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CHANGE RECORD

Issue	Date	Sheet	Description of Change	Release
0.1 DRAFT	Juanuary 2008	All	First draft of Document	
1.0	April 2008	All	Added Annex results	

TABLE OF CONTENTS

1 ACRONYMS

BEM	Back End Module
BEU	Back End Unit
DAE	Data Acquisition Electronics
FEM	Front End Module
LNA	Low Noise Amplifier
PH/SW	Phase Switch
P/S	Phase Shifter
RAA	Radiometer Array Assembly
RCA	Radiometer Chain Assembly
REBA	Radiometric Electronic Box Assembly
S/C	Spacecraft
TBC	To Be Checked
TBD	To Be Defined
TBW	To Be Written

2 INTRODUCTION

2.1 Purpose and Scope

This Note shows the strategy to proposed to tune the LFI LNA's (Vg1 & Vg2) in the test campaign at Satellite Level to be performed in CSL (Centre Spatiale de Liege) during the next Summer 2008 .
The baseline option was accepted to be the MATRIX scheme , mixing together Vg1 and Vg2 values. The main limit to this method is given (in CSL) by the time required to explore a large range of parameters, since in CSL it is limited and strictly related with the 4K cooler cooldown profile.
This note wants to give an overview of the philosophy and possible advantages or limits related with one or another strategy..

3 APPLICABLE AND REFERENCE DOCUMENTS

3.1 Reference Documents

[RD 1] Technical Note on Bias Tuning –DRAFT, F.Cuttaia, 07/01/2008
[RD 2] Note on matrix definition for tuning, F .Cuttaia , 31/03/2008
[RD 3] PL-LFI- PST-TN-084: RCA27 Flight Spare Tuning Results

4 BASELINE MATRIX TUNING

At present, the baseline ACA matrix tuning foresees that:
- the LFI will be switched on using the 'tuned' bias identified during the RAA test campaign
- currents will be compared with previous data to check that the LFI behaves as expected and that the grounding is representative of similar electrical conditions: on the contrary, a recovery action must be thought (in advance!!) to set the instrument in similar conditions.
- a unique table for all the ACAs, with the above optimized Vg1 and VG2, is used as starting point - - for each leg, the two extreme values and the number of steps of variation is provided for Vg1 and VG2

It means that the a unique tuning table can be foreseen with the following information:

RCA #	Detector ID		SCOS Parameter	Start Values				Stop Values				Step	Step
				VG1		VG2		VG1		VG2		VG1	VG2
				DEC	HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC	DEC
CH27	00	00	LP001320		0		0		0		0	7	7
	01	01	LP002320		0		0		0		0	7	7
	02	10	LP003320		0		0		0		0	7	7
	03	11	LP004320		0		0		0		0	7	7

The method to apply the bias change foresees two FOR cycles cascaded:

```
For i=0,n1_step
        For j=0,n2_step
➔ apply Vg1(i), Vg2(j)
```

It produces [n1*n2] combinations of Vg1, Vg2

This is repeated for each ACA (4) of each RCA (11) , following the scheme in Table 1 (channels of the same frequency- with the same integration time- but not belonging to the same power group and bias tray are matched) :

RCA Under Tests in parallel
RCA 18 + RCA 21
RCA 19 + RCA 22
RCA 20 + RCA 23
RCA 25 + RCA 24
RCA 26 + RCA 27
RCA 28

Table 1 groups of channels to be tuned simultaneously

The BASELINE Vg1 and Vg2 values are THE SAME used during RAA test campaign (7 for Vg1 and 7 for Vg2) , mixed in all possible combinations (49 combinations per ACA)

4.1 Limits from this method:

1) The bias variation explored by subdividing the full range in n1 and n2 steps (in the table above n1=n2=7) is not necessary linear (since the steps are given in DEC or HEX): so it is possible that each step differs from the others in terms of voltage applied.

2) The change in the total drain current flowing in the LNA can be also abrupt, depending on the combination each time i change to i+1. The expected behaviour for the drain current, following the bias order reported in Figure 2, is displayed below (Figure 1). It was observed (Technical Note on Bias Tuning –DRAFT, F.Cuttaia, 07/01/2008) that , especially for certain 70 GHz LNA's, the drain current drift due to bias

changes is related with the amplitude of the change: hence, a very smooth change would be preferred (since the integration time per step was reduced to 20 seconds to fit the maximum time allocated for the test)

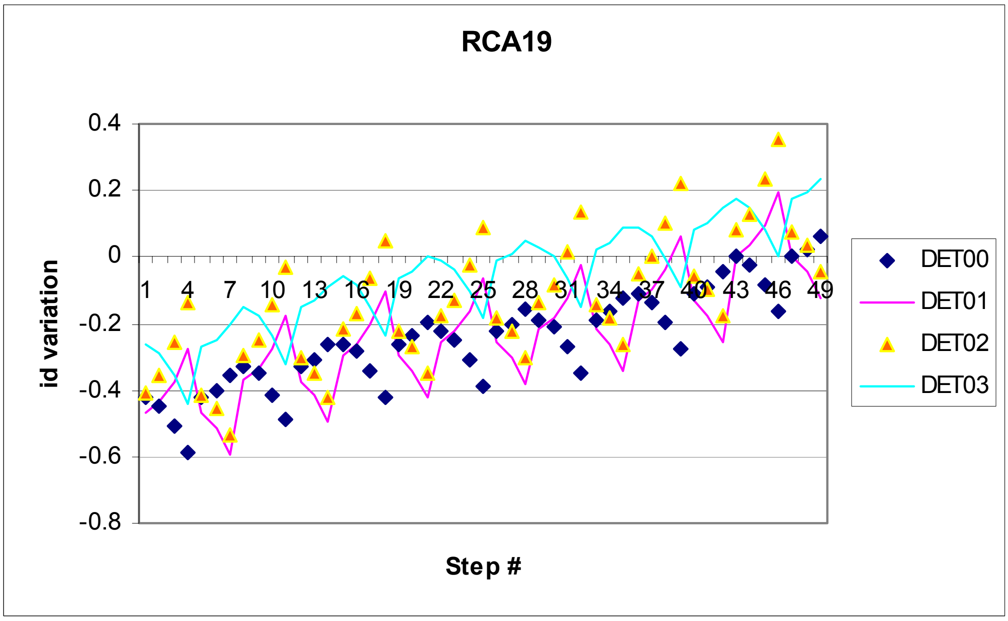


Figure 1 Id variation vs Vg1-Vg2 configuration (step #) for the 4 ACAs of RCA 19

3) Among the possible 49 combinations of Vg1 and Vg2 available for each leg, many are not useful since set the instrument in a status very far from the tuned one: hence, they should be discarded: several (the number and values depending on the ACA and RCA) Vg1-Vg2 combinations produce unacceptable currents (| DELTA id | > 40%) as several Vg1 or Vg2 independent changes (| DELTA id | > 25%). Superposing the two parameters the range of parameters to be explored (among those used in RAA calibrations) reduces sensibly.

4) The range explored during RAA calibrations in many cases is not symmetrical around the 'tuned value' that, in several cases: it was found to be the extreme (lowest or highest) value applied in the full range. In some cases could be then useful to symmetrise it around the expected optimum bias.

	RCA 19											
	DET 00			DET 01			DET 02			DET 03		
STEP #	Vg1	Vg2	Id expected	Vg1	Vg2	Id expected	Vg1	Vg2	Id expected	Vg1	Vg2	Id expected
1	168	201	10.86	166	193	3.12	172	204	9.22	159	201	10.41
2	168	196	9.76	166	198	4.81	172	209	9.92	159	196	9.95
3	168	186	7.79	166	208	6.03	172	219	11.35	159	186	9.12
4	168	171	5.43	166	223	6.69	172	234	13.51	159	171	7.98
5	168	206	9.58	166	188	7.37	172	199	9.19	159	206	10.45
6	168	216	12.00	166	178	8.72	172	189	8.55	159	216	10.87
7	168	231	14.31	166	163	10.82	172	174	11.86	159	231	11.81
8	183	201	12.48	181	193	4.81	187	204	11.12	174	201	11.87
9	183	196	11.37	181	198	6.50	187	209	11.81	174	196	11.42
10	183	186	9.41	181	208	7.73	187	219	13.25	174	186	10.58
11	183	171	7.05	181	223	8.39	187	234	15.41	174	171	9.44
12	183	206	11.20	181	188	9.06	187	199	11.09	174	206	11.92
13	183	216	13.62	181	178	10.42	187	189	10.44	174	216	12.33
14	183	231	15.93	181	163	12.52	187	174	13.75	174	231	13.27
15	193	201	13.80	191	193	6.03	197	204	12.62	184	201	12.97
16	193	196	12.69	191	198	7.73	197	209	13.32	184	196	12.51
17	193	186	10.73	191	208	8.95	197	219	14.75	184	186	11.68
18	193	171	8.37	191	223	9.61	197	234	16.91	184	171	10.54
19	193	206	12.52	191	188	10.29	197	199	12.59	184	206	13.01
20	193	216	14.94	191	178	11.64	197	189	11.94	184	216	13.43
21	193	231	17.25	191	163	13.74	197	174	15.25	184	231	14.37
22	198	201	14.50	196	193	6.69	202	204	13.41	189	201	13.55
23	198	196	13.40	196	198	8.39	202	209	14.11	189	196	13.10
24	198	186	11.43	196	208	9.61	202	219	15.54	189	186	12.27
25	198	171	9.07	196	223	10.27	202	234	17.71	189	171	11.12
26	198	206	13.23	196	188	10.95	202	199	13.38	189	206	13.60
27	198	216	15.64	196	178	12.30	202	189	12.74	189	216	14.01
28	198	231	17.95	196	163	14.40	202	174	16.05	189	231	14.95
29	203	201	15.27	201	193	7.37	207	204	14.24	194	201	14.14
30	203	196	14.17	201	198	9.06	207	209	14.93	194	196	13.68
31	203	186	12.20	201	208	10.29	207	219	16.37	194	186	12.85
32	203	171	9.84	201	223	10.95	207	234	18.53	194	171	11.71
33	203	206	14.00	201	188	11.62	207	199	14.21	194	206	14.18
34	203	216	16.42	201	178	12.98	207	189	13.56	194	216	14.60
35	203	231	18.73	201	163	15.08	207	174	16.87	194	231	15.54
36	213	201	16.87	211	193	8.72	217	204	15.95	204	201	15.35
37	213	196	15.77	211	198	10.42	217	209	16.65	204	196	14.90
38	213	186	13.80	211	208	11.64	217	219	18.08	204	186	14.07
39	213	171	11.44	211	223	12.30	217	234	20.24	204	171	12.92
40	213	206	15.60	211	188	12.98	217	199	15.92	204	206	15.40
41	213	216	18.02	211	178	14.33	217	189	15.28	204	216	15.81
42	213	231	20.33	211	163	16.43	217	174	18.59	204	231	16.75
43	228	201	19.41	226	193	10.82	232	204	18.61	219	201	17.26
44	228	196	18.31	226	198	12.52	232	209	19.31	219	196	16.80
45	228	186	16.34	226	208	13.74	232	219	20.74	219	186	15.97
46	228	171	13.98	226	223	14.40	232	234	22.91	219	171	14.82
47	228	206	18.14	226	188	15.08	232	199	18.59	219	206	17.30
48	228	216	20.56	226	178	16.43	232	189	17.94	219	216	17.72
49	228	231	22.87	226	163	18.53	232	174	21.25	219	231	18.65

Figure 2 expected currents for the bias variation following the order described above (numbers based on Vg1 and Vg2 bias applied during instrument level test campaign).

5 METHOD USED FOR CURRENTS CALCULATIONS

We have not a model able to predict the drain current of any bias combination. LABEN's model is able to recalculate the equivalent bias when you switch ON / OFF an ACA in the same power group, given a fixed current, but not to calculate the expected current 'a priori' when you change a bias.
Hence, at present, we have just, from experimental data, for each leg:
-Currents corresponding to 7 Vg1 steps with fixed Vg2 (set to the optimized value indicated from RCA tuning)
-Currents corresponding to 7 Vg2 steps with fixed Vg1 (set to the optimized value indicated from RAA Vg1 tuning)
.
To have a simple guess of the expected current change due to the 49 bias combinations we can suppose that Vg1 and Vg2 changes produce independent current changes and then can be tabulated and mixed together obtaining the total current variations just by summing them.
This should be true for 30 GHz and 44 GHz channels , since Vg1 and Vg2 stages are physically separated; for 70 GHz channels it is not absolutely true, since Vg1 and Vg2 are somehow interconnected . However it seems that , at the first order (to be verified the uncertainty with Hylinen) , this method could provide a reasonable result also for 70 GHz.
Expected currents have been calculated for all the legs and compared (%) with the nominal currents (tuned bias).
The model for expected currents calculation was tested on the Flight Spares. Results are encouraging, as displayed in the two plots below (Figure 3 and Figure 4) , , showing comparison between measured data (red line) and calculated currents following the above method.
Differences are always within 5% w.r.t. the nominal (tuned) bias when covering a range in current [-40% : + 60%].
The difference between measured and calculated data is about linear, as shown by Figure 4, with a spread of about 5%. It must also be noted that comparison between measured currents corresponding to the same bias couple Vg1Vg2 in the classic tuning (used to calculate expected currents) and in the matrix tuning gives already a difference by about 2.2% that must be considered as the uncertainty related with the current reading between two similar configurations in different times. These results will be fully commented in the

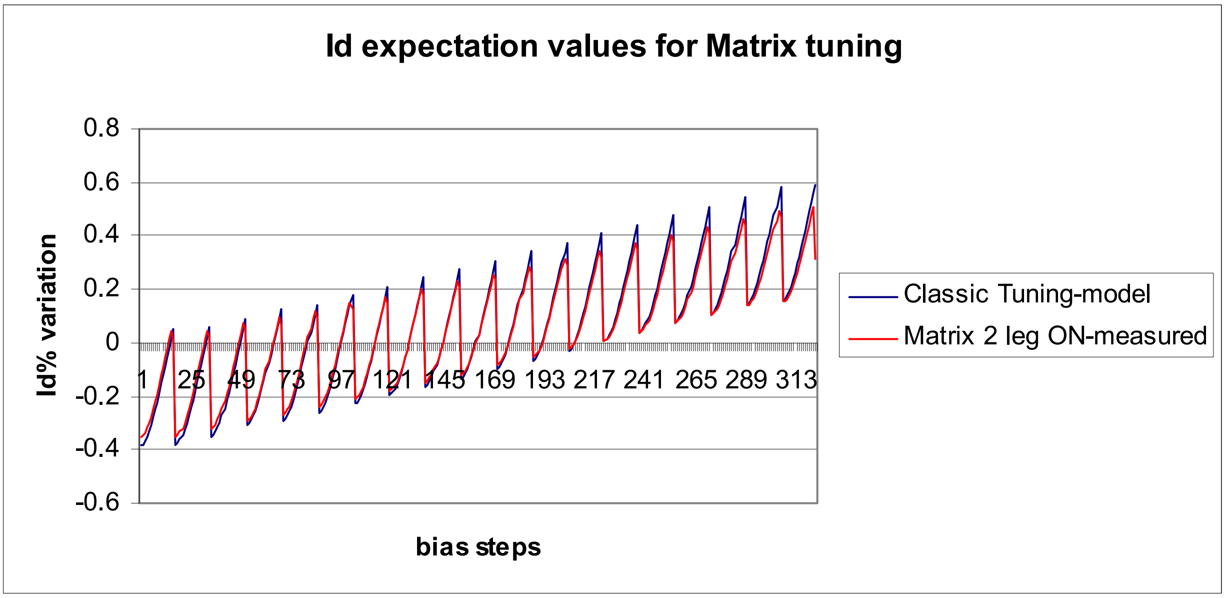


Figure 3

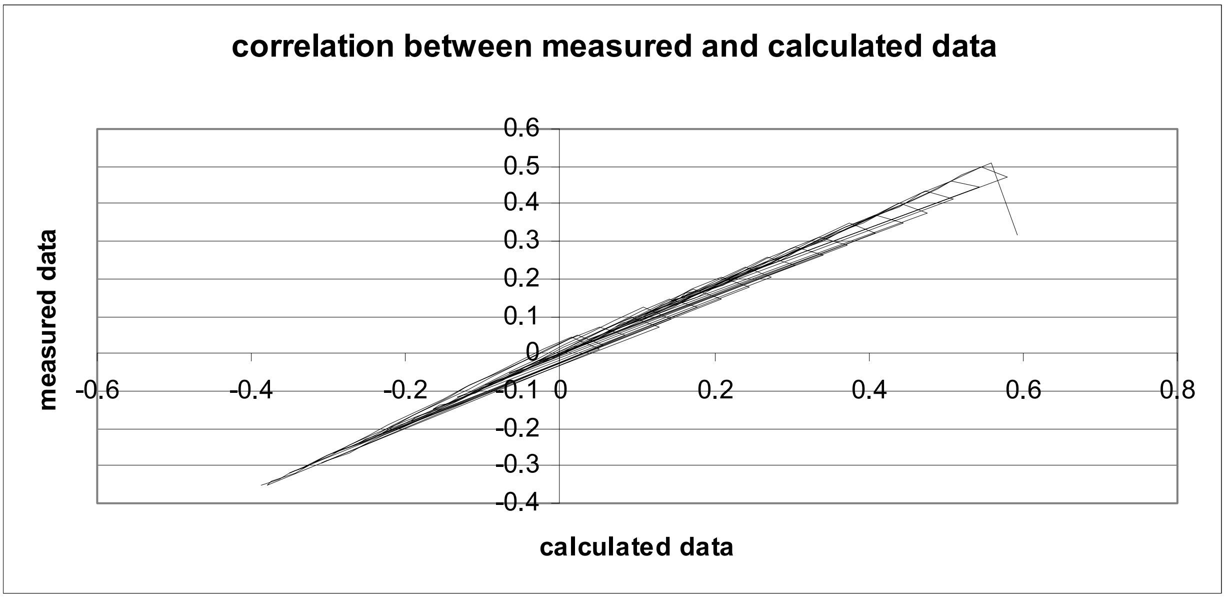


Figure 4

5.1 Criteria to discriminate 'unbelievable' results:

Many combinations produce currents far from the expected ones .
As described before, two criteria can be superposed to eliminate what is not-realistic.
In [RD 2][RD 1], performances (noise Temperature and Isolation) are plotted for each channel versus currents. In particular, it comes out that a range in current between [-10% : + 10%] of the nominal value (corresponding to tuned bias) should be satisfactory to explore a meaningful region. Look for example at Figure 5 and Figure 6.

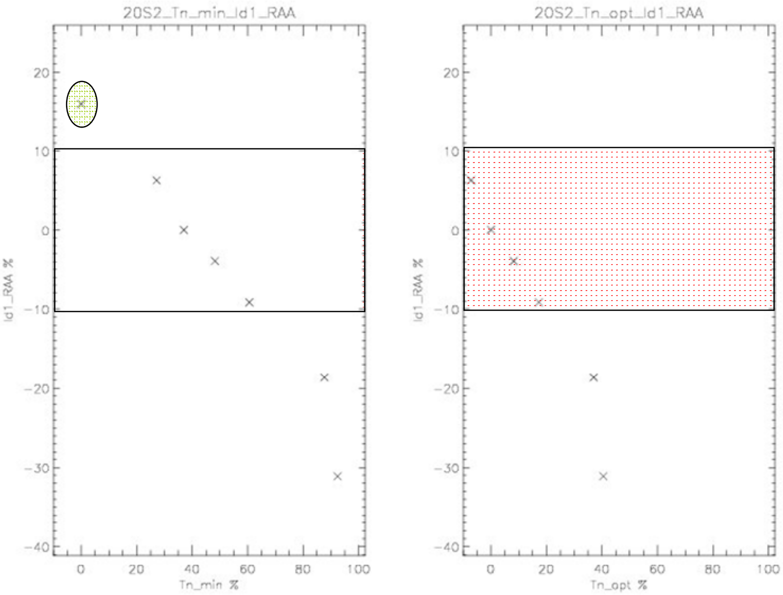


Figure 5 Noise temperature dependence with drain current during Vg1 tuning.

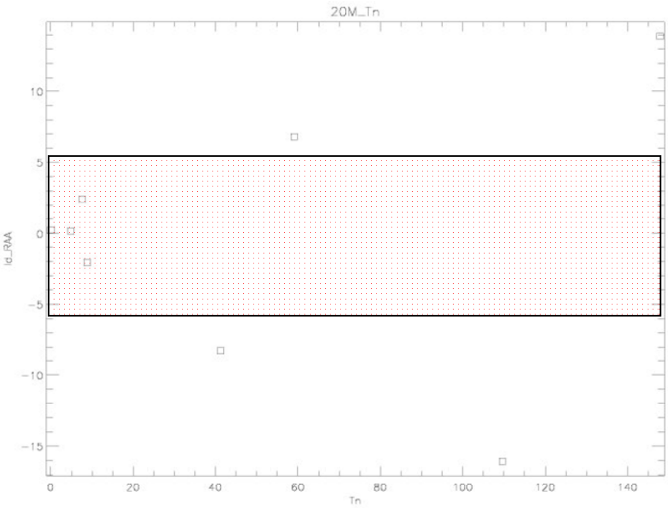


Figure 6 Isolation dependence with drain current during Vg2 Tuning.

The criterion for ISO variation with current could be also tighter , [-5% : + 5%], but to be conservative we can use the same of Vg1.
The second criterion to match with the above is that constraining the total current variation caused by simultaneous variations of Vg1 and Vg2. This requirement will be stronger than the sum of Vg1 and Vg2 req. and softer than Vg1 or Vg2 alone.
Variations will be referred to the nominal (RAA tuned bias) drain current for that leg.

6 PHYLOSOPHY FOR CSL

In order to define the range, the number of points and the values to be applied it is important to understand and define in advance the scope of the tests.

It is important to notice that:

A calibration was already done during the RAA test campaign, using a different strategy (classic tuning with separated Vg1 and Vg2 ramps).

A new calibration (the final one) will be done in flight (CPV), in principle using the Matrix tuning.

Matrix tuning have been tested during the FS (flight spare) test campaign , but just on ½ FEM (30 GHz).

Scope of the CSL test campaign can be double:

- Investigate functionality and capability to run the test for the 1st time
- Investigate performances and try to get as much information as possible , to use these data as input for CPV phase (and, in case of any failure in tuning during CPV, as final values)

Depending on the scope, the range to be explored can be enlarged, just avoiding those values that evidently produce unbelievable results, or restricted, exploring a narrow spaced grid. A parametric analysis is provided in APPENDIX 3

7 PROPOSAL

The proposal for CSL is something mixing the two possible objectives; this can be obtained matching different steps, as follows.
Relaxing something more requirements on Vg1 and Vg2 tuning Id currents: up to [-15% : + 15%]
Putting a requirement on total current variation [-25% : + 25%]
Symmetrising the interval around the expected tuned value.
Applying also all the Vg1 and Vg2 combinations (13) already explored during the RAA test campaign, to have a check of repeatability.
Ordering the bias application in time in terms of expected drain currents, in order to have not an abrupt variation producing a slow drift and requiring an integration time longer (especially 70 GHz channels) .
The requirements can be eventually enlarged by adding the uncertainty in drain currents, characteristic of each leg, observed when switching on the LFI with nominal tuned bias.

From a technical point of view, it could be solved as follows.

7.1 Proposed implementation:

Since we need to customize tables for each leg, we propose to write a dedicated table for each couple (except the case of RCA 28 that is tuned alone) of legs.
Here are two possibilities:

1) FIRST CASE: the table contains just the bias of the legs under tuning. Each row corresponds to a couple of Vg1 and Vg2 to be applied (step #). It means that each table has the shape as below (the table can also be double, containing the parameters of both channels to be tuned simultaneously, but the RCA 28)

	RCA 19											
	DET 00			DET 01			DET 02			DET 03		
STEP #	Vg1	Vg2	Id expected	Vg1	Vg2	Id expected	Vg1	Vg2	Id expected	Vg1	Vg2	Id expected
1	168	171	5.43	166	193	3.12	172	189	8.55	159	171	7.98
2	183	171	7.05	166	198	4.81	172	199	9.19	159	186	9.12
3	168	186	7.79	181	193	4.81	172	204	9.22	174	171	9.44
4	193	171	8.37	166	208	6.03	172	209	9.92	159	196	9.95
5	198	171	9.07	191	193	6.03	187	189	10.44	159	201	10.41
6	183	186	9.41	181	198	6.50	187	199	11.09	159	206	10.45
7	168	206	9.58	166	223	6.69	187	204	11.12	184	171	10.54
8	168	196	9.76	196	193	6.69	172	219	11.35	174	186	10.58
9	203	171	9.84	166	188	7.37	187	209	11.81	159	216	10.87
10	193	186	10.73	201	193	7.37	172	174	11.86	189	171	11.12
11	168	201	10.86	181	208	7.73	197	189	11.94	174	196	11.42
12	183	206	11.20	191	198	7.73	197	199	12.59	184	186	11.68
13	183	196	11.37	181	223	8.39	197	204	12.62	194	171	11.71
14	198	186	11.43	196	198	8.39	202	189	12.74	159	231	11.81
15	213	171	11.44	166	178	8.72	187	219	13.25	174	201	11.87
16	168	216	12.00	211	193	8.72	197	209	13.32	174	206	11.92
17	203	186	12.20	191	208	8.95	202	199	13.38	189	186	12.27
18	183	201	12.48	181	188	9.06	202	204	13.41	174	216	12.33
19	193	206	12.52	201	198	9.06	172	234	13.51	184	196	12.51
20	193	196	12.69	191	223	9.61	207	189	13.56	194	186	12.85
21	198	206	13.23	196	208	9.61	187	174	13.75	204	171	12.92
22	198	196	13.40	196	223	10.27	202	209	14.11	184	201	12.97
23	183	216	13.62	191	188	10.29	207	199	14.21	184	206	13.01
24	193	201	13.80	201	208	10.29	207	204	14.24	189	196	13.10
25	213	186	13.80	181	178	10.42	197	219	14.75	174	231	13.27
26	228	171	13.98	211	198	10.42	207	209	14.93	184	216	13.43
27	203	206	14.00	166	163	10.82	197	174	15.25	189	201	13.55
28	203	196	14.17	226	193	10.82	217	189	15.28	189	206	13.60
29	168	231	14.31	196	188	10.95	187	234	15.41	194	196	13.68
30	198	201	14.50	201	223	10.95	202	219	15.54	189	216	14.01
31	193	216	14.94	201	188	11.62	217	199	15.92	204	186	14.07
32	203	201	15.27	191	178	11.64	217	204	15.95	194	201	14.14
33	213	206	15.60	211	208	11.64	202	174	16.05	194	206	14.18
34	198	216	15.64	196	178	12.30	207	219	16.37	184	231	14.37
35	213	196	15.77	211	223	12.30	217	209	16.65	194	216	14.60
36	183	231	15.93	181	163	12.52	207	174	16.87	219	171	14.82
37	228	186	16.34	226	198	12.52	197	234	16.91	204	196	14.90
38	203	216	16.42	201	178	12.98	202	234	17.71	189	231	14.95
39	213	201	16.87	211	188	12.98	232	189	17.94	204	201	15.35
40	193	231	17.25	191	163	13.74	217	219	18.08	204	206	15.40
41	198	231	17.95	226	208	13.74	207	234	18.53	194	231	15.54
42	213	216	18.02	211	178	14.33	217	174	18.59	204	216	15.81
43	228	206	18.14	196	163	14.40	232	199	18.59	219	186	15.97
44	228	196	18.31	226	223	14.40	232	204	18.61	204	231	16.75
45	203	231	18.73	201	163	15.08	232	209	19.31	219	196	16.80
46	228	201	19.41	226	188	15.08	217	234	20.24	219	201	17.26
47	213	231	20.33	211	163	16.43	232	219	20.74	219	206	17.30
48	228	216	20.56	226	178	16.43	232	174	21.25	219	216	17.72
49	228	231	22.87	226	163	18.53	232	234	22.91	219	231	18.65

Figure 7 ORDERED TABLE (id increasing for each leg) representing the bias to be changed in the RCA 19 for each leg (DET #); also expectation currents are displayed, but shall not be used as input parameters (just to compare with results)

In this case we need:

a) a unique reference table with the bias of all RCA (11* 4 legs) in ‘nominal’ conditions

+

b) 5 (groups of RCA tuned simultaneously) + 1 (RCA 28) = 6 tables containing just the bias to be varied at the same time (step #); The RCA # and the detector number # will be selected by SW, example:

For i=0,5 — number of groups from table 1
For j=0,3 — number of ACA (DET #)
For k=0, 48 — number of steps (raws) in FIG.2

➔ apply: group (i), ACA (j) , Vg1(k), Vg2(k)
➔ For l=0,5 with l ≠i apply the standard table to channels not under tuning (table at point a)

2) SECOND CASE: the table contains the bias to be applied to all the RCA# for each step #. It means that a table for each leg is required. It is:
4(ACAs) * [5 (groups of RCA tuned simultaneously) + 1 (RCA 28)] = 24 tables

At this point, the difference between 1 and 2 it is just a problem of SW implementation but in both cases this solutions will allow to:

1) have a custom grid of values among witch to move, discarding in advance all the nonsense couple of bias. Include
2) include particular values important to be verified (as the values explored during instrument level and RCA level tests) , to check for method validity and differences.
3) Have a regular variation of bias , producing an expected regular variation of currents , as displayed in the figure below, after having reordered the couple of bias as in Fig 2 .

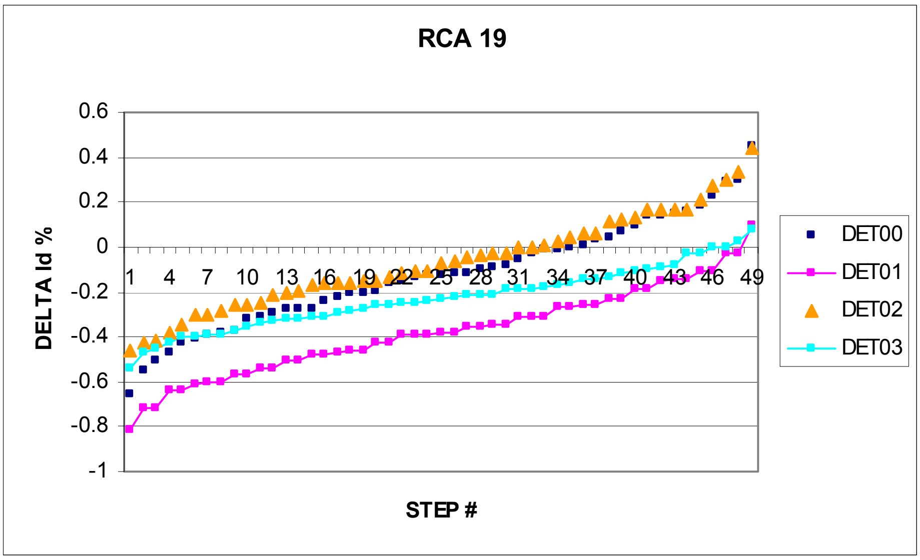


Figure 8 Example (RCA19) drain current variation after reordering of bias couples.

Both implementations described above are equivalent and allow to have a time margin to set the final bias , while THASF is writing the procedure to send TCs.

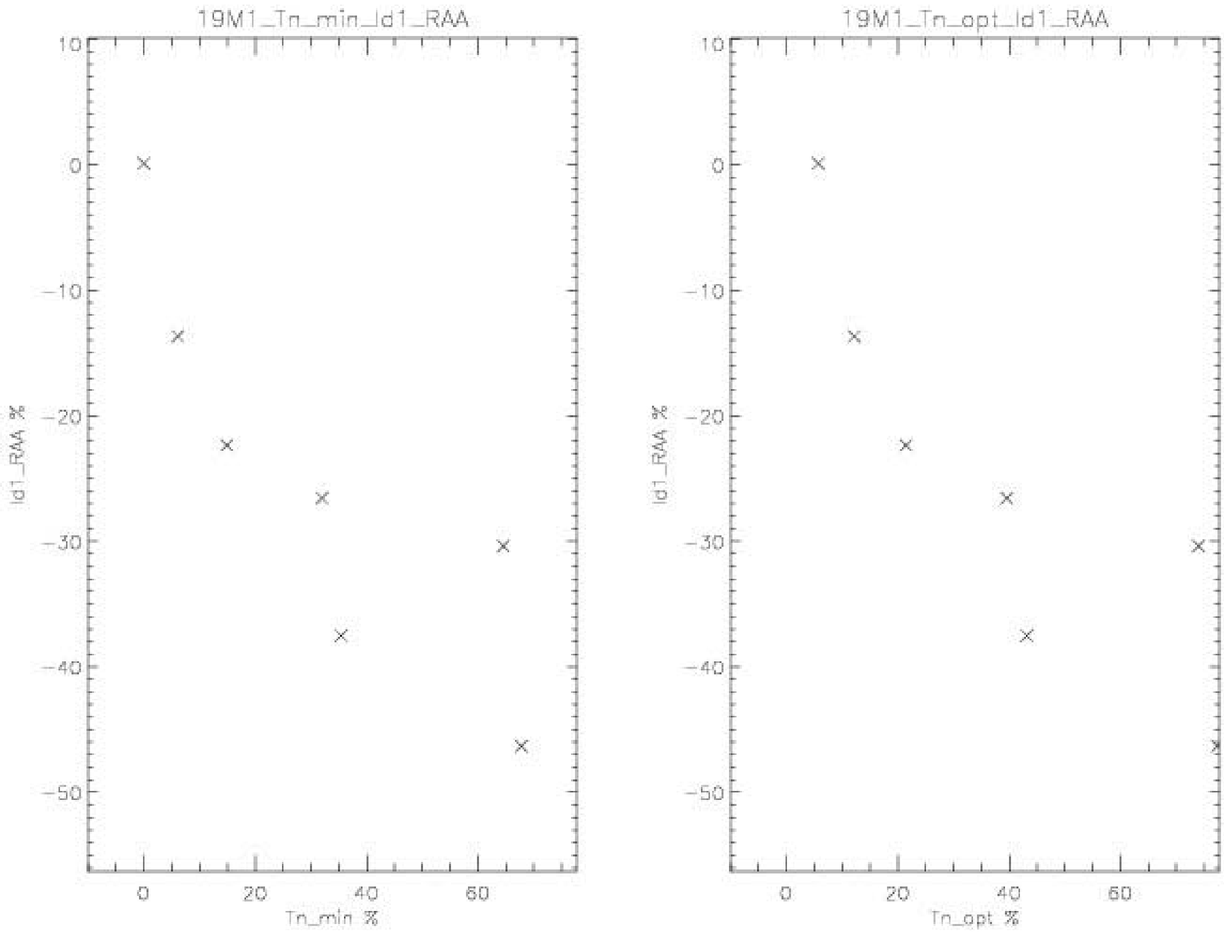
Attached to this document, in the **APPENDIX**, you can find the justification of many numbers given in this document :

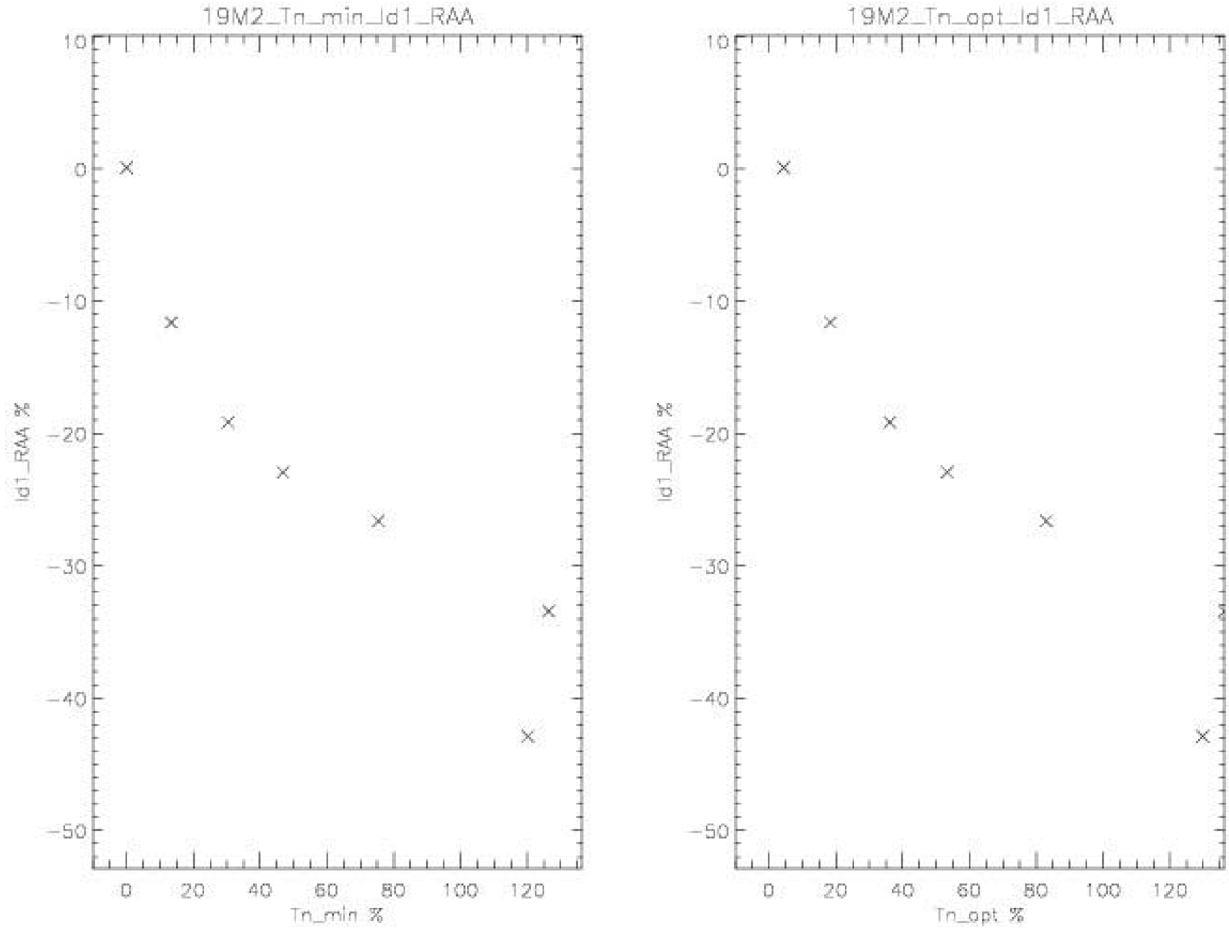
APPENDIX 1)
analysis displaying the Noise temperature vs. Drain current for all channels (RAA Tun). Noise Temperature variations (%) are referred to the minimum value registered (left panel) that not always is coincident with that chosen (left panel); drain current variations consistent with the Tn considered in the panel (minimum Tn on the left and optimized Tn on the right).
It is evident that, in all cases, a variation by 10% in drain current is sufficient to produce a variation by 40 % in noise temperature (70 GHz channels) while in the case of 30 GHz and 44 GHz channels the response is quite flat .

APPENDIX 2)
analysis displaying the Noise temperature and Isolation vs. Drain current for all channels (RAA Vg2 Tun) and the Noise temperature vs. Isolation
It comes out that a variation in drain current also by 5% is able to produce a large variation in noise temperature and much higher in Isolation (as it is evident from the plots displaying Noise temperature vs Isolation)

APPENDIX 3)
Results (tables) from Excel file (attached to this document, "SUMMARY_1.4.xls") containing all the combinations of bias explored during RAA calibration, ordered considering parametric requirements in terms of Id (Vg1), Id (Vg2) and total current deviation from the nominal (tuned) value. It is possible to change requirements from sheet "SUMMARY_COMBIN_<X.X"; the useful combinations Vg1Vg2 obtained, responding to requirements set, are reported in sheets from 'riepilogo 19' to riepilogo 28'.
The starting point, that is the Vg1 and Vg2 bias vectors applied during RAA tests , are reported in sheet 'MATRIX LABEN', containing also the electrical configuration of the channels belonging to the same power group.
Most significant results are displayed in the plots contained in APPENDIX 3: in all cases it is evident that for 30 GHz channels could be set a much tighter requirement, due to the flatness of the response in the range explored.
The number of useful combinations is here explored and displayed when varying requirements.
The expected (calculated as shown above) unordered and ordered drain current variation with Vg1Vg2 combination is displayed too in the further plots.

8 APPENDIX 1: VG1 RAA TUNING. Noise Temperature susceptibility LNA to drain current

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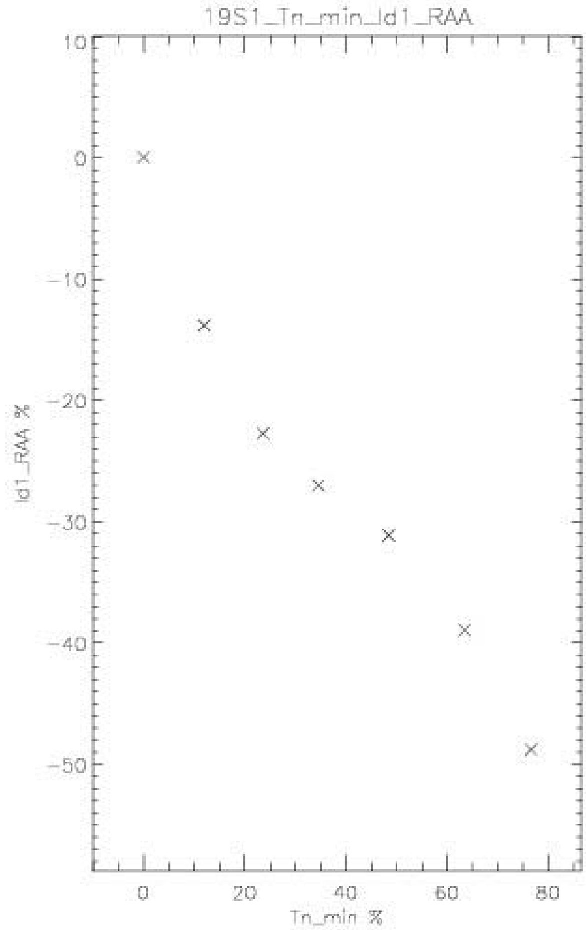
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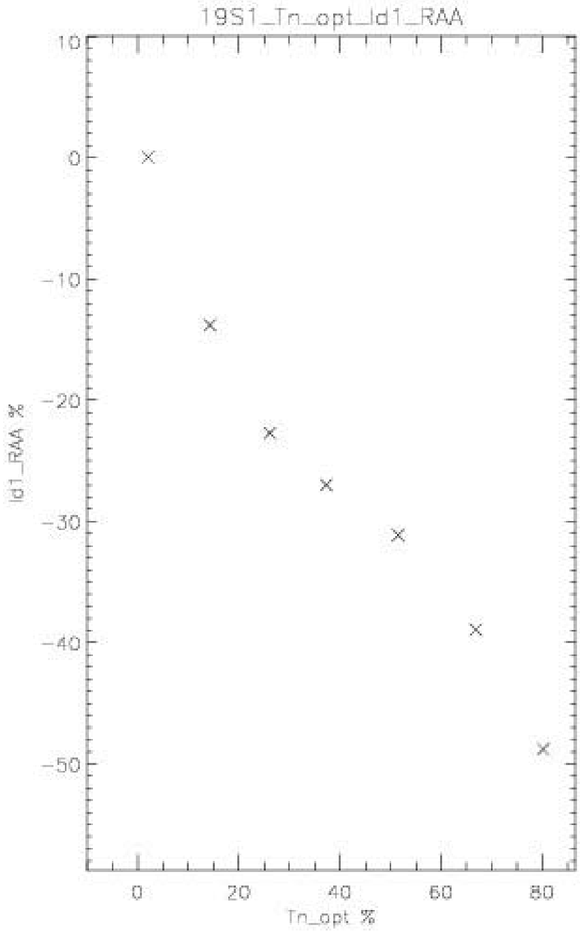
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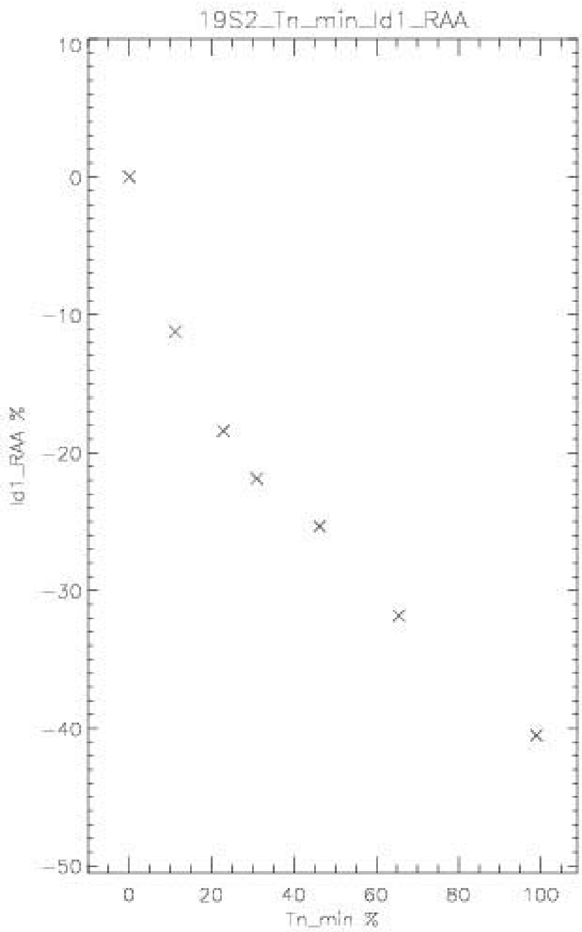
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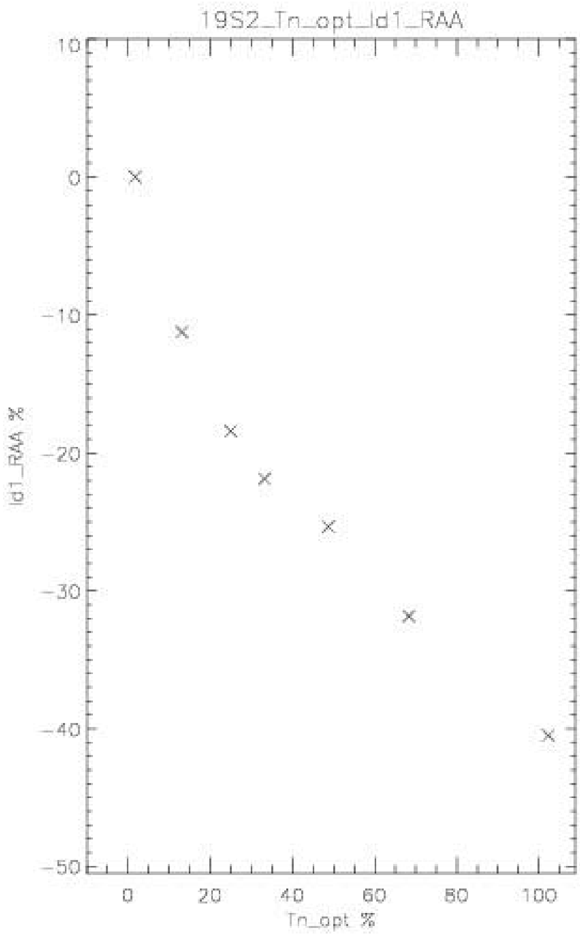
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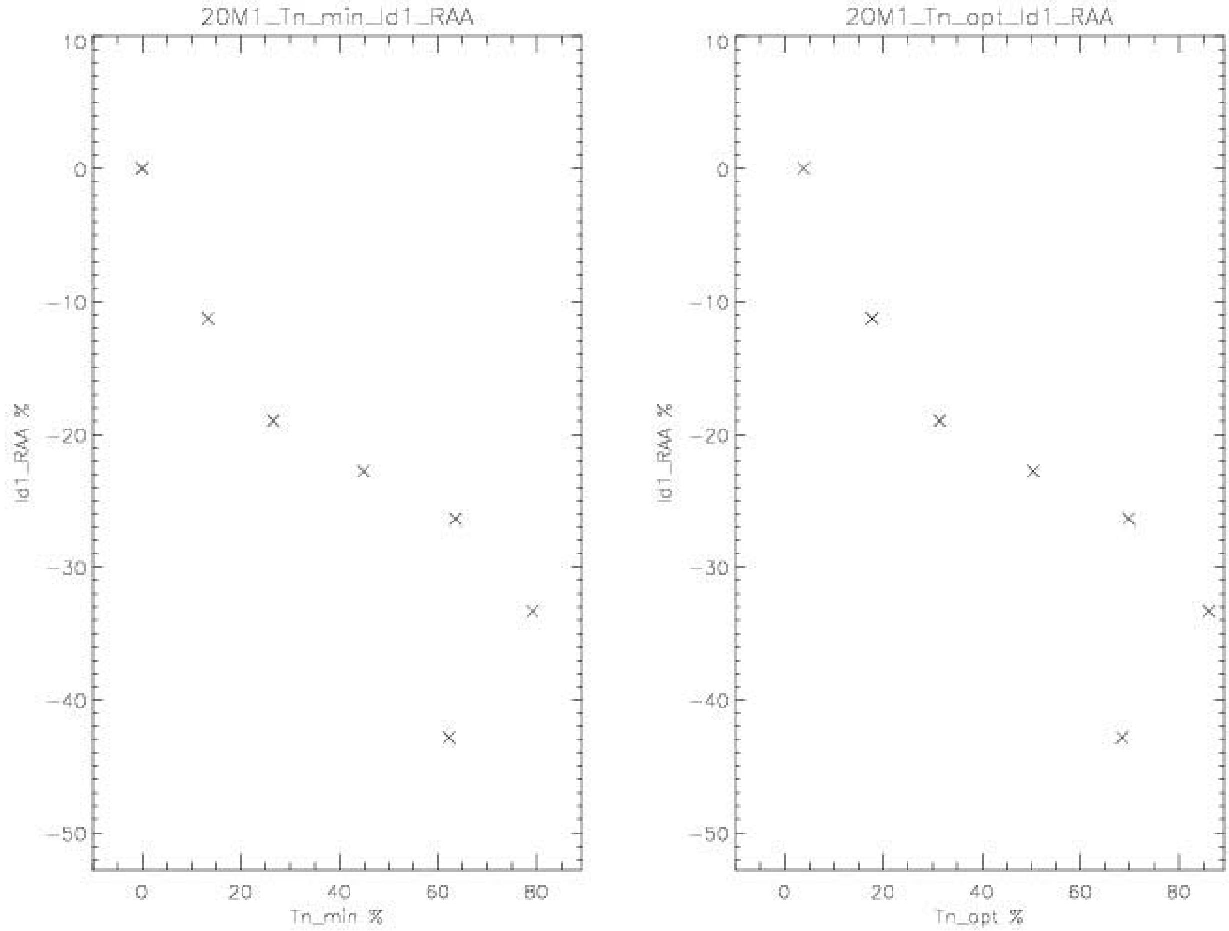
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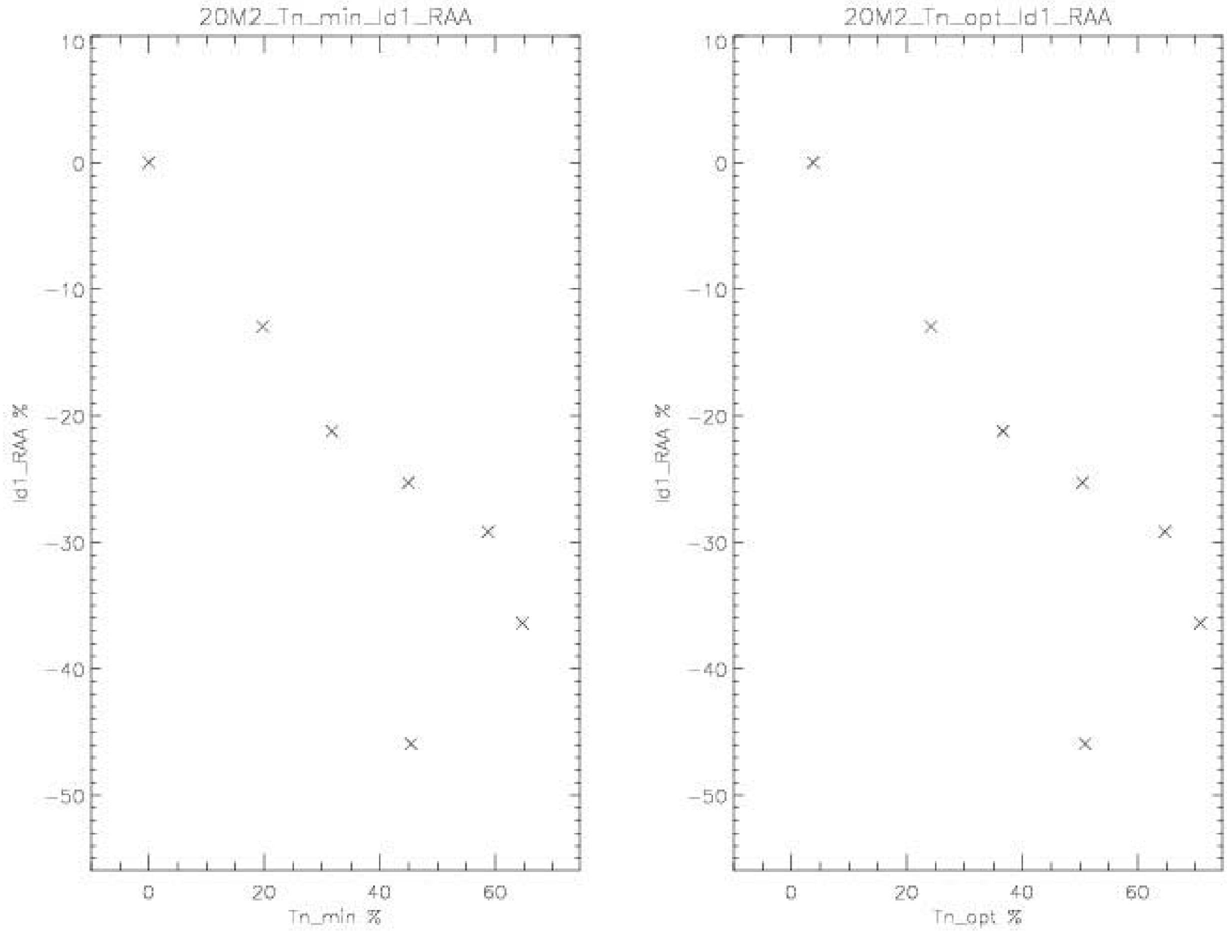
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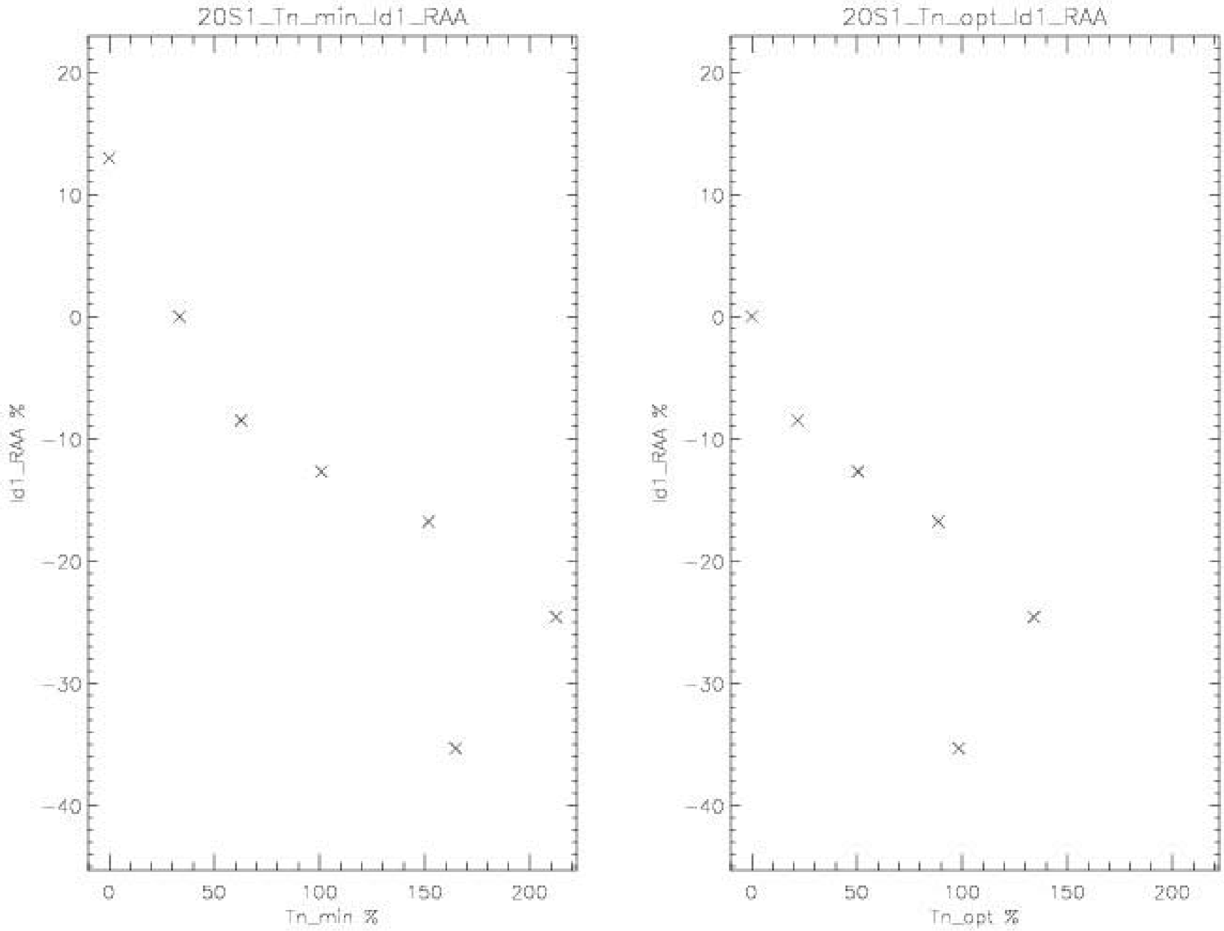
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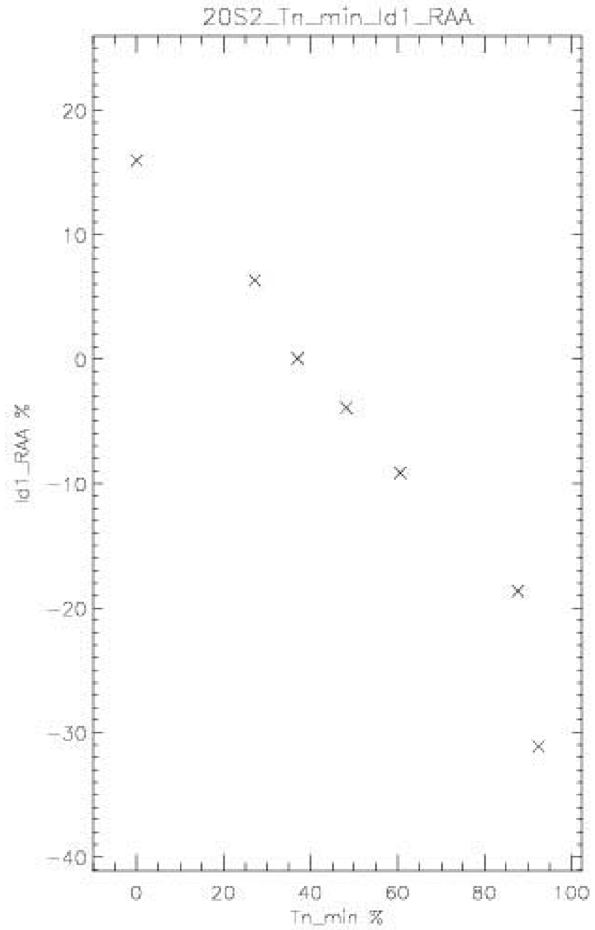
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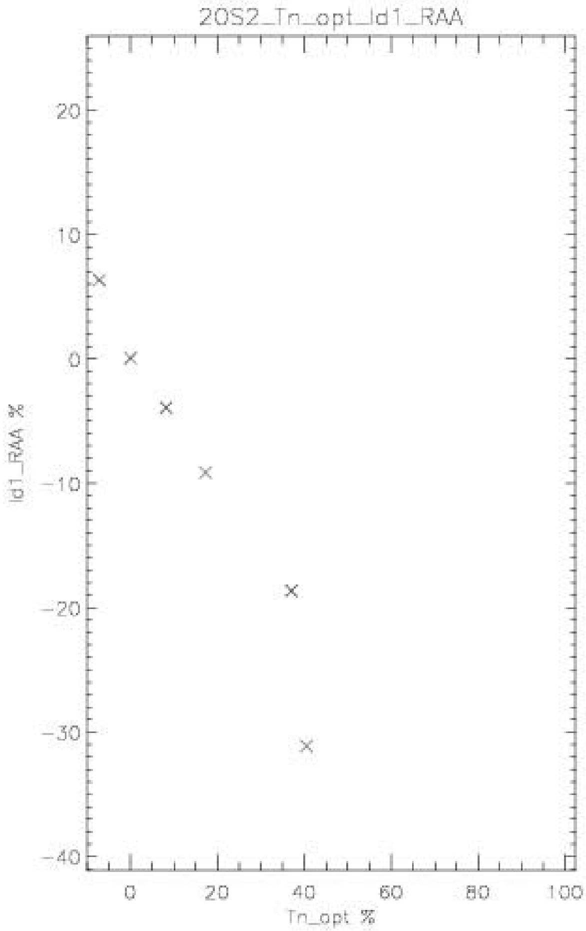
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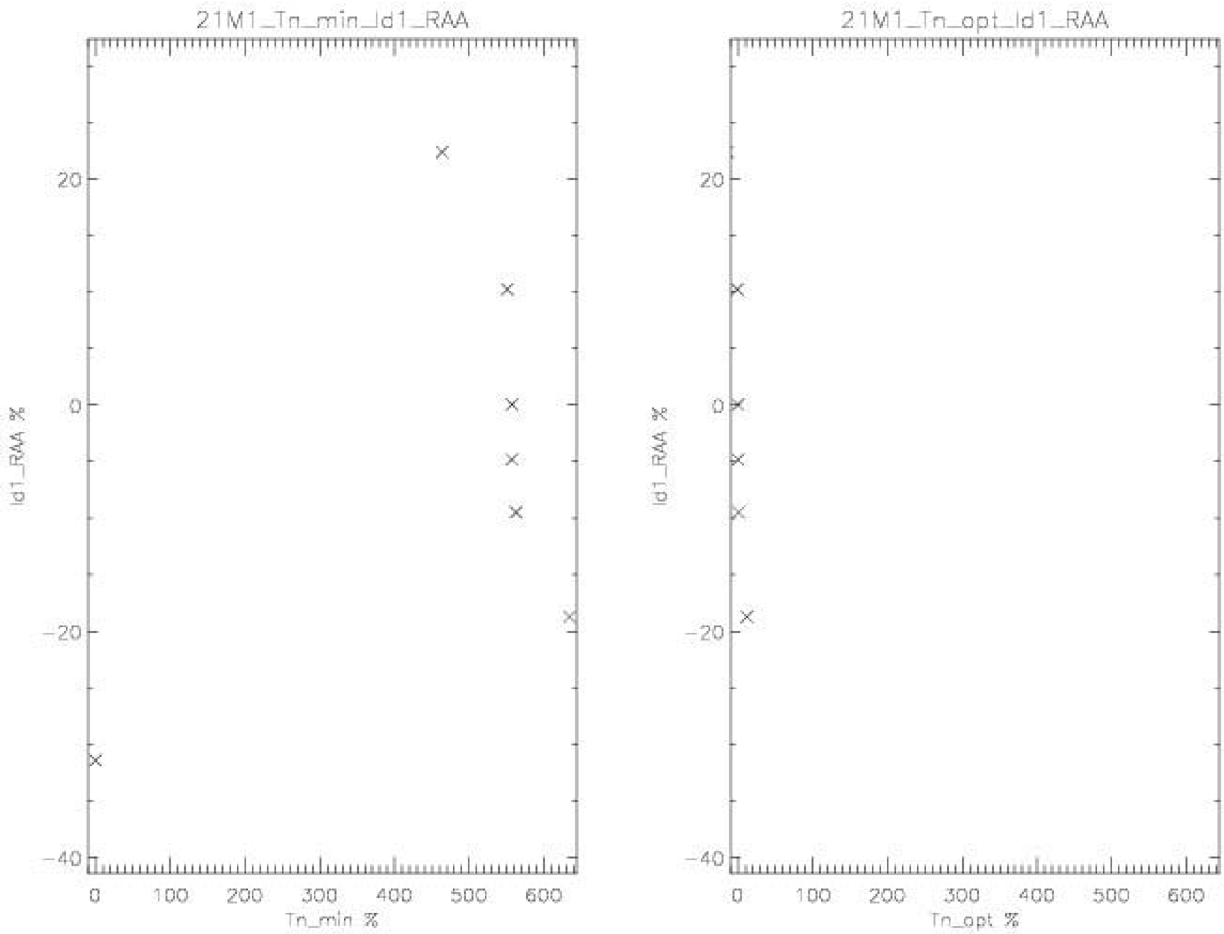
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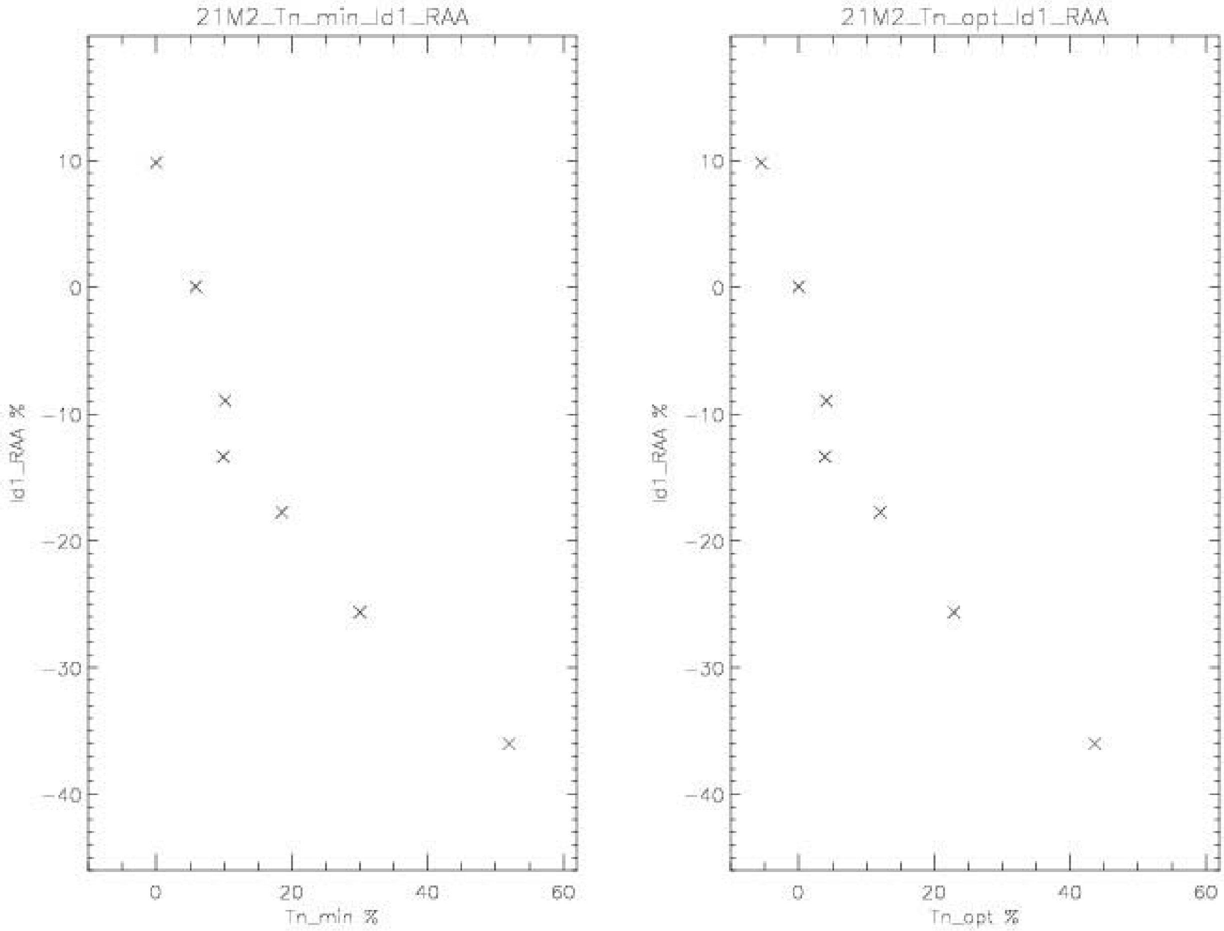
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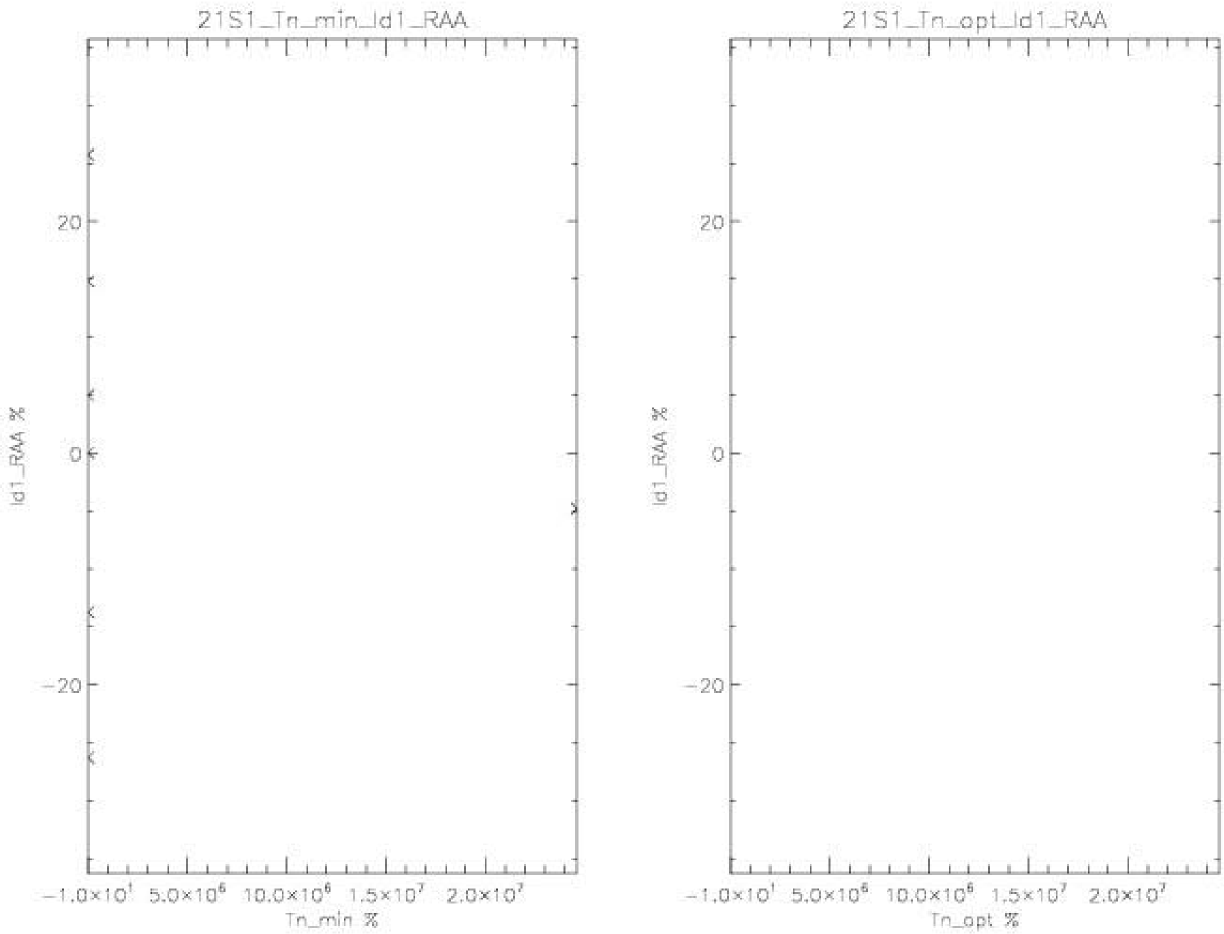
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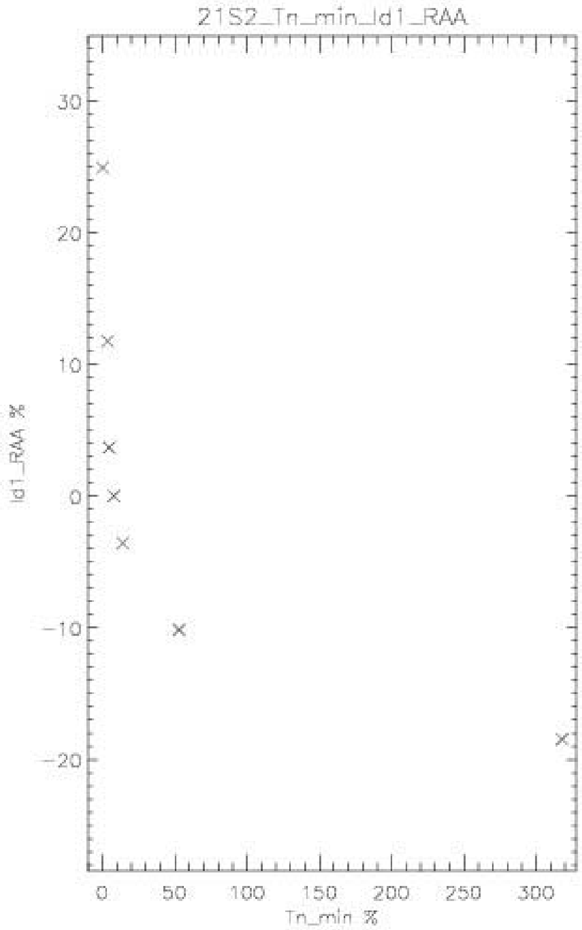
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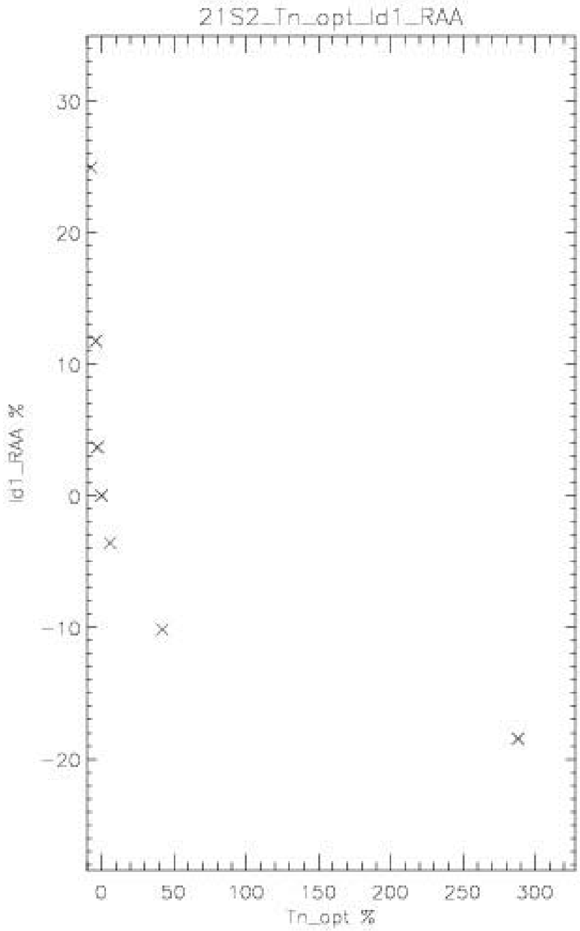
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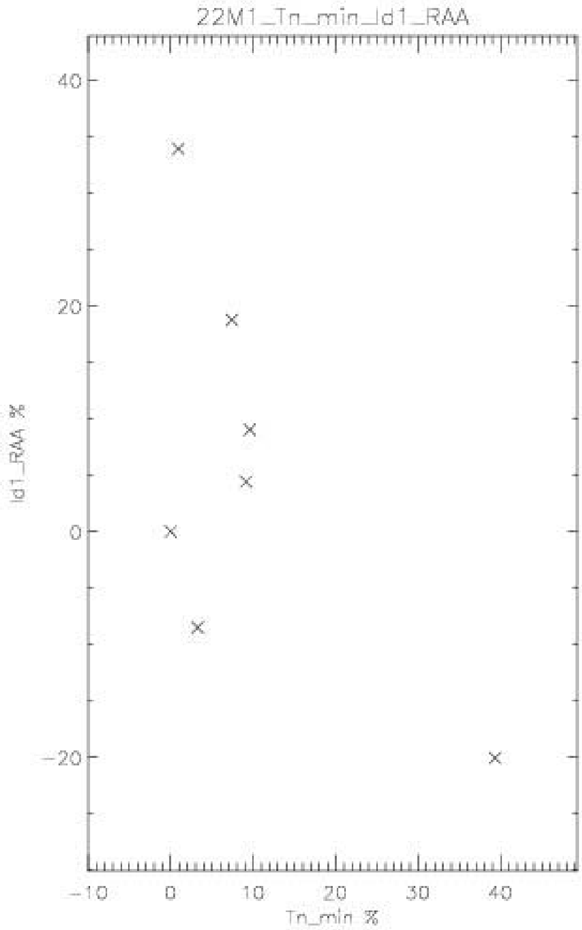
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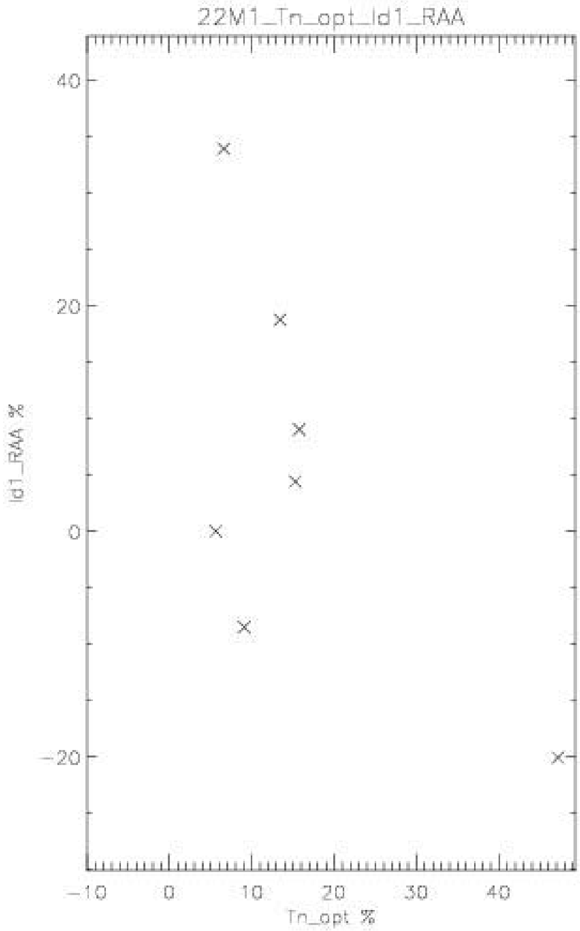
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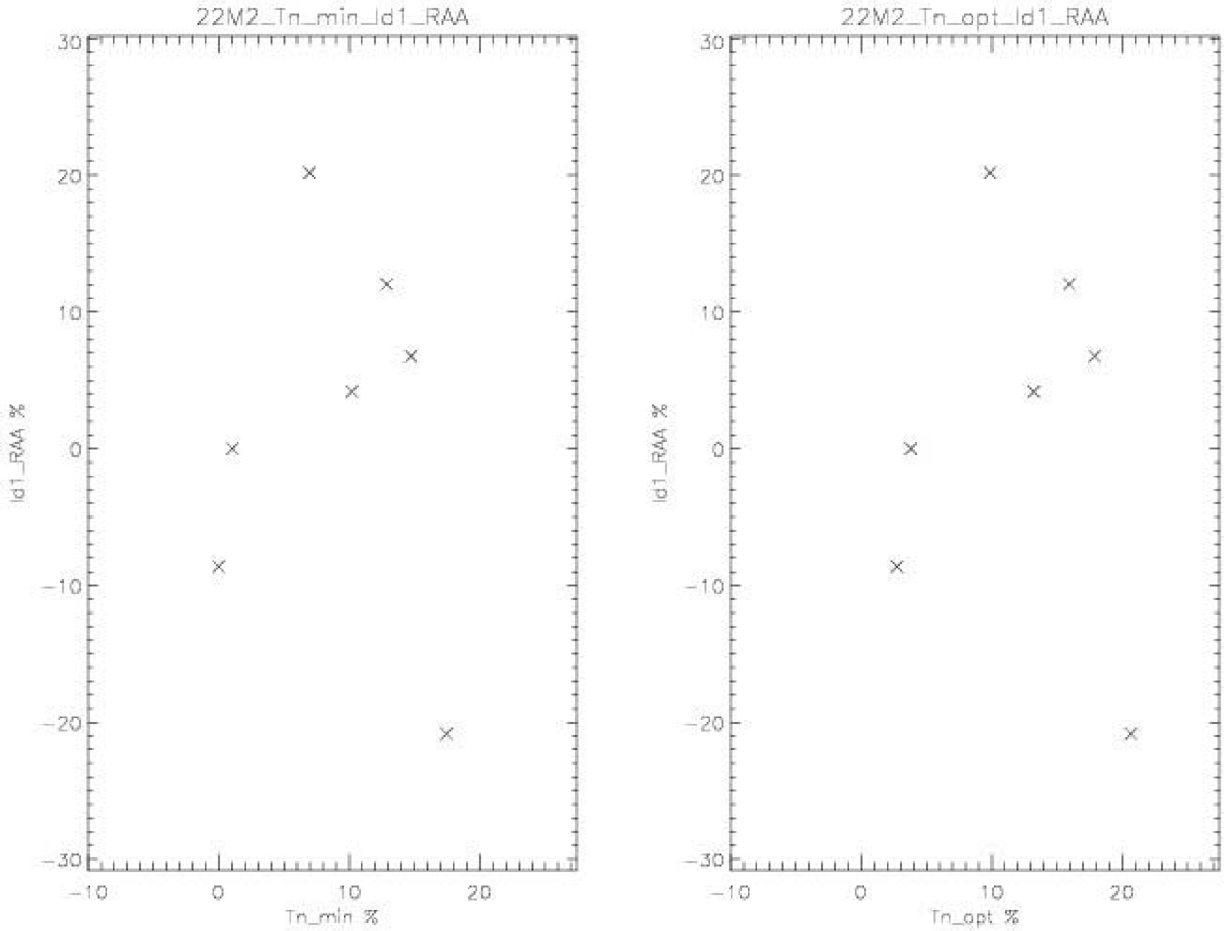
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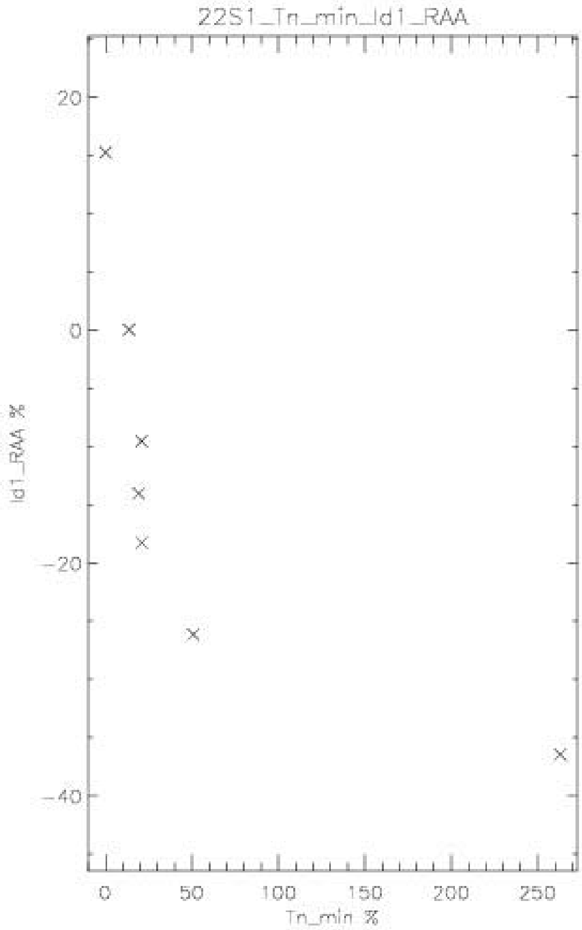
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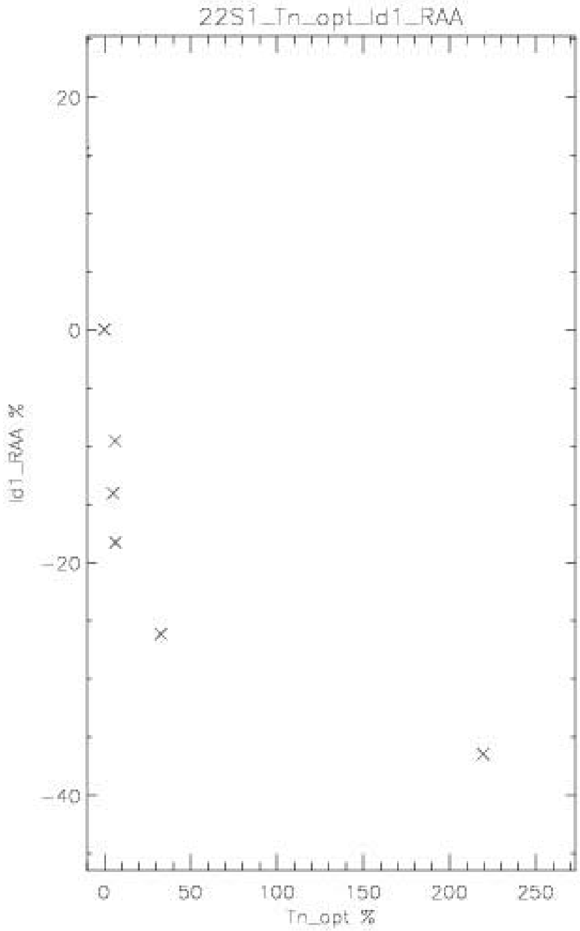
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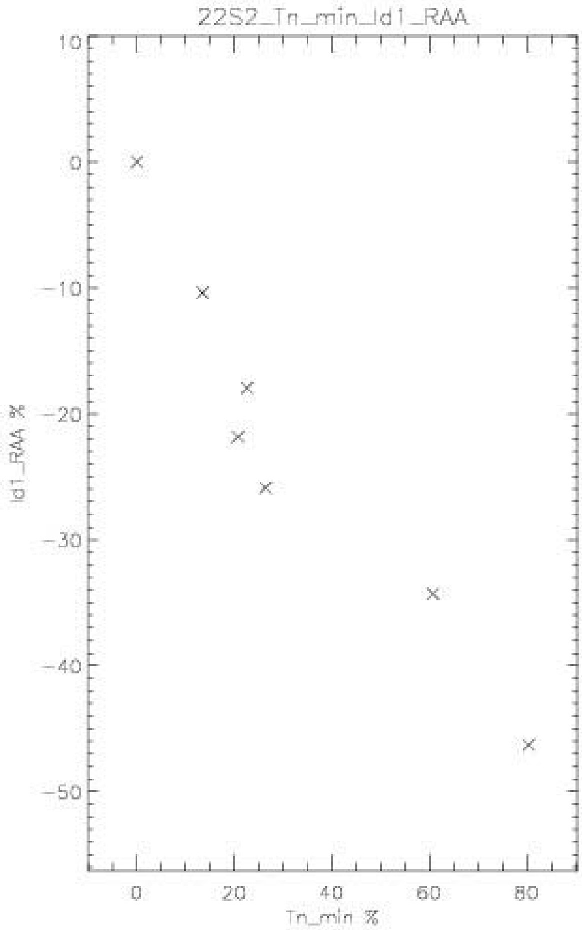
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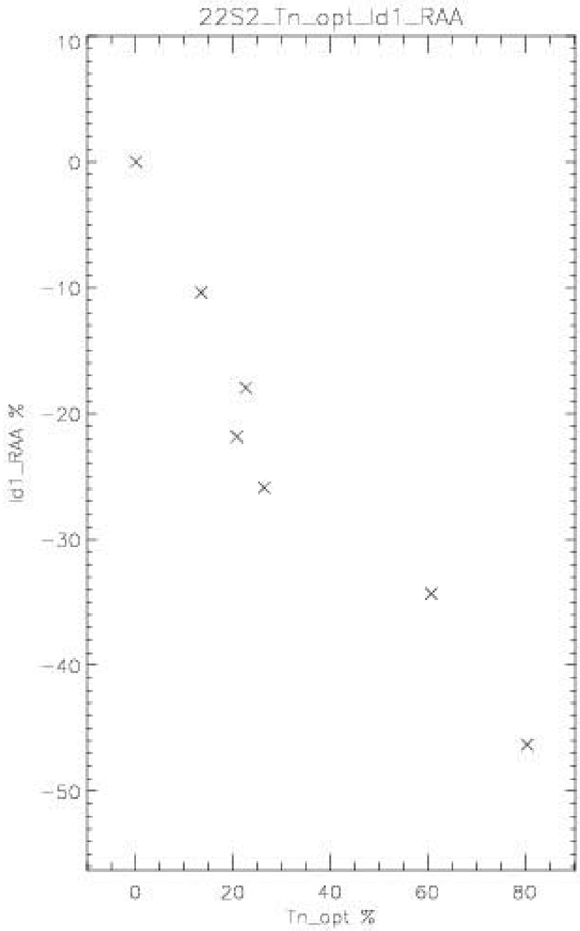
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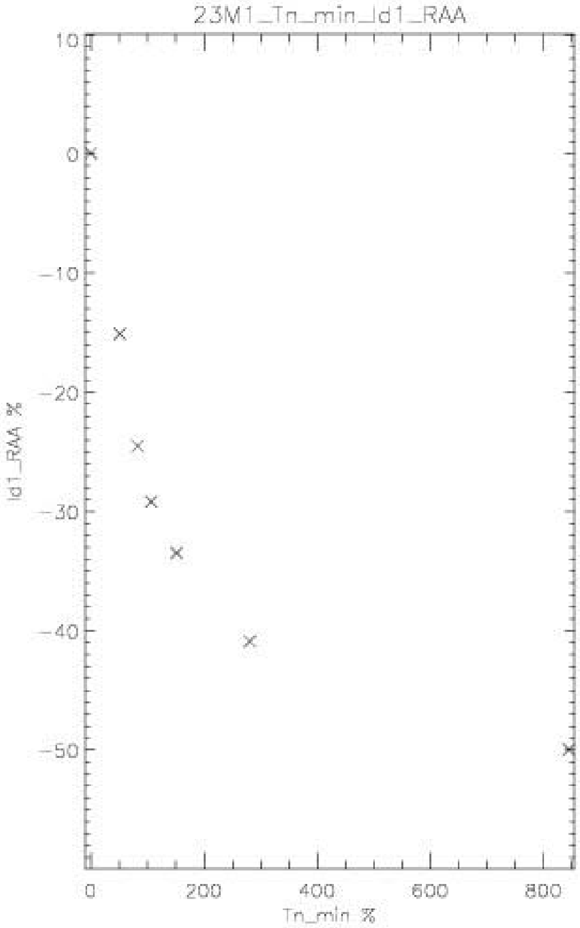
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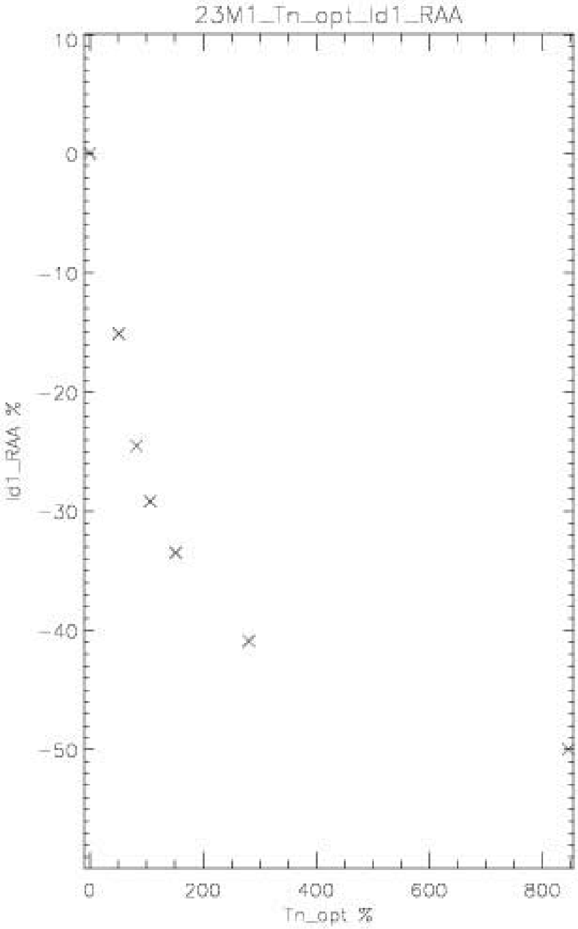
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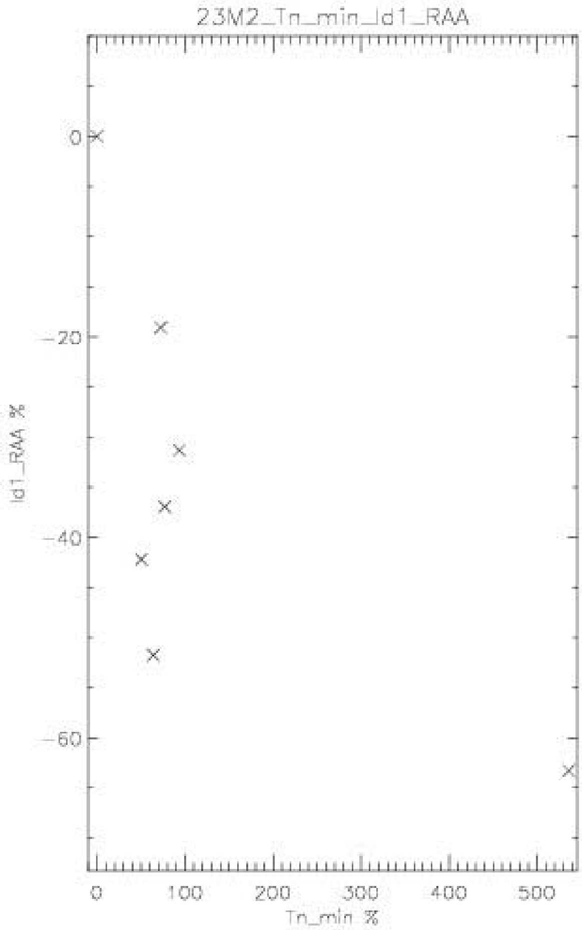
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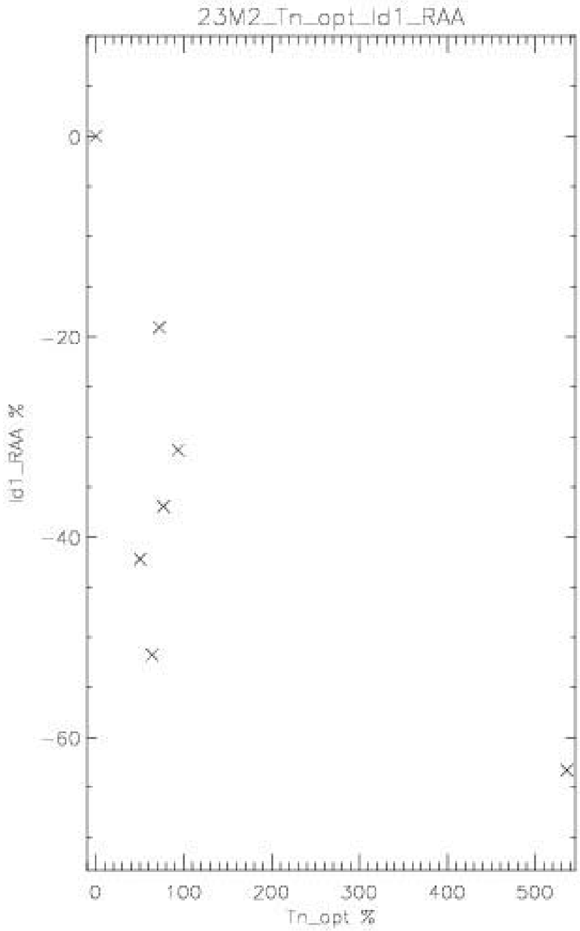
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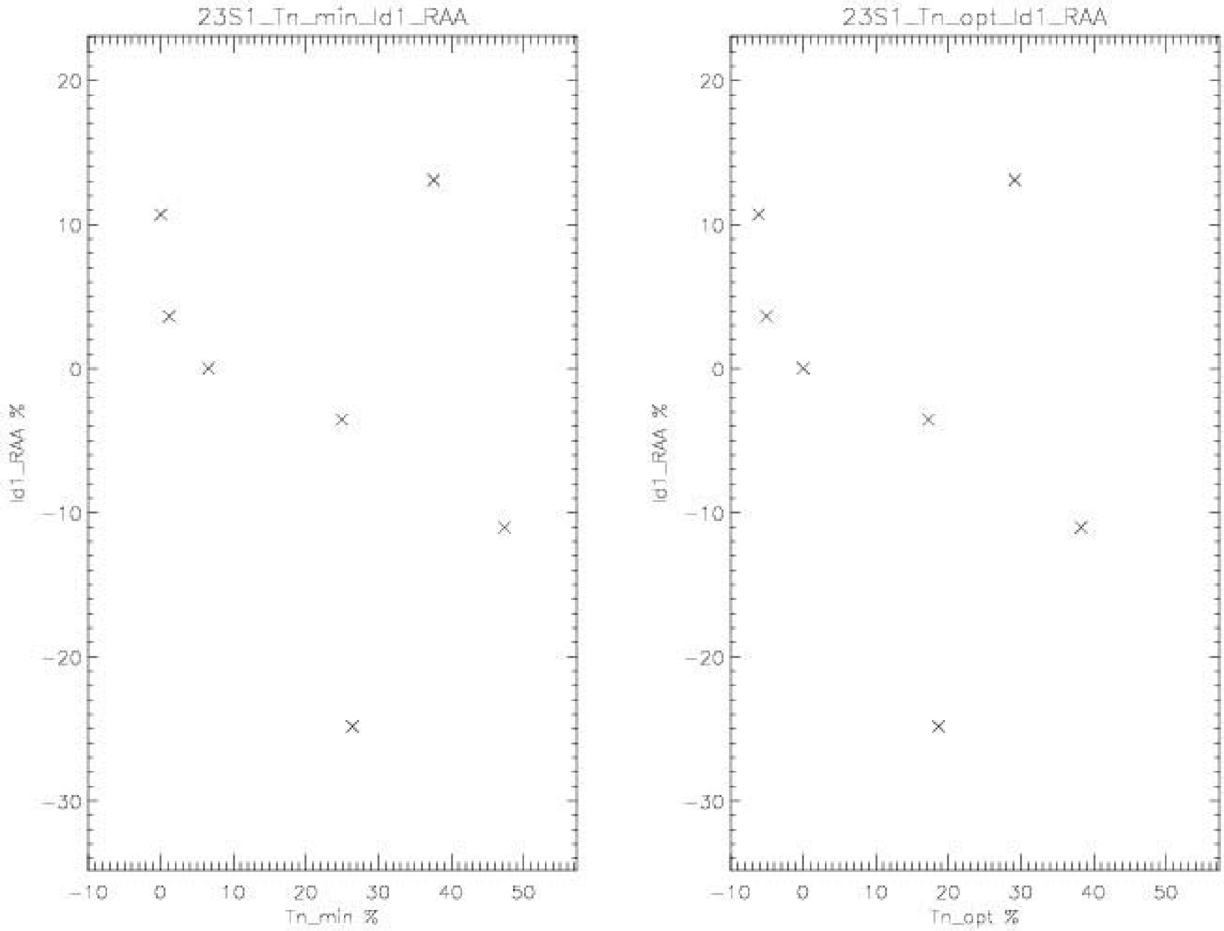

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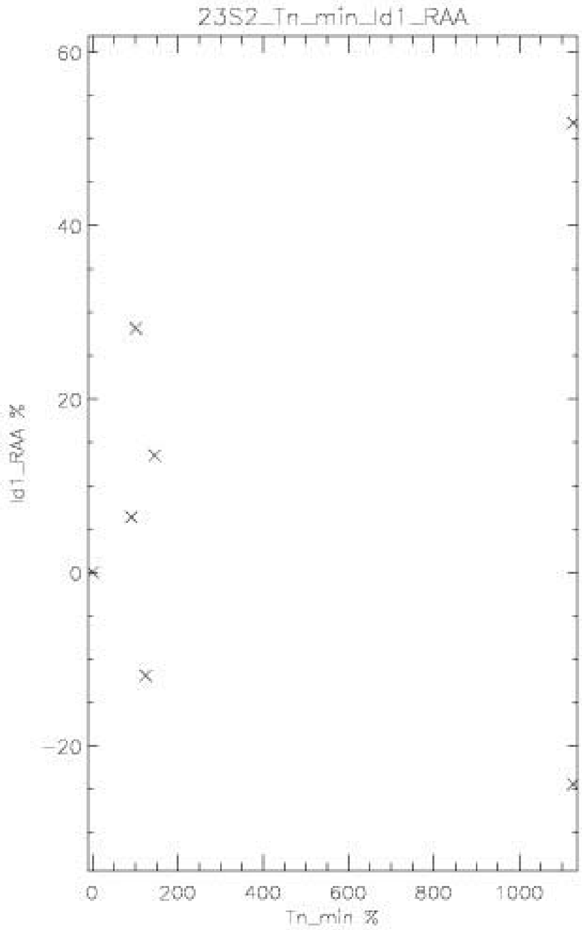
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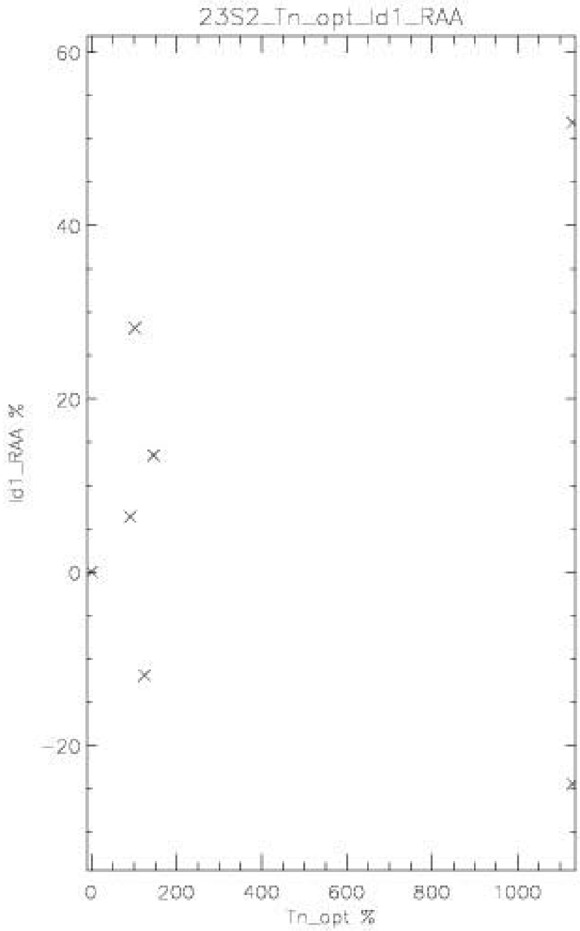
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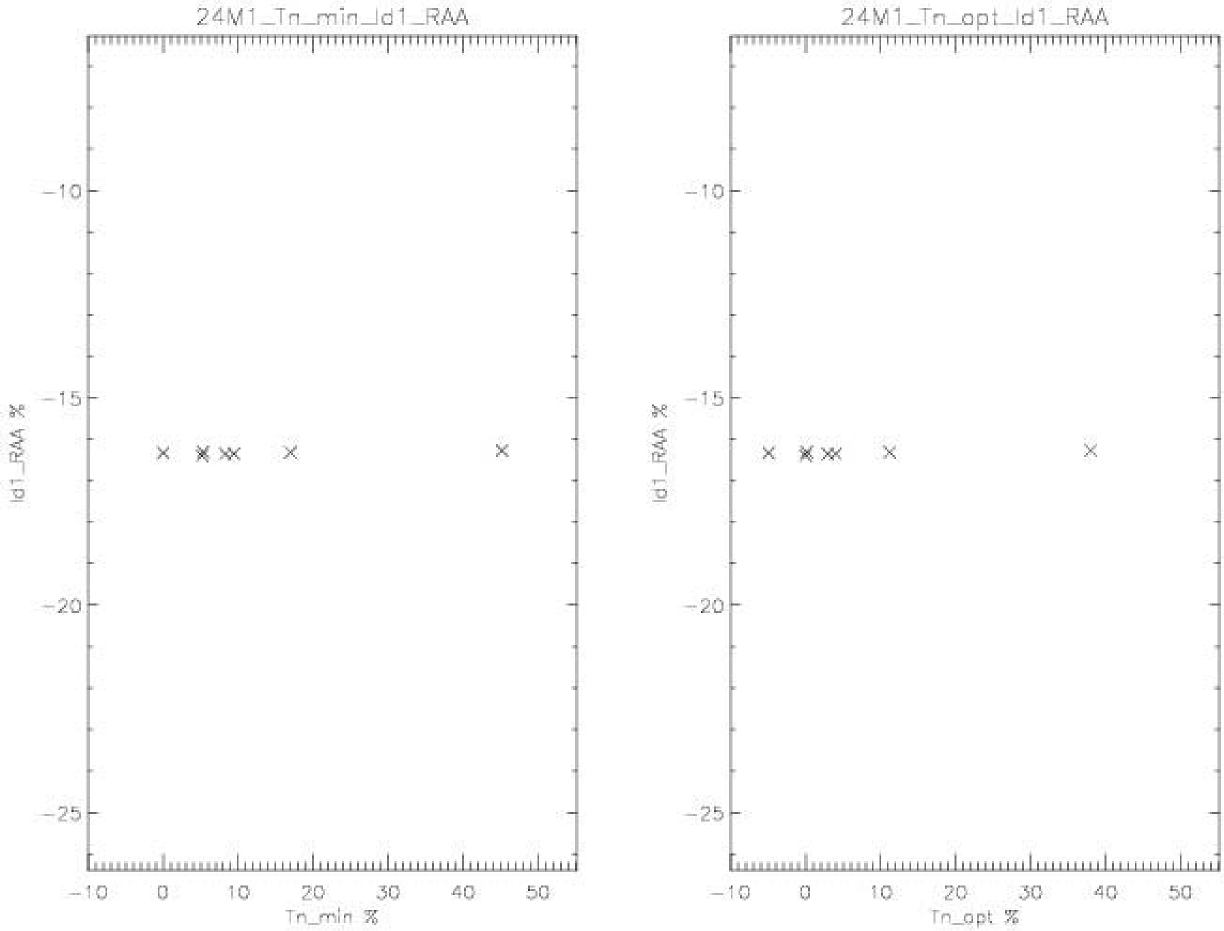
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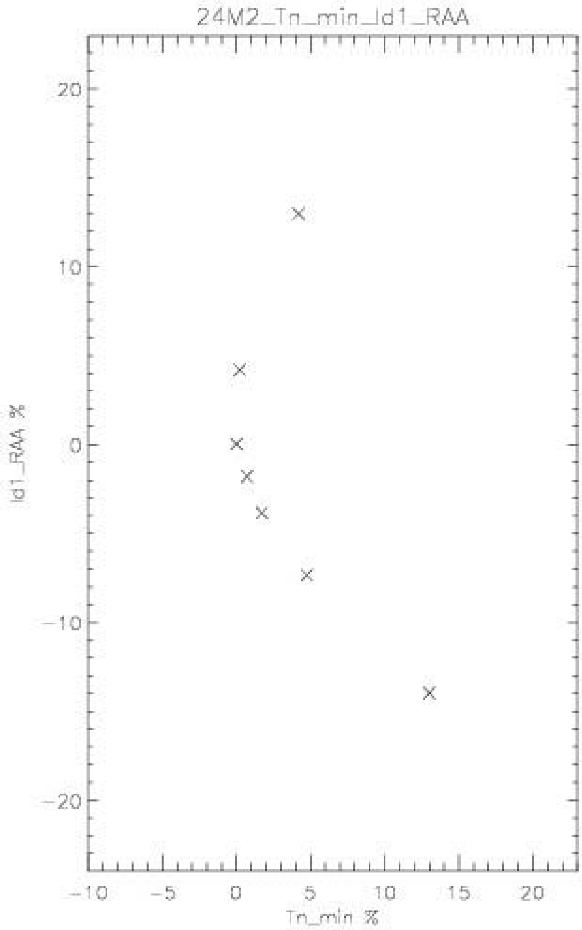
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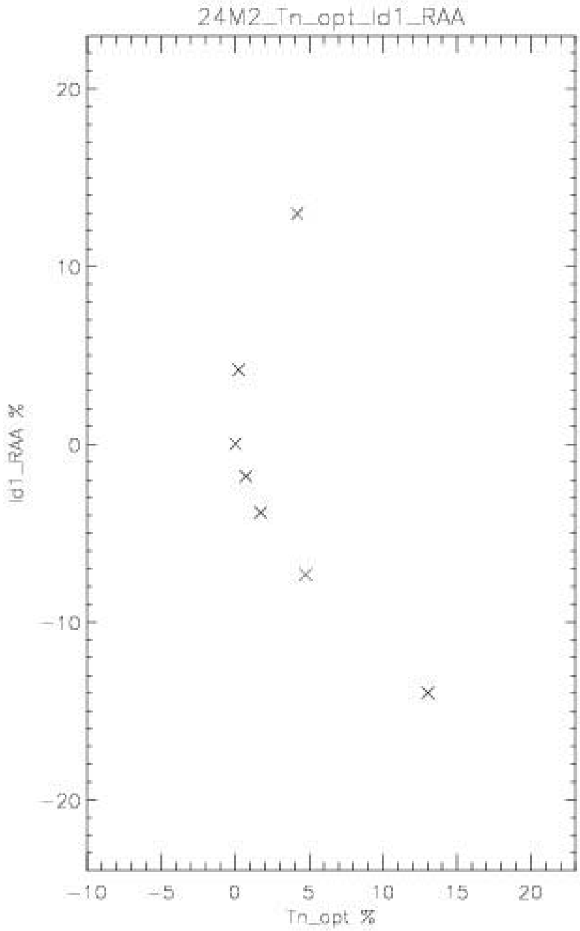
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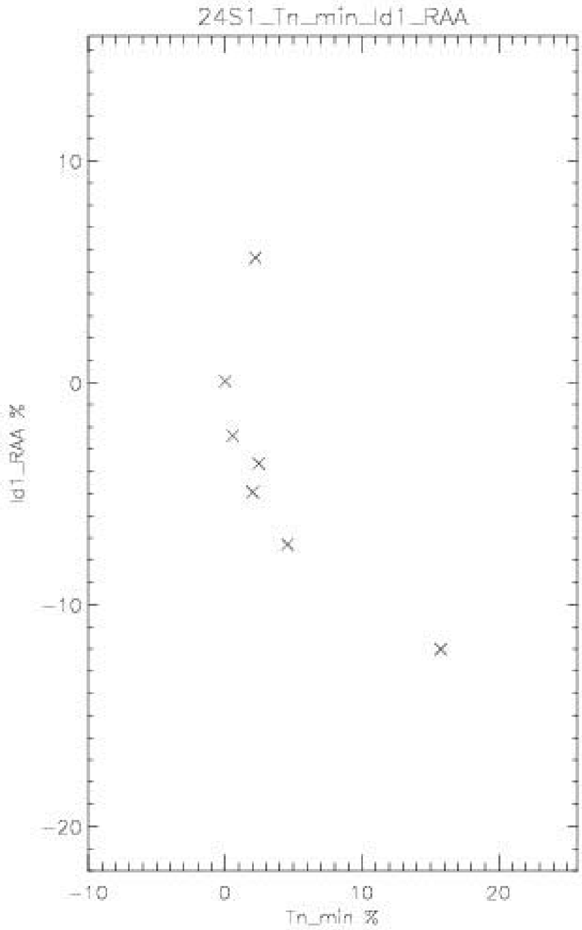
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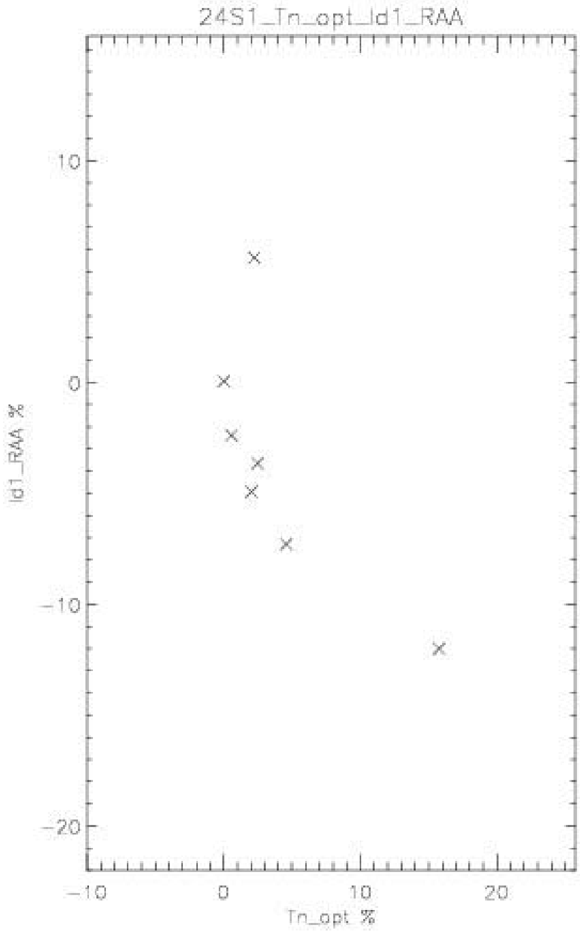
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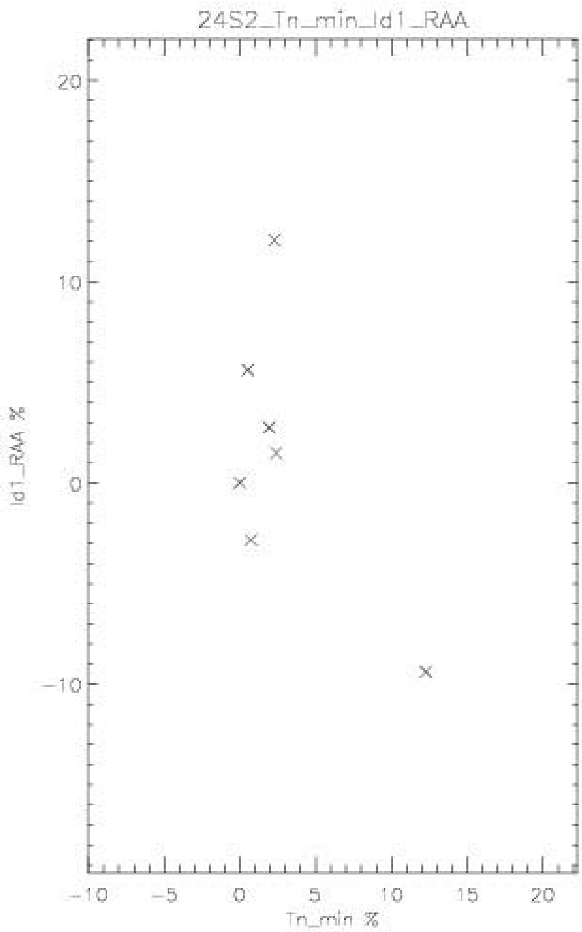
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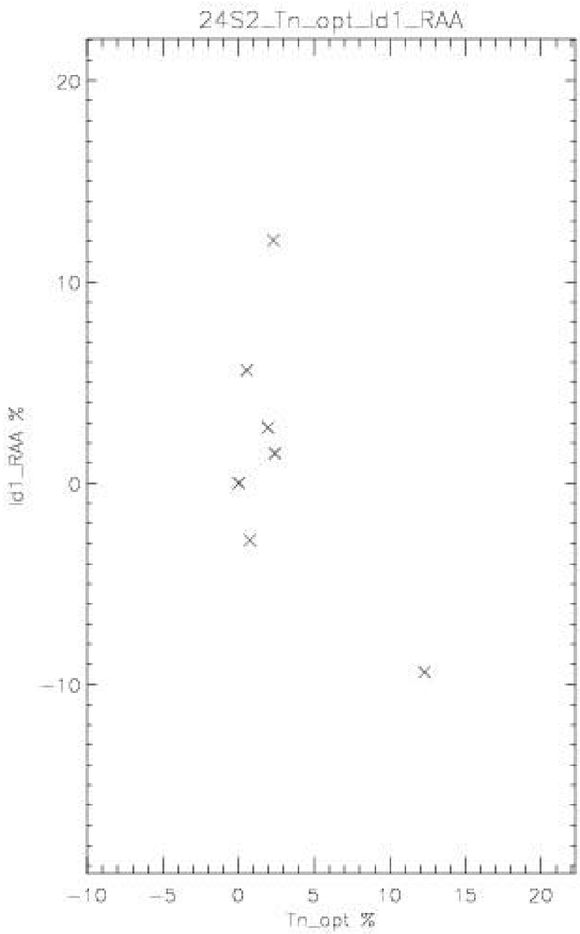
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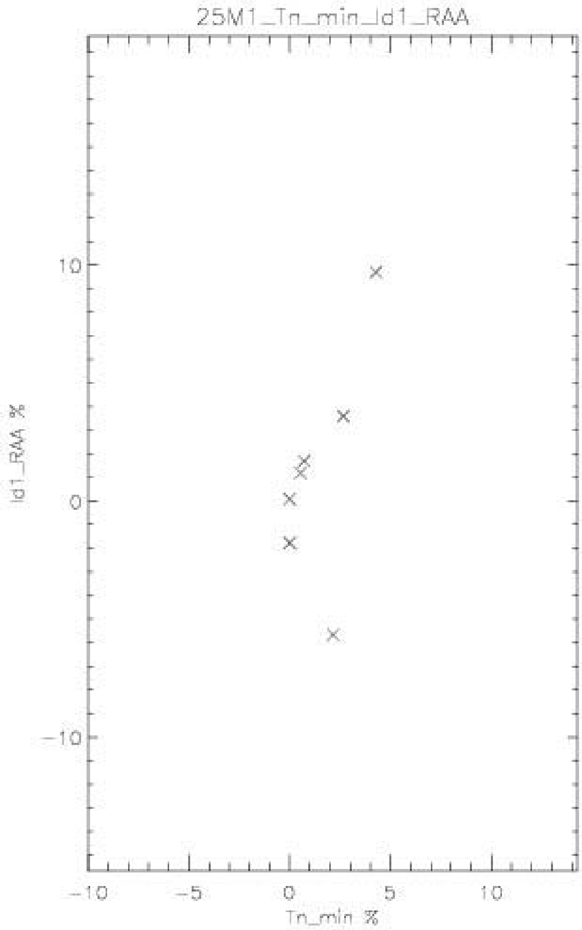
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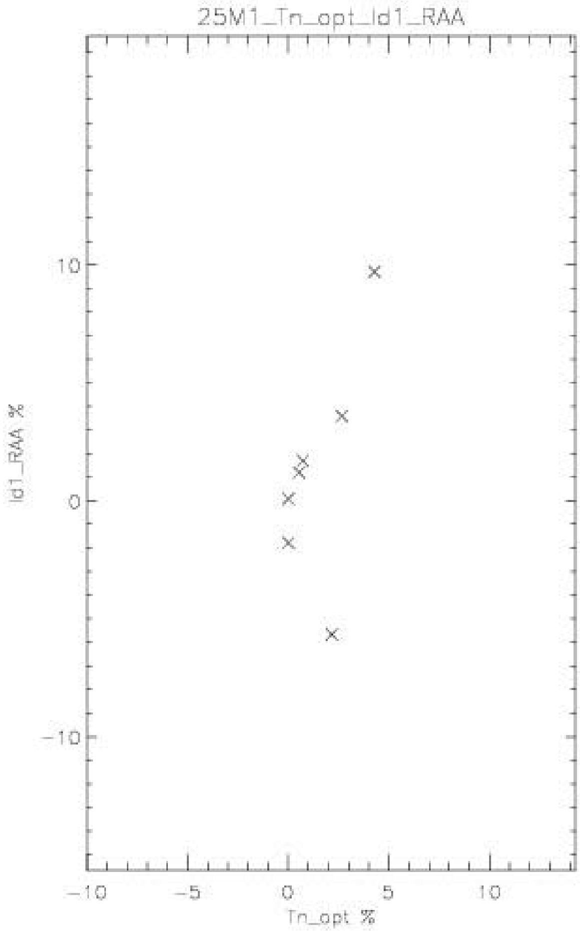
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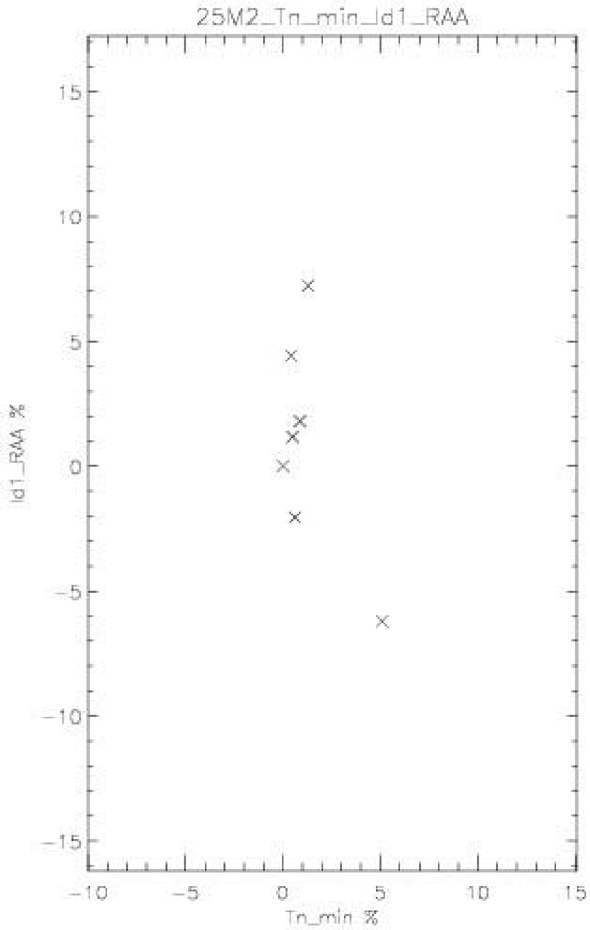
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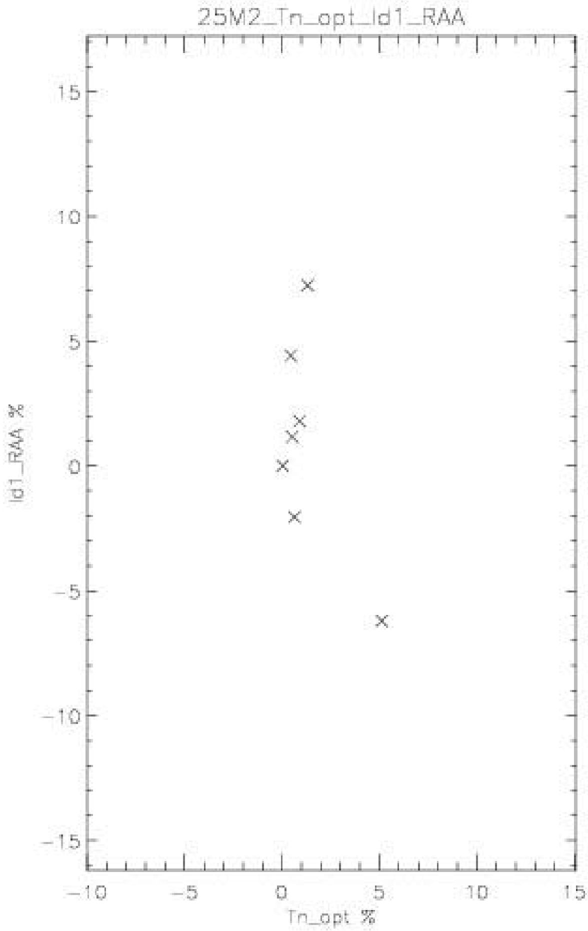
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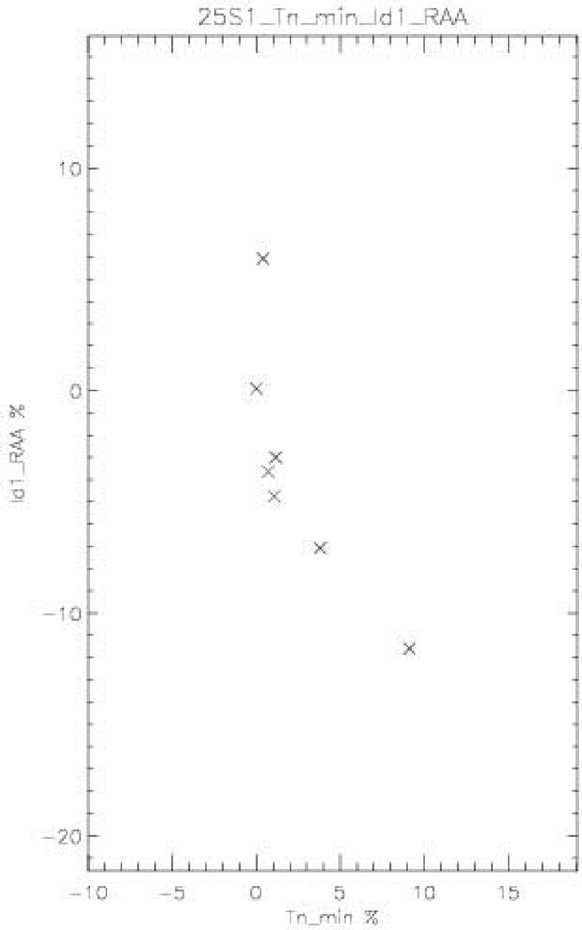
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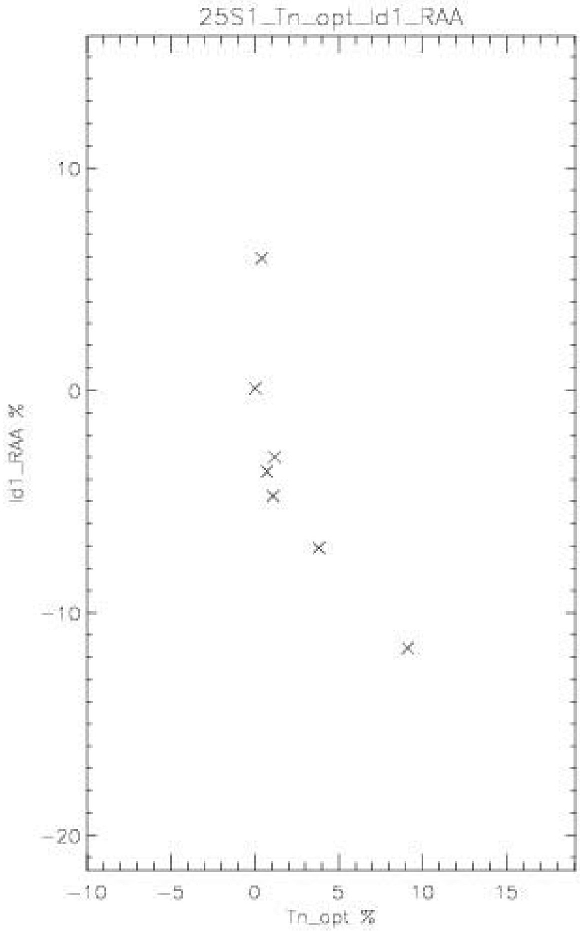
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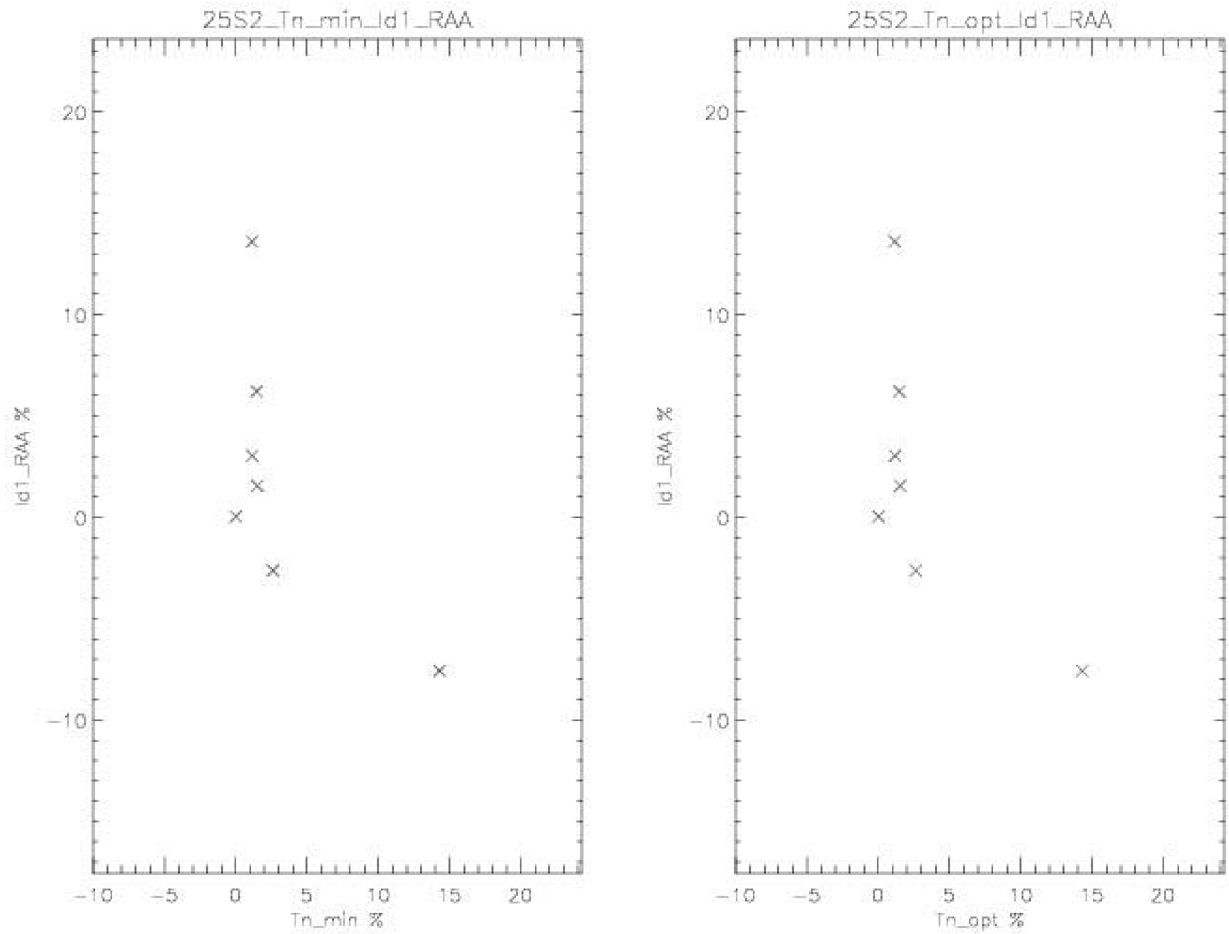
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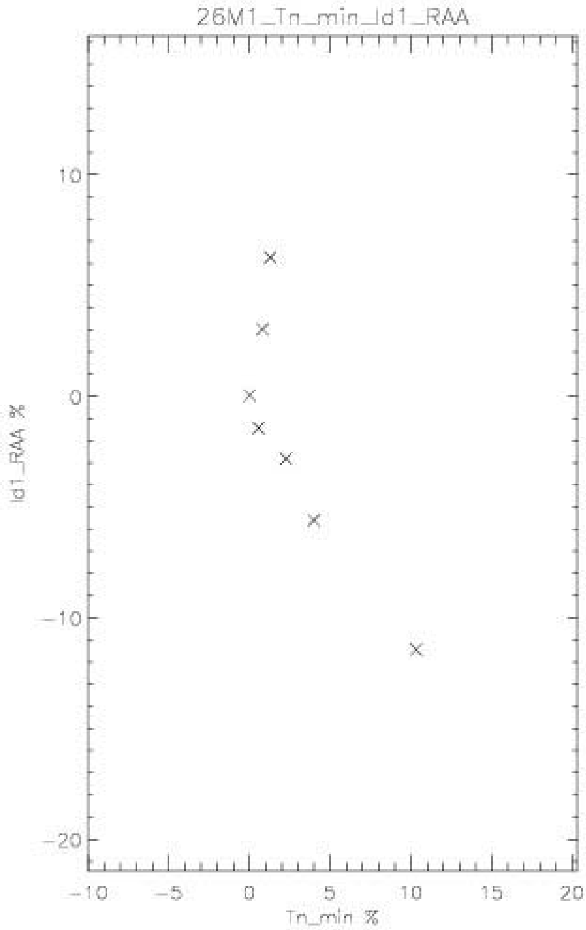
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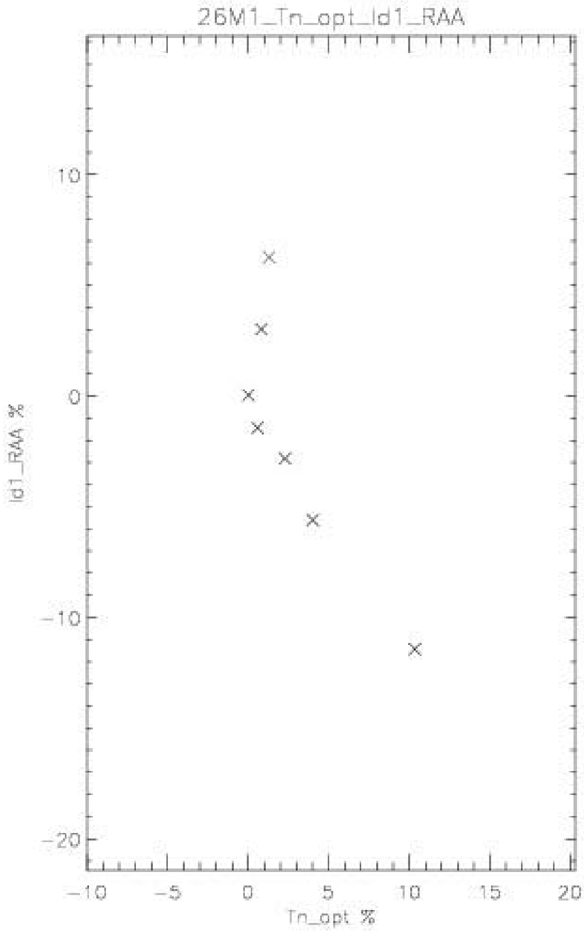
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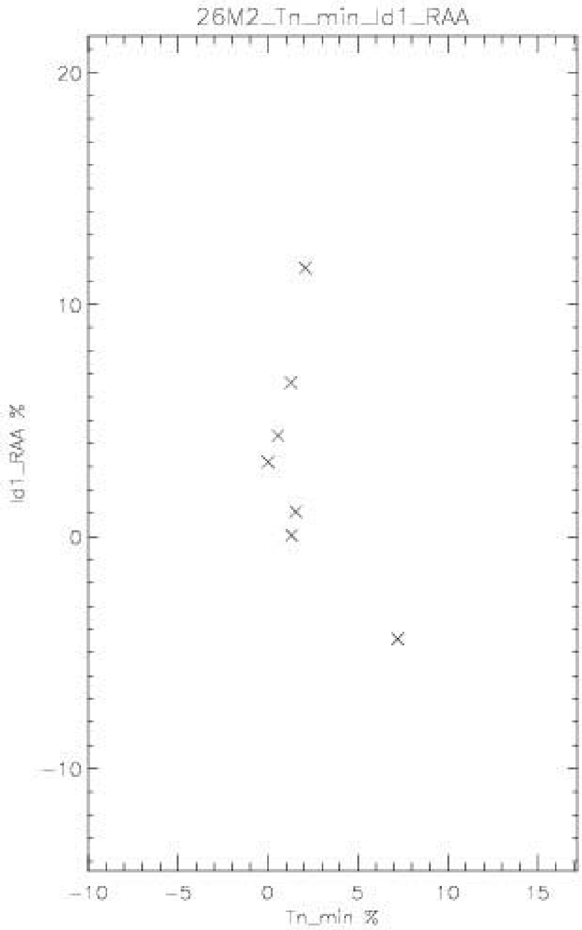
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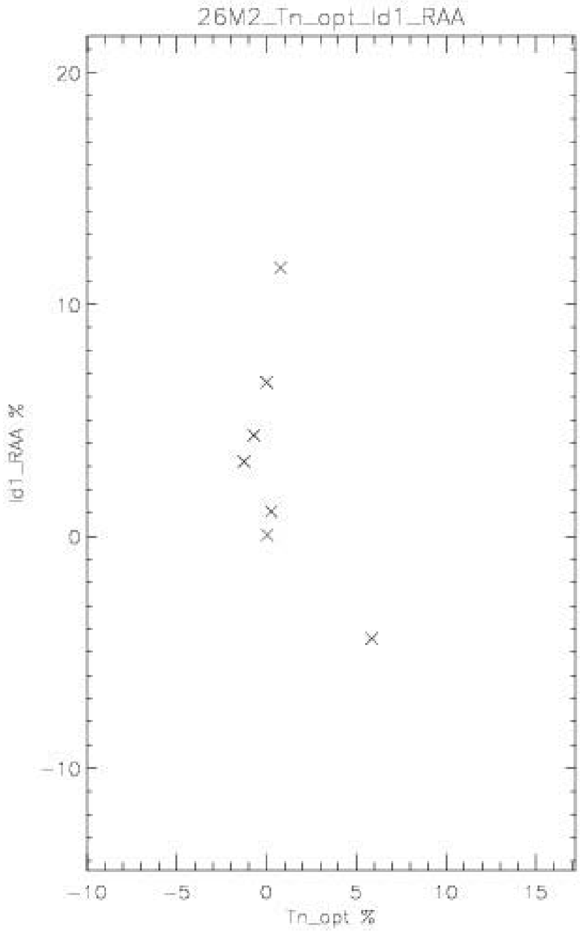
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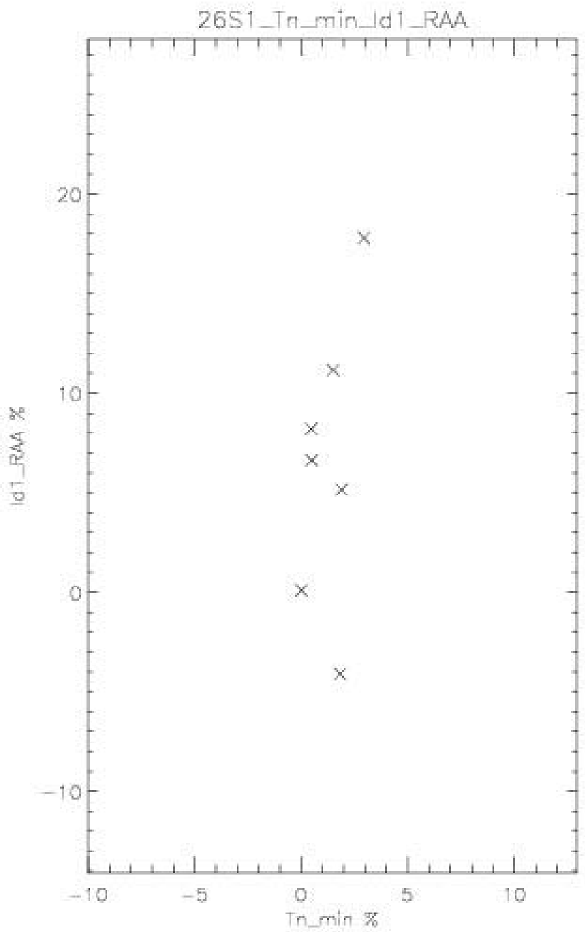
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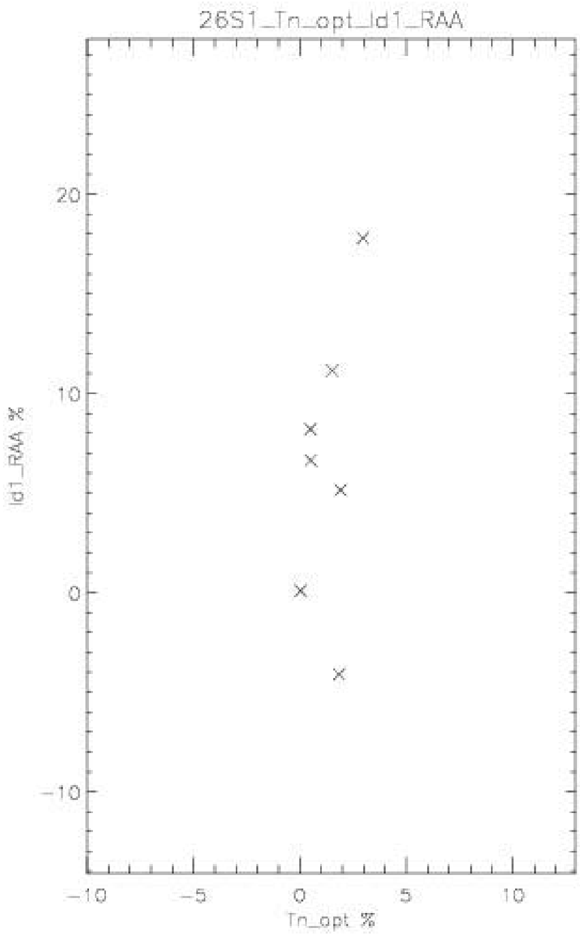
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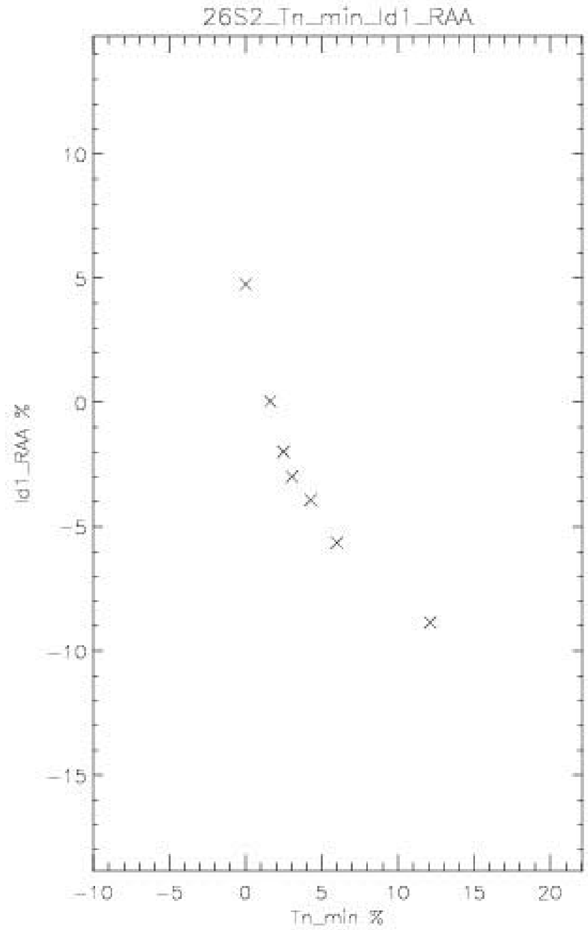
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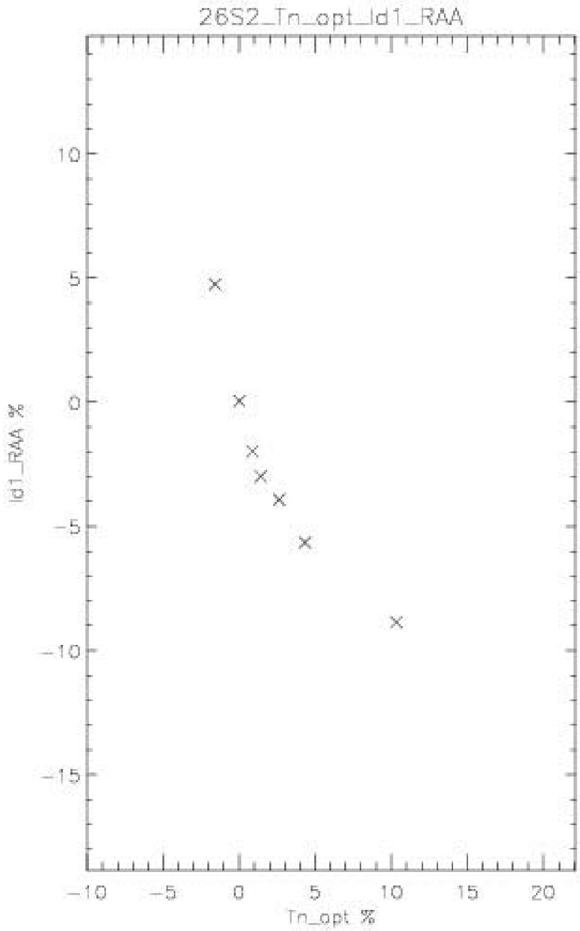
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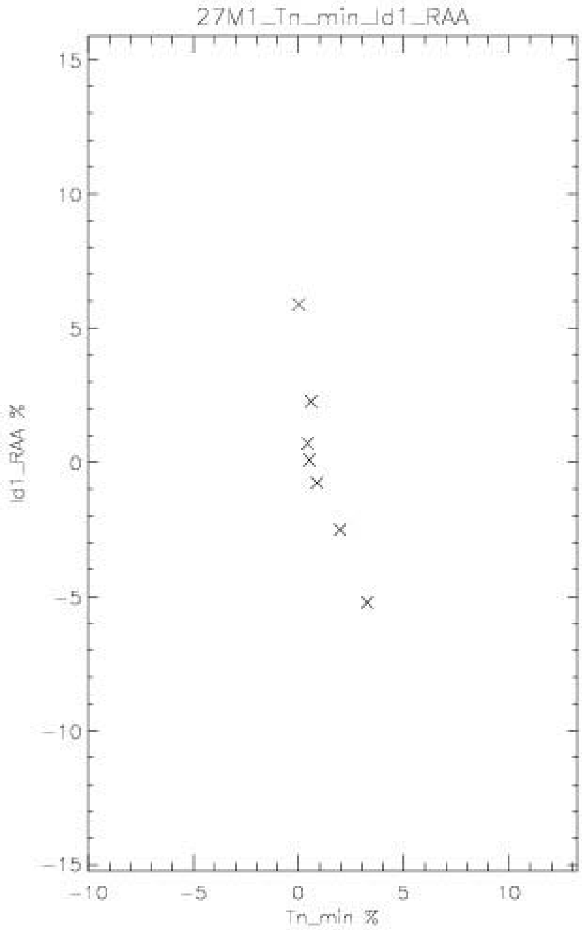
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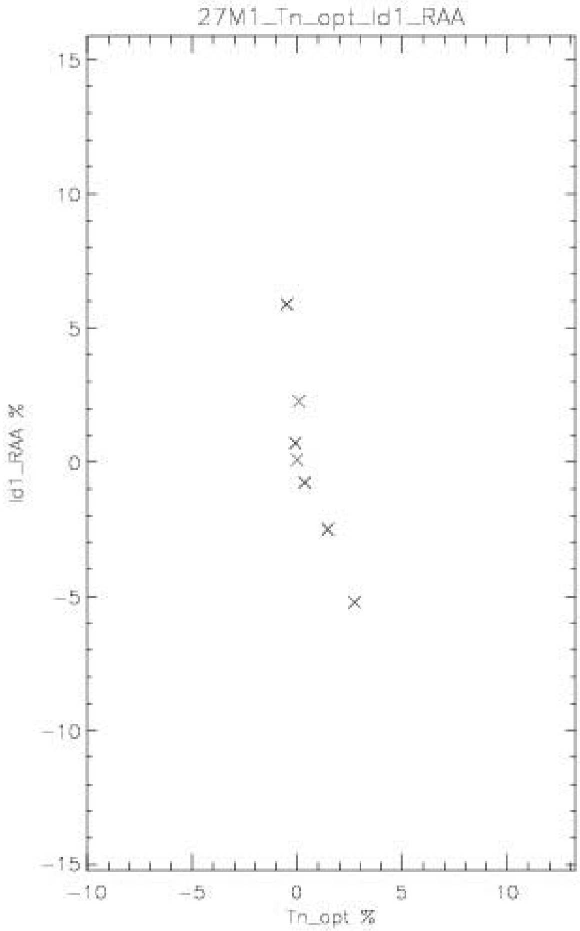
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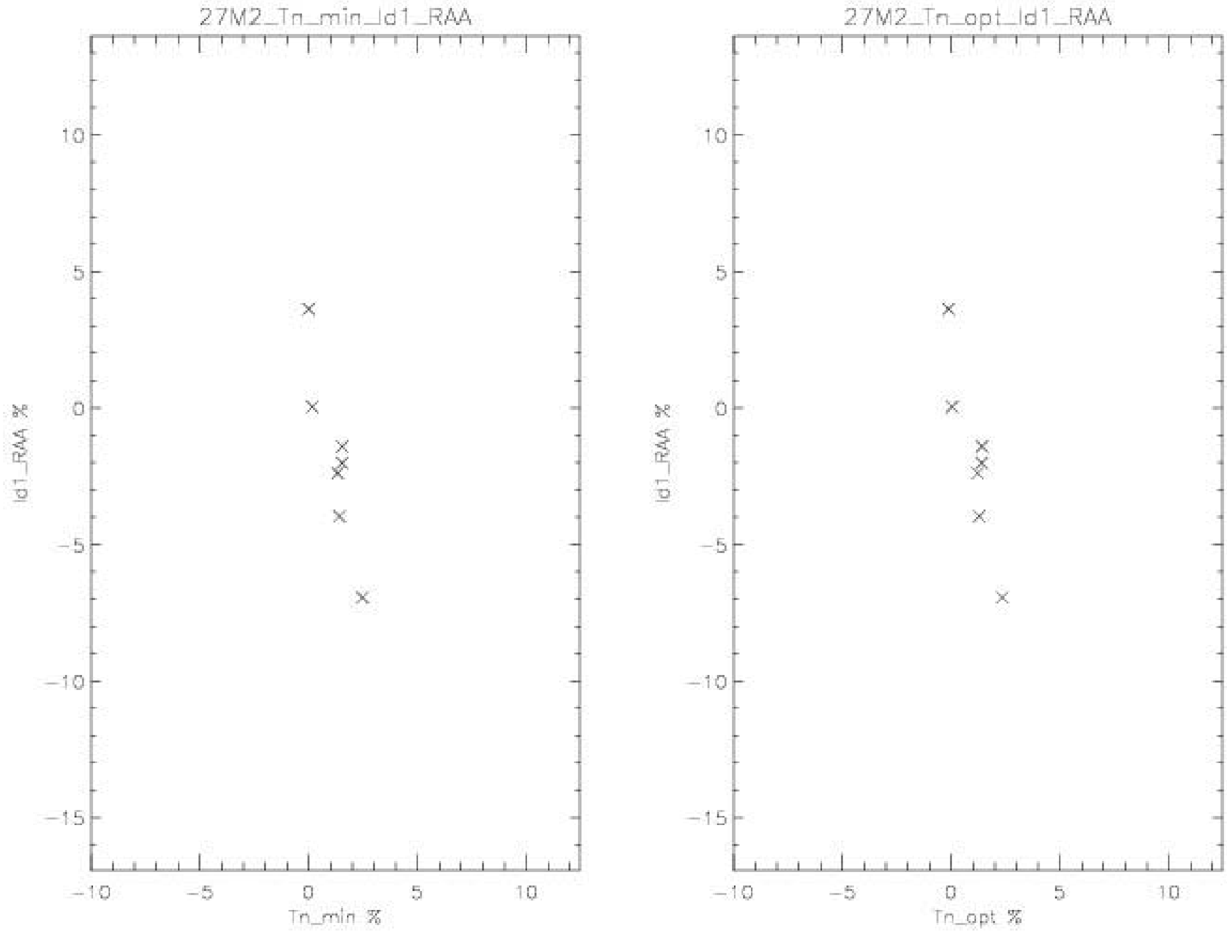
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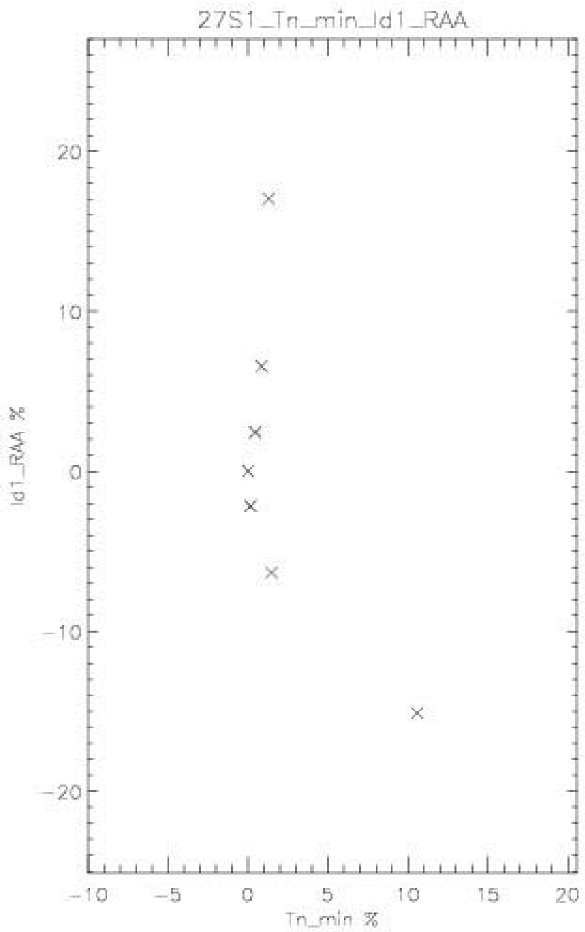
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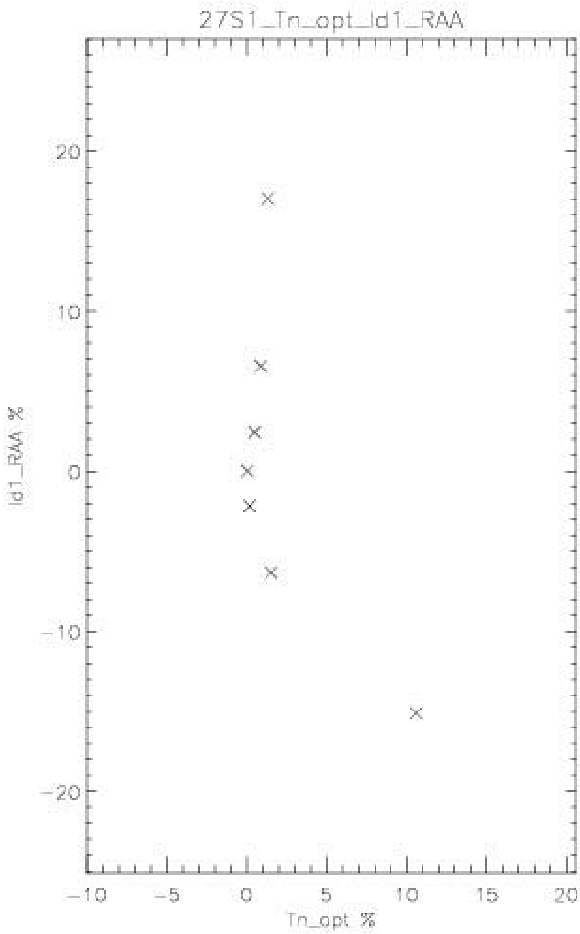
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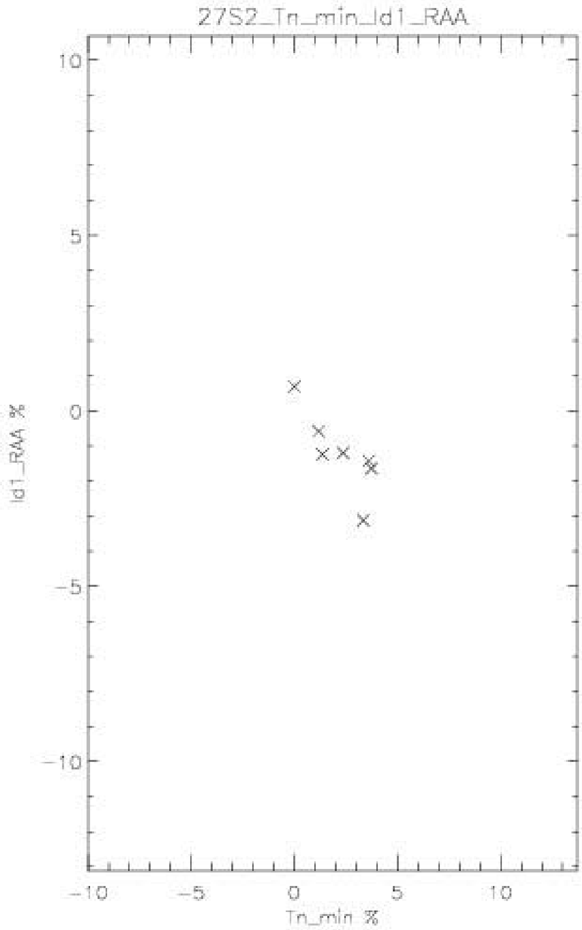
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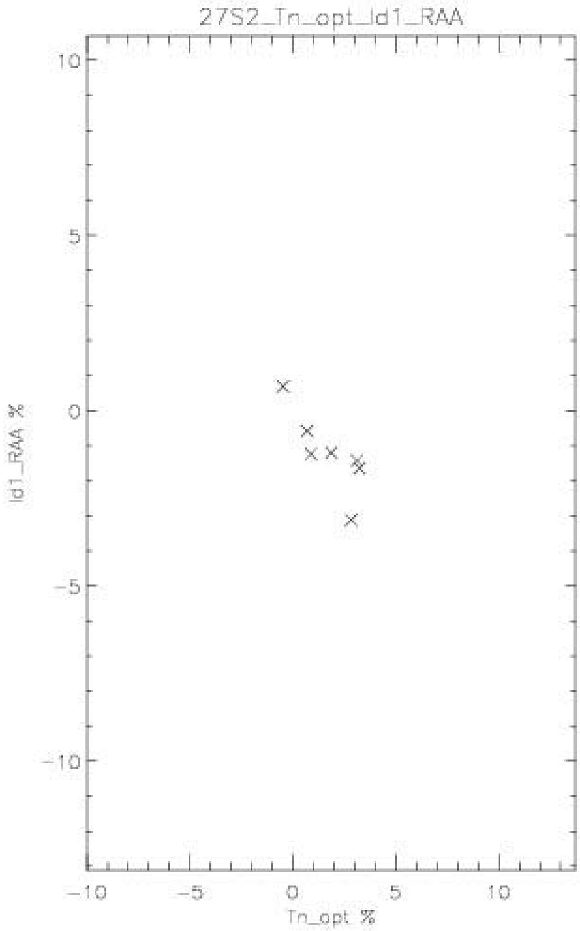
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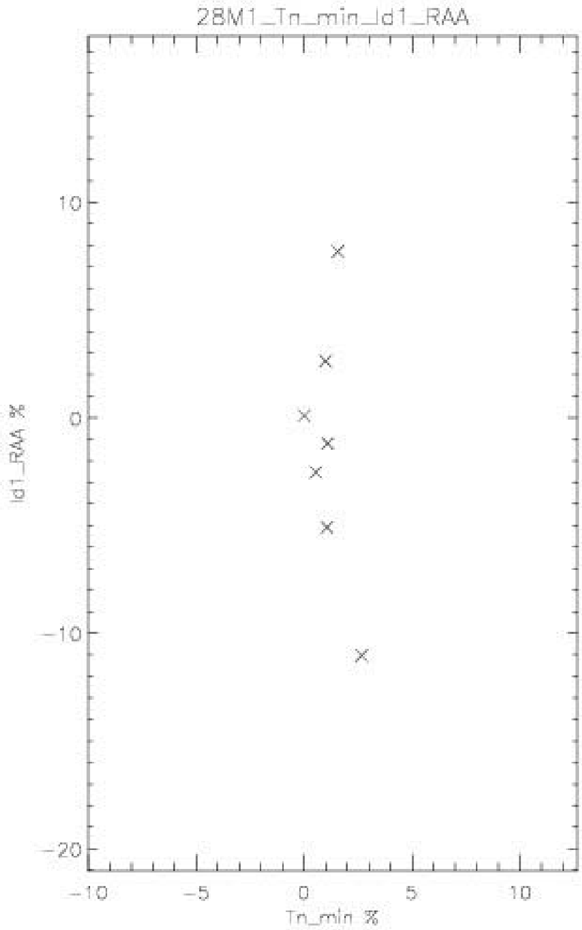
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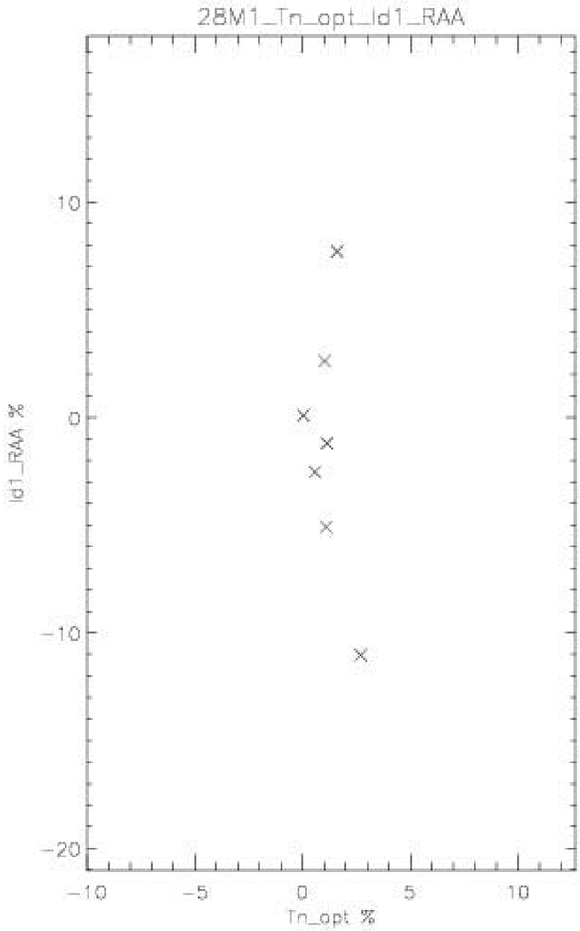
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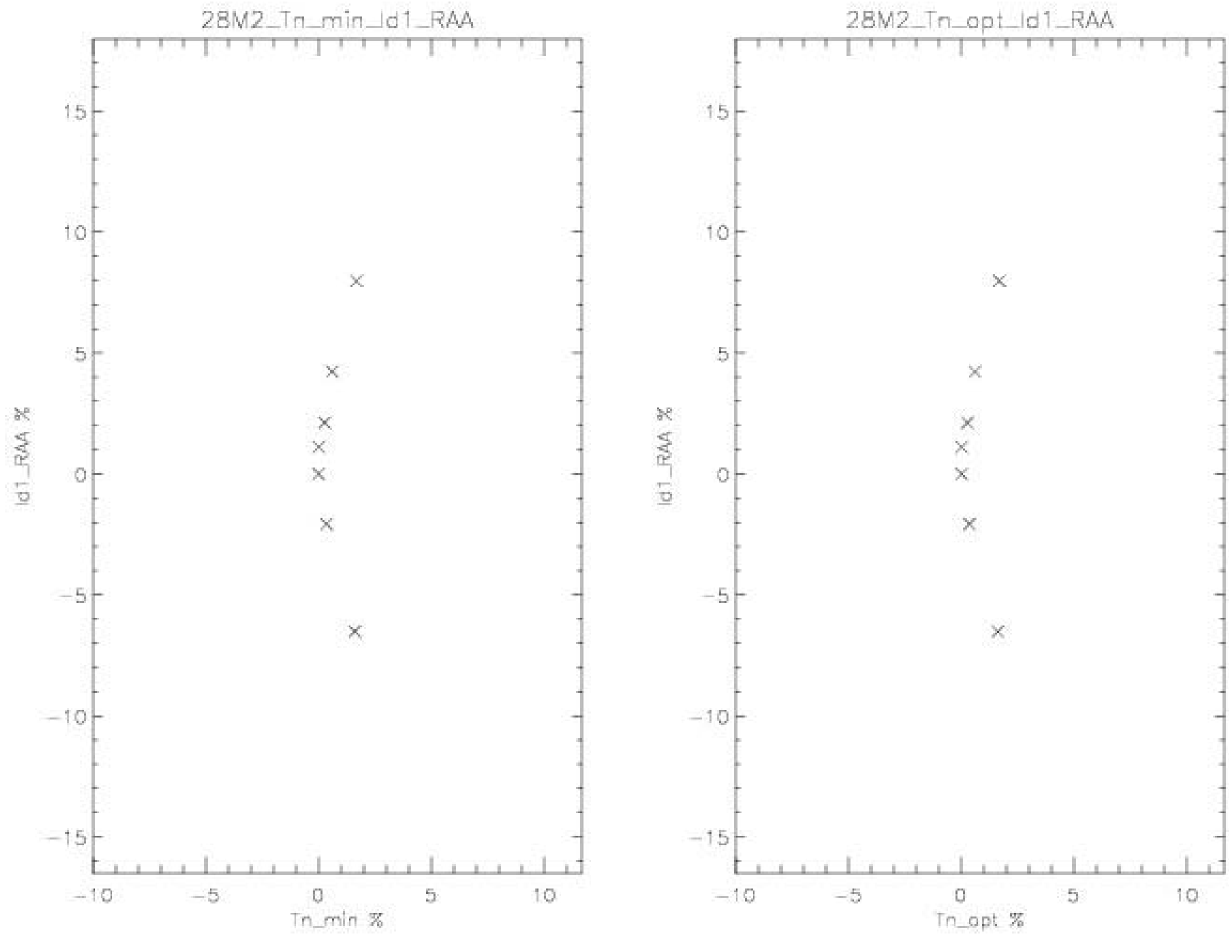
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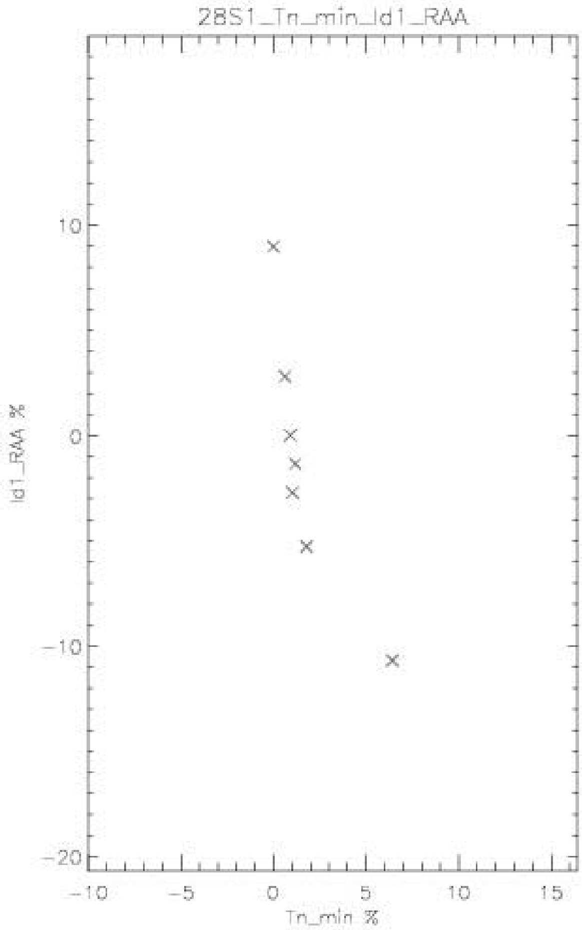
Tn_opt %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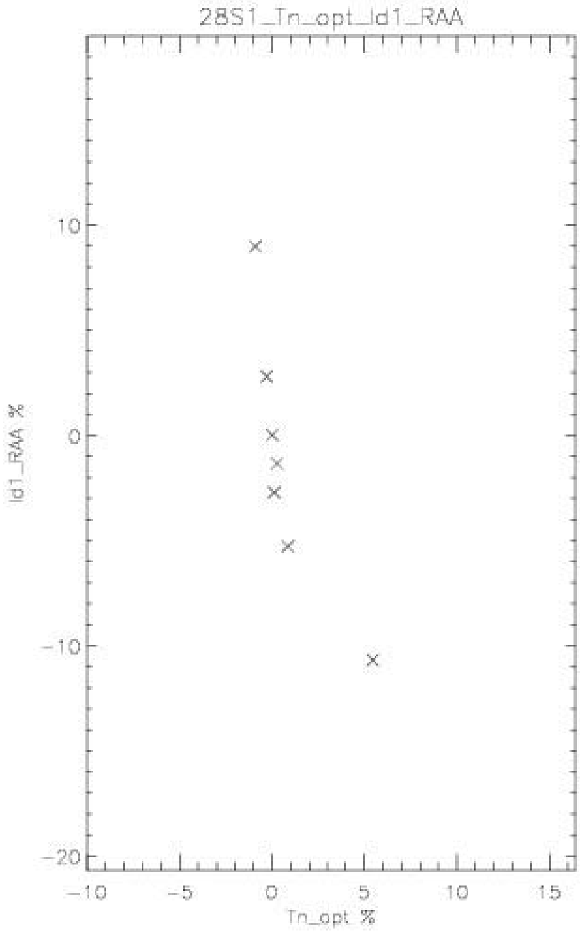
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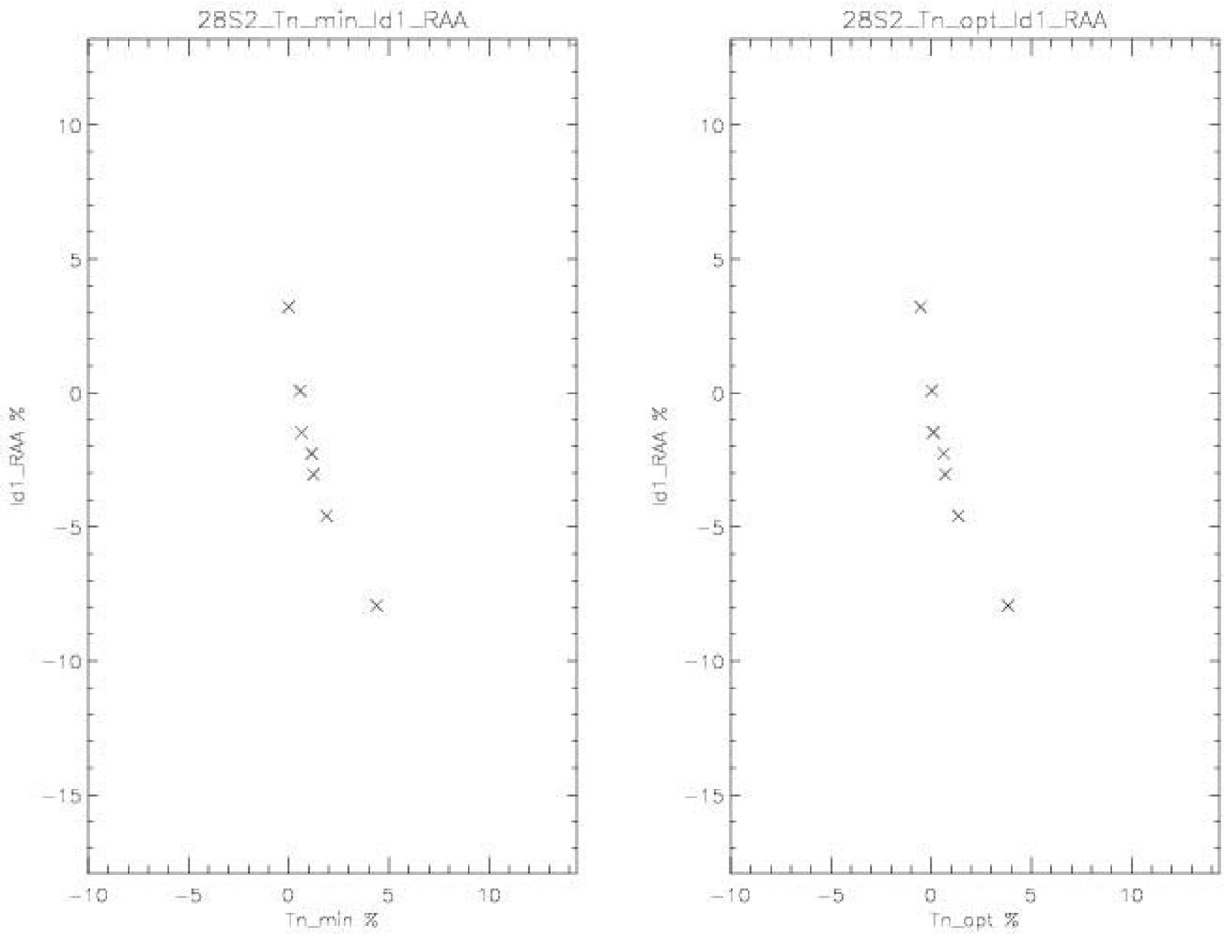
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Tn_min %
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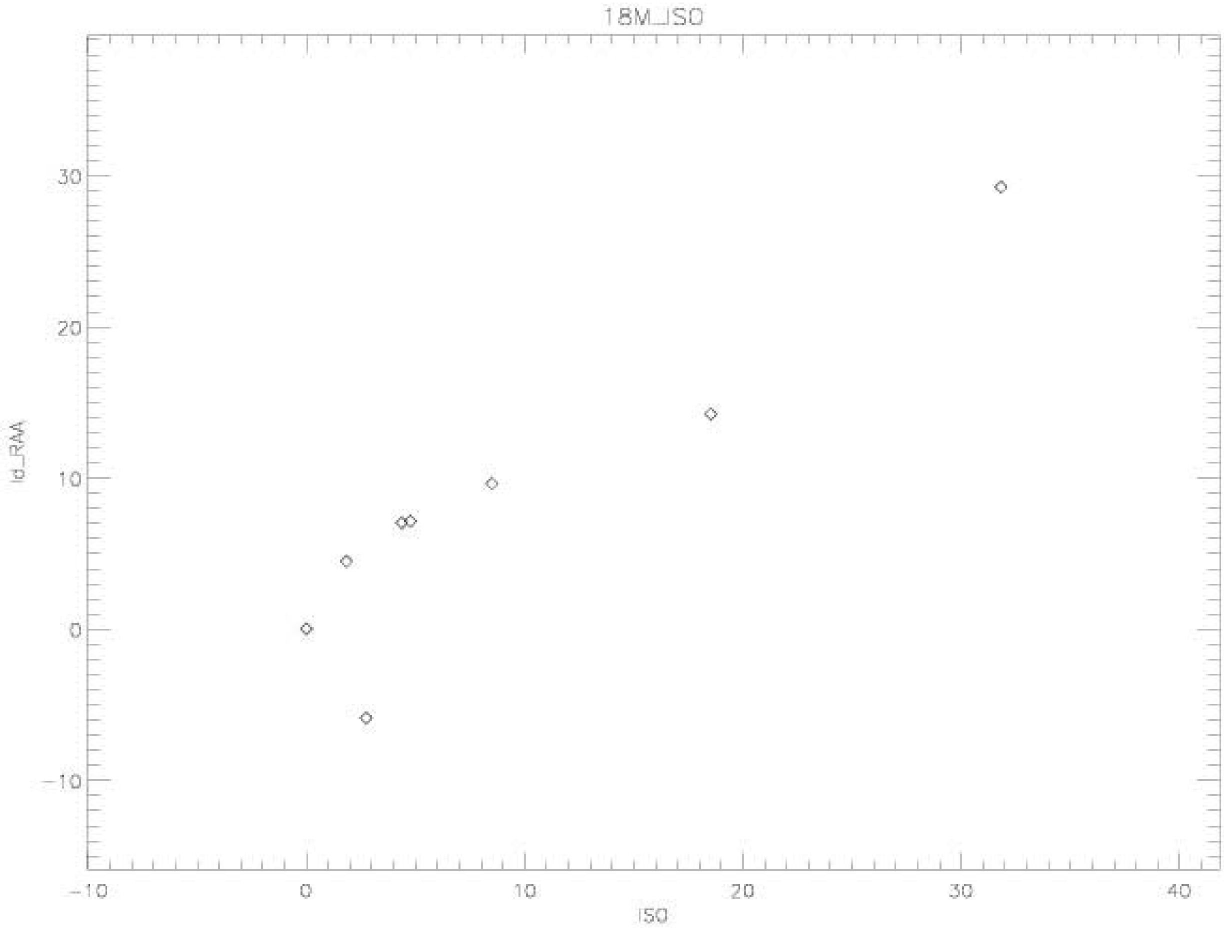
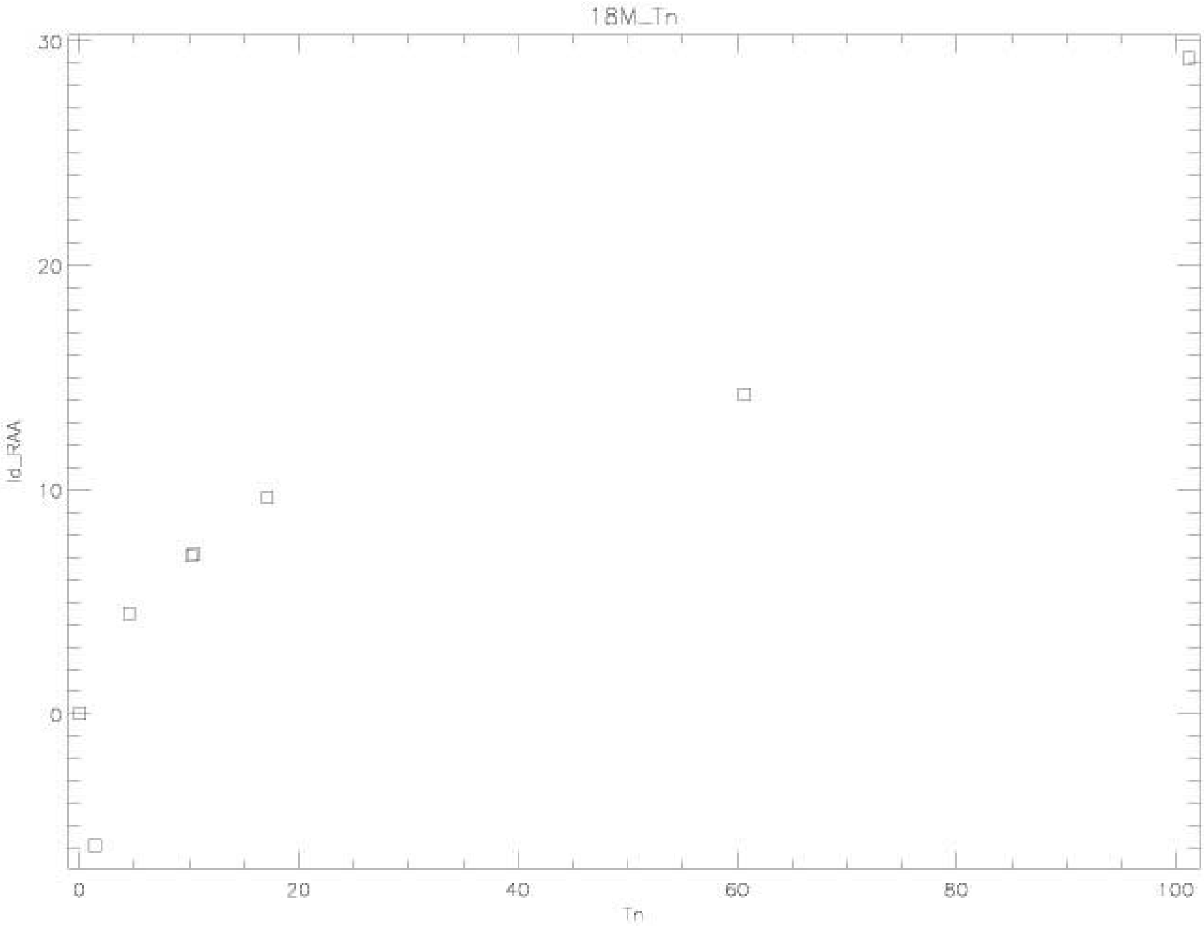
Tn_opt %

9 APPENDIX 2: Vg2 TUNING. Noise temperature and Isolation susceptibility to drain current.

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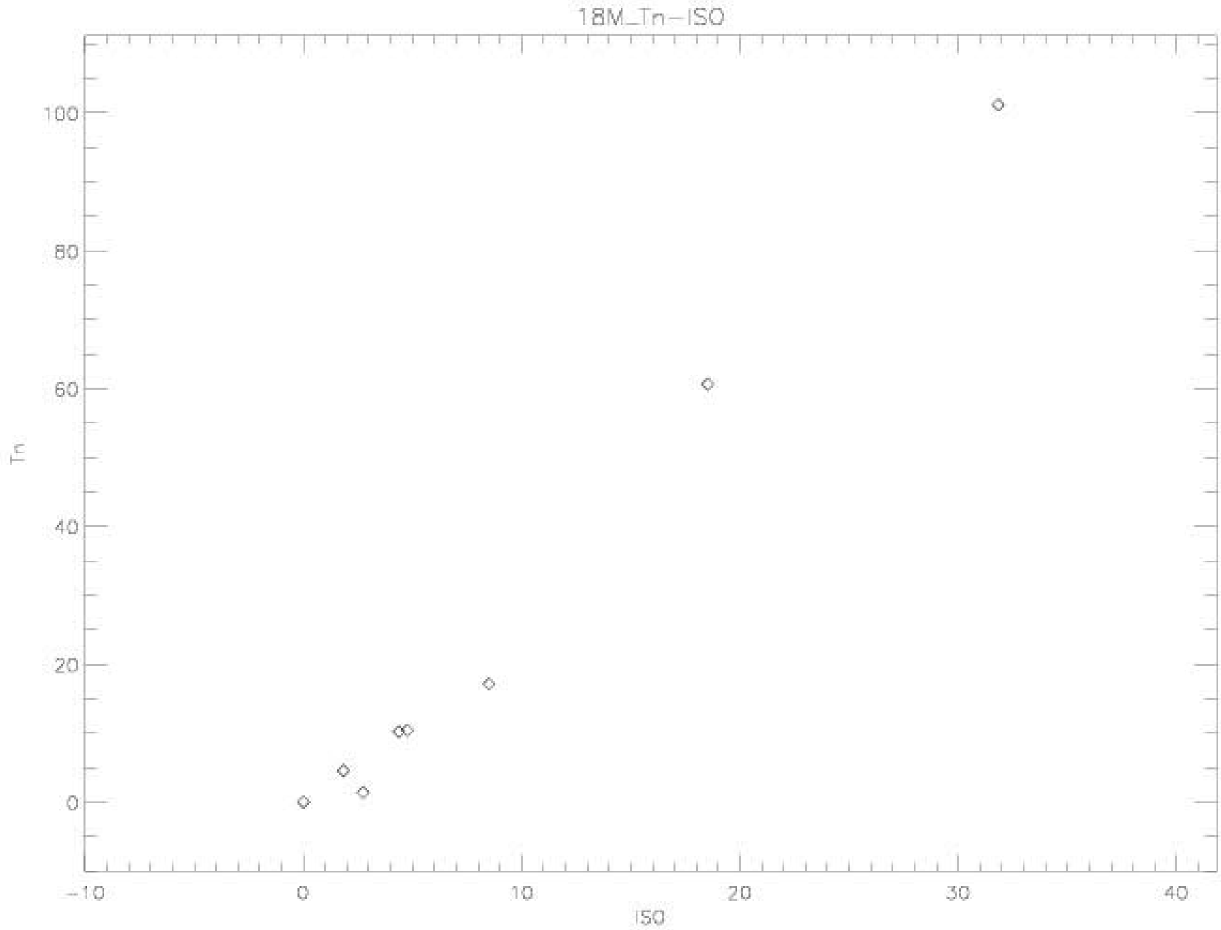
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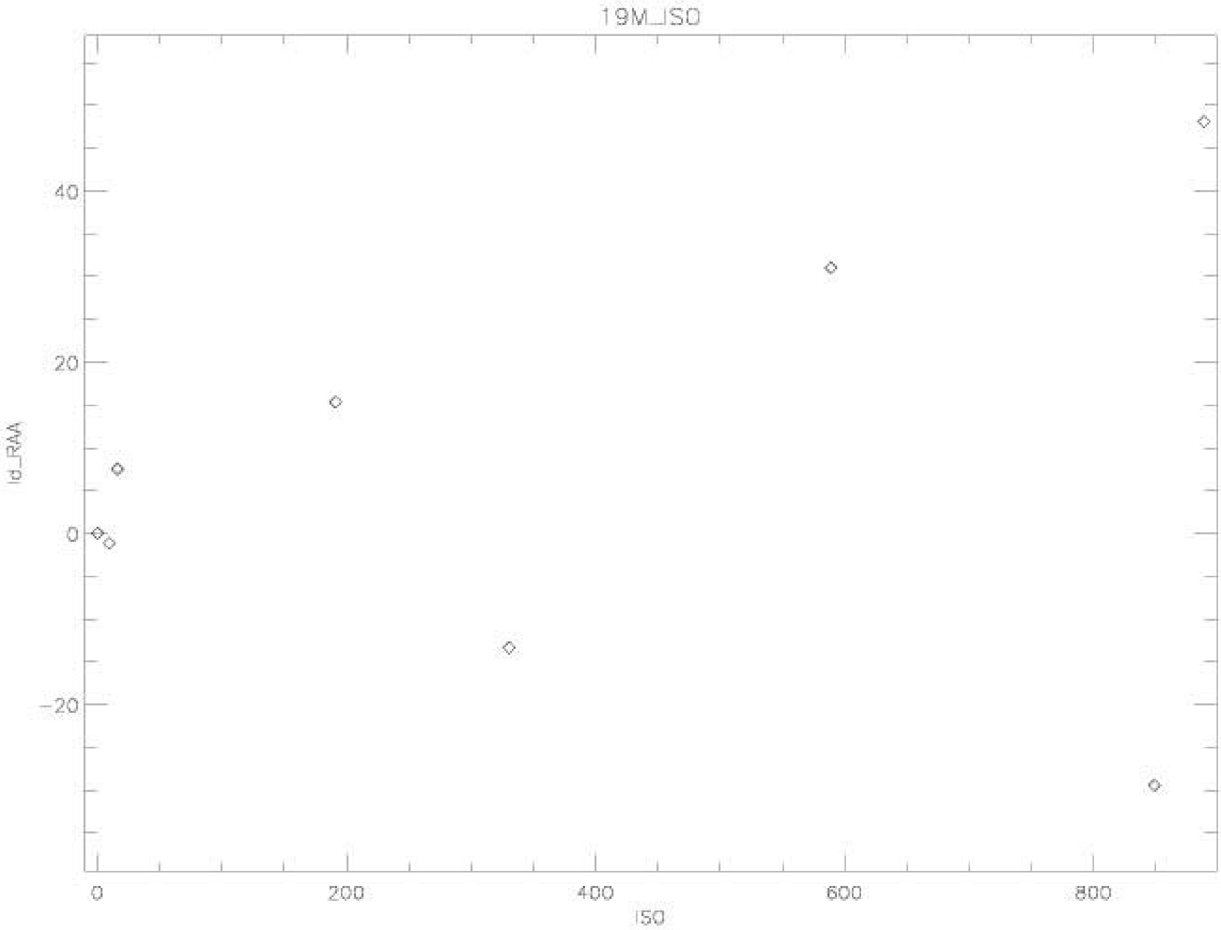
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ISO
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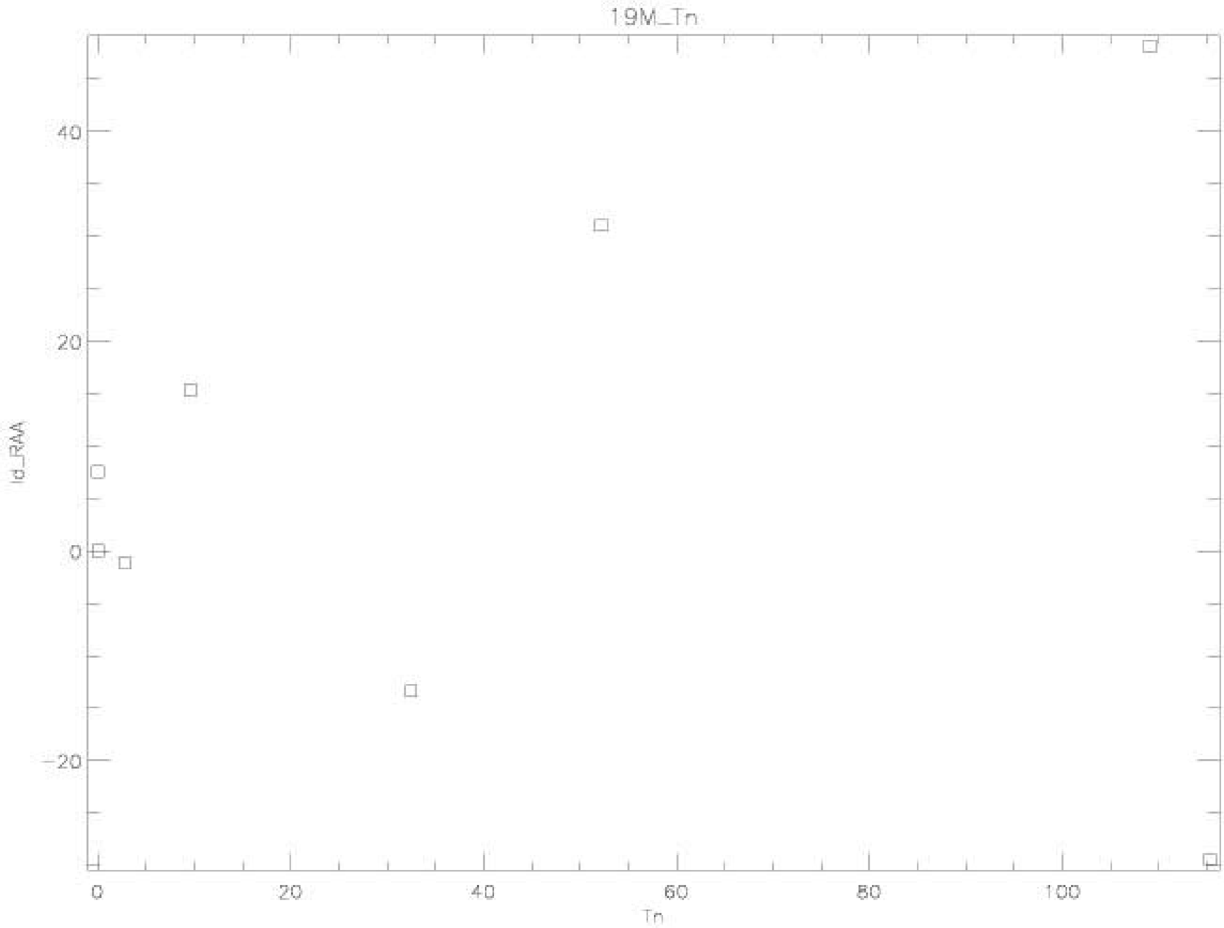
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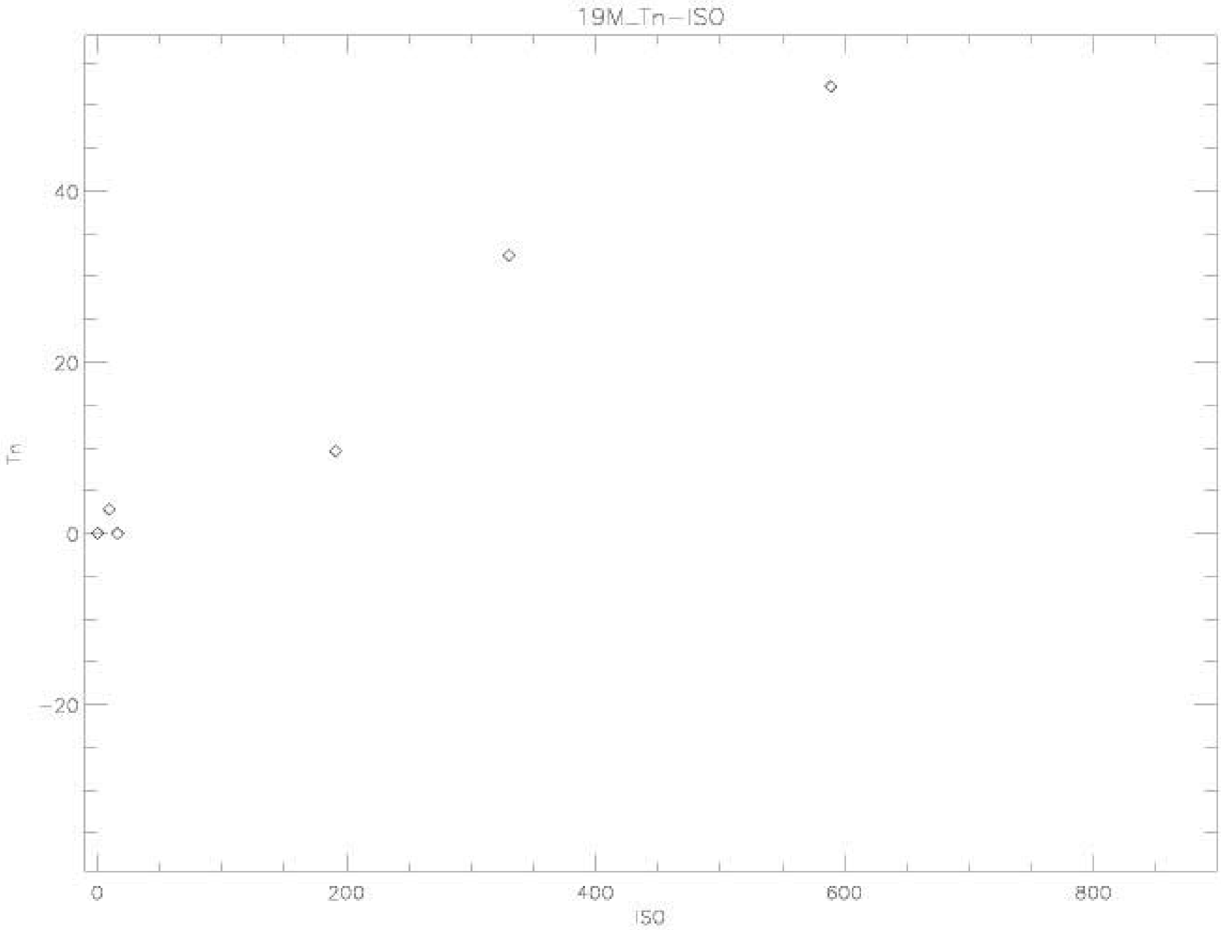
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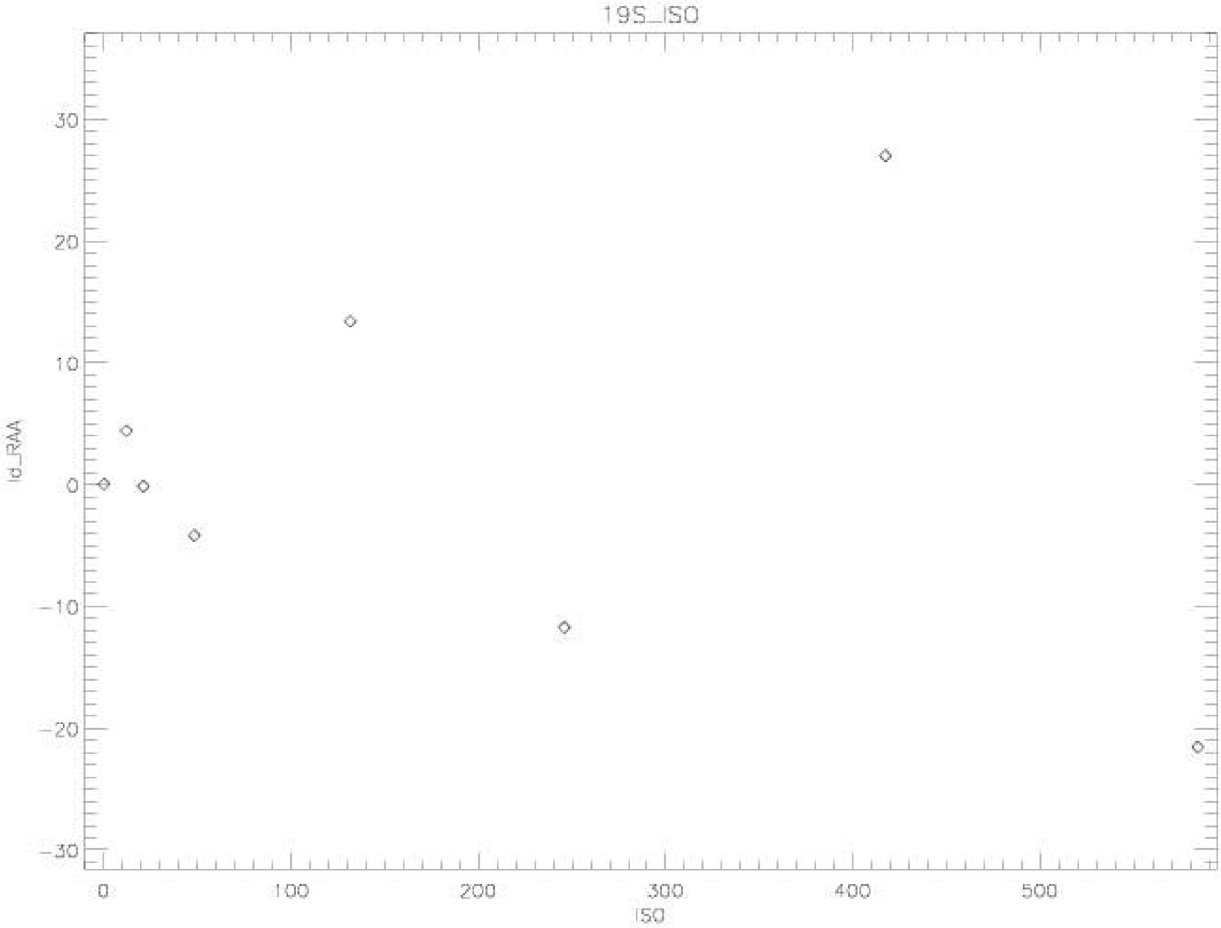
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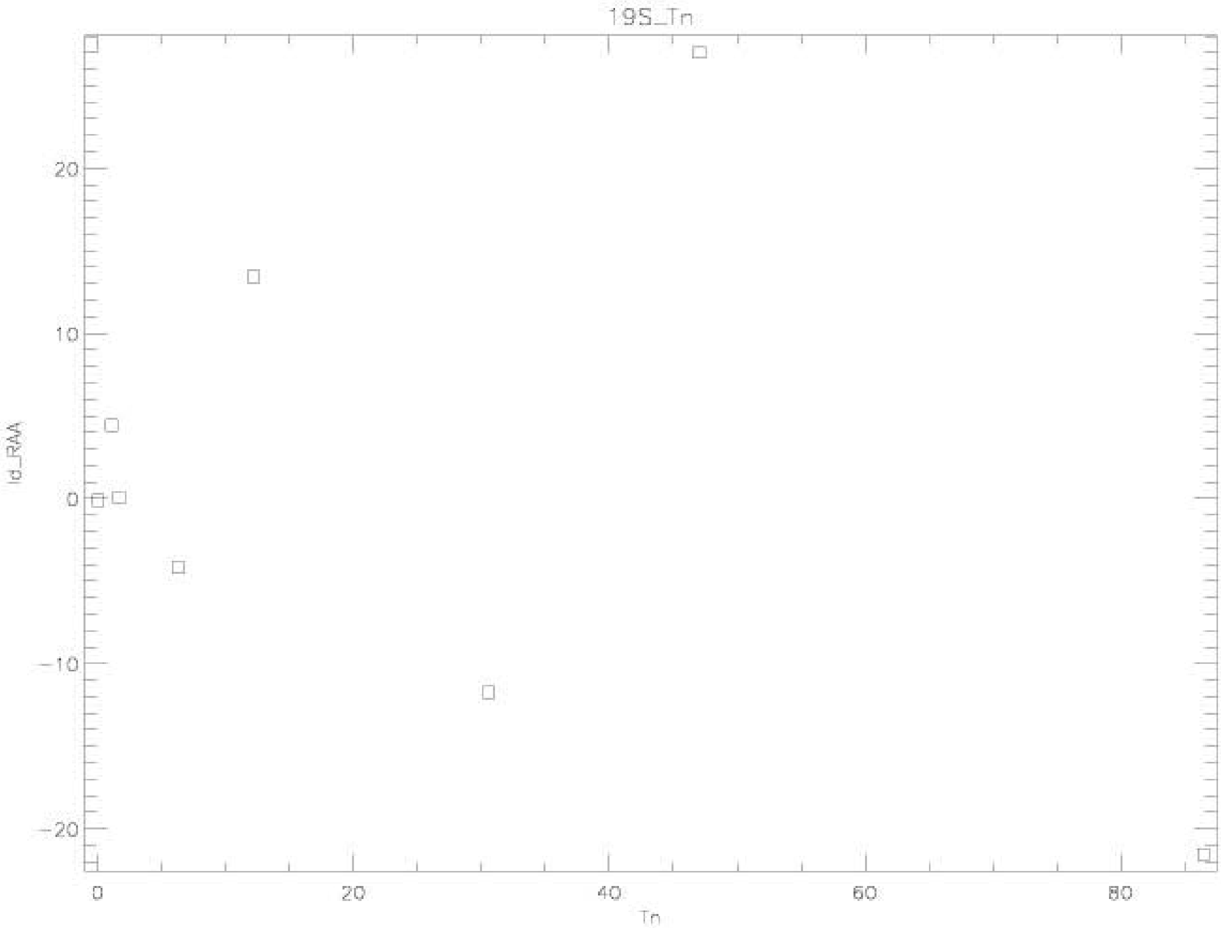
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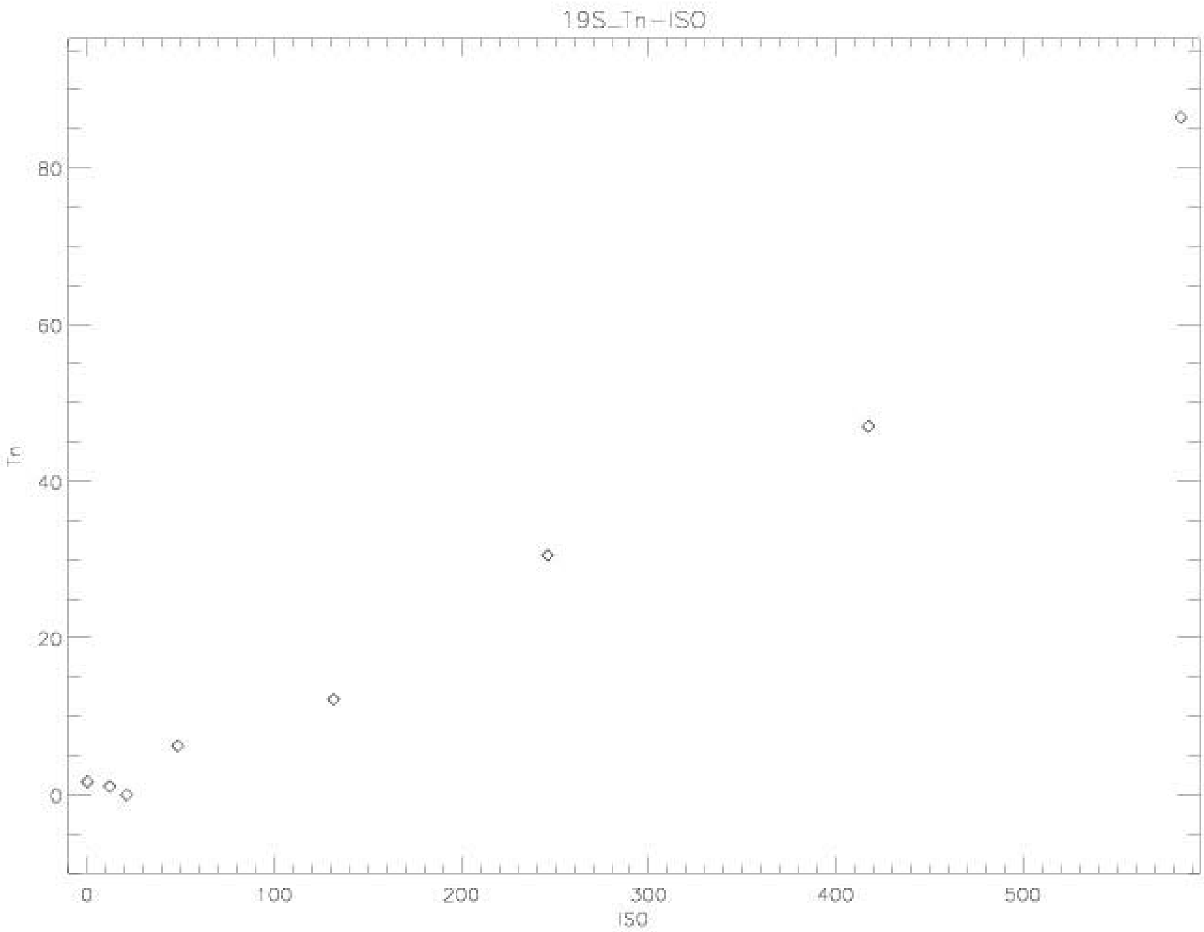
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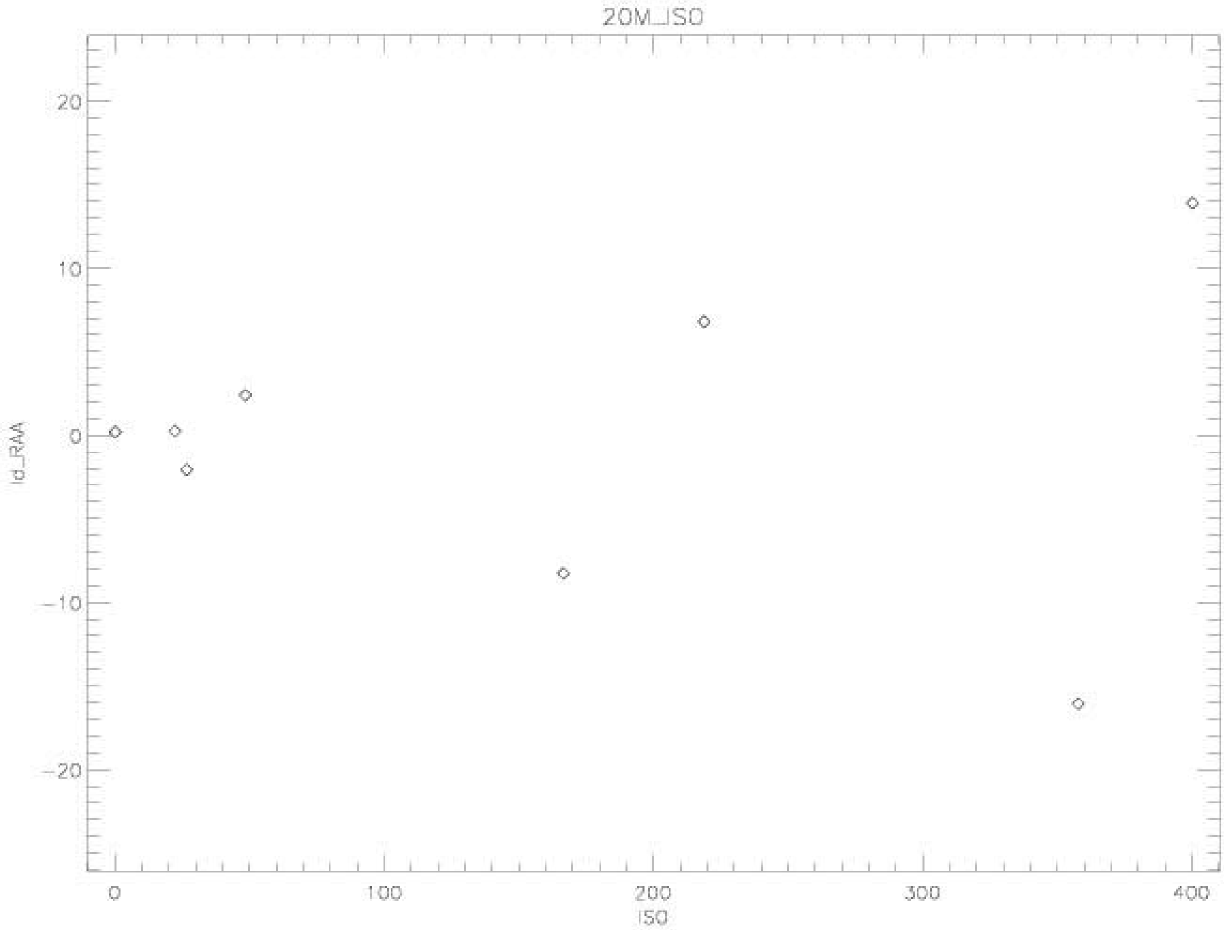
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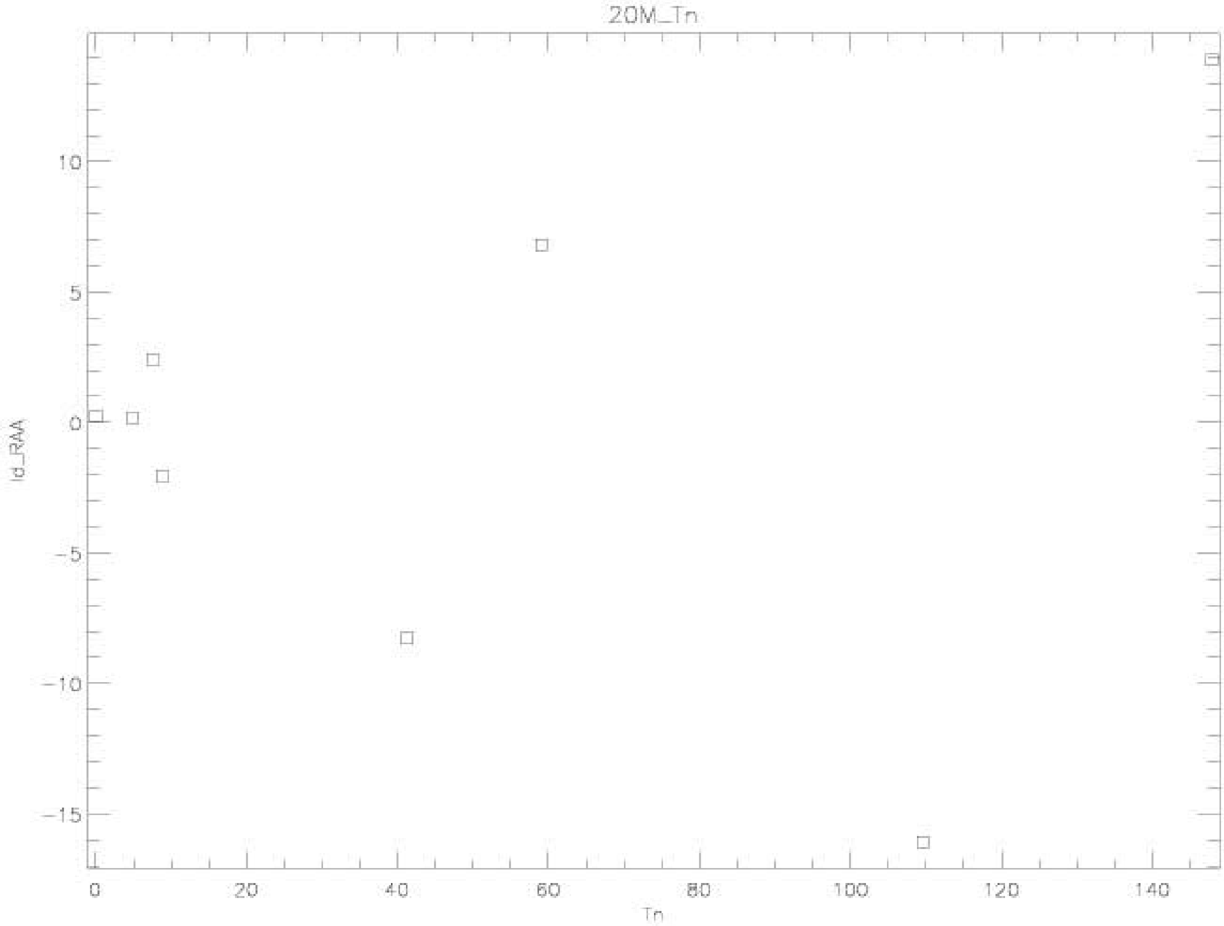
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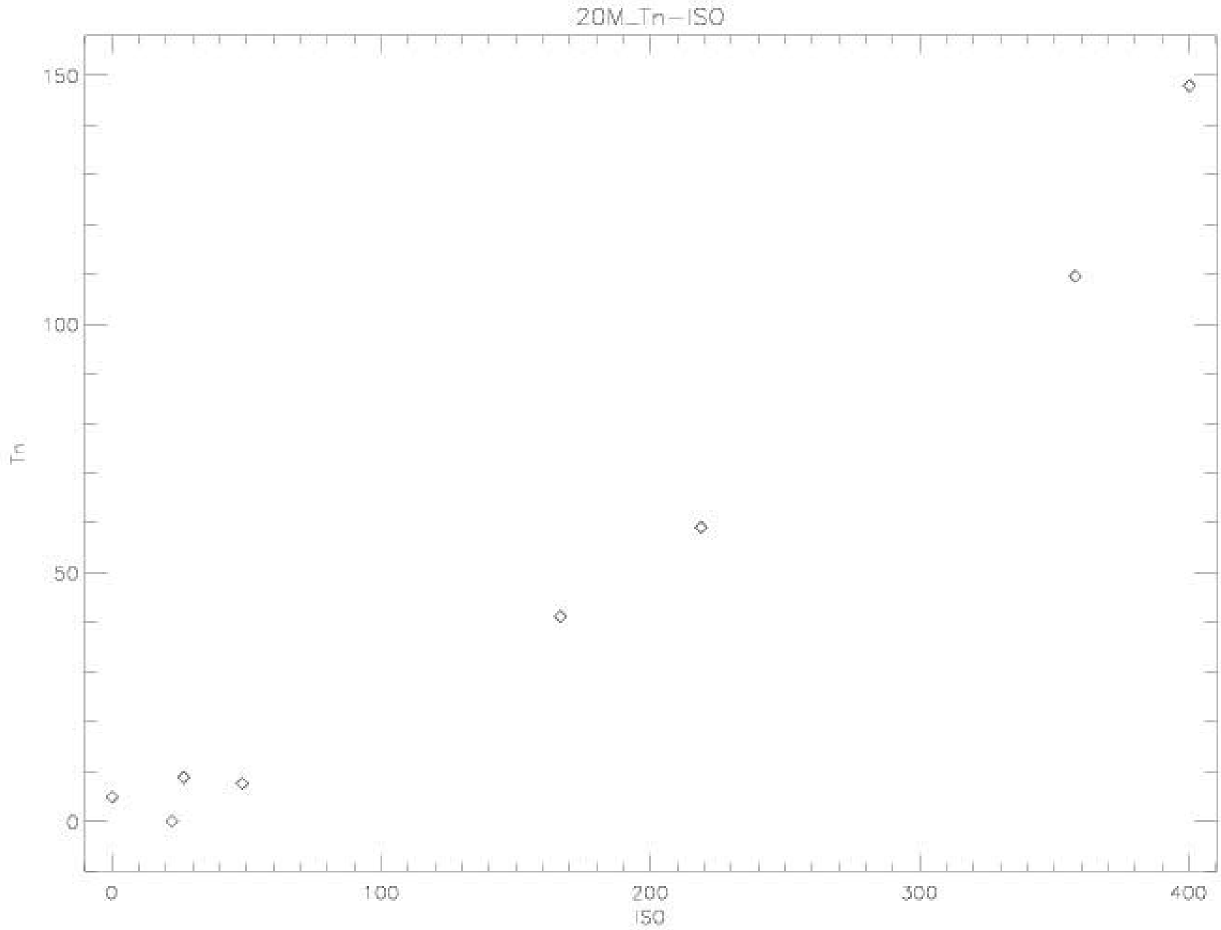
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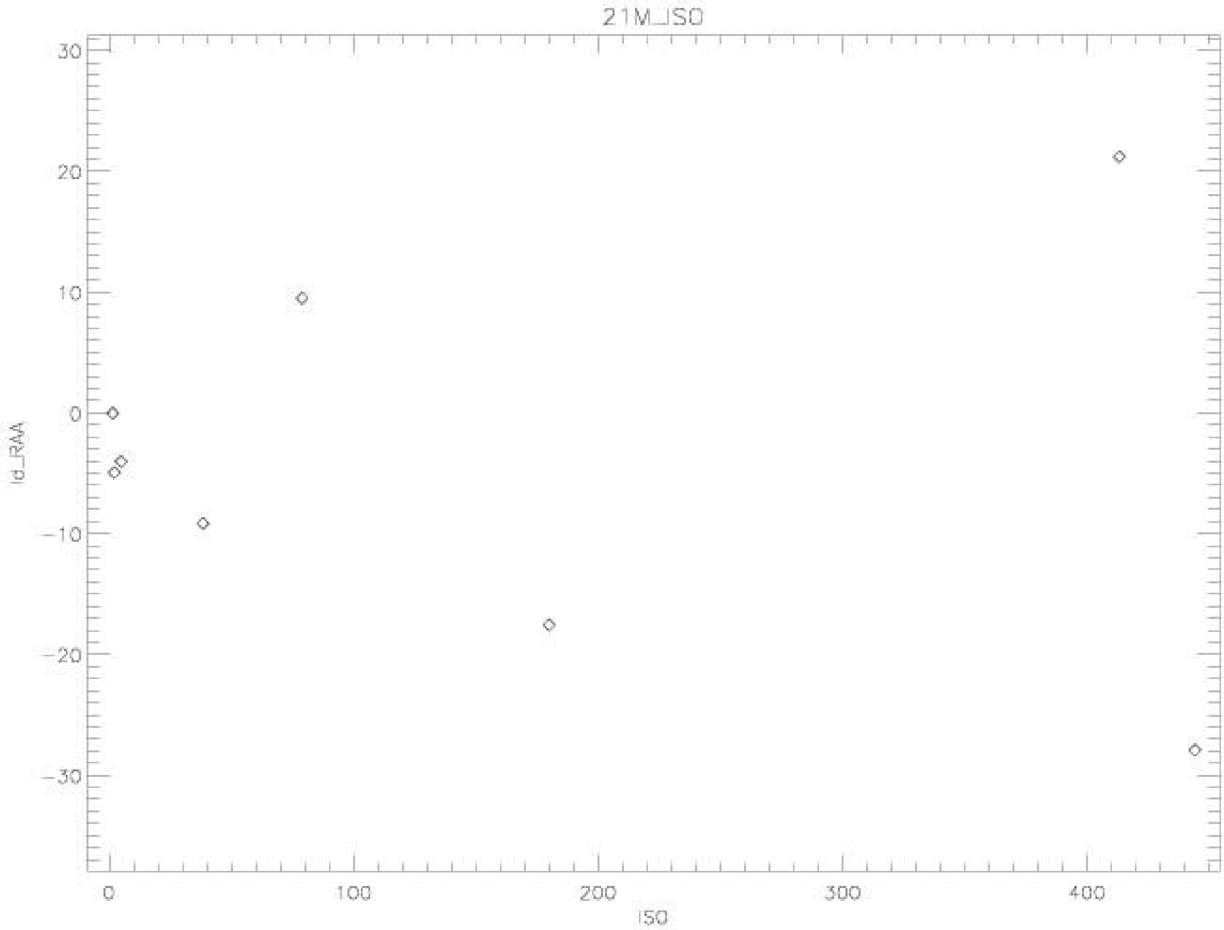
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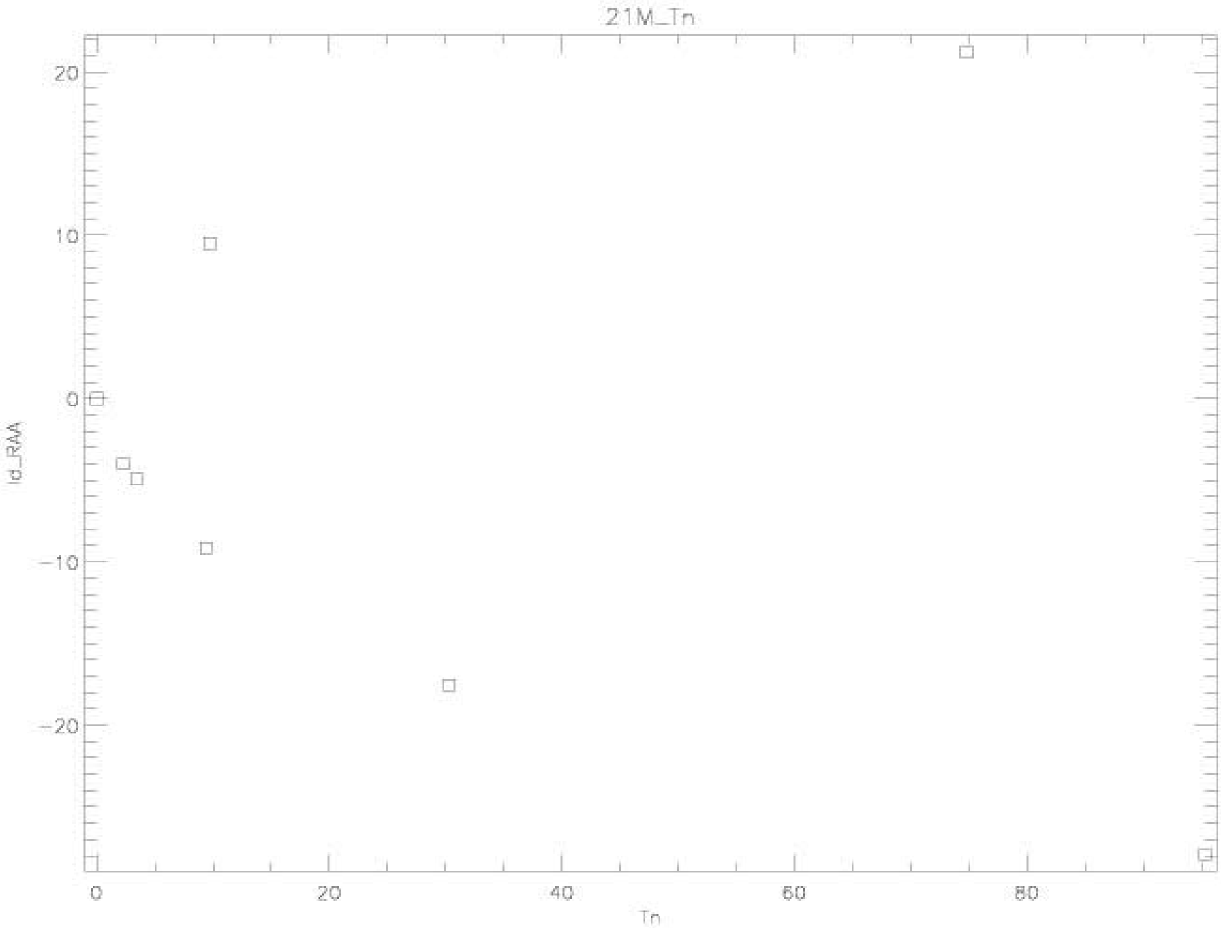
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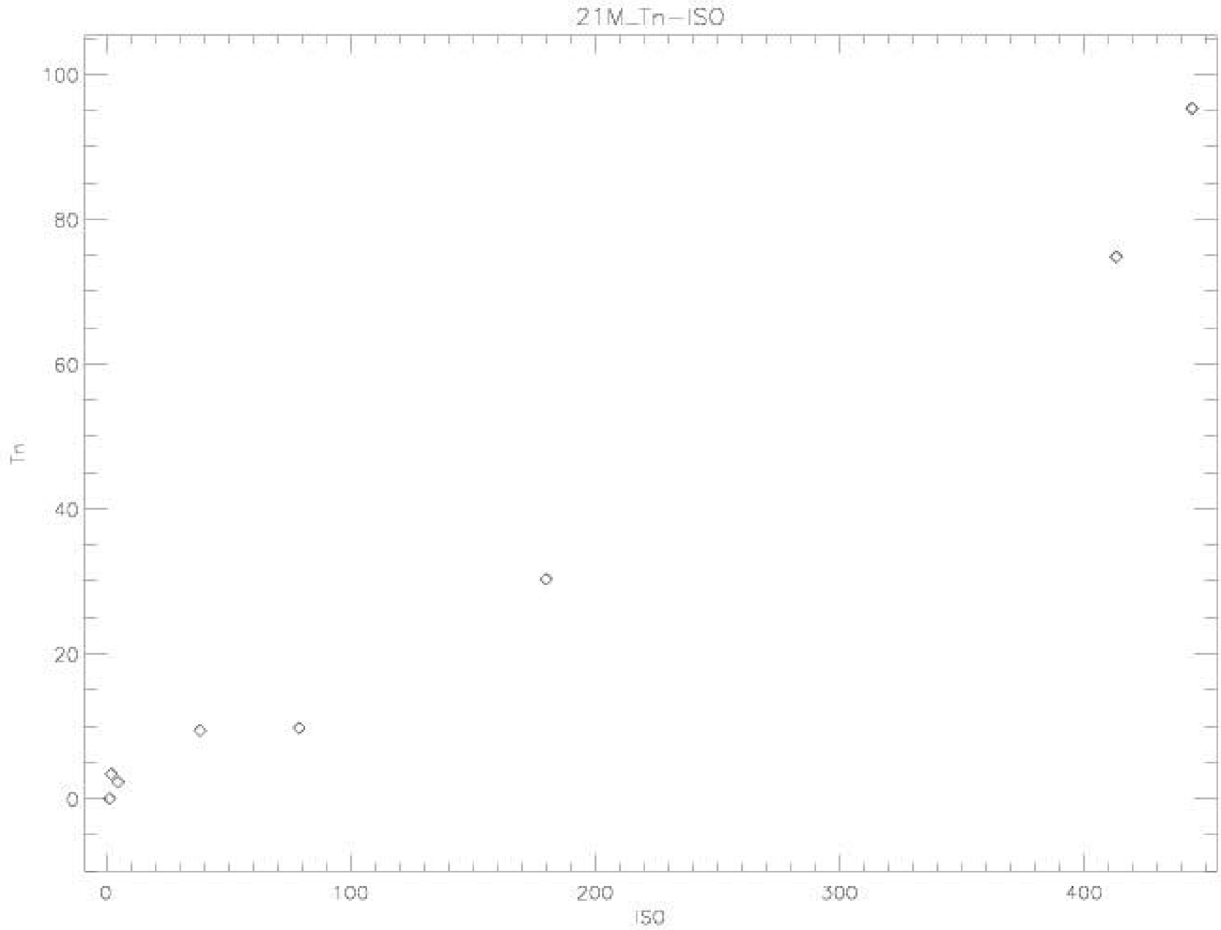
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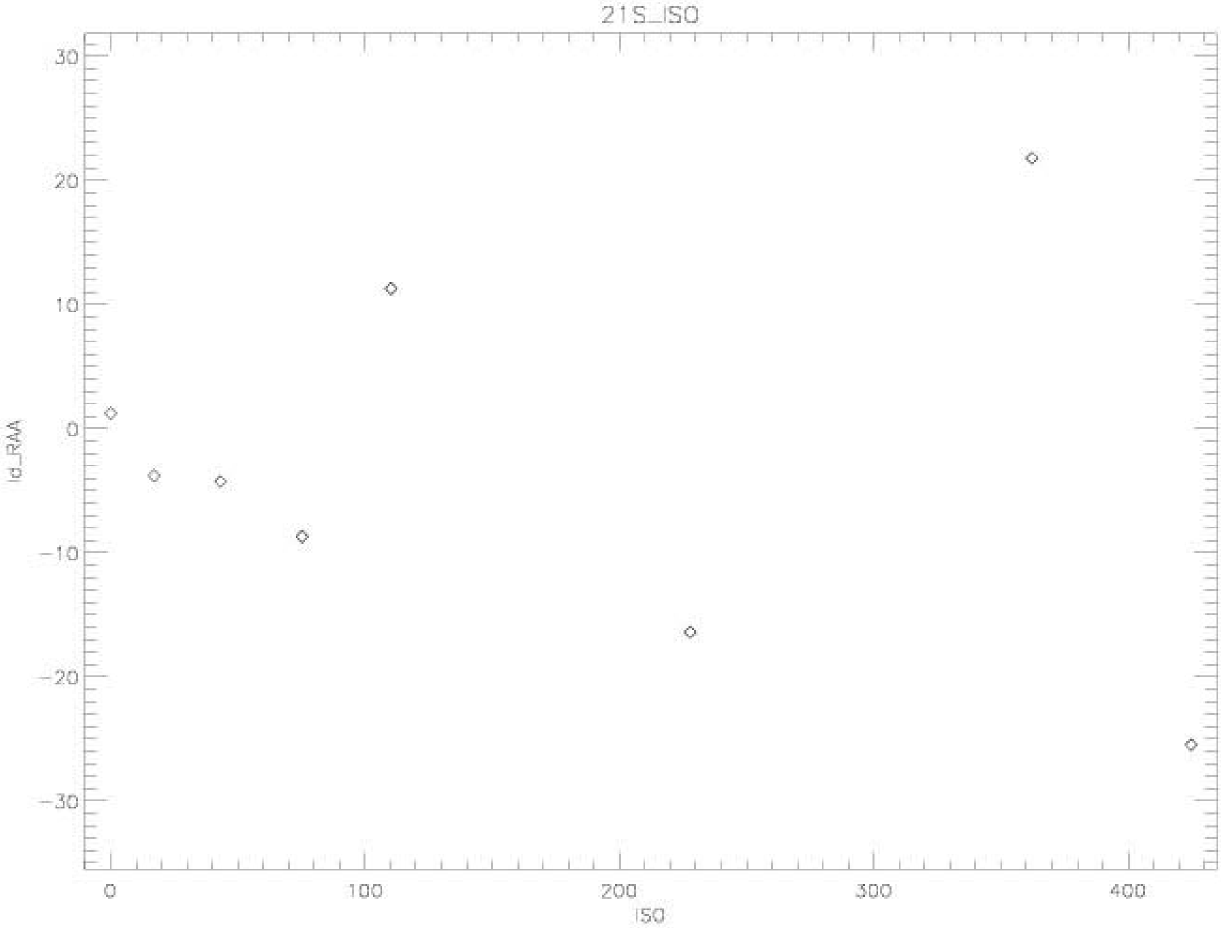
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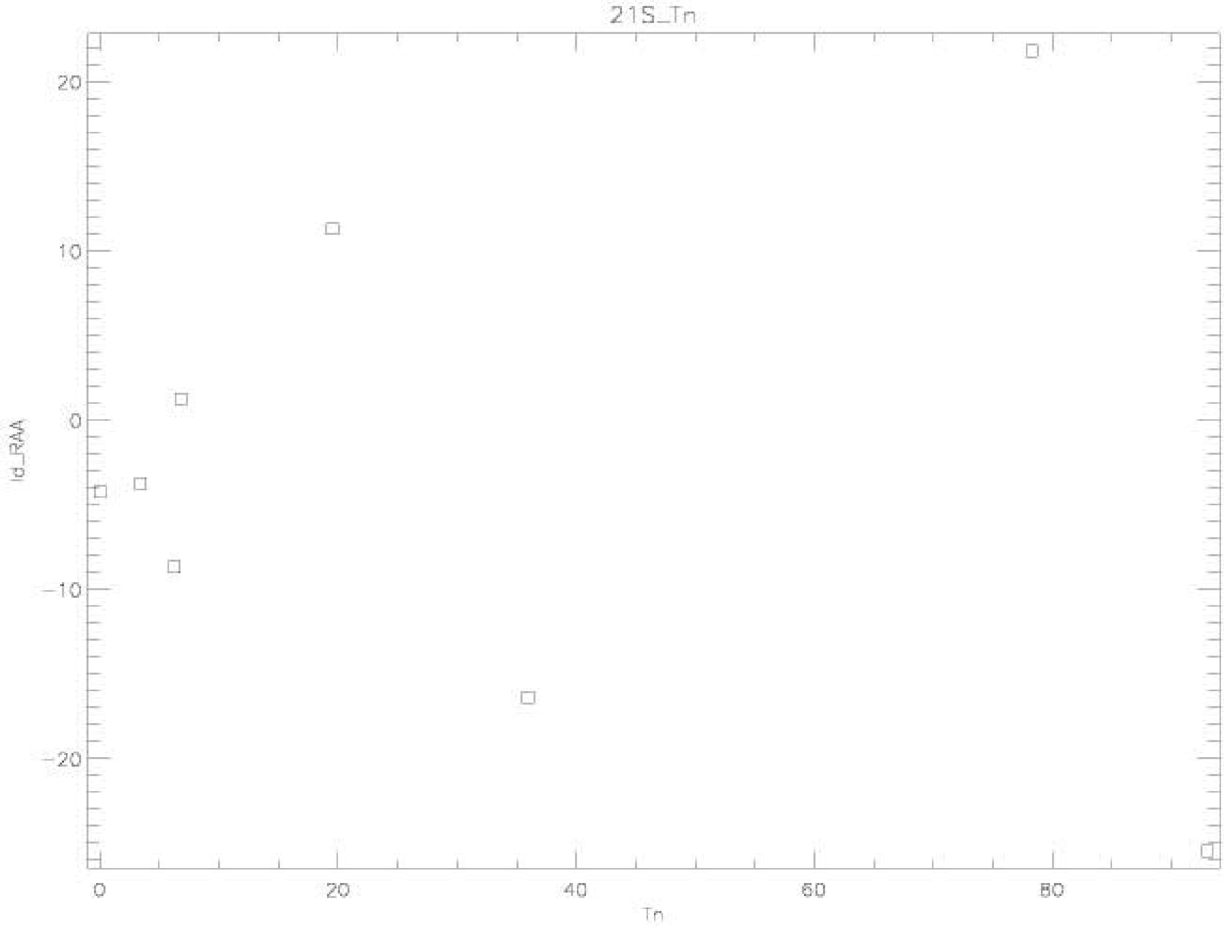
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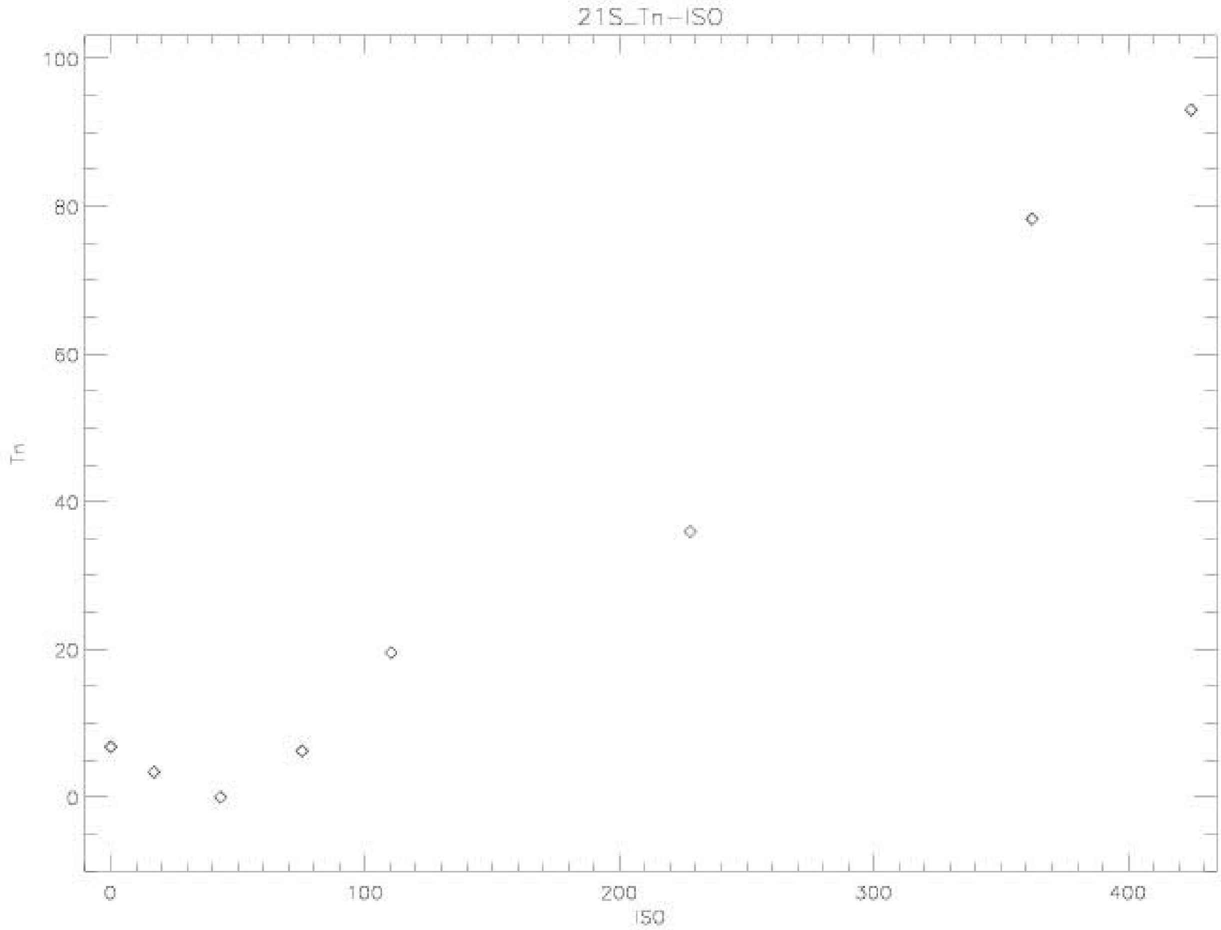
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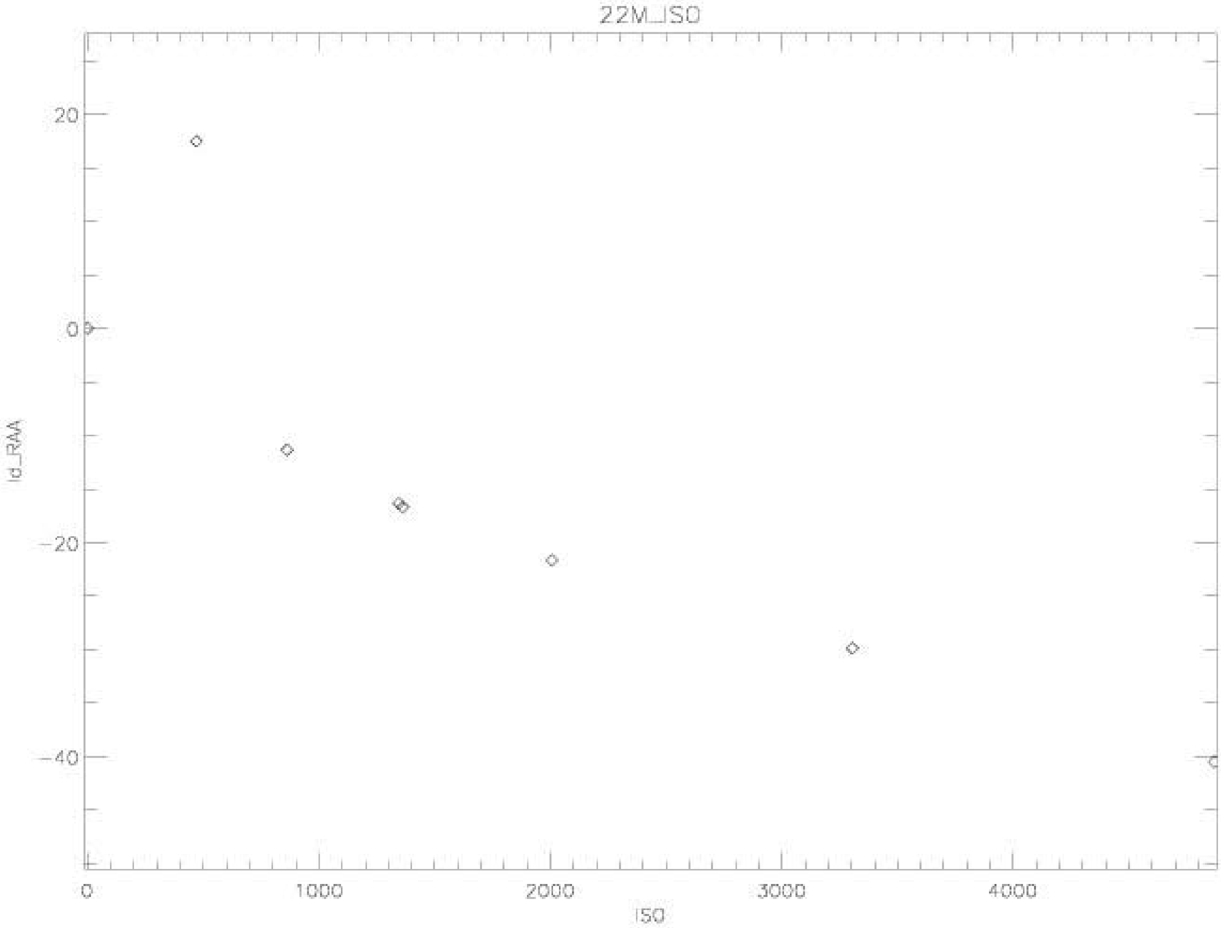
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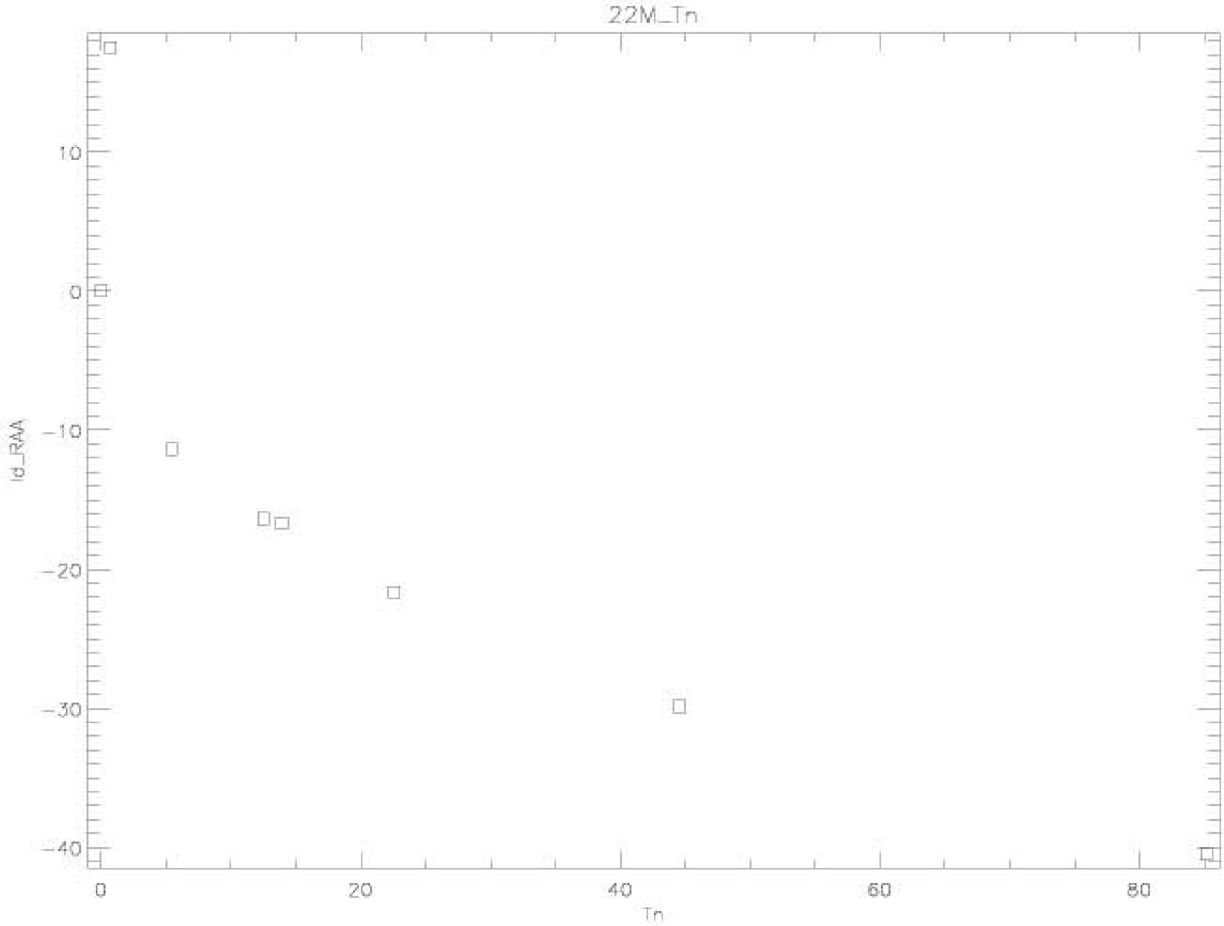
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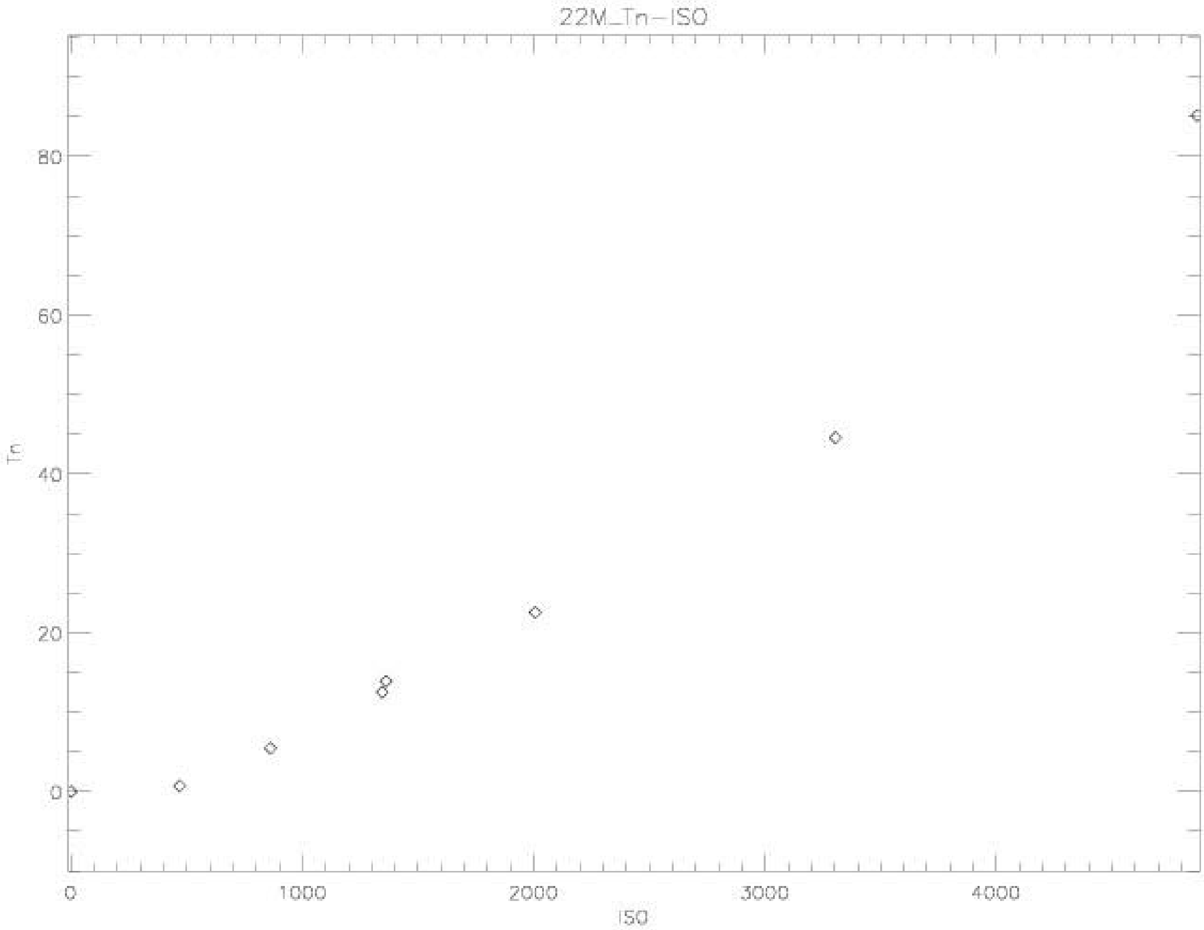
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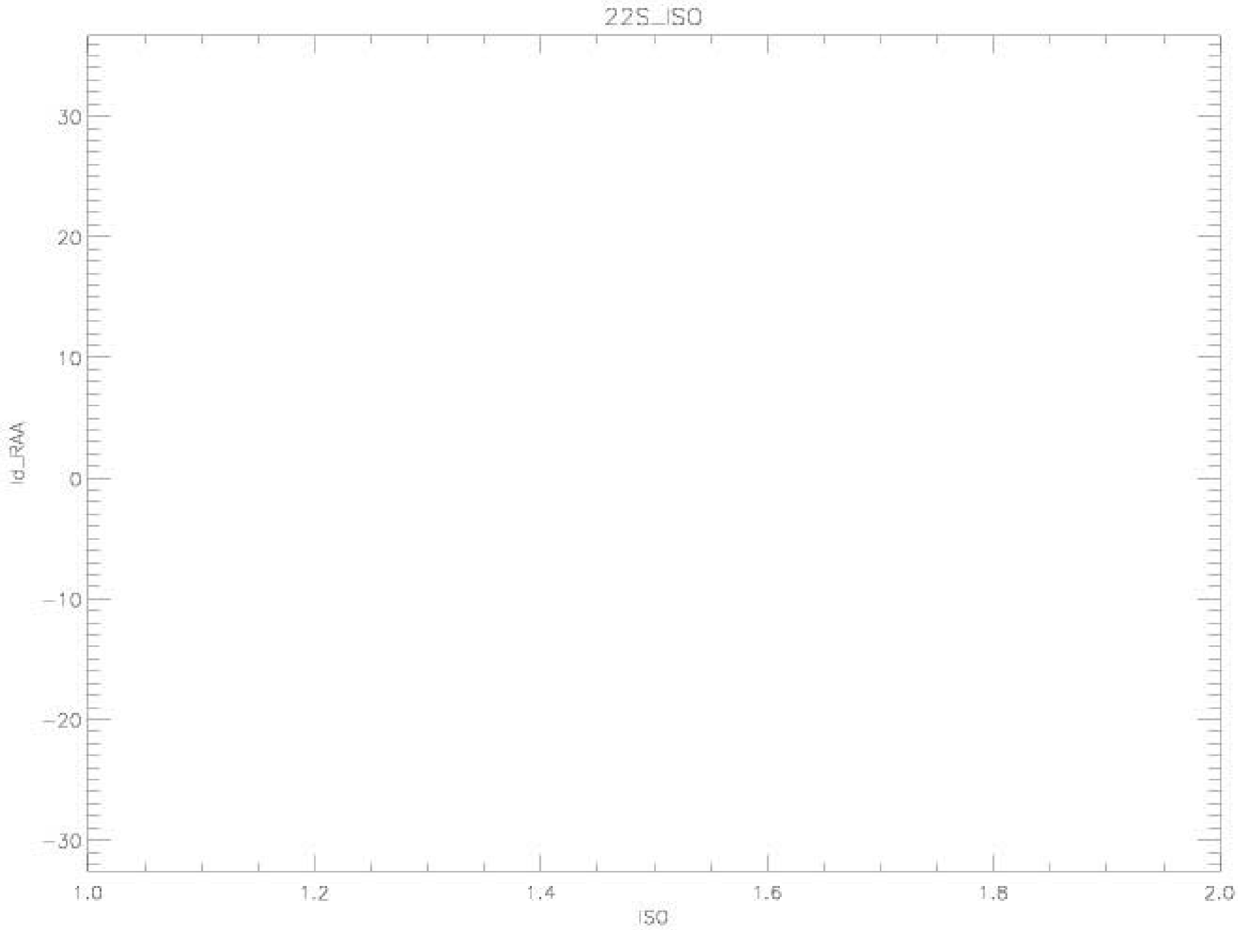
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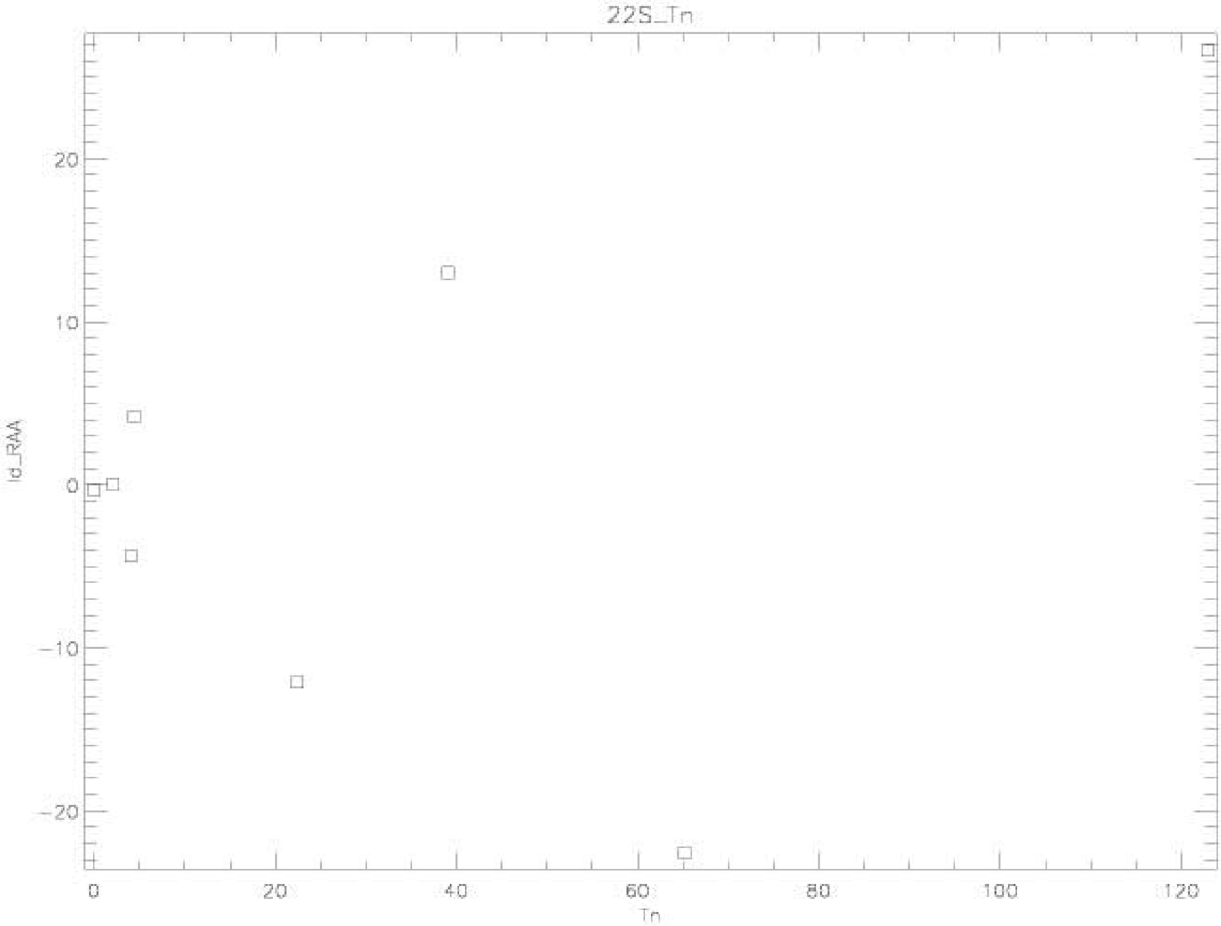
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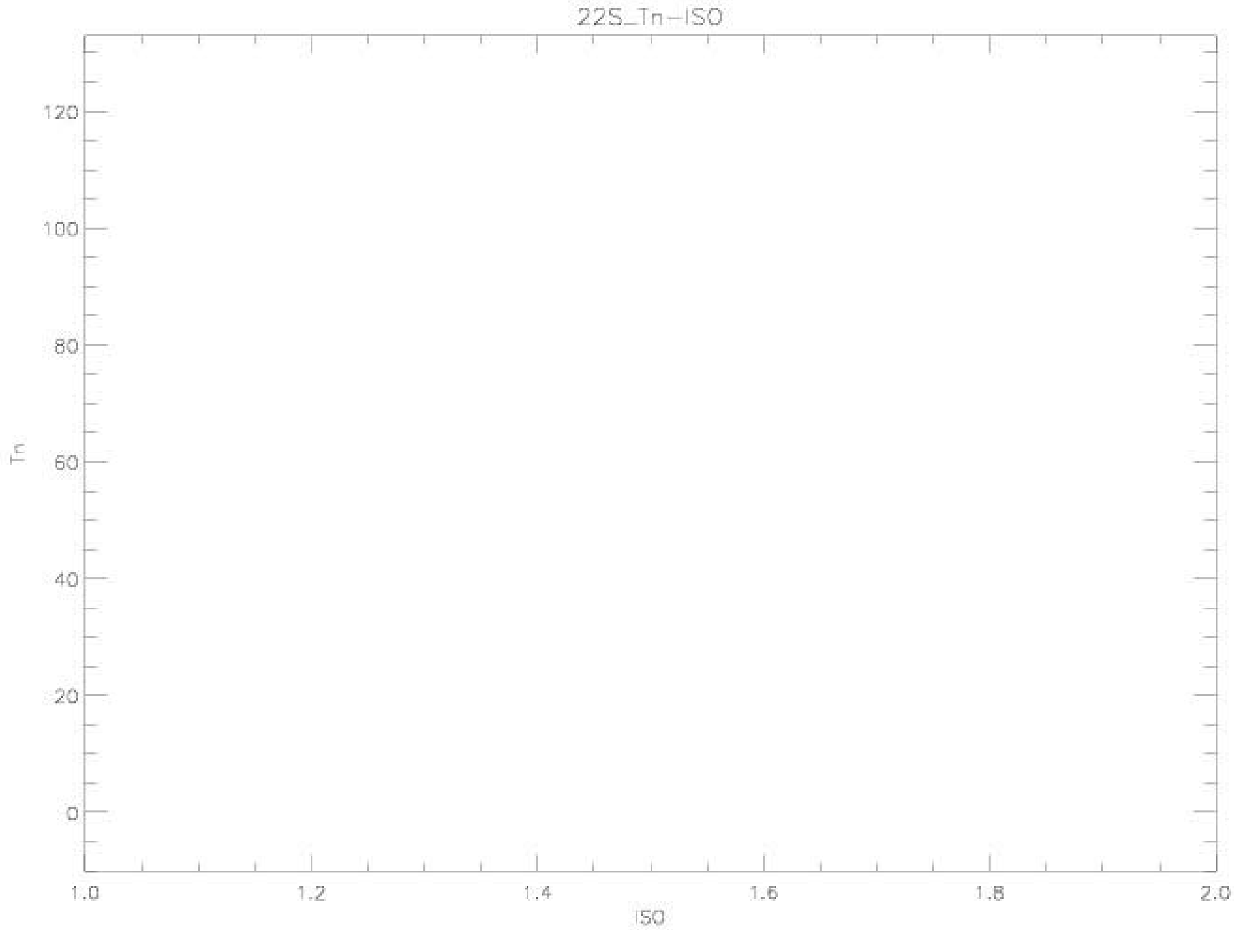
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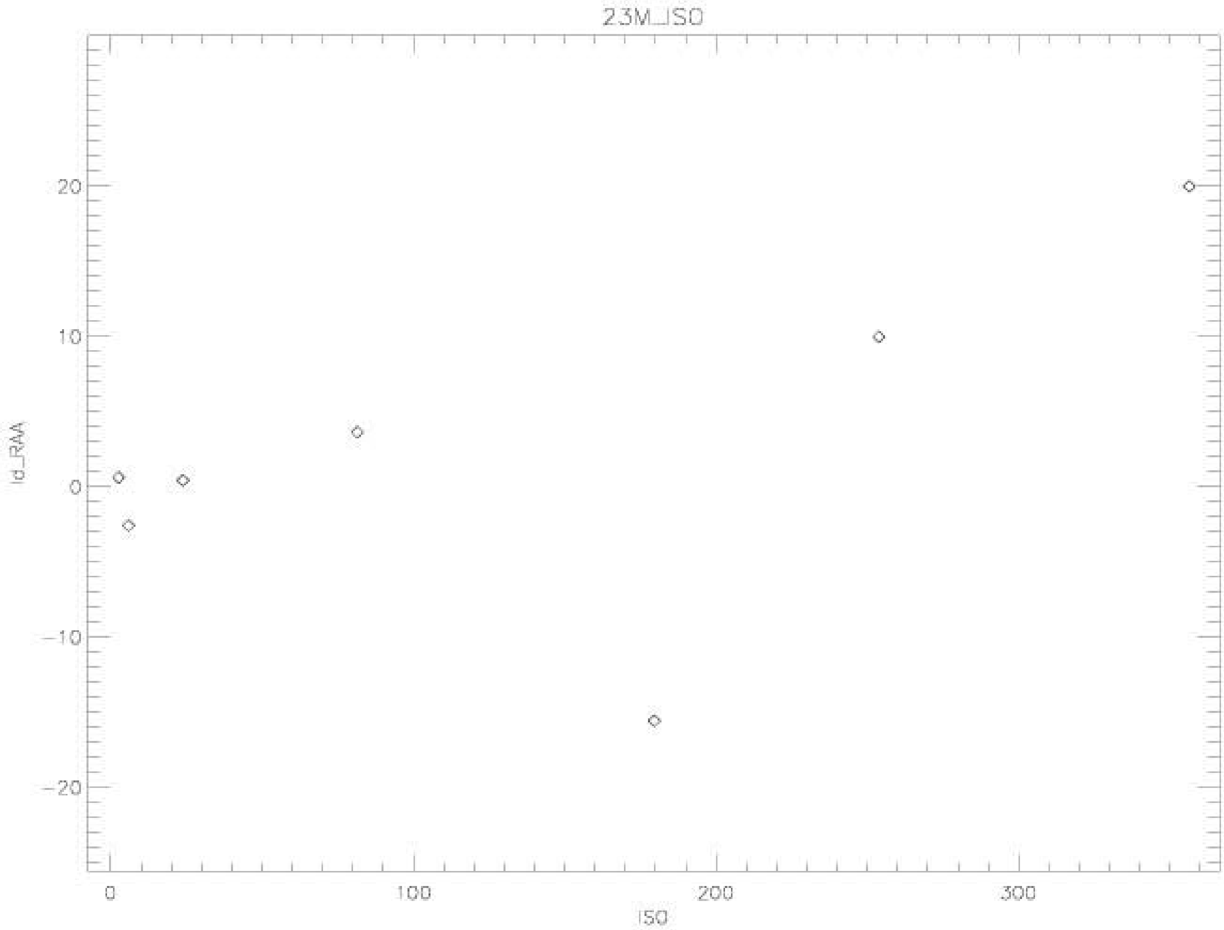
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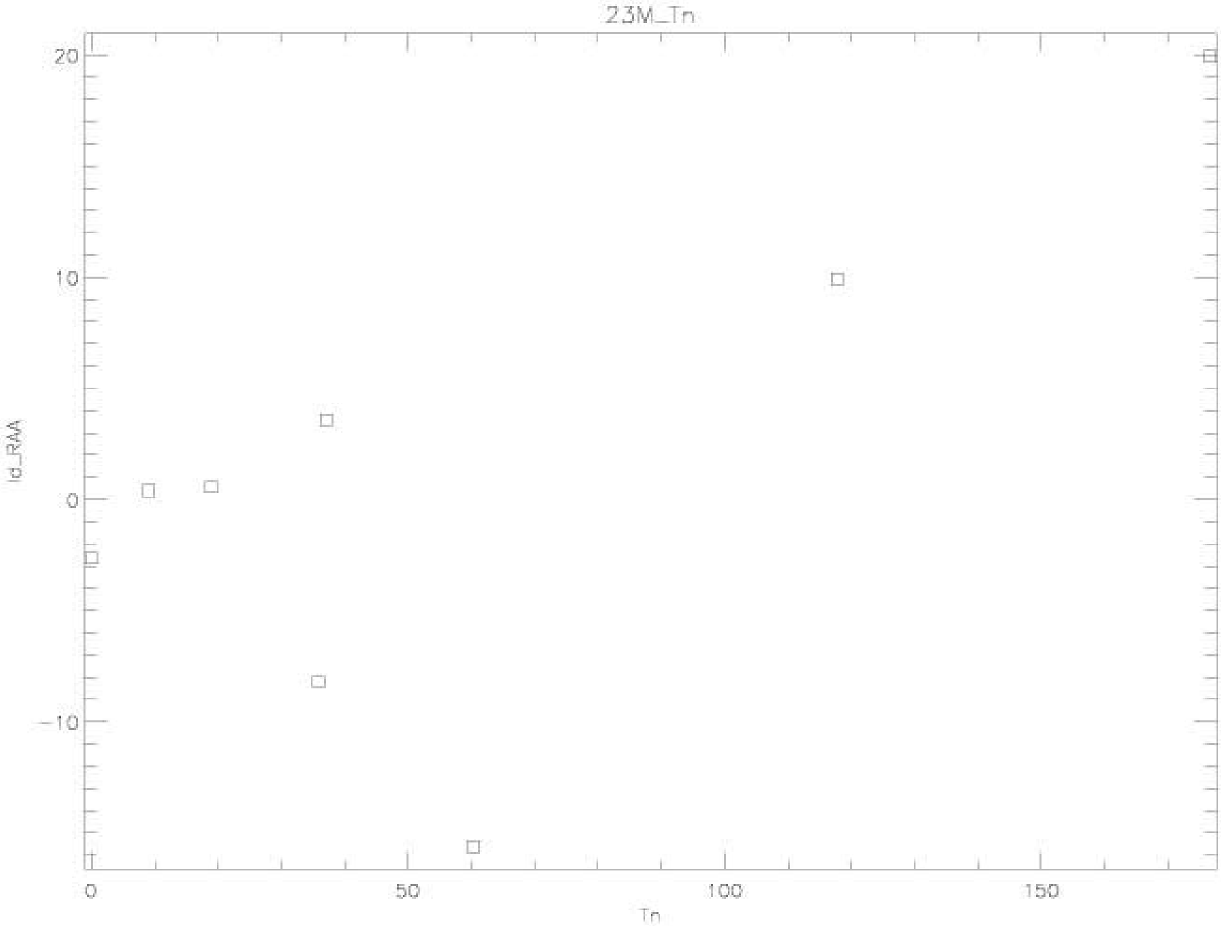
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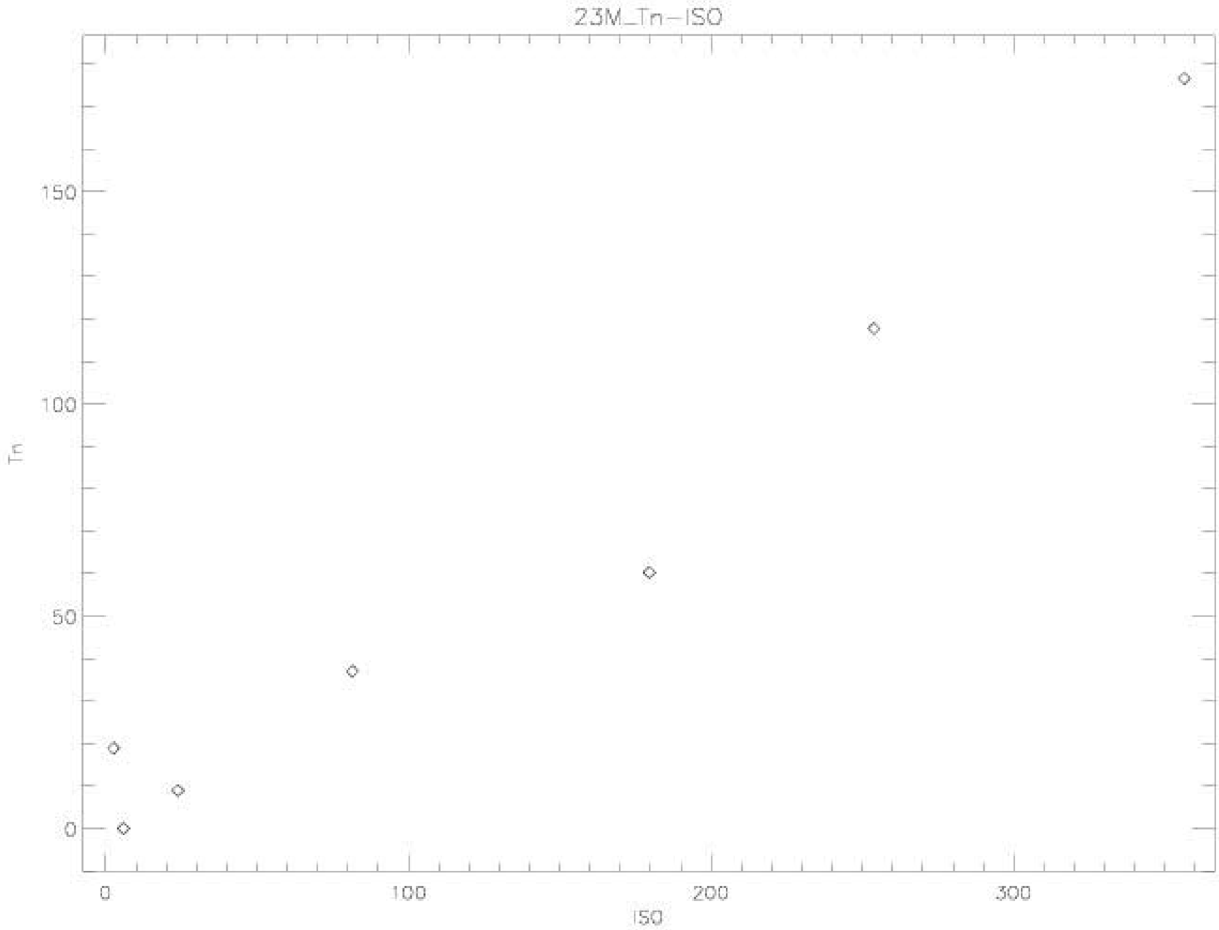
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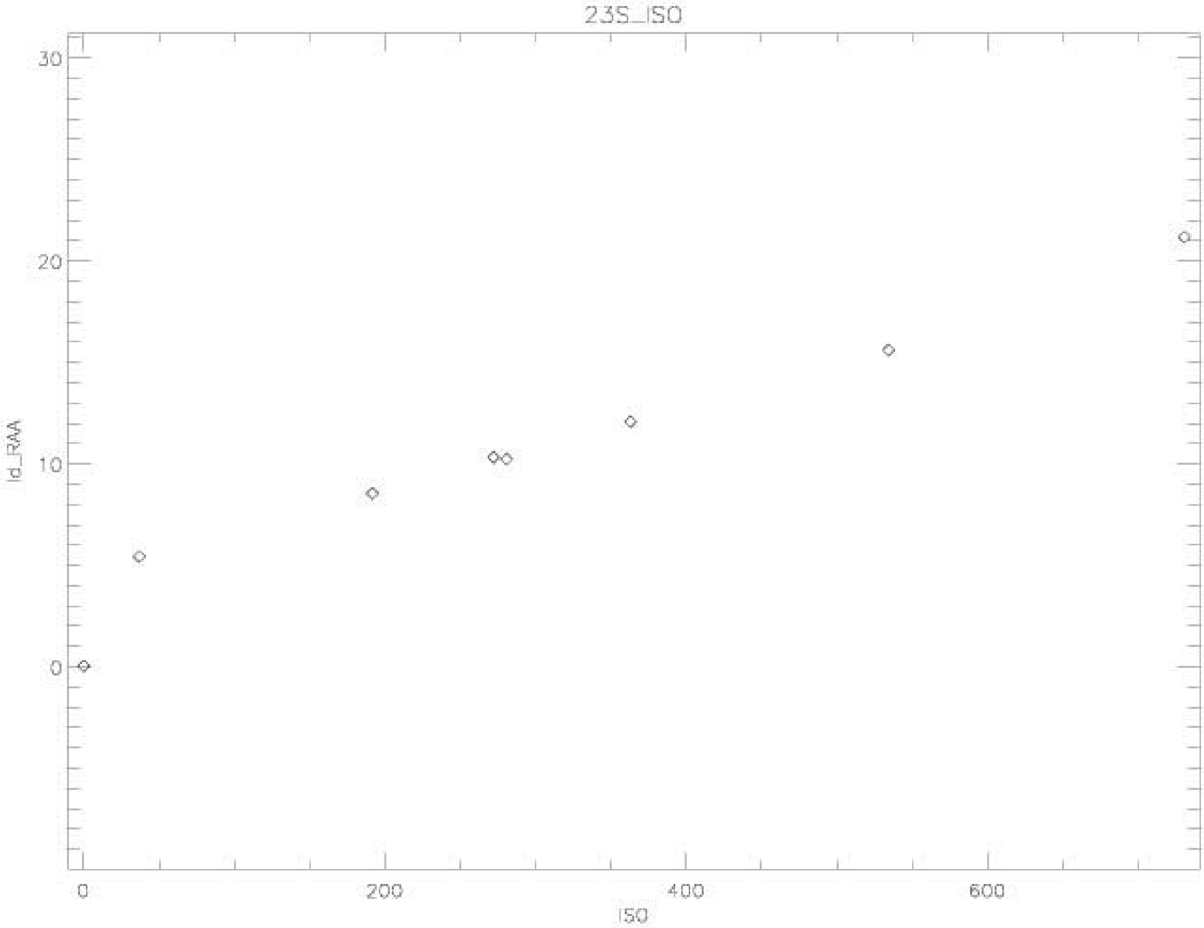
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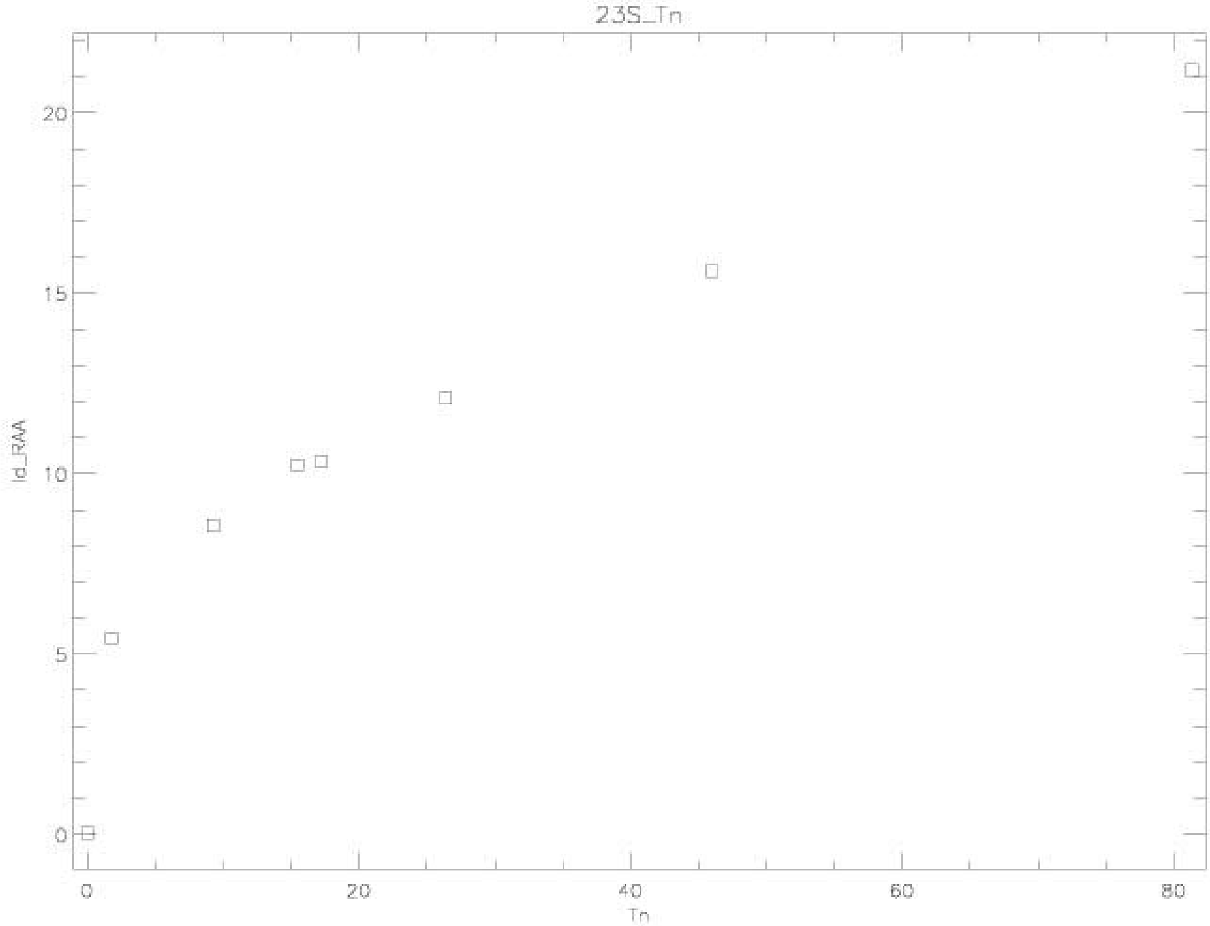
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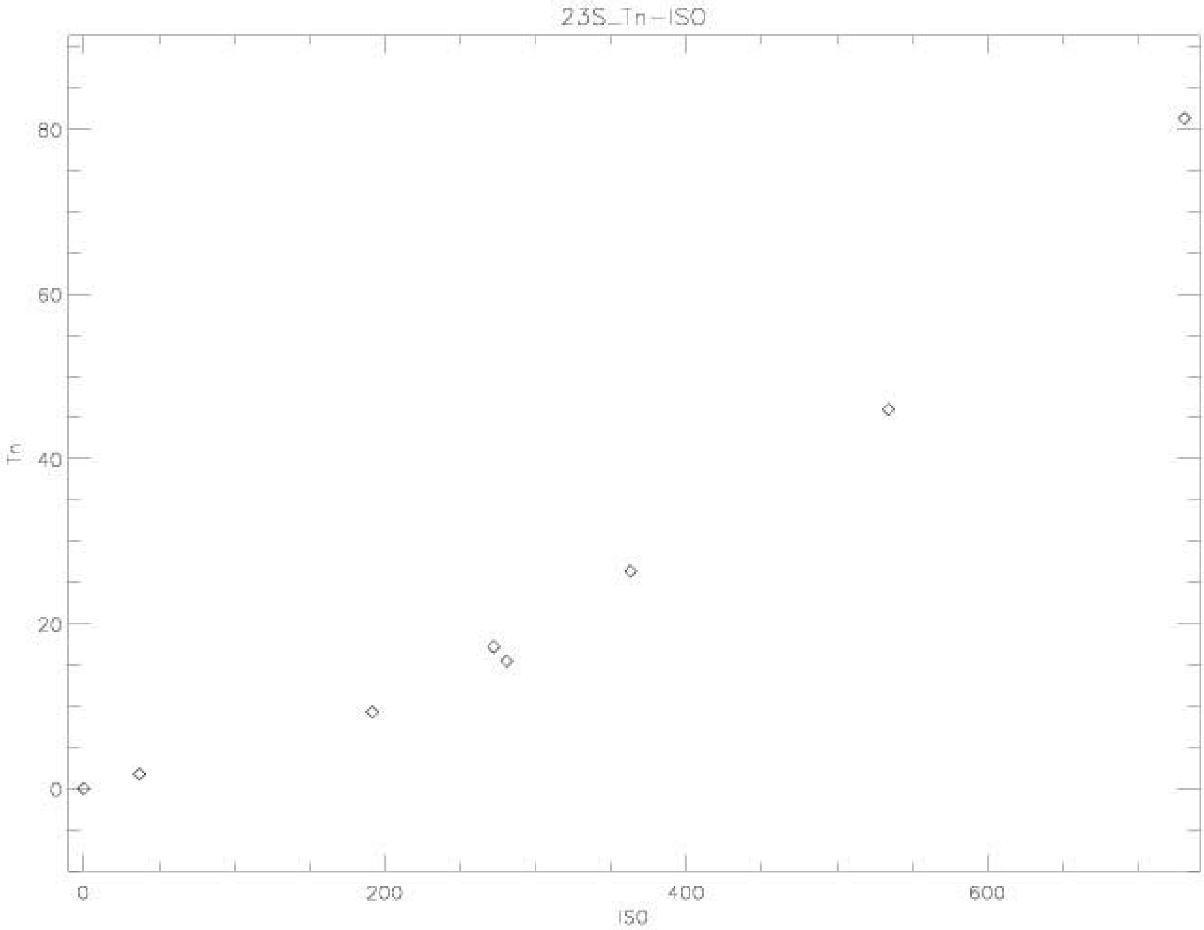
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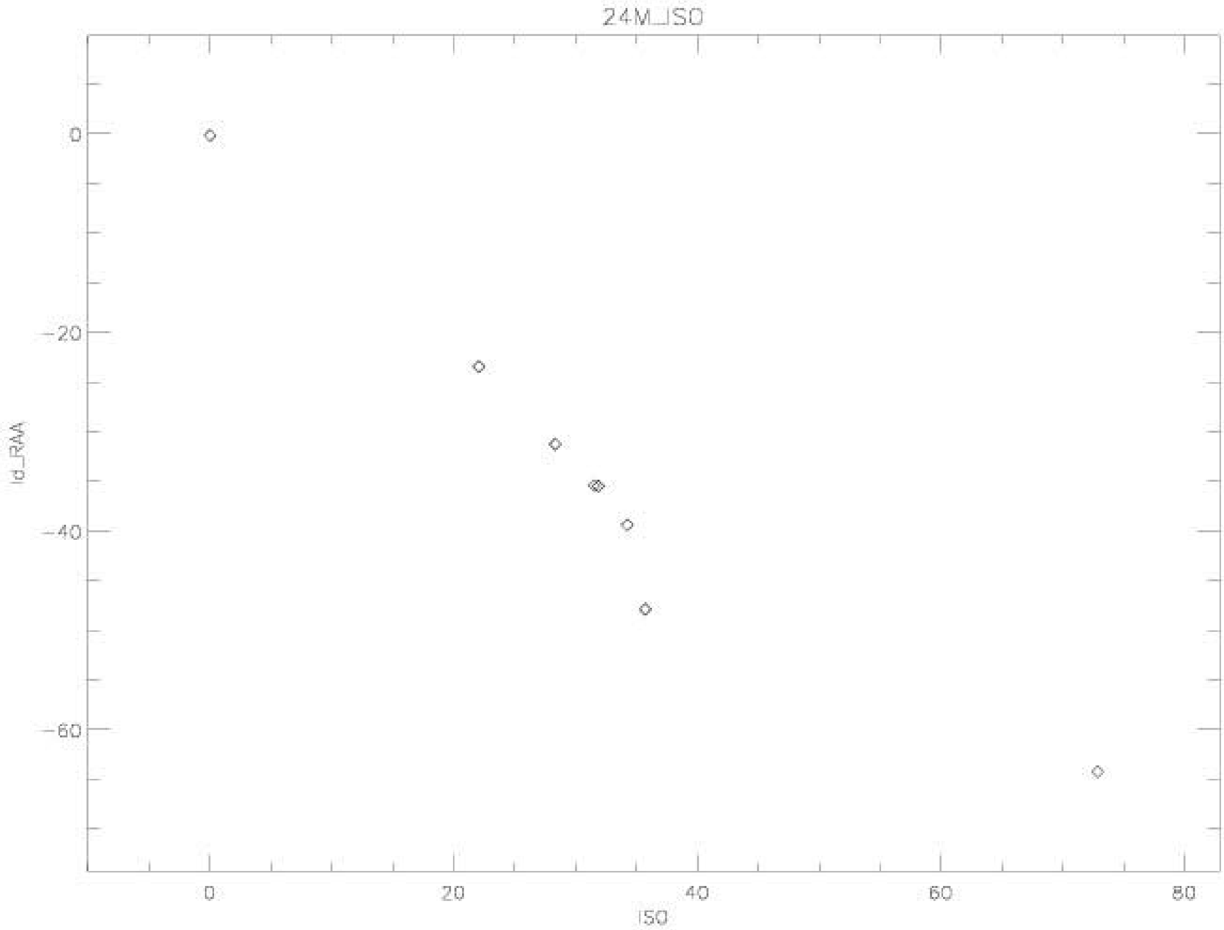
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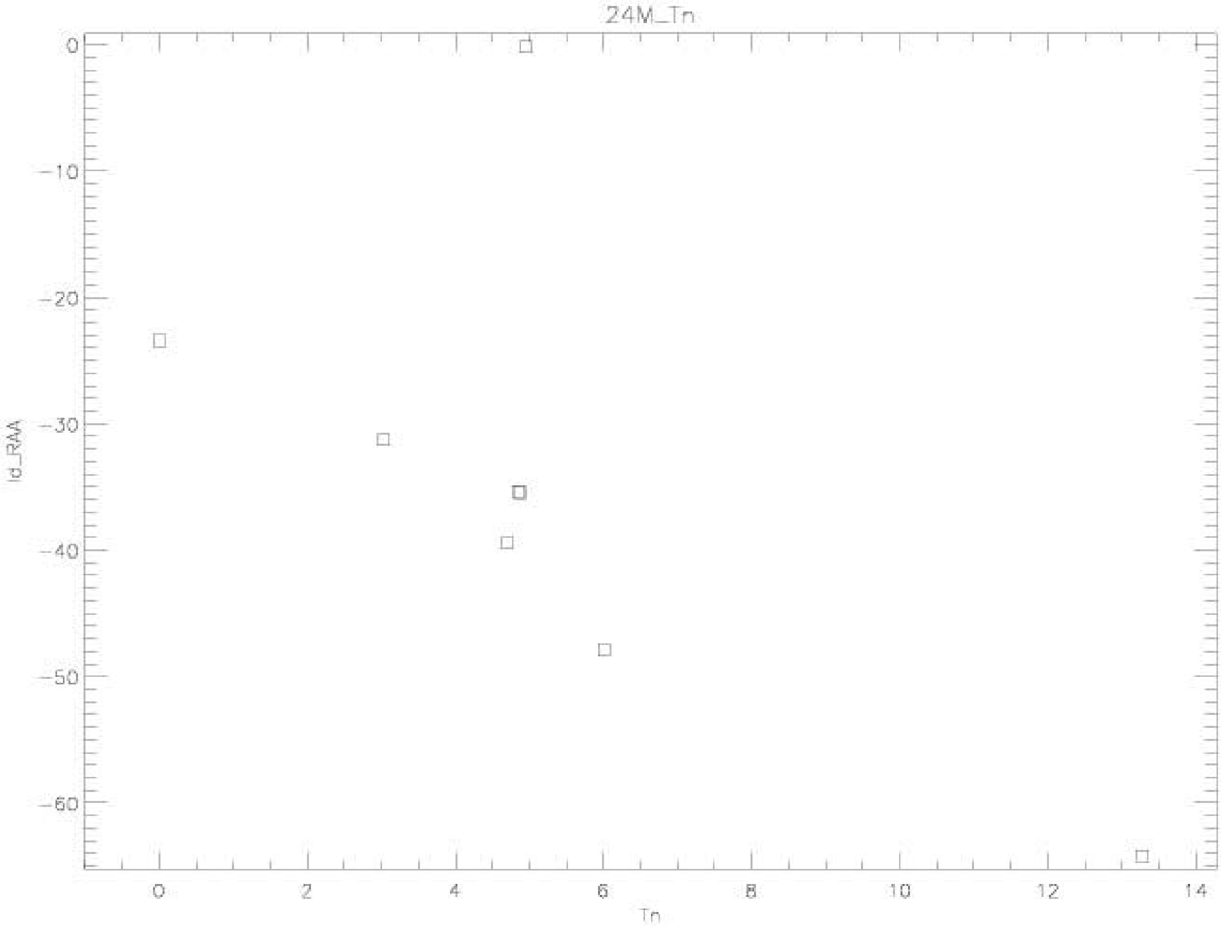
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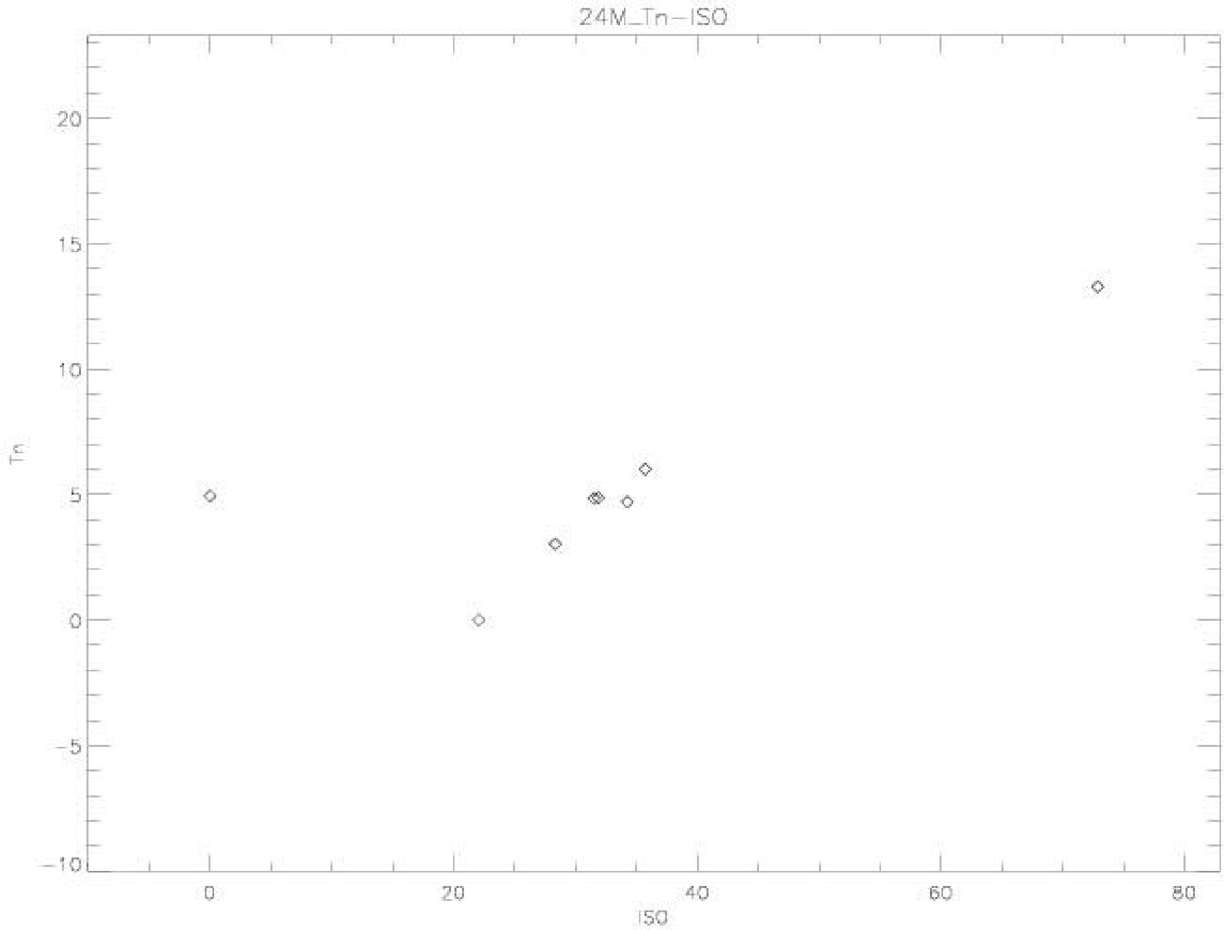
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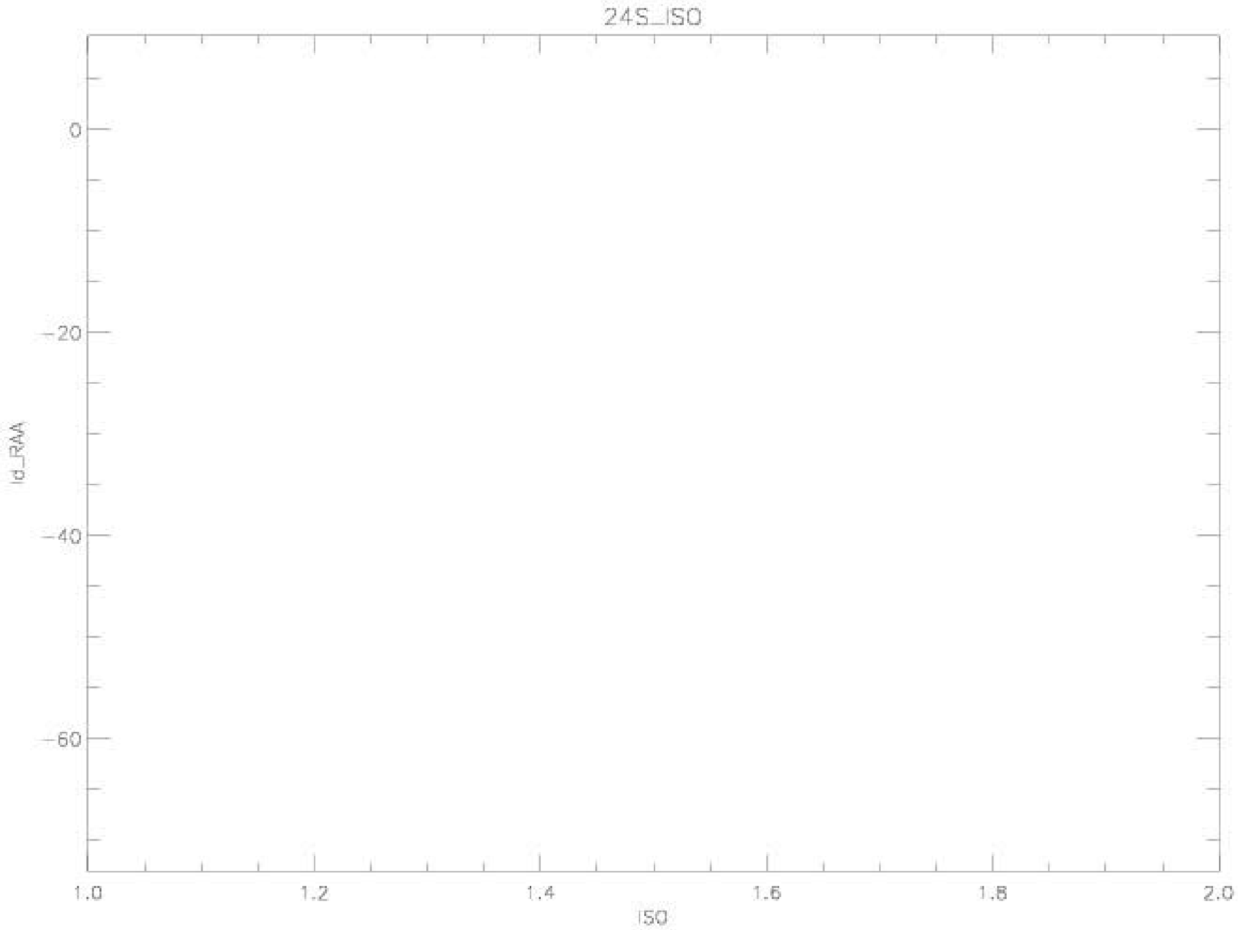
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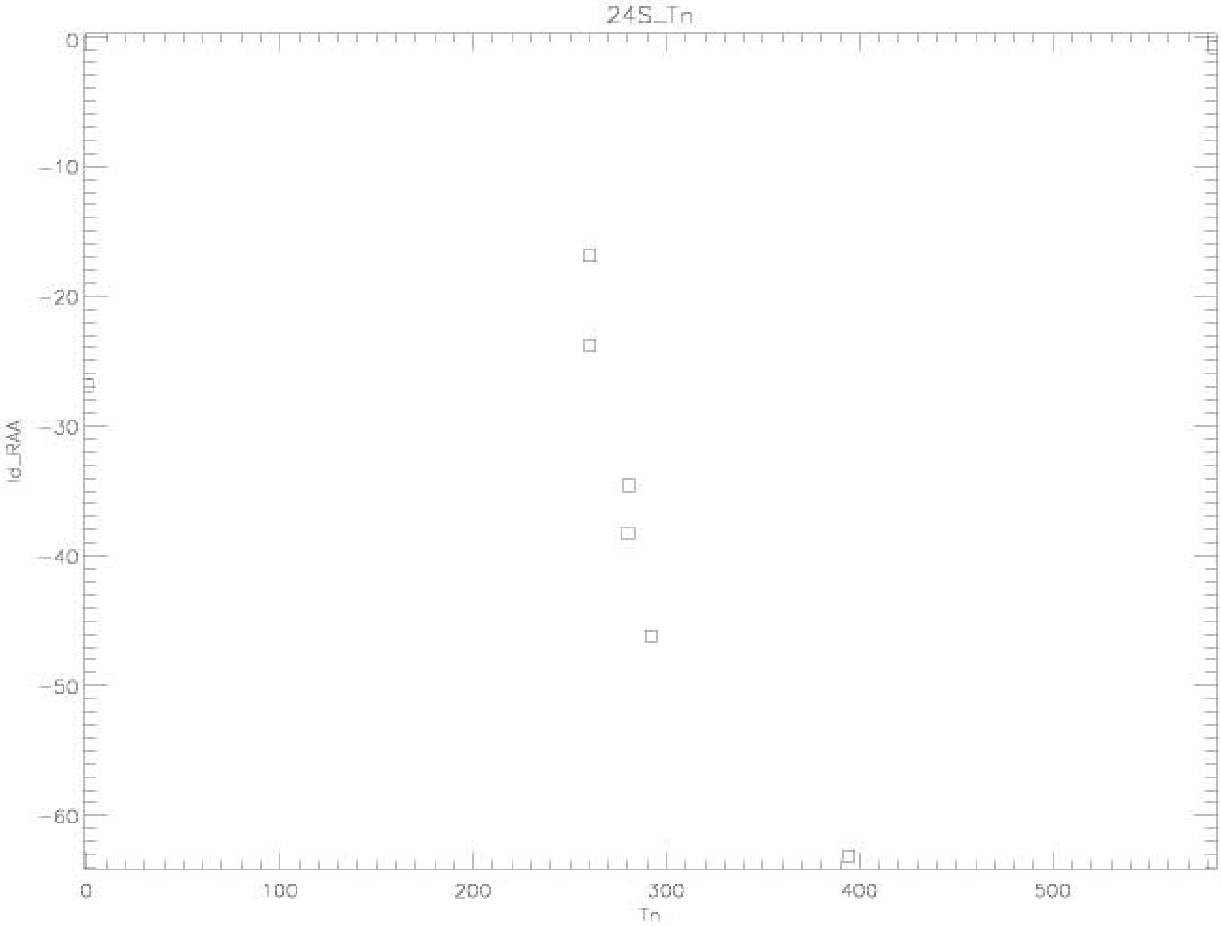
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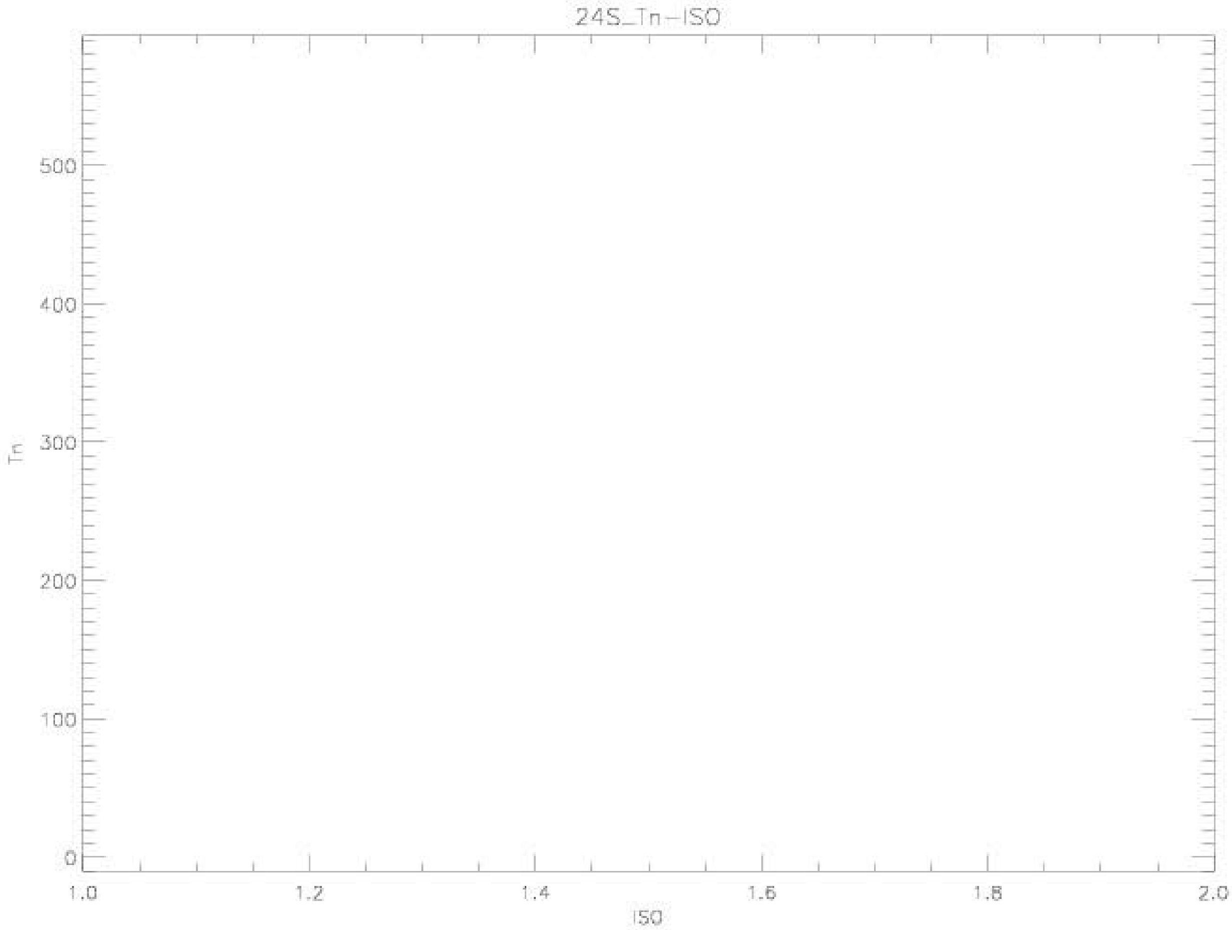
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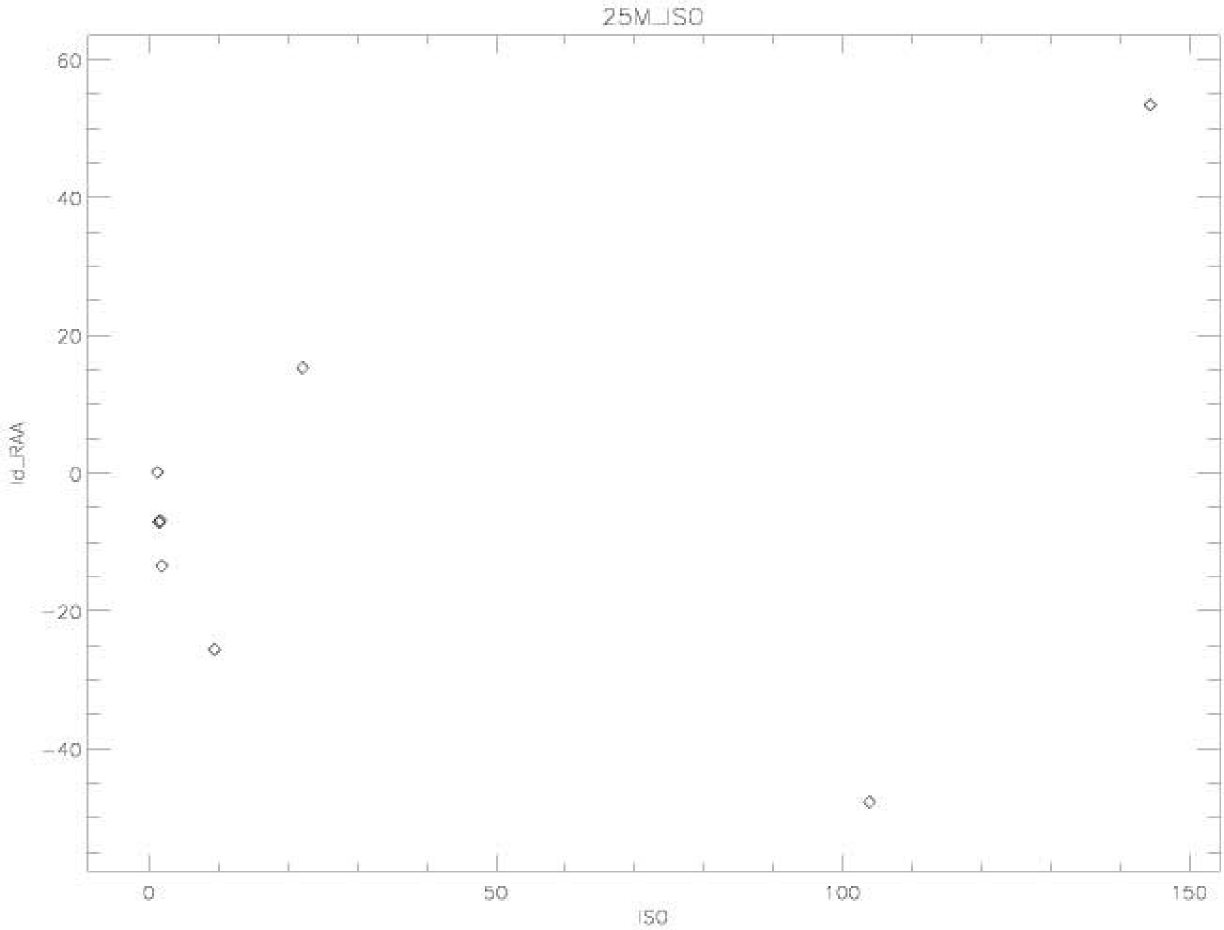
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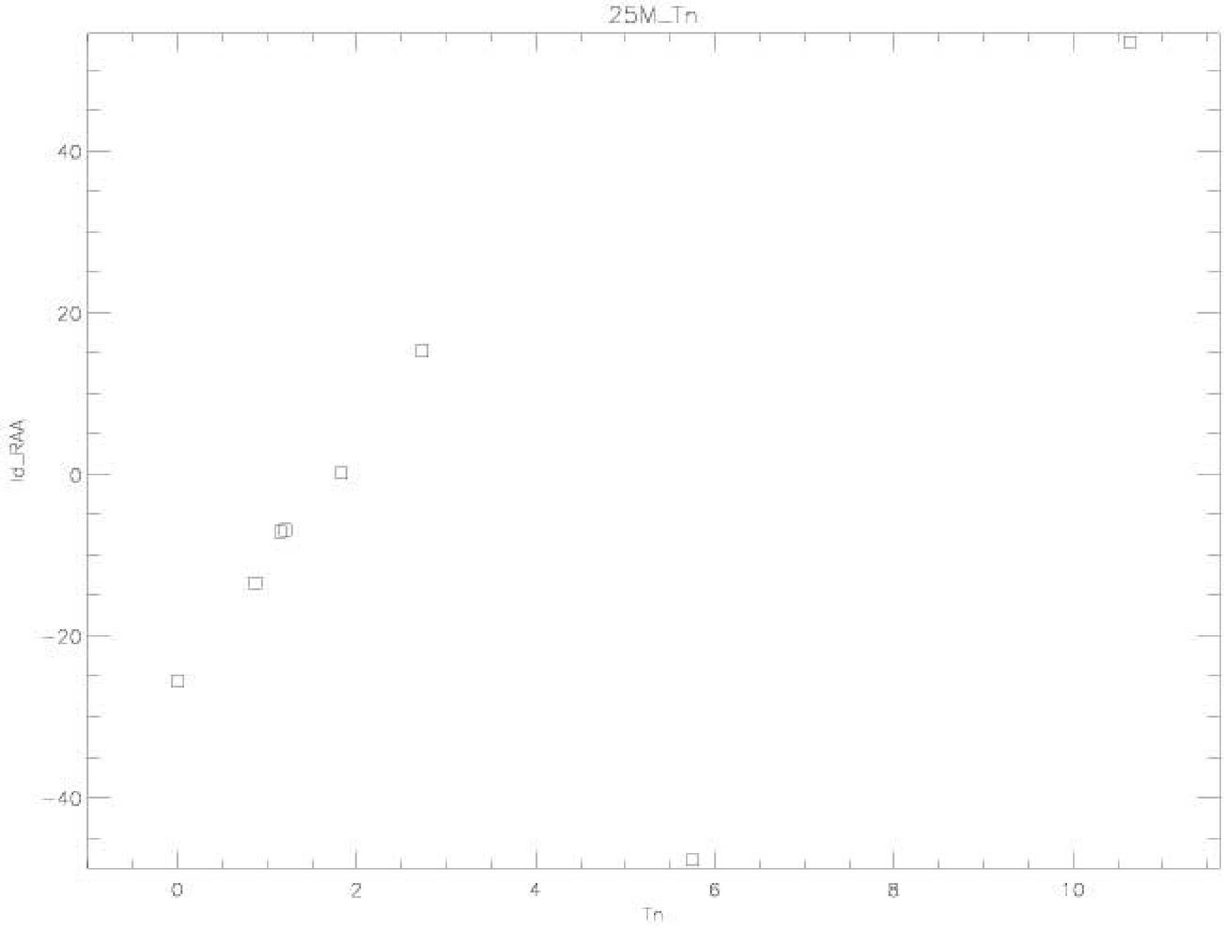
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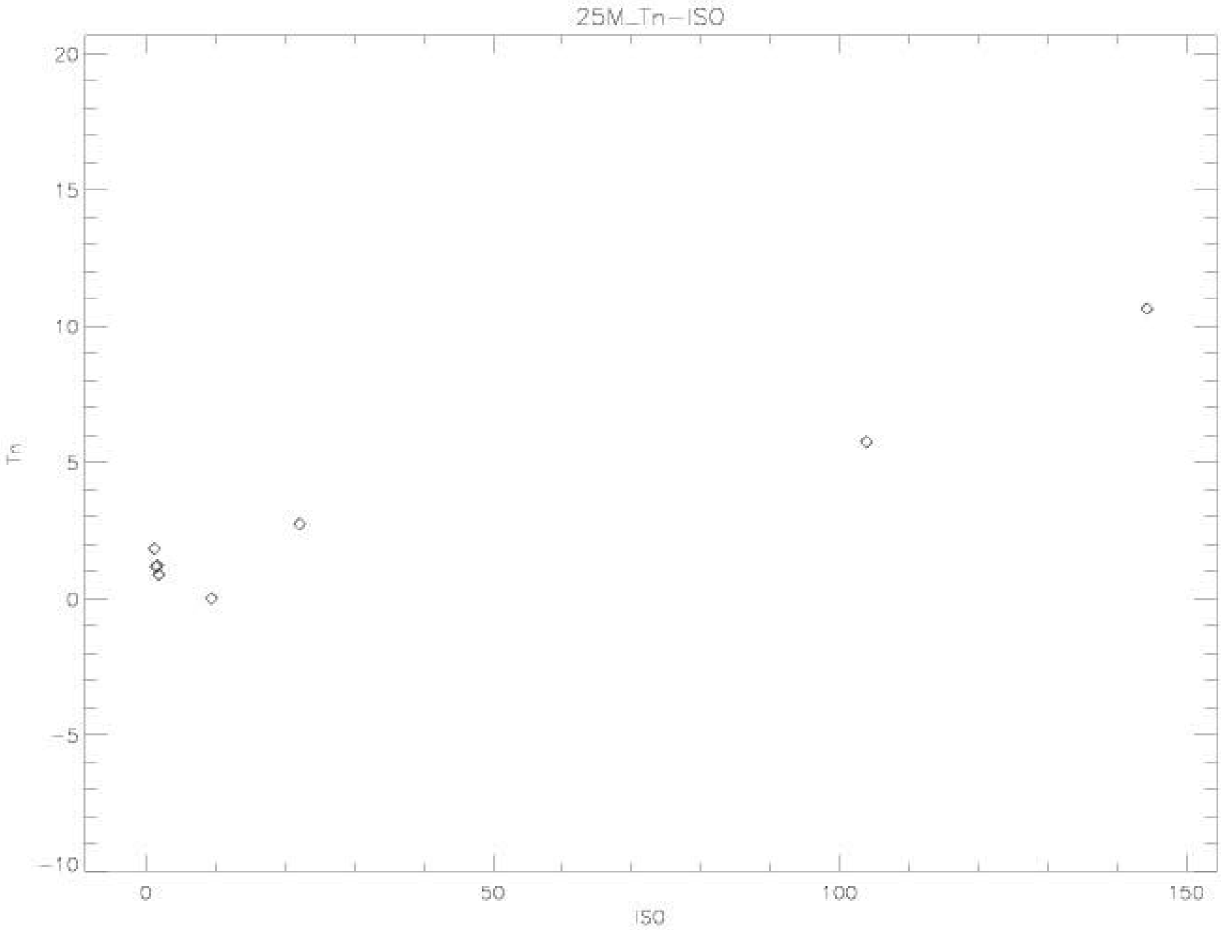
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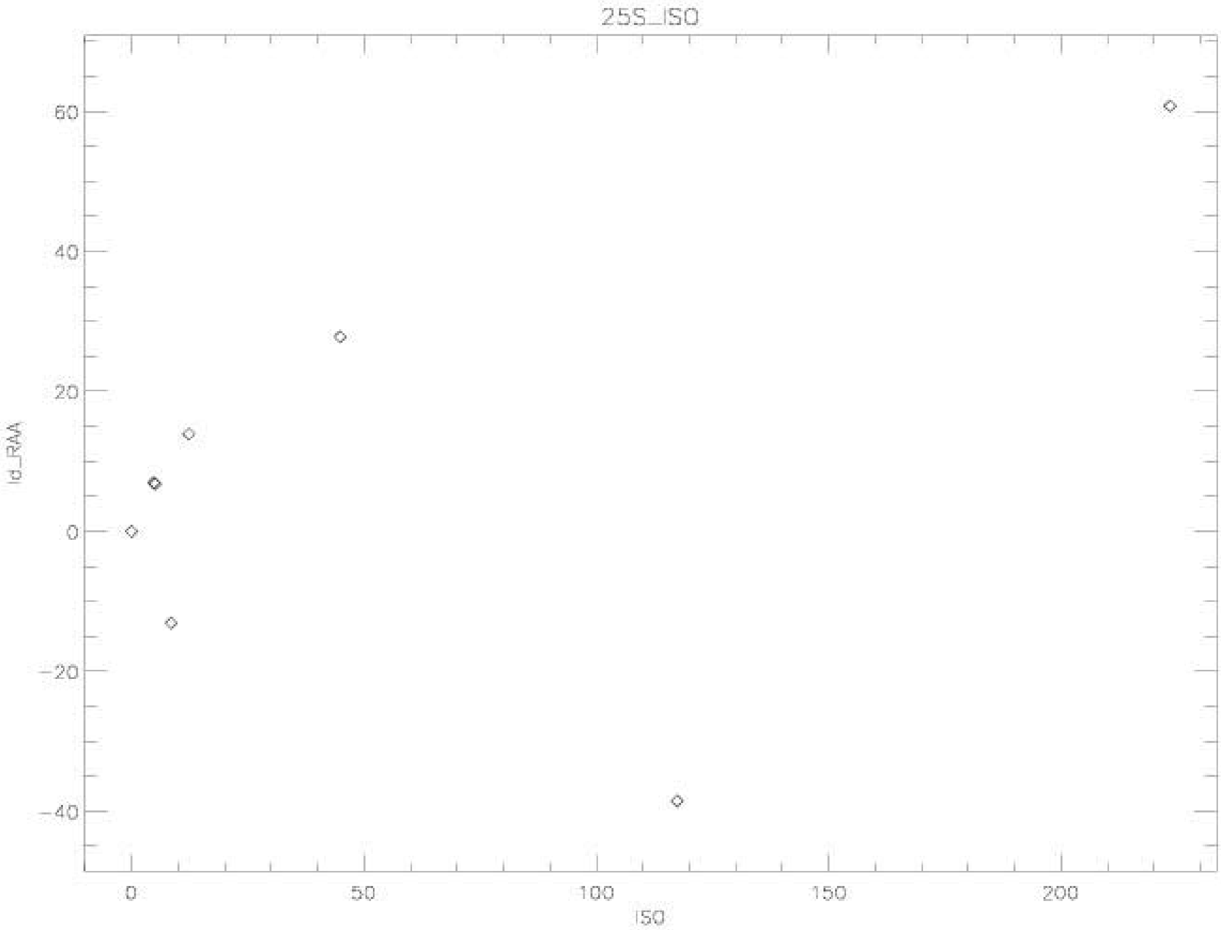
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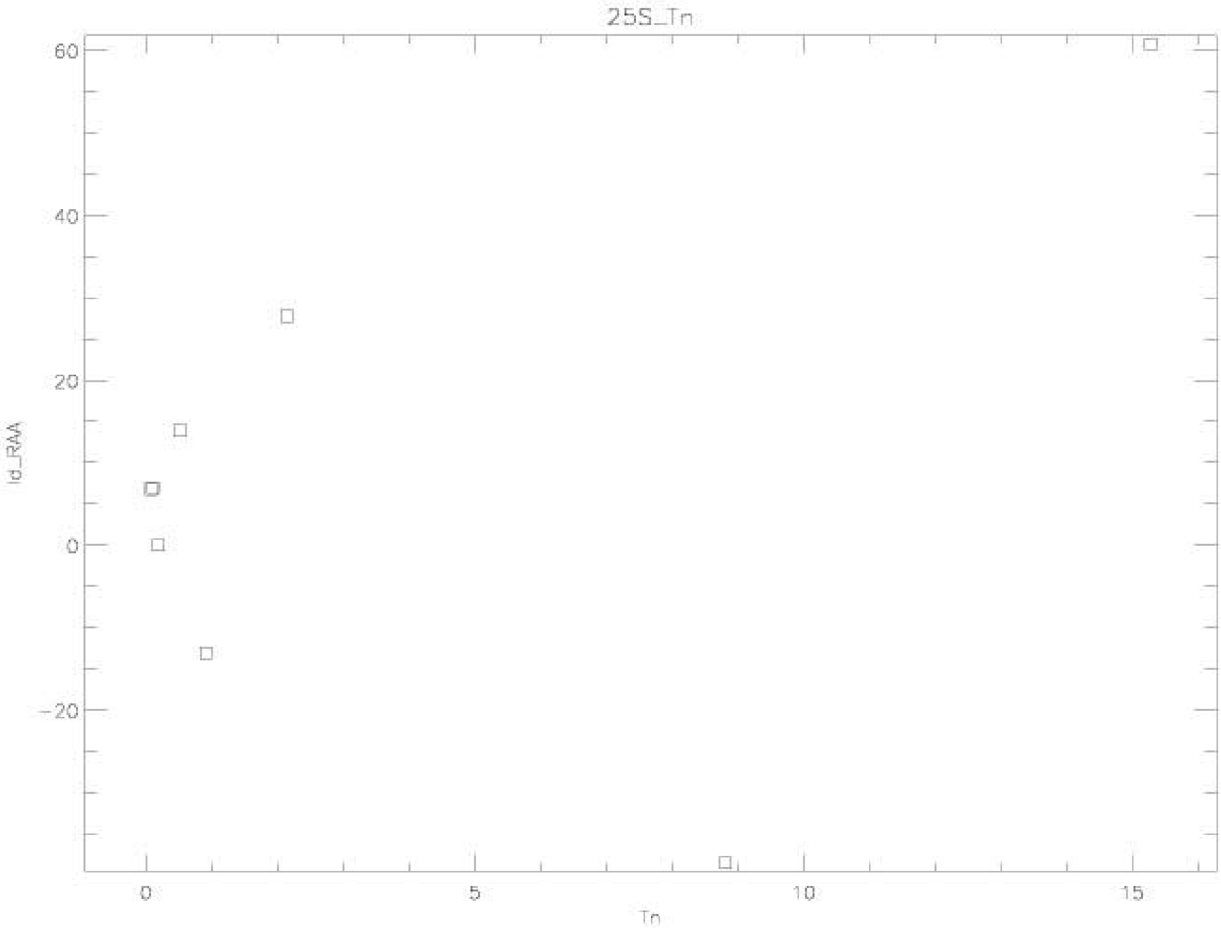
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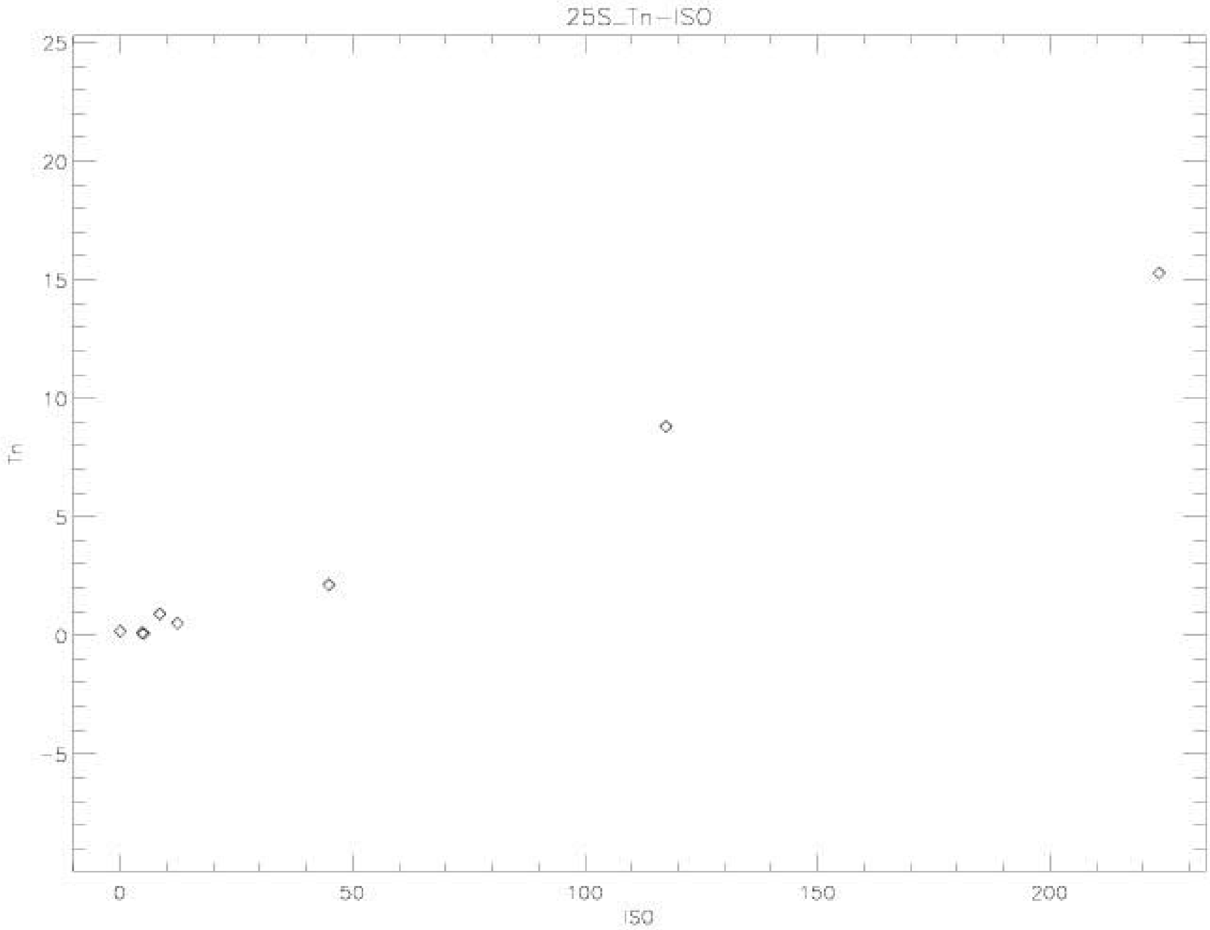
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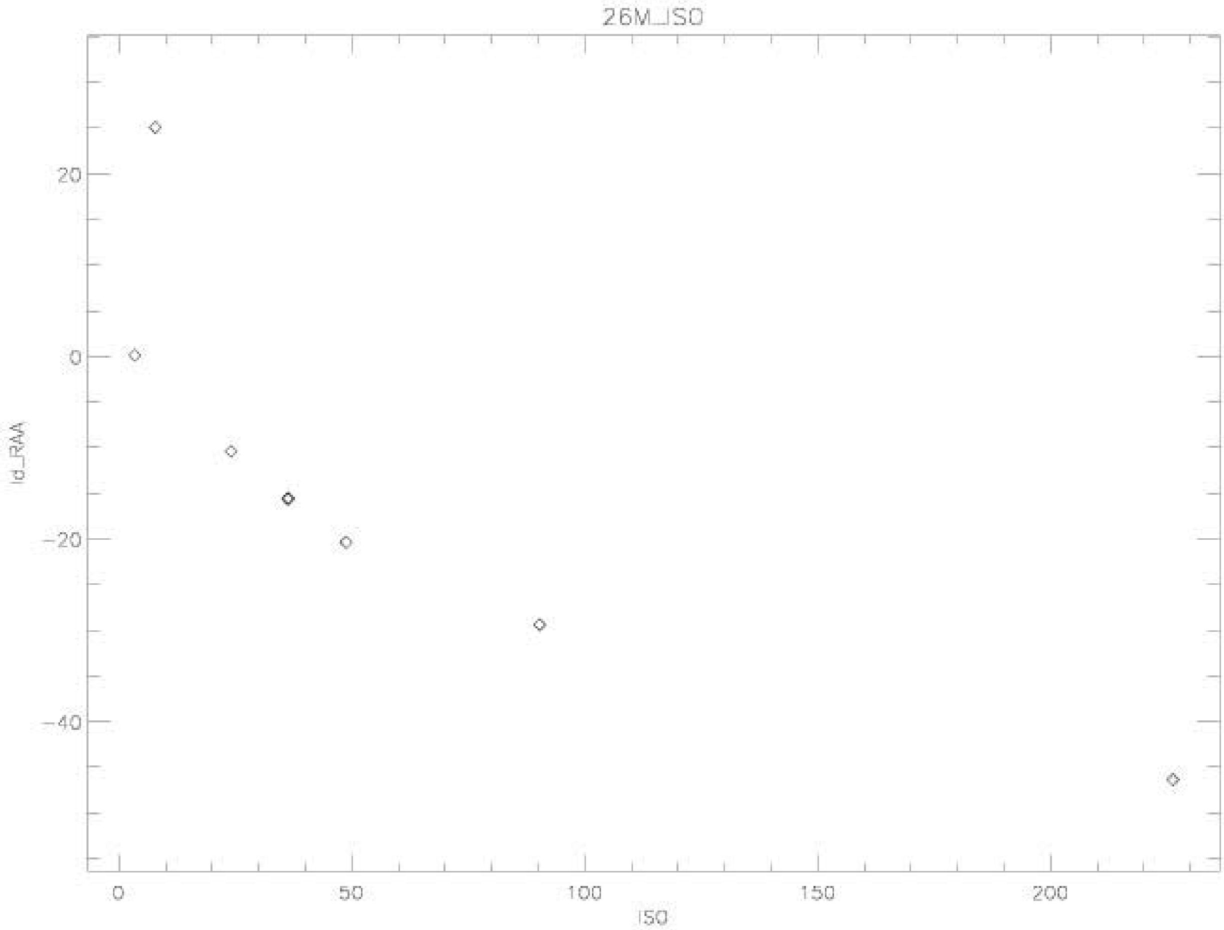
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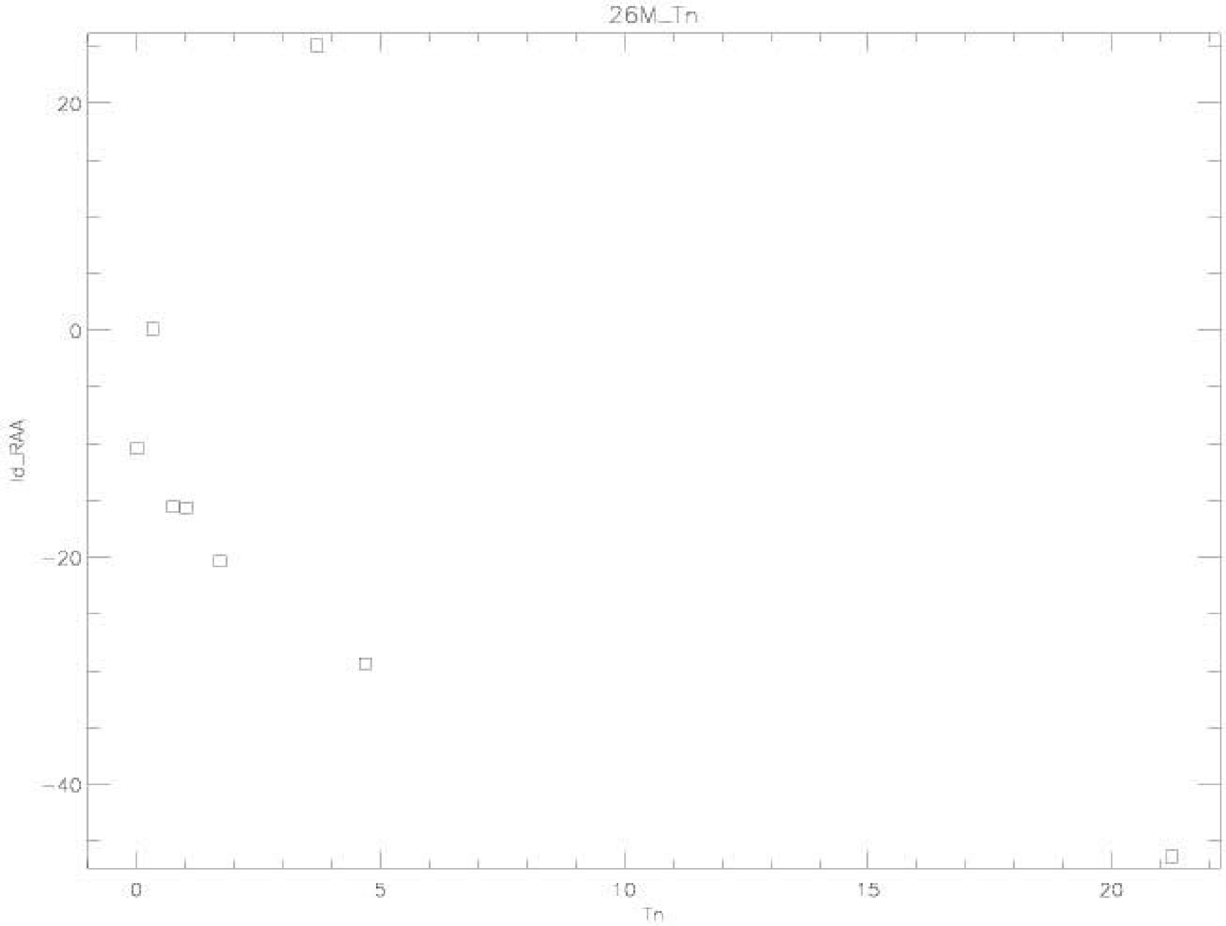
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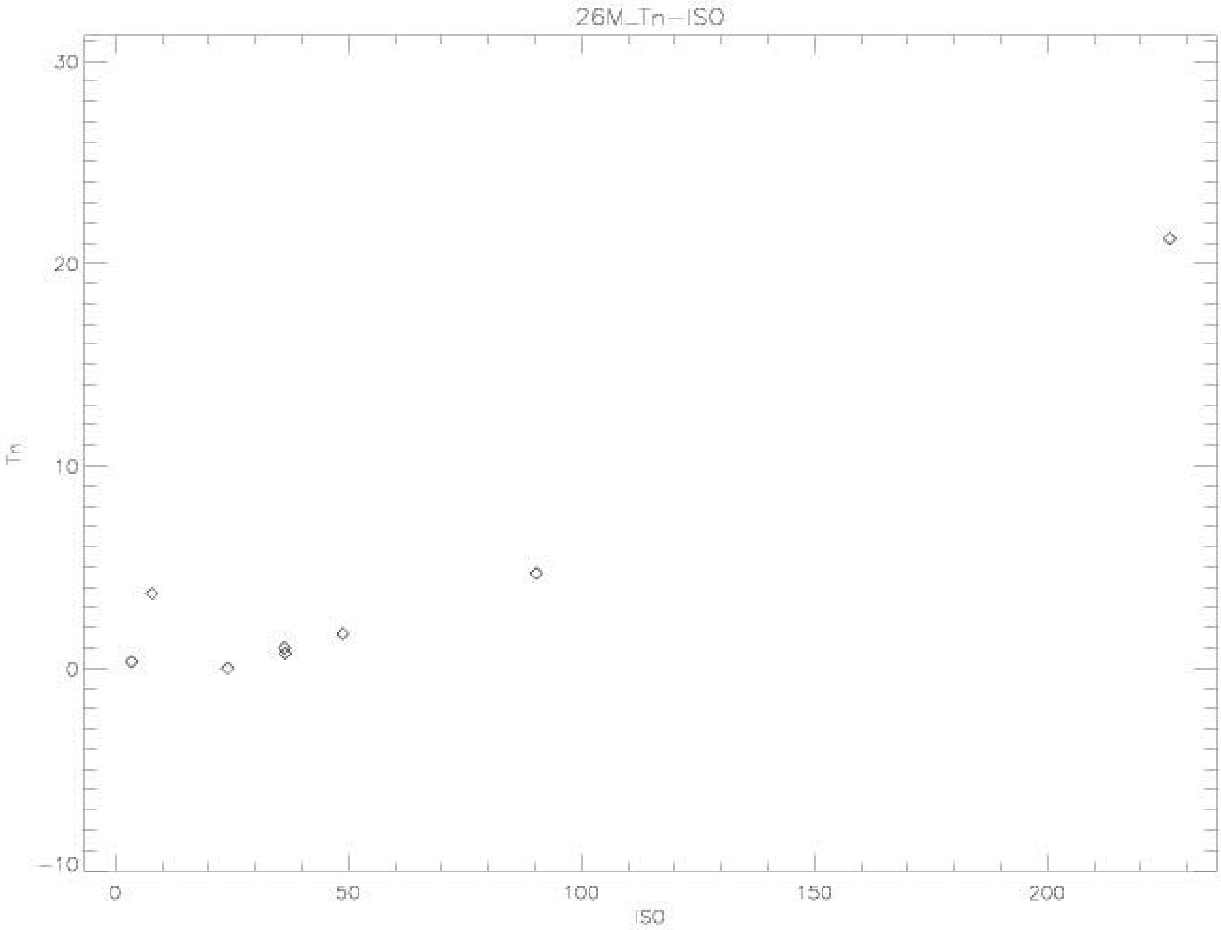
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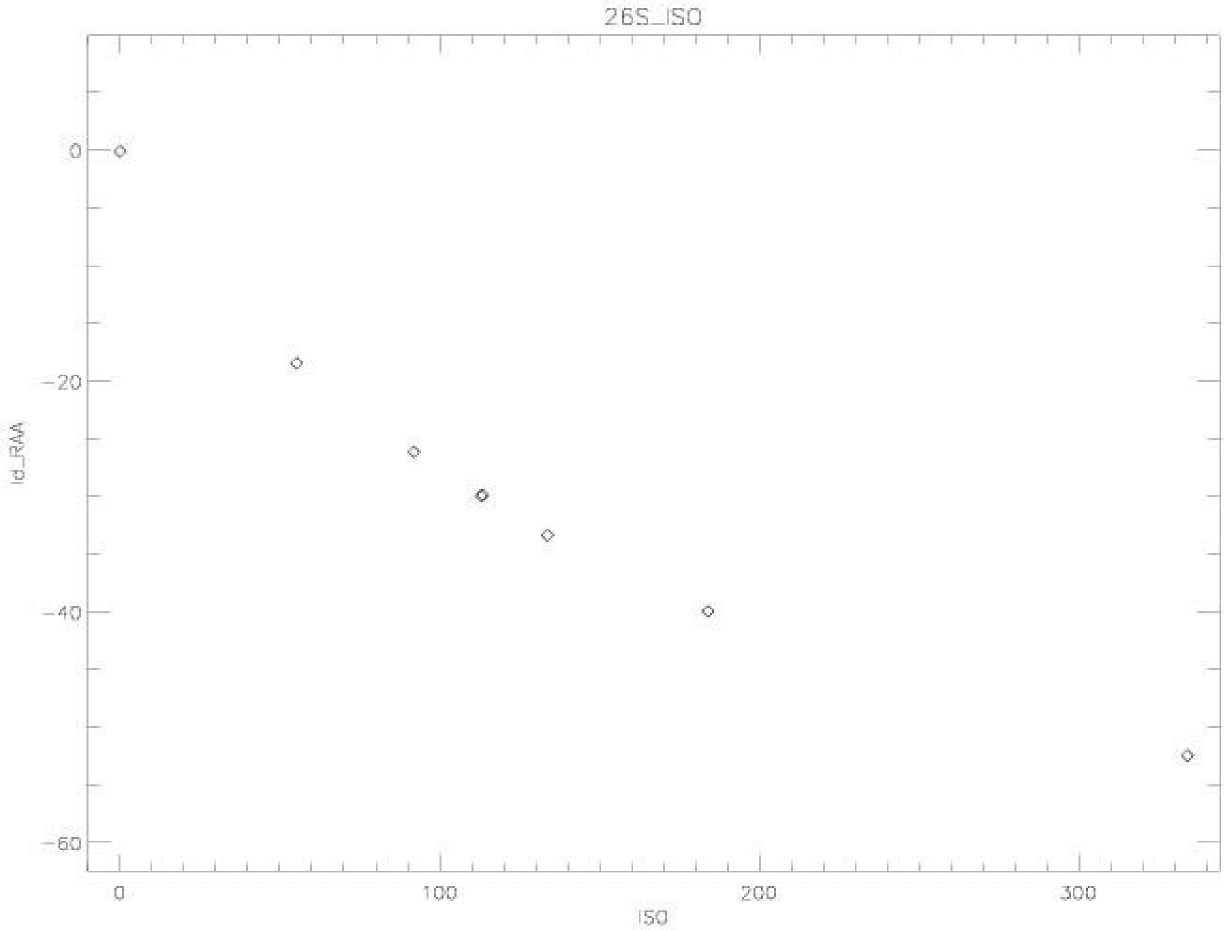
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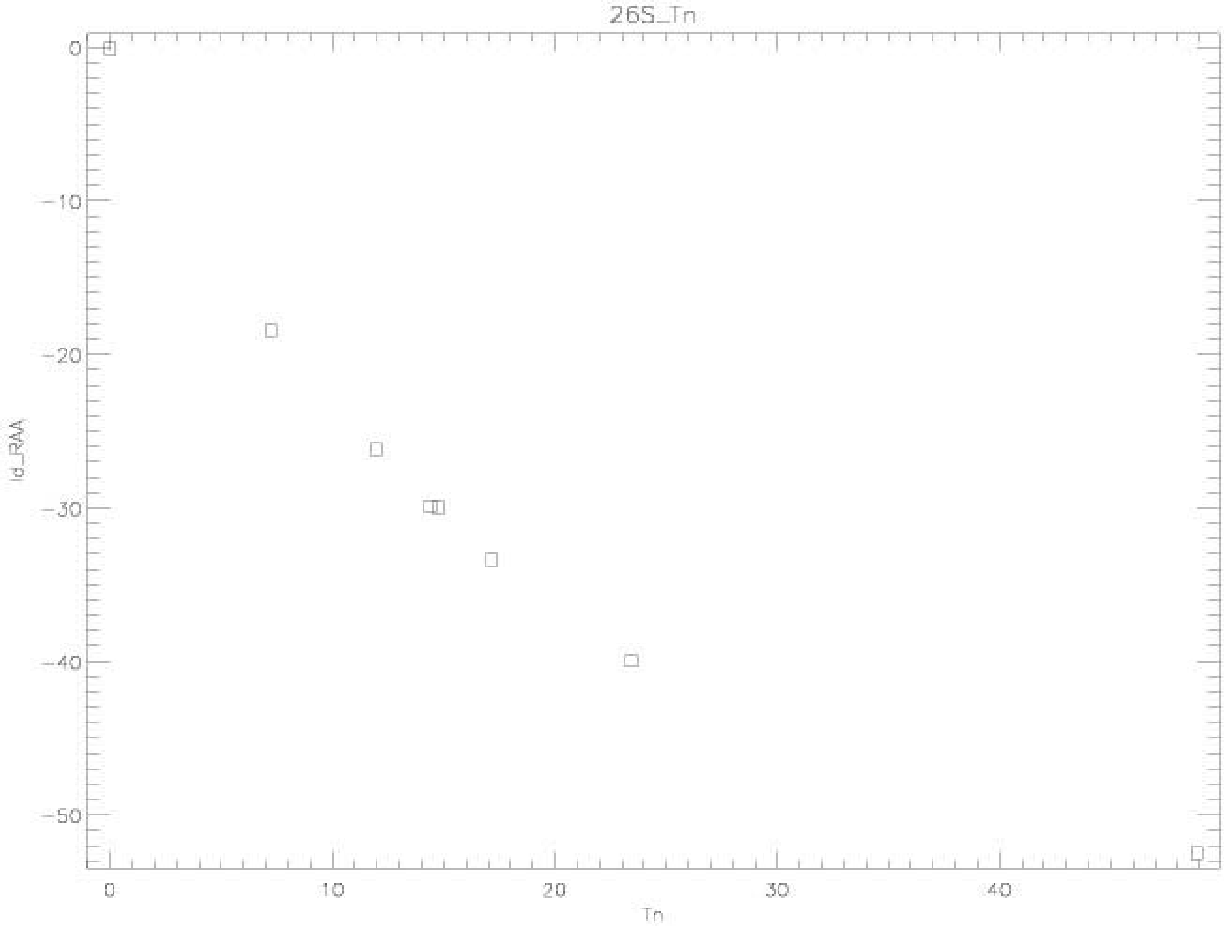
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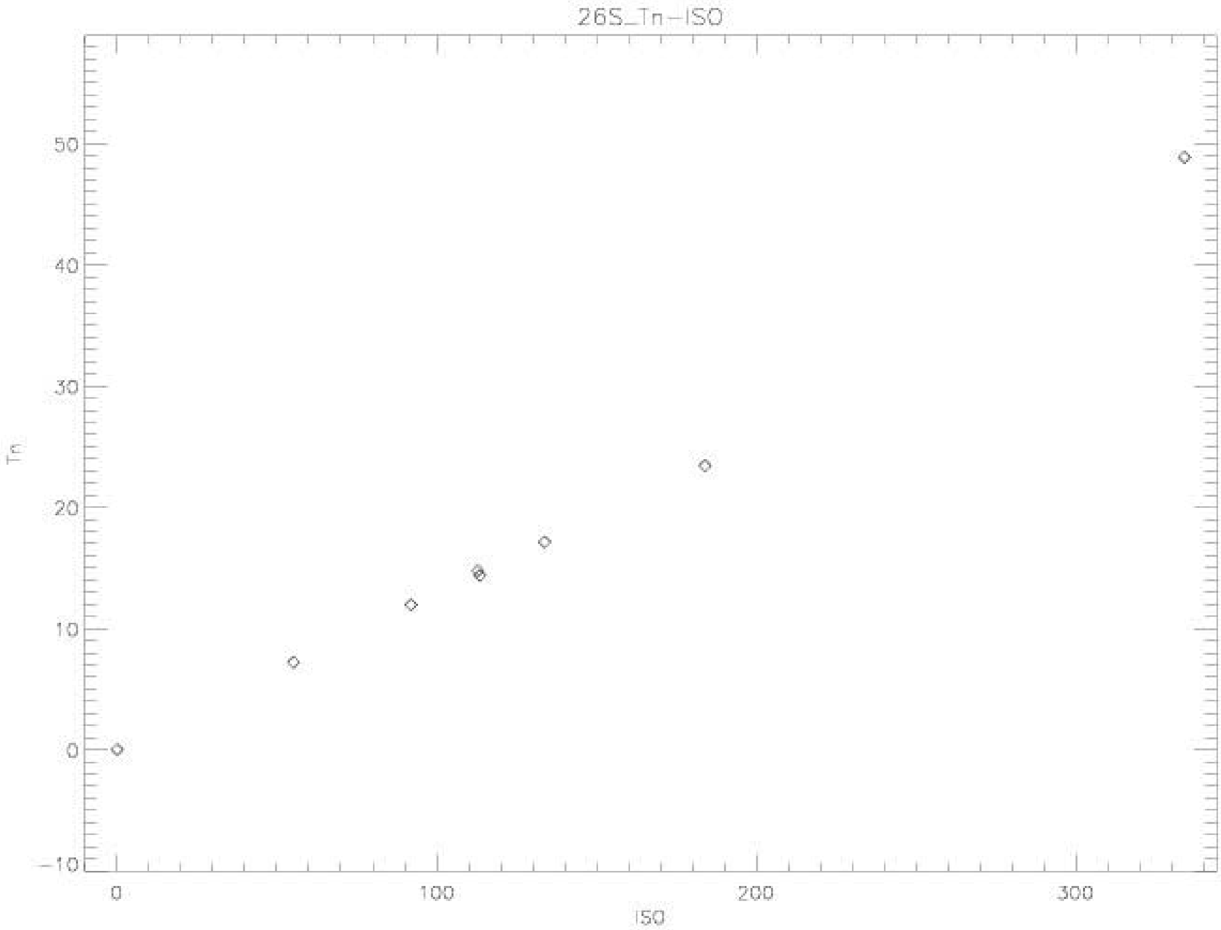
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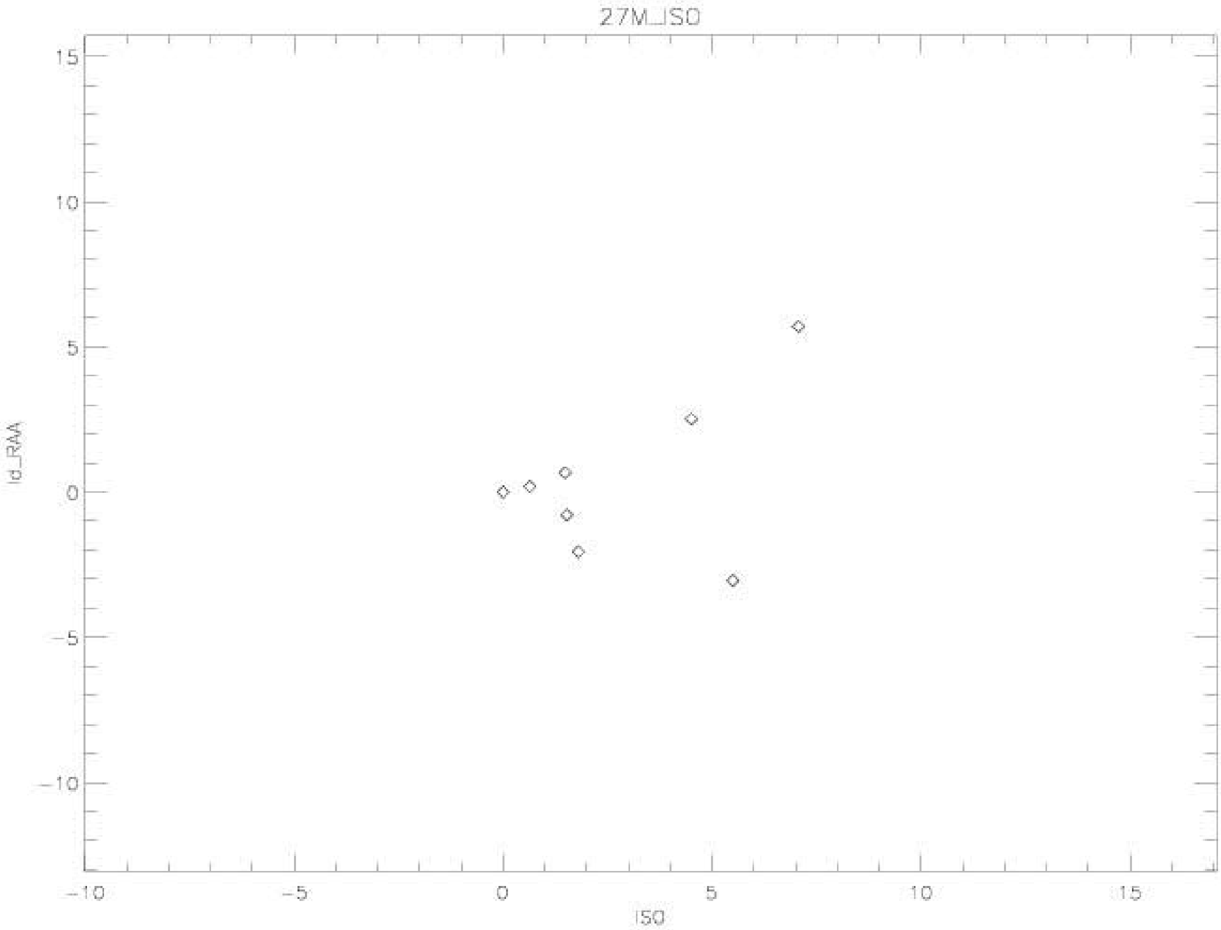
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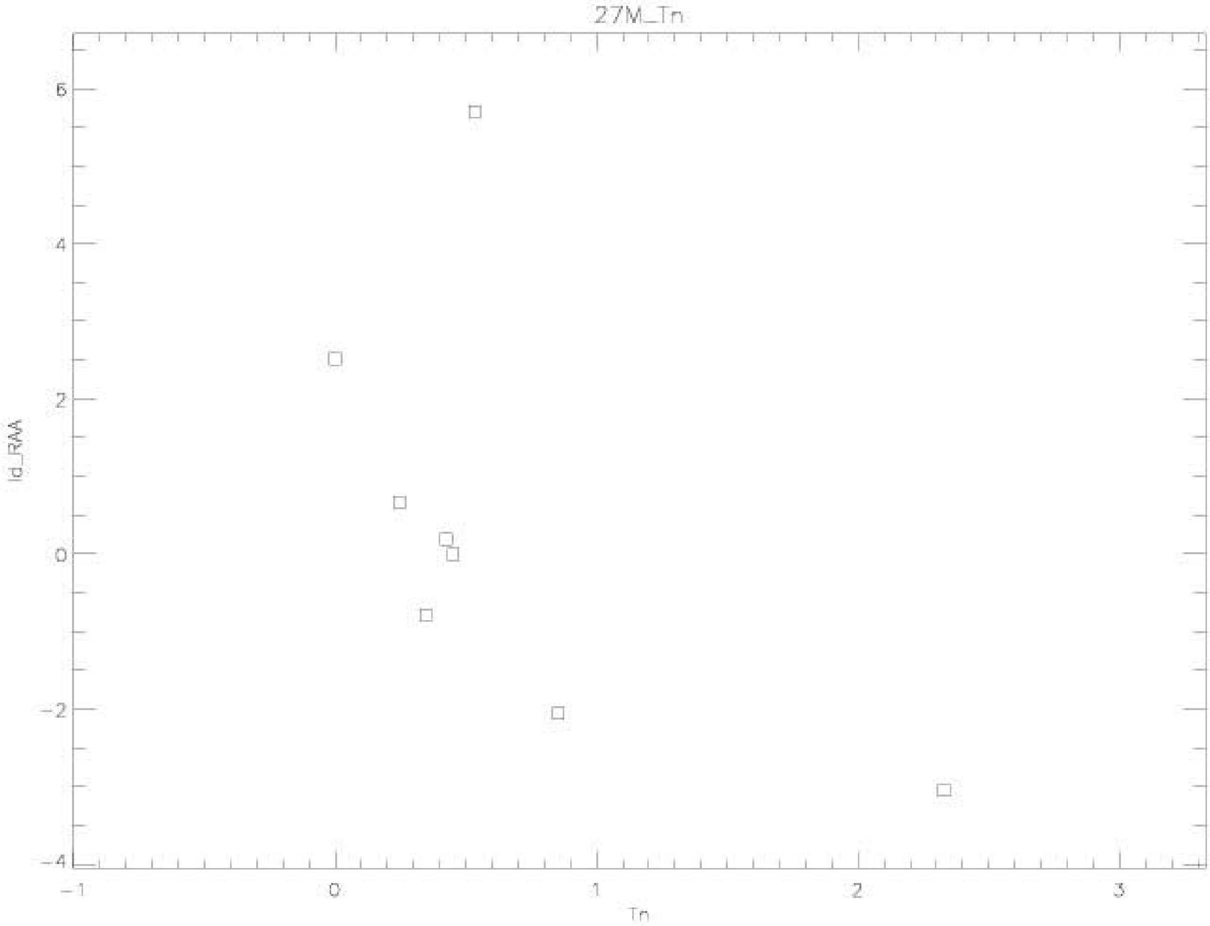
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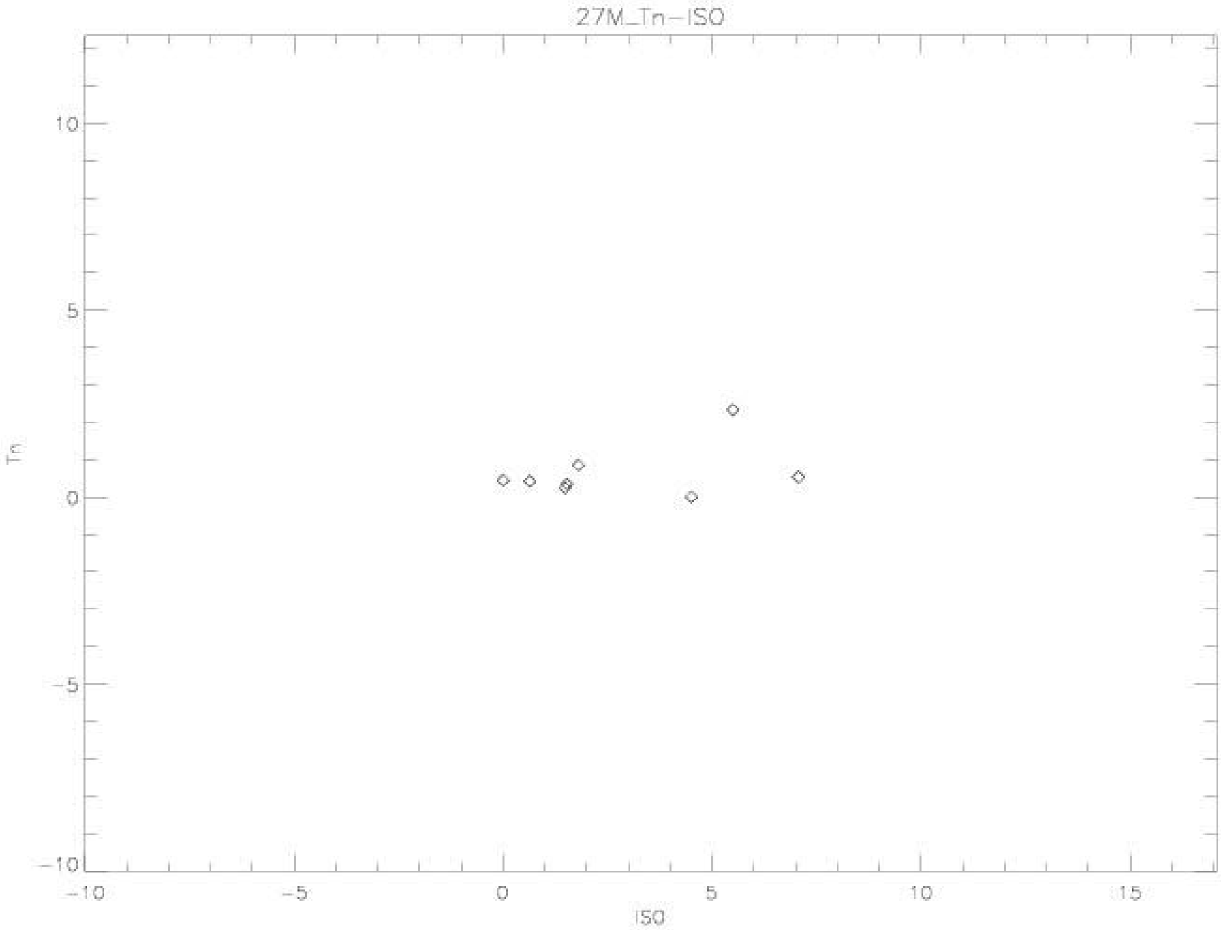
2
3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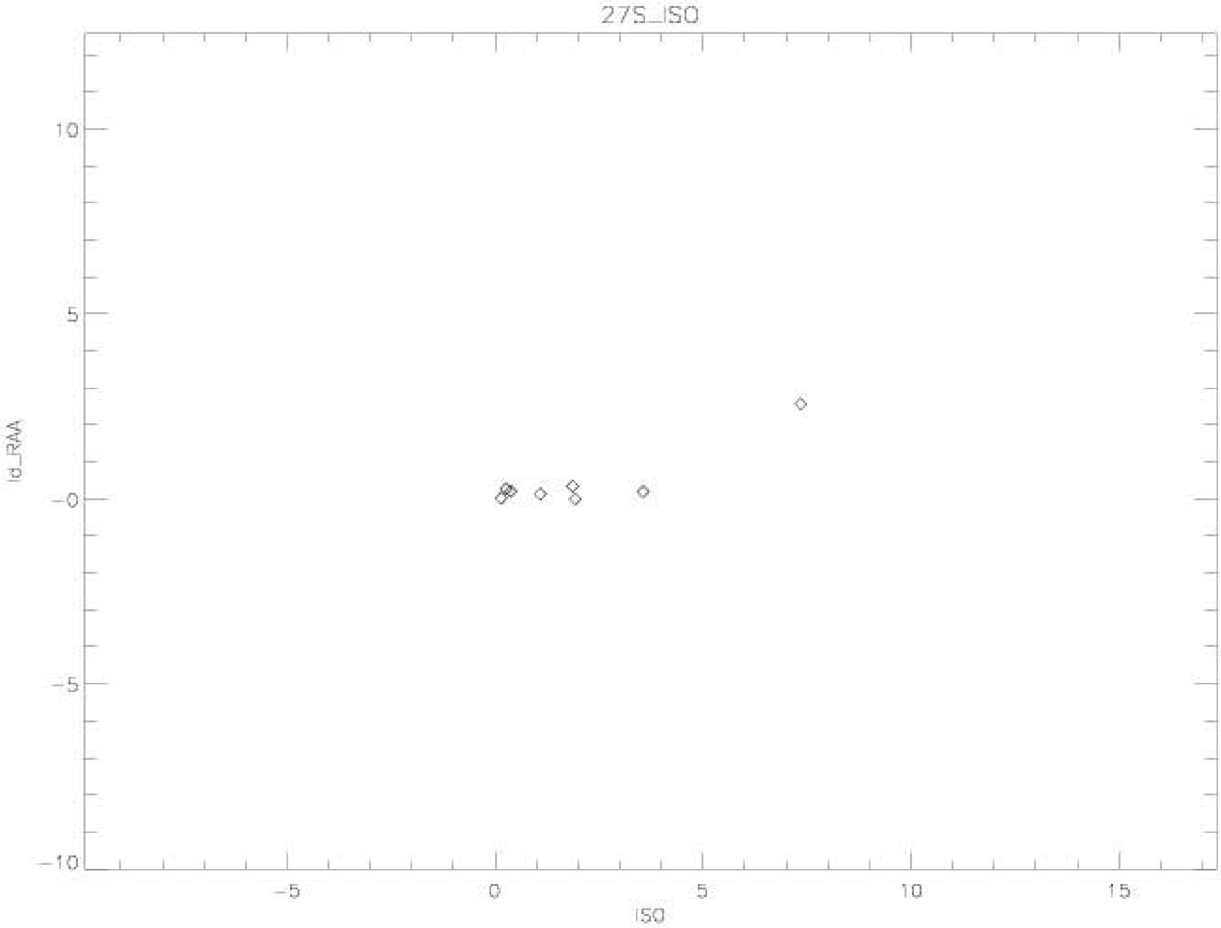
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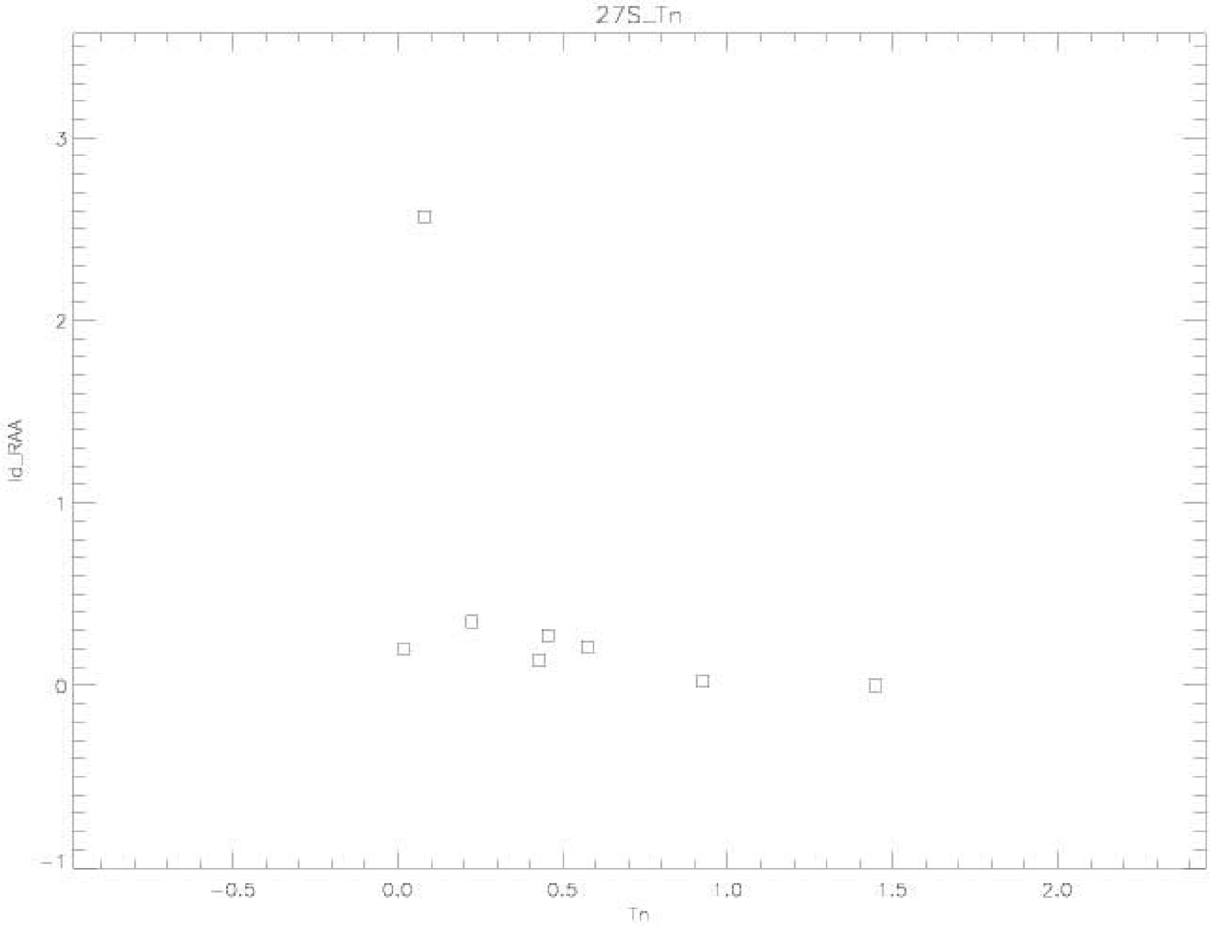
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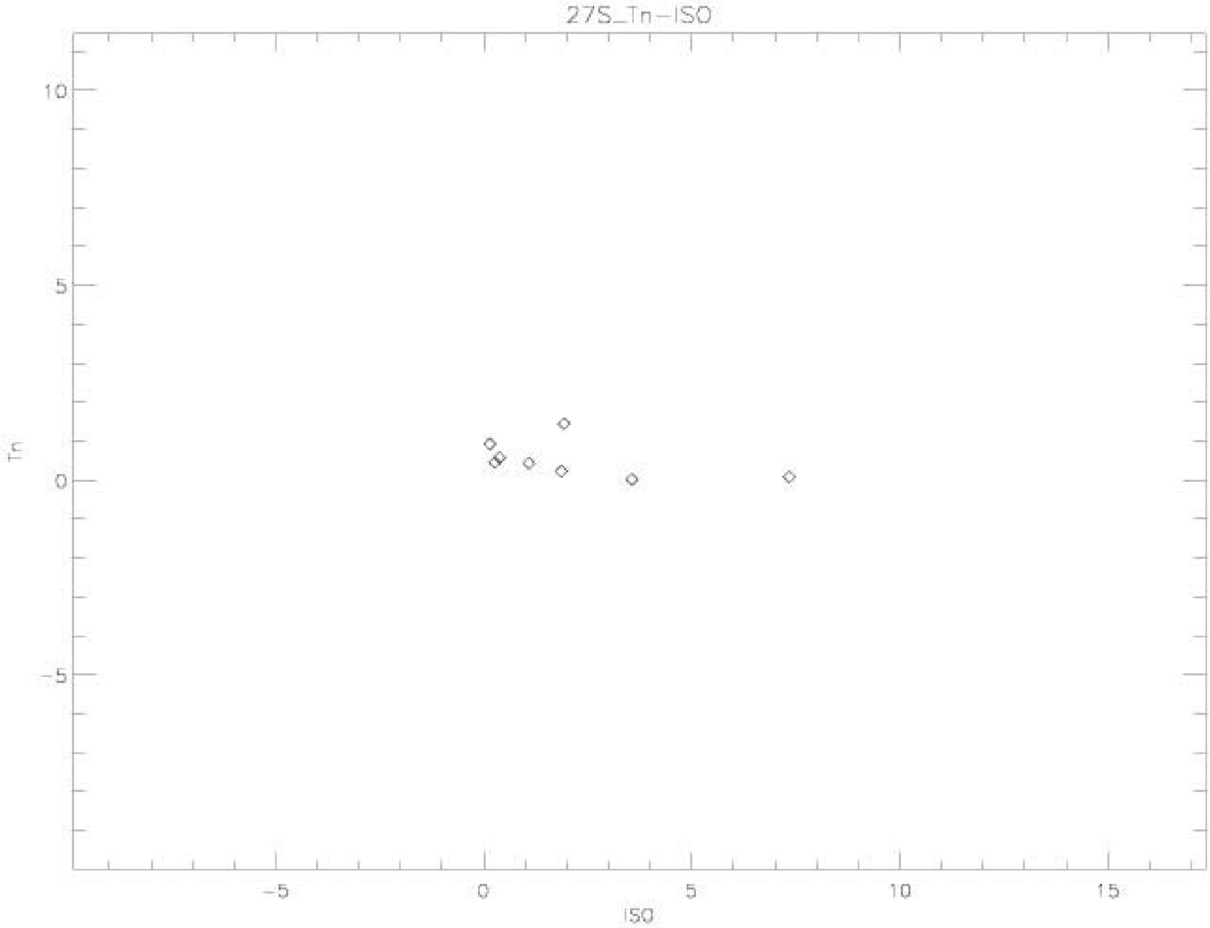
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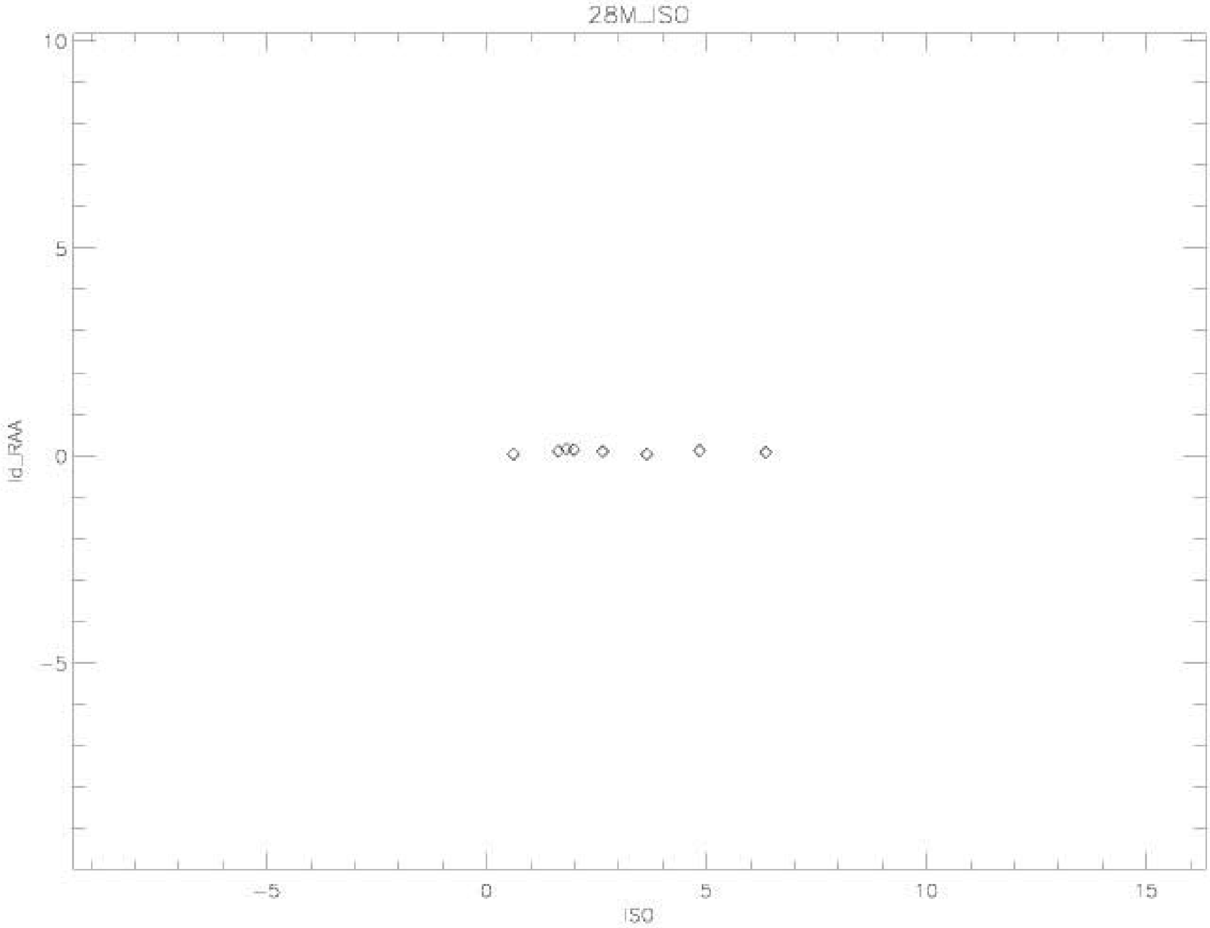
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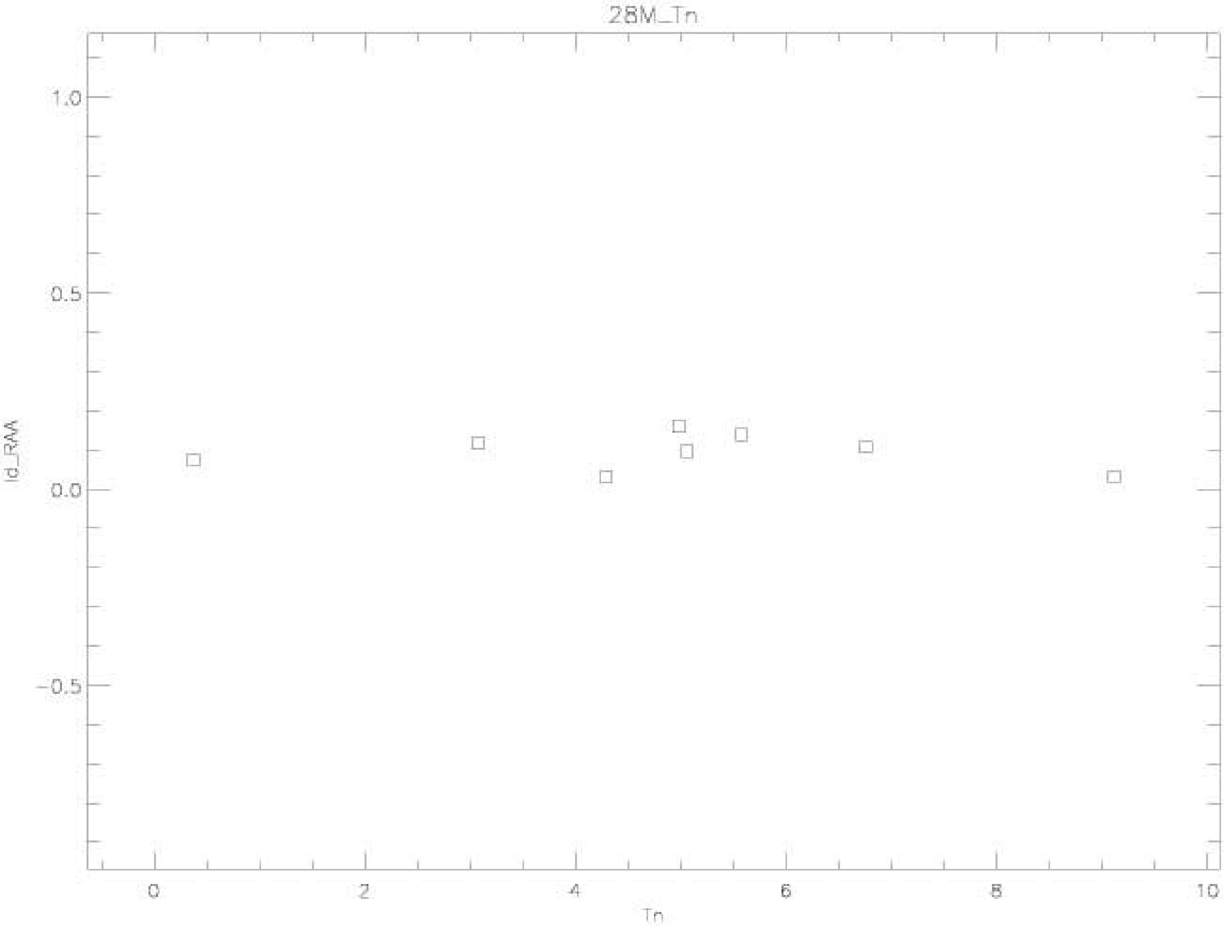
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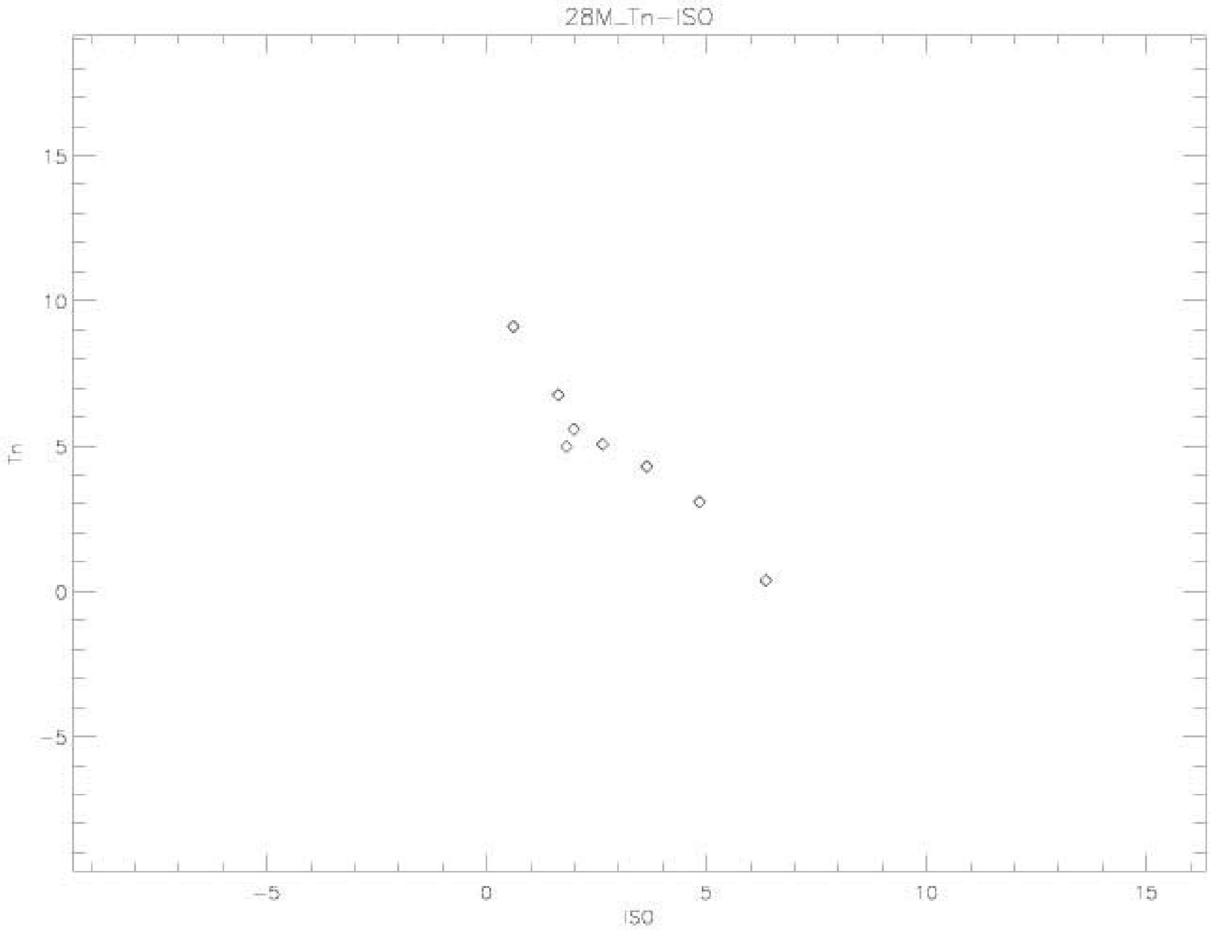
Tn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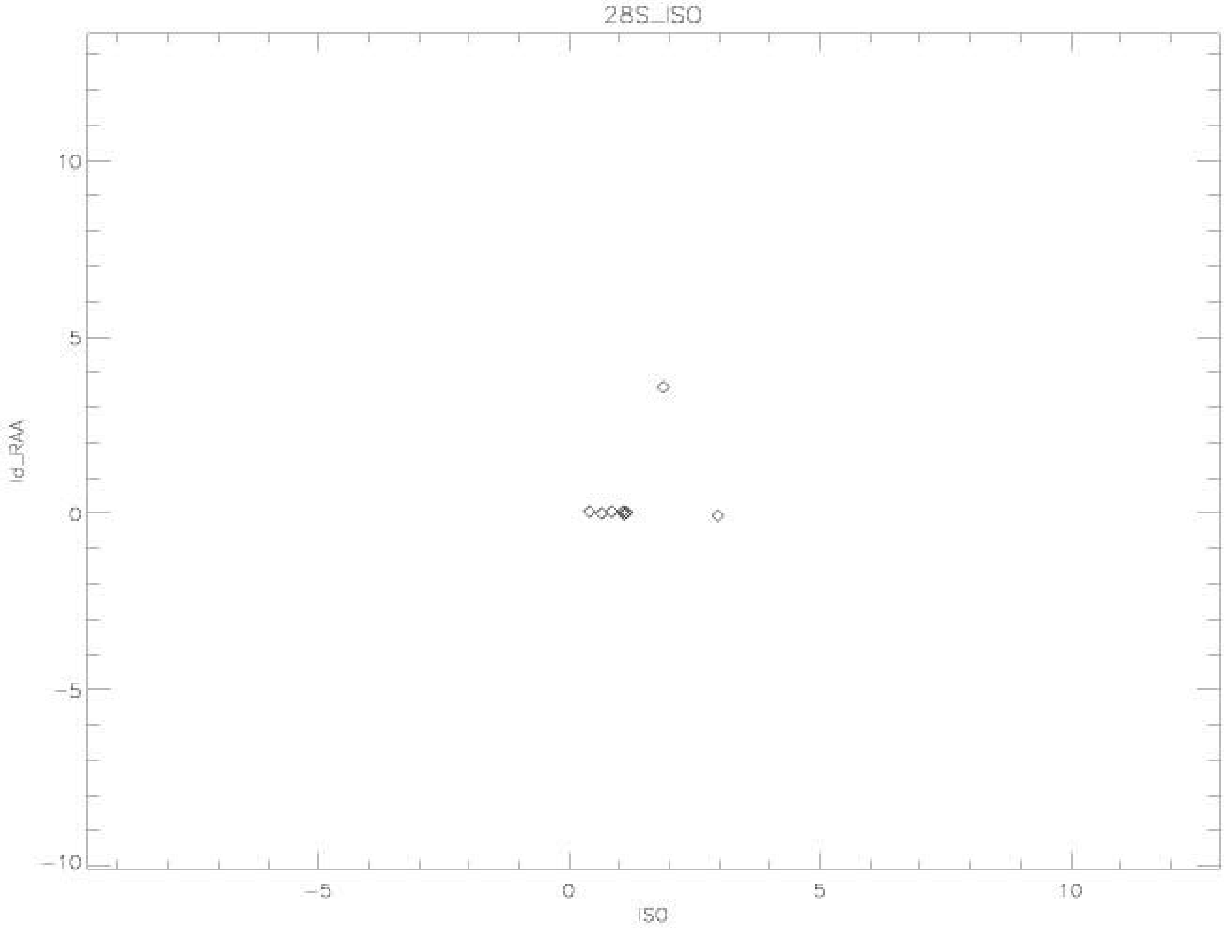
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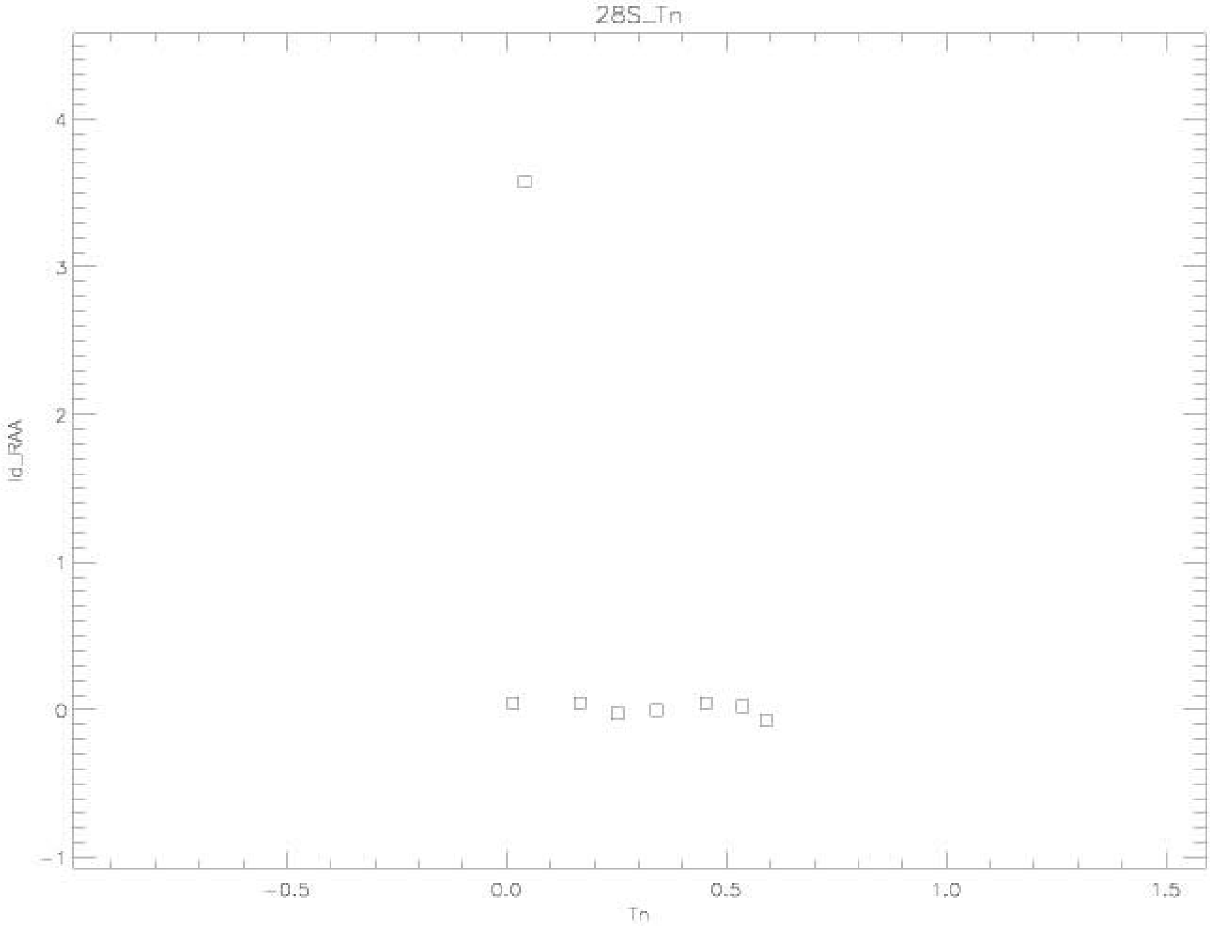
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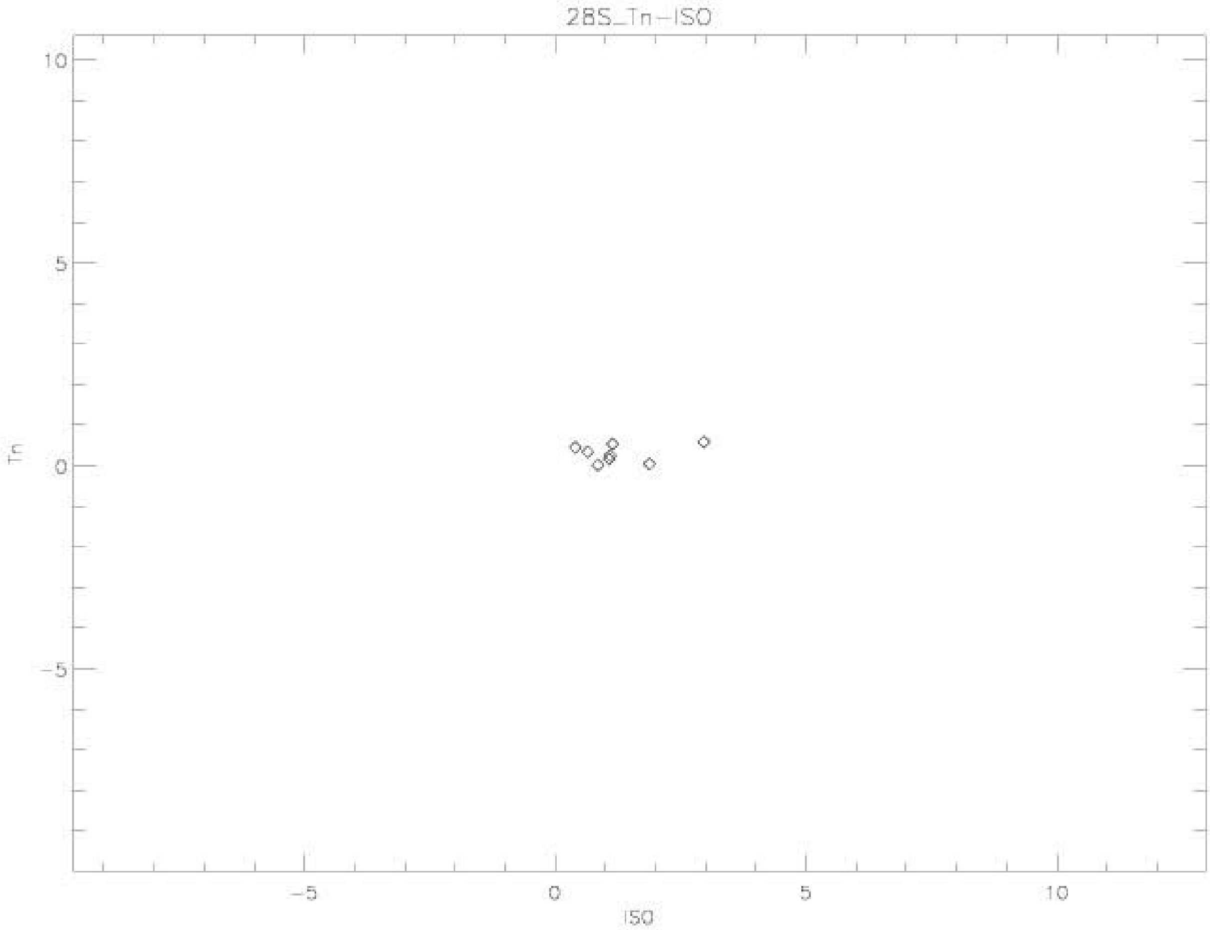
1.5


28S_Tn-ISO
Tn
ISO
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10
5
0
-5

10 APPENDIX 3 : parametric analysis of matrix grid with requirements changes

	I(Vg1)= I(Vg2)=10%, Itot req=15%			
RCA #	DET 00	DET 01	DET 02	DET 03
RCA18	#RIF!	#RIF!	#RIF!	#RIF!
RCA19	3	4	4	6
RCA20	6	5	7	23
RCA21	14	7	15	9
RCA22	3	4	3	3
RCA23	4	2	12	3
RCA24	14	28	12	12
RCA25	14	20	12	12
RCA26	13	6	7	6
RCA27	49	42	35	42
RCA28	42	40	42	42
	I(Vg1)=I(Vg2) = 15%;Itot = 25%			
RCA #	DET 00	DET 01	DET 02	DET 03
RCA18				
RCA19	10	4	10	13
RCA20	12	11	20	35
RCA21	20	20	34	19
RCA22	8	15	10	6
RCA23	11	2	33	8
RCA24	28	42	28	27
RCA25	21	28	28	27
RCA26	21	14	7	7
RCA27	49	42	42	49
RCA28	49	49	49	49

	I(Vg1)= I(Vg2)=20%, Itot req=30%			
RCA #	DET 00	DET 01	DET 02	DET 03
RCA18				
RCA19	23	12	22	20
RCA20	20	14	28	41
RCA21	29	30	35	29
RCA22	18	19	19	10
RCA23	12	3	41	9
RCA24	28	42	28	28
RCA25	28	28	28	28
RCA26	28	14	14	7
RCA27	49	49	49	49
RCA28	49	49	49	49

Figure 9 allowed combinations per channel considering different requirements of individual drain currents (corresponding to Vg1 and Vg2 tuning) coupled with total drain current; channel 18 data are missing or partial.

	Itot req=10%			
RCA #	DET 00	DET 01	DET 02	DET 03
RCA18				
RCA19	12	3	13	8
RCA20	8	10	15	24
RCA21	17	19	20	13
RCA22	15	10	11	8
RCA23	10	5	18	11
RCA24	16	30	18	15
RCA25	14	18	18	15
RCA26	12	10	9	6
RCA27	48	40	35	41
RCA28	42	34	42	42

	Itot req=20%			
RCA #	DET 00	DET 01	DET 02	DET 03
RCA18				
RCA19	26	10	31	20
RCA20	19	20	28	38
RCA21	28	33	37	30
RCA22	26	21	24	19
RCA23	19	7	37	23
RCA24	29	42	30	28
RCA25	27	29	29	26
RCA26	29	19	22	8
RCA27	49	49	49	49
RCA28	49	48	49	49

	Itot req=30%			
RCA #	DET 00	DET 01	DET 02	DET 03
RCA18				
RCA19	36	16	39	33
RCA20	31	33	38	46
RCA21	39	42	47	36
RCA22	37	31	35	27
RCA23	32	9	48	32
RCA24	35	49	36	34
RCA25	34	39	35	34
RCA26	41	28	38	12
RCA27	49	49	49	49
RCA28	49	49	49	49

Figure 10 allowed combinations per channel considering different requirements of total drain current; channel 18 data are missing or partial.

Drain current behaviour with Vg1-Vg2 combinations (from 1 to 49,not ordered and ordered in Id)

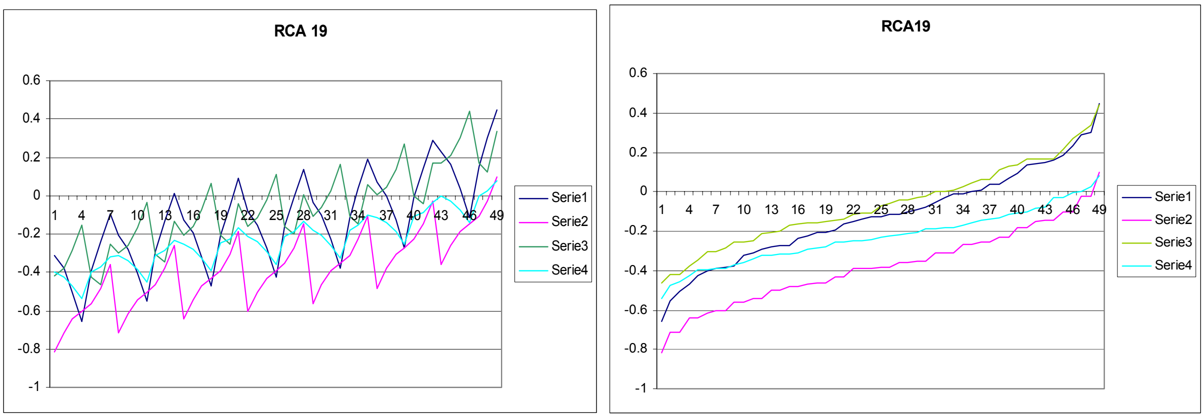


Figure 11 RCA 19

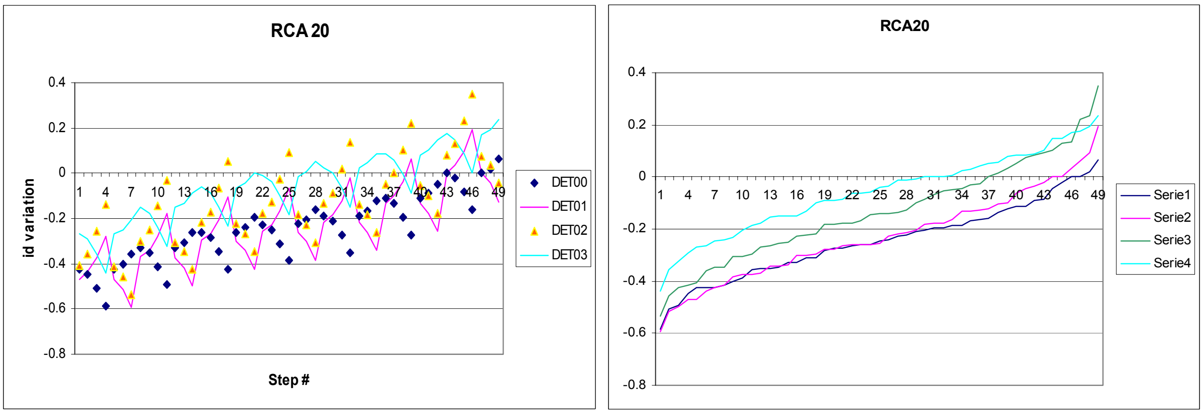


Figure 12 RCA 20

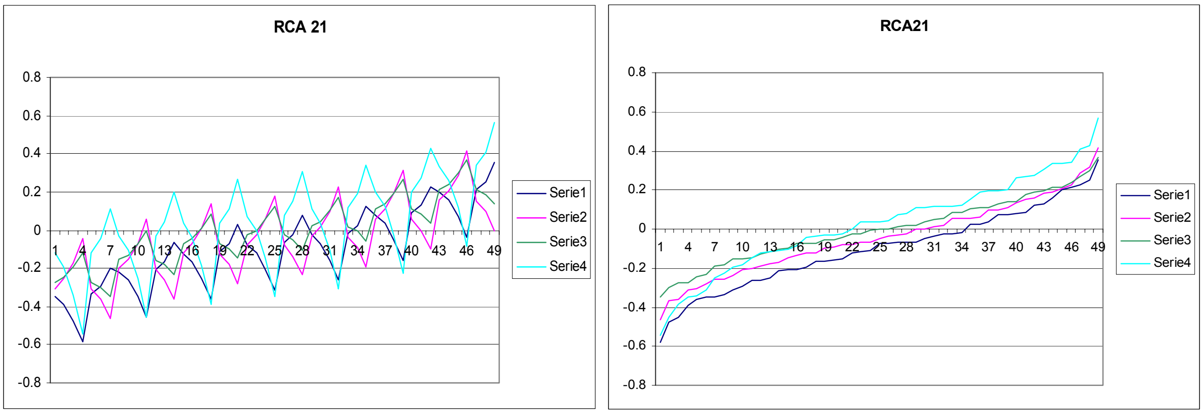


Figure 13 RCA 21

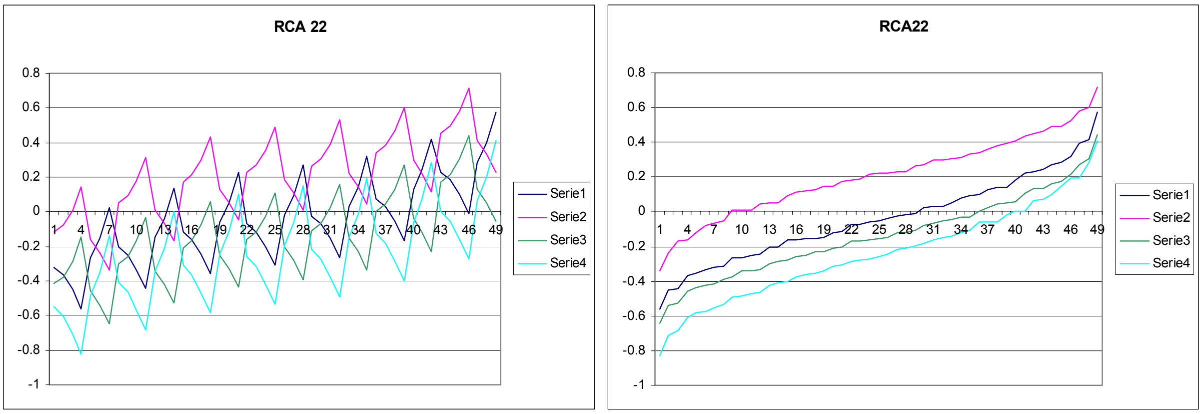


Figure 14 RCA 22

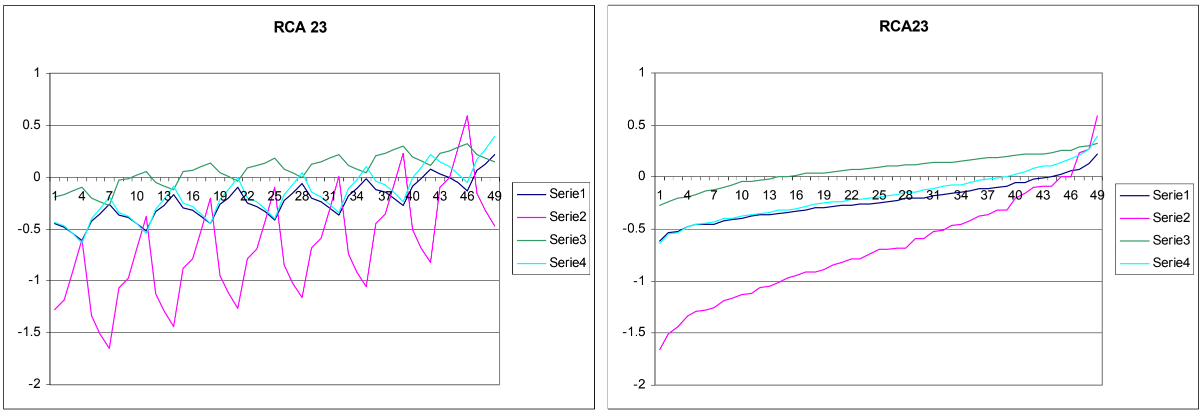


Figure 15 RCA 23

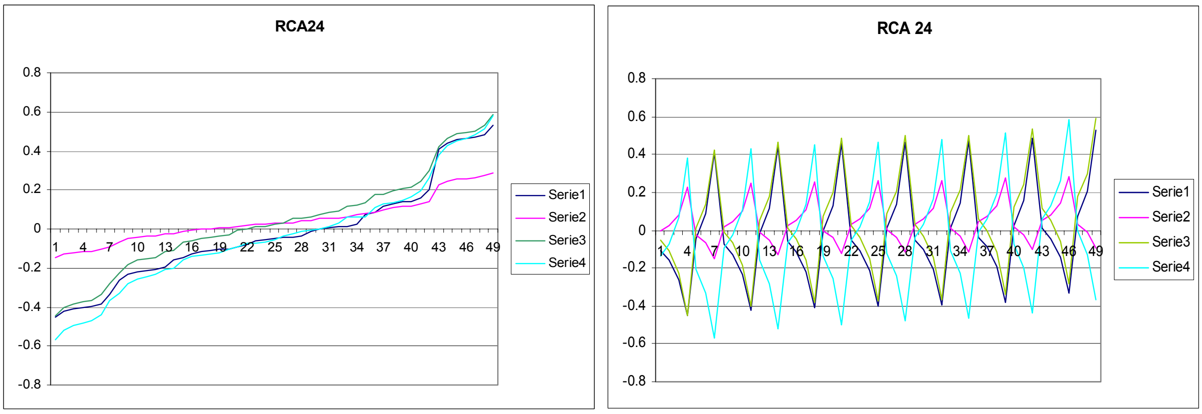


Figure 16 RCA 24

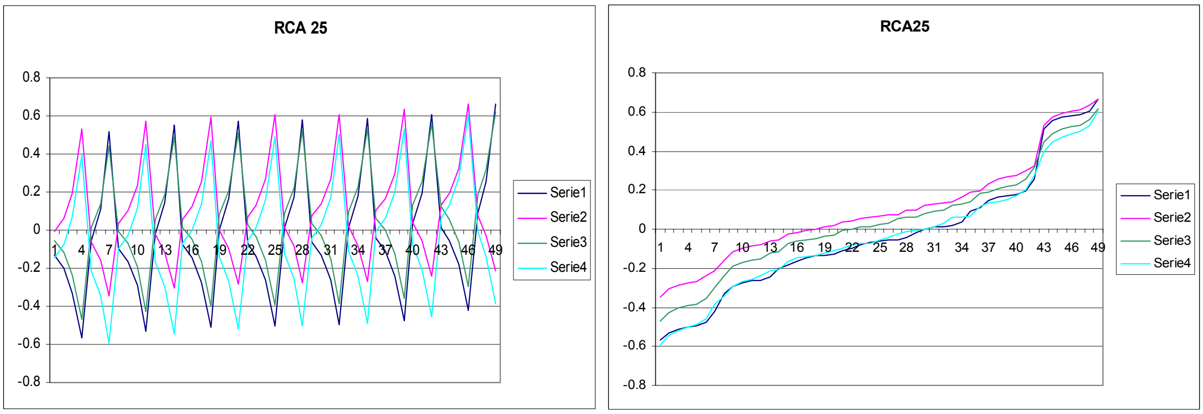


Figure 17 RCA 25

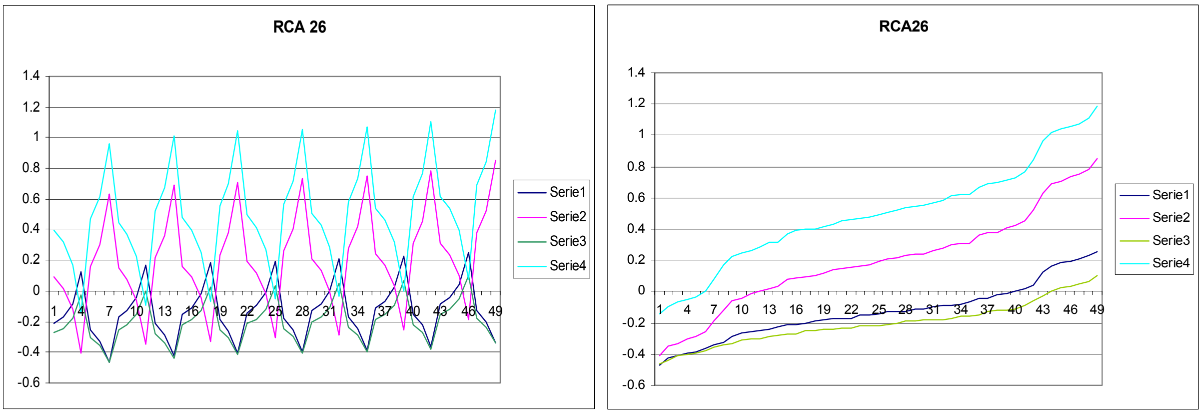


Figure 18 RCA 26

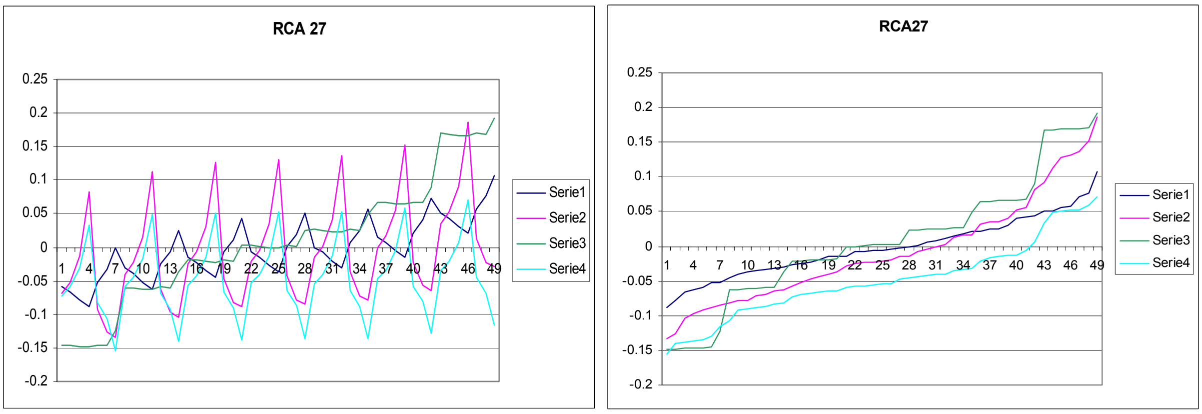
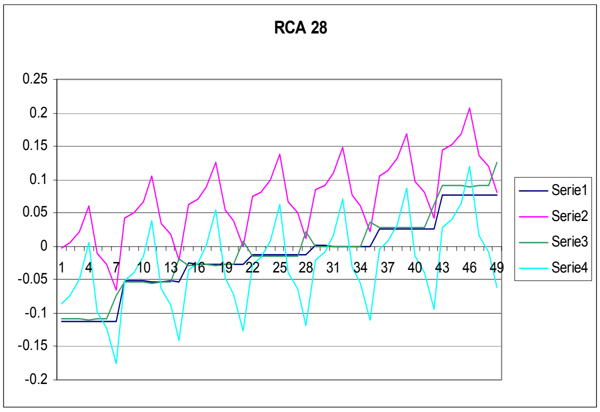


Figure 19 RCA 27



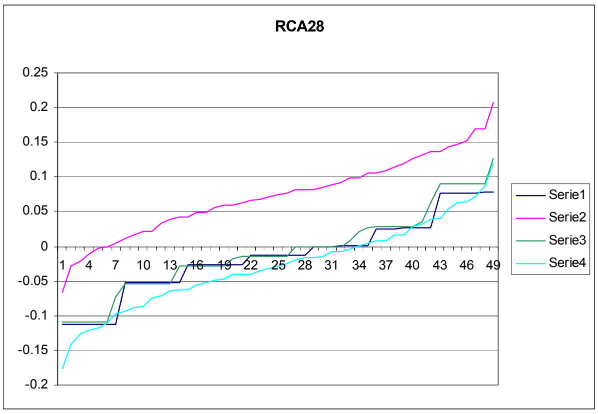


Figure 20 RCA 28