Improvements of ToO program

ToO program with Subaru instruments

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On behalf of Subaru SAC

Improvement proposals

1. ToO compensation factor
   - Current: the compensation factor is 1.
   - 現行：夜数を1倍して補填されている。
   - Issue: The interrupted non-ToO proposal loses nights by the weather factor (1.07 or 1.2).
   - 問題点：被ToO提案が天候ファクター分（1.07, 1.2倍）夜を失っている。
   - Proposal: Increase the ToO compensation factor for the classical mode to 1.5 and allocate compensation with rounding up to the nearest 0.5 night.
   - 解決案：クラシカル観測の補填を1.5倍にする。補填時は0.5夜単位に切り上げ。
2. Accelerated compensation
   - Current: compensation is made as early as possible, even in the same semester, on a best-effort basis, but not until about one year later in many cases.
   - 現行： 同じ期も含めてできるだけ早い補填を行っているが、1年後になるケースが多い
   - Issue: Interrupted non-ToO proposals are delayed. Large problems may be caused in by the delay, especially for student PI proposals.
   - 問題点：被ToO提案の遂行が遅れる。特に学生PI提案においては遅れが大きな問題となりえる。
   - Proposal: Leave TBD nights at least to compensate interrupted student PI proposals in the same semester. Compensate as early as possible and put higher priority on student PI proposals.
   - 解決案：できるだけ同一期に補填できるようTBD夜を確保する。補填の際、学生PI観測を優先する。

Improvement proposals

3. Intensive program
   - Current: Only non-ToO proposals can request intensive program.
   - 現行: non-ToO提案のみがIntensiveプログラムを申請できる。
   - Issue: All science categories should have access to the intensive program, which is not counted for the allocated, accepted, and consumed nights of normal program.
   - 問題：normalプログラムの夜数配分・採択・消費にカウントされないIntensiveプログラムにはすべてのサイエンスカテゴリから提案できるべき。
   - Proposal: Allow the submission of ToO proposals to the intensive program.
   - 解決案：ToO観測もintensiveに提案可能にする。
4. Establishment of a rare ToO category
   - Current: An execution rate of 50% is assumed for all ToO proposals, and the nights are counted for the allocated, accepted, and consumed nights of science categories.
   - 現行: 全ToOについて50%の遂行率が仮定され、サイエンスカテゴリの夜数配分、採択、消費にカウントされる。
   - Issue: ToO proposals are executed less than non-ToO proposals (by a factor of 0.36-0.39).
   - 問題：ToO提案はnonToO提案より遂行されていない。遂行率が0.36-0.39倍である。
   - Proposal: Establish a new rare ToO program for objects with low occurrence rates.
     - Independent of all science categories and the nights are not counted for the allocated, accepted, and consumed nights of science categories.
   - 解決案：発生率の低い天体を対象とするカテゴリ rare ToO というプログラムを新設する。
     - すべてのサイエンスカテゴリから独立、夜数配分・採択・消費にカウントしない

History

- In the Subaru UM FY2024, we discussed the ToO intensive program and concluded that quantitative investigation is needed.
- Quantitative investigation for previous ToO program since S10A has been made.
- Please see the Appendix: ToO summary as a reference.

Notation

- Submitted (number of nights [Nn], number of props. [Np])
- Allocated (Nn)
- Accepted (initial, additional) (Nn, Np)
- Scheduled (initial, final) (Nn, Np)
- Charged (Nn) only for ToO
- Executed (Nn, Np)

- Acceptance rate = $\frac{\text{Accepted (Nn, Np)}}{\text{Submitted (Nn, Np)}}$
- Schedule rate = $\frac{\text{Scheduled (Nn, Np)}}{\text{Accepted (Nn, Np)}}$
- Execution rate = $\frac{\text{Executed (Nn, Np)}}{\text{Scheduled (Nn, Np)}}$

Weather, Tel. trouble

Weather factor

- Executed Nn/Charged Nn
  - nonToO 0.728, ToO 0.781 (S10A-S25A)
  - nonToO 0.66, ToO 0.78 (S16A-S25A)

  The weather factors of ToO and nonToO proposals have been different by a factor of 1.07 or 1.2.

  It is fair to count this difference factor.

Low fraction of execution of ToO program

- In normal program, “fraction of submitted prop. ~ fraction of executed Nn” is expected for any categories in the Subaru operation and allocation scheme.

- ToO programs are executed less than non-ToO programs (by a factor of 0.36-0.39).
  - S10A-S25A: ToO: Fraction of submitted 5.07% executed 1.97%
  - S16A-S25A: ToO: Fraction of submitted 6.72% executed 2.40%
  - ~40 nights of the categories having the ToO program have been effectively used by the other categories over the past 15 years in total.

- “Fraction of submitted prop. ~ fraction of executed Nn” has not been realized in the ToO program.

Improvement proposals

1. ToO compensation factor
   - Proposal: Increase the ToO compensation factor for the classical mode to 1.5 and allocate compensation with rounding up to the nearest 0.5 night.
   - 解決案：クラシカル観測の補填を1.5倍にする。補填時は0.5夜単位に切り上げ。
2. Accelerated compensation
   - Proposal: Leave TBD nights at least to compensate interrupted student PI proposals in the same semester. Compensate as early as possible and put higher priority on student PI proposals.
   - 解決案：できるだけ同一期に補填できるようTBD夜を確保する。補填の際、学生PI観測を優先する。
3. Intensive program
   - Proposal: Allow the submission of ToO proposals to the intensive program.
   - 解決案：ToO観測もintensiveに提案可能にする。
4. Establishment of a rare ToO category
   - Proposal: Establish a new rare ToO program for objects with low occurrence rates.
   - 解決案：発生率の低い天体を対象とするカテゴリ rare ToO というプログラムを新設する。

1. ToO compensation factor

- Issues
  - If a ToO is triggered shortly before an observation, it places a substantial burden on the classical observers of interrupted non-ToO proposals.
  - The interrupted non-ToO proposal loses nights by the weather factor (1.07 or 1.2).
- Proposed solution
  - Increase the ToO compensation factor for the classical mode to 1.5 and allocate compensation with rounding up to the nearest 0.5 night.
  - The compensation factor for the queue mode unchanged (=1).
  - No upper limit.
- Discussion: the executed Nn may exceed the accepted Nn.
  - The compensation factor is 2 at Keck.
  - When compensation is granted, the observatory confirms what observations (for example, additional targets) will be conducted. This confirmation is made even in the current system.

2. Accelerated compensation

instrument	Original Others	Original Classical
HSC	8.4	2
PFS	0.5	0
FOCAS	1	8.96
HDS	2	2.5
MOIRCS	0.5	2.1
S-Cam	0	1

- Issues
  - Interrupted non-ToO proposals are delayed.
  - Large problems may be caused by the delay, especially for student PI proposals.

- Proposed solution
  - Reduce the additional acceptance at the initial scheduling, and leave TBD nights at least to compensate interrupted student PI proposals in the same semester (~1–3 nights).
  - Compensate as early as possible and put higher priority on student PI proposals.
  - The TBD nights are selected depending on the usable instruments, referring how often classical observations are interrupted by ToO triggers.
    - Example: 2/3 for FOCAS, HDS, and MOIRCS, 1/3 for HSC
    - Exchange of instruments on the TBD nights may be possible.
  - Supplementary acceptance is made about one month before the TBD nights.
    - The priority order for supplementary acceptance is the same as in the current system.
    - Backup normal programs, followed by service programs.

3. Intensive program

- Issue
  - All science categories should have access to the intensive program, which is not counted for the allocated, accepted, and consumed nights of normal program.

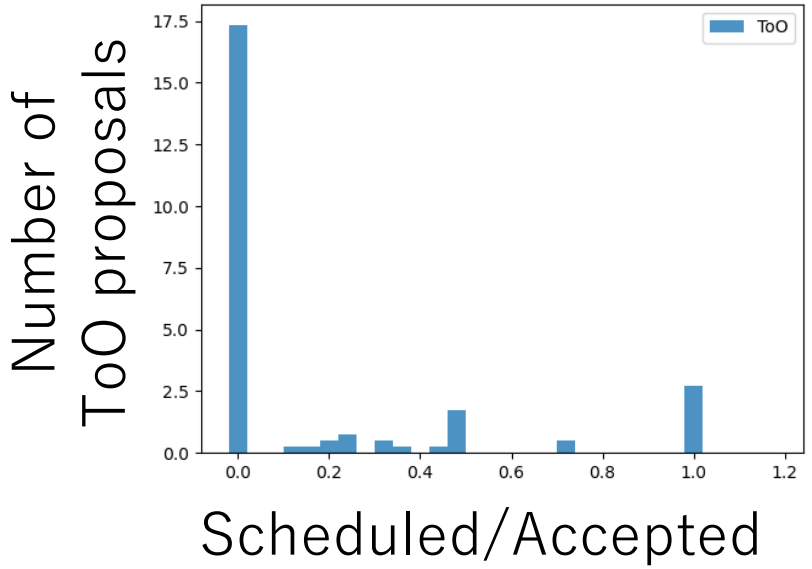
- Total number of allocatable nights for normal program

  = Total number of openuse nights – downtime – intensive – GT – SSP – service – ToO compensation – ToO arrangement – others (Rubin,GeminiFT)

- Proposed solution
  - Allow the submission of ToO proposals to the intensive program.
  - Limit to the ToO proposals that do not satisfy the criteria of rare ToO program (see below).
  - No concern were raised in Subaru UM FY2024.

4. Establishment of a rare ToO category

- Issue
  - ToO proposals are executed less than non-ToO proposals (by a factor of 0.36-0.39).
  - As many of the Subaru ToO proposals target rare events, the current counting fraction (50%) of the ToO proposals is overestimated. The actual schedule (trigger) rate of ToO proposals is <0.15.



- Proposed solution
  - Introduce a new independent category, ToO for rare events (“rare ToO”).
    - Apply for targets below a certain event-rate threshold.
    - Once accepted, a proposal remains active for 3 years.
    - Operation in the same way as a long (but normal-Nn) intensive program.
    - Indicative cap on total rare ToO nights (~100 nights)
  - Non-rare ToOs (“normal ToO”) remain in the regular allocation scheme, the counting fraction of 50% is kept.
  - Rare ToO proposals do not count for night consumption of review category.
  - Accept proposals above a TAC-defined threshold for each semester.

Continuous monitoring and re-arrangement

- SAC will monitor the status, including the burden on the observatory and on interrupted non-ToO proposals, maintain discussion, and re-arrange them as necessary.

Appendix:
ToO Summary

ToO program with Subaru instruments

Notation

- Submitted (number of nights [Nn], number of props. [Np])
- Allocated (Nn)
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- Scheduled (initial, final) (Nn, Np)
- Charged (Nn) only for ToO
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- Execution rate = $\frac{\text{Executed (Nn, Np)}}{\text{Scheduled (Nn, Np)}}$

Weather, Tel. trouble

Allocated Nn of science (review) categories -1

- Total number of openuse nights (Nopenuse) = half year x 0.65 + additional nights if UH time is <0.15
- Total number of allocatable nights for normal program (Nnormal)

  = Total number of openuse nights – downtime – intensive – GT – SSP – service – ToO compensation – ToO arrangement – others (Rubin,GeminiFT)

- Nnormal are distributed to science (review) categories in proportion to

  Fraction of submitted props. = (Nn of each cat./Nn of all cats.

  + Np of each cat./Np of all cats.) / 2

  - Since the fraction reflects the level of activity and demand in each science category within the Subaru community, the observing time is allocated in proportion to the fraction so that scientific outputs can be generated accordingly.
  - “Fraction of submitted prop. ~ fraction of executed Nn” is expected.

Fraction of executed Nn = Executed Nn of each cat. / Executed Nn of all cats.

Allocated Nn of science (review) categories -2

- The accepted Nn of ToO proposals are counted by 50% (counting fraction) in the allocated Nn of each category, assuming that the ToO proposals will be scheduled (triggered) with a probability of ~50%.
- 50% of accepted Nn (= allocated Nn) to ToO proposals are not initially scheduled, and thus non-ToO proposals are additionally accepted and initially scheduled.
- If ToO proposals are not finally scheduled (triggered), the non-ToO proposals remain on the final schedule and will be executed.
- If ToO proposals are not finally scheduled (triggered), the allocated Nn of the ToO program, on which the ToO proposals are not scheduled, will be returned to the allocated Nn of the science category in the next semester.
- If ToO proposals are finally scheduled (triggered), 0.5 night will be charged even if the actual execution time is only one hour, and the interrupted non-ToO proposals will be rescheduled and executed.

Example: S26A

- Nnormal = 77
  - Nopenuse = 181(half year)x0.65 + 4.85 (UH unused)=122.5
  - Downtime 7, intensive 14.8, GT 0, SSP 10.5, service 3.5
  - ToO compensation 1, ToO arrangement 6.25, other 2.5
  - S25A: ToO 14.5 accepted, 1 scheduled in B3 -> arrangement 14.5/2-1 = 6.25
  - S26A: if ToO 14 accepted in B3, 7 nonToO additionally accepted and initially scheduled

77			Fraction	Fraction		Allocated	Average –		Additionally	ToO	Accepted	Initially Scheduled	Initially scheduled
Category	Np	Nn	of Np	of Nn	Average	Nn	Allocated Nn		accepted Nn	arrangement	Nn	Nn	-allocated Nn
A-1	11	24.50	5.5	5.2	5.346	5.50	0.154	1	0.5		6.0	6	0.5
A-2	9	20.00	4.5	4.3	4.369	4.50	0.131	1	0.5		5.0	5	0.5
A-3	15	18.16	7.5	3.9	5.663	5.50	-0.163	2	1		6.5	6.5	1.0
B-2	19	37.00	9.4	7.9	8.666	8.50	-0.166	2	1		9.5	9.5	1.0
B-3	16	29.50	7.9	6.3	7.121	7.25	0.129	1	0.5	6.25	21.0	7	-6.5
C-1	11	23.71	5.5	5.1	5.261	5.50	0.239	1	0.5		6.0	6	0.5
C-2C	17	44.69	8.4	9.5	8.990	9.00	0.010	2	1		10.0	10	1.0
C-2G	16	50.97	7.9	10.9	9.411	9.50	0.089	1	0.5		10.0	10	0.5
C-3	19	58.46	9.4	12.5	10.955	11.00	0.045	1	0.5		11.5	11.5	0.5
C-4	22	53.93	10.9	11.5	11.217	11.00	-0.217	2	1		12.0	12	1.0
Total	155	360.92	77.0	77.0	77.000	77.25		14	7		97.5	83.5	

Example: S26A – if 7 ToO scheduled (triggered) in S25A

- Nnormal =77
  - Nopenuse = 181(half year)x0.65 + 4.85(UH unused) = 122.5
  - Downtime 7, intensive 14.8, GT 0, SSP 10.5, service 3.5
  - ToO compensation **7**, ToO arrangement **0.25**, other 2.5
  - S25A: ToO 14.5 accepted, **7** scheduled in B3 -> arrangement 14.5/2-**7** = **0.25**
  - S26A: if ToO 14 accepted in B3, 7 nonToO additionally accepted and initially scheduled

77													
Category	Np	Nn	Fraction of Np	Fraction of Nn	Average	Allocated Nn	Average – Allocated Nn		Additionally accepted Nn		ToO arrangement	Accepted Nn	Initially Scheduled Nn	Initially scheduled -allocated Nn
A–1	11	24.50	5.5	5.2	5.346	5.50	0.154	1	0.5			6.0	6	0.5
A–2	9	20.00	4.5	4.3	4.369	4.50	0.131	1	0.5			5.0	5	0.5
A–3	15	18.16	7.5	3.9	5.663	5.50	-0.163	2	1			6.5	6.5	1.0
B–2	19	37.00	9.4	7.9	8.666	8.50	-0.166	2	1			9.5	9.5	1.0
B–3	16	29.50	7.9	6.3	7.121	7.25	0.129	1	0.5		0.25	15.0	1	-6.5
C–1	11	23.71	5.5	5.1	5.261	5.50	0.239	1	0.5			6.0	6	0.5
C–2C	17	44.69	8.4	9.5	8.990	9.00	0.010	2	1			10.0	10	1.0
C–2G	16	50.97	7.9	10.9	9.411	9.50	0.089	1	0.5			10.0	10	0.5
C–3	19	58.46	9.4	12.5	10.955	11.00	0.045	1	0.5			11.5	11.5	0.5
C–4	22	53.93	10.9	11.5	11.217	11.00	-0.217	2	1			12.0	12	1.0
Total	155	360.92	77.0	77.0	77.000	77.25		14	7			91.5	77.5	

nonToO vs. ToO

S10A-S25A: Supplementary accepted and scheduled 120.5
ToO: Fraction of submitted 5.07% executed 1.97%

Nn	Submitted	Accepted	Scheduled	Charged	Down	Executed	Scheduled/accepted	Executed/scheduled	Executed/accepted	Executed/charged	Accepted/submitted	Executed/submitted
nToO	7500	1705	1814	-	571	1241	1.064	0.684	0.728	0.728	0.227	0.165
ToO	424	180	29	32	4	25	0.162	0.861	0.140	0.781	0.425	0.059

Np	Submitted	Accepted	Scheduled	Charged	Down	Executed	Scheduled/accepted	Executed/scheduled	Executed/accepted	Executed/charged	Accepted/submitted	Executed/submitted
nToO	3278			1085	1085	-	958	1.0	0.883	0.883	0.331	0.292
ToO	165			101	32	-	32	0.32	1.0	0.32	0.612	0.194

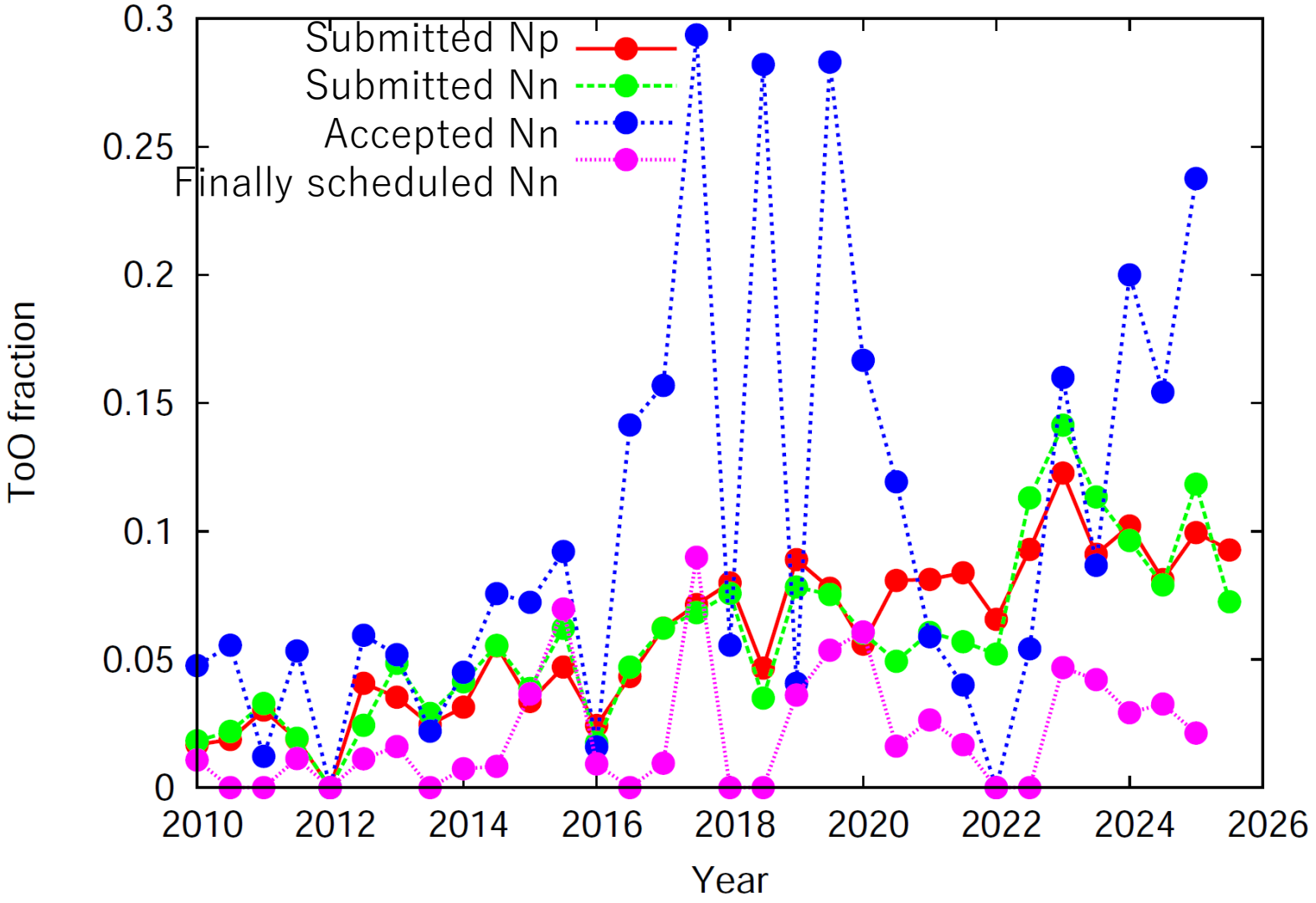
S16A-S25A: Supplementary accepted and scheduled 56
ToO: Fraction of submitted 6.72% executed 2.40%

Nn	Submitted	Accepted	Scheduled	Charged	Down	Executed	Scheduled/accepted	Executed/scheduled	Executed/accepted	Executed/charged	Accepted/submitted	Executed/submitted
nToO	3922	938	1016	-	396	618	1.08	0.61	0.66	0.66	0.239	0.158
ToO	301	141	17.7	19.5	2.5	15.2	0.13	0.86	0.11	0.78	0.468	0.051

Np	Submitted	Accepted	Scheduled	Charged	Down	Executed	Scheduled/accepted	Executed/scheduled	Executed/accepted	Executed/charged	Accepted/submitted	Executed/submitted
nToO	1869			602	602	-	500	1.0	0.83	0.83	0.322	0.268
ToO	126			74	20	-	20	0.27	1.0	0.27	0.587	0.159

nonToO vs. ToO

History of ToO fraction



Instruments – ToO fraction (Scheduled)

instrument	ToO nights	all nights	ToO props	all props	ToO fraction (nights)	ToO fraction (props)
Subaru	30.3	3672.5	33	1942	0.0082	0.017
HSC	10.4	874.7	12	294	0.0119	0.0408
PFS	0.5	40.3	1	10	0.0124	0.1
FOCAS	10	443.9	11	267	0.0225	0.0412
HDS	5.2	502.9	5	303	0.0103	0.0165
IRCS	6.1	699.2	9	464	0.0088	0.0194
IRD	0	193.7	0	85	0	0
SCExAO	0	262.6	0	170	0	0
COMICS	0	92.3	0	78	0	0
MOIRCS	2.1	299.6	4	193	0.0071	0.0207
S-Cam	1	283.2	1	162	0.0035	0.0062

Categories – ToO fraction (Scheduled)

S10A-S25A

category	ToO nights	Subaru nights	ToO props	Subaru props	ToO fraction (nights)	ToO fraction (props)
Subaru	29.8	1973.9	32	1083	0.0151	0.0295
A1	1	163.8	1	97	0.0061	0.0103
A2	0	284.3	0	153	0	0
A2-1	0	1	0	1	0	0
A2-2	0	5.1	0	2	0	0
B1	0	173.7	0	114	0	0
B2	2.2	164.8	2	101	0.0133	0.0198
B3	25.6	140.1	28	93	0.1825	0.3011
C1	0	173	0	98	0	0
C2	0	96.6	0	38	0	0
C2C	0	76	0	44	0	0
C2G	0	50	0	27	0	0
C2L	0	65.5	0	29	0	0
C2O	0	100.6	0	47	0	0
C3	0	190.5	0	102	0	0
C4	1	288.9	1	137	0.0035	0.0073

Categories normal

category	Submitted Np	Submitted Nn	Accepted Nn	Scheduled Nn	Queued Nn	Time exchange	Scheduled ToO	Accepted/submitted	Scheduled/accepted	Scheduled/submitted	Frac. of submitted Np	Frac. of submitted Nn	Frac. of submitted	Frac. of accepted	Frac. of scheduled	Frac. of accepted/frac. of submitted	Frac. of scheduled/frac. of submitted
A1	305	591.0	166.9	162.8	0.3	11	1	0.282	1.049	0.296	0.069	0.061	0.065	0.064	0.072	0.975	1.1
A2	488	1032.9	311.7	291.4	1.1	10.05	0	0.302	0.971	0.293	0.111	0.107	0.109	0.119	0.124	1.091	1.138
B1	404	773.9	200	174.7	0.5	23.5	0	0.258	0.994	0.257	0.092	0.08	0.086	0.076	0.081	0.887	0.947
B2	281	504.4	165.7	162.6	0	10.5	2.2	0.329	1.058	0.348	0.064	0.052	0.058	0.063	0.072	1.088	1.238
B3	406	893.7	330.6	118.7	10.6	34.51	23.97	0.37	0.568	0.21	0.092	0.092	0.092	0.126	0.077	1.364	0.833
C1	512	1166.5	273.8	173.0	46.3	38.5	0	0.235	0.941	0.221	0.116	0.121	0.118	0.104	0.106	0.88	0.891
C2A	1007	2380.3	560.1	389.2	59.39	97.5	0	0.235	0.975	0.229	0.229	0.246	0.237	0.213	0.224	0.898	0.942
C3	407	985.4	287.9	203.5	31.9	13.5	0	0.292	0.864	0.253	0.092	0.102	0.097	0.11	0.102	1.128	1.049
C4	594	1343.2	329.7	291.9	11.1	46.59	1	0.245	1.063	0.261	0.135	0.139	0.137	0.126	0.144	0.917	1.048

ToO triggered observations

instrument	ToO nights	all nights	ToO fraction (nights)
HSC	8.54	104.19	0.082
PFS	0.5	5.37	0.093
FOCAS	8.5	70.9	0.12
HDS	4.2	17.9	0.235
MOIRCS	2.12	12.58	0.169
S-Cam	1	9	0.111

|dt| < 7days

instrument	Original Others	Original Classical
HSC	8.4	2
PFS	0.5	0
FOCAS	1	8.96
HDS	2	2.5
MOIRCS	0.5	2.1
S-Cam	0	1

Instruments that can be used in the same night

		Primary		Cs				NsOpt		NsIR			
Obs. Focus	Main Inst	HSC	PFS	FOCAS	MOIRCS	COMICS	MCS (a part of PFS)	HDS	Turblance Profiler (Eng)	IRCS+AO	SCExAO	IRD	REACH
Primary	HSC	◉	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
Primary	PFS	✕	◉	✕	✕	✕	◉	✕	✕	✕	✕	✕	✕
Cs-Opt-M2	FOCAS	✕	✕	◉	✕	✕	✕	▲	✕	✕	✕	✕	✕
Cs-Opt-M2	MOIRCS	✕	✕	✕	◉	✕	✕	▲	✕	✕	✕	✕	✕
Cs-Opt-M2	HDS	✕	✕	▲	▲	✕	✕	◉	✕	✕	✕	✕	✕
IR-M2	MOIRCS	✕	✕	✕	◉	✕	✕	▲	▲	▲	▲	▲	▲
IR-M2	COMICS	✕	✕	✕	✕	◉	✕	▲	▲	▲	▲	▲	▲
IR-M2	HDS	✕	✕	✕	▲	▲	✕	◉	✕	▲	▲	▲	▲
IR-M2	TP (Eng)	✕	✕	✕	▲	▲	✕	✕	◉	▲	▲	▲	▲
IR-M2	IRCS+AO	✕	✕	✕	▲	▲	✕	▲	▲	◉	▲	▲	▲
IR-M2	SCExAO	✕	✕	✕	▲	▲	✕	▲	▲	▲	◉	▲	▲
IR-M2	IRD	✕	✕	✕	▲	▲	✕	▲	▲	▲	▲	◉	▲
IR-M2	IRD	✕	✕	✕	▲	▲	✕	▲	▲	▲	▲	▲	◉

* The instruments on Primary, Cs, and NsOpt foci are exclusive operation during the night. i..e. only one instrument can be used on each focus.
* The instruments on NsIR can be switched during the night.
* ◉ : main instrument, ▲: if the instrument is in standby, then it can be used. ✕ is not available.

Fraction of executed Nn of ToO program

- S10A-S25A: ToO: Fraction of submitted 5.07% executed 1.97%
- S16A-S25A: ToO: Fraction of submitted 6.72% executed 2.40%

- ToO proposals are executed less than non-ToO proposals (by a factor of 0.36-0.39).
  - ~40 nights of the categories having the ToO program have been effectively used by the other categories over the past 15 years in total.

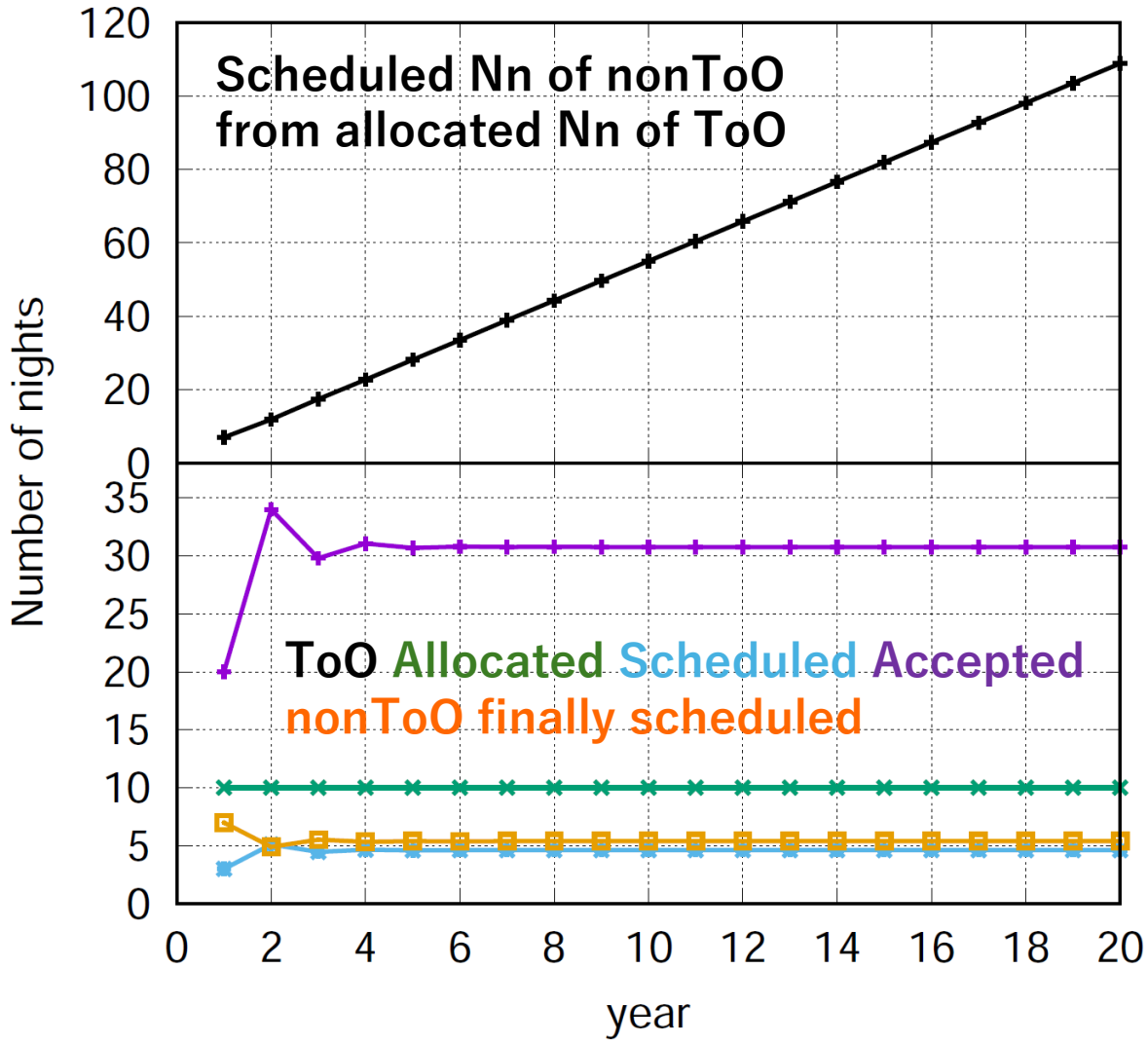
- “Fraction of submitted prop. ~ fraction of executed Nn” is not realized in the ToO program.

Reasons of low fraction of executed of ToO program - 1

Frac. of executed/frac. of submitted =0.36-0.39

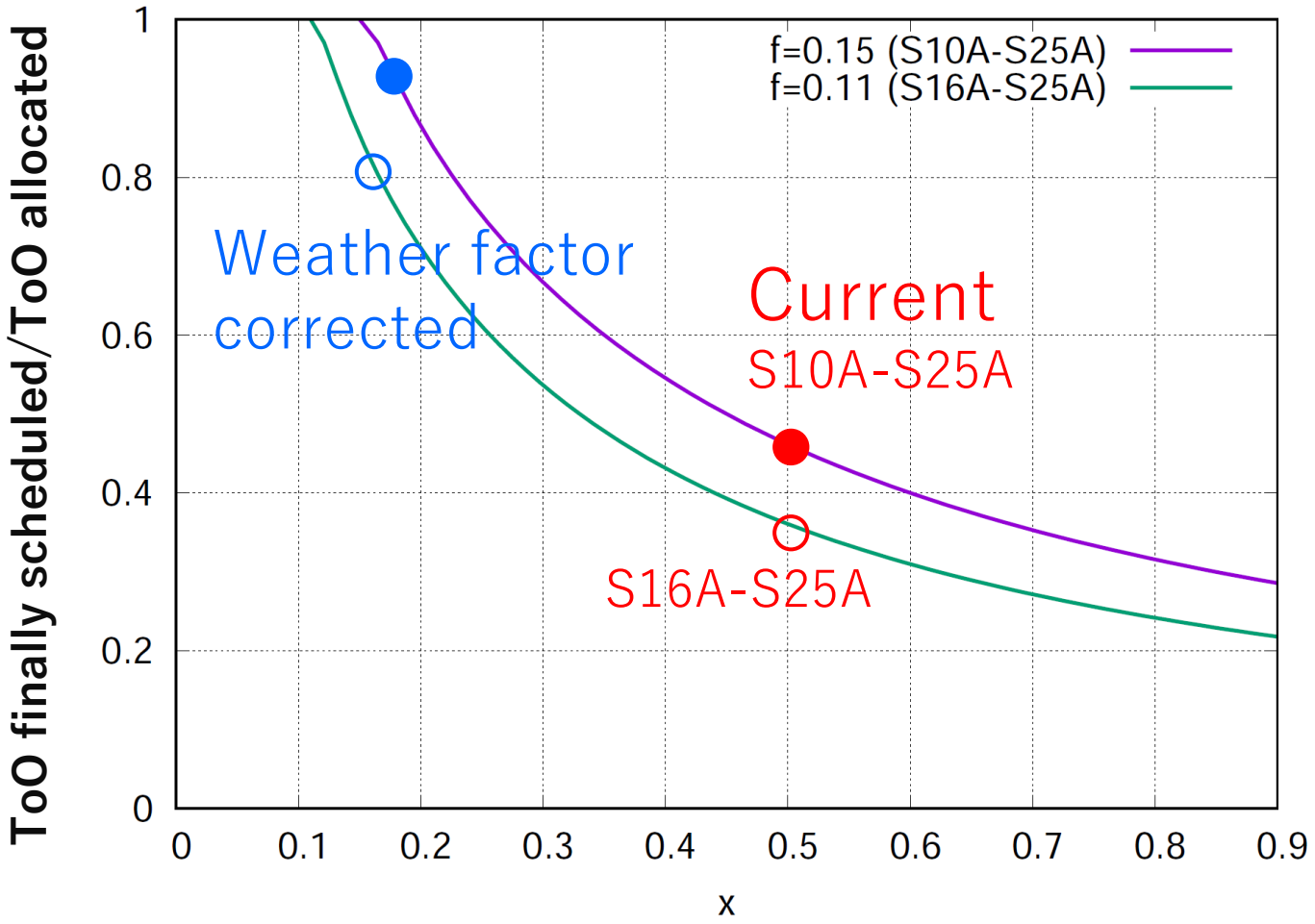
- N: nights for normal program
- a: fraction of submitted ToO proposals
  - Number of expected executed Nn: aN
- N_T: Number of accepted ToO Nn
- f: executed/accepted (schedule [trigger] rate) of ToO proposals (<~0.15)
  - Executed Nn of ToO proposals: fN_T
  - Returned Nn: $R = aN - fN_T$
- x: counting fraction of ToO program
  - $N_T = (aN+R)/x$
- 20 iterations

N=100, a=0.1, f=0.15, x=0.5



Reasons of low fraction of executed of ToO program - 2

Frac. of executed/frac. of submitted =0.36-0.39



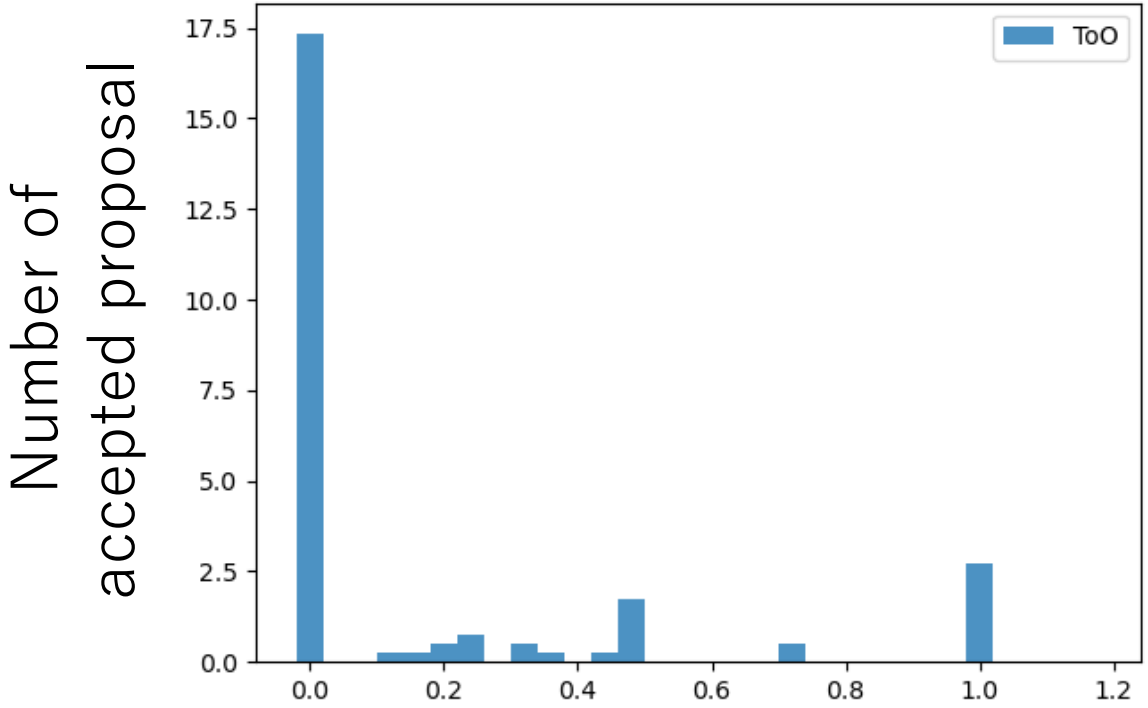
N=100, a=0.1

ToO finally executed
=ToO allocated
is realized only if x=f(=0.15)

Correcting weather factor (1.07 or 1.2), the counting fraction of ~0.2 is needed

Reasons of low schedule (trigger) rate

- Proposed number of nights is number of required nights when targets occur.
- The current assumption that the ToO proposals will be scheduled (triggered) with a probability of ~50% is an overestimate.
- In reality, ToO proposals with an (expected) schedule (trigger) rate < 0.5 event/semester are accepted.



More than half of ToO proposals does not trigger the observation.

Non-scheduled ToO proposals

- Non-scheduled ToO proposal != non-ToO proposal with low feasibility
  - If ToO proposals are not finally scheduled (triggered), the non-ToO proposals remain on the final schedule and will be executed.
  - While non-ToO proposals with low feasibility may waste Subaru time, non-scheduled ToO proposals does not waste any Subaru time.
  - The non-scheduled ToO proposals allow Subaru to keep prepared for rare and valuable targets.

Rare ToO program

- Rare ToO proposals
  - Independent from counts of allocated and accepted nights of science (review) categories
  - Accepted if it is ranked above a TAC-defined threshold
  - Indicative upper limit (cap) on total rare ToO nights (e.g., start with 100 nights and monitor)
  - If a proposal is re-classified from rare to normal in the reviewing process, the review category absorbs the accepted nights without changing allocated nights.
- Pros
  - Enables preparing for rare/valuable targets with minimal impact on other non-ToO proposals
  - Reduces repeated burden of proposal and reviewing process
  - Enables long-term planning, including for student projects
  - Makes acceptance rates across science (review) categories roughly comparable
  - Prevents excessive growth in number of rare ToO proposals
- Cons
  - Likely fewer rare ToO proposals are accepted than setting the counting fraction 0.2, making it harder to realize “fraction of submitted prop. ~ fraction of executed Nn”.

Quantitative summary of rare ToO

- Fraction of rare ToOs with a trigger rate < 0.5: 0.8 in Np, 0.85 in Nn
- Average trigger rate of rare ToOs with a trigger rate < 0.5
  - 0.037 in Np, 0.056 in Nn
- Average trigger rate of normal ToOs with a trigger rate > 0
  - ~0.6 in Nn
- How many rare ToO triggers are expected?
  - In 15 yrs (31 sems.), 165 ToO proposals, requesting 424 nights, are submitted.
  - In 3 yrs (6 sems.), even if all accepted, Np=32, Nn=82 (Nn=70 for rare ToO proposals).
  - The expected number of scheduled (triggered) nights is 3.5.
  - In reality, similar proposals are submitted repeatedly.
  - If the same proposals were submitted every semester, the average per semester is Np=5.3, Nn=14 (Nn=12 for rare ToO proposals).
  - The expected number of scheduled (triggered) nights is 0.6.

Condition on the occurrence rate for rare ToO program

- Schedule (trigger) rate: <0.5/semester
  - x 2 (North, South) x 2 (half year)
  - x 2.5 (daytime[coordinate])
  - x 2 (instruments)
  - (x 2.5 (daytime[time] for objects with short duration))

- Occurrence rate: <10/sky/yr @ Subaru depth

Occurrence rate of possible targets

- Supernovae: 10^{-4}/yr/Mpc^3
  - Targets' fraction should be applied to peculiar supernovae. (ex. SLSN: 0.1% of CCSN)
  - 8/yr/sky @<25Mpc, 400/yr/sky @<100Mpc, 4x10^5/yr/sky @<1Gpc (z<0.2)
- Tidal disruption event: $10^{-7\sim-6}$/yr/Mpc^3 (Yao+23)
  - 0.4-4/yr/sky @<100Mpc, 4x10^{2-3}/yr/sky @<1Gpc (z<0.2)
- Gamma-ray bursts: 1-10/yr/Gpc^3 (Wanderman & Piran 10)
  - 20/yr @z<5, 2/yr @z>5 (Swift 5 yr)
- Binary mergers (GWTC-4.0)
  - BNS: 7.6-250/yr/Gpc^3 -> 0.24-8/yr/sky @<200Mpc x2 @<250Mpc
  - BH-NS: 9.1-84/yr/Gpc^3 -> 0.29-2.6/yr/sky @<200Mpc
  - BBH: 14-26/yr/Gpc^3 -> 14-26/yr/sky @<1Gpc
    - If the target is limited to events with narrow localization, the fraction should be applied. (ex. <10% with area<10deg2)
- High-E neutrinos (IceCube+19)
  - Gold: 10/yr/sky (ex. <50% with 90% area<1deg2)
  - Bronze: 30/yr/sky
- MeV neutrinos: 0.01-0.03/yr/sky

Other rules

- Upper limit on number of nights: the same as for normal proposals (<=5 nights per proposal)
- No upper limit on the number of events
- Once an observation has been triggered,
  - The proposal can continue either until the originally accepted number of nights has been scheduled or up to three years.
  - Re-application during the three-year period is allowed.
    - If a similar proposal is submitted from the same group, the previous proposal will be invalidated.
- No exclusive-commitment requirement
- If a rare ToO proposal similar to an already accepted rare ToO proposal is also accepted from a different group
  - A ToO coordinator encourages coordination between the groups.
  - If coordination is not possible, priority will be assigned according to the rank at the time of acceptance.

Operation Scheme (to be confirmed)

1. The PI marks that a proposal is categorized in the rare ToO program in the form.
   - In the TJ, the PI provides an estimate of the occurrence rate of targets and explains why the proposal is categorized in the rare ToO program.
2. The proposal is reviewed in the same manner as in the current system.
   - Referees confirm that the occurrence rate is sufficiently low and satisfies the criteria of the rare ToO program.
   - For rare ToO proposals, referees evaluate the proposal based on its scientific value, assuming that the target occurs and that the ToO is triggered.
3. A rank is assigned to each proposal.
   - If a proposal is judged not to qualify as rare, it is instead treated as a normal ToO. Even though, the allocated nights of review categories does not change.
   - Its rank and the total number of proposals in the review category are kept for each accepted proposal.
4. Rare ToO proposals are excluded from the estimate of allocated Nn of review categories.
5. Excluding rare ToOs, accepted proposals are selected in the same way as in the current system.
   - Rare ToO proposals are not counted as the nights consumed by the review category.
   - Rare ToO proposals that exceed a TAC-defined threshold for the semester (for example, the acceptance rank for normal proposals, the rank relative to other proposals, or another TAC-defined criterion) are accepted.
6. As in the current system, an overall priority of ToO proposals, including both rare and normal ToO proposals across review categories, is defined.
   - Comparisons with continuing rare ToO proposals are made using the rank at the time of acceptance.
7. A ToO coordinator encourages coordination among similar proposals from Japan and across partner communities.

Simulation

If all proposed improvements are adopted,

1. ToO compensation factor
   - 1.5 times compensation (rounded up in 0.5-night units)
2. Accelerated compensation
   - Priority compensation of student PI proposals
   - Reserve TBD nights to compensate in the same semester
3. Intensive program
   - ToO acceptance
4. ToO execution fraction
   - Rare ToO program with an indicative 100-nights cap

Revisions

- Weather factor
  - The compensation factor for interrupted classical programs is increased to 1.5.
- Rare ToO
  - The acceptance threshold will be the same as in the current system.
  - Among 14 ToO nights, 12 rare ToO nights and 2 normal ToO nights.
  - Roughly half of proposals in the B3 category are rare ToO proposals.
- Accelerated compensation
  - Number of TBD nights to be reserved: N_{TBD}
  - Fraction of student PI proposals: 0.3
  - $N_{TBD} = (N_{rareToO} \times 0.05 + N_{normalToO} \times 0.5) \times 1.5 \times 0.3$
  - For $N_{rareToO} = 12$, $N_{TBD} = 0.7$
  - For $N_{rareToO} = 70$, $N_{TBD} = 2$
  - $N_{rareToO} \times 0.05 \times 1.5 \times 0.3$ are reserved as TBD nights for rare ToOs.

Example S26A

- Nnormal = **81.5**
  - Nopenuse = 181(half year)x0.65 + 4.85 (UH unused)=122.5
  - Downtime 7, intensive 14.8, GT 0, SSP 10.5, service 3.5
  - ToO compensation (assuming round up in 0.5n unit) **2**
  - ToO arrangement **0**, **rare ToO TBD 0.5**, other 2.5
  - **20** rare ToO proposal accepted
  - S25A: normal ToO **2** accepted, 1 scheduled in B3 -> arrangement 2/2-1 = **0**
  - S26A: if normal ToO **2** accepted in B3, N_{TBD}=**0.9**, **0.5** nonToO additionally accepted and initially scheduled

81.5 Category	Np	Nn	Fraction of Np	Fraction of Nn	Average	Allocated Nn	Average – Allocated Nn		Additionally accepted Nn	ToO arrangement	Accepted Nn	Initially Scheduled Nn	Initially scheduled -allocated Nn
A-1	11	24.50	6.1	5.8	5.931	6.00	0.069		0		6.0	6	0.0
A-2	9	20.00	5.0	4.7	4.848	5.00	0.152		0		5.0	5	0.0
A-3	15	18.16	8.3	4.3	6.294	6.00	-0.294	1	0.5		6.5	6.5	0.5
B-2	19	37.00	10.5	8.7	9.619	9.50	-0.119		0		9.5	9.5	0.0
B-3	8	15.00	4.4	3.5	3.982	4.00	0.018		0		5.0	3.0	-1.0
C-1	11	23.71	6.1	5.6	5.838	6.00	0.162		0		6.0	6	0.0
C-2C	17	44.69	9.4	10.5	9.970	10.00	0.030		0		10.0	10	0.0
C-2G	16	50.97	8.9	12.0	10.431	10.50	0.069		0		10.5	10.5	0.0
C-3	19	58.46	10.5	13.8	12.144	12.00	-0.144		0		12.0	12	0.0
C-4	22	53.93	12.2	12.7	12.443	12.50	0.057		0		12.5	12.5	0.0
Total	147	346.42	81.5	81.5	81.500	81.50		1	0.5		83	81	

Example S26A

- Nnormal = **79.5**
  - Nopenuse = 181(half year)x0.65 + 4.85 (UH unused)=122.5
  - Downtime 7, intensive 14.8, GT 0, SSP 10.5, service 3.5
  - ToO compensation (assuming round up in 0.5n unit) **2**
  - ToO arrangement **0**, **rare ToO TBD 2.5**, other 2.5
  - **100** rare ToO proposal accepted
  - S25A: normal ToO **2** accepted, 1 scheduled in B3 -> arrangement 2/2-1 = **0**
  - S26A: if normal ToO **2** accepted in B3, N_{TBD}=**2.7**, **0.5** nonToO additionally accepted and initially scheduled

79.5													
Category	Np	Nn	Fraction of Np	Fraction of Nn	Average	Allocated Nn	Average – Allocated Nn		Additionally accepted Nn	ToO arrangement	Accepted Nn	Initially Scheduled Nn	Initially scheduled -allocated Nn
A-1	11	24.50	5.9	5.6	5.786	6.00	0.214		0		6.0	6	0.0
A-2	9	20.00	4.9	4.6	4.729	5.00	0.271		0		5.0	5	0.0
A-3	15	18.16	8.1	4.2	6.140	6.00	-0.140		0		6.0	6	0.0
B-2	19	37.00	10.3	8.5	9.383	9.50	0.117		0		9.5	9.5	0.0
B-3	8	15.00	4.3	3.4	3.884	4.00	0.116		0		5.0	3.0	-1.0
C-1	11	23.71	5.9	5.4	5.695	5.50	-0.195		0		5.5	5.5	0.0
C-2C	17	44.69	9.2	10.3	9.725	9.50	-0.225	1	0.5		10.0	10	0.5
C-2G	16	50.97	8.7	11.7	10.175	10.00	-0.175		0		10.0	10	0.0
C-3	19	58.46	10.3	13.4	11.846	12.00	0.154		0		12.0	12	0.0
C-4	22	53.93	11.9	12.4	12.137	12.00	-0.137		0		12.0	12	0.0
Total	147	346.42	79.5	79.5	79.500	79.50		1	0.5		81	79	

Example S27A

- Nnormal = **80.5**
  - Nopenuse = 181(half year)x0.65 + 4.85 (UH unused)=122.5
  - Downtime 7, intensive 14.8, GT 0, SSP 10.5, service 3.5
  - ToO compensation (assuming round up in 0.5n unit) **3(4(=2x2)-1)**
  - ToO arrangement **0**, **rare ToO TBD 0.5**, other 2.5
  - **20** rare ToO proposal accepted, **1** scheduled in S26A
  - S25A: normal ToO **2** accepted, 1 scheduled in B3 -> arrangement 2/2-1 = **0**
  - S26A: if normal ToO **2** accepted in B3, N_{TBD}=**0.9**, **0.5** nonToO additionally accepted and initially scheduled
- Nnormal = **75.5**
  - Nopenuse = 181(half year)x0.65 + 4.85 (UH unused)=122.5
  - Downtime 7, intensive 14.8, GT 0, SSP 10.5, service 3.5
  - ToO compensation **6(9(=6x1.5)-3)**, ToO arrangement **0**, **rare ToO TBD 2.5**, other 2.5
  - **100** rare ToO proposal accepted, **5** scheduled in S26A
  - S25A: normal ToO **2** accepted, 1 scheduled in B3 -> arrangement 2/2-1 = **0**
  - S26A: if normal ToO **2** accepted in B3, N_{TBD}=**2.7**, **0.5** nonToO additionally accepted and initially scheduled