SSPRQ test pattern

Pete Anslow, Ciena

IEEE P802.3bs Task Force, Logic Ad Hoc, 28 April 2016

Introduction

P802.3bs D1.3 contains two PAM4 test patterns: PRBS13Q and PRBS31Q with characteristics analysed in anslow_01_1215_logic

The PRBS13Q pattern is conveniently short (8191 symbols), but is much less stressful than long periods of random data.

The PRBS31Q pattern is too long for easy capture (2,147,483,647 symbols), but is more stressful than long periods of random data.

anslow_01_0416_smf analysed two versions of an SSPRQ pattern that were chosen to be short enough to be captured (32,766 symbols or 65,535 symbols) and are more stressful than long periods of random data.

On the SMF Ad Hoc call, a preference for phase independence (the longer version) was expressed, it was questioned whether a shorter version could be found with acceptable characteristics and a concern was raised over whether the baseline wander was too onerous.

SSPRQ pattern, 2^16-1 symbols long

The proposed SSPRQ pattern is constructed from three sections of a PRBS31 binary sequence:

PRBS31 Start = 00000002 10924 bits	PRBS31 Start = 34013FF7 10922 bits	PRBS31 Start = 0CCCCCCC 10922 bits

Where Start is a 31 bit Hex number sent MSB first and represents the first 31 bits of the section.

The complete 32,768 bit binary sequence is sent twice and Gray coded according to 120.5.7, with the PAM4 symbols during the second version inverted (out = 3 – in).

This is followed by the above sequence again with the first and last binary bit removed.

The resulting 65,535 symbol PAM4 sequence is contained in the file anslow_03_0416_smf.csv

Baseline wander

Previous NRZ contributions have used a “baseline wander” parameter

This was defined as:

Baseline wander is the instantaneous offset (in %) in the signal generated by AC-coupling at the Baud rate / 10,000.

This analysis re-uses this definition unmodified, but it should be noted that for PAM4, the eye height is 1/3 that of NRZ so the effects of a given amount of baseline wander will be greater.

To explore the issue of the baseline wander for SSPRQ being too onerous, a plot has also been done for Baud / 50,000

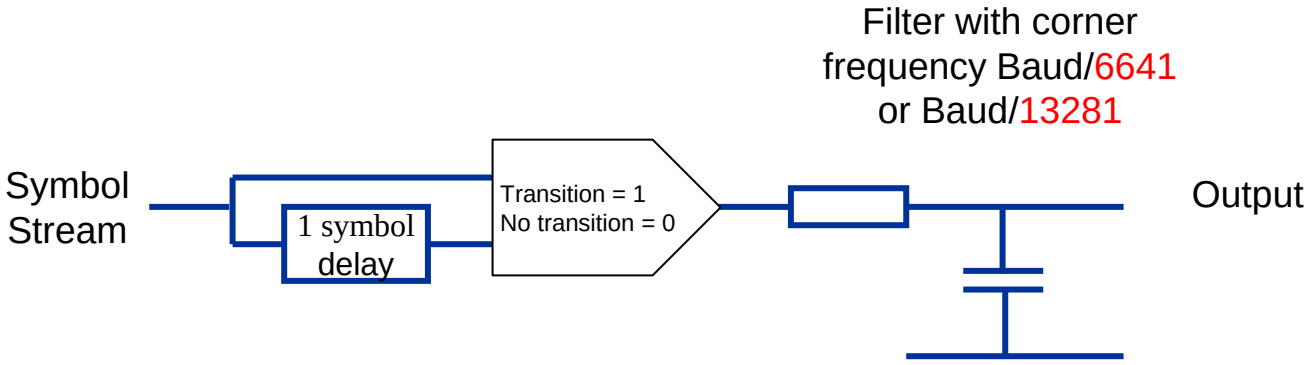
Clock content

The “clock content” parameter is defined here as:

Create a function which is a 1 for a transition and a 0 for no transition and then filter the resulting sequence with a corner frequency of Baud/6641 (or Baud/13281).

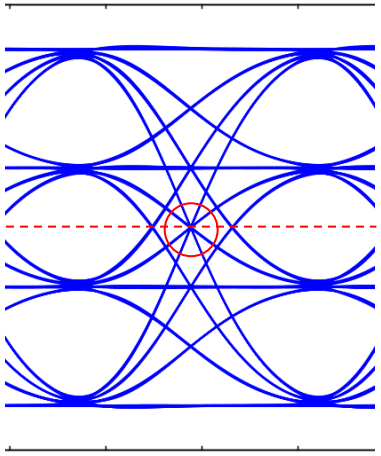
This analysis defines a transition as one of three possibilities (as per healey_3bs_01_1115):

- Symmetrical transitions through the signal average
- Transitions through the signal average
- All transitions

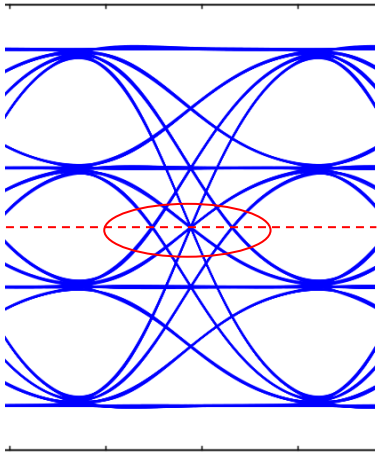


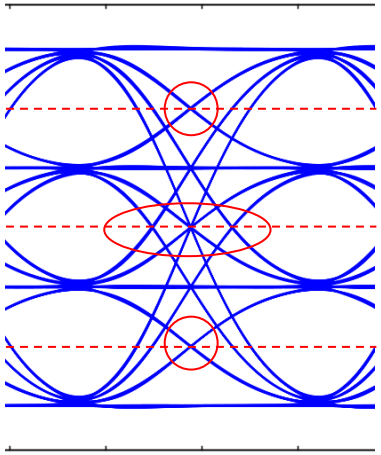
Clock content illustration

Symmetrical transitions through the signal average



Transitions through the signal average





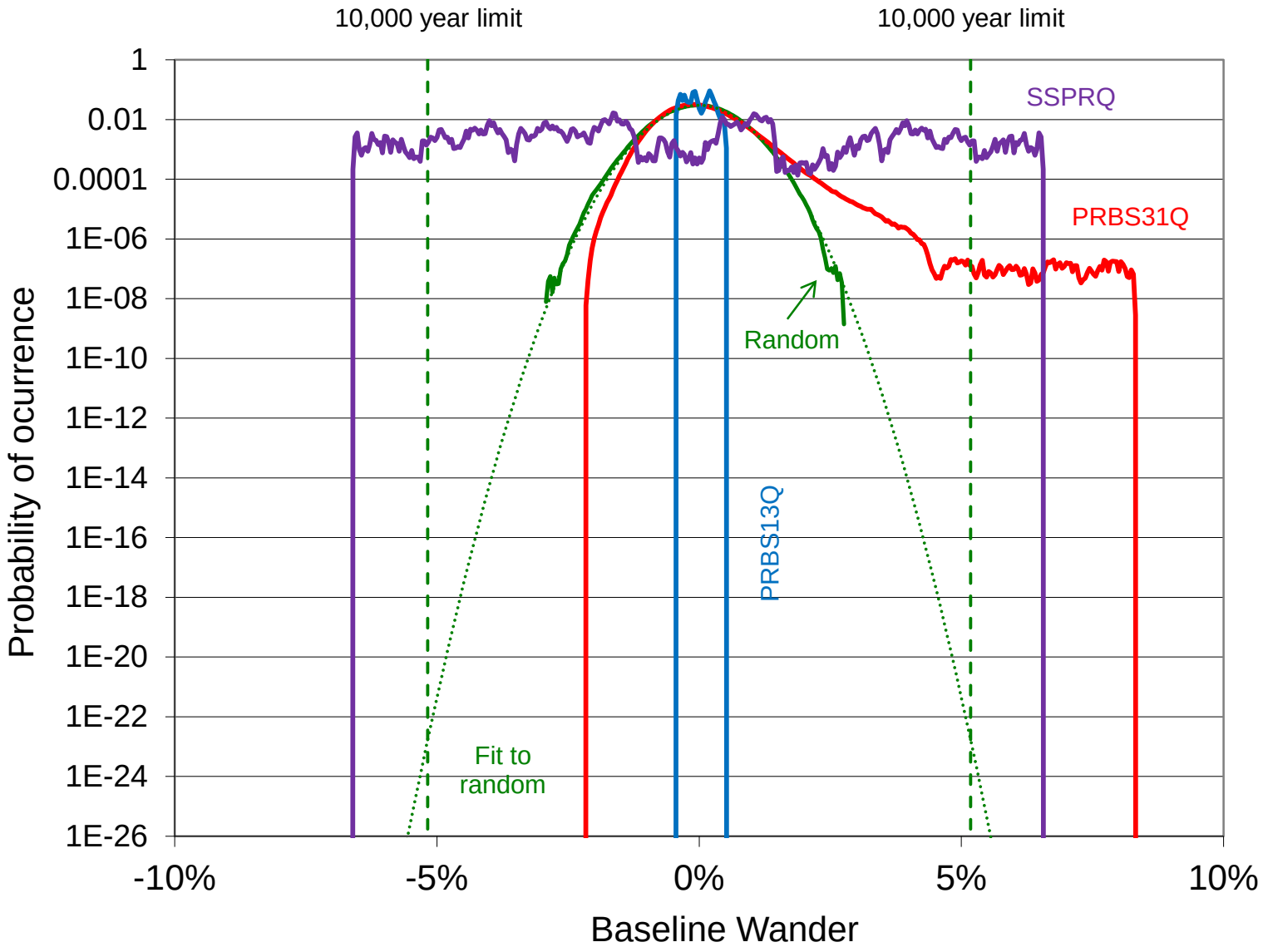
All transitions

PRBS13Q and PRBS31Q

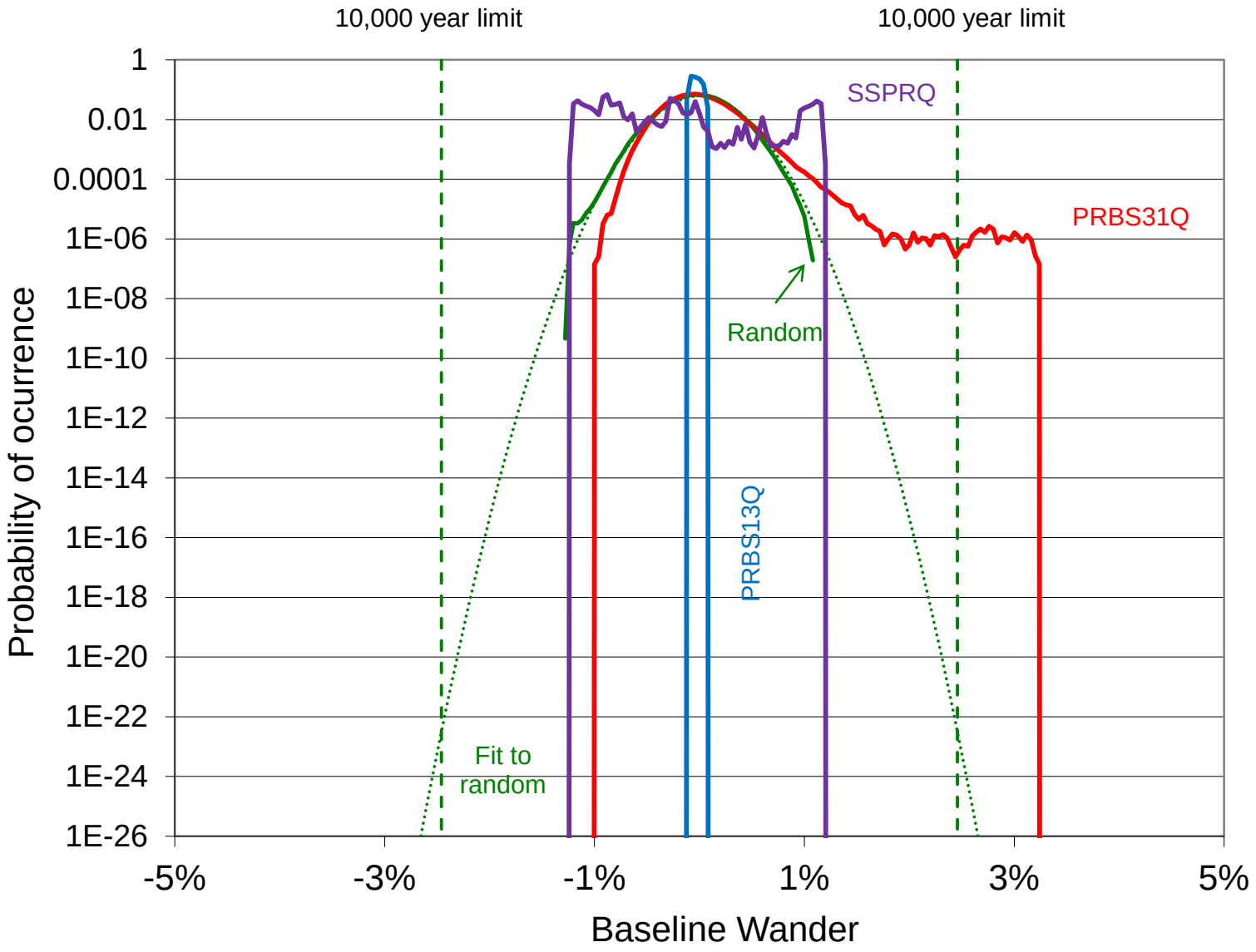
The following slides contain the baseline wander and three clock content probability density plots for:

- Random data (solid green)
- Fit to random data (dotted green)
- PRBS13Q (blue)
- PRBS31Q (red)
- Proposed SSPRQ (purple)

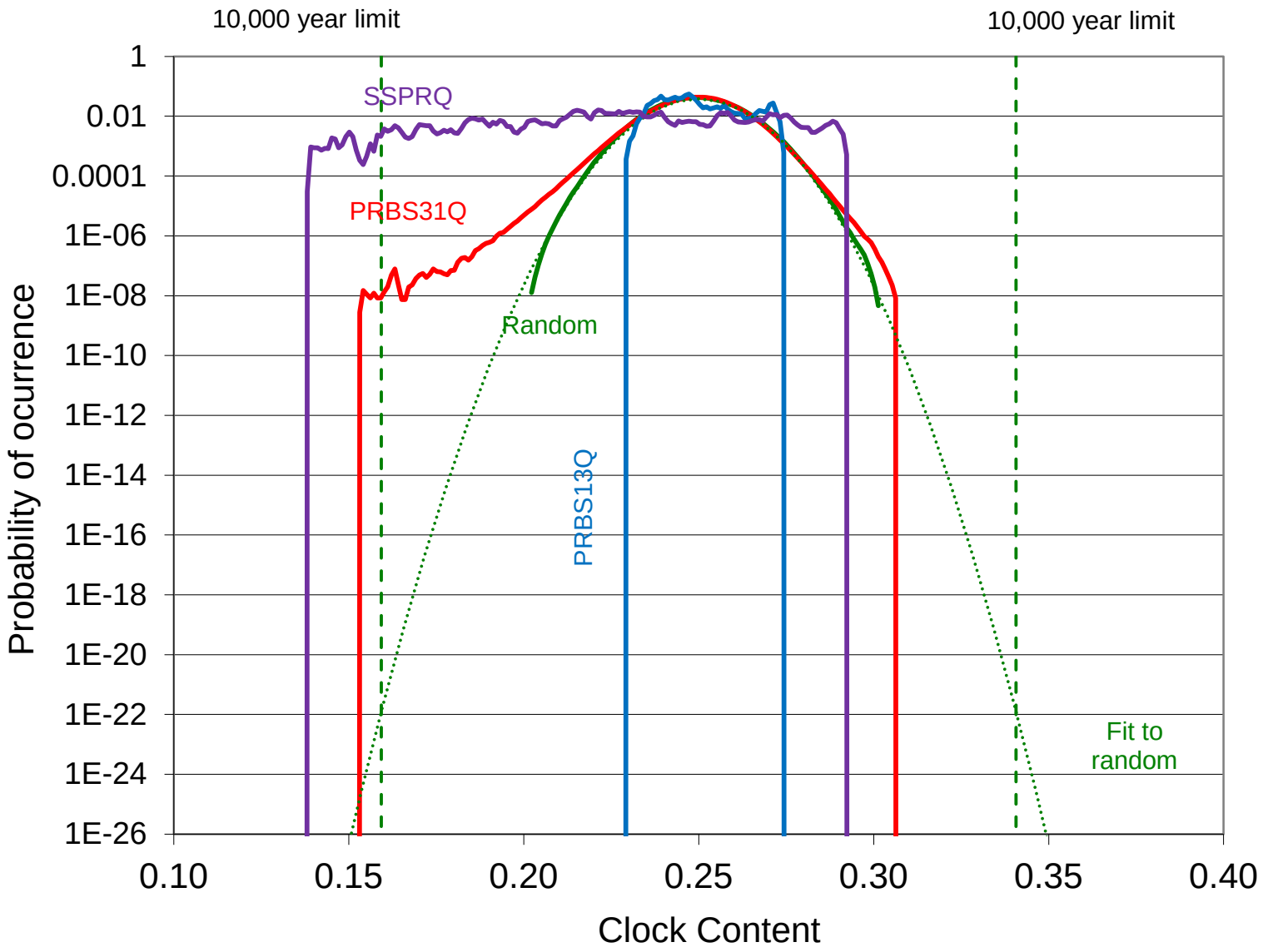
Baseline wander (Baud / 10,000)



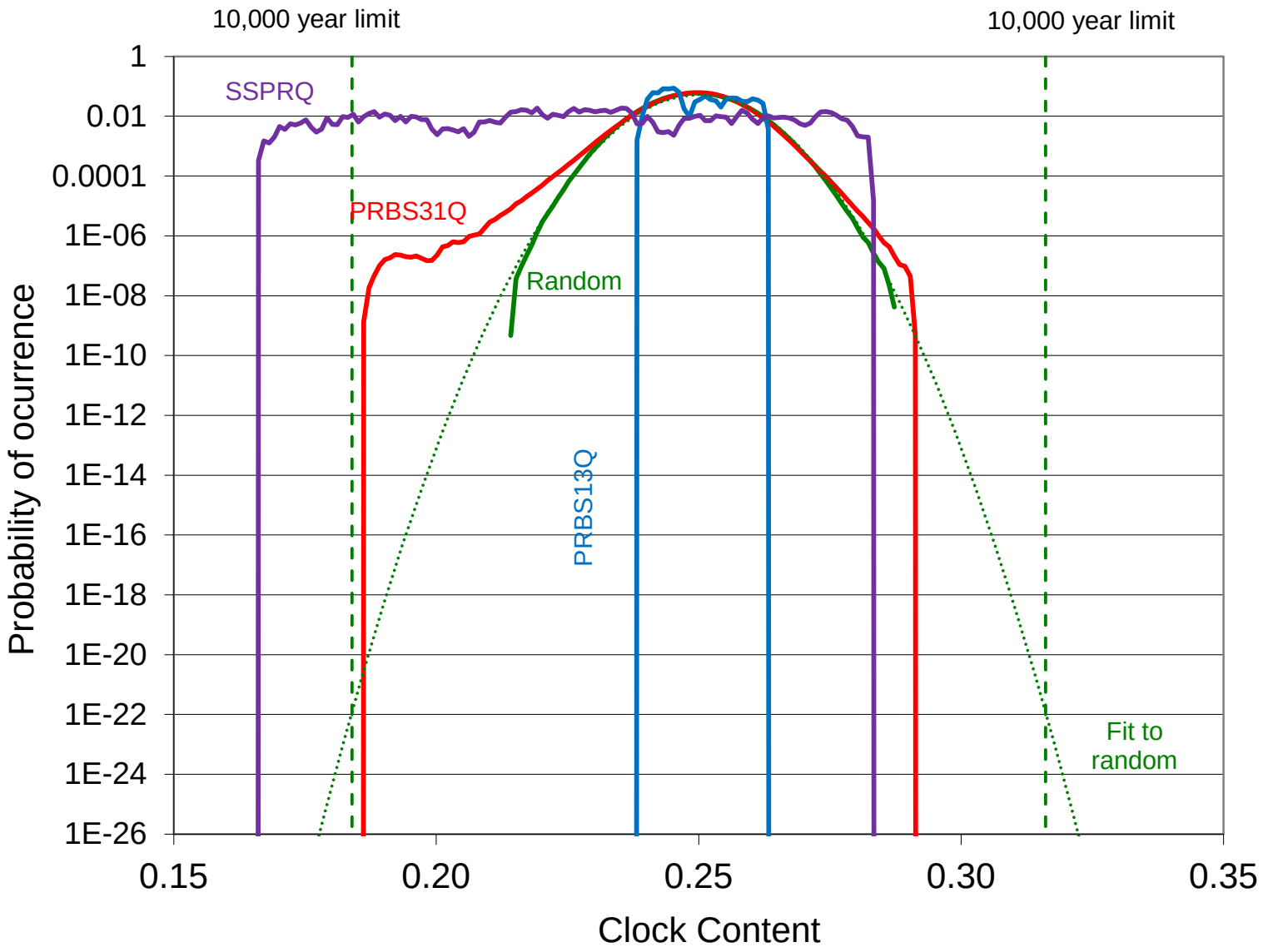
Baseline wander (Baud / 50,000)



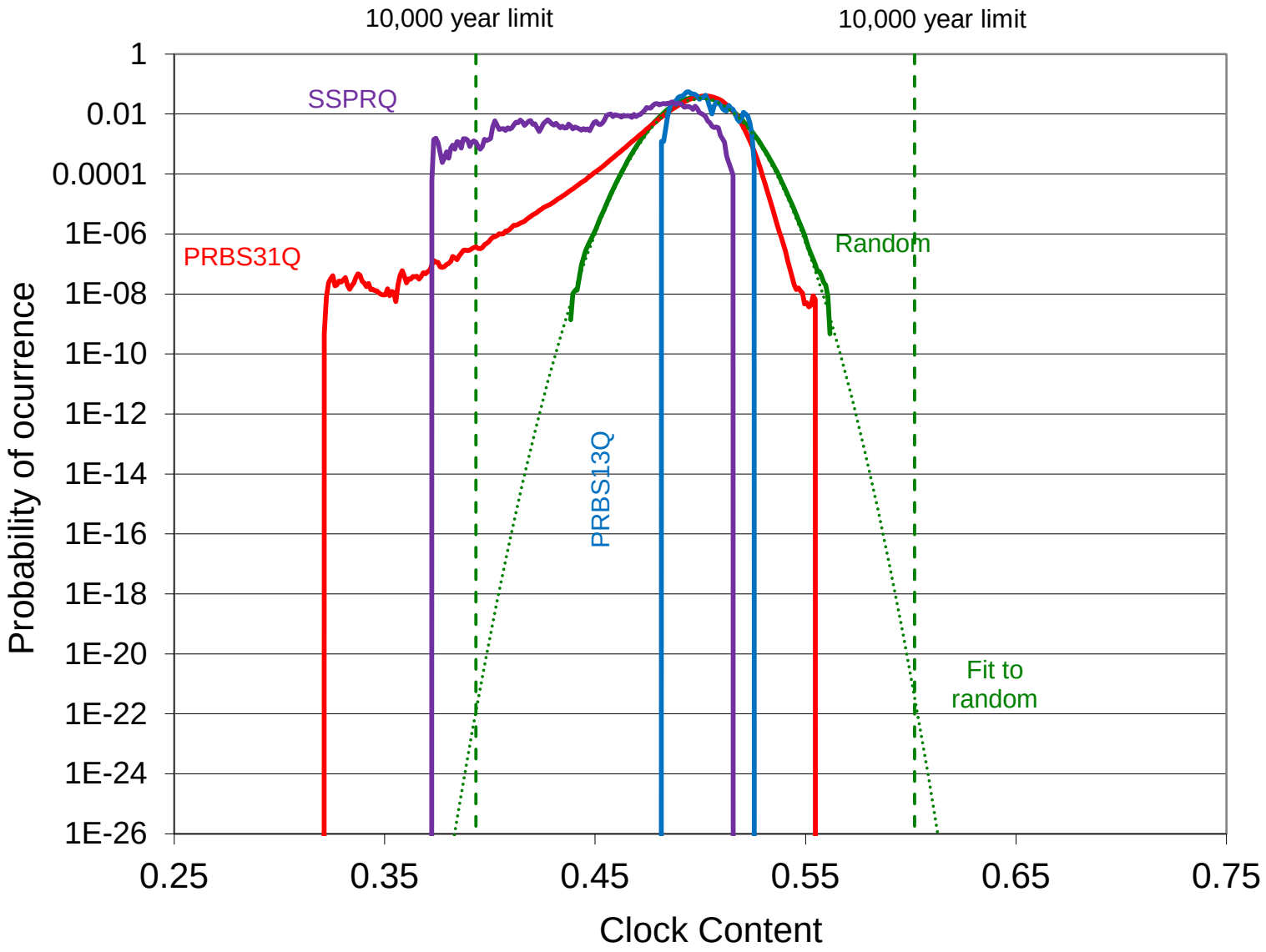
Clock, sym. trans. through ave, Baud/6641



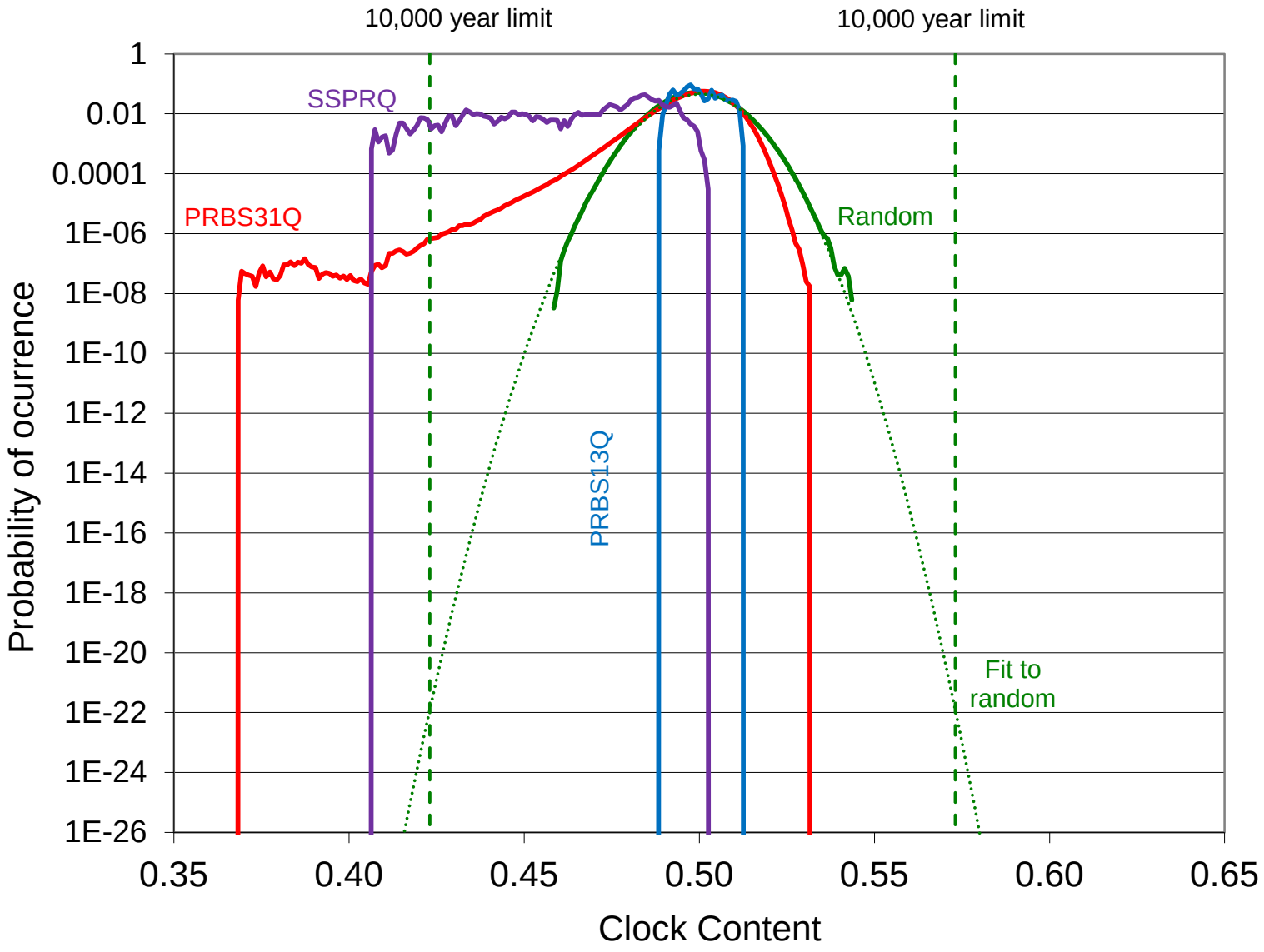
Clock, sym. trans. through ave, Baud/13281



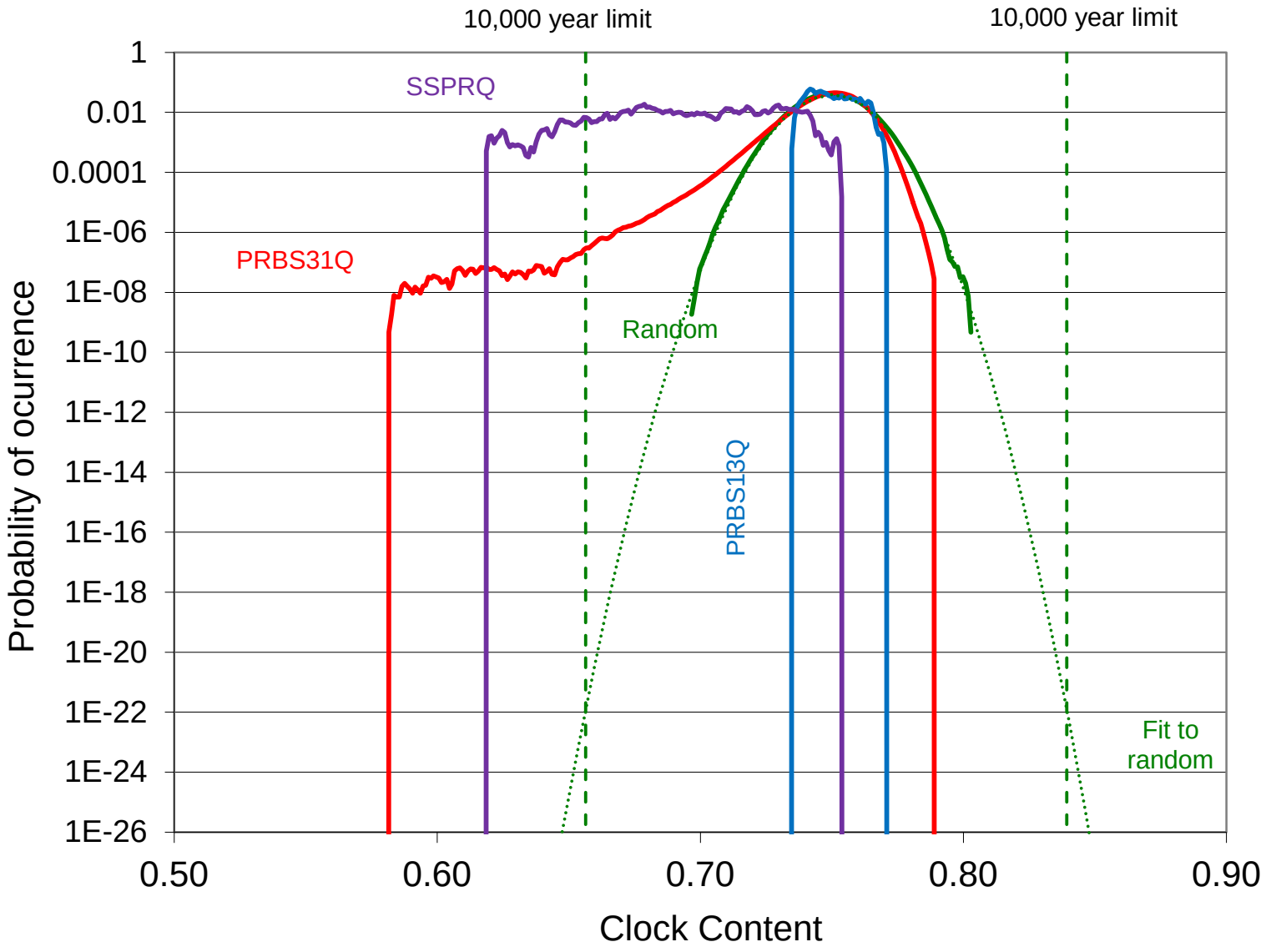
Clock, transitions through average, Baud/6641



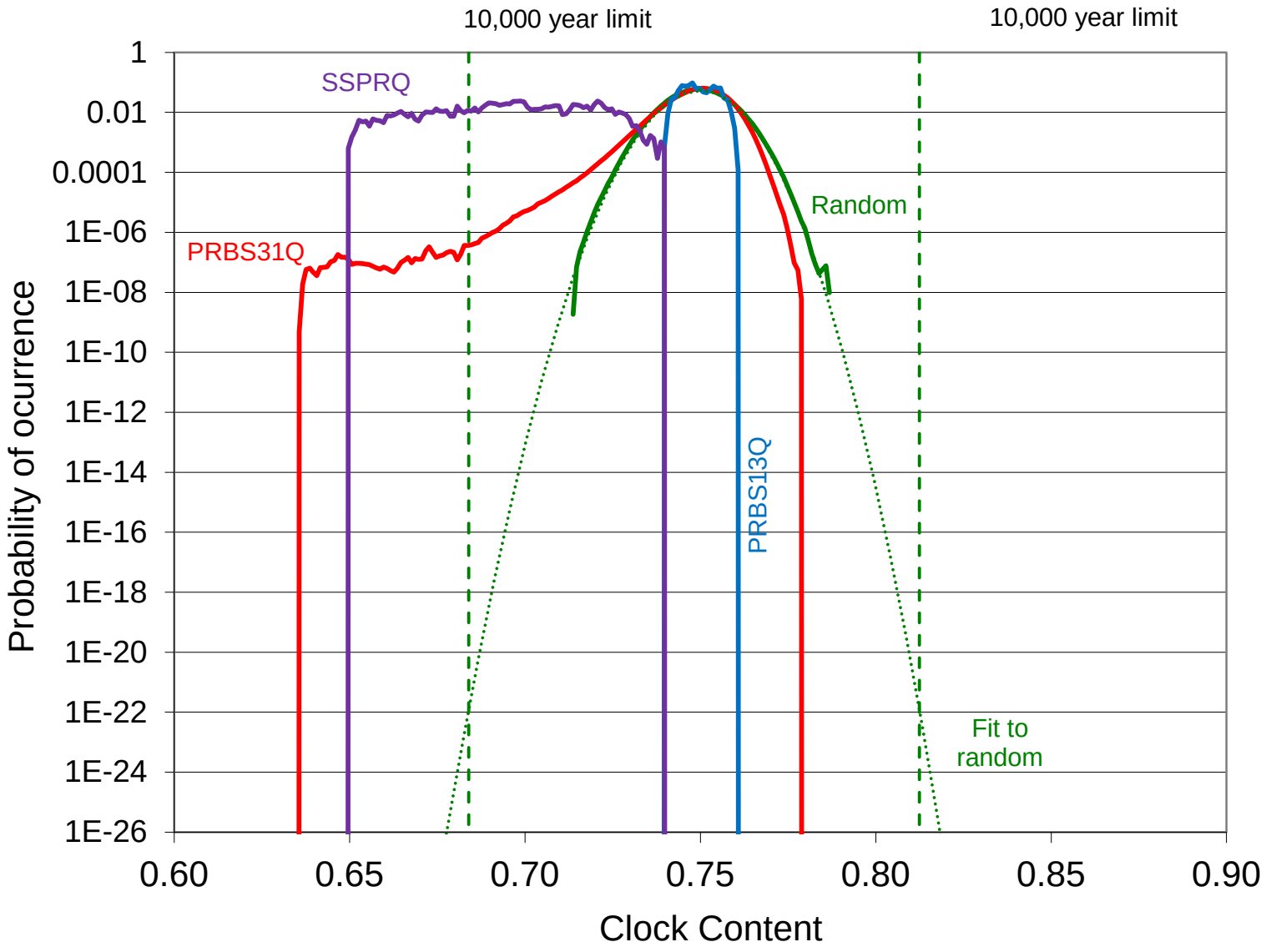
Clock, transitions through average, Baud/13281



Clock, all transitions, Baud/6641



Clock, all transitions, Baud/13281



SSPRQ pattern, 2^15-1 symbols long

The proposed SSPRQ pattern is constructed from three sections of a PRBS31 binary sequence:

PRBS31 Start = 00000002 5462 bits	PRBS31 Start = 34013FF7 5462 bits	PRBS31 Start = 0CCCCCCC 5460 bits

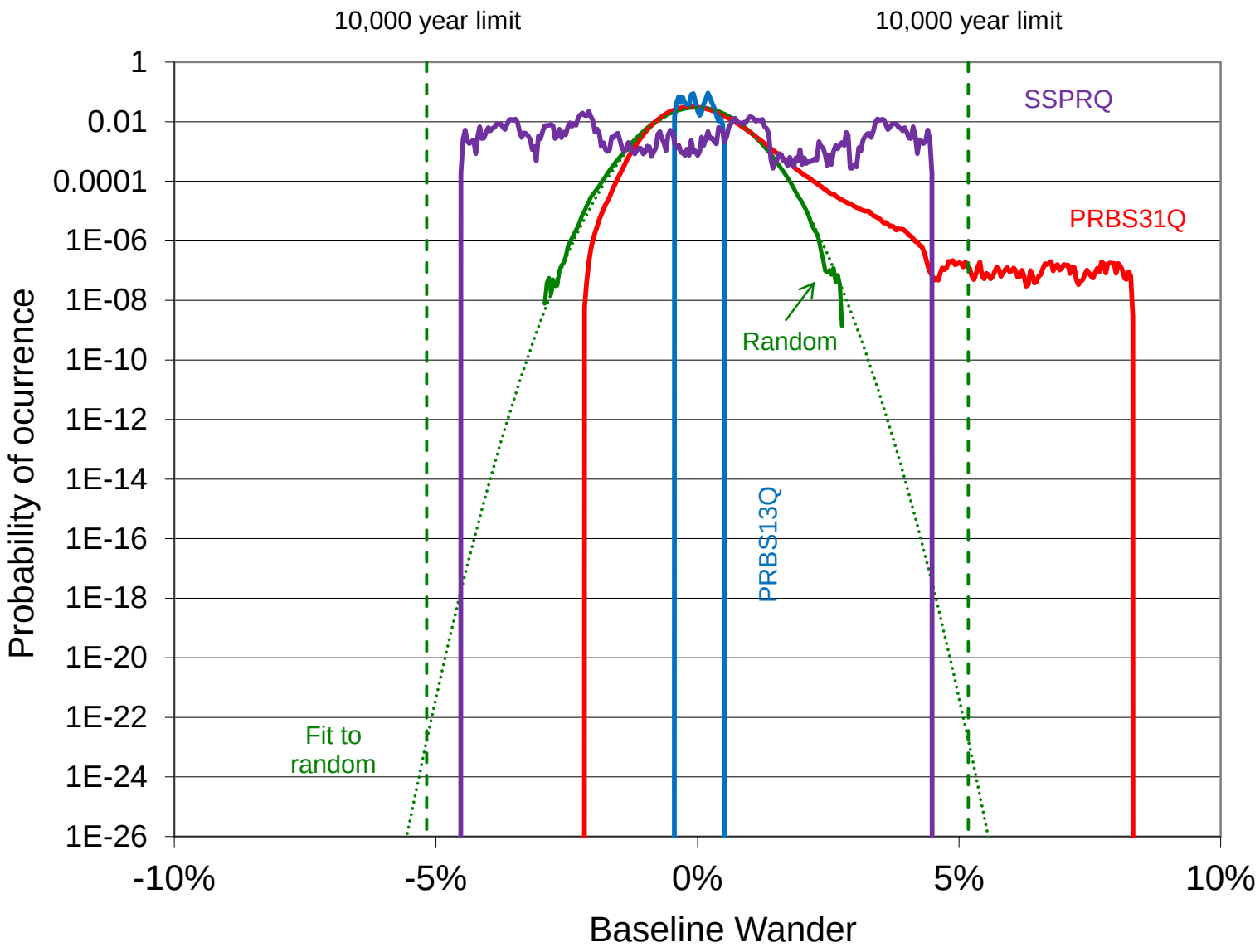
Where Start is a 31 bit Hex number sent MSB first and represents the first 31 bits of the section.

The complete 16,384 bit binary sequence is sent twice and Gray coded according to 120.5.7, with the PAM4 symbols during the second version inverted (out = 3 – in).

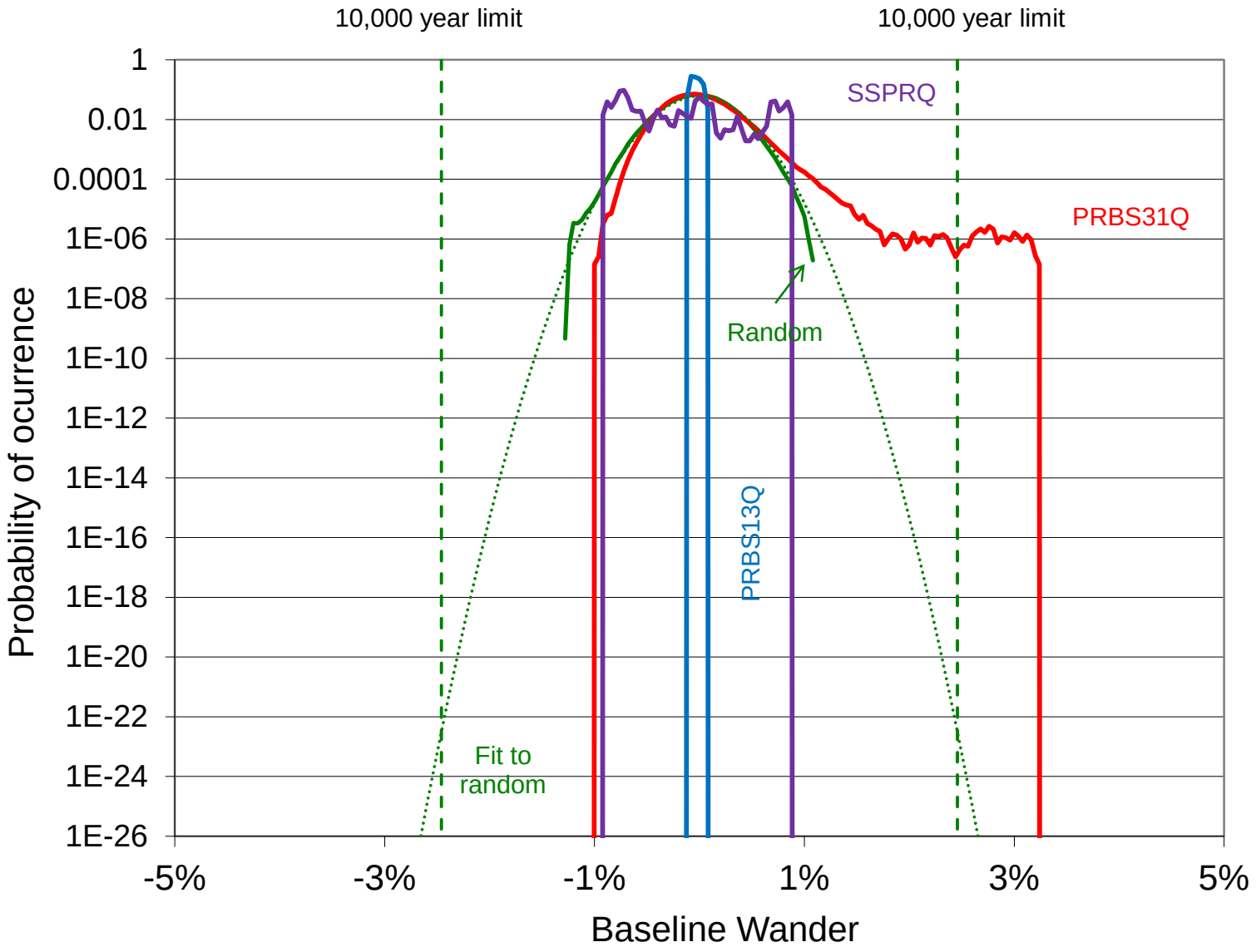
This is followed by the above sequence again with the first and last binary bit removed.

The resulting 32,767 symbol PAM4 sequence is contained in an accompanying file anslow_02_0416_logic.csv

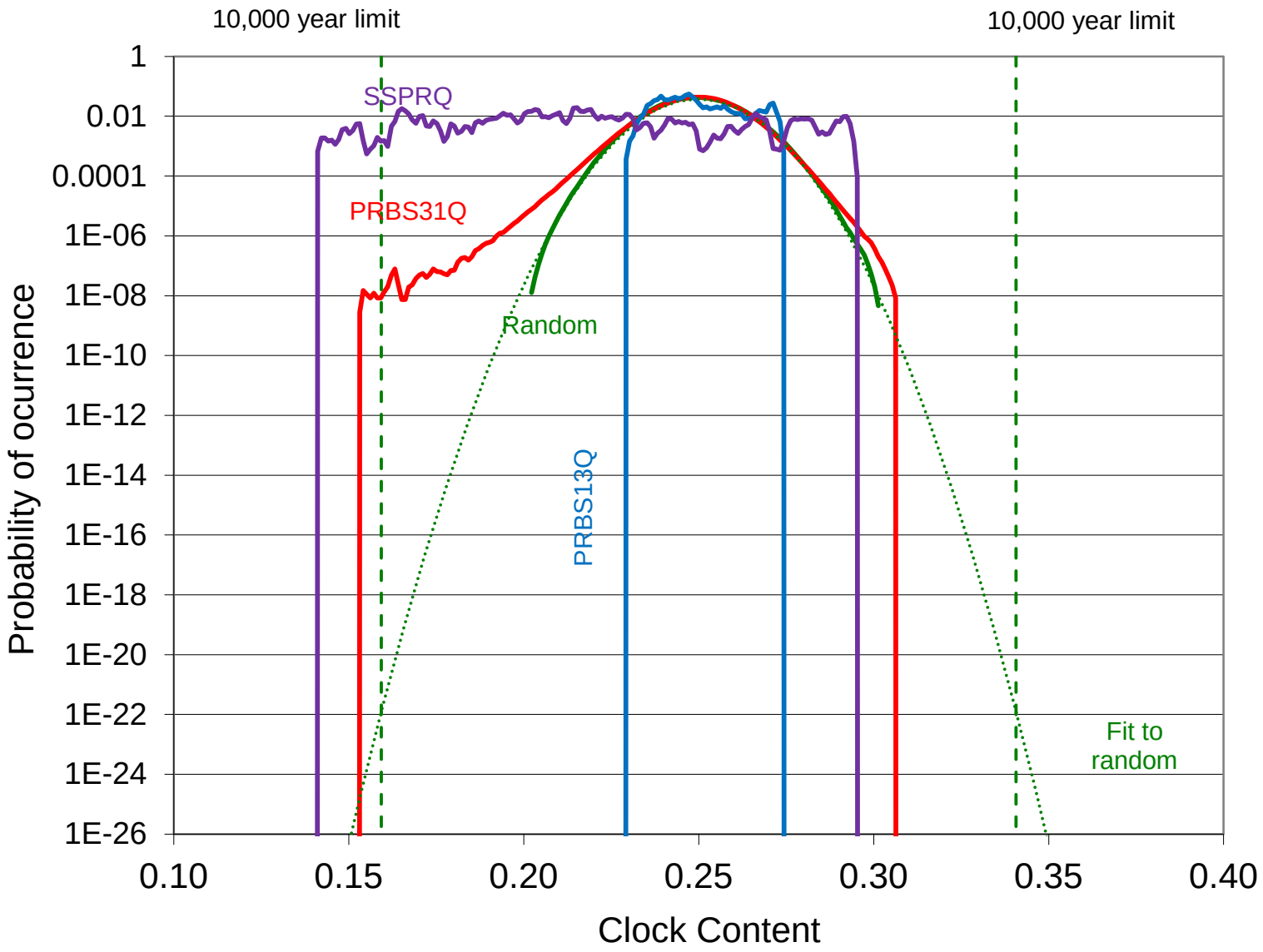
Baseline wander (Baud / 10,000)



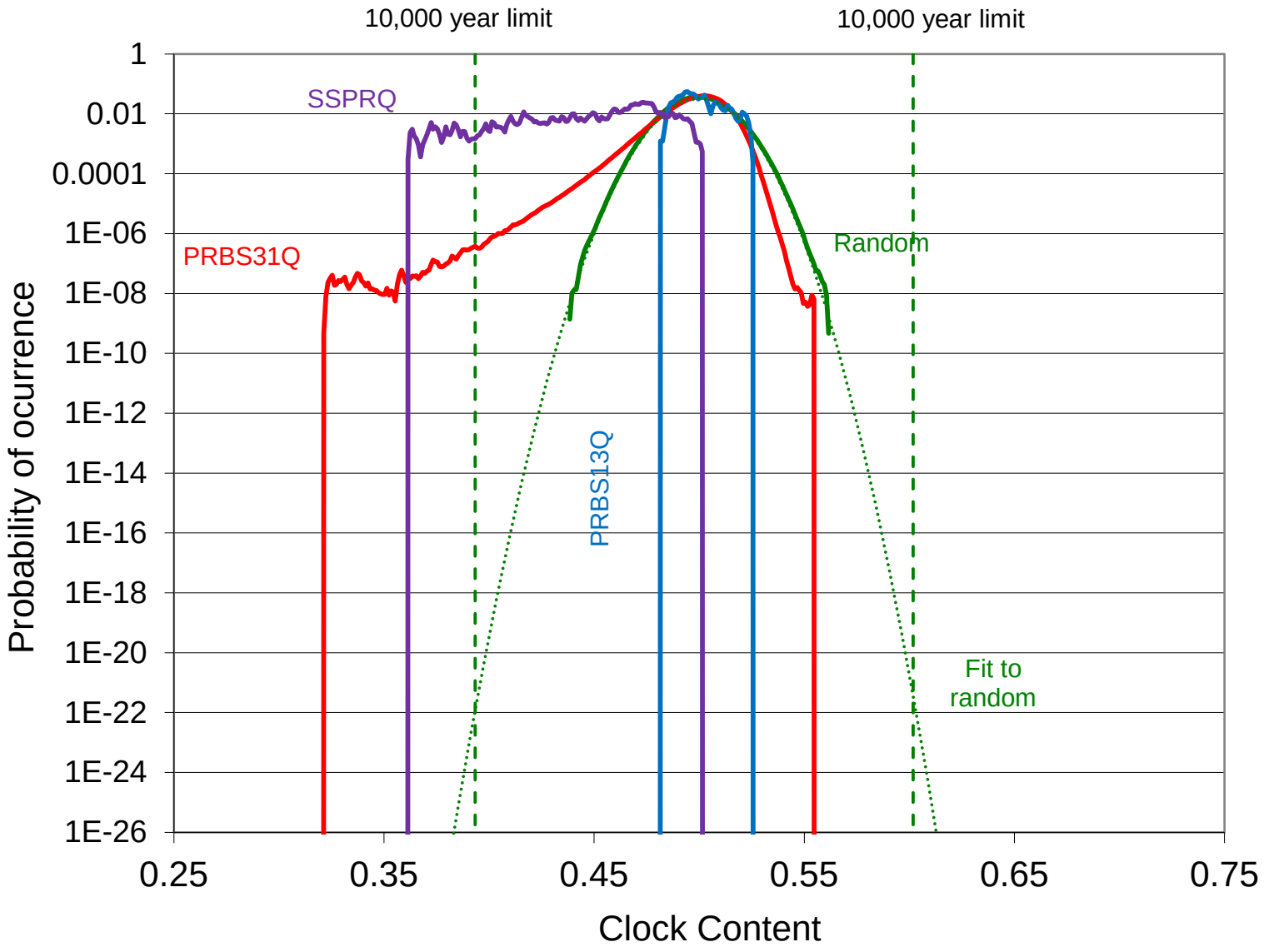
Baseline wander (Baud / 50,000)



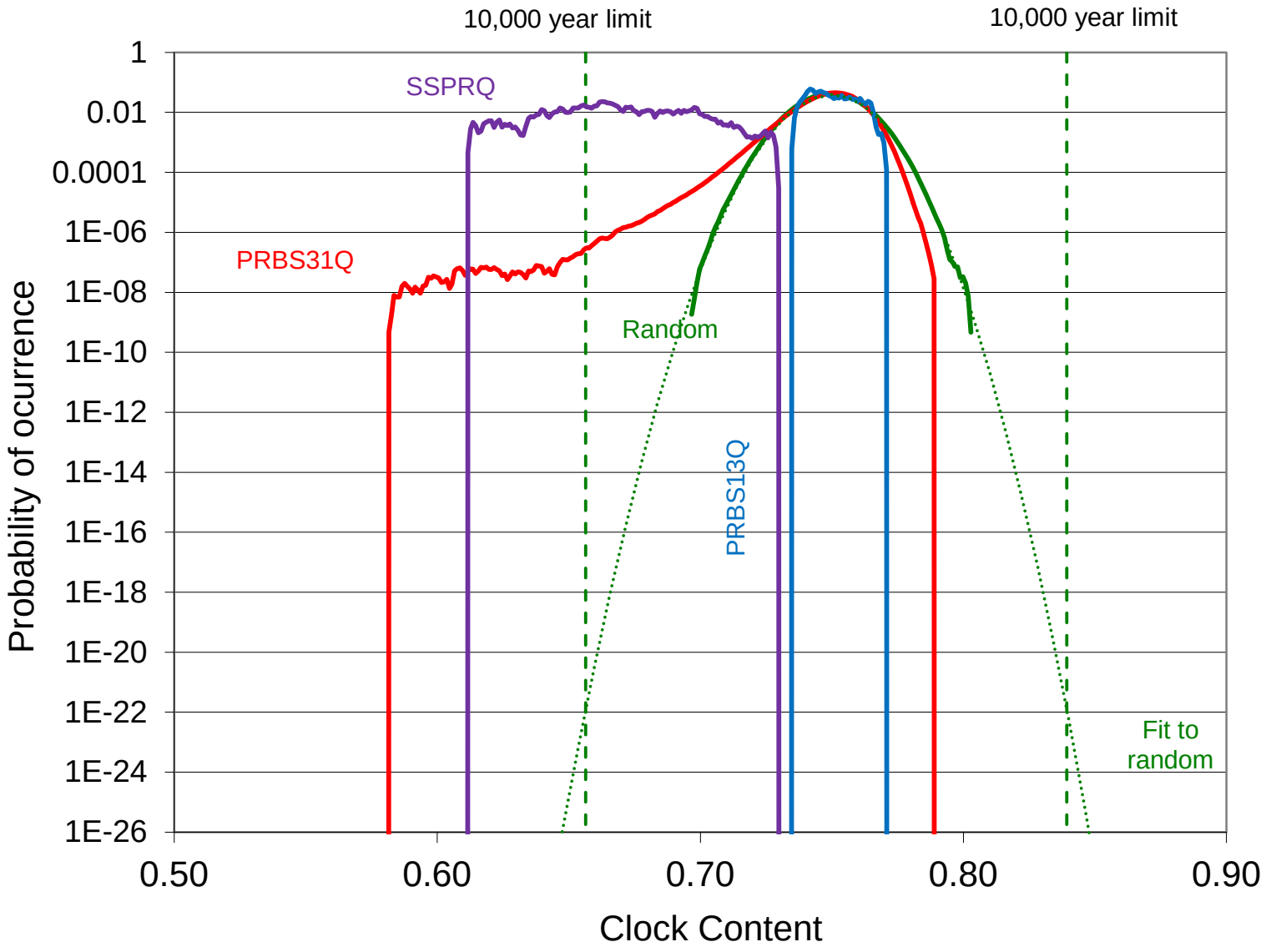
Clock, sym. trans. through ave, Baud/6641



Clock, transitions through average, Baud/6641



Clock, all transitions, Baud/6641



Conclusion

Two versions of the proposed SSPRQ test pattern have been analysed.

The first version is 65,535 symbols long and exceeds the baseline wander (Baud/10,000) and min clock content of 10,000 years of random data.

The second version is 32,767 symbols long and exceeds min clock content of 10,000 years of random data, but does not exceed the baseline wander (Baud/10,000).

Because of the limited length of the SSPRQ test pattern, changing the baseline wander AC-coupling to be Baud/50,000 makes the SSPRQ test pattern much less stressful than 10,000 years of random data. This effect is worse for the 32,767 symbol version.

It is therefore proposed to use the 65,535 symbol test pattern for any tests that require a stressful pattern and the symbol sequence to be captured.

Thanks!