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New constraints on the parameters of the neutron star in the SNR HESS J1731-347

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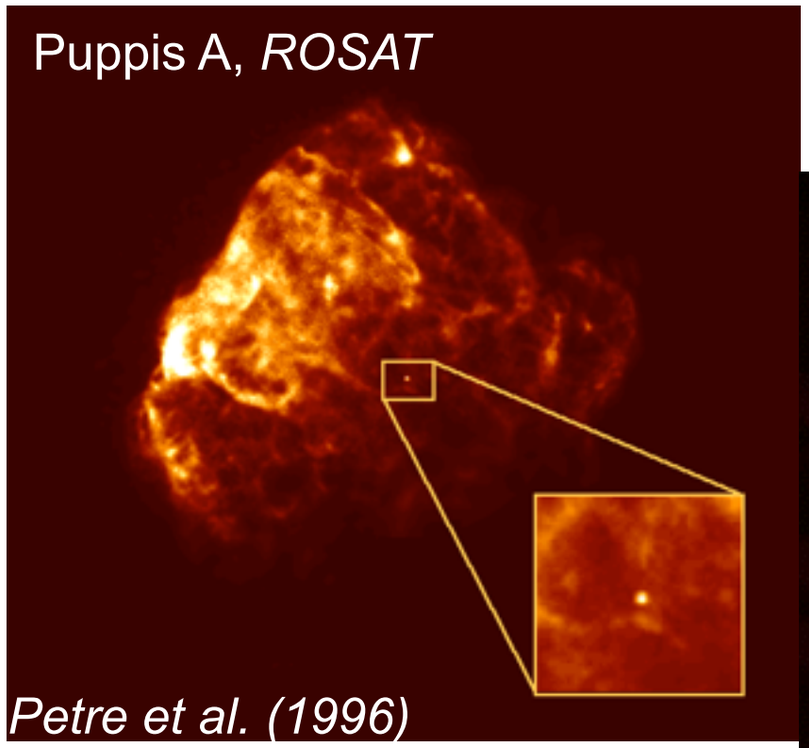
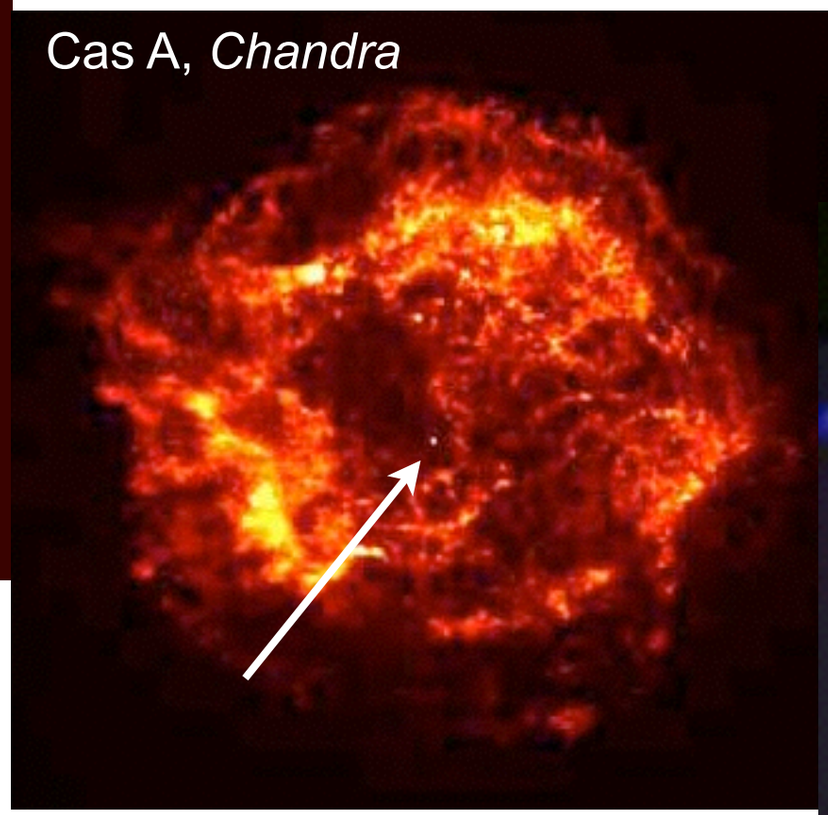
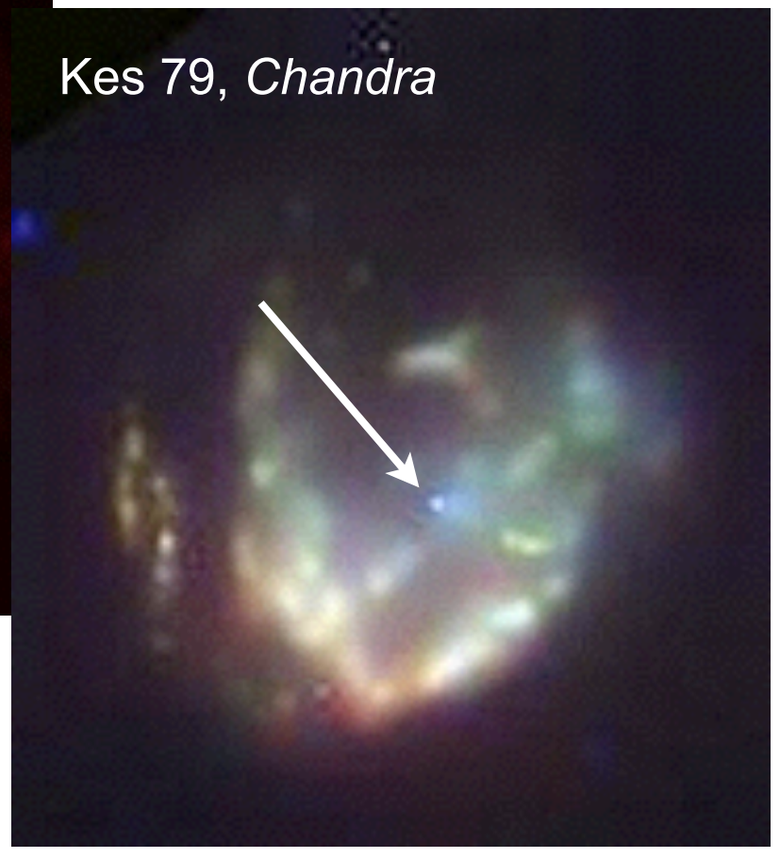
Central Compact Objects (CCO) - radio-quite, thermally emitting NS located close to geometrical centers of some SNRs







- ~11 objects are known
- kT ~ 0.2 - 0.5 keV
- 3 of 11 show pulsations
- **$B < 10^{10}..10^{11}$ G**

Physical motivation to study CCOs

1

NSs in SNRs

~11 radio pulsars
(Helfand 1998)

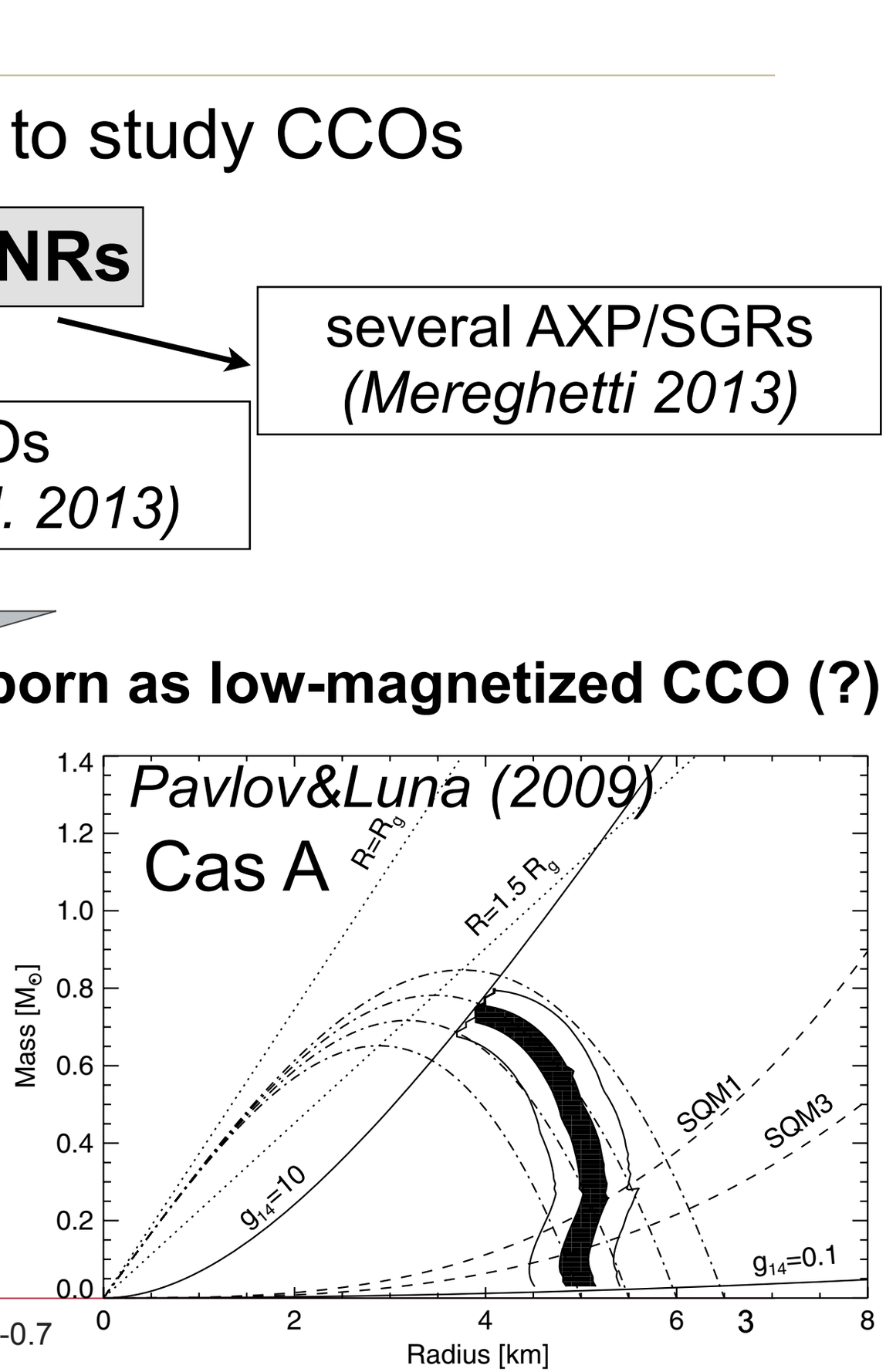
~11 CCOs
(Gotthelf et al. 2013)

several AXP/SGRs
(Mereghetti 2013)

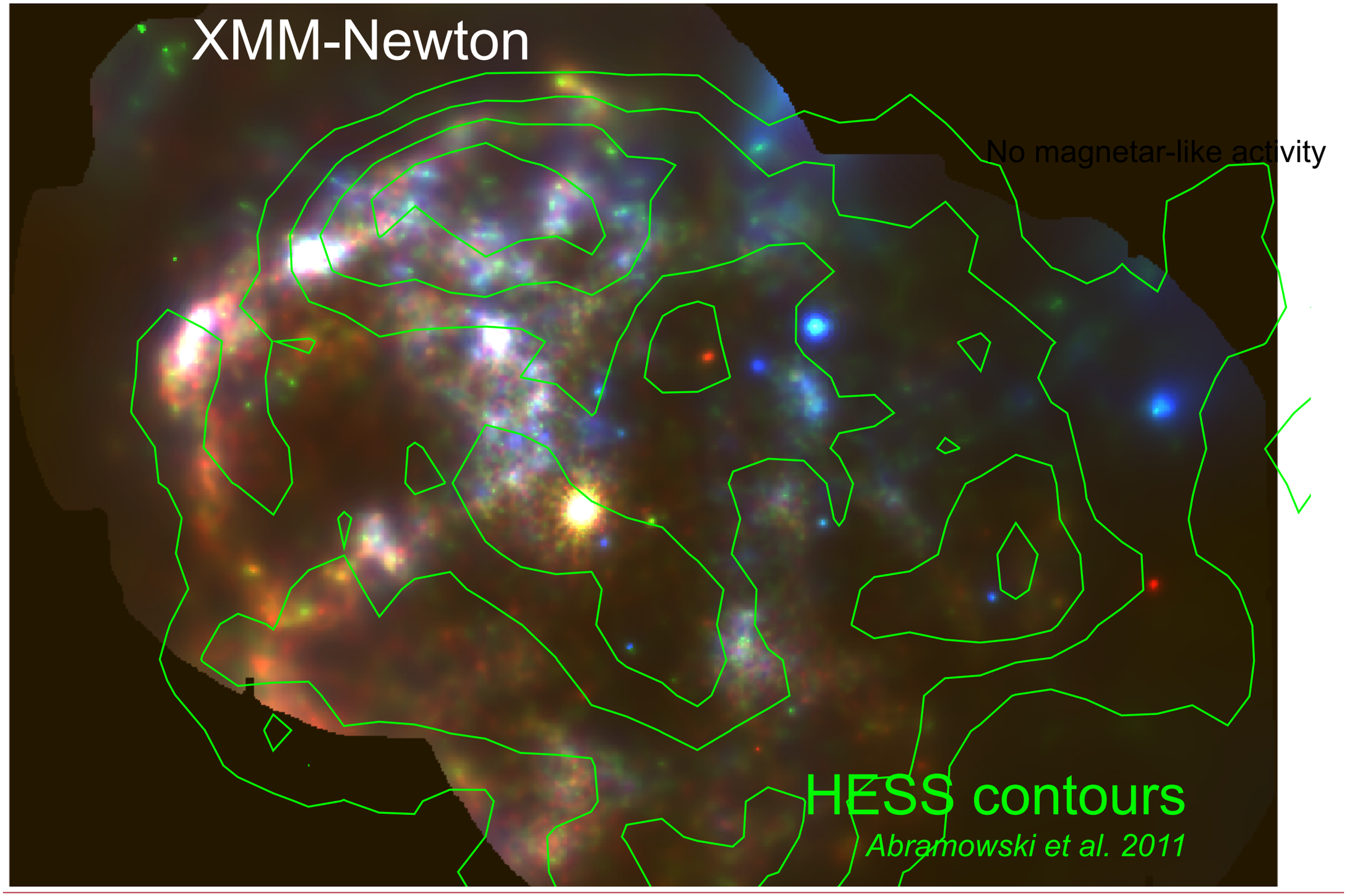
A substantial fraction of NSs are born as low-magnetized CCO (?)

2

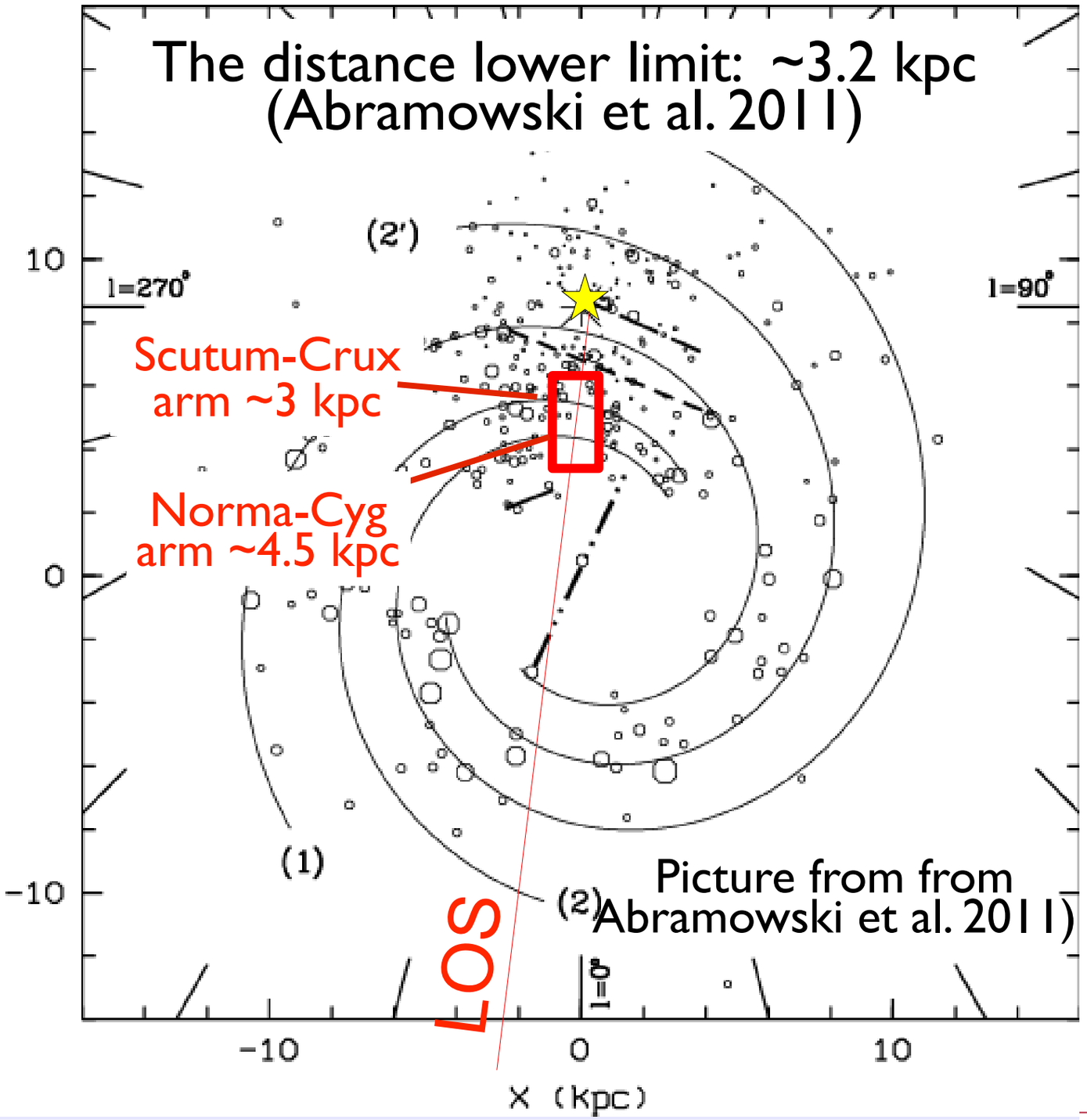
Together with XDINSs („M7“), CCOs provide an “undisturbed” view of the NS surface (or even better because of low ***B***) → **constraints on fundamental NS parameters**



CCO in HESS J1731-347



CCO in HESS J1731-347: distance & emitting area



Search for pulsations down to 0.2 ms:

No pulsations with A>11.5%

Emission comes from the entire NS surface.

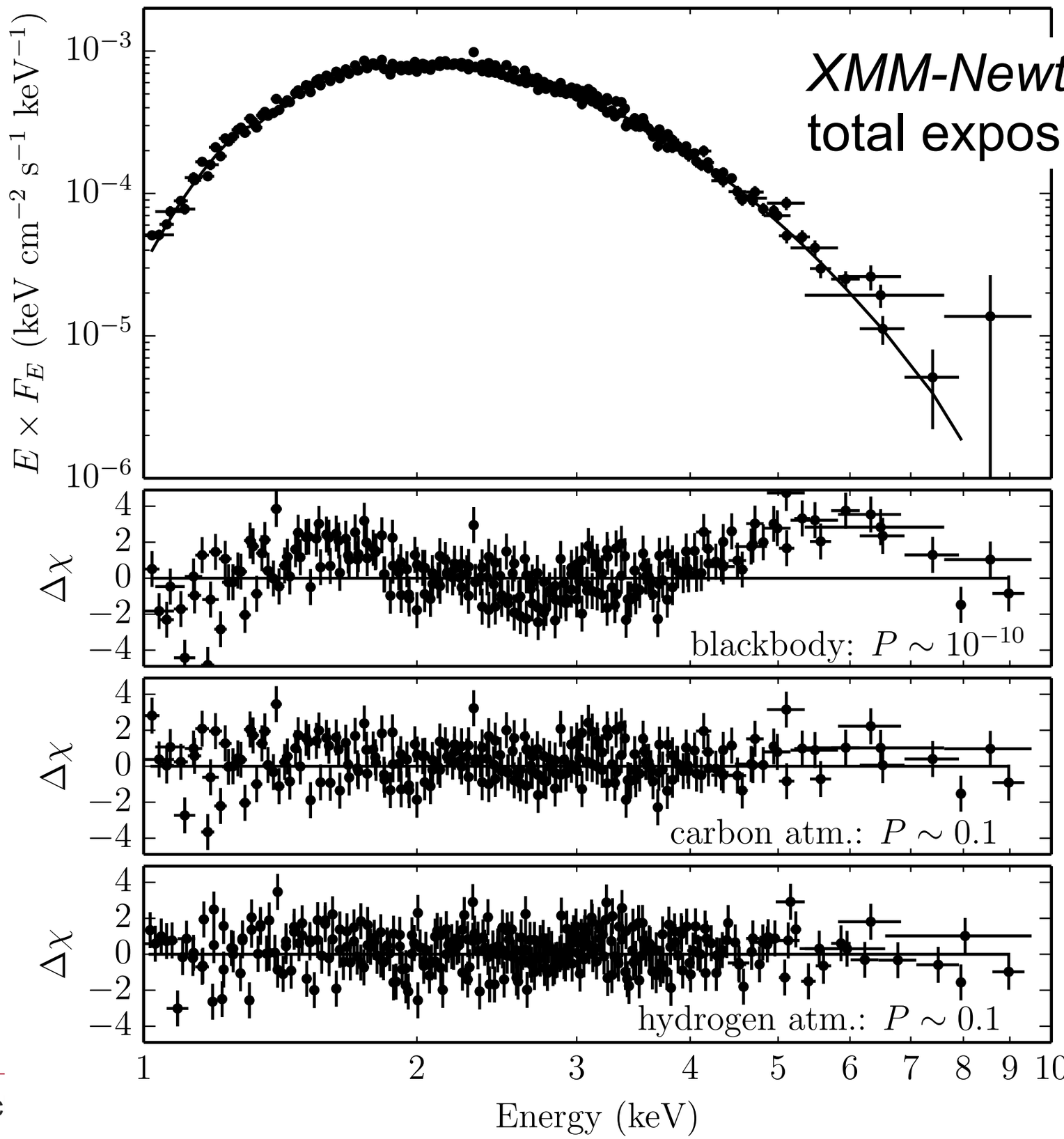
Carbon atmosphere fit is consistent with D = 3.2 and 4.5 kpc!

Observations (2007-2013)

Date	Satellite	exposure [ksec]	time res.
2007 Feb 23	*Suzaku*	41	8 s
2007 Mar 21	*XMM-Newton*	25	70 ms (PN)
2008 Apr 28	*Chandra*	30	3.2 s
2009 Feb 4	*Swift*	1.4	2.5 s
2009 Mar 9	*Swift*	1.4	2.5 s
2010 May 18	*Chandra*	40	2.85 ms
2012 Mar 2	*XMM-Newton*	24	0.03 ms (PN)
2013 Mar 7(*)	*XMM-Newton*	72	70 ms (PN)
2013 Oct 6(*)	*XMM-Newton*	61	70 ms (PN)

(*)The new observations analyzed in this work.

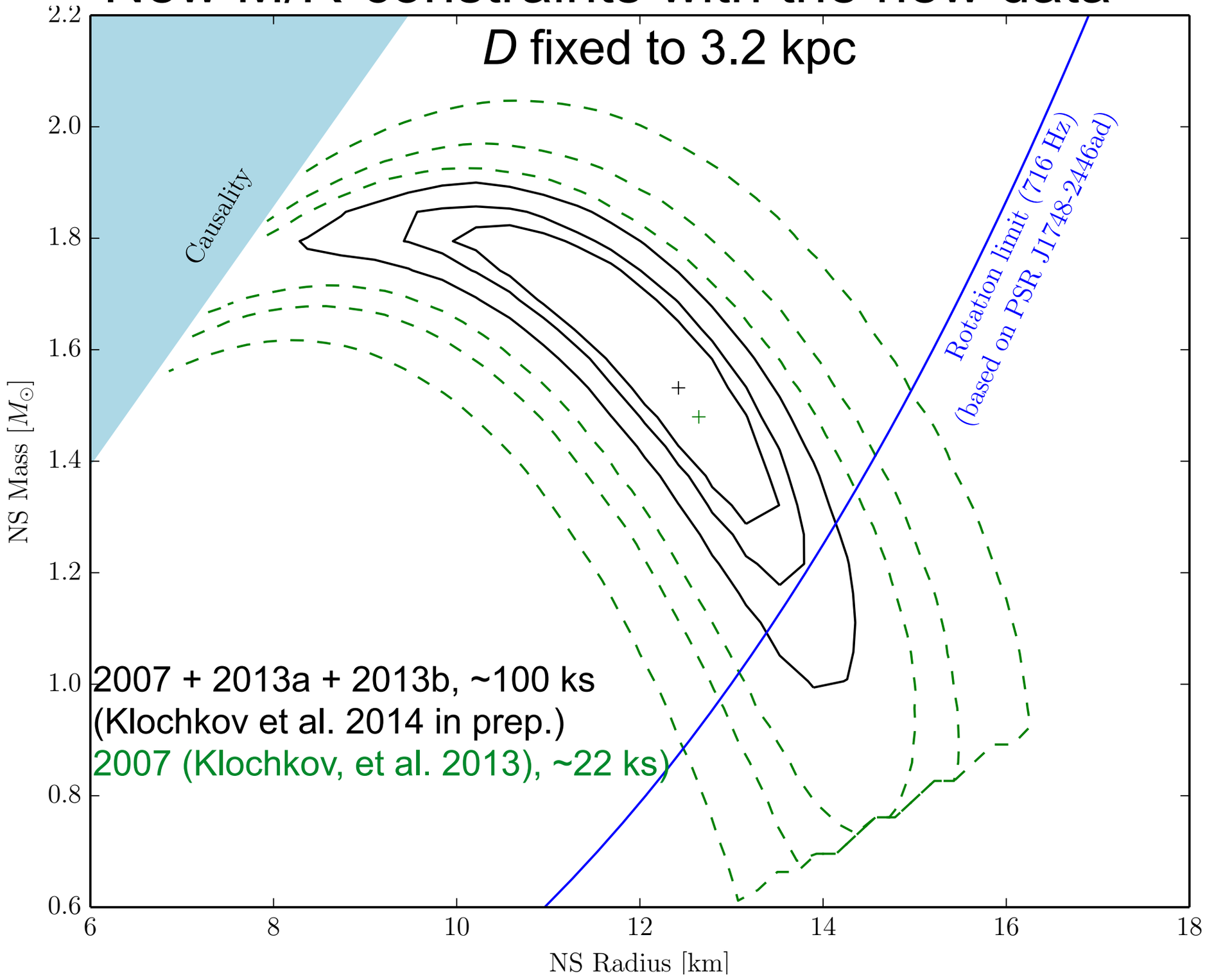
Pure blackbody is rejected



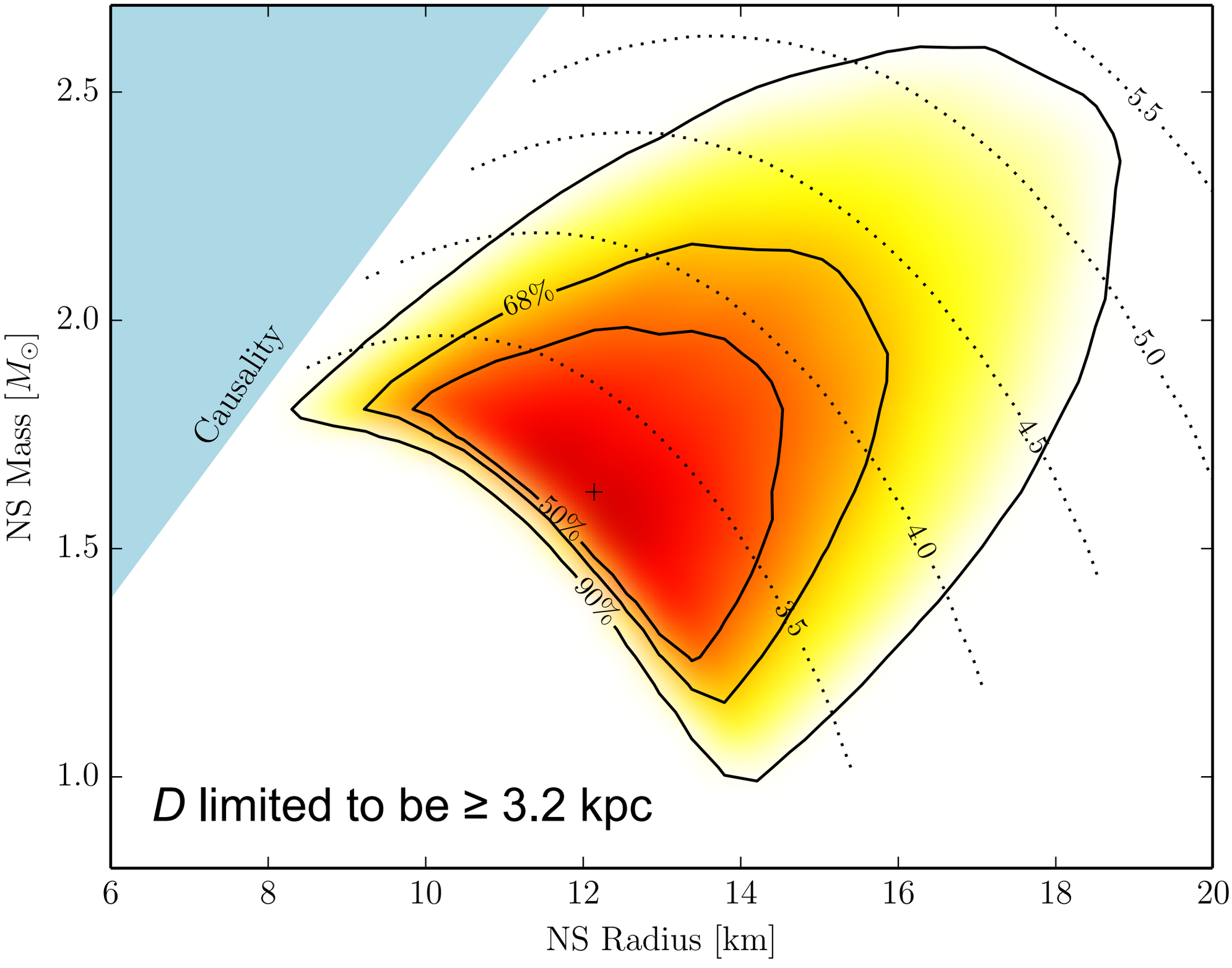
XMM-Newton,
total exposure: ~100 ksec

(„carbatm“ in XSPEC, *Suleimanov et al. 2014*)

New M/R-constraints with the new data

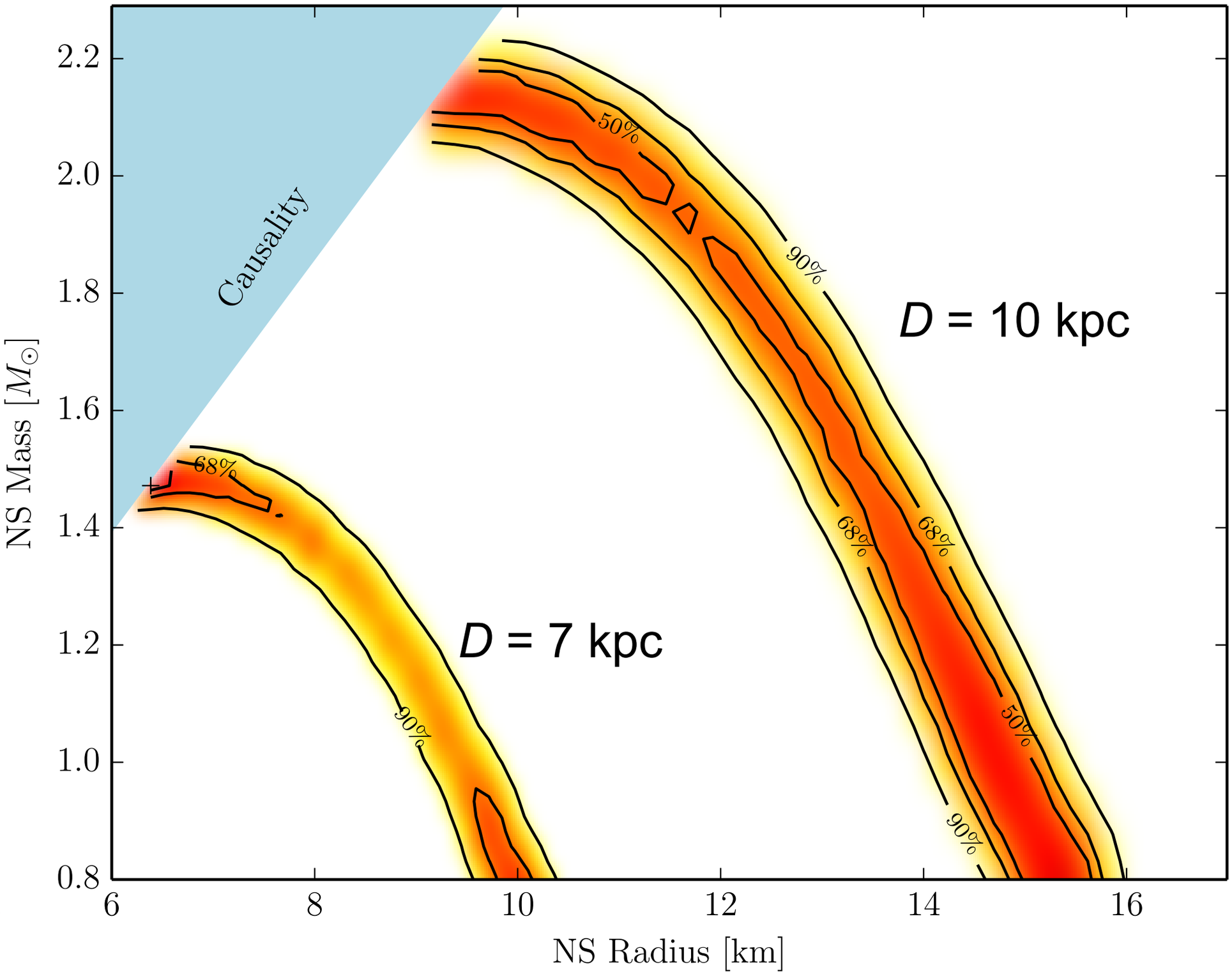


Constraints on the distance

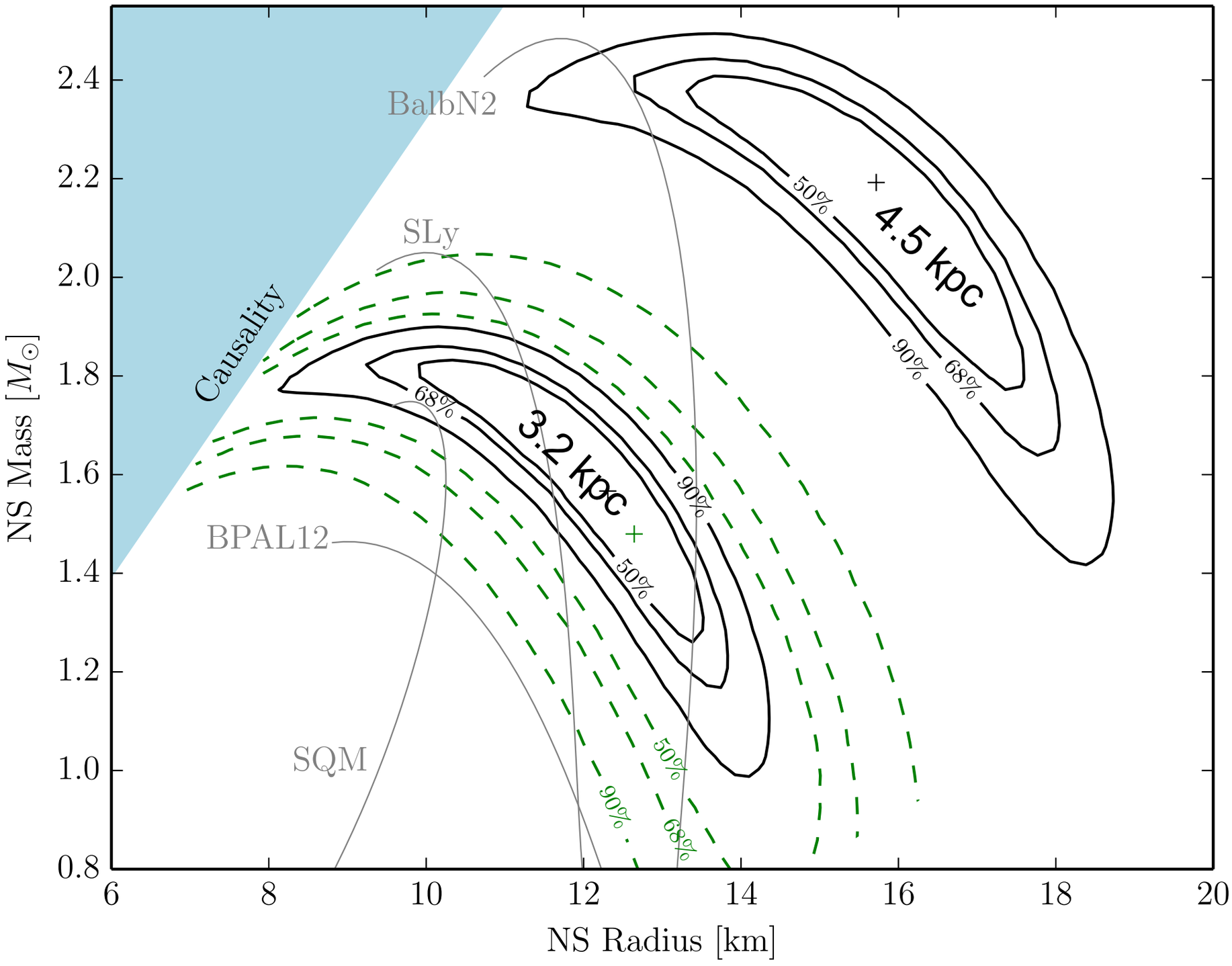


D fixed to 10 kpc!

Fit with H-model



Carbon, summary



Conclusions

CCOs are vary promising laboratories for studying neutron stars.
The amount of XMM-Newton data on the CCO in HESS J1731-347 has increased by a factor of five. The new analysis lead to following results:

- ~7.5% upper limit on pulsed fraction for P > 0.14 s
- no long-term variability/cooling
- C or H atmosphere spec. fit is clearly preferred over BB-fit
- hydrogen atm. fit lead to unrealistic distances, R_{NS}, and M_{NS}
- with the carbon atm. fit, the data prefer D < 5..6 kpc
- new constraints on the neutron star M and R
- most „conventional“ EoSs require a distance of 3-4 kpc

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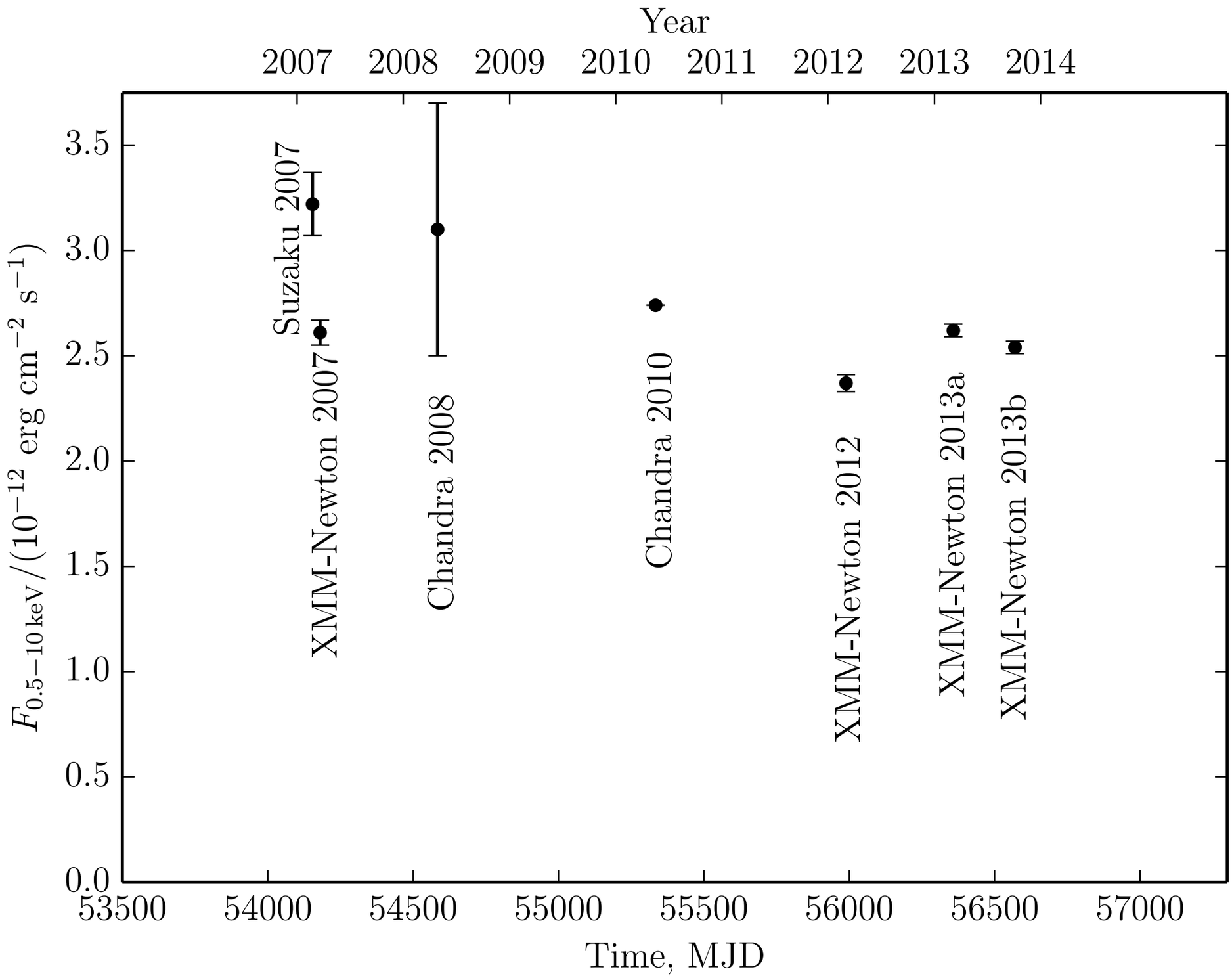
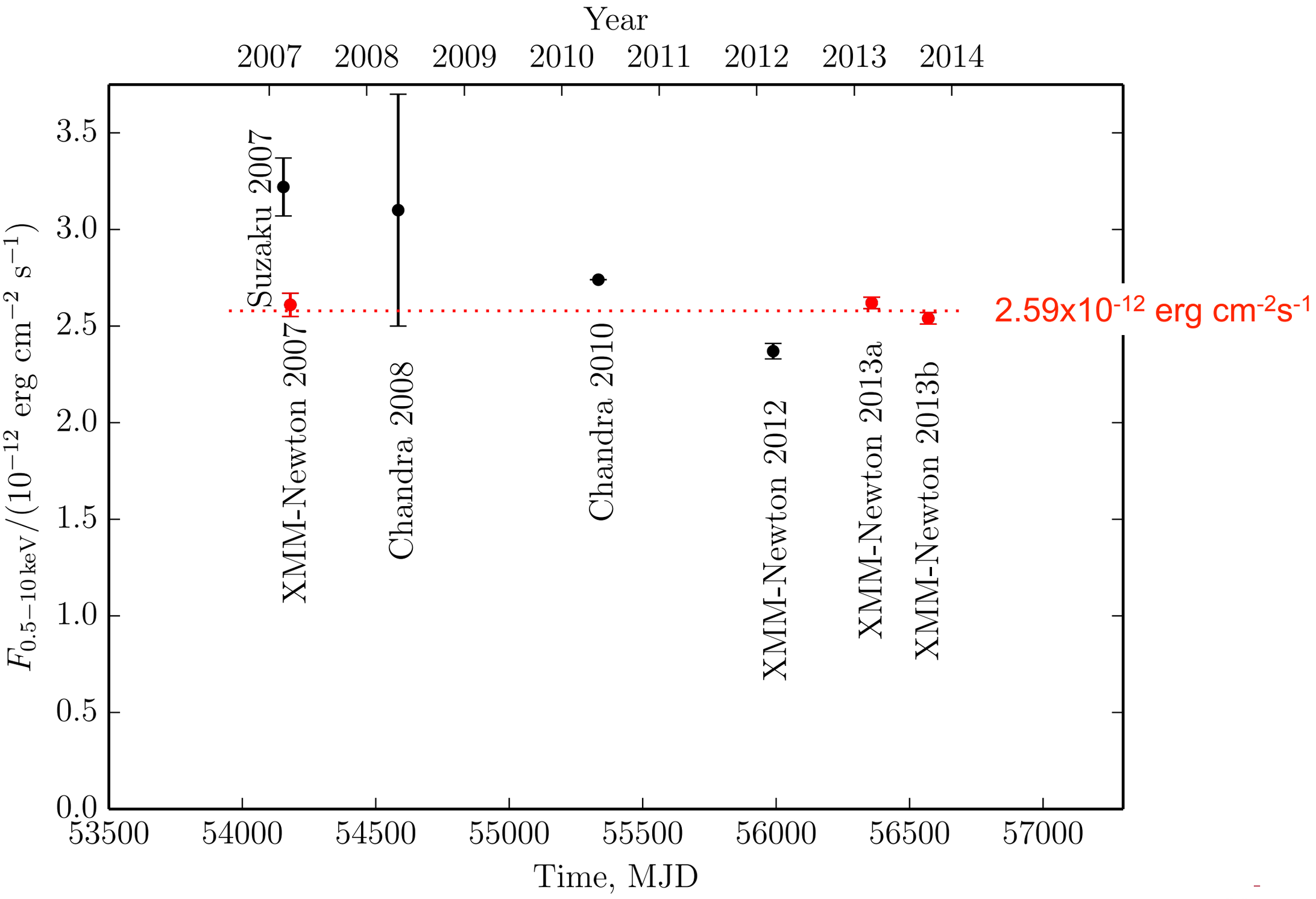
Long-term flux monitoring: ~7 years



Long-term flux monitoring: ~7 years



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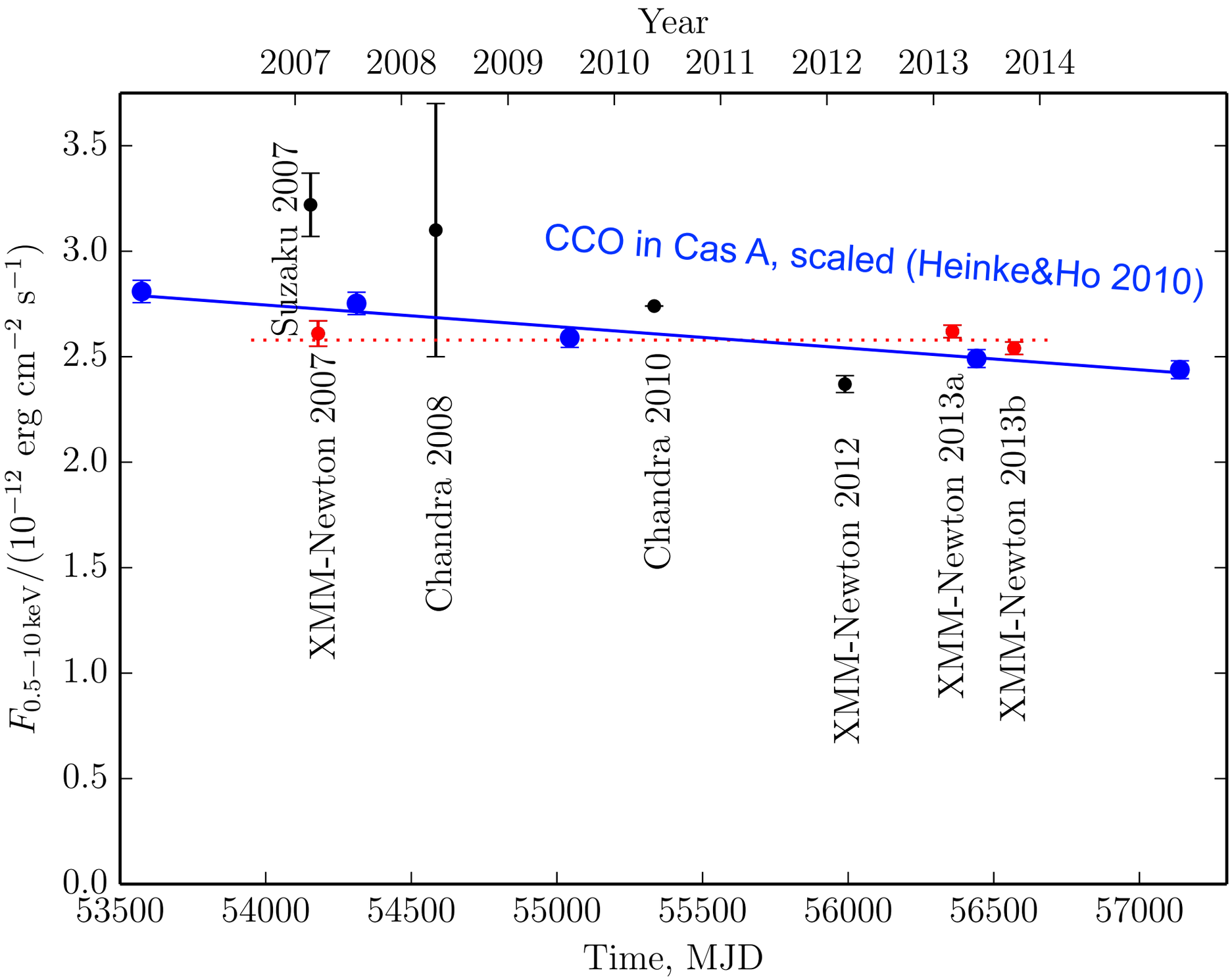


Search for pulsations

March 2013 (AO11), useful exp.: ~44 ks

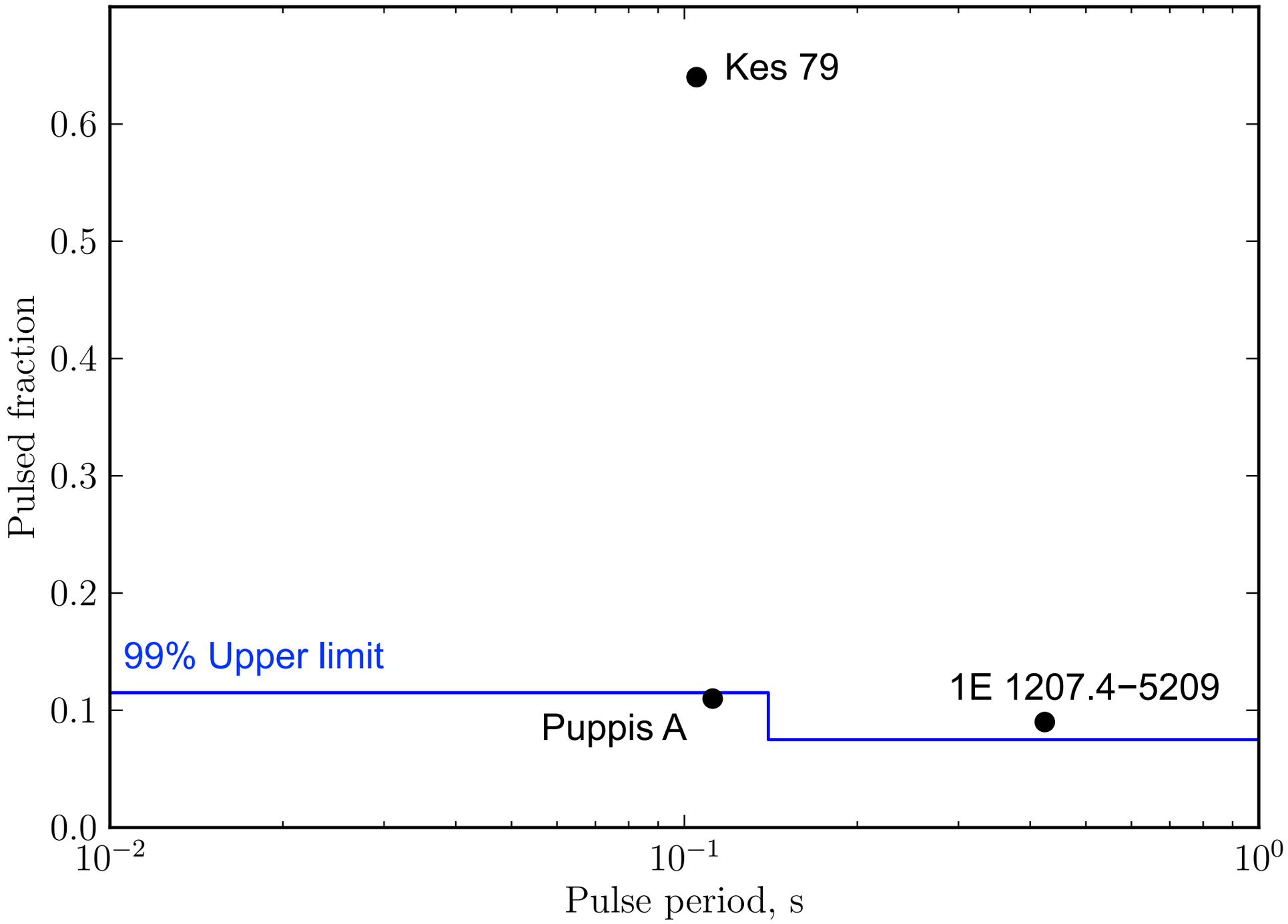
Rayleigh Z_1^2-statistics: no periodic signal above 99% c.l.

The 99% upper limit on the pulsed fraction of the source signal in 0.35-5.5 keV for sinusoidal pulsations down to 2x70ms = **0.14s** is **7.5%** (for the total signal - 7.1%)

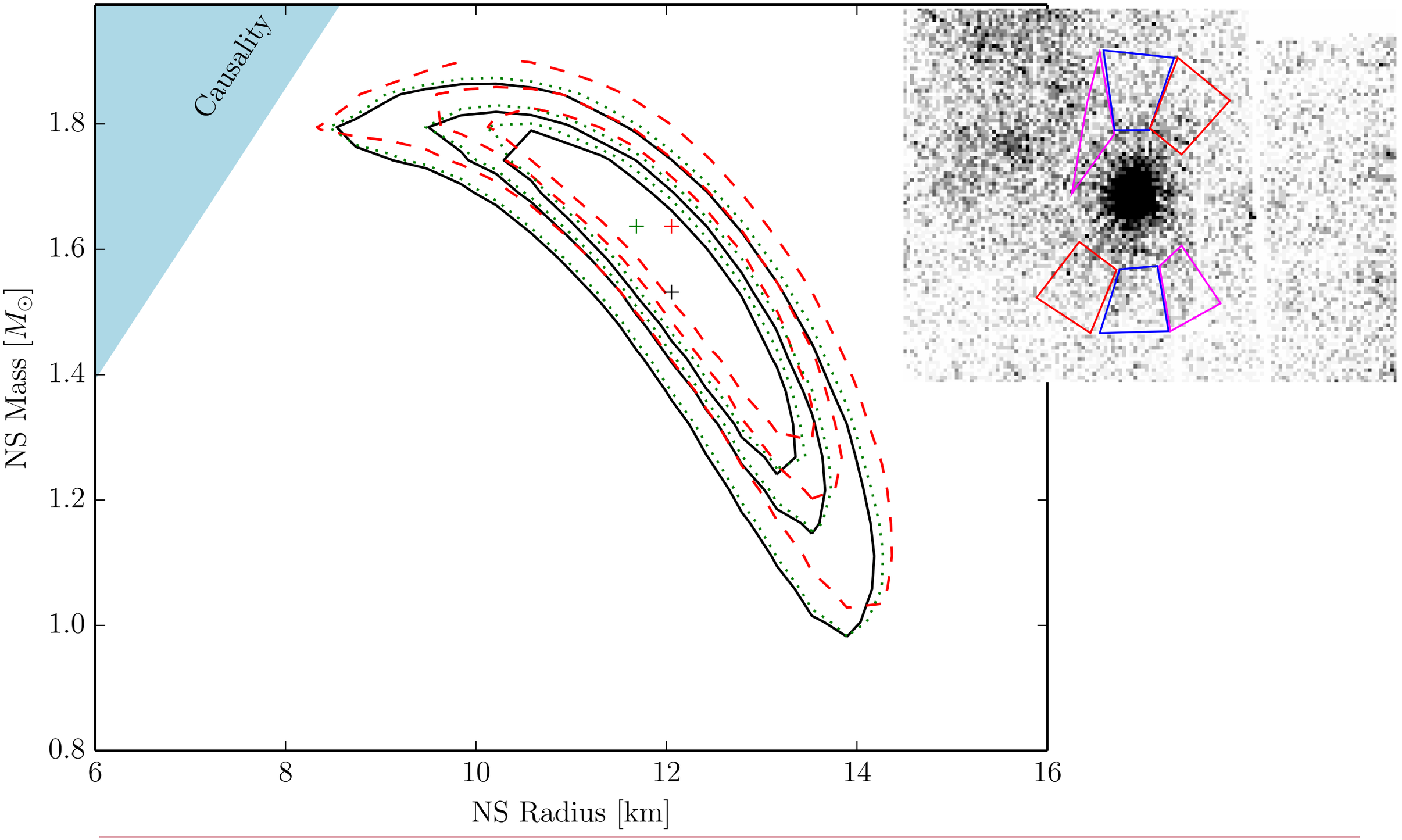
Timing observations in 2012 (AO10), useful exp.: ~22 ks

The 99% upper limit on the pulsed fraction of the source signal in 0.35-10 keV for sinusoidal pulsations down to **0.2ms** is **11.5%** (for the total signal - 8.3%, *Klochkov et al. 2013)*

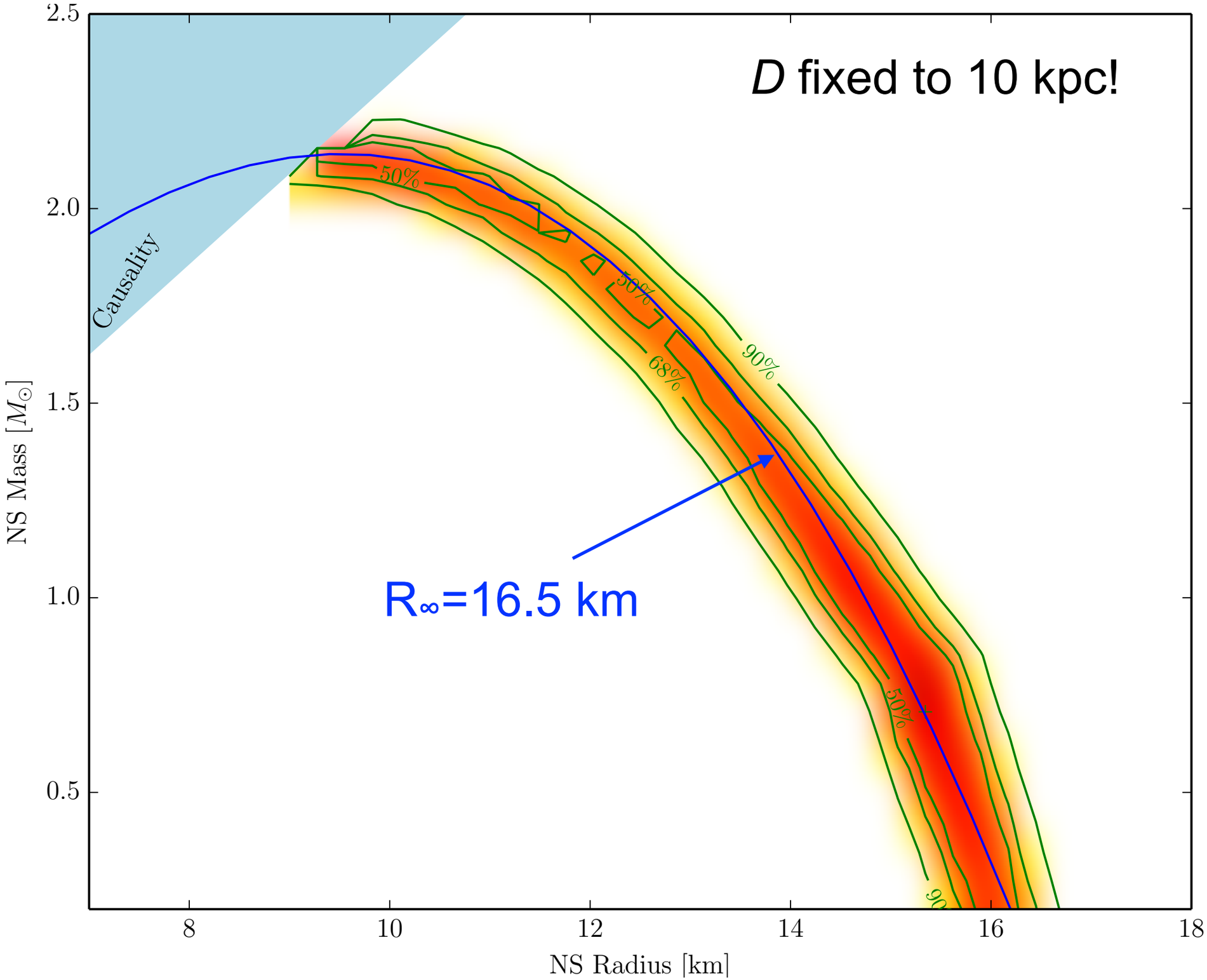
Search for pulsations



Systematics due to BG-region selection



Fit with H-model



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The distance with H-model