Brazilian Large and Long Programs (BrLLP)
Progress Report – 2016B

The DIVING3D project: Deep IFS View of Nuclei of Galaxies

J. E. Steiner[1], R. Cid Fernandes[2], P. Coelho[1], N. Vale Asari[2], R. B. Menezes[1], T. V. Ricci[3], A. L. Amorim[2], D. May[1], Patricia da Silva[1], Inaiara Andrade[1] & Maiara S. Carvalho[2]

Theses: Patricia da Silva[1], Inaiara Andrade[1] & Maiara S. Carvalho[2]

[1]Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Rua do Matão 1226, Cidade Universitária, São Paulo, SP CEP 05508-090, Brazil
[2]Departamento de Física, Universidade Federal de Santa Catarina, PO Box 476, 88040-900, Florianópolis, SC, Brazil
[3]Universidade Federal da Fronteira Sul – Rua Jacob Reinaldo Haupenthal, 1580, sala 111, Cerro Largo RS, CEP 97900-000

1. Executive summary

The DIVING3D project - Deep IFS View of Nuclei of Galaxies – is one of the two Brazilian LLPs. By the end of 2016B it will be 70% completed. Additional time is requested to bring the degree of completion to 81%.

The main goals of this survey are to perform a study of the a) nuclear and b) circumnuclear emission of a complete sample of all galaxies brighter than B=12.0 in the southern hemisphere. As a by-product we will also obtain stellar c) kinematics and d) archaeology.

Although the El Nino phenomenon has affected badly the operations of Gemini South and 15 galaxies of the program were not observed in the semesters 2015B and 2016A, the sample of ETGs is now completed. For the mini-DIVING3D only 2 galaxies are missing and we expect them to be observed in the semester 2016B.

We are now in the situation of publishing papers with statistical analysis. The first three are in preparation.

So far we have published 7 papers on individual or small samples of galaxies. Two more papers have been submitted.

2. Work progress

Here, a detailed description of the work done in the semester related to LLP activities such as:

The data quality is, in general, very good. Although all data cubes have instrumental fingerprints, we have been able to remove them.

The signal-to-noise obtained for the emission line analysis is very good. For the stellar component of the central bulge it is quite appropriate. In two cases, at the edges of the FOV, we had deficit of s/n for analysing the stellar component, but this has not been a problem, given our objectives.

Only one object, NGC 4856, was not observed because of lack of guiding star. We will propose an observation with SOAR; either with SIFS or Goodman.

The wavelength calibration has been made very accurately. The flux calibration is not better then ~30%.

All data cubes are submitted to the following procedures:

- Bias subtraction and flat-field correction
- Cosmic ray removal
- Wavelength calibration

- Sky subtraction
- Flux calibration
- Telluric absorption removal
- Correction for the differential atmospheric refraction (DAR).
- High frequency spatial noise removal with Butterworth filter
- Fingerprint removal
- Richardson-Lucy deconvolution

The data analysis is done with the following techniques:

- PCA Tomography
- Starlight spectral synthesis
- pPXF kinematic analysis, obtaining the Gauss-Hermite momenta

Software development

All software developed by our group in IDL is available in the site:

www.astro.iag.usp.br/~pcatomography

3. Recent results

The paper IV of the series on the 10 early type galaxies (ETGs) has been published. This paper is about the stellar kinematics and is available in the following link:
http://adsabs.harvard.edu/doi/10.1093/mnras/stw2318

Two additional papers have been submitted to the MNRAS; one reports the detection of a possible LBV/Hypergiant and Wolf-Rayet stars near the central cluster in the bulgeless galaxy NGC 1313. This paper is being revised and we are waiting for a second referee report.

A second paper with the title "Integral Field Unit Spectroscopy of the inner 1 kpc of the galaxy NGC 5044" by Suzi I.F. Diniz1, Miriani G. Pastoriza, Jose A. Hernandez-Jimenez, Rogerio Riffel1,
Tiago V. Ricci, J. E. Steiner, Rogemar A. Riffel has also been submitted to MNRAS.

One of the main surprises of the data reduced so far is the frequency in which we find indications of past mergers:

a) At least in two cases we see double or well elongated central bulges. Associated with this there is strong indication of stellar population with 1 Gyear.
b) In two cases we see double AGN (~1" separation). In one case it is associated with a double central bulge.
c) In one case there is a suggestion of a triple AGN (within 0.7")
d) In two cases we see off-centered AGN. Perhaps this indicates the ejection of the central black hole, as a consequence of black hole merger.

The fact that this is an IFU survey with unprecedented resolution and signal-to-noise, such unprecedented findings are not surprising.

Considering the central source, we can make a preliminary statistics and compare it to the Palomar survey. The result shows that we are looking much deeper and finding significantly more AGNs.

Preliminary comparison with the Palomar Survey for massive ETGs (σ>200 km/s)

Type	Palomar Survey		DIVING3D	
	Nr	%	Nr	%
No Em.	19	33%	3	9%
L1.9	6	11%	10	31%
Lb?	0	0%	6	19%
S1.5	1	2%	2	6%
T1.9:	1	2%	0	0%
S2	0	0%	0	0%
S2:	1	2%		
L2	8	14%	4	13%
L2::	6	11%	7	22%
T2	2	4%		
T2:	7	12%		
H:	1	2%	0	0%
T2/L2-S2:	4	7%		
S2/L2	1	2%		
Total	57	100%	32	100%
No Em.	***19***	***33%***	***3***	***9%***
L b/Sy b	***8***	***14%***	***18***	***56%***
S2/L2/T2	***29***	***51%***	***11***	***34%***

We believe that a significant number of papers in individual objects will be published. The main goal, however is, at the end, publish statistical analysis on:

- The ETGs
- Early-type galaxies
- Milky Way Twins
- Late-type galaxies

Our perspective is that in all cases we will address:

- Nuclear emission line properties
- Circumnuclear emission line properties
- Stellar archaeology
- Stellar kinematics

4. Overall status

The current membership of the project is:
Joao Steiner: Coordinator
Roberto Menezes: reduction, data processing and analysis. Emission line properties of the mini-DIVING3D.
Tiago Ricci: reduction and data processing and analysis. Priority on ETG galaxies.
Roberto Cid Fernandes, Natália do Vale e André Amorin: Spectral synthesis and stellar archaeology.
Paula Coelho: Spectral libraries; alfa enhancement.

Theses:
Patricia da Silva: the master thesis was concluded and she has started her PhD thesis, following the work on Sbc galaxies (Milky Way twins).
Inaiara Andrade: her PhD thesis focuses on IFU spectroscopy of nuclei of S0 galaxies.
Maiara S. Carvalho: her master thesis focuses on stellar archaeology of the mini-DIVING3D.

External collaboration:

One paper in collaboration with the RS group was submited:
Integral Field Unit Spectroscopy of the inner 1 kpc of the galaxy NGC 5044
Suzi I.F. Diniz1, Miriani G. Pastoriza, Jose A. Hernandez-Jimenez, Rogerio Riffel1,
Tiago V. Ricci, J. E. Steiner, Rogemar A. Riffel

An additional paper is being prepared with Rogério Riffel, Rogemar Riffel and Gabriel Hahn in which the GMOS data of the galaxy NGC 1052 will be combined with their NIFS data.

5. Observing plan and data release

The current observing strategy is to observe sub-samples as listed below.

Observational strategy

Sub-samples

The observational status of the subsamples, by the end of semester 2016B, will be:

Sub-sample	***Obs***	***Unobs***	***Total***
1 – High-mass (σ>200 km/s) ETGs	32	0	32
2 – Low-mass (σ<200 km/s) ETGs	29	1	30
3 – Early type (Sa-Sb) spiral galaxies	14	22	36
4 – Milky Way twins	20	3	23
5 – Late type (Sc-Sd) spiral galaxies	25	24	49
Total	***119***	***51***	***170***

The degree of completion, per subsample, by the end of the semesters 2016A , 2016B and 2017A will be:

Priority	***Completion degree***		
	16A	16B	17A
1 – High –mass ETGs	100%	100%	100%
2 – Bright (B<11.0) Mini-DIVING^{3D}	93%	100%	100%
3 – Low-mass ETGs	80%	100%	100%
4 – Milky Way twins	74%	89%	96%
5 – Early type spirals	33%	39%	64%
6 – Late type spirals	45%	51%	61%
Total	***63%***	***70%***	***81%***

This means that, by the end of 2016B, we will have a degree of completion of 100% for the sub-samples High-mas ETGs, Low-mass ETGs and Mini-DIVING 3D.

It is very important to notice that the two semesters B were not completed, as shown in the following table. The program DIVING3D was approved in Nov/2013 and the time allocated by semester was:

Semester	time	observed	not observed
2014A	8.5hs	7	0
2014B	17hs	9	7
2015A	21hs	20	0
2015B	21.6	12	8
2016A	17hs	8	7

In the semester 2014B, 7 galaxies were not observed due to an operational mistake by the Gemini Observatory. In 2015B, 8 galaxies were not observed because of the bad weather due to the strong El Niño phenomenon. In the semester 2016A, 7 galaxies were not observed due to the El Nino phenomenon.

The proposed objects for the remaining semesters are:

2017A - 17.04h
NGC 3887, NGC 3672, NGC 4487, NGC 7083, NGC 7552, NGC 4593, NGC 7496, NGC 3223, NGC 5170, NGC 5556, NGC 4818, NGC 4902, NGC 4941, NGC 4995, NGC 5334, IC 5273

2017B - 17.04h
IC 5332, NGC 1448, NGC 1512, NGC 1350, NGC 7582, NGC 578, NGC 1042, NGC 1371, NGC 1637, NGC 1532, NGC 7727, NGC 1087, NGC 1425, NGC 1964, NGC 1385, NGC 7713

2018A - 8.23h
NGC 6118, NGC 4504, NGC 6753, NGC 5584, NGC 5161, NGC 5530, NGC 3513

2018B - 10.65h
NGC 210, NGC 1744, NGC 150, NGC 986, NGC 1249, NGC 1493, NGC 2090, NGC 7723, NGC 779, NGC 685

The Legacy strategy

Our commitment is to deliver the data to the Brazilian Astronomical Community. The idea is to give access to our community not only to the raw data (available after 1 year anyway) but also the reduced and the processed data. For this reason we will deliver two data cubes for each galaxy:

A – One data-cube with all spectra:
- Wavelength calibrated
- Flux calibrated
- Corrected for the differential atmospheric refraction (DAR).
- Removal of high frequency spatial noise with Butterworth filter
- Fingerprint removed

B – One additional cube will be available to the community with the additional data processing:
- Richardson-Lucy deconvolution

The data has been located in the projects' site ("DIVING3D" in CLOUD-USP). Due to budgetary restrictions, the University is not allowing any more such a use. The new site is being prepared in the VO server at IAG. In the meantime any data can be requested to
Tiago Ricci: tvricci@iag.usp.br or
Roberto Menezes: Roberto.menezes@iag.usp.br

As suggested by the NTAC we contacted LNA and the idea is to locate temporarily the archive in the VO server at IAG with a mirror in the LNA server. The idea is to minimize the labor for LNA staff. Perhaps in the future this can be change, as long as the labor of maintaining the archive is responsibility of the DIVING3D group and not of the LNA. This has been agreed with Dr. Alberto Ardila.

We plan to deliver the data releases six months after each of the subsample is completed. The next release will be in 2017A for the subsample "Low-mass ETGs". The "Mini-DIVING3D" will be completed in 2016B and, if the two remaining galaxies are observed, this sample will be released 6 months later.

6. Publications

Menezes, R. B., Steiner, J. E., Ricci, T. V. 2013 Ap J 765, L40
Collimation and Scattering of the Active Galactic Nucleus Emission in the Sombrero Galaxy

Ricci, T. V., Steiner, J. E. & Menezes, R. B. 2014 MNRAS 440, 2429 – Paper I
Integral field unit spectroscopy of 10 early-type galactic nuclei - I. Principal component analysis Tomography and nuclear activity

Ricci, T. V., Steiner, J. E. & Menezes, R. B. 2014 MNRAS 440, 2442 – Paper II
IFU spectroscopy of 10 early-type galactic nuclei - II. Nuclear emission line properties

Menezes, R. B., Steiner, J. E. & Ricci, T. V. 2014 Ap J Lett 796, L13
An off-centered active galactic nucleus in NGC 3115

Ricci, T. V.; Steiner, J. E.; Menezes, R. B. 2015 MNRAS 451, 3728
IFU spectroscopy of 10 early-type galactic nuclei - III. Properties of the circumnuclear gas emission.

R. B. Menezes, J. E. Steiner and Patrícia da Silva 2016, Astrophysical Journal 817, 150
The off-centered Seyfert-like compact emission in the nuclear region of NGC 3621

IFU spectroscopy of 10 early-type galactic nuclei - IV. Properties of the circumnuclear stellar kinematics
http://adsabs.harvard.edu/doi/10.1093/mnras/stw2318

The following papers are submitted for publication:

The emission-line regions in the nucleus of NGC 1313 probed with GMOS-IFU: Wolf-Rayet stars and a B[e]/LBV candidate.
R. B. Menezes and J. E. Steiner submitted to MNRAS, 2016

Integral Field Unit Spectroscopy of the inner 1 kpc of the galaxy NGC 5044
Suzi I.F. Diniz, Miriani G. Pastoriza, Jose A. Hernandez-Jimenez, Rogerio Riffel1, Tiago V. Ricci, J. E. Steiner, Rogemar A. Riffel – submited to MNRAS.

- Separately papers published by the group, which are related to the LLP (at least in terms of IFU methodology) and that did not make use of the LLP data.

Steiner, J. E.; Menezes, R. B.; Ricci, T. V.; Oliveira, A. S. Mapping low- and high-density clouds in astrophysical nebulae by imaging forbidden line emission 2009 MNRAS.396, 788

Steiner, J. E.; Menezes, R. B.; Ricci, T. V.; Oliveira, A. S. PCA Tomography: how to extract information from data cubes 2009 MNRAS 39, 64

Oliveira, A. S.; Steiner, J. E.; Ricci, T. V.; Menezes, R. B.; Borges, B. W. Optical identification of the transient supersoft X-ray source RX J0527.8-6954, in the LMC 2010 A&A 517, L5

Ricci, T. V.; Steiner, J. E.; Menezes, R. B. NGC 7097: The Active Galactic Nucleus and its Mirror, Revealed by Principal Component Analysis Tomography 2011 ApJ 734 L10

Steiner, J. E.; Menezes, R. B.; Amorim, Daniel Identification of a high-velocity compact nebular filament 2.2 arcsec south of the Galactic Centre 2013 MNRAS 431, 2789

Menezes, R. B.; Steiner, J. E.; Ricci, T. V. Collimation and Scattering of the Active Galactic Nucleus Emission in the Sombrero Galaxy 2013 ApJ 765 L40

Menezes, R. B.; Steiner, J. E.; Ricci, T. V. Discovery of an Hα Emitting Disk around the Supermassive Black Hole of M31 2013 ApJ 762 L29

Menezes, R. B., Steiner, J. E. & Ricci, T. V. 2014, MNRAS 438, 2597
A treatment procedure for Gemini North/NIFS data cubes: application to NGC 4151

Ricci, T. V.; Steiner, J. E.; Giansante, L. 2015 A&A 576, 58
A hot bubble at the centre of M81

Menezes, R.B., da Silva, P., Ricci, T.V., Steiner, J. E. & May, D., 2015 MNRAS 450, 369
A treatment procedure for VLT/SINFONI data cubes: application to NGC 5643

Menezes, R. B. & Steiner, J. E. 2015 Astrophysical Journal 808, 27
The molecular H2 emission and the stellar kinematics of the nuclear region of the Sombrero Galaxy.

May, D., Steiner, J. E., Ricci, T.V., Menezes, R.B, & Andrade, I.S. 2016 MNRAS 457, 949
Digging process in NGC 6951: the molecular disc bumped by the jet

All publications up to now have treated individual or small (~10 objects) samples. Now that the ETGs have been observed (and soon the mini-DIVING3D), we plan the first three statistical papers:

Paper I: The DIVING3D Project: sample definition, strategy and early results.
Paper II: The DIVING3D Project: nuclear emission line properties of Early Type Galaxies.
Paper III: The DIVING3D project: Statistical analysis of the complete sample of B<11.0 galaxies.

- **Thesis or dissertation work finished that are related to the LLP.**

Roberto Menezes (2012): Methodology development for the program
Tiago Ricci (2013): 10 early type galaxy studies, including some from the DIVING3D
Patrícia da Silva (April 2016): Analysis of 4 SBsc galaxies (Milky Way twins).

7. Response to NTAC questions

Include here the responses to the specific questions raised by the NTAC.

The NTAC recommends that the reduced data should be made available on a www server, preferably by the LNA.

As suggested by the NTAC we contacted LNA and the idea is to locate temporarily the archive in the VO server at IAG with a mirror in the LNA server. The idea is to minimize the labor for LNA staff. Perhaps in the future this can be change, as long as the labor of maintaining the archive is responsibility of the DIVING3D group and not of the LNA. This has been agreed with Dr. Alberto Ardila.

The committee noticed that in the last report there is a contradictory information stating that "...deliver the next data releases one year after each of the subsample is completed"; this should comply with the original plan (LLP proposal), that the data will be released 6 months after the data being processed.

We agree and the statement has been corrected. We plan to release the next two subsamples (Low-mass ETGs and mini-DIVING3D) in 2017A.

8. Additional material (optional)

Appendix A - Status of each object/subsample

1 - The sub-sample of high-mass (σ>200 km/s) ETGs

Name	Sem./ Red.	Type NED	B mag	d Mpc		gr/clust	AddObs
Ellipticals							
NGC 1316	13B/R	E4	9.6	20	SAB0^0(s)	Forn A	SINFONI; ACS/WFPC2
NGC 1549	13B/R	E0-1	10.76	16		Dor gr	
NGC 1399	08B/T	cD	10.79	18		Forn cl	SINFONI; ACS/WFPC2
NGC 3923	13A/T	E4-5	10.91	21			ACS
NGC 1407	13B/R	E0	10.93	23		Erid cl	ACS
NGC 3585	13A/T	E6	10.93	18			ACS/WFPC2
IC 1459	08B/T	E3-4	10.96	27			WFPC2
NGC 1404	08B/T	E1	11.04	19		Forn cl	ACS/WFPC2
NGC 720	13B/T	E5	11.15	24			
NGC 1395	13B/R	E2	11.18	21			
NGC 584	13B/T	E4	11.2	20			WFPC2
NGC 7507	13B/T	E0	11.43	22			
NGC 3557	13A/T	E3	11.46	37			WFPC2
NGC 1052	13B/T	E4	11.53	19			NIFS; ACS/WFPC2
IC 4296	13A/T	E	11.58	51		Gr(30)	ACS/WFPC2
NGC 4696	13A/T	cDpec	11.59	38		Cen cl	ACS/WFPC2
NGC 3962	13A/T	E1	11.66	31			
NGC 5018	13A/T	E3?	11.71	38			WFPC2
NGC 2974	13A/T	E4	11.78	25			WFPC2
NGC 6868	13A/T	E2	11.83	32			
NGC 4105	13A/T	E3	11.88	28			
NGC 5044	13A/T	E0	11.92	35			WFPC2
NGC 3904	13A/T	E2-3?	11.95	25			
NGC 1700	13B/T	E4	11.96	41			WFPC2
S0s							
NGC 3115	13A/R	S0^-	9.98	10.2			ACS/WFPC2
NGC 1380	08B/T	SA0	11.1	19		Forn cl	ACS/WFPC2
NGC 1574	13B/T	SA0^-(s)?	11.19	19		Dor gr	WFPC2
NGC 2784	13A/T	SA0^0(s)?	11.21	8.5			WFPC2
NGC 1332	13B/T	S0^-?(s)	11.24	20		Erid cl	SINFONI; WFPC2
NGC 5101	13A/T	(R)SB0/a(rs)	11.58	27			
NGC 2217	13B/T	(R)SB0+(rs)	11.59	19			
NGC 7049	13A/T	SA0^0(s)	11.64	28			ACS

Note (second column) - Reduced by: R = Roberto Menezes; T = Tiago Ricci; P = Patrícia Silva; I = Inaiara Andrade.
N1316 is a giant E. NED lists it as SAB0ˆ0(s)
NGC 1332, an elliptical (E6) or S0? (Kormendy and Ho, 2013

2 - The sub-sample of low-mass (σ<200 km/s) ETGs

Name	Sem/ Red	Type NED	B mag	d Mpc		group/clust	
Ellipticals							
NGC 5128	15A/R	S0 pec	7.89	3.7	-24.34	Cen A	SINFONI
NGC 4697	14A/R	E6	10.11	12.3			
			11.00				
NGC 1344	16B	E5	11.28	18.7		Erid cl	
NGC 5061	15A	E0	11.35	25.6			
NGC 7144	15B	E0	11.79	25.5			
NGC 0596	16B	cD pec?	11.88	21.5			
NGC 1427	16B	cD	11.94	19.4		Erid cl	
IC 5328	16A	E4	11.95	34.7			
S0s							
NGC 1291	14B/I	(R)SB0/a(s)	9.42	8.6			
NGC 1553	14B/R	SA0^0(r)	10.42	15.1		Dor gr	
NGC 5102	15A/I	SA0^-	10.64	18.8			SINFONI?
NGC 4753	15A/	I0	10.85	16.9		Virgo cl	
			11.00				
NGC 0936	15A/R	SB0^+(rs)	11.19	20.7			
NGC 4546	08A/T	SB0^-(s)?	11.3	18.1			WFPC2
NGC 1326	16B/I	(R)SB0^+(r)	11.34	17.0			
NGC 6684	15A /I	(R')SB0^0(s)	11.34	12.4			
NGC 1302	16B	(R)SB0/a(r)	11.38	20			
IC 5267	15A	SA0/a(s)	11.39	26.1			
NGC 4856		SB0/a(s)	11.4	21.1	(Não observável; 15A)		SOAR?
NGC 4958	15A	SB0(r)? e-o	11.48	18.5			
NGC 1543	15B	(R)SB0^0(s)	11.49	17.2		Dor gr	
NGC 1201	16B	SA0^0(r)?	11.56	20.4			
NGC 1537	15B	SAB0^- pec?	11.62	18.5			
NGC 1527	15B	SAB0^-(r)?	11.7	16.6			
NGC 1411	15B	SA0^-(r)?	11.7	15.5			
NGC 4691	15A	(R)SB0/a(s) p	11.7	22.5			
NGC 1533	15B	SB0^-	11.71	18.4		Dor gr	
NGC 4984	16A	(R)SAB0^+(rs)	11.71	21.3			
NGC 1387	15B	SAB0^-(s)	11.83	17.2		Erid cl	
NGC 1947	15B	S0^- pec	11.86	16.3			

D(median) = 18.7 Mpc
NGC 5128 (Cen A) is an elliptical with a merger in progress (Kormendy and Ho, 2013).

3 - The sub-sample of early spiral galaxies (Sa-Sb)

Name		Type NED	B(T) mag	d (Mpc) Mpc	MksT		
M 104	10B/R	SA(s)a e-on	9.28	10.4	-25.36		NIFS; ACS/WFPC2
NGC 1068	/R	(R)SA(rs)b	9.55	13.5	-24.66		NIFS; SINFONI
NGC 1097	16B/Thai	SB(s)b	10.16	20.0			
NGC 1365	14B/	SB(s)b	10.21	17.9		Forn cl	
NGC 4699	13A/T	SAB(rs)b	10.44	24.7			
NGC 1398	15B/	(R')SB(r)a	10.6	21.0		Erid cl	
NGC 1433	15B/	(R')SB(r)ab	10.68	10.0			
NGC 1808	15B/	(R)SAB(s)a	10.7	11.5			
			11.00				
NGC 1672	15B/	SB(s)b	11.03	14.5		Dor gr	
NGC 7213	15A/	SA(s)a?	11.18	22			
NGC 7410	15A/	SB(s)a	11.3	20.1			
NGC 1617	16B /	SB(s)a	11.37	13.4		Dor gr	
NGC 1512	17B /	SB(r)a	11.38	12.3			
NGC 1350	17B /	(R')SB(r)ab	11.4	20.9		Erid cl	
NGC 7552	17A/	(R')SB(s)ab	11.4	17.1			
NGC 7582	17B/T	(R')SB(s)ab	11.46	20.6			SINFONI?
NGC 1371	17B/	SAB(rs)a	11.5	23.2		Erid cl	
NGC 1532	17B/	SB(s)b pec e-on	11.53	17.0		Forn cl	
NGC 7606	16A/ok	SA(s)b	11.55	31.5			
NGC 7727	17B/	SAB(s)a pec	11.55	23.3			
NGC 1425	17B/	SA(s)b	11.6	21.3		Forn cl	
NGC 1964	17B/	SAB(s)b	11.6	21.4			
NGC 0210	17B/	SAB(s)b	11.65	21.0			
NGC 4593	17A/	(R)SB(rs)b	11.72	33.9			
NGC 5792	16Aok	SB(rs)b	11.72	24.4			
NGC 0150	18B /	SB(rs)b?	11.75	21.0			
NGC 7496	17A/	SB(s)b	11.78	15.0			
NGC 0986	18B/	SB(rs)ab	11.8	17.1			
NGC 7723	18B/	SB(r)b	11.85	27.4			
NGC 0779	18B/	SAB(r)b	11.86	17.7			
NGC 3223	17A	SA(s)b	11.88	33.4			
NGC 4818	17A/	SAB(rs)ab pec?	11.89	20.0			
NGC 4941	17A/	(R)SAB(r)ab?	11.9	18.2			
NGC 4995	17A/	SAB(rs)b	11.9	28.9			
NGC 4902	17A/	SB(r)b	11.9	39.2			
NGC 6753	17A/	(R)SA(r)b	11.93	42			

D (median) = 21 Mpc

4 - The sub-sample of Milky Way twins (Sbc)

Name	Sem Red	Type NED	B(T) mag	d Mpc	MksT	Gr/cl	
NGC 6744	14A/P	SAB(r)bc	9.24	9.5	double liner?		
NGC 1566	13B/P	SAB(s)bc	10.21	12.2		Dor gr	WFPC2
NGC 613	14B/P	SB(rs)bc	10.75	25.1	double bulge		HST; SINFONI H, K
NGC 1792	14B/	SA(rs)bc	10.85	13.2			
NGC 134	15A/P	SAB(s)bc	10.96	18.9			
			11.00				
NGC 157	14B/	SAB(rs)bc	11.04	19.5			
NGC 4030	14A/	SA(s)bc	11.07	24.5			
NGC 5247	15A/	SA(s)bc	11.1	22.2			
NGC 1300	13B/T	SB(rs)bc	11.1	18.0	-24.11	Erid cl	ACS/WFPC2; SINFONI H, K
NGC 2442	14A/	SB(s)bc pec	11.16	17.1			
NGC 2207	15A/	SAB(rs)bc pec	11.35	26.5			WFPC2
NGC 5054	15A/	SA(s)bc	11.51	19.8			
NGC 4939	15A/	SA(s)bc	11.56	39			
NGC 7205	16A	SA(s)bc	11.57	19.4			
NGC 1255	16B	SAB(rs)bc	11.6	21.5			
NGC 3887	17A	SB(r)bc	11.6	19.3			
NGC 7314	16A ok	SAB(rs)bc	11.65	18.5			
NGC 7083	17A	SA(s)bc	11.8	33.3			
NGC 0289	16B	SB(rs)bc	11.81	22.8			
NGC 4981	16A ok	SAB(r)bc	11.83	24.7			
NGC 1515	16B	SAB(s)bc	11.93	16.9			
NGC 1421	16B	SAB(rs)bc?	11.95	26.4			
NGC 5530	18A	SA(rs)bc	11.98	14.			

D (median) = 19.5 Mpc

5 - The sub-sample of late type galaxies (Sc-Sd)

Name	Sem Red	Type Ned	B(T) mag	d Mpc	Gr/cl	
NGC 253	13B/R	SAB(s)c	8.13	3.1	Phoenix;	ACS/WFPC2
N5236/M83	14A/R	SAB(s)c	8.51	7.0		ACS/WFPC2
NGC 300	13B/R	SA(s)d	8.7	2.0		ACS/WFPC2
NGC 1313	12B/R	SB(s)d	9.37	3.9	paper	
NGC 247	15A/R	SAB(s)d	9.51	3.6	like N5102?	NIFS(2008)
NGC 7793	16B	SA(s)d	9.65	4.2		
NGC 3621	14A/R	SA(s)d	10.03	6.8	paper off-nucl Sy?	GNIRS(Mason) ACS/WFPC2
NGC 2997	14B/R	SAB(rs)c	10.32	10.8	ACS/WFPC2	
NGC 1232	16B	SAB(rs)c	10.5	18.7	Erid cl	
NGC 5068	15A/R	SAB(rs)cd	10.53	6.1	strong off-nuc HII	WFPC2
NGC 908	14B/R	SA(s)c	10.87	17.6	double bulge??	
NGC 5643	14A/R	SAB(rs)c	10.89	16.9		WFPC2
NGC 1187	14B/R	SB(r)c	10.93	18.8	commet-shaped bulge??	
NGC 2835	15A/	SB(rs)c	10.95	10.8		
NGC 1559	13B/	SB(s)cd	10.97	15.7		WFPC2
NGC 7424	13A/R	SAB(rs)cd	10.99	11.5		WFPC2
			11.00			
NGC 7090	15B	SBc? e-on	11.1	8.4	ACS/WFPC2	
NGC 1084	16B	SA(s)c	11.25	21.2		
IC 5332	17B	SA(s)d	11.25	8.4		WFPC2
NGC 1448	17B	SAcd? e-on	11.3	17.4		ACS
NGC 578	17B	SAB(rs)c	11.48	21.8		
NGC 1042	17B	SAB(rs)cd	11.49	9.4		WFPC2
NGC 1637	17B	SAB(rs)c	11.52	10.7		
IC 5201	15A	SB(rs)cd	11.54	14.4		
NGC 4731	15A	SB(s)cd	11.55	19.7		
NGC 3511	15A	SA(s)c	11.56	14.3		
NGC 1087	17B	SAB(rs)c	11.56	17.5		
NGC 4666	15A	SABc?	11.56	18.2		
NGC 7713	18B	SB(r)d?	11.65	10.3		
NGC 1385	17B	SB(s)cd	11.65	14.9	Erid cl	
NGC 3672	17A	SA(s)c	11.66	27.1		
NGC 4487	16A2xok	SAB(rs)cd	11.66	20.0		
NGC 7184	16Aok	SB(r)c	11.67	33.6		
NGC 4781	16Aok	SB(rs)d	11.69	16.1		
NGC 1744	18B	SB(s)d	11.7	10.8		
NGC 4775	16Aok	SA(s)d	11.74	26.6		
NGC 1249	18B	SB(s)cd	11.8	15.8		
NGC 1493	18B	SB(r)cd	11.82	11.3		
NGC 2090	18B	SA(rs)c	11.85	12.8		
NGC 5170	17A	SA(s)c? e-on	11.88	27.3		
NGC 5556	17A	SAB(rs)d	11.88	18.7		
NGC 5334	17A	SB(rs)c?	11.9	32.6		
IC 5273	17A	SB(rs)cd?	11.9	16.6		
NGC 6118	18A	SA(s)cd	11.91	23.4		
NGC 4504	18A	SA(s)cd	11.92	21.8		
NGC 5584	18A	SAB(rs)cd	11.95	26.7		
NGC 685	18B	SAB(r)c	11.97	15.2		
NGC 5161	18A	SA(s)c?	11.98	24.3		
NGC 3513	18A	SB(rs)c	11.99	13.1		

D(median) = 15.7 Mpc
Note- Reduced by: R = Roberto Menezes; T = Tiago Ricci; P = Patrícia Silva; I = Inaiara Andrade.

Gemini Integration Time Calculator
GMOS-S - 2016B.2.1.1

Click here for help with the results page.
Read noise: 4.1
derived image size(FWHM) for a point source = 1.01 arcsec

Sky subtraction aperture = 250.0 times the software aperture.

Requested total integration time = 1800.00 secs, of which 1800.00 secs is on source.

S/N for BB:

The peak pixel signal + background is 23090 e- (12827 ADU). This is 22% of the full well depth of 106000 e-.

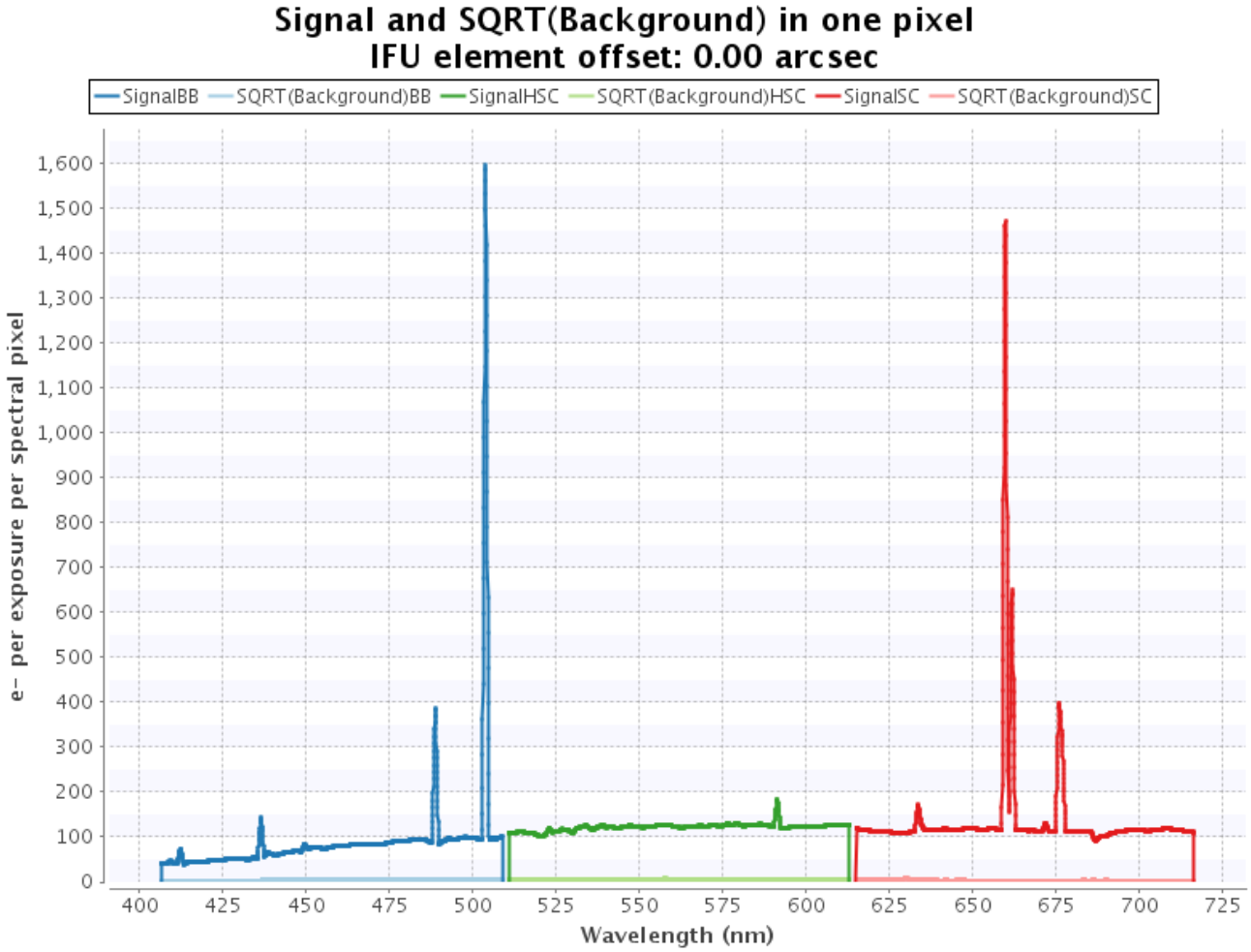
S/N for HSC:

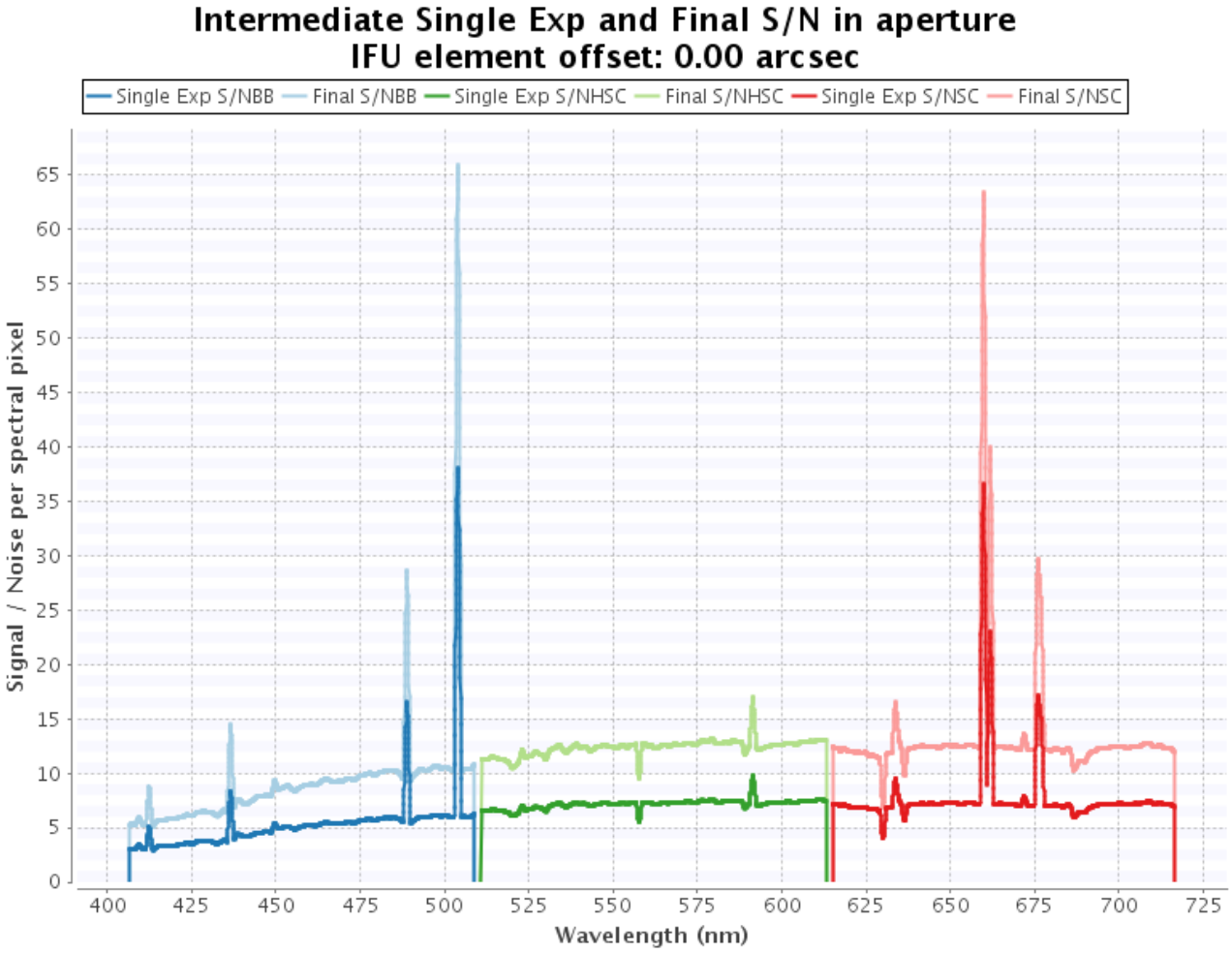
The peak pixel signal + background is 24950 e- (13861 ADU). This is 24% of the full well depth of 106000 e-.

S/N for SC:

The peak pixel signal + background is 6499 e- (3610 ADU). This is 6% of the full well depth of 106000 e-.

Click here for ASCII signal spectrum.
Click here for ASCII background spectrum.
Click here for Single Exposure S/N ASCII data.
Click here for Final S/N ASCII data.


Signal and SQRT(Background) in one pixel
IFU element offset: 0.00 arcsec
SignalBB
SQRT(Background)BB
SignalHSC
SQRT(Background)HSC
SignalSC
SQRT(Background)SC
e- per exposure per spectral pixel
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
400
425
450
475
500
525
550
575
600
625
650
675
700
725
Wavelength (nm)



Output:
- Spectra autoscaled.

Input Parameters:
Instrument: GMOS-S

Source spatial profile, brightness, and spectral distribution:
The z = 0.00581 extended source is a 17.5 Vega/arcsec² spiral-galaxy in the B band.

Instrument configuration:
Optical Components:
- Fixed Optics
- IFU Transmission
- Grating Optics: B600_G5323
- Detector - Hamamatsu array

Amp gain: Low, Amp read mode: Slow
- Focal Plane Mask: IFU Right Slit (red)

Central Wavelength: 562.0 nm

Spatial Binning: 1
Spectral Binning: 1
Pixel Size in Spatial Direction: 0.080778arcsec
Pixel Size in Spectral Direction: 0.05nm
IFU is selected,with a single IFU element at 0.0arcsecs.

Telescope configuration:
- silver mirror coating.
- side looking port.
- wavefront sensor: oiwfs

Observing Conditions:
- Image Quality: 70.00%
- Sky Transparency (cloud cover): 70.00%
- Sky transparency (water vapour): 100.00%
- Sky background: 80.00%
- Airmass: 1.50

Frequency of occurrence of these conditions: 39.20%

Calculation and analysis methods:
- mode: spectroscopy
- Calculation of S/N ratio with 3 exposures of 600.00 secs, and 100.00 % of them were on source.
- Analysis performed for aperture that gives 'optimum' S/N and 250 fibres on sky.

Gemini Integration Time Calculator
GMOS-S - 2016B.2.1.1

Click here for help with the results page.
Read noise: 4.1
derived image size(FWHM) for a point source = 0.99 arcsec

Sky subtraction aperture = 250.0 times the software aperture.

Requested total integration time = 2700.00 secs, of which 2700.00 secs is on source.

S/N for BB:

The peak pixel signal + background is 23602 e- (13112 ADU). This is 22% of the full well depth of 106000 e-.

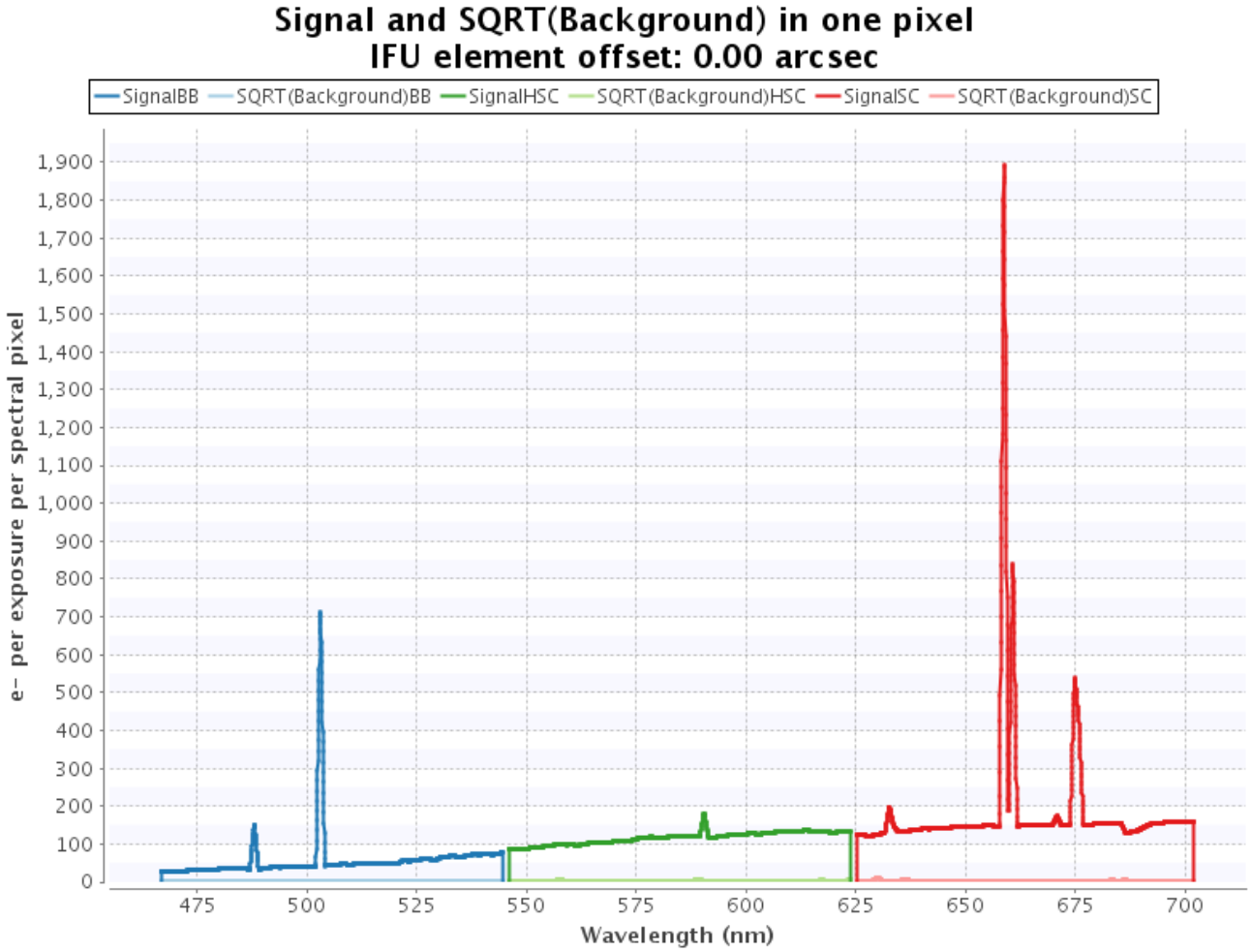
S/N for HSC:

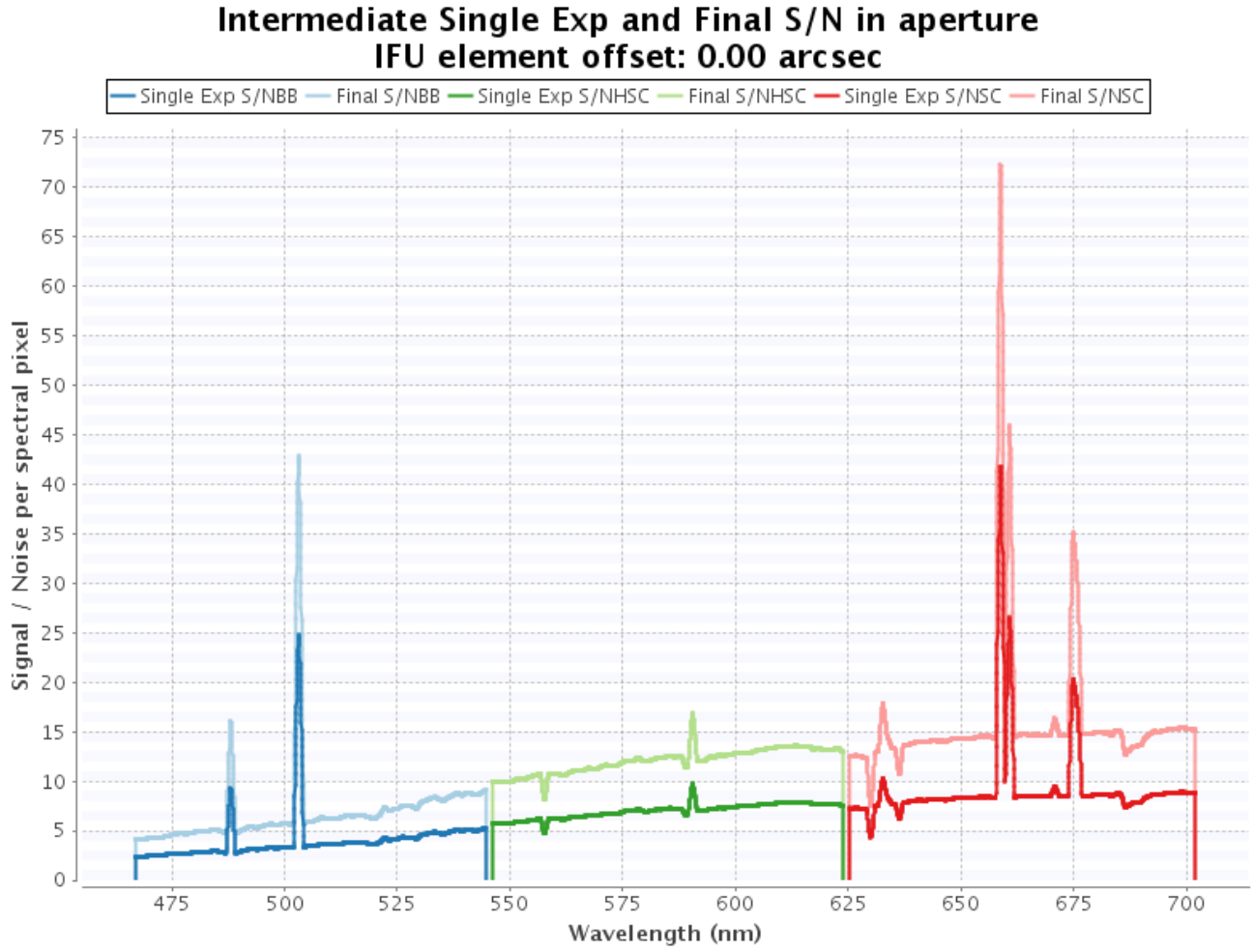
The peak pixel signal + background is 25503 e- (14168 ADU). This is 24% of the full well depth of 106000 e-.

S/N for SC:

The peak pixel signal + background is 3086 e- (1714 ADU). This is 3% of the full well depth of 106000 e-.

Click here for ASCII signal spectrum.
Click here for ASCII background spectrum.
Click here for Single Exposure S/N ASCII data.
Click here for Final S/N ASCII data.


Signal and SQRT(Background) in one pixel
IFU element offset: 0.00 arcsec
SignalBB
SQRT(Background)BB
SignalHSC
SQRT(Background)HSC
SignalSC
SQRT(Background)SC
e- per exposure per spectral pixel
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
475
500
525
550
575
600
625
650
675
700
Wavelength (nm)



Output:
- Spectra autoscaled.

Input Parameters:
Instrument: GMOS-S

Source spatial profile, brightness, and spectral distribution:
The z = 0.00431 extended source is a 17.5 Vega/arcsec² spiral-galaxy in the B band.

Instrument configuration:
Optical Components:
- Fixed Optics
- IFU Transmission
- Grating Optics: R831_G5322
- Detector - Hamamatsu array

Amp gain: Low, Amp read mode: Slow
- Focal Plane Mask: IFU Right Slit (red)

Central Wavelength: 585.0 nm

Spatial Binning: 1
Spectral Binning: 1
Pixel Size in Spatial Direction: 0.080778arcsec
Pixel Size in Spectral Direction: 0.038nm
IFU is selected,with a single IFU element at 0.0arcsecs.

Telescope configuration:
- silver mirror coating.
- side looking port.
- wavefront sensor: oiwfs

Observing Conditions:
- Image Quality: 70.00%
- Sky Transparency (cloud cover): 70.00%
- Sky transparency (water vapour): 100.00%
- Sky background: 80.00%
- Airmass: 1.50

Frequency of occurrence of these conditions: 39.20%

Calculation and analysis methods:
- mode: spectroscopy
- Calculation of S/N ratio with 3 exposures of 900.00 secs, and 100.00 % of them were on source.
- Analysis performed for aperture that gives 'optimum' S/N and 250 fibres on sky.