Classical Novae as supersoft X–ray sources in the Andromeda galaxy (M 31)

Martin Henze

for the M 31 nova monitoring collaboration

The monitoring collaboration

The Team (past and present)

Wolfgang Pietsch (PI; MPE), Vadim Burwitz, Frank Haberl, Martin Henze, Michael Freyberg, Jochen Greiner, Arne Rau (all MPE), Ralf Bender, Jürgen Fliri, Arno Riffeser, Stella Seitz (University observatory Munich / MPE), Massimo Della Valle (Osservatorio Astrofisico di Arcetri, Italy), Margarita Hernanz (IEEC, Spain), Dieter Hartmann (Clemson University, USA), Despina Hatzidimitriou, Pablo Reig (both University of Creete, Greece), Gloria Sala (UPC, Spain), Marina Orio (Osservatorio Astronomico di Torino, Italy & University of Wisconsin, USA)

The Goals

Discover and characterise supersoft X-ray counterparts of novae in M 31

Population study of X-ray properties of nova in M 31

Nova outburst: thermonuclear runaway

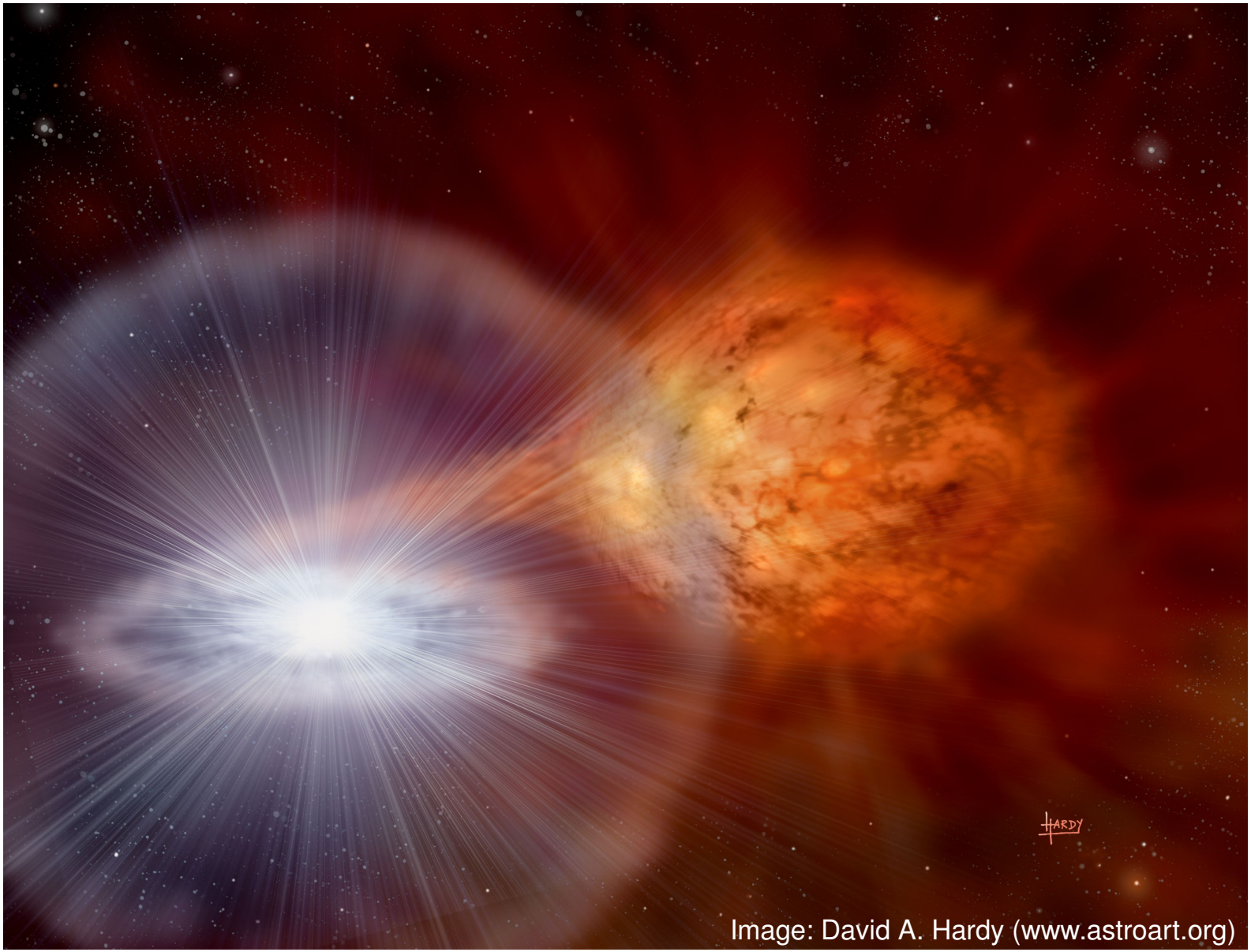
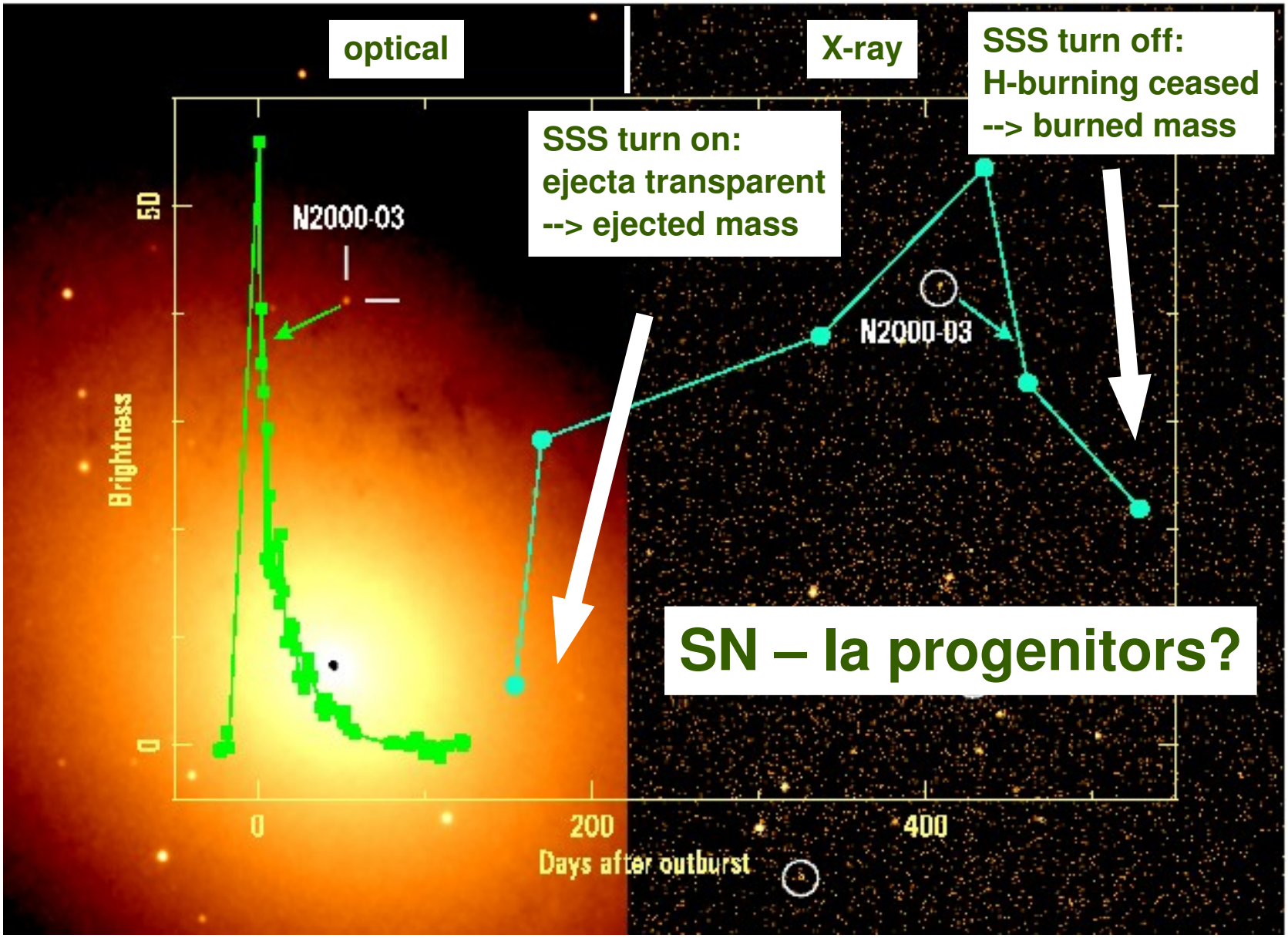


Image: David A. Hardy (www.astroart.org)

Novae as supersoft X-ray sources (SSSs)



Why M 31?

Credits: TLS Tautenburg; Image size: 1.7° x 2.0°

Nearest big spiral galaxy

- large stellar mass

→ high nova rate

(~65 y^{-1}, ~60% in the bulge; Darnley et al. 2006)

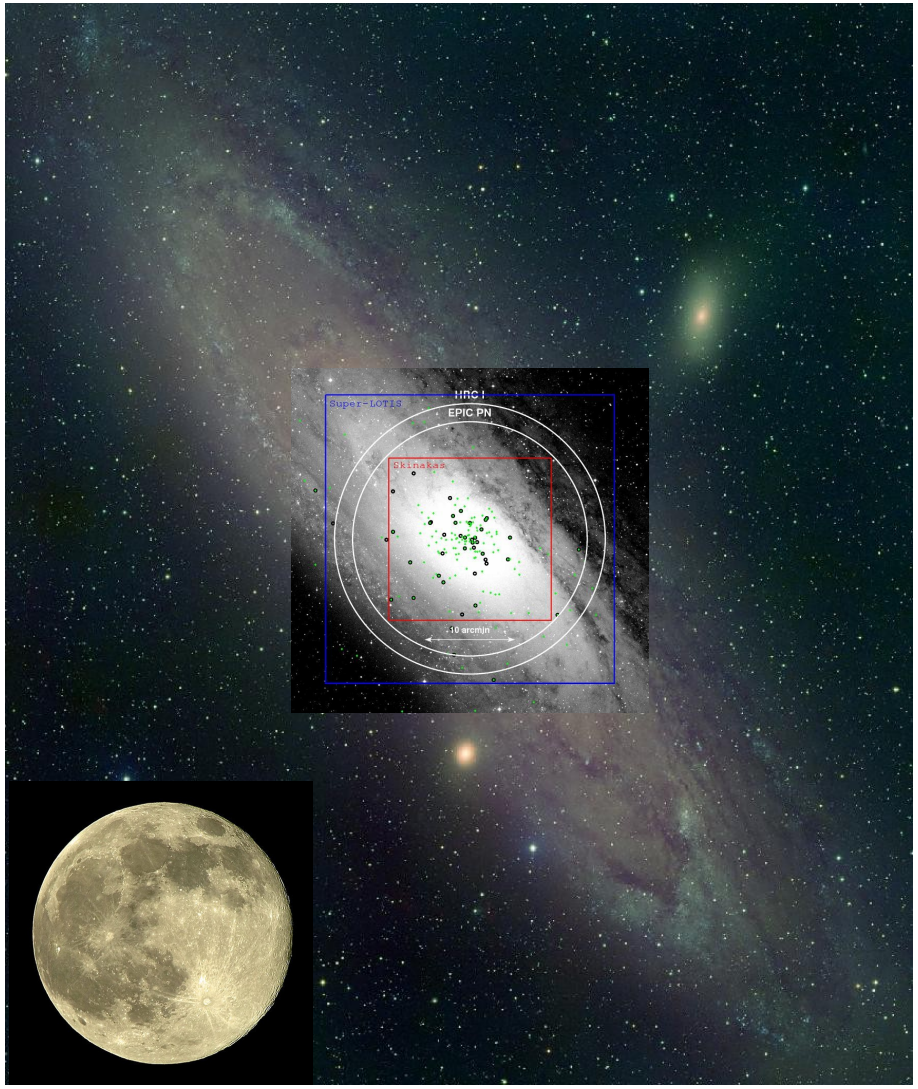
- distance 780 kpc

→ Novae can be found with small optical telescopes

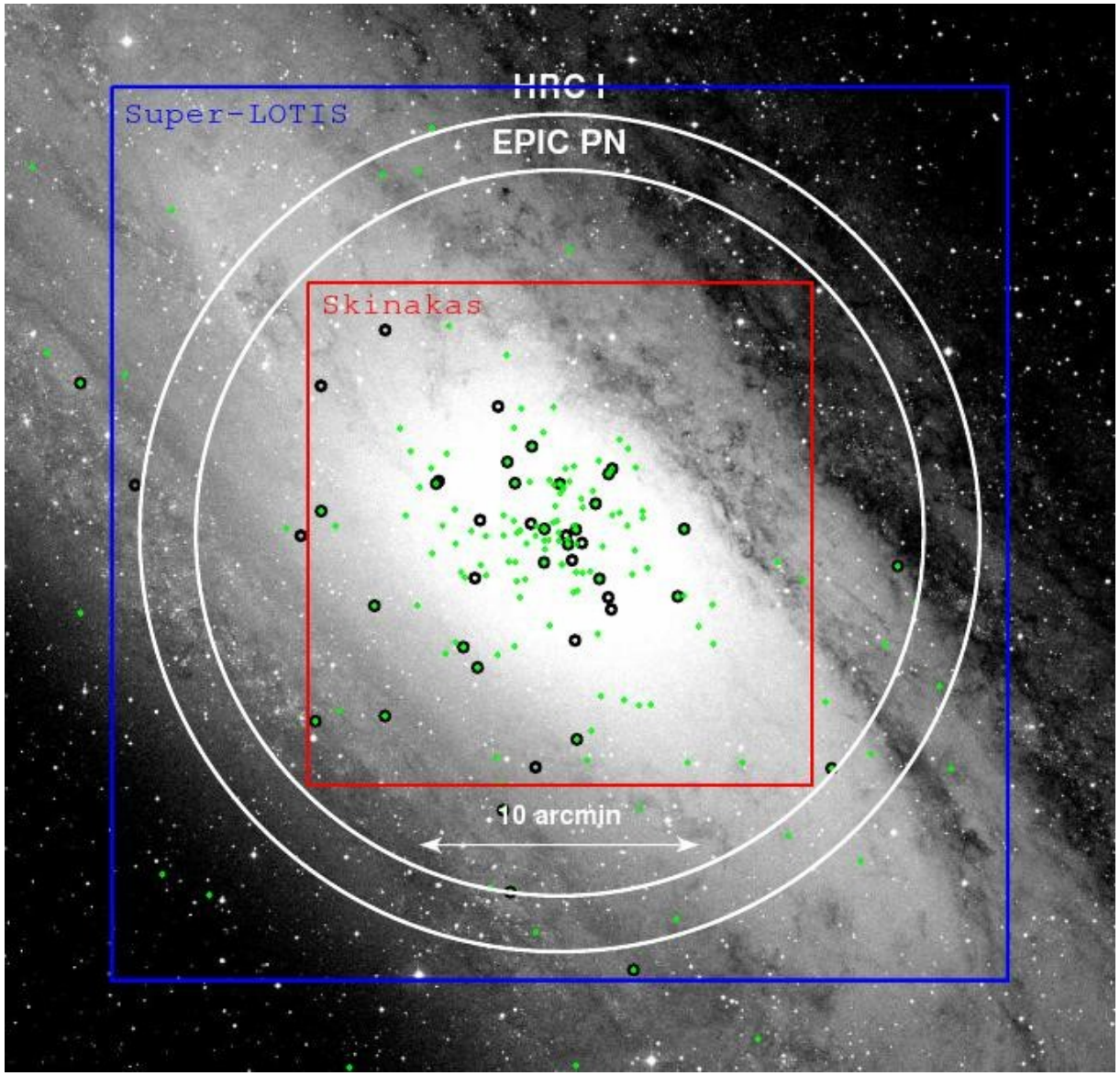
(apertures 14“ - 60“)

More than **100** nova candidates found over the last **five** years

Why M 31?



Why M 31?



Green:
optical novae
Black:
with SSS
counterpart

Why M 31?

	M 31 novae	vs	Galactic novae
Quantity	~ 850	# novae known	~ 400
	~ 22 y^{-1}	observed rate (2000 – 2009)	~ 7 y^{-1}
Quality	Many novae in one field of view Low Galactic foreground Effectively the same distance for all novae		High resolution spectra (XMM-Newton, *Chandra*) Detailed light curves (*Swift*) Have to be observed separately
Objective	Study nova population		Study individual novae

X–ray monitoring: strategy

First dedicated monitoring campaigns for SSS states of classical novae in M 31 with XMM-Newton and Chandra

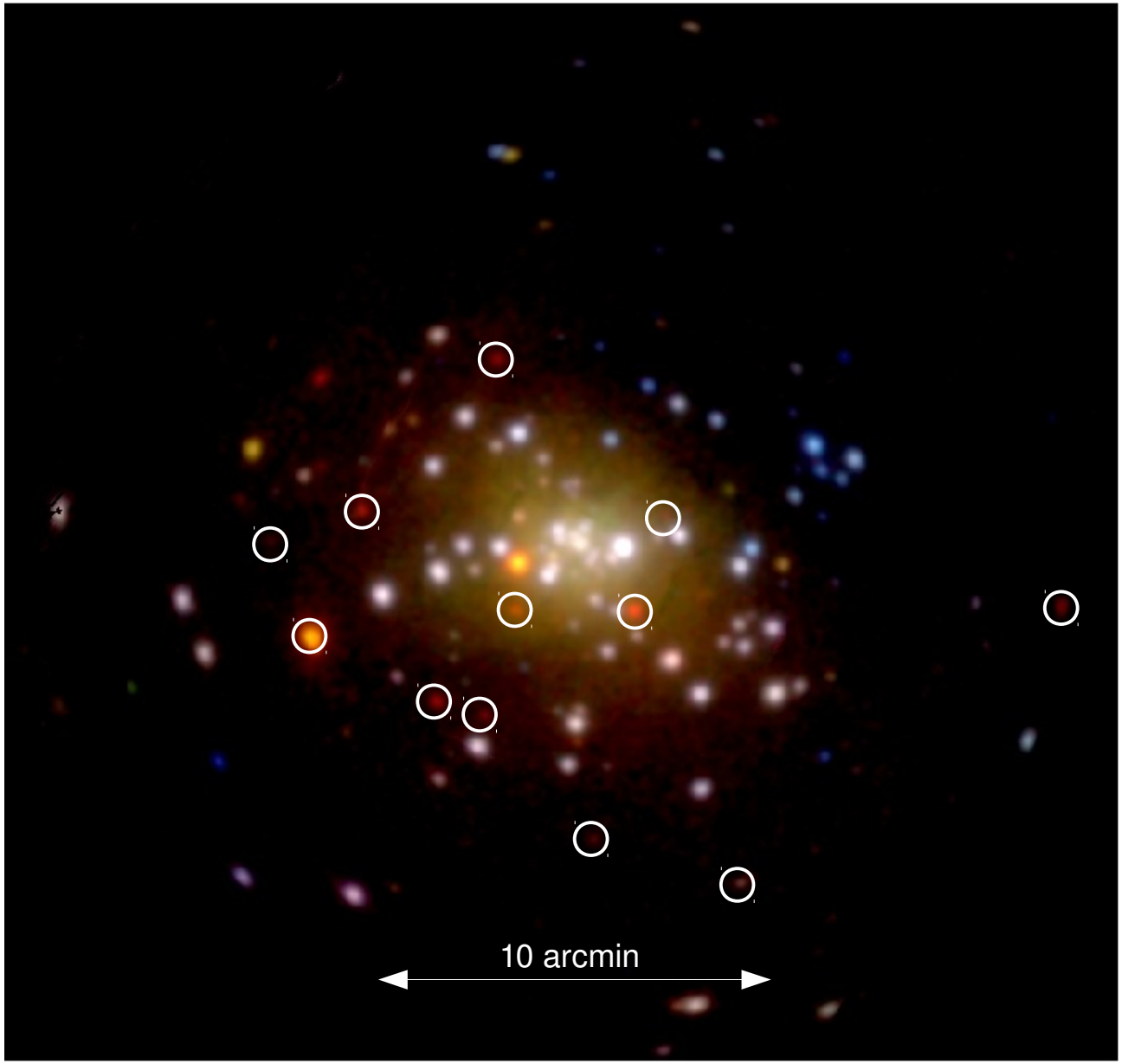
2006 – 2009: 3 campaigns (~ 160 hours exposure) with a dense sampling (every 30 and 10 days)

Supported by optical observations → 25 novae in 3 years (24 ATel's) → follow-up spectroscopy

X–ray monitoring: 3 years XMM

XMM-Newton
EPIC RGB
(0.2-0.5,0.5-1,
1-2 keV)
2006 – 2009
(300 ks)

White circles:
nova SSSs



X–ray monitoring – results

17 novae discovered as SSSs

Henze et al. 2010b; “X-ray monitoring of Novae in M31 – I“; A&A, 523, A89
Henze et al. 2011; “X-ray monitoring of Novae in M31 – II“; A&A sub.

➡ Individual remarkable SSSs

Henze et al. 2009b; “First 2 SSS in M31 globular clusters“; A&A, 500, 769
Henze et al. 2009a; “Very short SSS state of M31N 2007-11a“; A&A, 498, L13
Pietsch et al. 2011; “Nova M31N 2007-12b: SSS intermediate polar?”, A&A, acc.

➡ see Wolfgang Pietsch's talk at 18:30 today

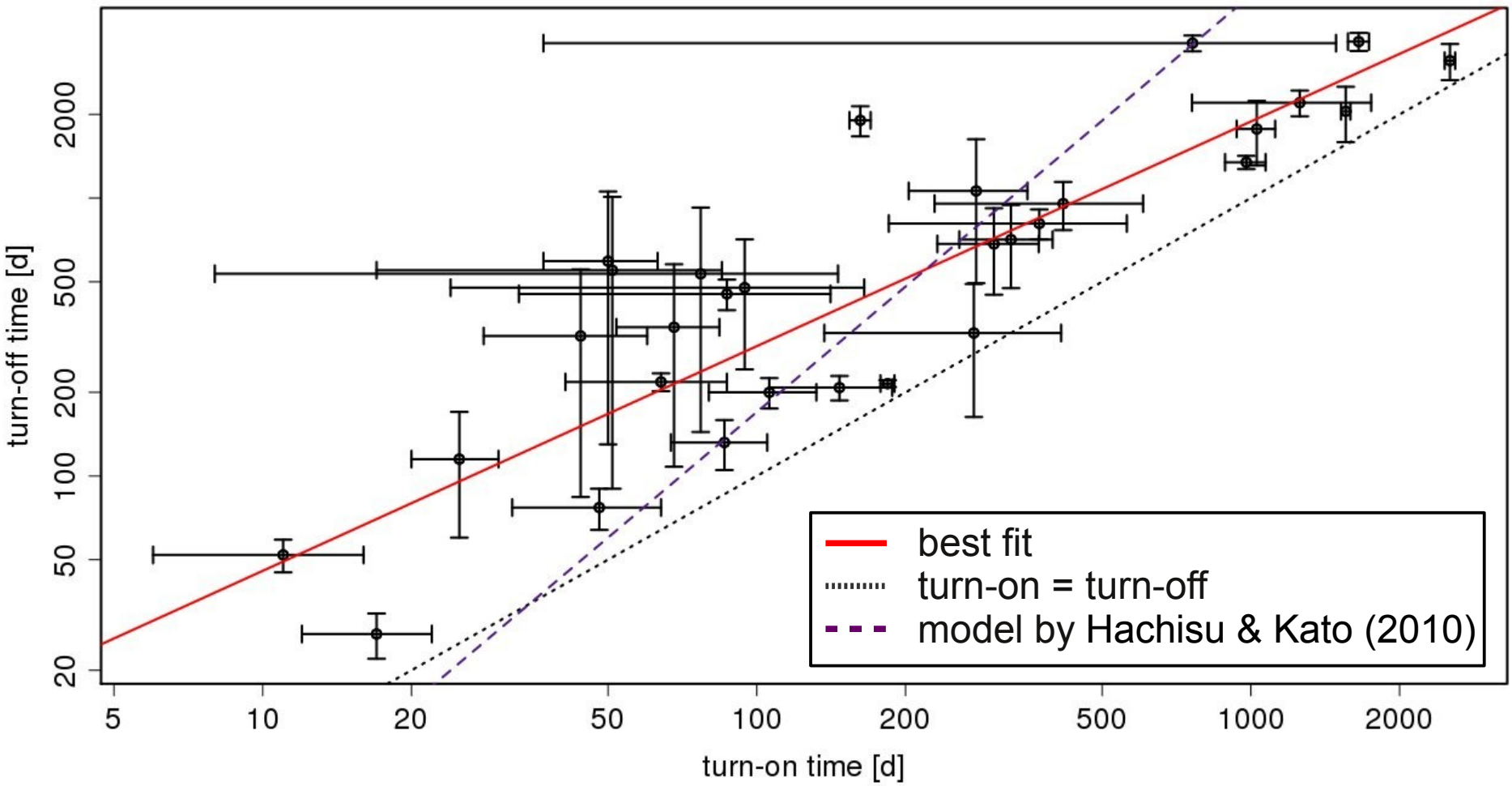
➡ in total *60 nova SSSs* (our Galaxy: ~ 20)

➡ strongly improved quality of total sample

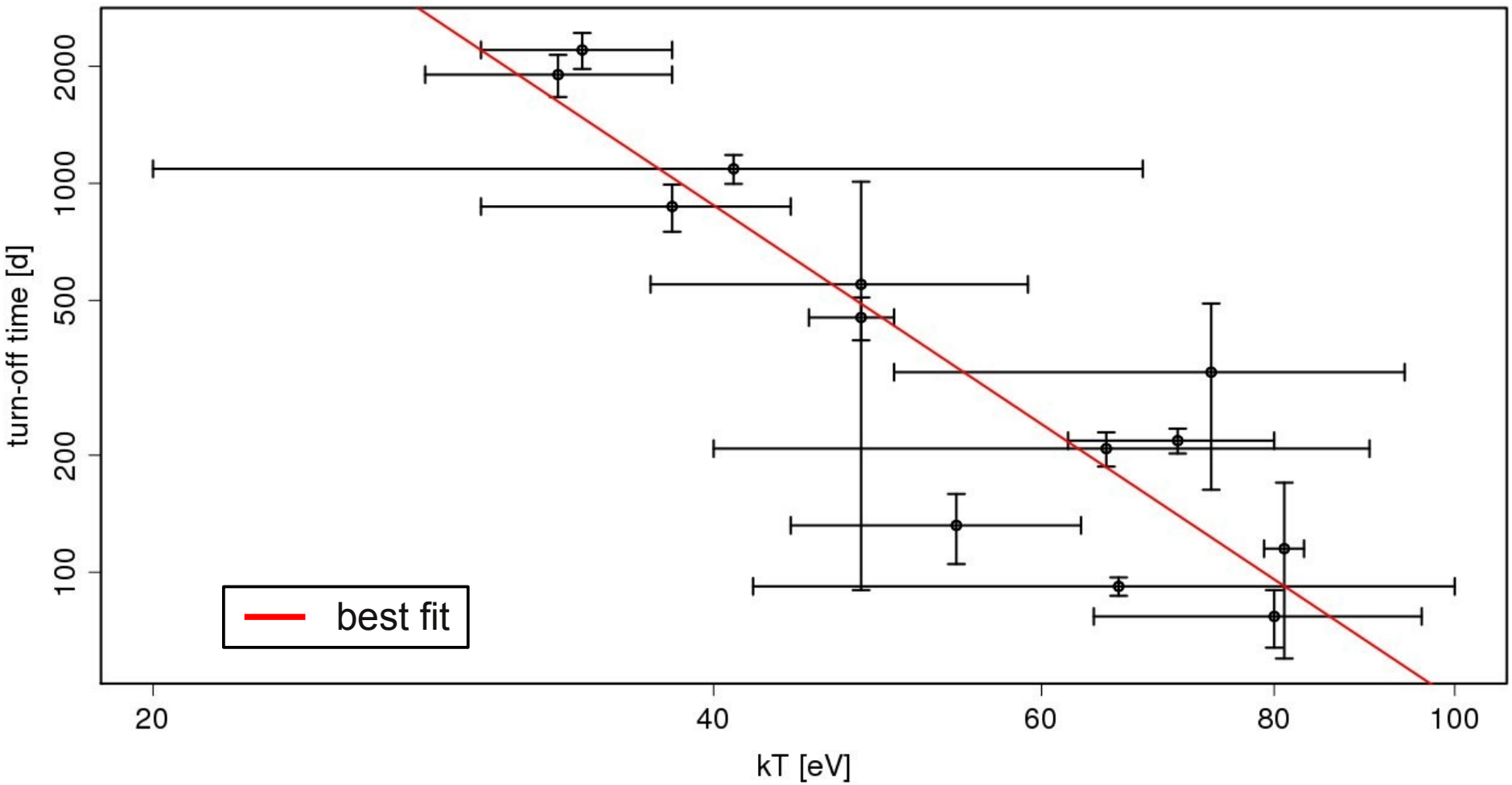
Source statistics and population study possible for 1st time

→ Henze et al. (2011)

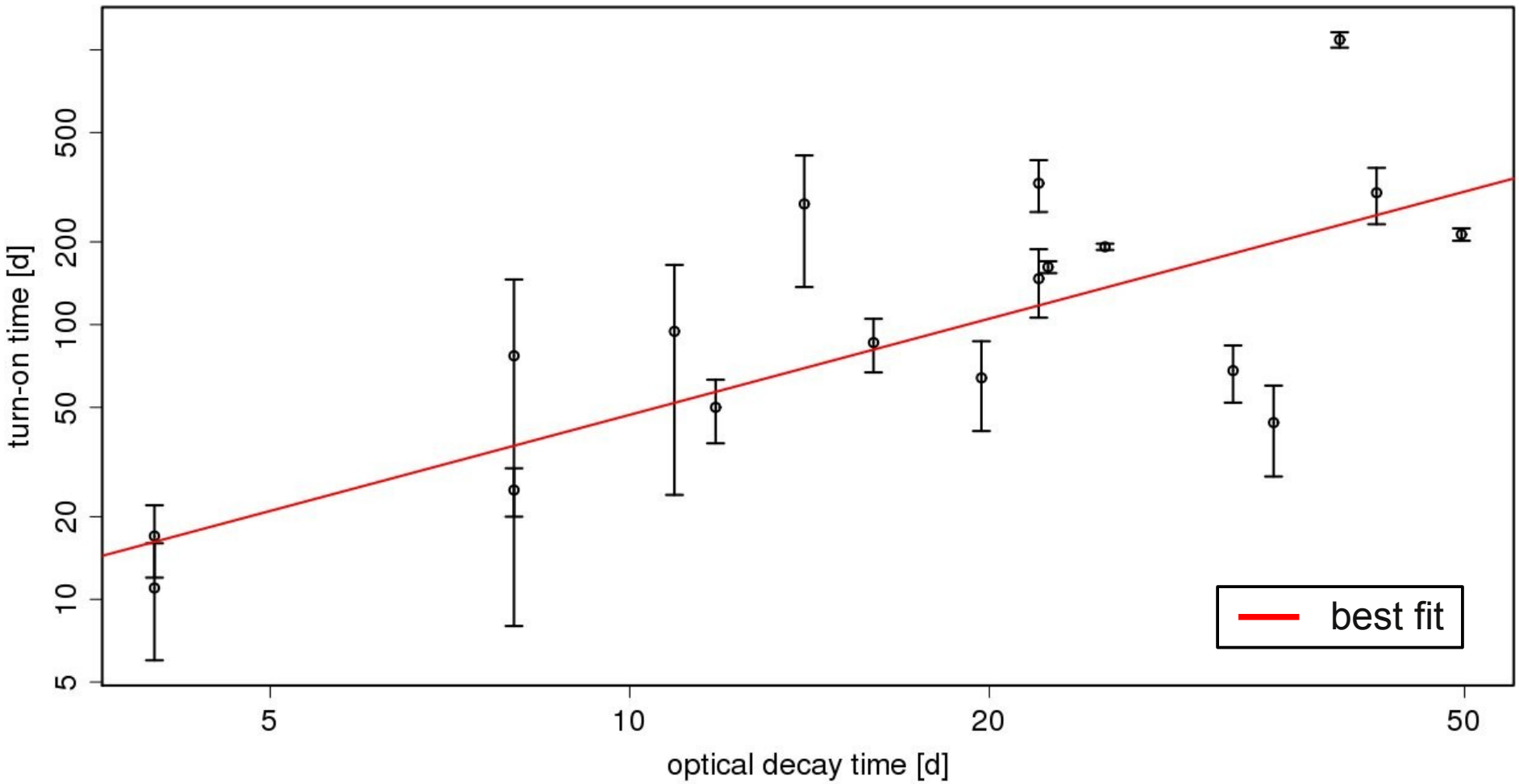
Statistical analysis: correlations – I



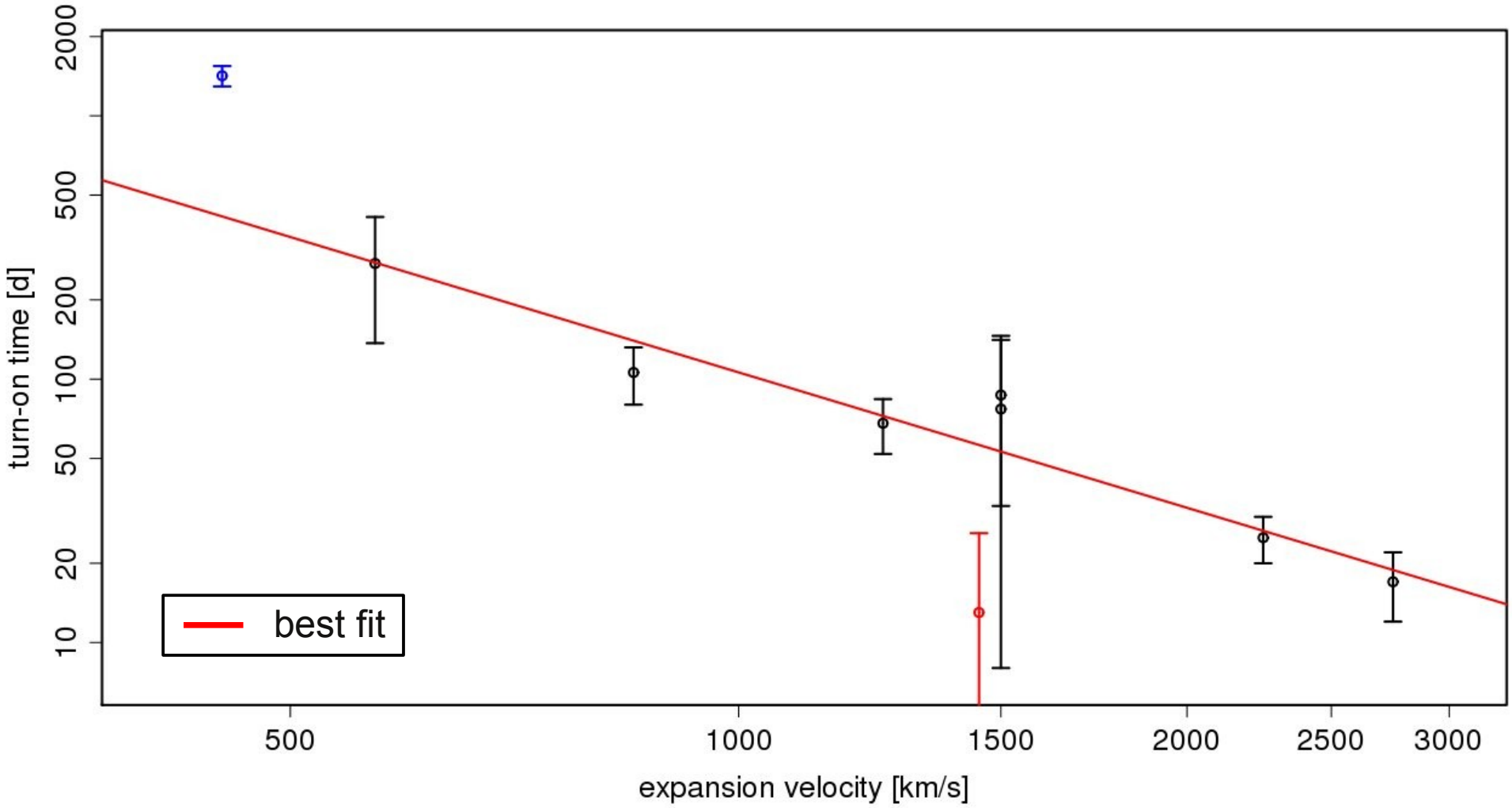
Statistical analysis: correlations – II



Statistical analysis: correlations – III



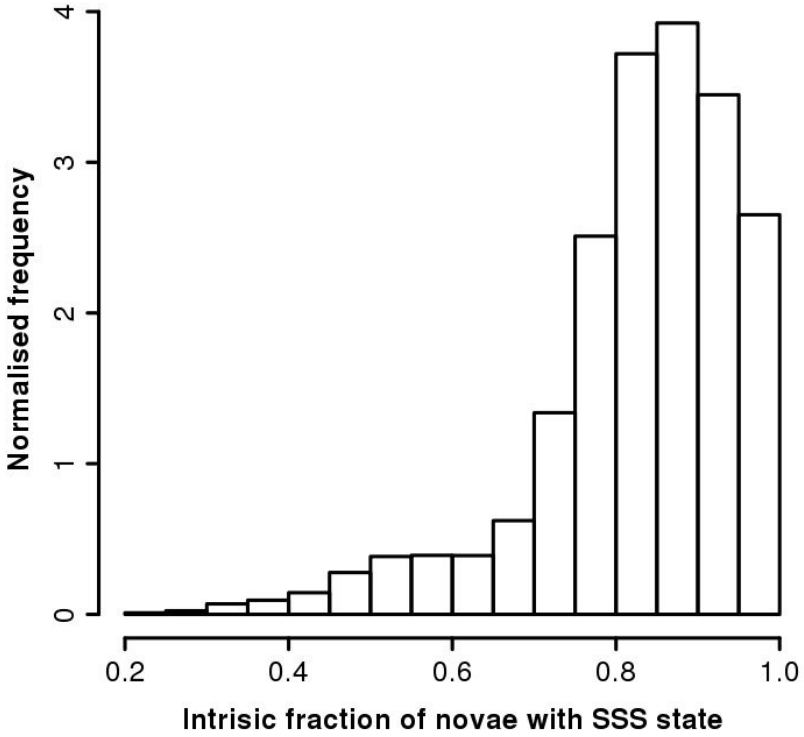
Statistical analysis: correlations – IV



Statistical analysis: Nova → SSS ?

Theory: Nova → SSS. But: only 20% of M 31 novae found as SSS → intrinsic effect or observational bias?

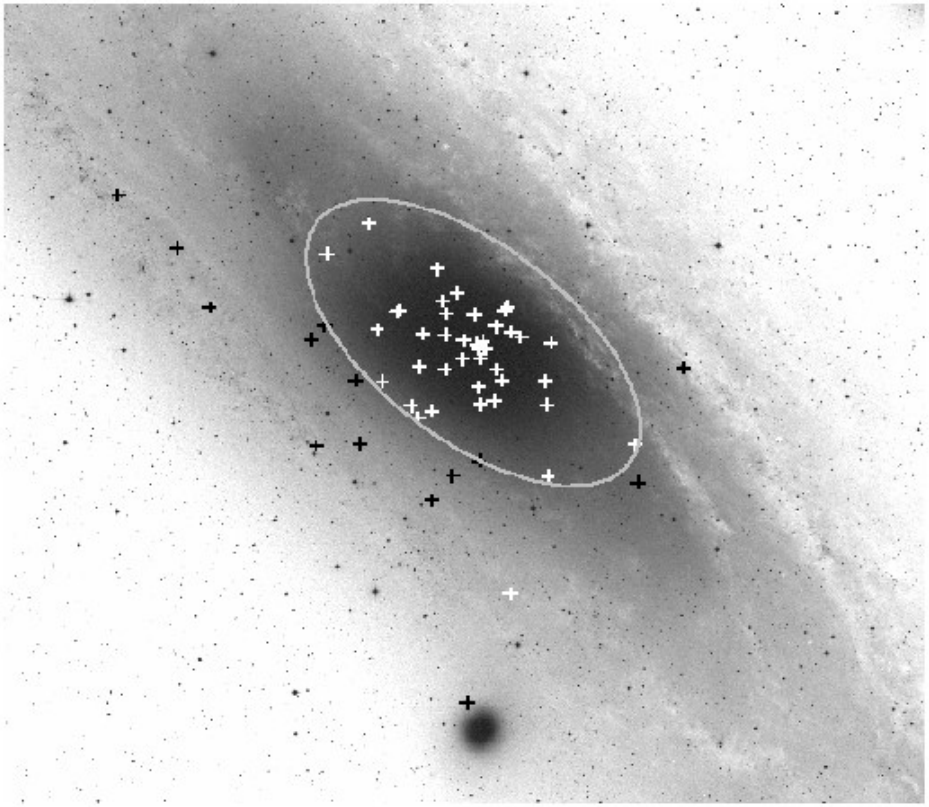
Simulation: compare theoretical modells (→ WD mass distribution → duration of SSS phase) with our observations

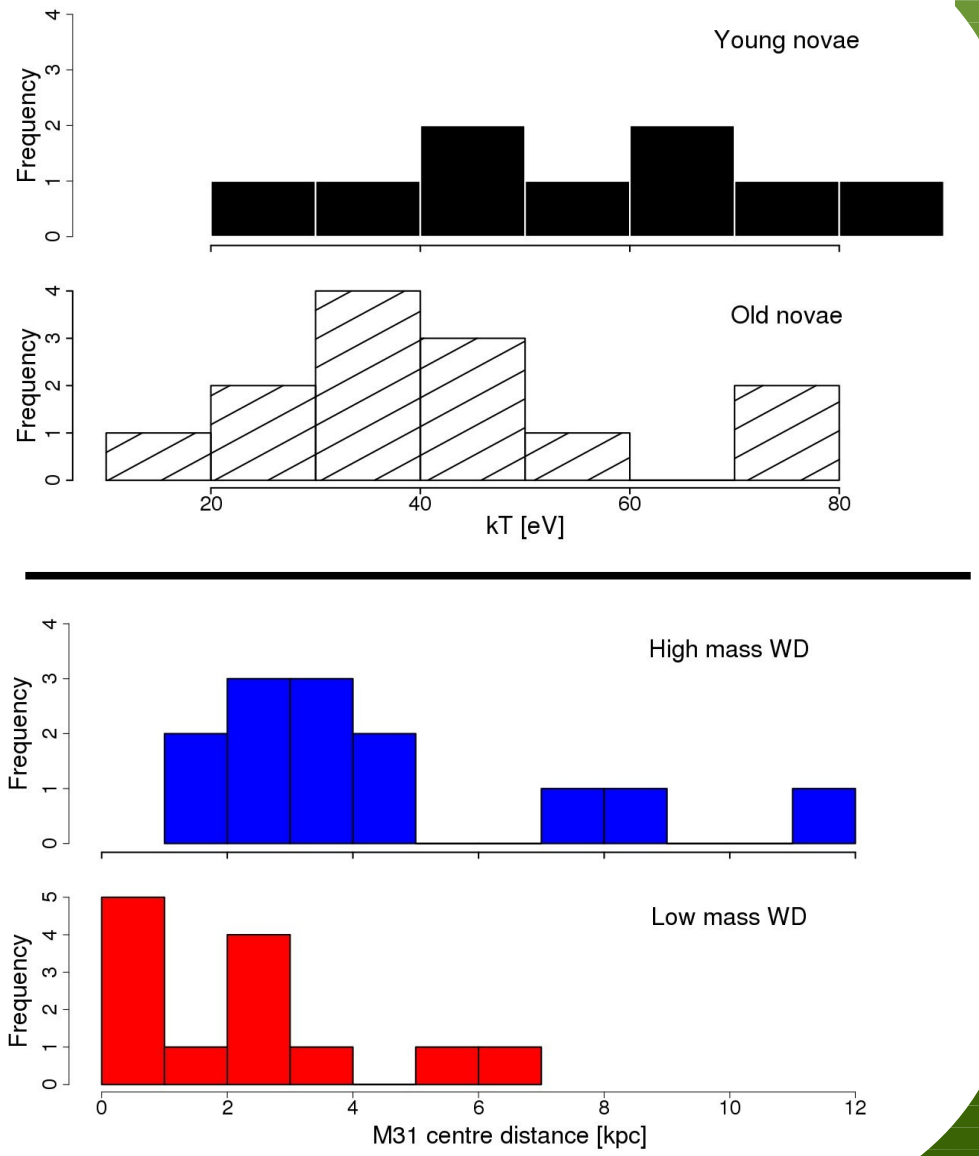


Simulate: Intrinsic fraction of novae in M 31 with SSS counterpart that leads to 20% detection rate

→ Observational bias possible

Statistical analysis: nova populations





Different X-ray properties of novae in M 31 bulge & disk

Summary & Outlook

Compilation and study of a homogeneous and relatively large sample of novae in X-rays - *only possible for M 31*

Discovered rare objects and fast SSS → strategy successful

First time statistical study of correlations of nova parameters, connection nova – SSS and nova populations in X-rays

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2 new campaigns: data analysed → several novae detected

Out soon: paper on 2009/10 and 2010/11 monitorings

At least 1 more campaign (2011/12): sample will grow further