European Organisation for Astronomical Research in the Southern Hemisphere

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APPLICATION FOR OBSERVING TIME

PERIOD: **102A**

Important Notice:

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of CoIs and the agreement to act according to the ESO policy and regulations, should observing time be granted.

1. Title

Category: **D–5**

The All-weather MUse Supernova Integral field Nearby Galaxies (AMUSING) survey VIII: The local environments of type Ia supernovae

2. Abstract / Total Time Requested

Total Amount of Time: 0 nights VM, 99 hours SM

Type Ia supernovae (SNIa) are the most accurate extragalactic distance indicators to date, thanks to empirical correlations between light-curve shape/B-V color and peak brightness that homogenize SNIa light-curves down to 7% scatter. However, it is now established that SNIa Hubble residuals correlate with global host galaxy parameters, such as total mass, and the addition of a term in the SNIa standardization accounting for these environmental parameters have reduced the scatter in the SNIa peak brightness. In this proposal we aim to further study these correlations by using MUSE observations of host galaxies of well-studied SNe Ia selected from the Carnegie Supernova Project (CSP), to reduce further the scatter in the SNIa Hubble diagram by looking for correlations between Hubble residuals and both global and local galactic spectroscopic properties.

3.

Run	Period	Instrument	Time	Month	Moon	Seeing	Sky	Mode	Type
A	102	MUSE	99h	any	n	n	THN	s	

4. Number of nights/hours

Number of nights/hours	Telescope(s)	Amount of time
a) already awarded to this project:	UT4	27h 098.D-0115, 35h 099.D-0022
b) still required to complete this project:		

5. Special remarks:

This project is a ‘filler’ program, with targets across the full RA and DEC range, and that are observable in THN, bad seeing conditions, and during bright time. We understand that only part of the observations may be completed. This is a continuation of the AMUSING survey to investigate the host galaxies of SNe Ia, where the current science case is a continuation of that from of previous semesters (P98/P99).

6. Principal Investigator: Joseph Anderson, janderso@eso.org, ESO, ESO Office Santiago

6a. Co-investigators:

L.	Galbany	University of Pittsburg,Department of Physics & Astronomy,US
H.	Kuncarayakti	Finnish Centre for Astronomy with ESO (FINCA),FI
C.	Burns	Las Campanas Observatory,US
J.	Falcón-Barroso	Instituto de Astrofisica de Canarias, Headquarters,E

Following CoIs moved to the end of the document ...

7. Description of the proposed programme

A – Scientific Rationale:

Optical observations of type Ia supernovae (SNIa) have been widely used in the last decades to measure cosmological distances, and have been key in measuring the Hubble constant and demonstrating cosmic acceleration (Riess et al. 1998; Perlmutter et al. 1999; Betoule et al. 2014). Although SNe Ia show significant dispersion $\sim$2.5 mag in their absolute peak magnitudes in optical wavelengths, a correlation between peak brightness and both the shape of the light curve (LC) and observed color, enabled their standardization and converted SNe Ia into the most precise (7%) extragalactic distance indicators.

In recent years, the literature sample of optical SNIa at cosmological distances has grown substantially, and at this point statistical errors are comparable to systematic uncertainties (Goobar et al. 2011). Further improvement in reducing these systematic errors require a much better understanding of the physical model of the explosion, which is still incomplete, a direct observational constraint on which kind of progenitors can produce SNe Ia, which is still lacking, as well as better control of reddening effects due to interstellar and/or circumstellar dust.

Optical studies of SNIa have now firmly established a dependence of Hubble diagram *residuals* ($\approx$ differences between distances estimated from SNIa peak brightness and those calculated assuming a fiducial cosmological model) on global host galaxy parameters, such as mass, age, and metallicity (e.g. Sullivan et al. 2010, Lampeitl et al. 2010, Gupta et al. 2011, D'Andrea et al. 2011, Childress et al. 2013, Johansson et al. 2013). Moreover, these galaxy parameters might in principle correlate with the properties of the progenitor star, which might in turn influence the observational photometric and spectroscopic SN properties. The addition of a term in the standardization of SNIa absolute magnitudes in the optical that accounts for these environmental properties (e.g. the 'mass step' or the γ-metallicity term Moreno-Raya et al. 2016) has proved to further reduce the scatter of the Hubble residuals.

Most of these studies are based on analyses of the integrated or central host galaxy spectra, and broad-band or narrow-band Hα imaging. The effect of the local environment of SN Ia within galaxies in cosmological studies is almost unexplored. As an exception, Rigault et al. (2014) showed that SNe Ia exploding at locations with higher star-formation intensity could be more standardizable than those in passive local environments. More recently, Roman et al. (2018) presented an analysis of the dependences of SN light-curve parameters and Hubble residuals on their local environment using broad-band photometry. They show a significant dependence on the U-V color, which is treated as a proxy for the stellar age of the underlying populations (bluer being younger). However, age derived from photometry (color) has several uncertainties, and degeneracies (with extinction and stellar metallicity), and it is not enough to determine precisely the cut-out in stellar ages of such dependence.

Here we propose to go one step further and make use of the capabilities of Integral Field Spectroscopy (IFS) to search for correlations between SN Ia Hubble residuals and the properties of both their global and local environments (e.g., metallicity, age, SFR), through observing their host galaxies with MUSE. Our SN Ia sample is compiled from the Carnegie Supernova Project (CSP) II, that observed around 240 objects with the du Pont and Swope telescopes at Las Campanas Observatory (LCO) in Chile. These are unprecedented well-sampled light-curves in 6 optical and 3 near-infrared bands, in addition to a few optical and near-infrared spectra per object, which enables detailed photometric and spectroscopic analyses. These MUSE observations will allow a detailed characterization of both the global and the local environment of these SNe Ia, as well as the ability to then map galaxy-wide SN host properties, and analyze where within the overall distribution of, e.g., host metallicity the SN environment falls (See Galbany et al. 2018).

B – Immediate Objective:

We propose to obtain MUSE observations of a sample of 99 nearby (z<0.1) SN Ia host galaxies, with high quality optical and NIR SN Ia observations from the Carnegie Supernova Project II (CSP-II) survey, that are observable during P102 from Paranal. We already posses Blue and near-infrared imaging of these host galaxies from CSP SN host galaxy filed templates, and these will be combined with MUSE optical IFS to help breaking degeneracies among age/metallicity/extinction. These will provide both global host properties in addition to spectral information on the immediate environments of SNe (and every single environment within the host). Using these observations, we will perform single stellar population (SSP) synthesis, and maps will be made of line-of sight ISM and stellar features, such as that of gas-phase and stellar metallicity, stellar age, and star-formation rate density (see details of the data analysis in Galbany et al. 2016). This will allow a detailed study of the correlations between the SNIa residuals to the ΛCDM cosmology in the Hubble diagram and both the global and the local environmental properties (See Figure 1), further reducing systematic uncertainties in the determination of cosmological distances with SN Ia observations in the NIR. The immediate goals of this proposal are:

(i) Produce host galaxy 2 dimensional maps of: light- and mass-weighted age (through both SSP modeling and Hα equivalent width measurements), metallicity (through emission line ratios i.e. O3N2- and N2- calibrators,

7. Description of the proposed programme and attachments

Description of the proposed programme (continued)

population modeling, and absorption lines when the S/N allows). SN environments will then be placed within these distributions providing further progenitor constraints; and

(ii) Look for correlations between the SNIa residuals in the Hubble digram (assuming ΛCDM) and those local/global environmental properties, and use them to further refine the use of SNe as precise distance indicators.

Finally, this data will provide a gold mine for further study; it will be extremely useful for studies of galaxy dynamics, stellar populations and chemical evolution, and hence we expect many other projects to spawn from the proposed dataset. The AMUSING project has run for 5 semesters (plus data being collected for P100, and observations planned for P101). The main purpose of this project is to perform environmental analyses of SNe, thus large number of observations are needed. The first data release including reduced cubes and dataproducts for observations for the first 3 semesters is planned for December 2018 (Anderson et al. 2018), and the first analysis of SN Ia environments is in advanced stage (Galbany et al. see Figure 1). However, the project has already published 8 papers mostly on individual objects (Sánchez et al. 2015 A&A, 573, A105; Galbany et al. 2016, MNRAS, 455, 4087; Sánchez-Menguiano et al. 2016, ApJ, 830 L40; Sánchez-Menguiano et al., 2018, A&A, 609, A119; López-Cobá et al. 2017, ApJ, 850, L17; Prieto et al. 2016, ApJ, 830, L32; Anderson et al. 2018, NatureAstro, accepted; Krühler et al. 2017, A&A, 602, A85), and many other projects are currently ongoing.

References: Betoule, M. et al 2014,A&A, 568, 22; Childress, M. et al 2013, ApJ, 770, 108; D'Andrea, C.B. et al 2011, ApJ, 743, 172; Friedman, A., et al. 2015, ApJS, 220, 9; Galbany et al., 2016, MNRAS, 455, 4087; Goobar & Leibundgut, 2011, ARNPS, 61, 251; Gupta, R.R. et al 2011, ApJ, 740, 92; Johansson, J. et al 2013, MNRAS, 435, 1680; Krisciunas, K., et al. 2004, ApJ, 602, 81; Lampeitl, H. et al 2010, MNRAS, 401, 2331; Moreno-Raya, M. et al. 2016, 2016, ApJ, 818, 19; Sánchez et al., 2015, A&A, 573, 105; Stanishev et al. 2015, arXiv:1505.07707; Sullivan, M. et al 2010, MNRAS, 406, 782; Perlmutter, S. et al. 1999, ApJ, 517, 565; Riess, A. et al 1996, 473, 88; Weyant, A. et al. 2014, ApJ, 784, 105; Wood-Vasey, W.M. et al. 2008, ApJ, 689, 377.

Attachments (Figures)

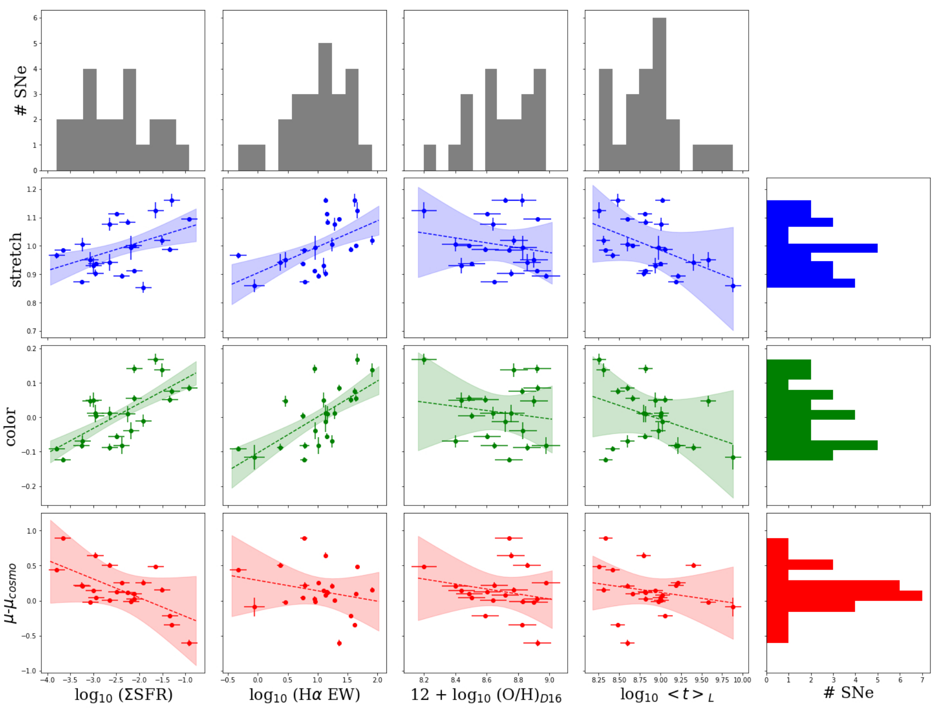

Fig. 1: Preliminary results from MUSE data obtained in semesters P96, P98 and P99 (Galbany et al. in prep.). First row shows histograms of galaxy parameters measured at SN locations in MUSE data detailed in the X-axis label, while last column shows histograms of SNIa parameters from light-curve fits to CSP data. Second to fourth rows correspond to light-curve stretch, color, and Hubble residual, respectively, and the four first columns are the local star formation intensity, Hα equivalent width, oxygen abundance, and average stellar age, respectively.

8. Justification of requested observing time and observing conditions

Lunar Phase Justification: Our targets can be observed in any lunar phase as this project is a 'filler' program.

Time Justification: (including seeing overhead) Our proposed MUSE observations aim to detect and measure the strength of H II region emission lines throughout target galaxies, together with narrow absorption features seen on top of the galaxy continuum. To estimate exposure times we assume a typical r-band surface brightness of 21 mag per arcsec^2 for faint HII regions (James et al. 2004). We then use the MUSE ETC with the following parameters to estimate our required exposure times. We assume an 'Infinitely extended source' and the HII region template (at a redshift of 0.05) together with an r-band surface brightness of 21 mag per arcsec^2. As our proposal is submitted as a 'filler' we set conditions to: 7 days from new moon; airmass 1.4; seeing 1.5$''$.

In order to remove the edges of each IFU on the detector (artifacts of the image slicer) it is best to combine observations with all four 90 degree angles. With 4$\times$550 second exposures the ETC gives a S/N of $\sim$5 in the continuum, which translates to a S/N of more than 100 for all the emission lines we wish to detect (e.g., Hα, [NII], [O III], Hβ). In many galaxy regions we will obtain much higher S/N in the continuum, and this will allow more detailed analysis modelling stellar populations, using absorption line indices as an indicator of stellar metallicities in the place of gas phase values. This is required for the small number of elliptical galaxies included in our sample. Together with 2$\times$220 second sky exposures and overheads, this totals roughly 1 hr per galaxy. The extent of most galaxies in our sample is covered by one MUSE pointing, hence, we require 99 hrs to observe our sample of 99 host galaxies. However *we recall that this is a 'filler' proposal, where any amount of data obtained will be beneficial to our project.*

We previously obtained MUSE data with very similar conditions/observing strategy to that outlined above, and show that with those exposure times we are able to make the necessary measurements. We have already published several papers based on these data (See publications section). Within our team are experts on the reduction, analysis and interpretation of IFS galaxy observations, hence, while IFS data and their analysis can sometimes prove somewhat daunting, our team provides all the required knowledge to fully exploit this rich data set. Furthermore, these data will remain in the archive as a legacy for future extragalactic studies.

8a. Telescope Justification:

MUSE at the VLT is the only currently available IFU instrument that has a FoV of sufficient size to cover the majority of our targets, while at the same time having high spatial resolution, high sensitivity, and being extremely efficient, hence enabling targets to be observed in a relatively small amount of time.

We stress here that even in relatively bad seeing conditions (in which the data will sometimes be observed, given the 'filler' nature of our proposal) we will still have the potential to unravel kinematic and population substructure in these galaxies over a large FoV. Indeed, even in bad seeing conditions these data will still be a better position to probe SN environments and galaxy characteristics than any current or past IFU survey (SAURON, ATLAS3D, CALIFA, SAMI, MaNGA).

8b. Observing Mode Justification (visitor or service):

Targets are observable throughout the semester, and as this is a 'filler' program, service mode is required.

8c. Calibration Request:

Standard Calibration

9. Report on the use of ESO facilities during the last 2 years

296.D-5003: 2hr DDT MUSE (P.I. Anderson); 1 paper accepted to Nature Astronomy (Anderson et al. 2018);
098.D-0115: 27hr from 45hr SM MUSE finally executed (P.I. Galbany); data reduced, main analysis ongoing (See Figure 1). 1 paper published (Sánchez-Menguiano, et al. 2018, A&A, 609, A119);
098.D-0103: 11hr SM FORS2 (P.I. Kuncarayakti); data reduced, analysis ongoing;
099.D-0022: 35hr from 99hr SM MUSE finally executed (P.I. Galbany); analysis ongoing (Fig. 1);
100.D-0326 9.6hr from 20.8hr SM VIMOS currently executed (P.I. Kuncarayakti);
100.D-0341 20hr from 85hr SM MUSE currently executed (P.I. Kuncarayakti);
101.D-0748 99hr SM MUSE (P.I. Kuncarayakti); not observed yet

9a. ESO Archive - Are the data requested by this proposal in the ESO Archive (http://archive.eso.org)? If so, explain the need for new data.

We checked for available observations of all of our targets on the ESO archive, and we found no observations of these fields with MUSE, with the exception of SN2008C which was included in our P95 program but observations were aborted in the middle of the first exposure. We checked the data and it was not recoverable for our purposes.

9b. GTO/Public Survey Duplications:

No.

10. Applicant's publications related to the subject of this application during the last 2 years

(In **bold** those publications using MUSE data)

- Galbany, et al., 2016, MNRAS, 455, 4087: Characterizing the environments of supernovae with MUSE
- Galbany, et al., 2018, ApJ, 855,107: PISCO: The PMAS/PPak Integral-field Supernova Hosts Compilation
- Krühler, et al., 2017, A&A, 602,A45: Hot gas around SN1998bw: Inferring the progenitor from its environment
- Kuncarayakti, et al., 2016, A&A, 593, A78: Unresolved versus resolved: testing the validity of young simple stellar population models with VLT/MUSE observations of NGC 3603
- Kuncarayakti, et al., 2018, A&A, accepted: Constraints on core-collapse supernova progenitors from explosion site integral field spectroscopy
- Lyman, et al., 2018, MNRAS, 473, 1359: Investigating the diversity of supernovae type Iax: a MUSE and NOT spectroscopic study of their environments
- Lopéz-Cobá, et al., 2017, ApJL, 850, L17: Serendipitous Discovery of an Optical Emission-line Jet in NGC232
- Moreno-Raya, et al., 2016, ApJL, 818, 19: On the dependence of the type Ia SNe luminosities on the metallicity of their host galaxies
- Moreno-Raya, et al., 2018, MNRAS, 476, 307: Elemental gas-phase abundances of intermediate redshift type Ia supernova star-forming host galaxies
- Prieto, et al., 2016, ApJL, 830, L32: MUSE Reveals a Recent Merger in the Post-starburst Host Galaxy of the TDE ASASSN-14li
- Sánchez-Menguiano, et al., 2016, ApJL, 830, L40: Evidence of Ongoing Radial Migration in NGC 6754: Azimuthal Variations of the Gas Properties
- Sánchez-Menguiano, et al., 2018, A&A, 609, A119: The shape of oxygen abundance profiles explored with MUSE: evidence for widespread deviations from single gradients

11. List of targets proposed in this programme

Run	Target/Field	α(J2000)	δ(J2000)	ToT	Mag.	Diam.	Additional info	Reference star
A	ASAS14hp	21:30:31.420	-70:38:34.35	1				
A	ASAS14kd	22:53:24.95	+04:47:57.3	1				
A	ASAS14lq	22:57:19.41	-20:58:00.8	1				
A	ASAS14my	11:38:29.980	-08:58:35.79	1				
A	ASAS15da	05:23:51.880	-24:42:08.38	1				
A	ASAS15fr	09:20:20.44	-07:38:26.78	1				
A	ASAS15go	06:11:30.50	-16:29:03.52	1				
A	CSP13aam	05:14:47.50	-66:50:29.10	1				
A	CSP13aay	03:25:33.51	-53:44:19.00	1				
A	CSP13abm	03:05:59.89	+04:32:38.20	1				
A	CSP13abs	12:03:06.88	-01:01:31.70	1				
A	CSP13af	11:41:44.17	-17:13:48.00	1				
A	CSP13V	10:13:10.00	-16:31:54.00	1				
A	CSP13Z	10:52:06.06	-13:34:24.70	1				
A	CSP14acl	01:01:07.04	-10:18:39.90	1				
A	CSP14acy	00:42:28.75	-64:45:51.00	1				
A	LSQ11bk	04:20:44.25	-08:35:55.75	1				
A	LSQ12blp	13:36:05.59	-11:37:16.87	1				
A	LSQ12btn	09:21:30.47	-09:41:29.86	1				
A	LSQ12cdl	12:53:39.96	-18:30:26.16	1				
A	LSQ12cid	10:03:57.04	-06:14:37.76	1				
A	LSQ12fxd	05:22:17.02	-25:35:47.01	1				
A	LSQ12gpw	03:12:58.24	-11:42:40.13	1				
A	LSQ12gxj	02:52:57.38	+01:36:24.25	1				
A	LSQ12gyc	02:45:50.07	-17:55:45.74	1				
A	LSQ12hjm	03:10:28.72	-16:29:37.08	1				
A	LSQ12hno	03:42:43.25	-02:40:09.76	1				
A	LSQ12hnr	10:43:14.77	-08:46:40.89	1				
A	LSQ13dby	03:26:42.84	-34:38:05.49	1				
A	LSQ13dpm	10:29:08.32	-17:06:50.19	1				
A	LSQ13dqh	04:22:05.90	-02:53:24.24	1				
A	LSQ13lq	13:44:10.81	+03:03:43.42	1				
A	LSQ13pf	13:48:14.35	-11:38:38.58	1				
A	LSQ13ry	10:32:48.00	+04:11:51.75	1				
A	LSQ13vy	16:06:55.85	+03:00:15.23	1				

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Target Notes: All targets above are SN Ia host galaxies from the sample we compiled from the CSP II survey that are well-observable from Paranal throughout the semester. The transient name is given in the first column, followed by the RA and Dec of its host galaxy. When available the galaxy name is also listed.

12. Scheduling requirements

13. Instrument configuration

Period	Instrument	Run ID	Parameter	Value or list
102	MUSE	A	WFM-NOAO-E	-

6b. Co-investigators:

...continued from Box 6a.

F.	Förster	Other,CL
S.	González-Gaitán	Universidad de Chile,Cerro Calan,CL
E.	Hsiao	University of Florida,Department of Astronomy,US
P.	James	Astrophysics Research Institute,Liverpool John Moores University,UK
J.	Lyman	University of Warwick,UK
E.	Perez	Instituto de Astrofisica de Andalucia, IAA-CSIC,E
M.	Phillips	Las Campanas Observatory,US
J.L.	Prieto	Universidad Diego Portales,CL
F.	Rosales-Ortega	Instututo Nacional de Astrofisica Optica y Electronica (INAOE),MX
S.	Sánchez	UNAM,Instituto de Astronomia,MX
M.	Stritzinger	University of Aarhus,DK

11a. List of targets proposed in this programme

Run	Target/Field	α(J2000)	δ(J2000)	ToT	Mag.	Diam.	Additional info	Reference star
	...continued from box 11.							
A	LSQ14auy	14:28:11.30	-04:03:17.50	1				
A	LSQ14ba	11:01:23.01	-15:37:10.29	1				
A	LSQ14fms	00:14:59.82	-51:12:39.54	1				
A	LSQ14foj	00:26:34.67	-32:48:33.09	1				
A	LSQ14fom	21:59:49.73	-30:16:15.56	1				
A	LSQ14gfb	05:10:05.76	-36:18:43.57	1				
A	LSQ14gfn	03:28:32.16	-04:12:14.22	1				
A	LSQ14ghv	03:23:44.15	-31:35:03.17	1				
A	LSQ14gov	04:06:01.33	-16:01:41.49	1				
A	LSQ14ip	09:44:20.22	+04:35:52.56	1				
A	LSQ15adm	20:14:21.82	-58:08:20.31	1				
A	PTF13dyt	05:01:48.26	+02:41:49.70	1				
A	PTF14aaf	14:36:51.00	+06:08:31.30	1				
A	PTF14w	12:03:31.29	+02:02:34.00	1				
A	PTF15wb	08:28:18.07	+00:17:22.70	1				
A	SN2004dt	02:02:12.77	-00:05:51.5	1				
A	SN2005A	02:30:43.25	-02:56:19.8	1				
A	SN2005al	13:50:00.33	-30:34:34.2	1				
A	SN2005am	09:16:12.47	-16:18:16.0	1				
A	SN2005el	05:11:48.72	+05:11:39.4	1				
A	SN2005iq	23:58:32.50	-18:42:33.0	1				
A	SN2006ax	11:24:03.46	-12:17:29.2	1				
A	SN2006bh	22:40:16.10	-66:29:06.3	1				
A	SN2006gj	03:17:35.80	-01:41:30.2	1				
A	SN2006hb	05:02:01.28	-21:07:55.1	1				
A	SN2007as	09:27:36.01	-80:10:39.2	1				
A	SN2007bm	11:25:02.30	-09:47:53.8	1				
A	SN2007jg	03:29:50.82	+00:03:24.6	1				
A	SN2007jh	03:36:01.54	+01:06:12.2	1				
A	SN2007st	01:48:42.47	-48:38:57.8	1				
A	SN2008bd	10:18:23.32	-13:06:11.2	1				
A	SN2008bq	06:41:02.51	-38:02:19.0	1				
A	SN2008bt	10:50:16.88	-12:06:32.0	1				
A	SN2008cc	21:03:29.62	-67:11:01.1	1				
A	SN2008cd	13:15:01.75	-15:57:06.8	1				
A	SN2008fl	19:36:44.84	-37:33:04.5	1				
A	SN2008fu	03:02:28.50	-24:27:21.5	1				
A	SN2008fw	10:28:55.97	-44:39:55.6	1				
A	SN2008gg	01:25:23.04	-18:10:20.8	1				
A	SN2008gl	01:20:54.82	+04:48:19.1	1				
A	SN2008gp	03:23:00.73	+01:21:42.8	1				
A	SN2008hu	08:09:14.76	-18:39:13.1	1				
A	SN2008O	06:57:34.46	-45:48:44.3	1				
A	SN2008R	03:03:53.70	-11:59:39.4	1				
A	SN2009ab	04:16:36.39	+02:45:51.0	1				
A	SN2009ag	07:11:40.81	-26:41:06.3	1				
A	SN2009F	04:59:23.56	-11:07:50.1	1				
A	SN2011jn	12:57:14.79	-17:24:00.50	1				
A	SN2012ah	23:25:59.63	-81:54:33.30	1				
A	SN2012ar	16:20:36.02	-10:27:38.30	1				

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11a. List of targets proposed in this programme

Run	Target/Field	α(J2000)	δ(J2000)	ToT	Mag.	Diam.	Additional info	Reference star
	…continued from previous page.							
A	SN2012U	02:06:04.33	-55:11:37.50	1				
A	SN2013ay	18:42:37.86	-64:56:13.50	1				
A	SN2013bc	13:10:21.31	-07:10:24.10	1				
A	SN2013cg	09:26:56.77	-24:46:59.60	1				
A	SN2013ct	01:12:54.92	+00:58:45.70	1				
A	SN2013gy	03:42:16.88	-04:43:18.48	1				
A	SN2013hn	13:48:59.17	-30:17:26.50	1				
A	SN2014ao	08:34:33.32	-02:32:36.10	1				
A	SN2014ba	22:55:01.97	-39:39:34.50	1				
A	SN2014eg	02:45:09.27	-55:44:16.90	1				
A	SN2014I	05:42:19.80	-25:32:39.90	1				
A	SN2014Z	01:44:07.99	-61:07:07.40	1				
A	SN2015F	07:36:15.76	-69:30:23.00	1				
A	SNhunt281	15:05:30.07	+01:38:02.40	1				