Cosmology from Dome A?

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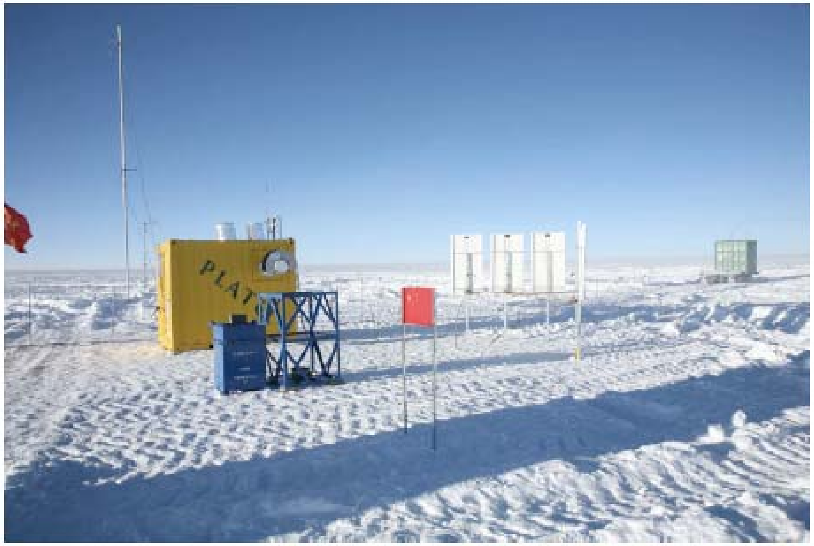

人民日报

RENMIN RIBAO

2009年1月29日

和平利用南极的新篇章

本报评论员

胡锦涛致电祝贺中国南极昆仑站胜利建成

坚定信心 加强合作 推动世界经

温家宝总理出席世界经济论坛年会并发表

"家电下乡"放大农村近7倍购买力

元旦以来各地下乡产品销量大幅攀升

我国跻身国际极地考察"第一方阵"

链接

温暖 祥和 欢乐 喜庆

军民同乐庆新春

英模游园度佳节

文艺下乡送欢乐

节日现场

"所有"惠民生

A Wide Field Telescope at Dome A

- needs to be sufficiently large for deep imaging
- has a field of view big enough for whole sky surveys
- covers wavelength ranges that are required for precision cosmology
- is capable of spectroscopic observations of selected targets

A telescope at a superb site

FWHM=0.3

Filter	m_{lim} (2m)	m_{lim} (4m)	m_{lim} (8m)
V	25.5	26.3	27.1
R	25.1	25.9	26.7
I	24.3	25.1	25.9
J	22.5	23.3	24.1
H	21.4	22.3	23.2
K	21.3	22.3	23.3

Outperforms LSST

Mag of SNIa at z = 1.7

SNAP level depth

Complimentary
IR data to LSST

S/N = 10, exposure time=1 hour

A slide by Wang @ the 2006 workshop Wide Field Astronomy at Dome A

KDUST – Kunlun Dark Universe Survey Telescope

- 4 meter aperture
- 0”.1/pixel
- Seeing of 0”.3 in the optical, 0.”2 in the NIR
- Sky background from optical to 2.2 micron similar to those of Paranal or Mauna Kea

	U	B	V	R	I	J	H	Ks	L	M-NB
Paranal	22.28	22.64	21.61	20.87	19.71	16.5	14.4	13.0	3.9	1.2
Dome A	22.28	22.64	21.61	20.87	19.71	16.5	14.4	13.0	?	?

KDUST

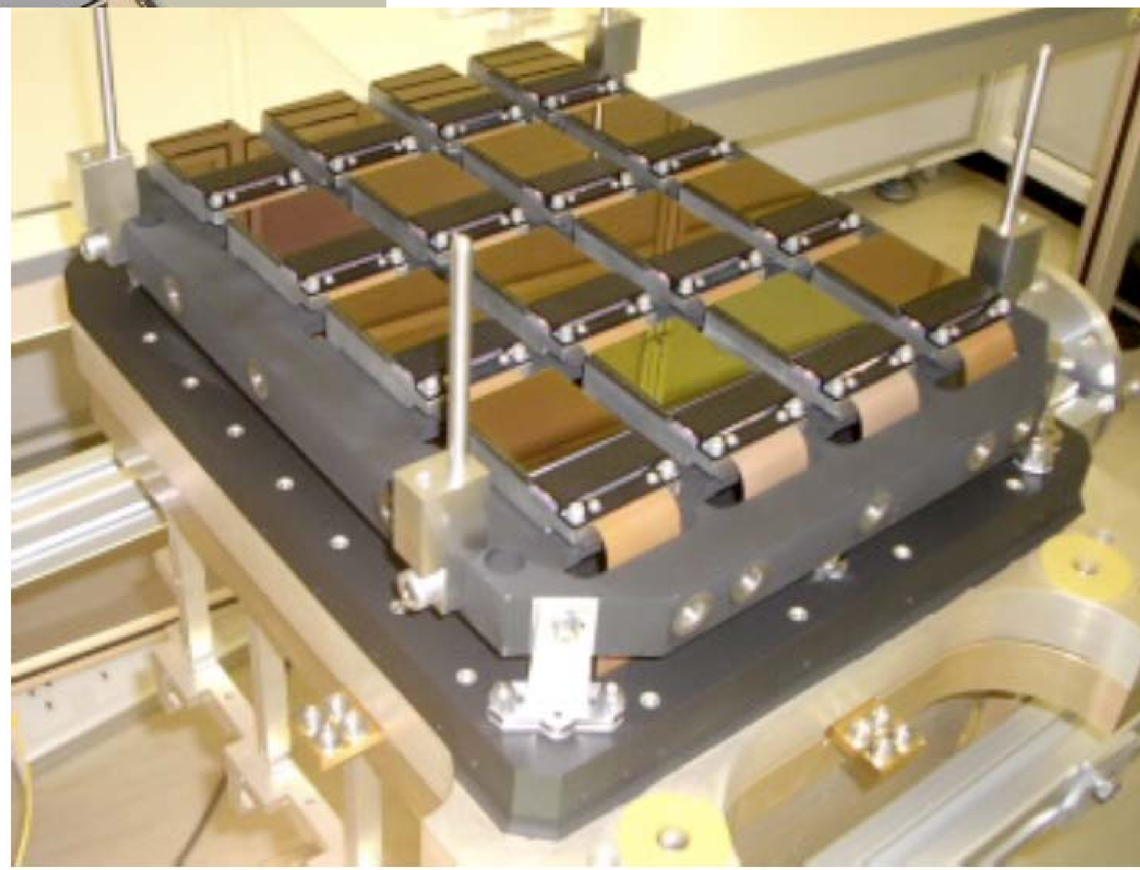

Fig. 9.— 16 VIRGO 2K*2K arrays delivered to UK Astronomy Technology Centre and installed at Rutheford Appleton Laboratory. These arrays will be used at the ESO VISTA telescopes.

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Sensitivity Comparison

Limiting Mag. of Existing and Hypothetical Telescopes
(SDSS r-band, two 1000-sec Exposure, SNR = 10, point source)

Dome C 2.4m: 24.8
Mauna Kea (8m): 25.6
Dome C 2.4m (tip tilt): 26.2
Dome C 8m: 26.7
HST: 27.1
Dome C 8m (tip tilt): 29.3
VLST (30m Space): 33.3

Limiting Mag. of Existing and Hypothetical Telescopes
(K-band (2.2 micron), two 1000-sec Exposure, SNR = 10, point source)

Mauna Kea (8m): 20.9
Dome C 2m: 21.0
Dome C 2.4m (AO): 21.4
Dome C 8m: 23.0
HST: 21.3
Dome C 8m (AO): 24.0
JWST: 24.3

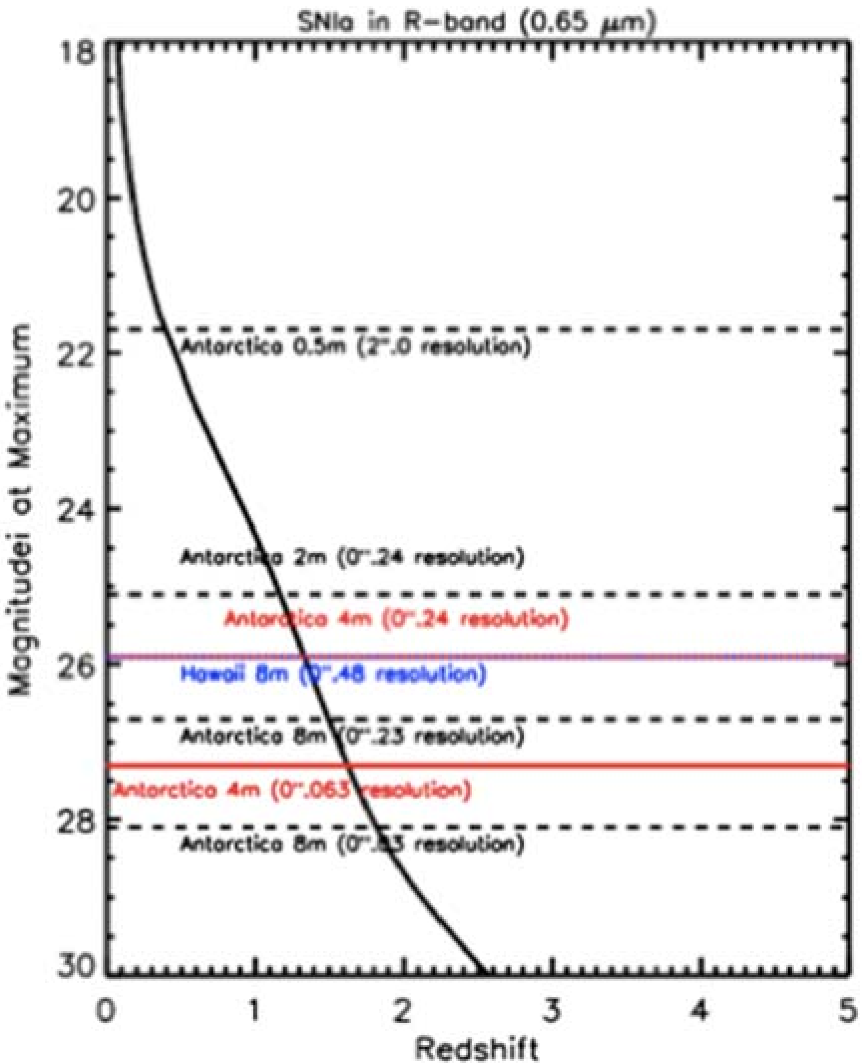
Limiting Mag. of Existing and Hypothetical Telescopes
(M-band (4.6 micron), two 1000-sec Exposure, SNR = 10, point source)

Mauna Kea (8m): 14.1
Dome C 2.4m: 14.6
Dome C 8m: 17.1
Dome C 8m (AO): 18.5
Dome C 25m (AO): 21.0
JWST 21.8

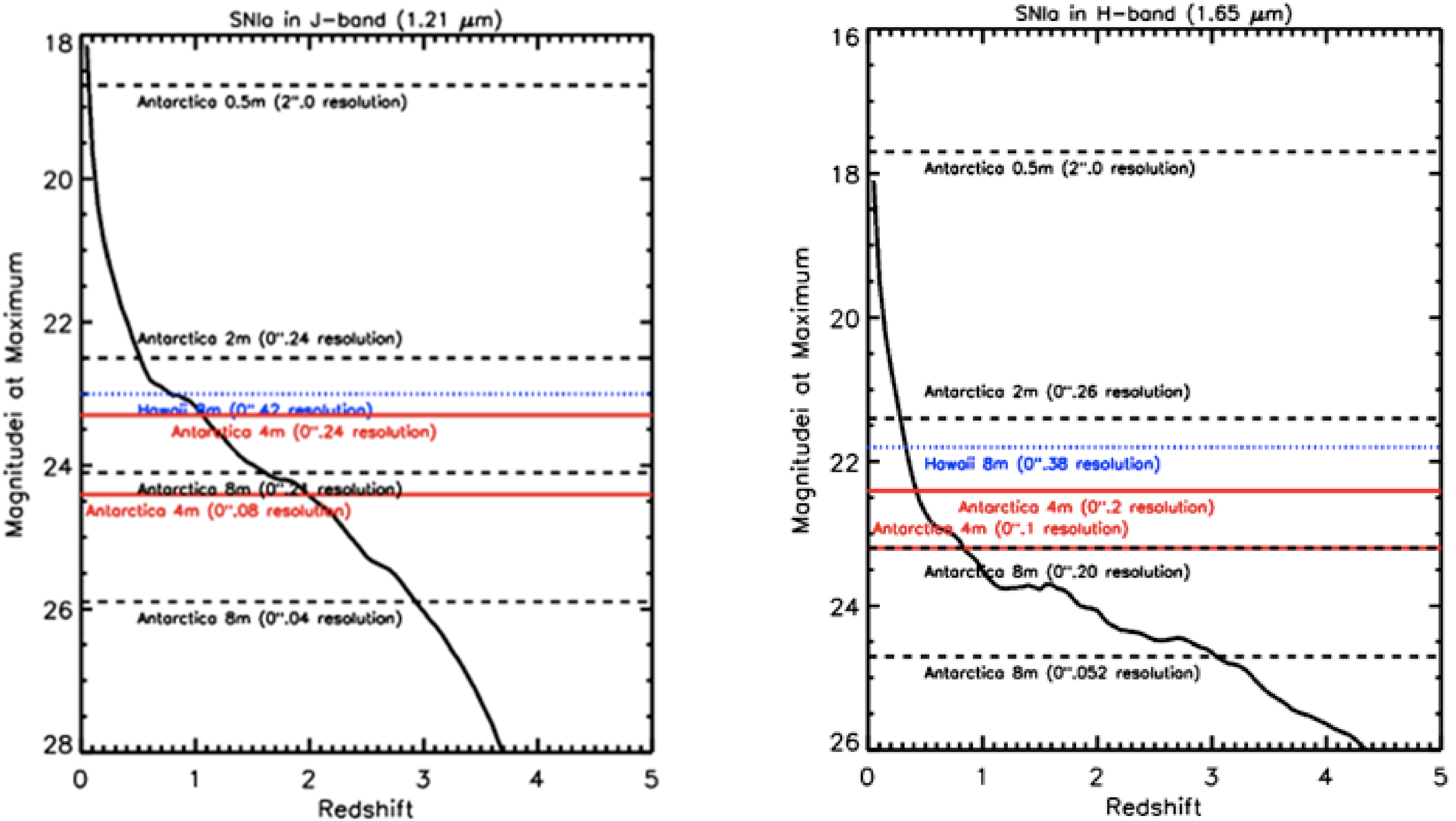
Links to relevant articles:

- Comparing a small diffraction limited 2.4 meter telescope at Dome C to HST: http://www.aip.de/ARENA-2/presentations/Andersen.pdf
- 2.4 meter PILOT: http://arxiv.org/pdf/astro-ph/0411612
- Adaptive Optics at LBT: http://caao.as.arizona.edu/publications/MLH%20AO%20LBT%20paper.pdf
- An Imaging FTS at Dome C: http://www.ugr.es/~fteorica/festelar/maillard.pdf
- Considerations by Nicholas Epstein: Wide Field HAR imaging surveys in the thermal infrared (3-5 μm) from Dome C

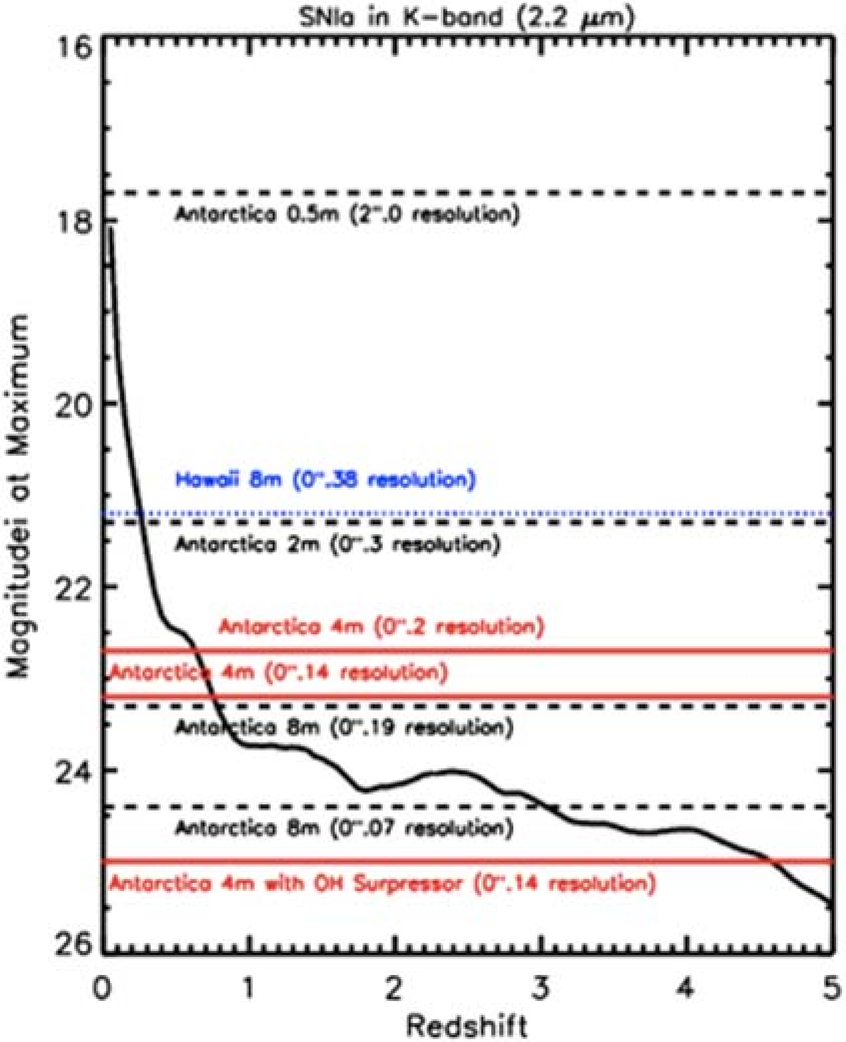
Point Source Sensitivity



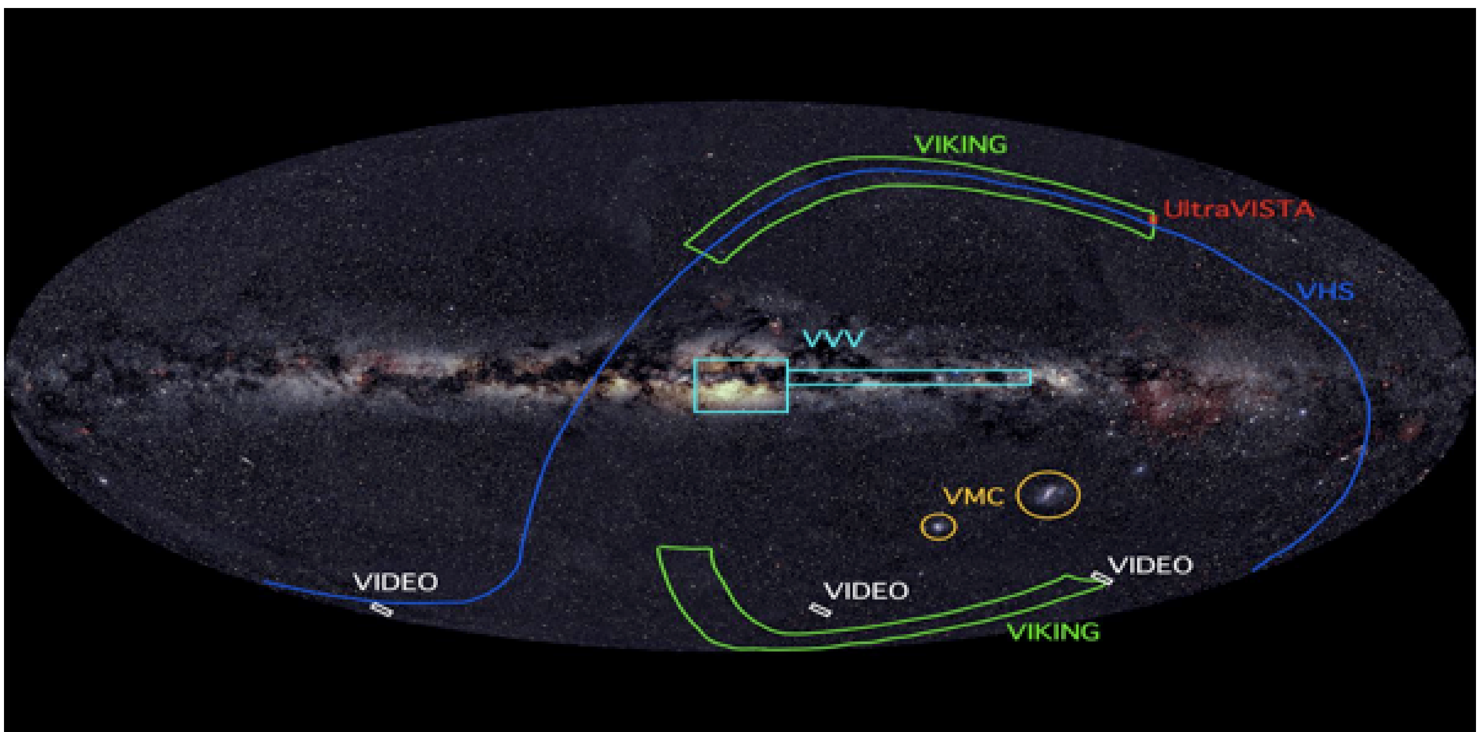
In r-band a 4-meter telescope at Dome A outperforms an 8-meter at a temperate site



SNIa in J-band (1.21 μm)
Magnitudei at Maximum
Redshift
18
20
22
24
26
28
0
1
2
3
4
5
Antarctica 0.5m (2".0 resolution)
Antarctica 2m (0".24 resolution)
Hawaii 8m (0".42 resolution)
Antarctica 4m (0".24 resolution)
Antarctica 8m (0".24 resolution)
Antarctica 4m (0".08 resolution)
Antarctica 8m (0".04 resolution)
SNIa in H-band (1.65 μm)
Magnitudei at Maximum
Redshift
16
18
20
22
24
26
0
1
2
3
4
5
Antarctica 0.5m (2".0 resolution)
Antarctica 2m (0".26 resolution)
Hawaii 8m (0".38 resolution)
Antarctica 4m (0".2 resolution)
Antarctica 4m (0".1 resolution)
Antarctica 8m (0".20 resolution)
Antarctica 8m (0".052 resolution)


SNIa in K-band (2.2 μm)
Magnitudei at Maximum
Redshift
16
18
20
22
24
26
0
1
2
3
4
5
Antarctica 0.5m (2".0 resolution)
Hawaii 8m (0".38 resolution)
Antarctica 2m (0".3 resolution)
Antarctica 4m (0".2 resolution)
Antarctica 4m (0".14 resolution)
Antarctica 8m (0".19 resolution)
Antarctica 8m (0".07 resolution)
Antarctica 4m with OH Surpressor (0".14 resolution)

VISTA survey observing strategies			
Survey	**Area (deg^2)**	**Filters and Depth Measure(mag (10σ, AB)**	**Depth (mag)**
Ultra-VISTA	0.73 (ultra-deep)	5α, AB	Y=26.7 J=26.6 H=26.1 K_s=25.6 NB=24.1
VIKING	1500	5α, AB	Z=23.1 Y=22.3 J=22.1 H=21.5 K_s=21.2
VMC	184	10α, Vega	Y=21.9 J=21.4 Ks=20.3
VVV	520	5α, Vega	Z=21.9 Y=21.2 J=20.2 H=18.2 K_s=18.1
VHS	20 000	5α, AB	Y=21.2 Y=21.2 J=21.2 H=20.6 Ks=20.0
VIDEO	15	5α, AB	Z=25.7 Y=24.6 J=24.5 H=24.0 K_s=23.5



Sky coverage of VISTA surveys, overlaid on a 2MASS image of the whole sky.

KDUST will be significantly deeper than any of the planned VISTA surveys. For example, the Ultra VISTA will need 1000 hours on to reach depth of H(AB) = 26.1 (5) and Ks(AB) = 25.6 (5). Table 2 shows that KDUST can reach 5 down to H(AB) = 25.4 and Ks(AB) = 26.0 mag in just one hour. This is deeper than the targeted depth of UltraVISTA in Ks band.

It is thus apparent that KDUST will make it possible to perform a wide area survey as large as 5,000-10,000 square degrees that is deeper than the UltraVISTA survey. The cold weather also allow for deep survey in the conventional thermal infrared, allowing deep wide field imaging around 3-4 μm.

Hubble Ultra Deep Field

Survey (1)	Camera + Filter (2)	Pivot Lamdda (3)	No. of Orbits (4)	Lim AB Mag (5)	Depth increase w.r.t the HDF (6)
UDF	ACS, F435W (B)	4311.80	56	28.7	1.0
UDF	ACS, F606W (V)	5915.38	56	29.0	0.9
UDF	ACS, F775W (i)	7697.34	150	29.0	1.4
UDF	ACS, F850LP (z)	9103.29	150	28.4	N/A

The Deepest Ever Image of the Universe

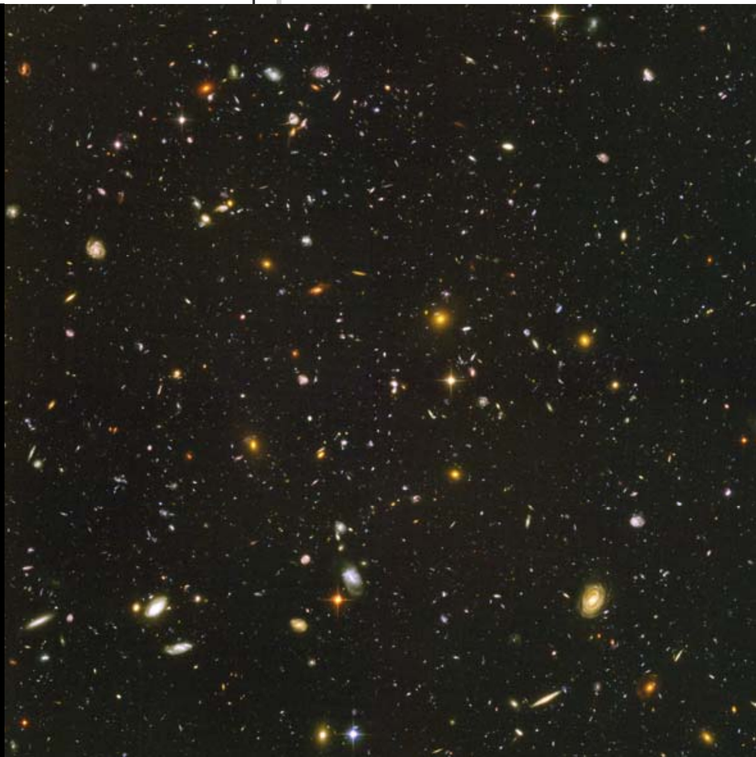


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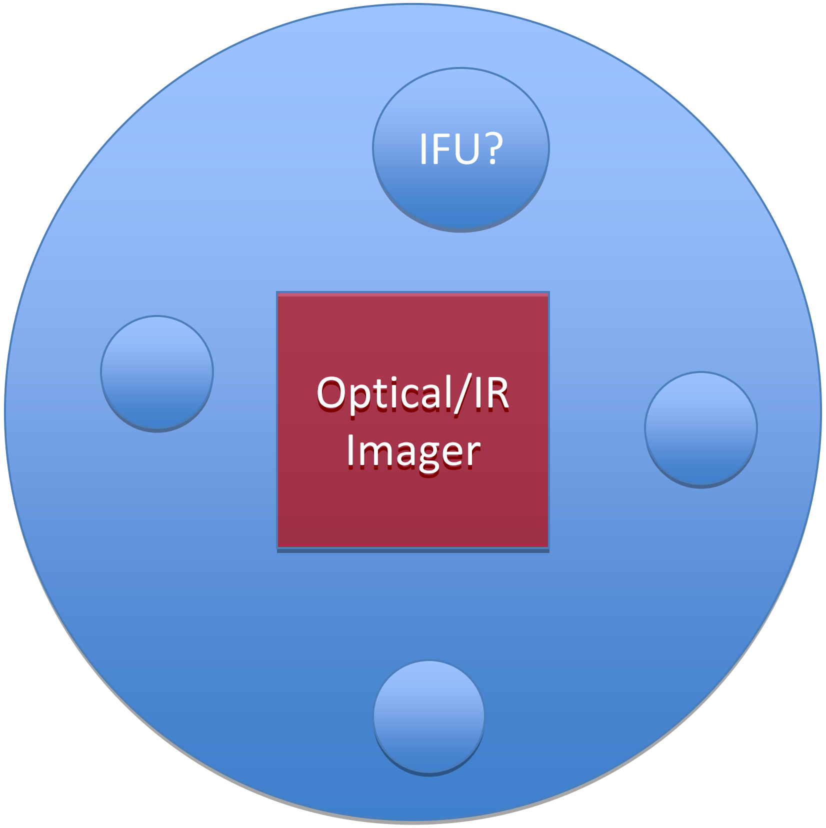
Table 1: Calculated Point Source Sensitivities

Band	λ (μm)	$\Delta\lambda$ (μm)	MK 8m	Ant 2m (PILOT)	Ant 8m	Spatial Resolution (arcseconds) MK 8m	Ant 2m	Ant 8m	Background (Jy arcsec^{-2}) MK	Ant
V	0.55	0.09	26.3 1 (-7)	25.5 2 (-7)	27.1 5 (-8)	0.50	0.25	0.24	6 (-6)	6 (-6)
R	0.65	0.15	25.9 1 (-7)	25.1 3 (-7)	26.7 6 (-8)	0.48	0.24	0.23	1 (-5)	1 (-5)
I	0.80	0.15	25.1 2 (-7)	24.3 4 (-7)	25.9 9 (-8)	0.46	0.24	0.23	2 (-5)	2 (-5)
J	1.21	0.26	23.0 1 (-6)	22.5 2 (-6)	24.1 4 (-7)	0.42	0.24	0.21	9 (-4)	5 (-4)
H	1.65	0.29	21.8 2 (-6)	21.4 3 (-6)	23.2 6 (-7)	0.40	0.26	0.20	3 (-3)	1 (-3)
K	2.16 2.30	0.22 0.23	21.2 2 (-6)	21.3 2 (-6)	23.3 3 (-7)	0.38	0.30	0.19	2 (-3)	1 (-4)
L	3.76	0.65	16.7 5 (-5)	16.3 8 (-5)	18.6 9 (-6)	0.35	0.42	0.19	2 (+0)	2 (-1)
M	4.66	0.24	14.4 3 (-4)	14.9 2 (-4)	17.4 2 (-5)	0.34	0.52	0.20	4 (+1)	5 (-1)
N	11.5	1.0	10.7 2 (-3)	9.1 8 (-3)	12.0 6 (-4)	0.40	1.2	0.32	2 (+2)	2 (+1)
Q	20	1.0	7.2 4 (-2)	5.5 2 (-1)	8.5 1 (-2)	0.57	2.1	0.53	3 (+3)	5 (+2)

With a 4m at Dome A, a 1 degree camera, we can get down to R = 29 mag, (S/N = 10) in 10 days, over a 180 sq deg area.
This is 56,000 times larger than HUDF (HUDF is 11.5 sq arcmin).

4m Dome A
（1hr, S/N=10)

- V 26.4
- R 26.0
- I 25.6
- J 23.4
- H 22.5
- K 22.6
- L 17.9
- M 16.7
- N 11.3
- Q 7.8


IFU?
Optical/IR
Imager

Cosmology

- Supernovae
- BAO
- Weak gravitational lensing
- The first star