in renewable power savings not realised for outer 3 dishes)	2
5.24.1	Reduce Bmax MID to 120 km: C, remove infra, remove dishes		MID	(1.5 in renewable power savings not realised for outer 3 dishes)	2
5.13.2	Reduce Bandwidth output of band 5 to 2.5GHz		MID	Longer SPF5 observing times (2x)	2
5.13.2.1	Reduce MID Band 5 feeds: A, from 130 to 67		MID	Deploy in arms, but not core. High res HPSOs OK, low res	2
5.25.2	Reduce PSS-LOW: B, 167 nodes to 125 nodes		LOW	Reduction in PSS parameter space (1.3x)	2
5.25.2	Reduce PSS-MID: B, 500 nodes to 375 nodes		MID	Reduction in PSS parameter space (1.3x)	2
5.35	Reduce MID CBF BW: 5 to 1.4 GHz (1.4 GHz imaging all bands, 1500 beams Pulsar 300MHz, 16 beams PST 1.4 GHz, zoom windows)		MID	Included the 2.3 from DSH	2
5.31	Reduce CBF-LOW BW: A, 300 to 200 MHz		LOW	Longer observing times (1.5x)	2
8	SDP- HPC: Deploy 150 Pflops (from 200 Pflops)		COMM	Science Risk to HPC-intensive objectives (lower allowed duty	3
5.30.0	Reduce Bmax LOW to 50km: A, remove infra, add 18 stations to core		LOW	High Science Risk to EoR: Bmax. With Deployment in the inner core.	3
5.30.0	Reduce Bmax LOW to 50km: B, remove 18 stations		LOW	High Science Risk to EoR: Bmax	3
5.25.2	Reduce PSS-LOW: B, 125 nodes to 83 nodes		LOW	Reduction in PSS parameter space (2x)	3
5.25.2	Reduce PSS-MID: B, 375 nodes to 250 nodes		MID	Reduction in PSS parameter space (2x)	3
5.30a	Reduce Bmax LOW to 40km: B, remove next 18 stations		LOW	High Science Risk to EoR: Bmax	3
8	SDP- HPC: Deploy 100 Pflops (from 150 Pflops)		COMM	Science Risk to HPC-intensive objectives (lower allowed duty cycle)	4
8	SDP- HPC: Deploy 50 Pflops (from 100 Pflops)		COMM	Science Risk to HPC-intensive objectives (lower allowed duty cycle)	4
5.24	Remove 11 MID Dishes from core		MID	10% Sensitivity loss in core	4
5.30	Remove 54 LOW stations from core		LOW	10% Sensitivity loss in core	4
5.24	Remove additional 11 MID Dishes from core		MID	20% Sensitivity loss in core	4
5.30	Remove additional 54 LOW stations from core		LOW	20% Sensitivity loss in core	4
5.24.a	Reduce Bmax MID to 100 km: D, remove infra, remove next 3 dishes		MID	Lose Science (Planetary disks, High res Star Formation)	4
5.5.1	Remove MID Band 1 feeds: 108 to 0		MID	Lose Science (Cosmology, Galaxy Evolution) Excluded the already counted 6 Band1 because shorter baseline	4
5.5.2	Reduce MID Band 5 feeds: B, from 67 to 0		MID	Lose Science (Plantary disks, Star Formation) Excluded the already counted 6 Band5 because shorter baseline	4

+/- 50 M€

Most of these items have high uncertainty in cost saving (20-40%)

Total could be ~50M€?

Most of these items have low uncertainty in cost saving (<20%)

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Our Galaxy KSP ideas

Tier 1: Deep Band 5 Galactic Plane survey - spectroscopy RRLs, anomalous H_2CO absorption

Tier 2: Wide Band 5 Galactic Plane survey - continuum only - compact accreting objects, stars from cradle to grave

Tier 3: Very wide Band 2 Galactic Plane survey - broadband RRLs from low density ISM, non-thermal stellar continuum

“Not a Tier ”: SKA-Low Carbon RRLs & nearby stars, SKA-Mid VLBI Clusters, maser parallaxes…

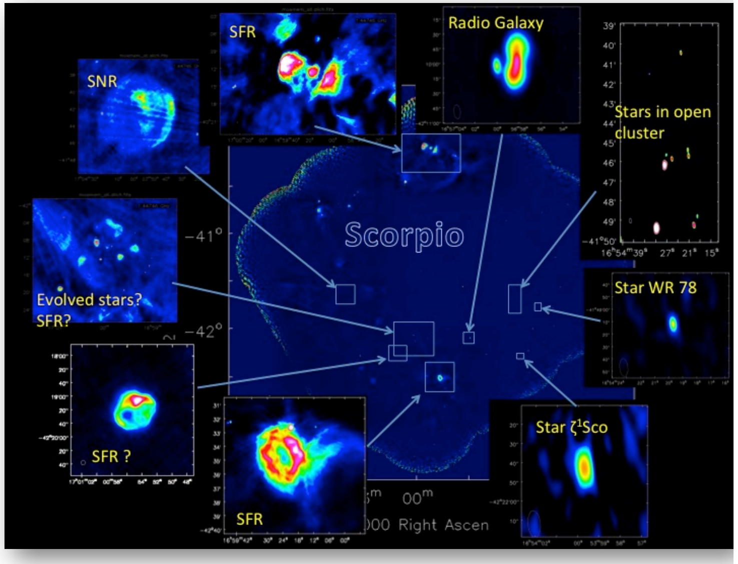
Impact on Our Galaxy Science: Band 2

Band 2 science (Tier 3 survey) largely unaffected

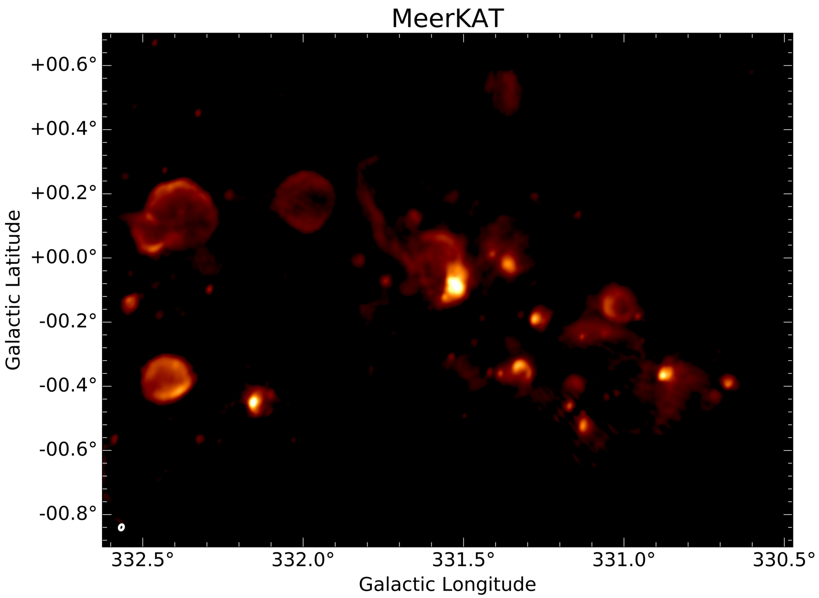
Possible exception to RRLs if major cuts to SDP

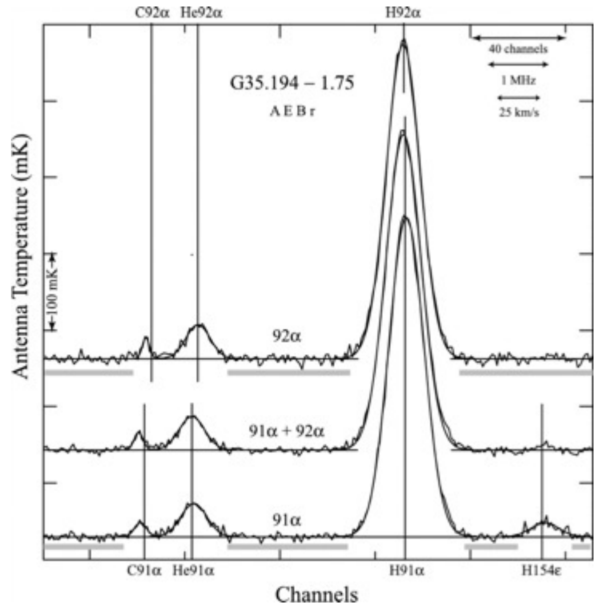
- need full continuum resolution to resolve lines
- don't want to lose commensal HI/OH zoom windows

Reducing B_{max} in MID will make it harder to ID stellar counterparts in crowded Plane - need to get a handle on confusion limit



Umana et al 2015





Impact on Our Galaxy Science: Band 5

Band 5 science (Tier 1 & 2 survey) massively affected:

- removing Band 5 feeds from core removes T_b sensitivity for H_2CO absorption
- Anomalous H_2CO then becomes impossible
- removing Band 5 feeds from core means no phasing up for VLBI
- 6.7 GHz maser parallax/stellar cluster parallaxes then become impossible
- reducing continuum bandwidth affects Tier 2 survey progressively

Cumulative impact of cuts to Band 5 severe

Strongly recommend that they are not all implemented - science **will** be lost

Preferred option would be to reduce continuum bandwidth & place feeds in core + arms to maintain T_b sensitivity on extended scales

Impact on Our Galaxy Science: SKA Low

Main science drivers here are Carbon RRLs as neutral medium tracer and non-thermal continuum from nearby stars/exoplanets

- largely neutral impact on continuum bandwidth changes
- lower S/N in RRLs due to loss of line stacking
- important to maintain core sensitivity and flexibility in channelisation
- impact of B_{max} changes not yet clear & work needs to be done

Summary

Ongoing clarity on cost savings is really needed

Preferred general strategy of “fitted for but not with”

Cumulative impact on Band 5 really needs to be considered - especially given its science ranking in the rebaselining

Cumulative impact of cuts here is not “science impact 2” - more like 3 or 4

Share the pain with Band 1!

Optimal placement of Band 5 feeds needs to be tensioned against conflicting demands from VLBI, high resolution continuum & lower resolution spectroscopy

Loss of VLBI not a good signal to send to international partners

Band 2 largely OK but impact of SDP cuts needs to be explored

SKA Low largely OK but impact of baseline changes needs to be explored