

# T3 project: searching for comets in the asteroidal population

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**Luca Buzzi**

**“G.V.Schiaparelli” Astronomical Observatory – Italy**

**MPC 204**

## T3 project: the beginning

T3 project was born at the end of 2005 thanks to various contacts and collaborations mainly between Sergio Foglia and Gianluca Masi. It was officially presented during MACE 2006 in Vienna.



In 2007, a paper regarding this project appeared in the Minor Planet Bulletin no.34, edited by Richard Binzel and in "The Comet's Tale" (Newsletter of the Comet Section of the BAA) edited by Jonathan Shanklin.

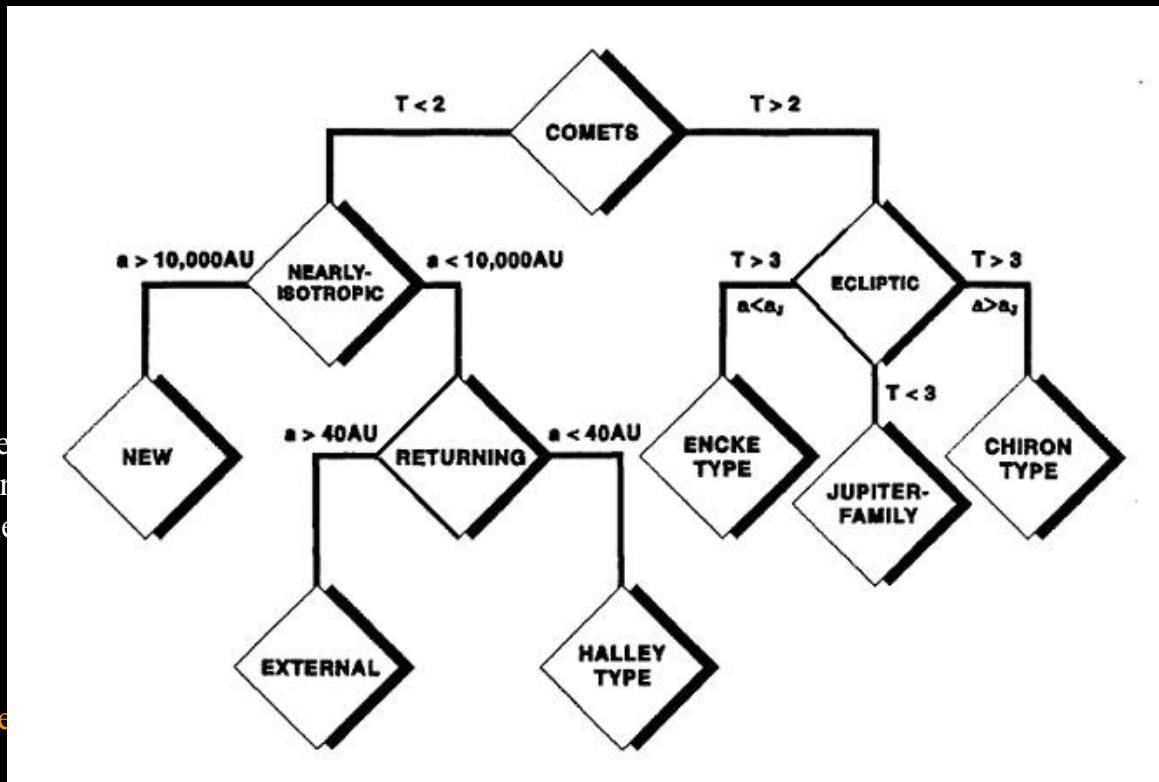
# T3 project: uses of the Tisserand parameter

Tisserand parameter was invented by Francois-Felix Tisserand in the second half of the 18th century when he was studying the 3-bodies problem. It is a dynamical value used to determine the encounter properties between a minor body (comet or asteroid) and a planet (Jupiter for example). When the orbit of an asteroid is altered due to the close encounter with a planet, Tisserand parameter is conserved during both the pre- and post-encounter.

Tisserand parameter's formula is the following:

$$\frac{1}{2a_1} + \sqrt{a_1(1 - e_1^2)} \cos i_1 = \frac{1}{2a_2} + \sqrt{a_2(1 - e_2^2)} \cos i_2$$

Tisserand criterion



In our specific case  
This has been done  
Astronomical Soci

system.  
of the Solar System,

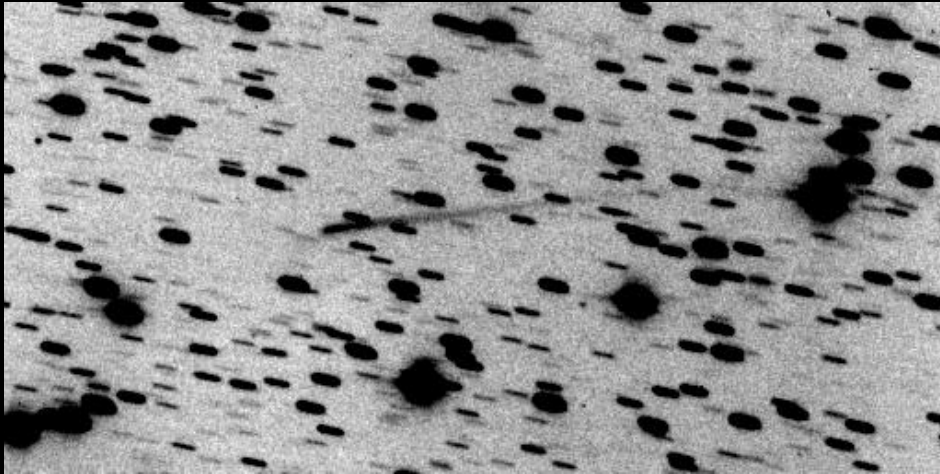
“The critical value  
Y. Fernandez, D. Je

is a simple criterion.“

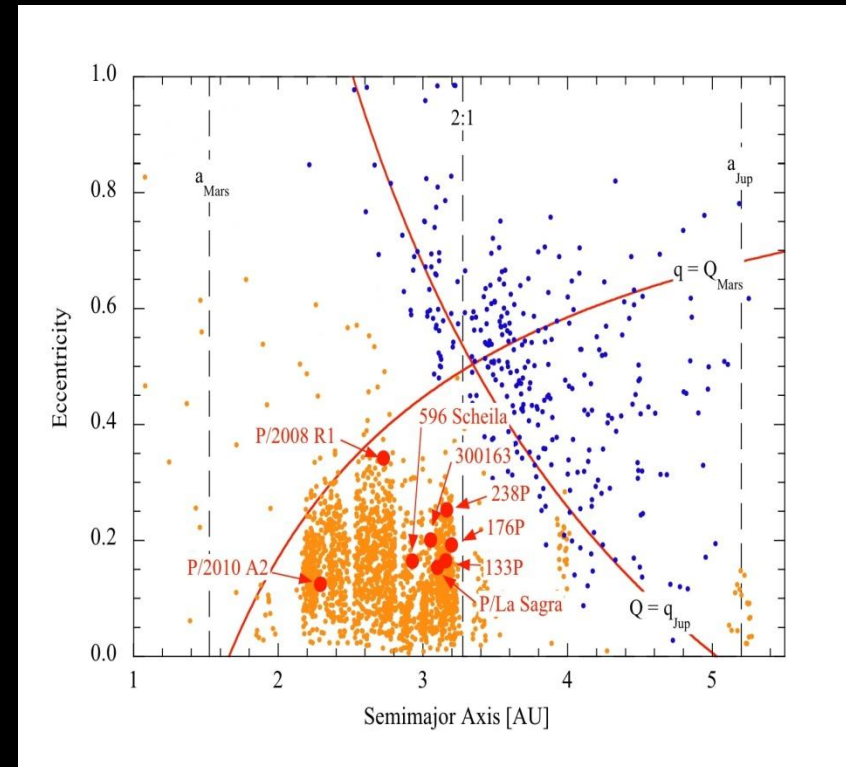
# T3 project: Main-Belt Comets

A particular case is the Main-Belt Comets: they have orbits well inside the main belt and a Tisserand parameter  $> 3$ , low eccentricity and inclinations and so are dynamically indistinguishable from a normal asteroid.

133P/Elst-Pizarro	$T_j = 3.18$
176P/(118401) LINEAR	$T_j = 3.17$
238P/Read	$T_j = 3.15$
P/2008 R1 (Garradd)	$T_j = 3.22$
P/2010 A2 (LINEAR)*	$T_j = 3.58$
P/2010 R2 (La Sagra)	$T_j = 3.10$
(596) Scheila	$T_j = 3.21$
(300163) 2006 VW139	$T_j = 3.20$



P/2010 A2 (LINEAR) – 16/01/2010 – 20 min. – 0.60-m (MPC 204)



# T3 project: list of targets

Thanks to Sergio Foglia, we developed a special software which, starting from MPCORB, creates our targets list, with some constraints like:

$T_j < 3$  (2.95)

NO numberd objects

MOID<sub>j</sub> < 1 AU (no if  $T_j < 2.6$ ) \*

Magnitude ≤ 20

Elongation > 30°

perihelion Tisserand oppositions      Orbital fraction respect to perihelion      alert if (r/q) < 2

DESIGNATION ORDER:

Minor Planet no	Planet name	Design code	flag	NEO Prob	Tper year	mo	day	T <sub>j</sub>	Opp	a	e	i	R.A.2000 hh mm.mm	Decl.2000 dd pp.p	Delta A.U.	r A.U.	Mag V	Elong °	(t-T)/P	r/q	k	JMoid	
2000	AU242	K00A02U	1000	0.00	2011	1	12	2.74	6	4.814	0.488	9.5	5 54.06	+12 2.4	2.747	3.439	19.4	127.6E	-0.192	1.40	!	0.360	
2000	EJ37	K00E37J	0006	0.00	2011	3	8	2.44	2	4.685	0.703	10.2	11 53.04	- 2 27.1	3.162	3.973	19.7	140.5W	-0.230	2.86	!	0.580	
2000	YH138	K00YD8H	1000	0.00	2008	8	6	2.92	5	3.960	0.342	11.5	11 13.43	+11 38.6	3.012	3.926	19.8	154.5W	0.381	1.51	!	0.959	
2002	EV71	K02E71V	0000	0.00	2010	4	18	2.91	4	4.276	0.313	11.0	6 39.64	+36 34.4	2.166	2.961	19.4	136.5E	-0.044	1.01	!	0.037	
2002	FA9	K02F09A	2000	0.00	2010	3	22	2.95	1	4.005	0.314	8.9	11 56.30	- 7 44.8	1.953	2.759	18.8	137.2W	-0.029	1.00	!	0.044	
2003	BU35	K03B35U	0000	0.00	2010	3	24	2.77	2	3.742	0.537	14.9	4 7.49	+16 53.3	1.279	1.783	19.6	103.1E	-0.032	1.03	!	0.195	
2006	KD1	K06K01D	0003	0.00	2010	2	24	2.83	2	2.482	0.785	30.7	0 7.41	-26 29.6	0.698	0.619	18.9	38.5E	-0.017	1.16	!	0.968	
2006	KZ112	K06RB2Z	0003	0.00	2010	4	4	2.57	2	2.524	0.887	37.8	0 15.73	-18 7.8	1.831	1.246	19.8	39.9E	-0.059	4.38	!	0.253	
2008	UD253	K08UP3D	0000	0.00	2008	12	14	2.72	4	4.736	0.485	13.7	8 35.67	+37 25.1	2.874	3.788	20.0	154.4E	0.244	1.55	!	0.867	
2008	YB3	K08Y03B	000A	0.00	2011	3	1	-0.25	2	11.652	0.443	105.1	7 42.04	-41 10.4	6.181	6.711	18.0	118.7E	-0.091	1.04	!	1.510	
2009	UV18	K09U18V	0004	2	0.00	2010	1	18	2.84	2	3.177	0.633	8.3	15 13.95	- 1 16.3	0.622	1.198	17.2	93.5W	0.018	1.03	!	0.601
2009	W06	K09W06O	0004	0.00	2010	2	22	2.78	1	3.089	0.560	28.7	2 27.94	+27 21.7	0.972	1.306	19.6	83.7E	-0.012	1.01	!	0.870	
2010	AB76	K10A76B	0000	0.00	2009	11	30	2.87	1	3.137	0.336	34.4	9 29.03	+29 44.4	1.172	2.140	18.5	165.1E	0.062	1.03	!	0.958	
2010	BC3	K10B03C	0004	0.00	2010	2	11	2.84	1	3.135	0.649	4.8	13 53.37	- 0 20.9	0.237	1.102	19.3	113.1W	-0.002	1.00	!	0.007	

There are over a thousand asteroids with  $T_j < 3$  (650 with  $T_j < 2.95$  and Jupiter MOID < 1 AU). Those observable with elongation and magnitude constraints listed above are around 30.

\* Currently there are no active comets with Jupiter MOID greater than 1 AU.

# T3 project: observing strategy

One of our first collaborations was with Raoul Behrend, University of Geneva, who maintains our internal mailing-list, where all the participant receive usually twice a month our targets list.

When an observer chooses a candidate, he can observe it like any other asteroid, but he must keep in mind a couple of things:

- 1) It is strongly suggested to use nights with good seeing for his/her location
- 2) Don't lack in exposure time: the more SNR the better!
- 3) Images must be normalised (dark-subtraction & flat field calibration) and stacked on the motion of the asteroid

And the work is done! (almost...)

## T3 project: the FWHM technique

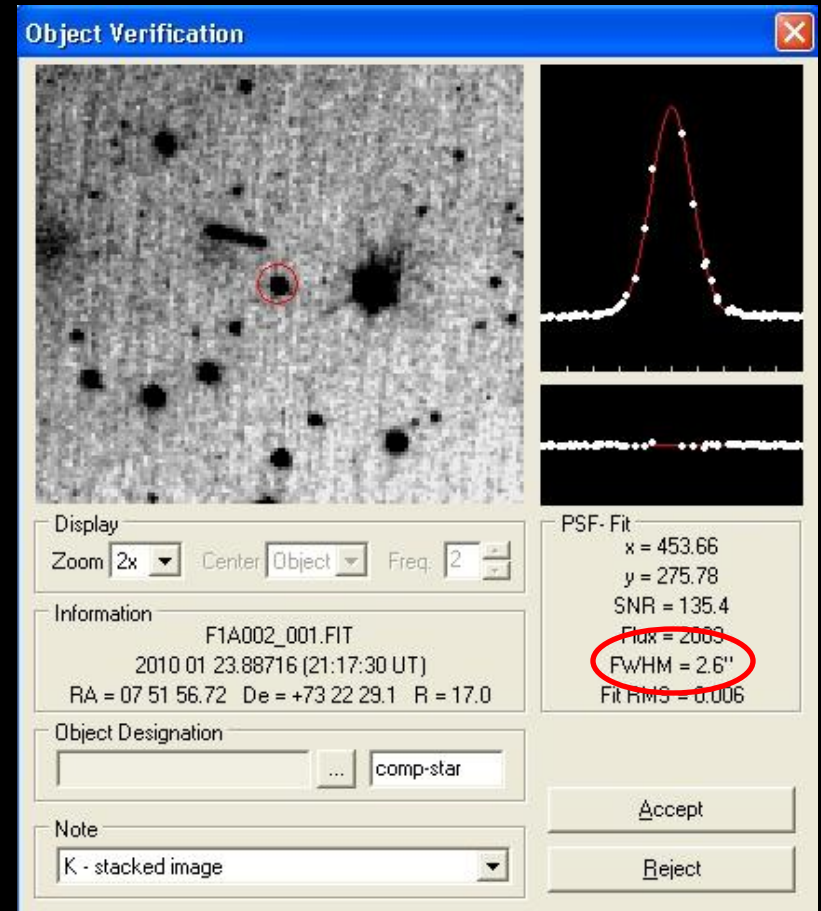
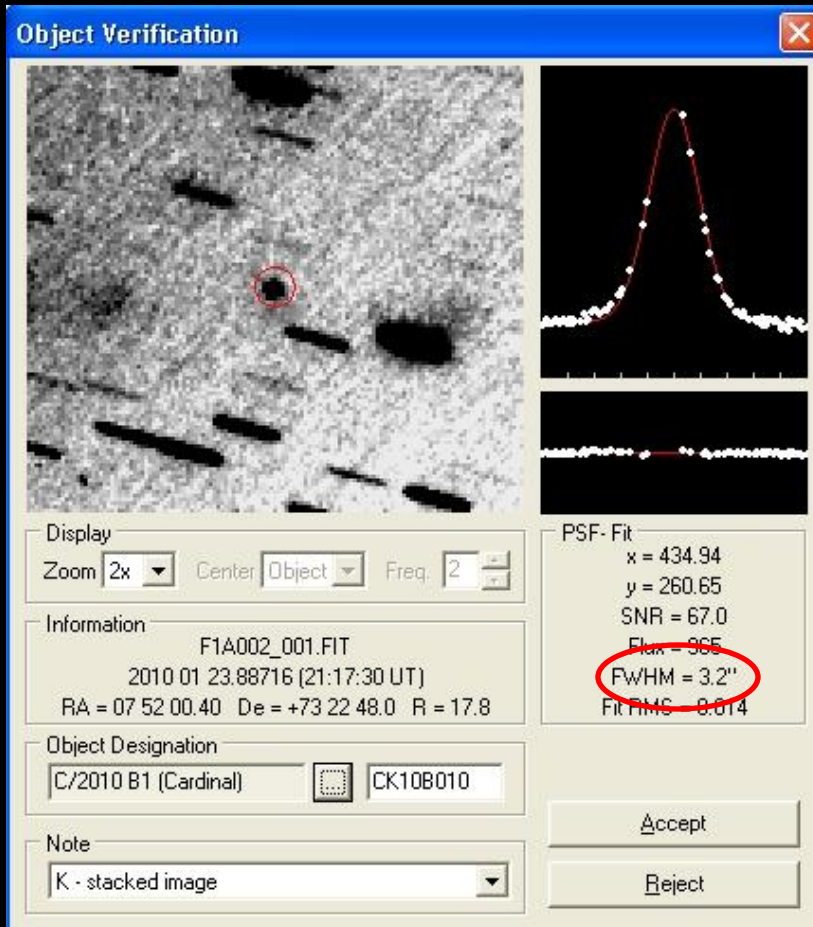
A quite clear example was comet C/2010 B1 (Cardinal), here imaged when it was still in the NEO Confirmation Page:



F1A002 - 23-01-2010 h. 21.30 UT - 50x30sec - 0.38-m f/6.8 + ST8XME

# T3 project: the FWHM technique

More in detail:

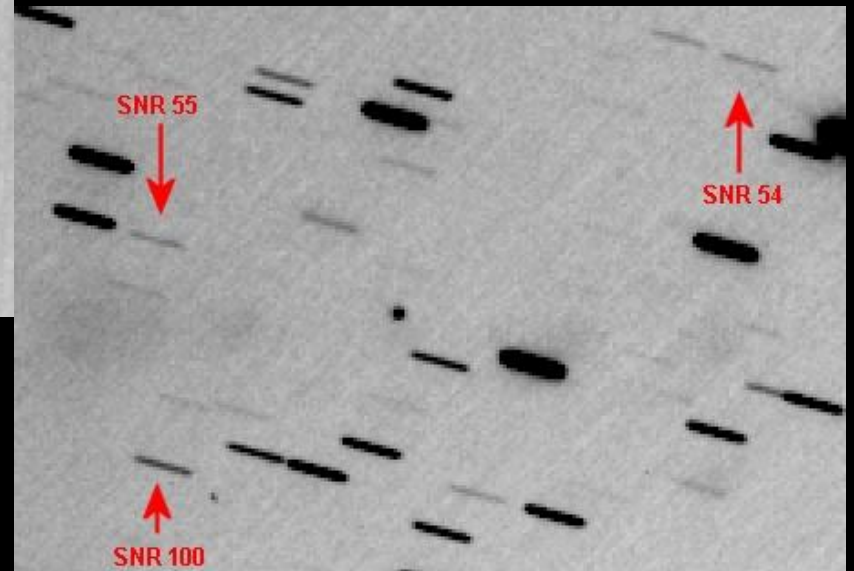
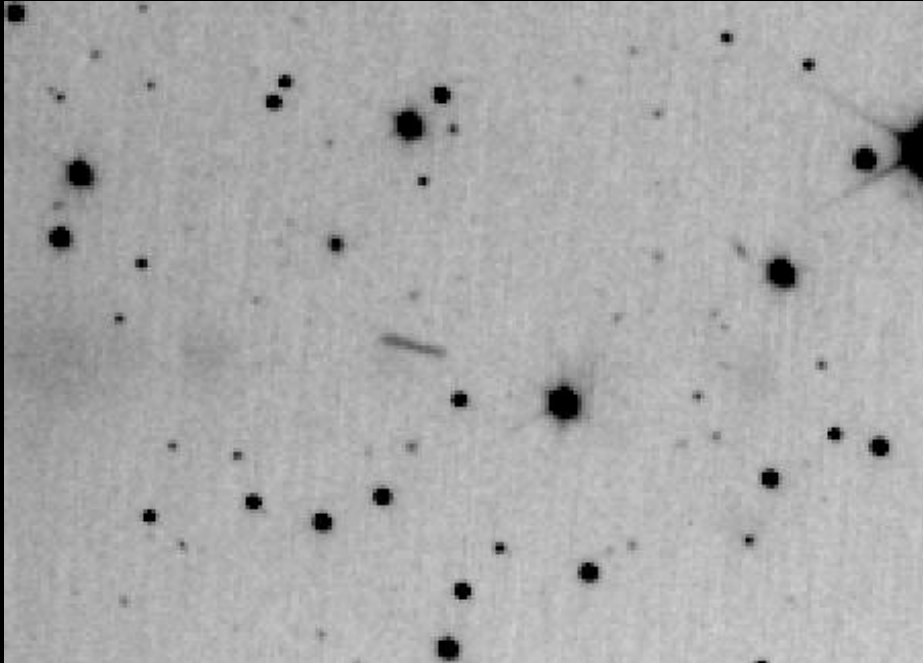


F1A002 - 23-01-2010 h. 21.30 UT - 50x30sec - 0.38-m f/6.8 + ST8XME



# T3 project: the FWHM technique

More in detail:



F1A002 - 23-01-2010 h. 21.30 UT - 50x30sec - 0.38-m f/6.8 + ST8XME

# T3 project: latest results

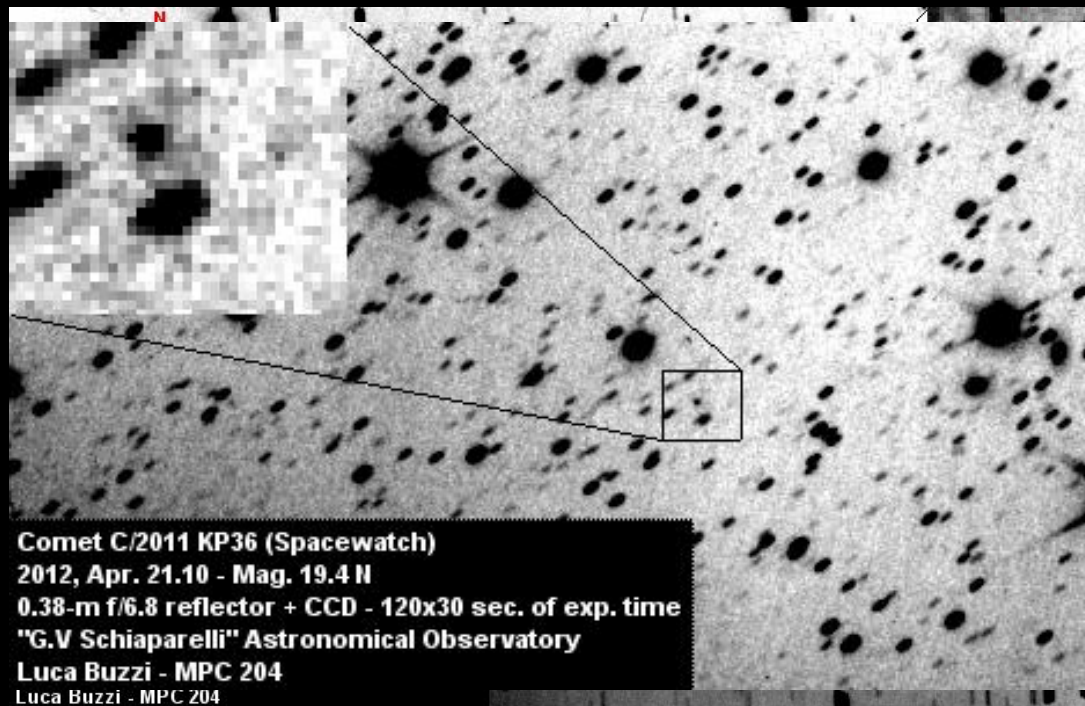
Sine the end of 2005 our project had many successes, following are the most recent ones:

P/2010 UH55 (Spacewatch) - CBET 2923 - 2011, Nov. 30

C/2011 UF305 (LINEAR) - CBET 2960 - 2011, Dec. 29

P/2011 FR143 (Lemmon) - CBET 3082 - 2012, Apr. 13

C/2011 KP36 (Spacewatch) - CBET 3109 - 2012, May 17



# T3 project: collaborations

Results are possible only with collaborations, so in years we created an international network of astronomical observatories:



I-net Telescopes  
(H. Sato)



H21 - ARO  
(R. Holmes)

# T3 project: the FWHM technique

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Faulkes Telescopes

(P.Roche, R.Miles, P.Miller et al.)

TRAPPIST – La Silla

(E. Jehin et al.)



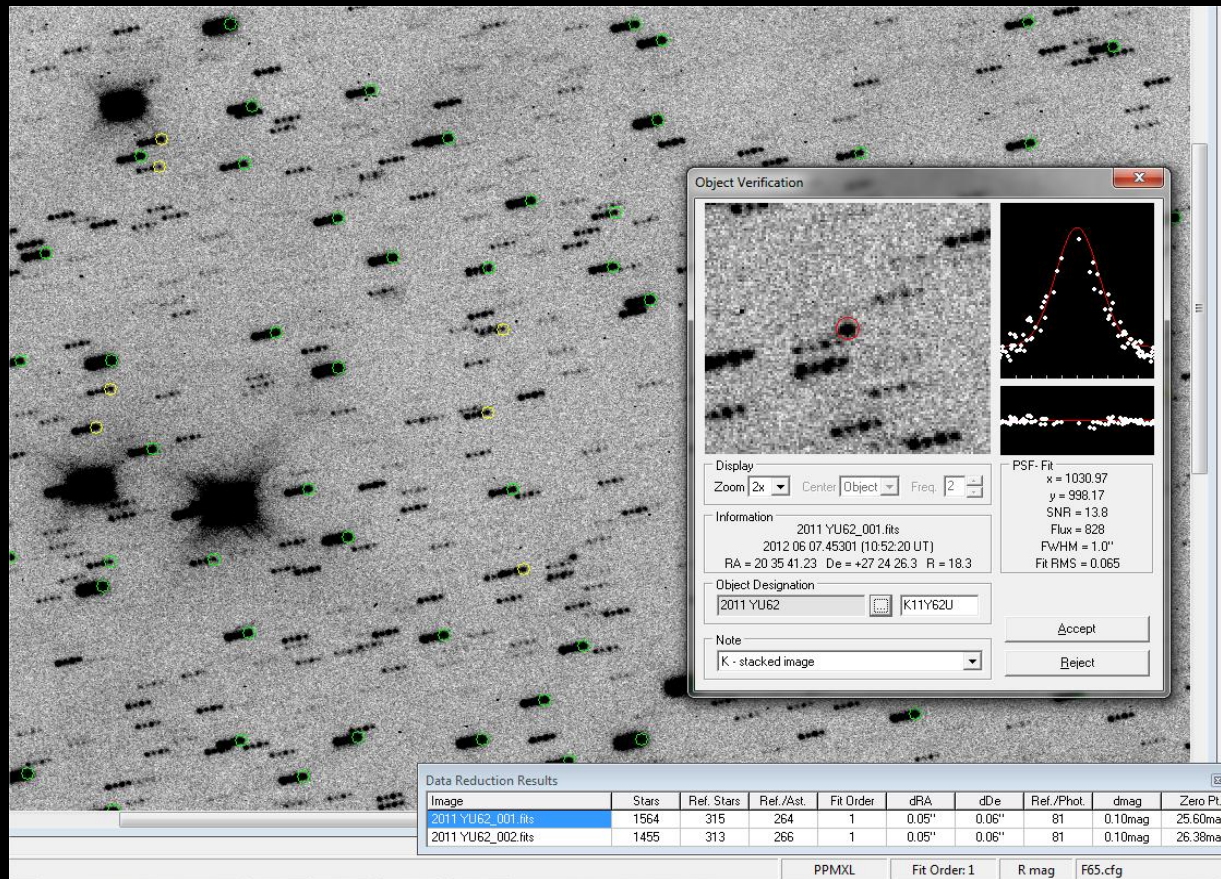
Kitt Peak

(T.Vorobjov)



# T3 project: using Faulkes telescopes

We are also developing a special method for Faulkes observations, because FWHM method is not so efficient with such an overestimated scale...



2011 YU62 – 2012, Jun. 07 – 60sec – FTN – 0.3"/pixel

# T3 project: searching for comets in the asteroidal population

*Ehi! Where are you?*



T3 project is open to all!

If you're interested, please contact me or Sergio Foglia:

[lucabuzzi.204@gmail.com](mailto:lucabuzzi.204@gmail.com)

[s.foglia@libero.it](mailto:s.foglia@libero.it)