The new MPC NEO Confirmation Page: Improvements and results

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The NEO Confirmation Page

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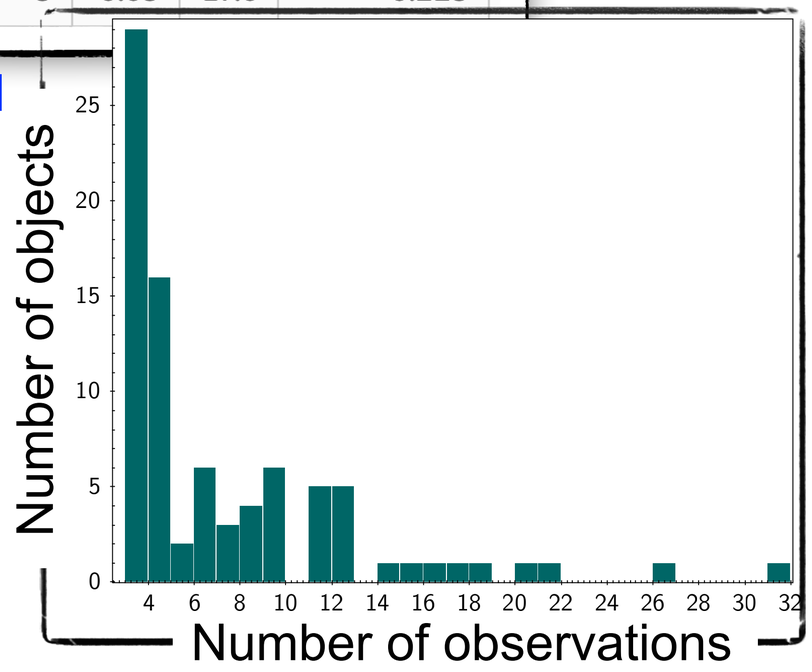
Minor Planet Center

Temp Desig	Score	Discovery	R.A.	Decl.	V	Updated	Note	NObs	Arc	H	Not Seen/dys
P11fbXR	97	2021 04 14.5	14 42.1	+03 08	21.1	Added Apr. 14.74 UT		3	0.02	19.5	0.217
P11fbPG	97	2021 04 14.6	15 24.2	+06 58	22.1	Added Apr. 14.70 UT		3	0.03	21.2	0.176
P11fbPq	99	2021 04 14.6	15 44.3	+07 07	22.4	Added Apr. 14.69 UT		3	0.02	21.7	0.161
P11fbPp	99	2021 04 14.6	15 24.2	+07 30	22.0	Added Apr. 14.69 UT		4	0.04	14.4	0.164
TMG0046	98	2021 04 14.6	16 56.9	+37 02	15.7	Updated Apr. 14.75 UT		23	0.15	26.5	0.023
P11fao5	71	2021 04 14.5	14 31.9	+06 43	22.0	Added Apr. 14.59 UT		3	0.02	15.8	0.233
P11fao4	78	2021 04 14.5	14 09.3	+04 24	22.0	Added Apr. 14.59 UT		3	0.03	17.0	0.223

NEOCP: https://minorplanetcenter.net/iau/NEO/toconfirm_tabular.html

Main goals:

- Real-time publication of **NEA candidates**
- Help and facilitate a rapid **follow-up**



Recent improvements - 1

OrbFit @ MPC:

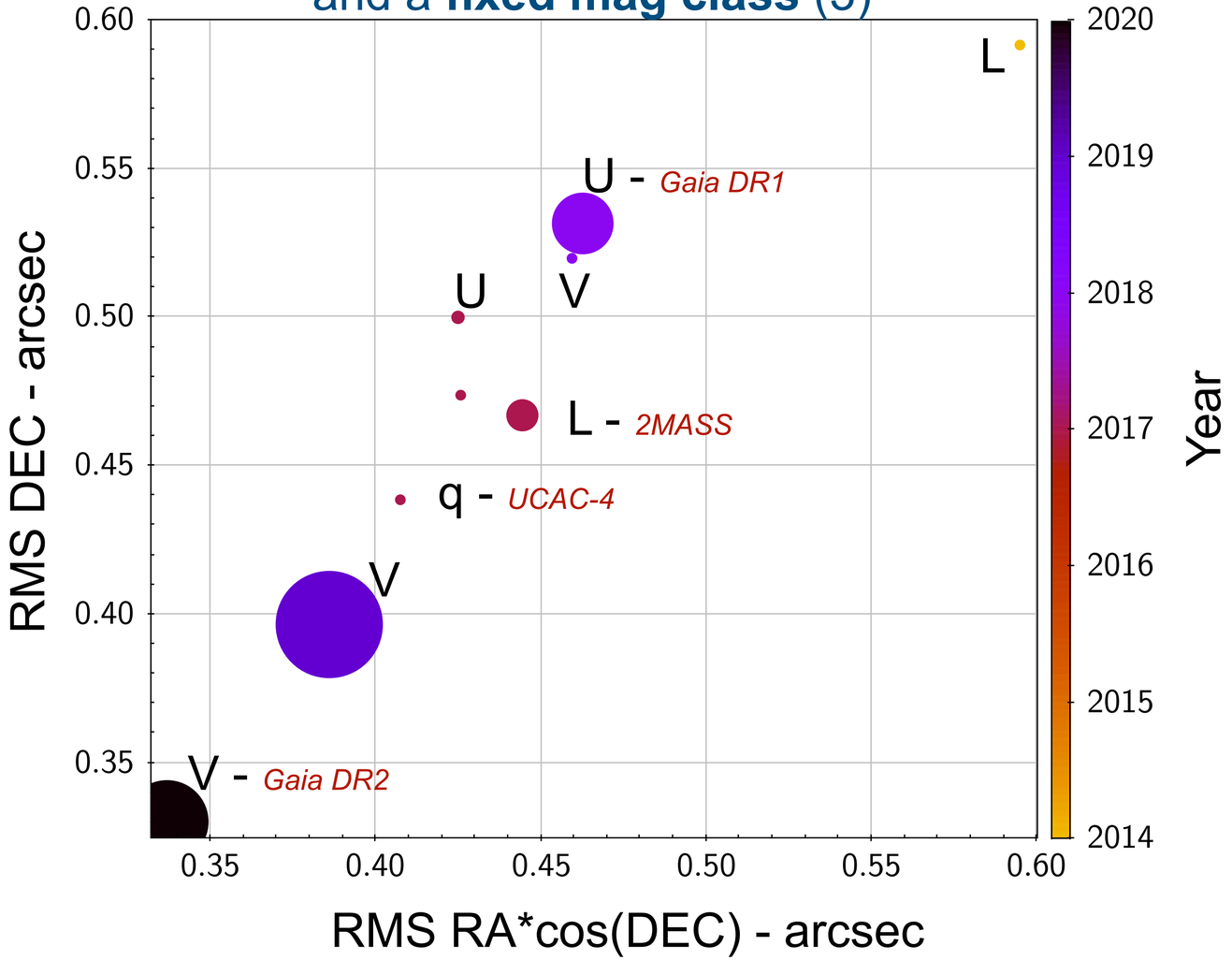
- Orbital elements **uncertainties**
- Use of a new **weighting scheme**
- Use of ADES
- …

Analysis of all the available residuals

- Grouped by:
  - **Observatories**
  - **Year**
  - **Stellar catalog (including no catalog)**
  - **Magnitude class (including no magnitude)**

(Spoto et al., in preparation)

Weights for T08 (ATLAS-MLO, Mauna Loa)
and a **fixed mag class** (3)



Recent improvements - 2

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Our error model

Obs and catalog code *RMS used* *Mag class*

Year

```
2014,  T08 ,  L,    19555,    11440, 0.585,   0.59496,   0.59166,   0.92946,   0.92027,  3,   0.59496,   0.59166
2017,  T08 ,  2,   118920,   118920, 1.000,   0.42596,   0.47360,   0.42596,   0.47360,  3,   0.42596,   0.47360
2017,  T08 ,  L,   952170,   925138, 0.972,   0.44471,   0.46662,   0.50289,   0.52312,  3,   0.44471,   0.46662
2017,  T08 ,  U,   356038,   356034, 1.000,   0.42506,   0.49973,   0.42516,   0.49987,  3,   0.42506,   0.49973
2017,  T08 ,  q,    28957,    28825, 0.995,   0.40744,   0.43853,   0.41992,   0.45592,  3,   0.40744,   0.43853
2018,  T08 ,  U,  1767943,  1767859, 1.000,   0.46265,   0.53138,   0.46323,   0.53188,  3,   0.46265,   0.53138
2018,  T08 ,  V,     6259,     6257, 1.000,   0.45945,   0.51985,   0.46149,   0.52465,  3,   0.45945,   0.51985
2019,  T08 ,  V,  3083272,  3083188, 1.000,   0.38613,   0.39627,   0.38684,   0.39655,  3,   0.38613,   0.39627
2020,  T08 ,  V,  2381419,  2381408, 1.000,   0.33708,   0.33001,   0.33715,   0.33022,  3,   0.33708,   0.33001
```

(Spoto et al., in preparation)

Use of observations in ADES format

Epoch of the observation (UTC) *RMS sent* *Stellar catalog (V)* *Mag*

```
2021-04-04T11:18:27.52Z     | 0.402 |  0.402 | Gaia2  | 19.61
2021-04-04T10:50:49.64Z     | 0.369 |  0.369 | Gaia2  | 19.74
2021-04-04T10:50:49.64Z     | 0.269 |  0.269 | Gaia2  | 18.87
2021-04-04T09:12:48.89Z     | 0.351 |  0.351 | Gaia2  | 19.75
2021-04-04T10:24:27.82Z     | 0.312 |  0.312 | Gaia2  | 18.69
2021-04-04T11:19:47.23Z     | 0.305 |  0.305 | Gaia2  | 19.47
2021-04-04T09:22:46.61Z     | 0.304 |  0.304 | Gaia2  | 19.57
2021-04-04T10:36:11.78Z     | 0.322 |  0.322 | Gaia2  | 18.98
```

ADES data in the MPC database sent by T08

- RMS sent **<** RMS computed → **RMS computed**
- RMS sent **>** RMS computed → **RMS sent**

NEOCP: new code

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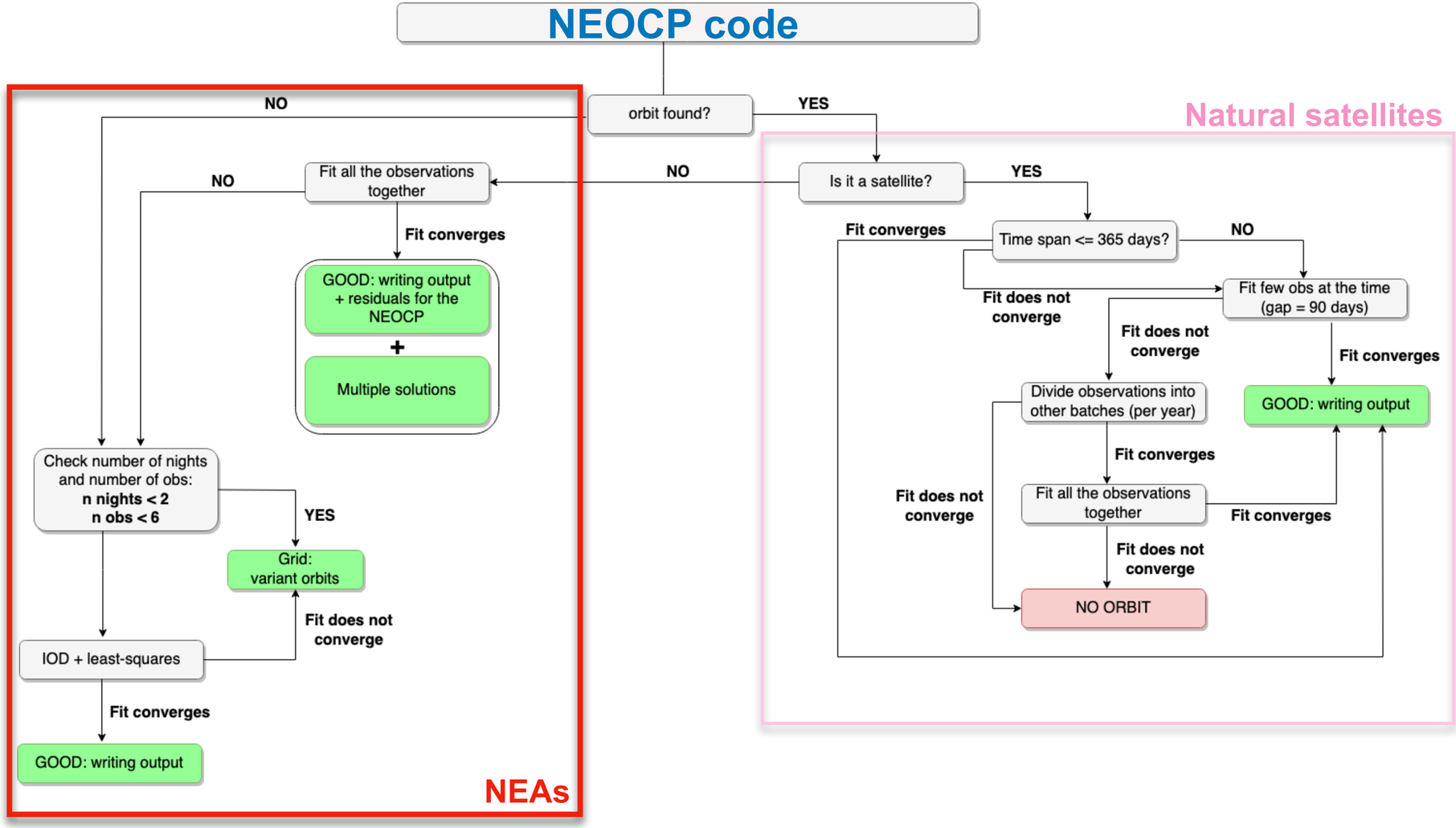
Code Requirements:

- ★ Fast
- ★ Reliable
- ★ Little manual intervention
- ★ Use of all the available data

Theory behind:

- Admissible region
- Systematic ranging
  - 2 grids

(Spoto et al. 2018, Farnocchia et al. 2015, Milani et al. 2005)



Choice of the nominal solution

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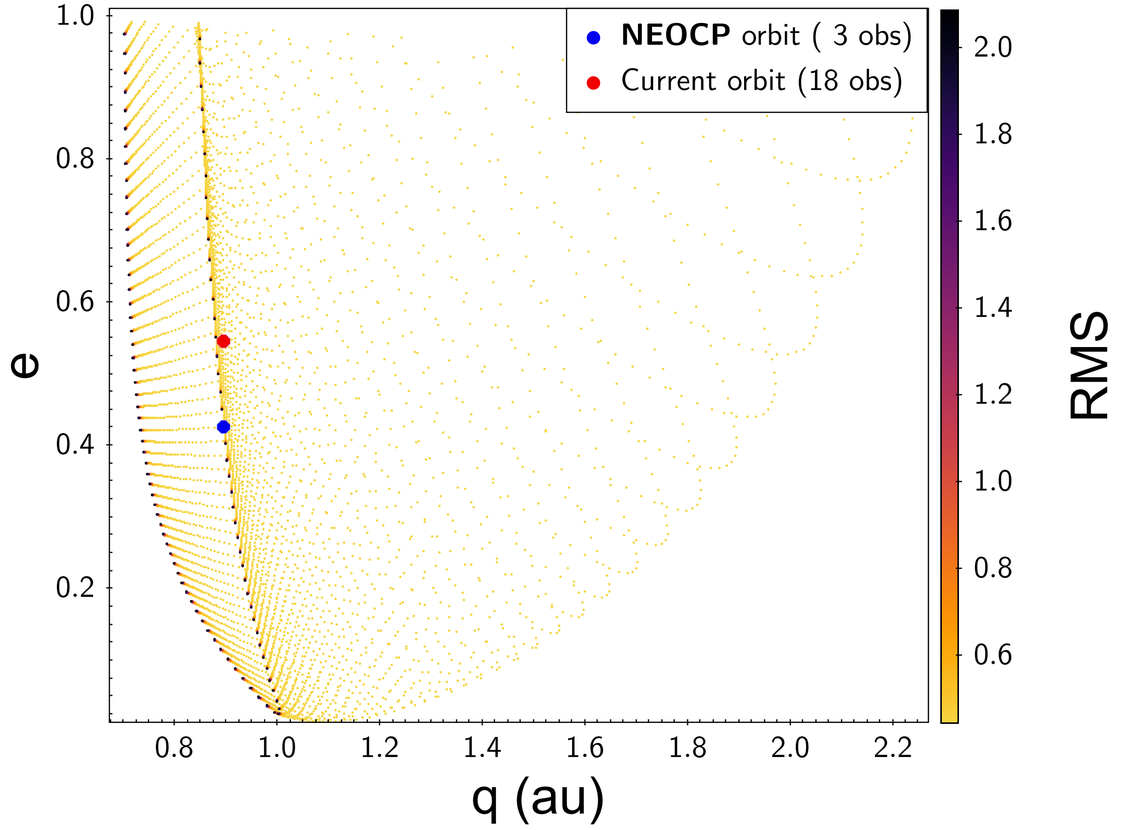
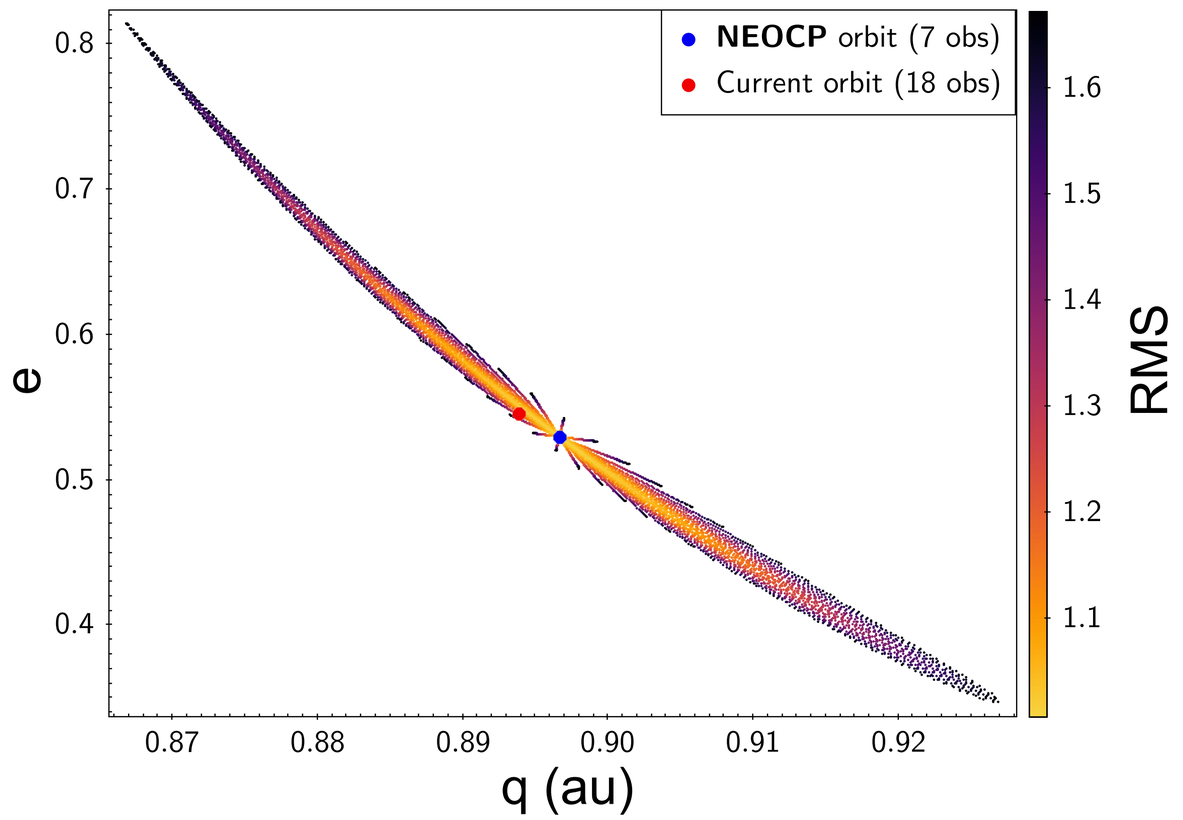
3 possible options:

- Orbit with the **minimum RMS**
- Orbit in the grid that is the **closest one to the orbit corresponding to the median** of the RA and DEC values (obtained from the prediction of each reliable orbit in the grid)
- Orbit that **corresponds to the median** of the RA and DEC value predictions

3 obs from 703



3 obs from 703 + 4 obs from G96



Vera Rubin/LSST exercise

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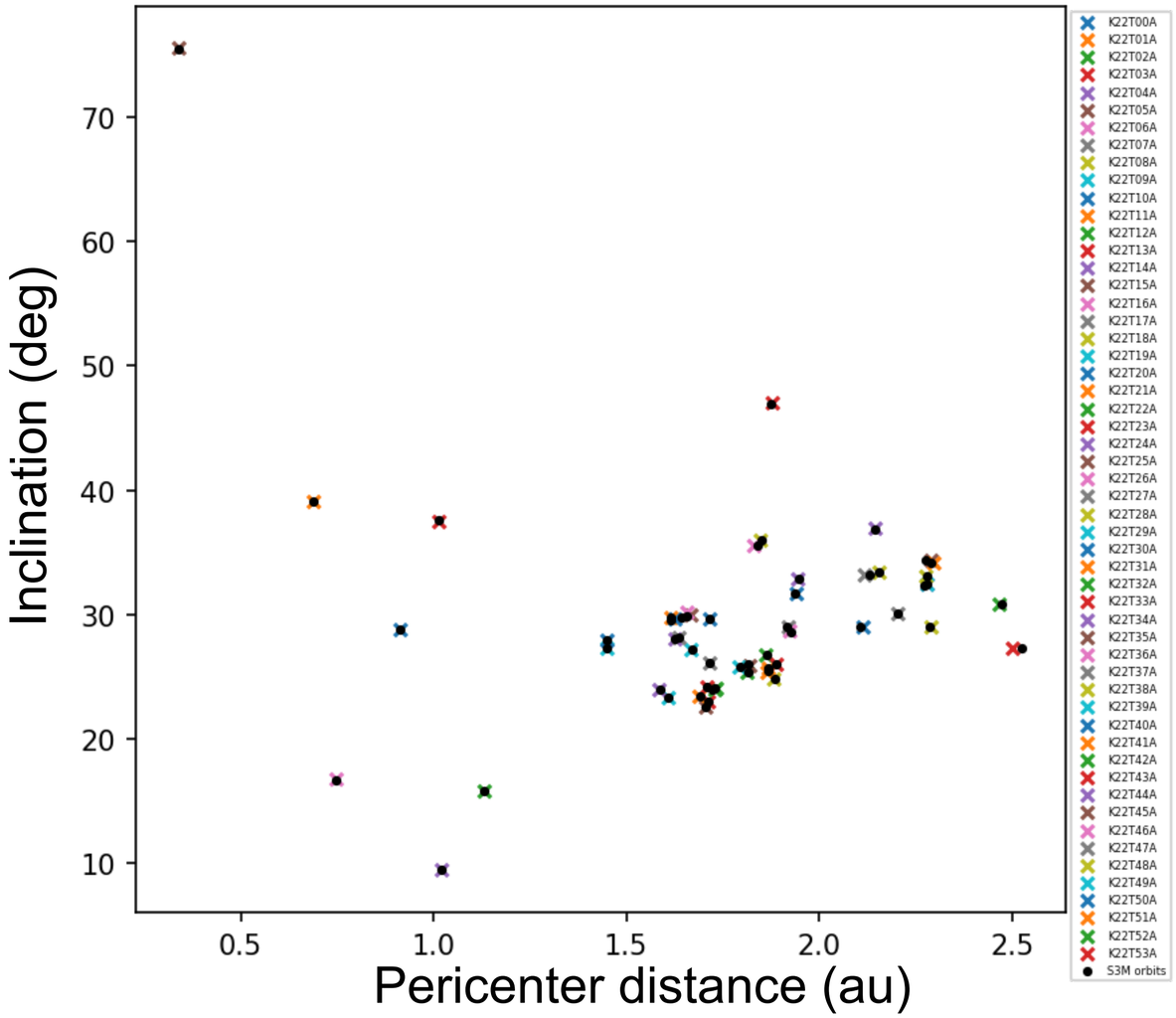
Main goals:

- Assess MPC's current and expected future ability to **ingest LSST-sized submissions**
- Test the MPC's capability to re-fit orbits and **generate a new orbit catalog**

Hugely succesfull:

- Demonstrated **ingestion of multiple nights** of LSST data
- **Demonstrated MPC's capability to fit all "New" objects in ~2 hours** (using ~300 cores)

Simulated orbits vs derived MPC orbits



Courtesy of Siegfried Eggl (University of Washington)

Near future plans

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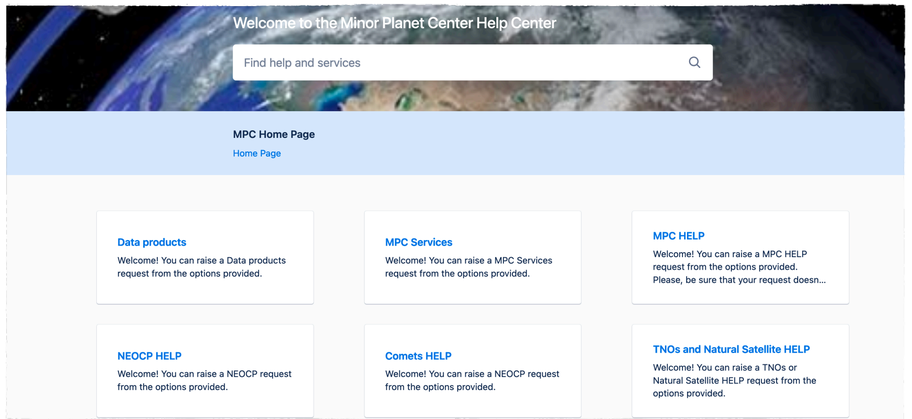
Start flagging suspected artificial objects on the NEOCP (see Editorial, 2021 Apr 19th)

P11fmQd	100	2021 04 15.5	14 38.5	-04 04	22.3	Added Apr. 15.85 UT	**S**	3	0.03	26.7	0.574
P11fmQ3	100	2021 04 15.4	12 05.4	-04 22	22.2	Added Apr. 15.84 UT		3	0.02	25.5	0.673
P11fmCm	67	2021 04 15.3	11 15.7	+16 42	22.7	Added Apr. 15.81 UT		3	0.02	13.1	0.789
P11fmCi	100	2021 04 15.3	11 34.4	+11 35	22.7	Added Apr. 15.80 UT		3	0.04	19.5	0.784

Use the JIRA Helpdesk to submit requests



- **New NEOCP page**
- Producing and publishing **orbits** and **residuals** using **OrbFit**