THE DARK ENERGY SURVEY: 3 YEARS OF SUPERNOVA IN <15

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University of Southampton
Supernova Group

THE DARK ENERGY SURVEY

. . . .SUMMARY: WE ROCK!

THE DARK ENERGY SURVEY: THE OVERVIEW SLIDE

AIM: "WHAT IS DARK ENERGY?"

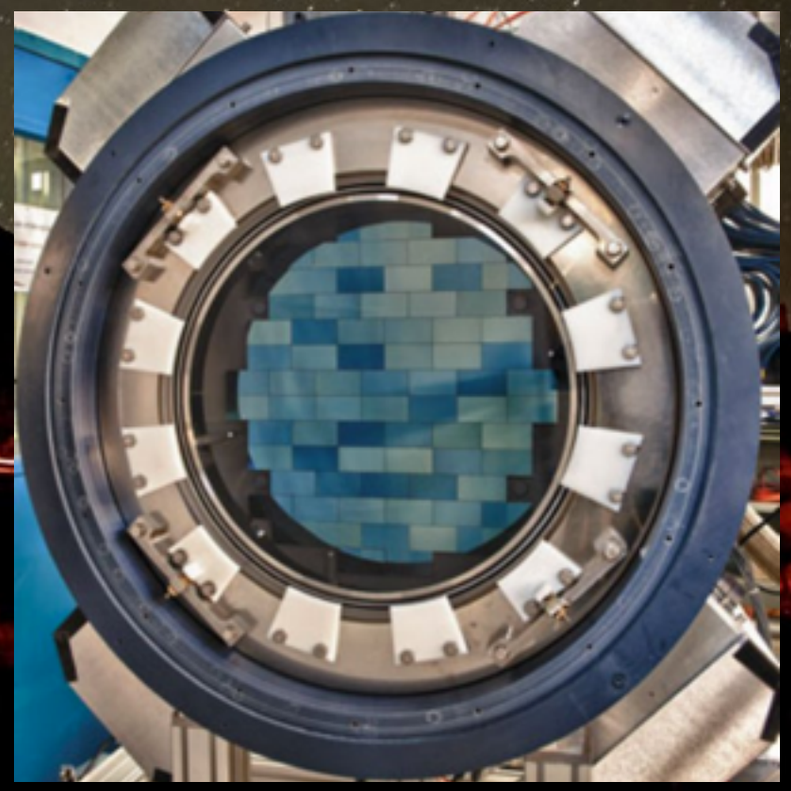
One survey, comprised of multiple probes, to determine the nature of cosmic acceleration

DES-Wide

- 5000 deg^2 in *grizY*: r_{AB} ~ 24.3, i_{AB} ~23.5 (10σ)
- Large Scale Structure, Weak Lensing & Galaxy Clustering

DES-SN

- ~ 6-day cadenced *griz survey* over 27 deg^2
- Type Ia supernovae & other transients



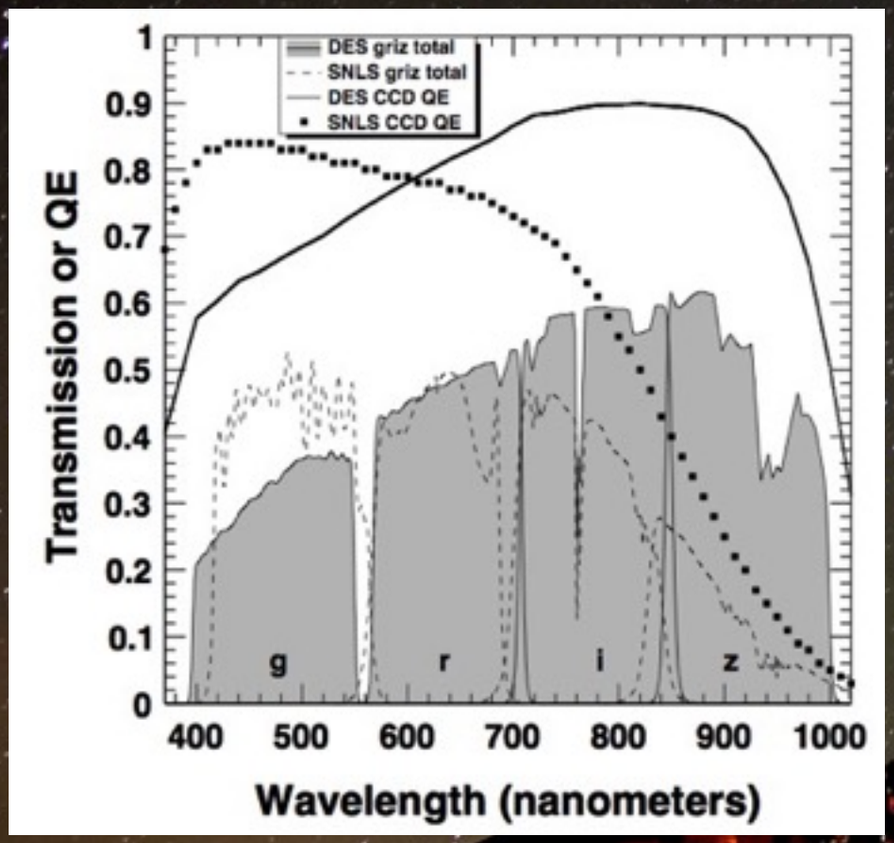
Overall

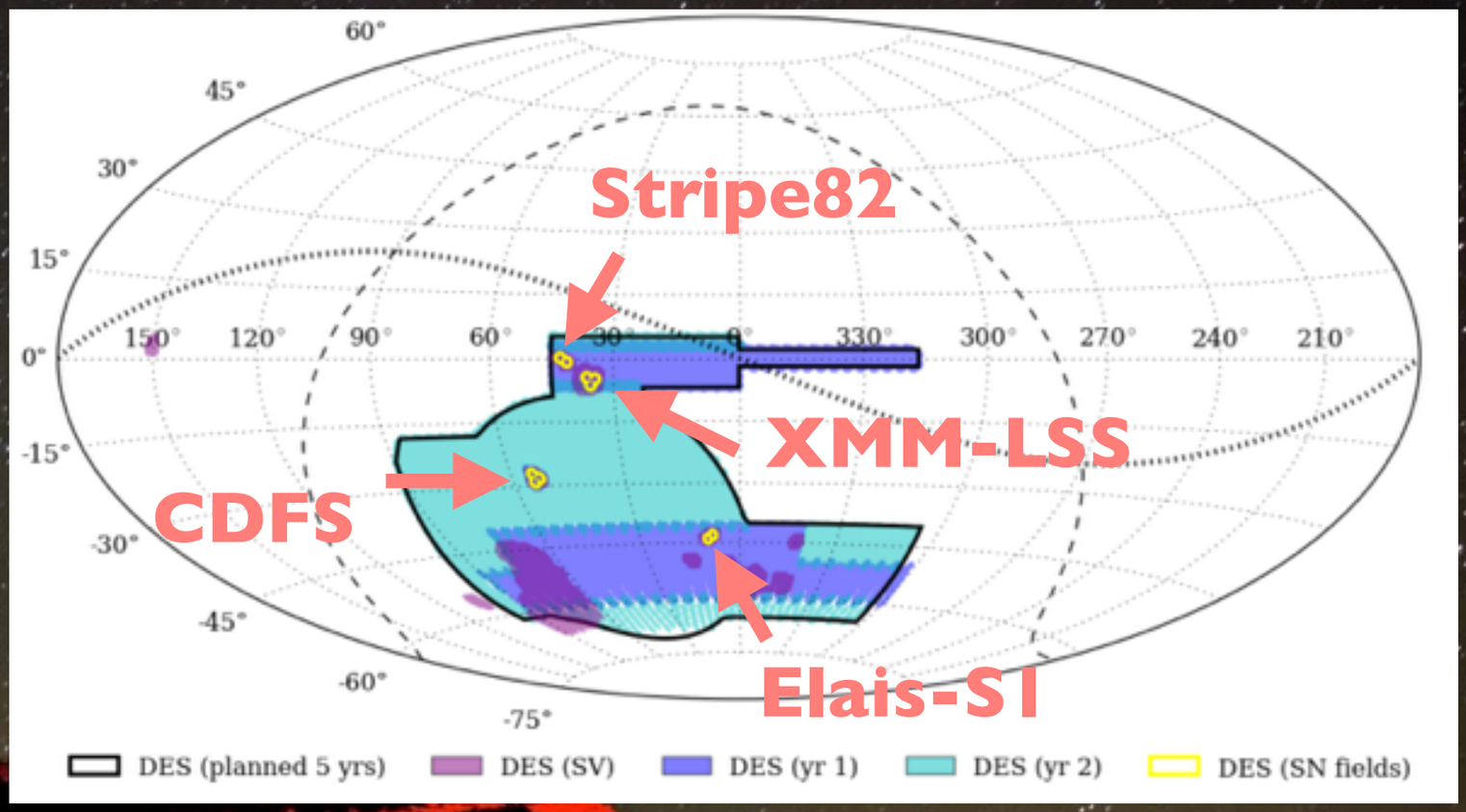
- Probes of both Distance v Redshift & Growth of Structure
- Multiple probes to break degeneracies & minimise systematics
- Lots of ancillary science (understatement alert)

- *See plenty of other talks…. (DES is great!)*

THE DARK ENERGY SURVEY: THE "HOW DOES IT WORK" SLIDE

ONE LARGE, RED, SURVEY IN THE SOUTH



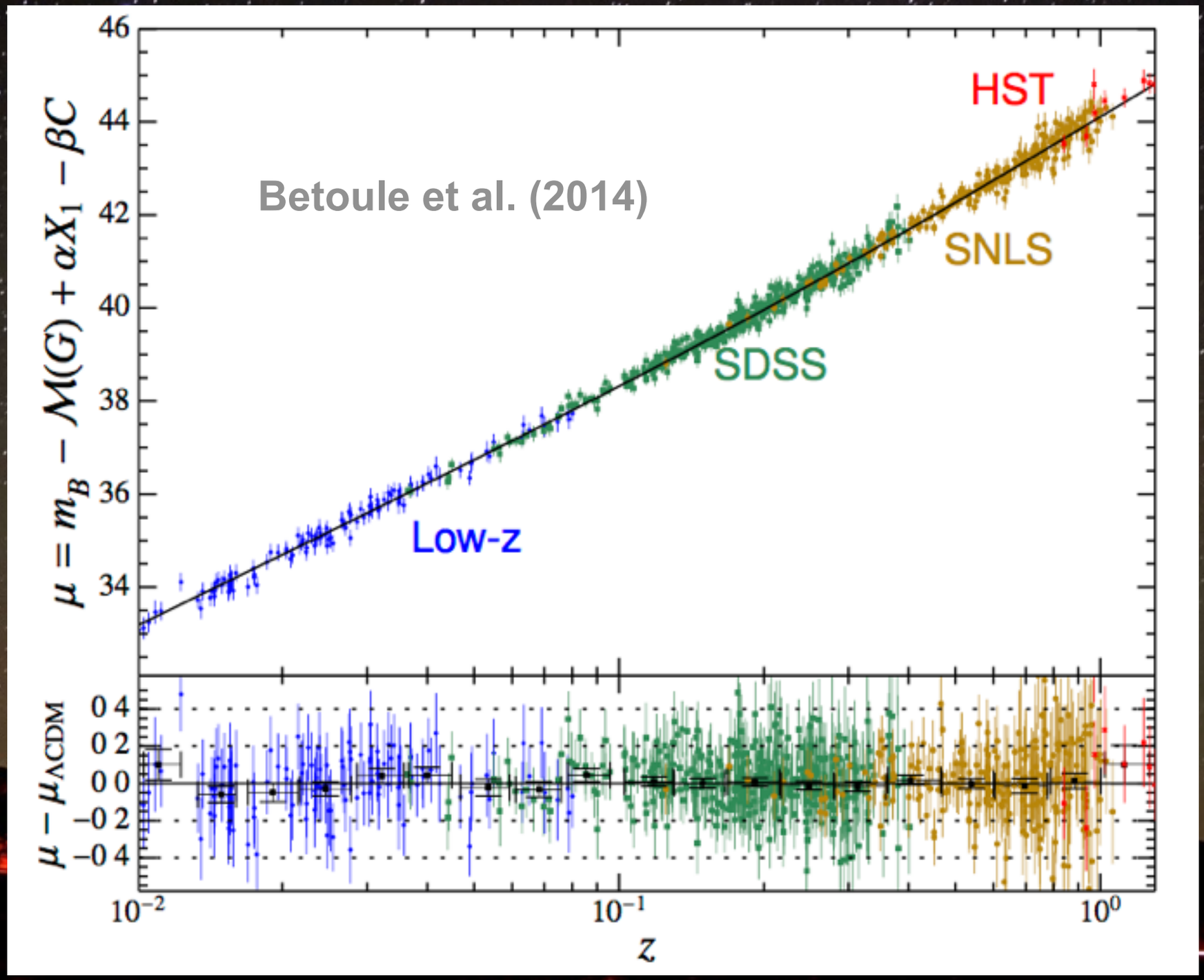


Dark Energy Camera (DECam) on 4m Blanco Telescope at CTIO

- 520 Mpx camera; 3 deg^2 FoV; deep-depleted LBNL CCDs
- Allocated 525 nights over 5 observing seasons (Aug - Feb)
  - *DESY4 starts 13 August 2016*

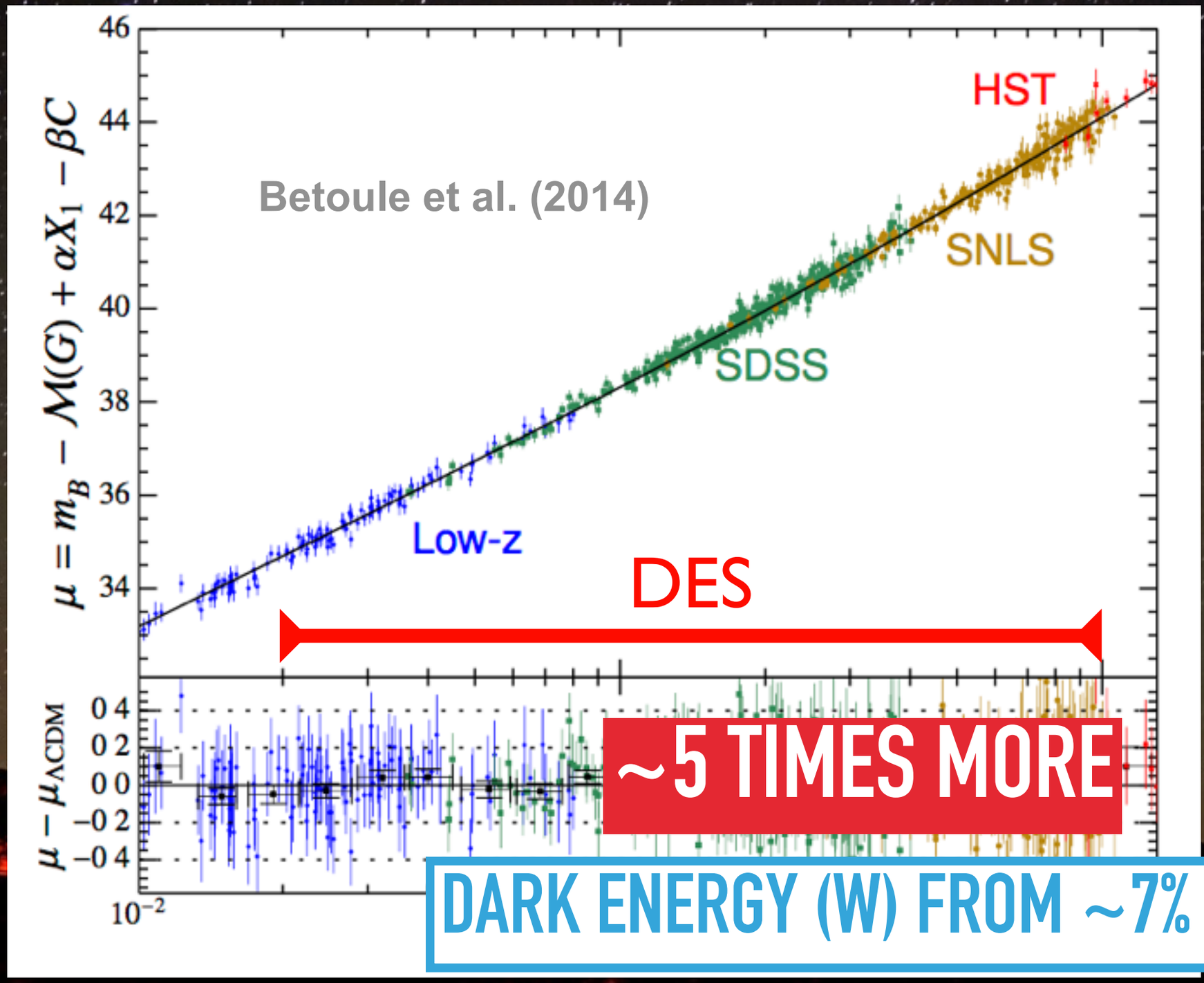
But this is a supernova talk….

TYPE IA SUPERNOVA TODAY



~750 SNIA, ALL SPECTROSCOPICALLY CONFIRMED, FROM DIFFERENT SURVEYS

TYPE IA SUPERNOVA AFTER DES



~5 TIMES MORE

DARK ENERGY (W) FROM ~7% TO <1%

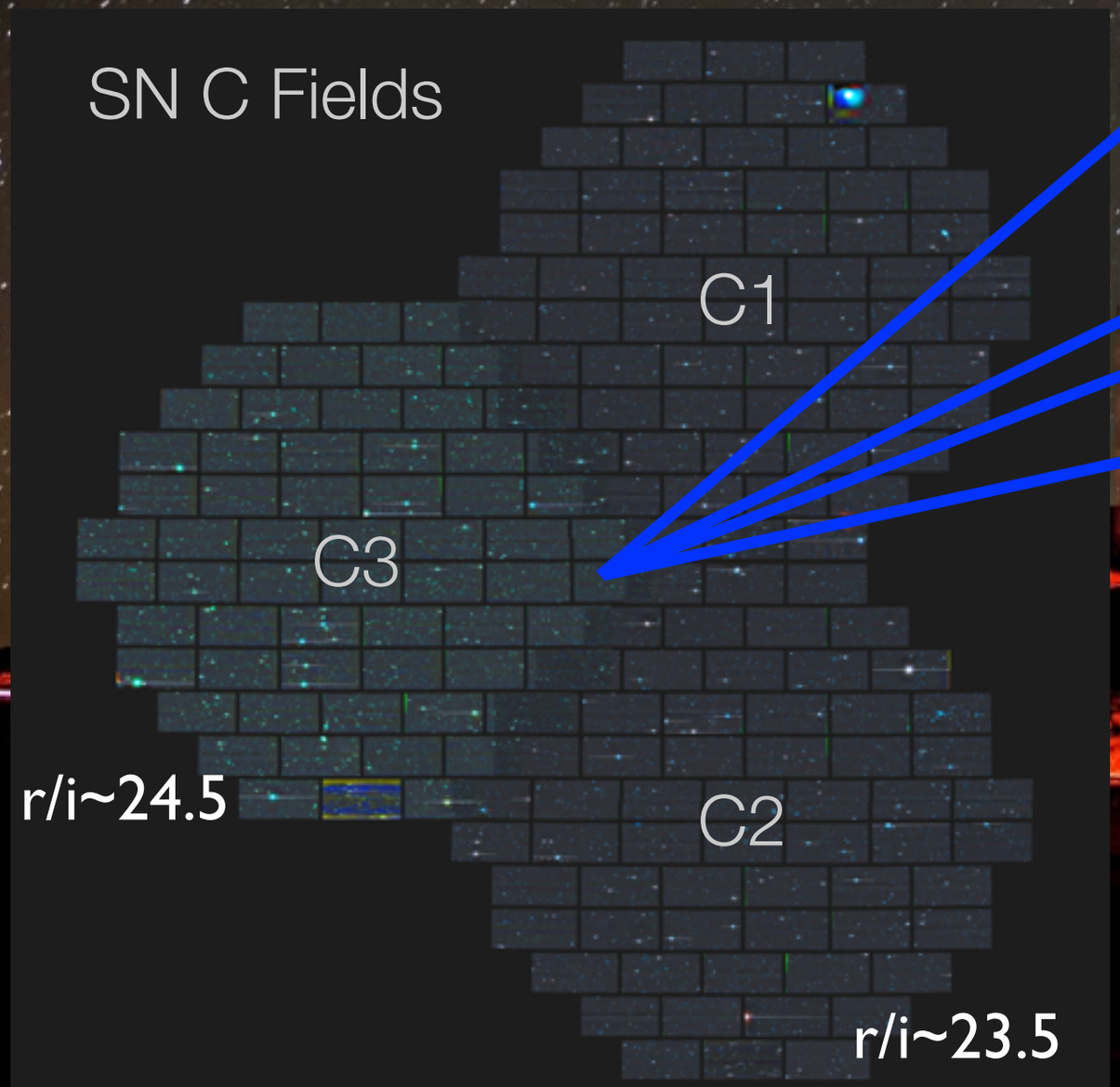
ALL IN ONE SURVEY: LIMITED CROSS-CALIBRATION SYSTEMATICS

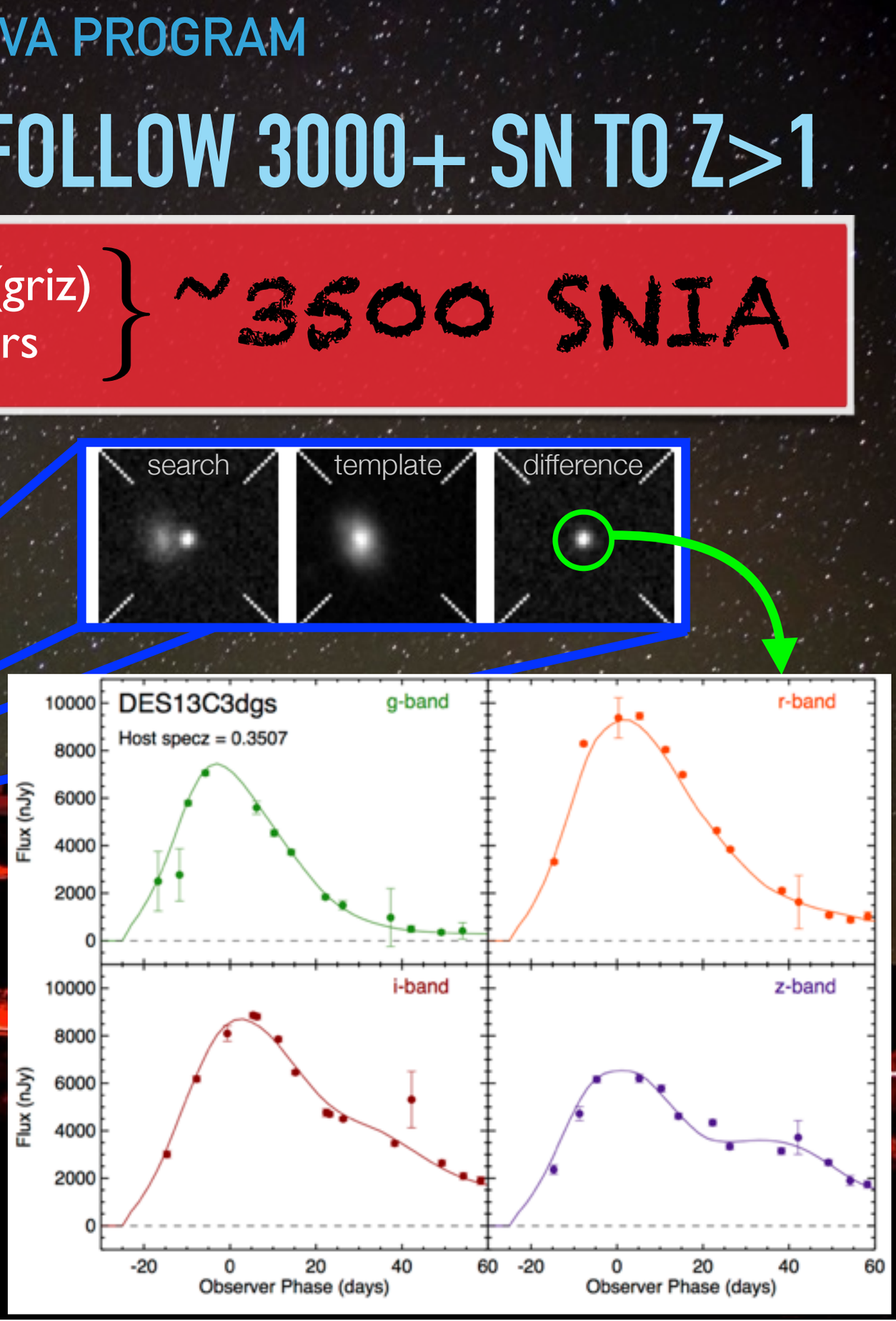
THE DARK ENERGY SURVEY: SUPERNOVA PROGRAM

TO FIND, CHARACTERISE & FOLLOW 3000+ SN TO Z>1

- 10 fields (8 shallow, 2 deep) in 4 filters (griz)
- Every 7 nights, for 5+ months for 5 years

} ~3500 SNIA



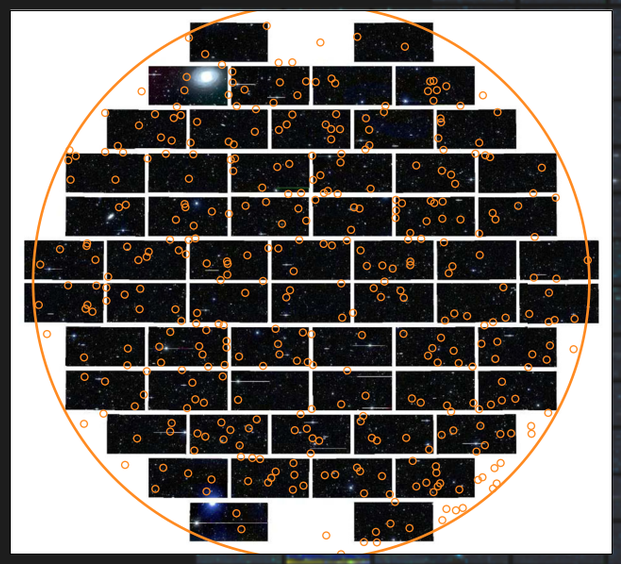


DES-SN: SPECTROSCOPIC FOLLOW-UP: THE WAY FORWARD

OZDES: REDSHIFTS FOR EVERYTHING

- 100 night survey on the AAT, overlapping with the DES fields
- Target the host galaxies of DES transients (and plenty of other things)
- Repeat observations gives an effective limiting magnitude of r~24.0

SN C Fields



C1

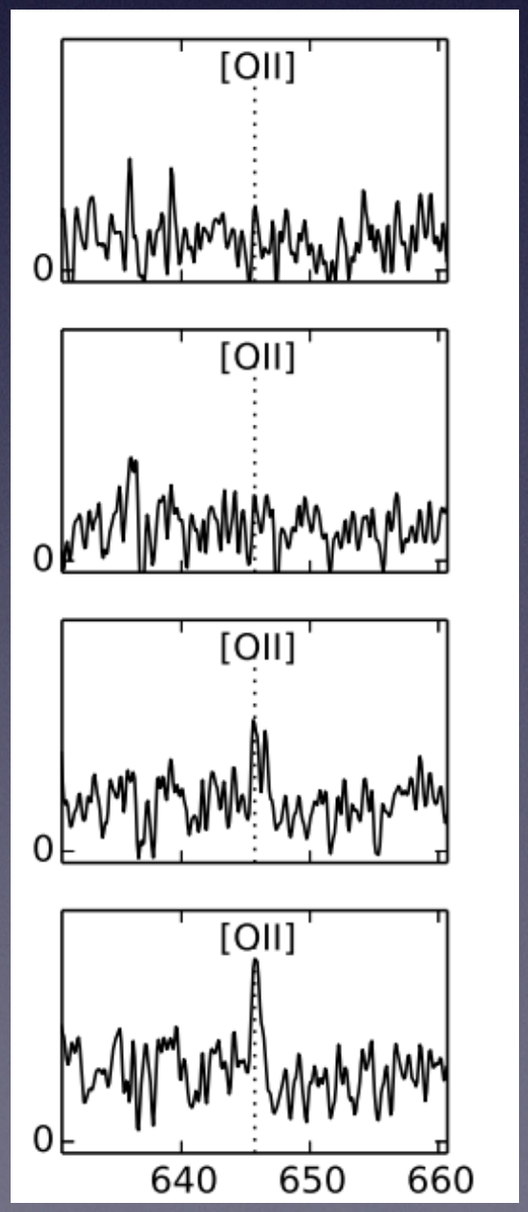
C2

Exp=7200 s

Exp=14400 s

Exp=32400 s

Exp=51600 s



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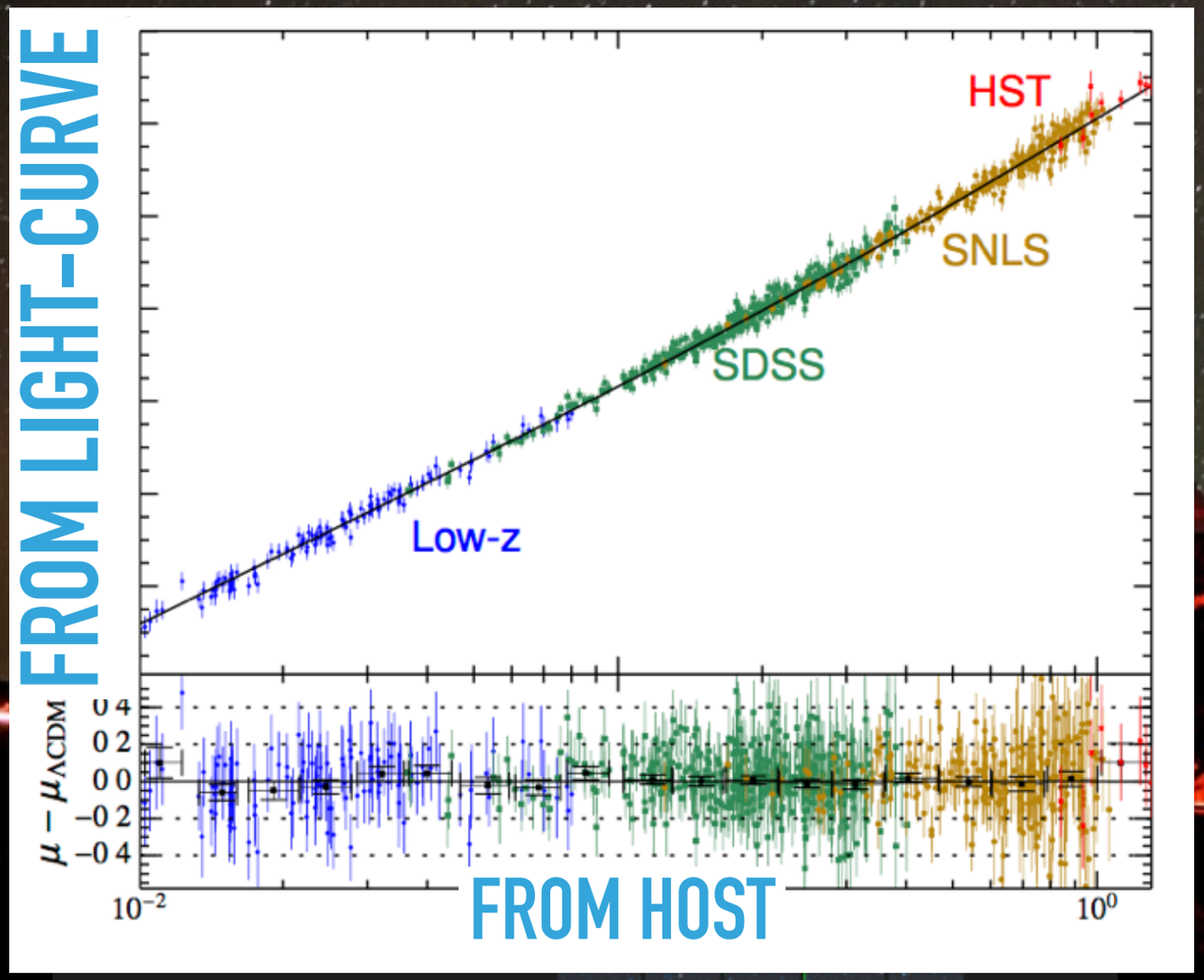
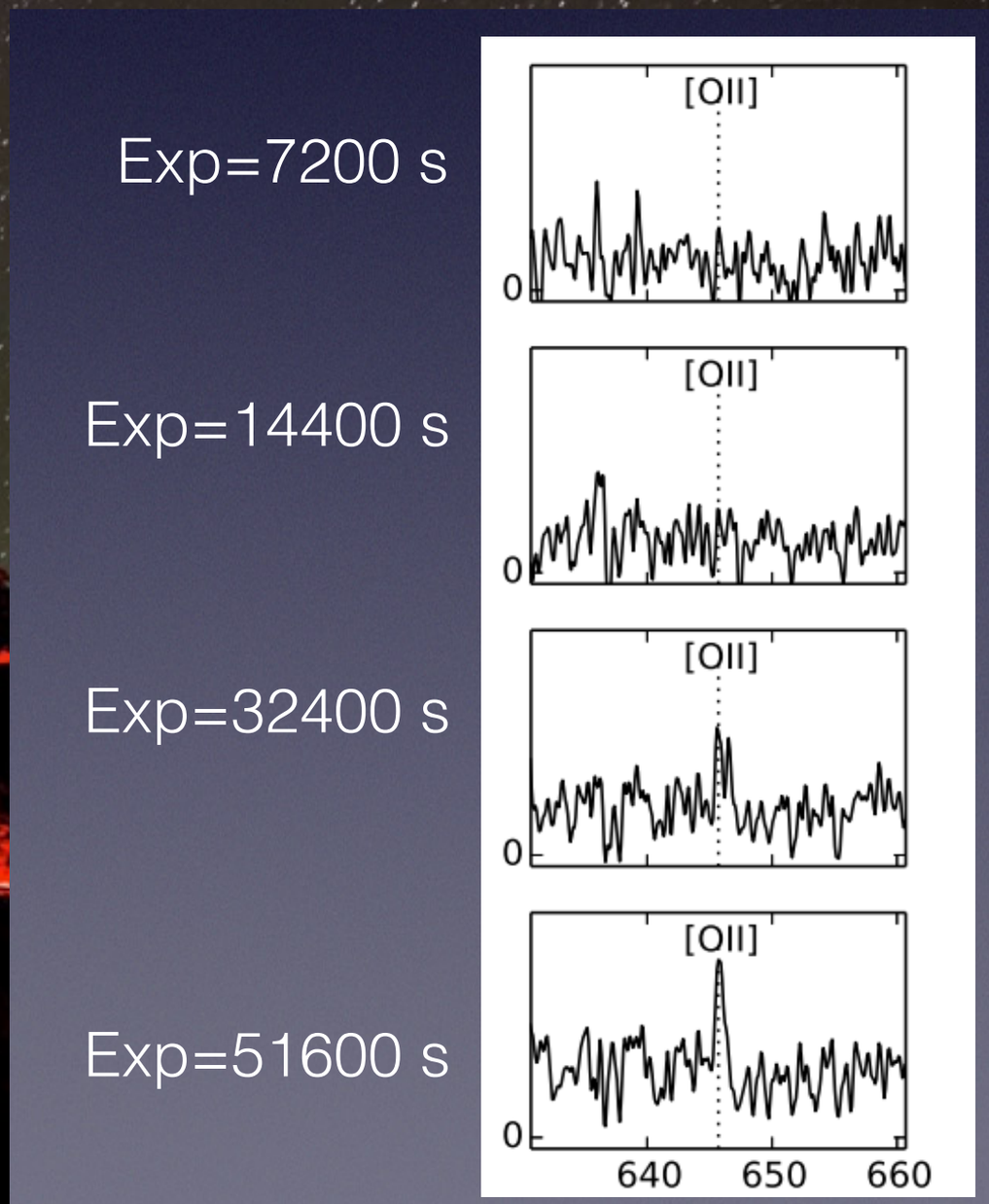
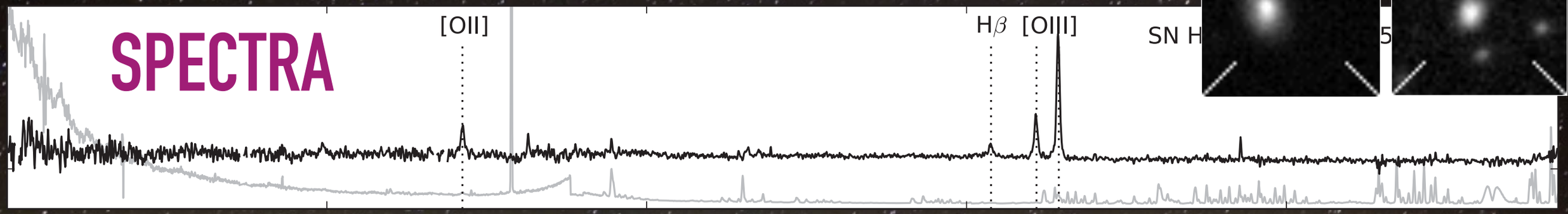


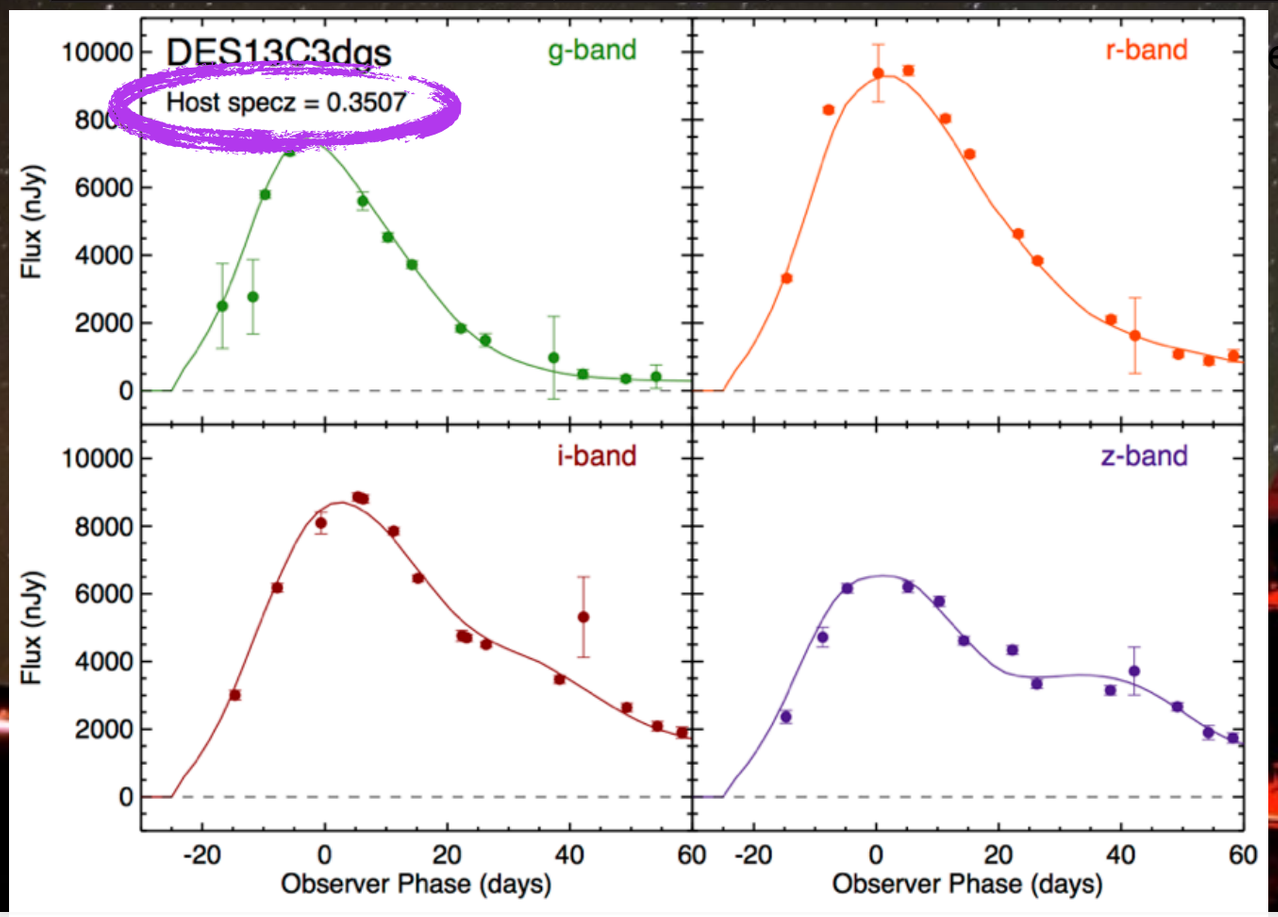


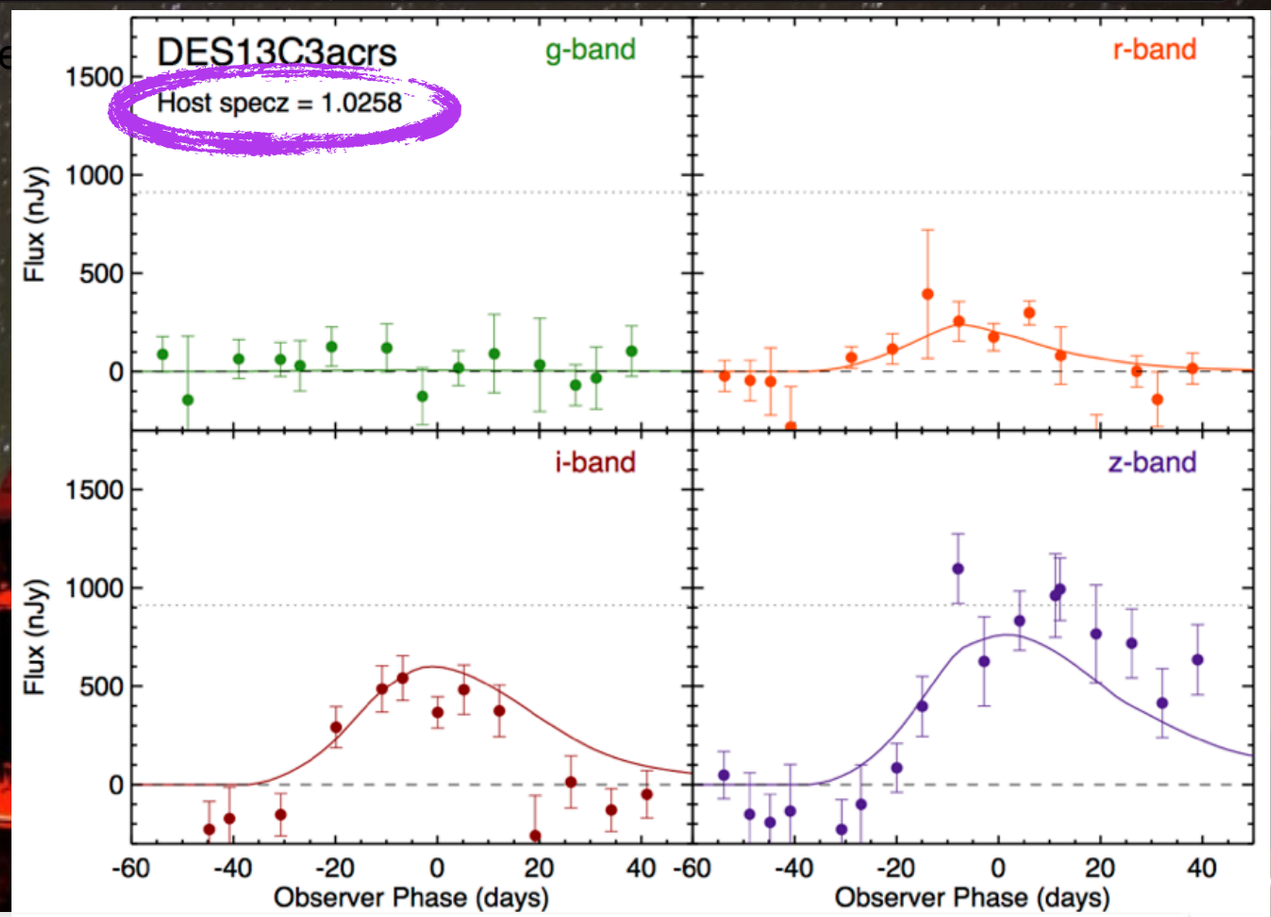
DES-SN: SPECTROSCOPIC FOLLOW-UP: THE WAY FORWARD

DOES IT WORK?

SPECTRA







- *Chris L will explain all in <10!, but this takes 5 years…..*

DES-SN: SPECTROSCOPIC FOLLOW-UP: IN THE MEANTIME…

LOTS OF SUPERNOVA, TOO FEW (BUT STILL LOADS OF) TELESCOPES

	Instrument	Time	S	Targets	DESY4+
AAT	AAOmega/2dF	48n	Y123	1027/544	52n over Y4+Y5
VLT	X-Shooter	14n+13h	Y23	91/89	7n + 7n (2016/7:A/B)
Magellan	LDSS-3, IMACS	14.5n	Y23	88/86	6n (2016B)
SALT	RSS	79h	Y123	52/44	17h (to Oct31)
Gemini	GMOS-N/S	53.2h	Y3	32/29	95.1h (2016B) LPP: 99h 2017B
MMT	BCS	8n	Y23	31/28	2n (2016B)
Keck	LRIS, DEIMOS	6n	Y123	23	2n (2016B)
GTC	OSIRIS	55h	Y123	19/18	12h (2016B)

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~Complete z<0.3

Faint hosts & high-z

Representative & mid-z

~Complete z<0.3

Representative & high-z

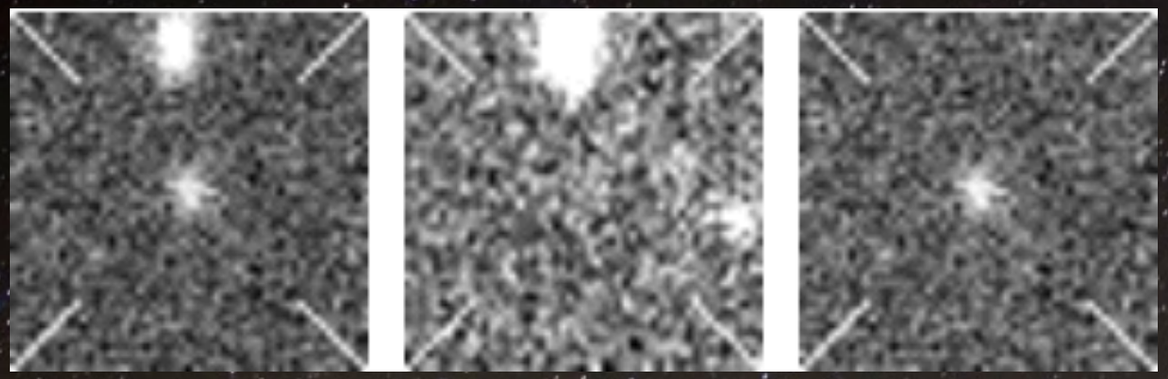
Representative & mid-z

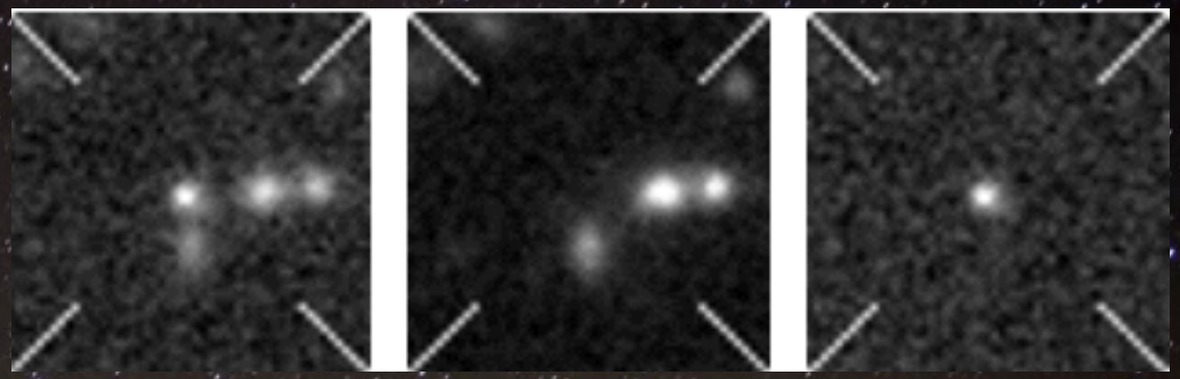
Weirdos & high-z

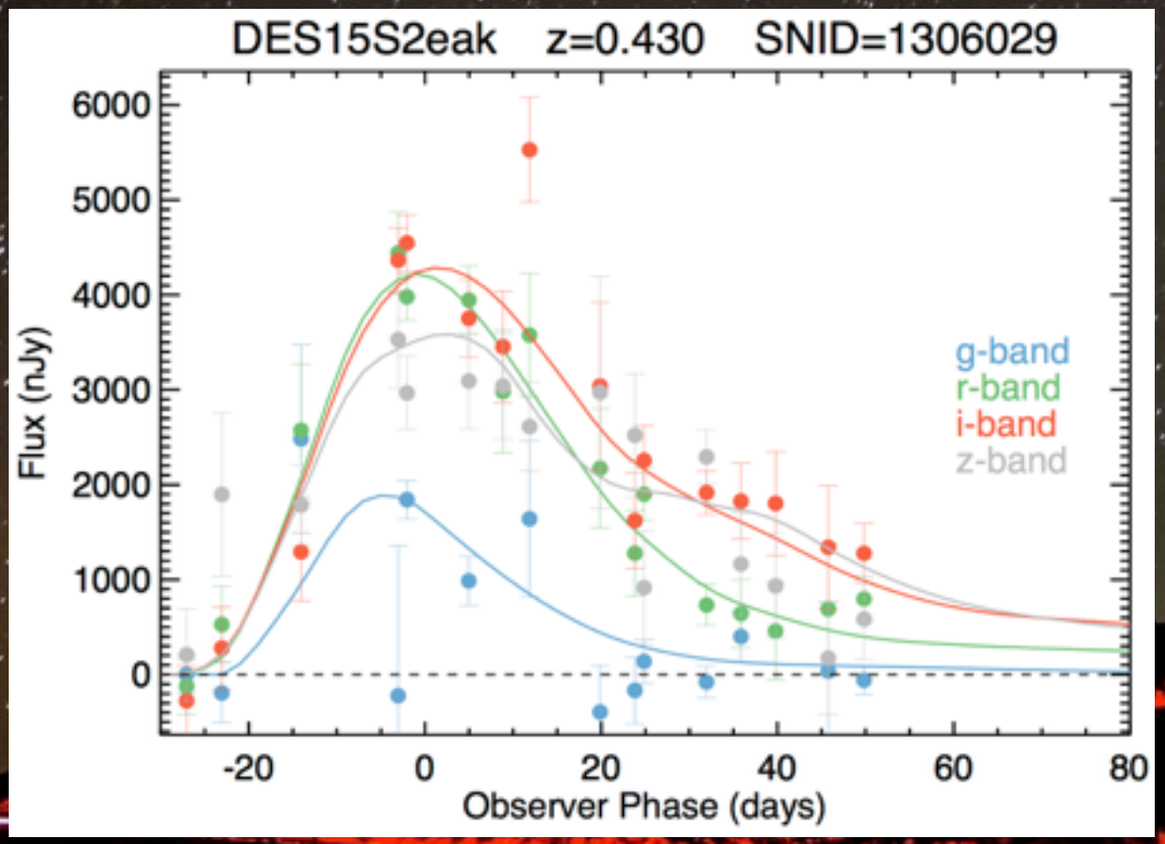
Weirdos!

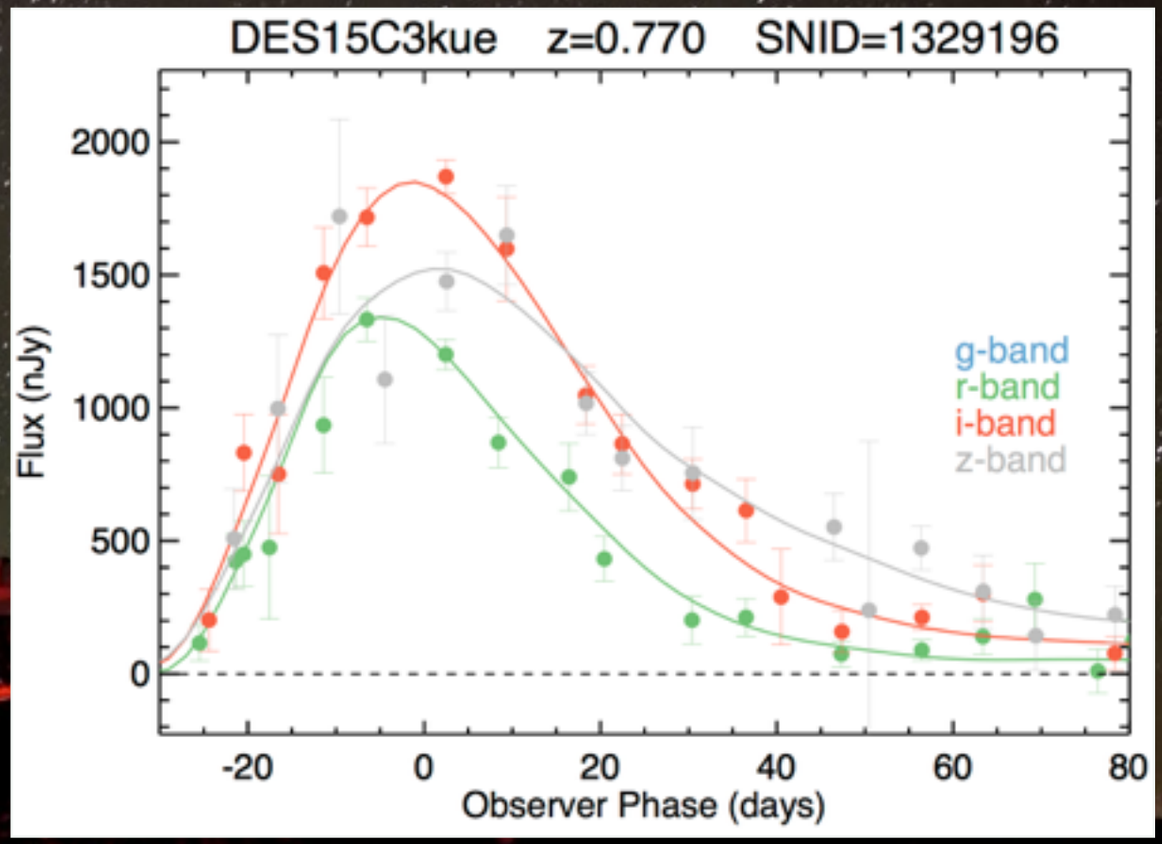
- Spectroscopy needed, at least, to test photometric classification…

DES-SN @ AGE 3







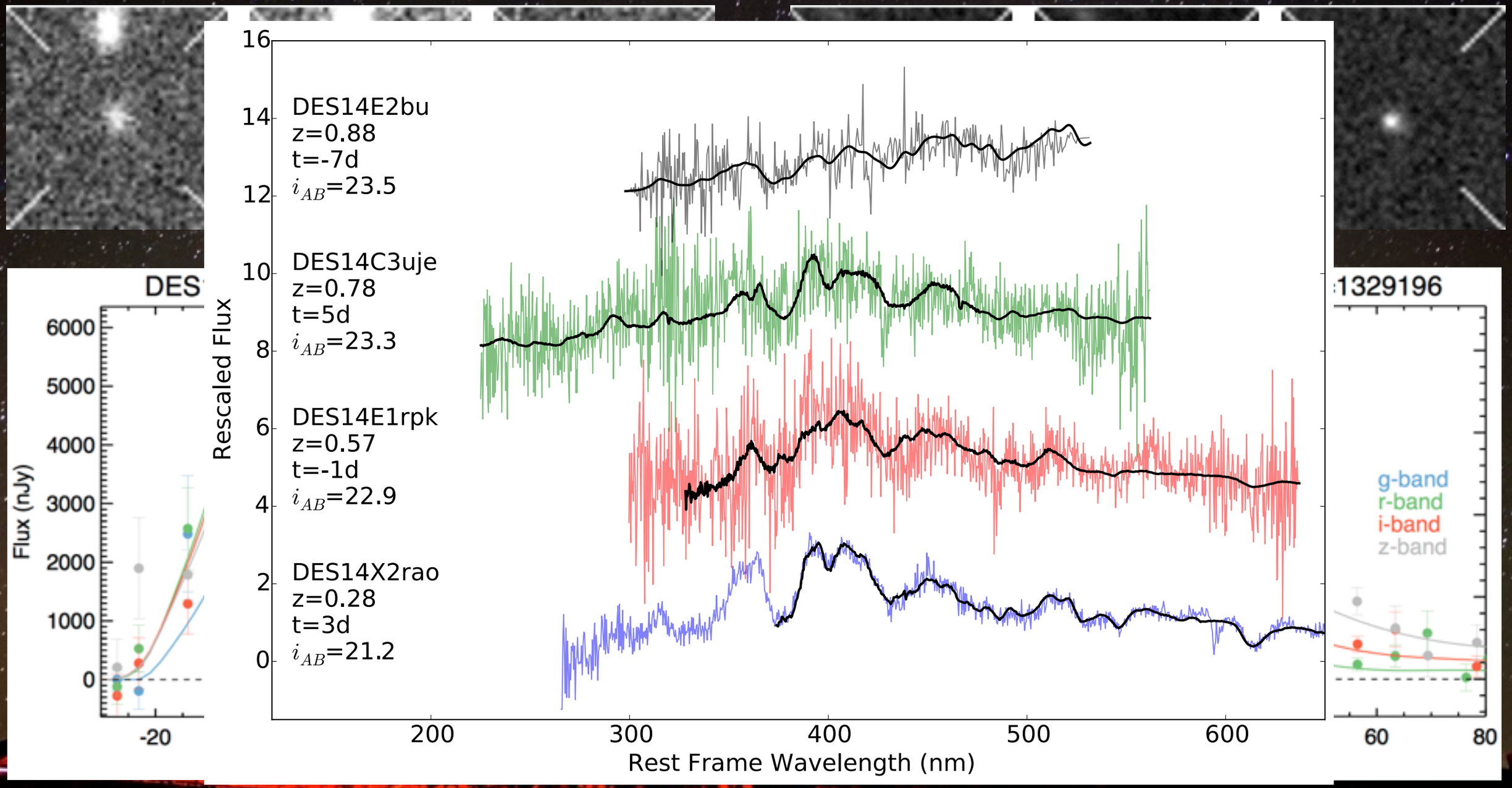


lowish-z

high-z

- *We can find supernova…*

DES-SN @ AGE 3

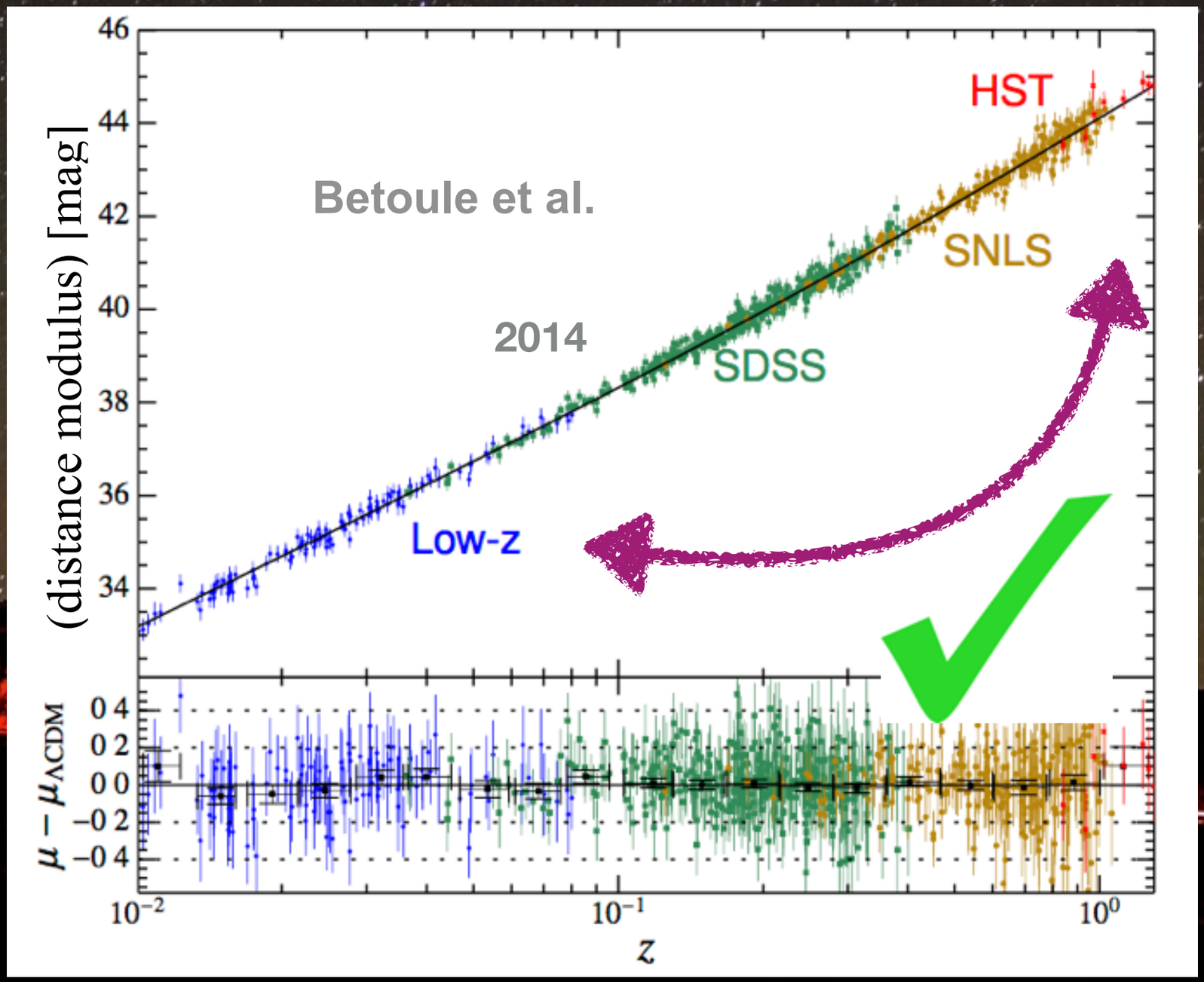


lowish-z *high-z*

- *We can find supernova… and confirm that they are Ia's!*

DES-SN @ AGE 3 - IN SUMMARY

TO RE-CAP:
DES: "ALL OF THIS AND MORE WITH ONE SURVEY"

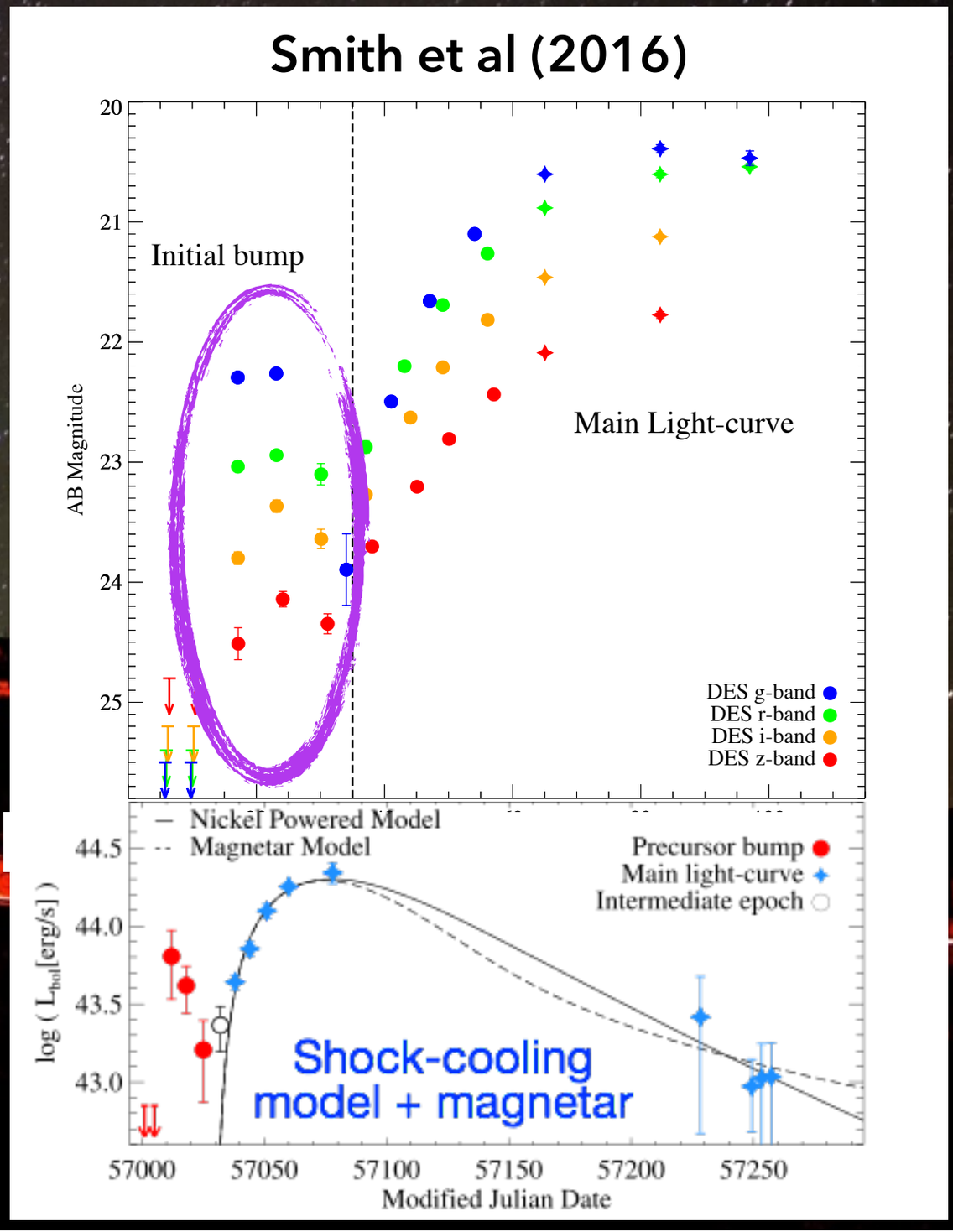


DES-SN @ AGE 3 - AN ASIDE

TRANSIENT SURVEYS = COOL STUFF: SUPER-LUMINOUS SN

V. RARE & IN NEED OF UNDERSTANDING

- *13 total; 6 @ z>1 & new physics!*



DES-SN: THE ROUTE TO A COSMOLOGY…

PLENTY OF STEPS BEFORE WE REACH "W"

✓	TRANSIENT DETECTION:	KESSLER ET AL (DIFFIM) + GOLDSTEIN ET AL (ML)
~	CALIBRATION:	BIGGEST SYSTEMATIC (CURRENTLY): LASKER ET AL
~	PHOTOMETRY:	"SCENE MODELLING": BROUT ET AL (IN PREP)
✓	HOST IDENTIFICATION / TARGETING:	GUPTA ET AL (IDENT) + YUAN ET AL (OZDES)
~	CLASSIFICATION:	PSNID: SAKO ET AL &/OR KESSLER+SCOLNIC
✓	SPECTROSCOPY / BIASES:	D'ANDREA ET AL
~	HOST GALAXY PROPERTIES:	SMITH EL AL (IN PREP)
~	COSMOLOGICAL ESTIMATION:	BAYESIAN-NESS: HINTON ET AL (IN PREP) + OTHERS

- *Some outstanding issues, but things are moving forward….*

DES-SN @ AGE 3 - WHERE WE ARE

SPEC-CONFIRMED COSMOLOGY

DO WE KNOW HOW WE GOT HERE?

- *Cosmology to come shortly!*

- *Data broadly matches simulation and "evolves" with redshift as expected - this still needs to be corrected for!!!*

DES-SN @ AGE 3 - WHERE'S NEXT: PHOTOMETRIC CLASSIFICATION

DES Y1-3: >1500 SNIA'S; 900+ CURRENTLY WITH SPEC-Z

Currently modelling biases, selection functions & contamination

DES-SN @ AGE 3 - MY SUMMARY

- DES-SN is great!
  - 3 years down, 2 to go!
    - 250+ spectroscopically-confirmed SNe Ia
    - 13 SLSNe, inc. highest redshift ever!
    - 1500+ photometrically-classified SNe Ia
      - Twice as many as largest published sample!
        - we just need redshifts & time ;)
    - New techniques for calibration, photometry, classification & cosmology
    - Stay tuned!

DES-SN @ AGE 3 - FEEL FREE TO CLAP!

CHEERS MATE!