MAGICS TECHNOLOGIES

LOW POWER RADIATION HARDENED BY DESIGN TDC WITH 8 PS SINGLE-SHOT PRECISION

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esa

MAGICS

ABOUT MAGICS TECHNOLOGIES NV

Located in Geel, Belgium, Magics Technologies is a fabless semiconductor supplier focused on Empowering the Future of the Space Economy and Energy applications employing 42 FTEs.

With the aspiration to become the leading supplier of rad-hard semiconductors for the Space, Energy and Defense markets, Magics has doubled its staff and revenue almost annually.

Magics utilizes a rad-hard-by-design methodology to create state-of-the-art, high-performance chips. This method integrates allows to use the latest technology nodes to ensure competitive performance while maintaining outstanding reliability.

We integrate components to reduce the bill of materials and increase functionality, lowering overall costs for our customers while excelling in performance.

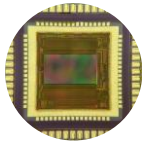
OUR RELIABLE CHIP SERIES

Magics' chips are an enabler for various applications in radiation environments

An I&C platform for data acquisition and control

- Reduced cabling and digitalisation without shielding.
- Cold sparring and Hot swapping functions
- Remote terminal units (RTU), positioning systems

MOTION Series
Sensor front ends and motion control



World-first complete digital CMOS-based camera solution for nuclear environments with 100Mrad radiation tolerance

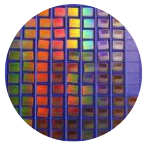
- A full-HD CMOS image sensor and
- A Coax-Press Video/Image serialisation and transmission chip

VISION Series
Nuclear camera solutions

Excelling in Time measurement & generation

- An ITAR-free rad-hard frequency synthesizer (clock generation)
- A rad-hard time-to-digital converter (time measurement) for space applications and nuclear applications
- * Supported by esa European space agency.

TIME Series
Clock and timing



Engineering to improve reliability of electronic systems

- Increase reliability of electronics
- Reduce replacement cycles

Custom solutions

TDC development project with ESA

TIME SERIES

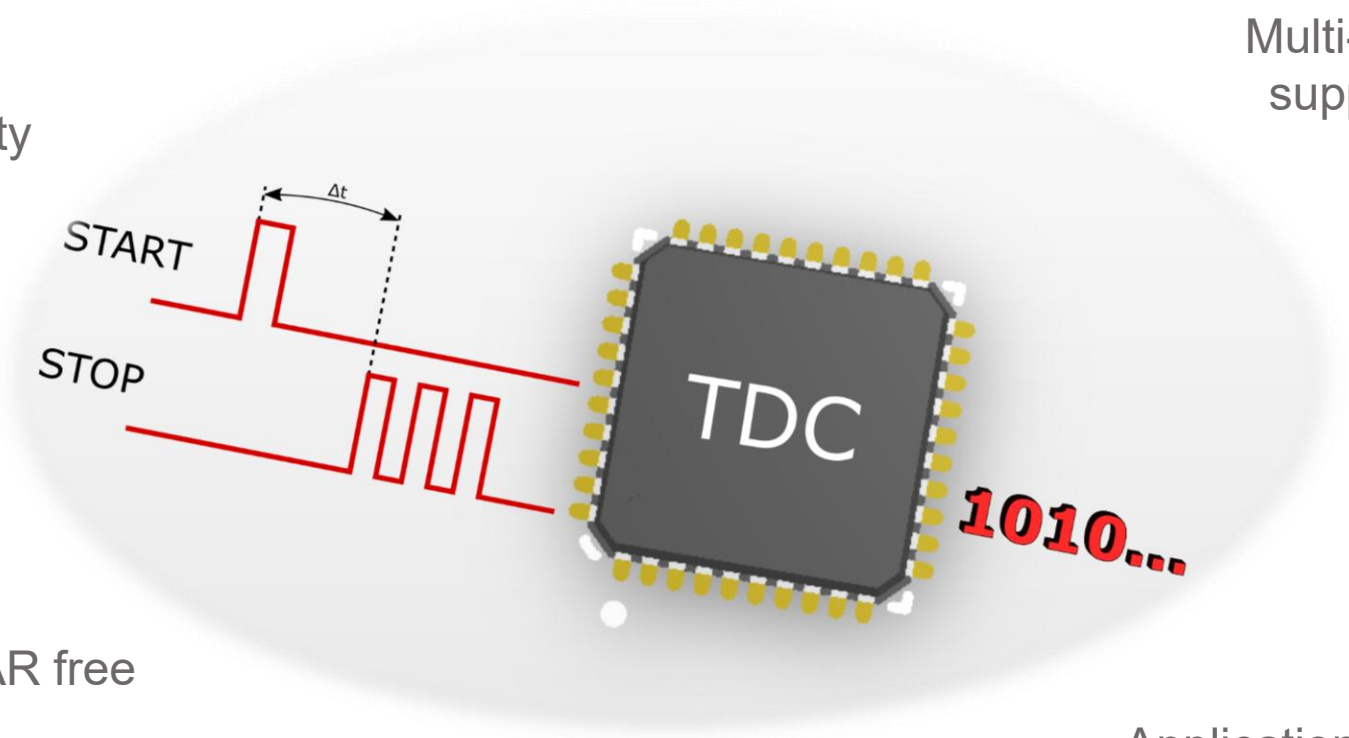
ESA PROJECT OBJECTIVES

Achieve sub-10 picosecond single-shot precision, with more than 100 microsecond measurement range.

Zero dead zone

Multi-stop support

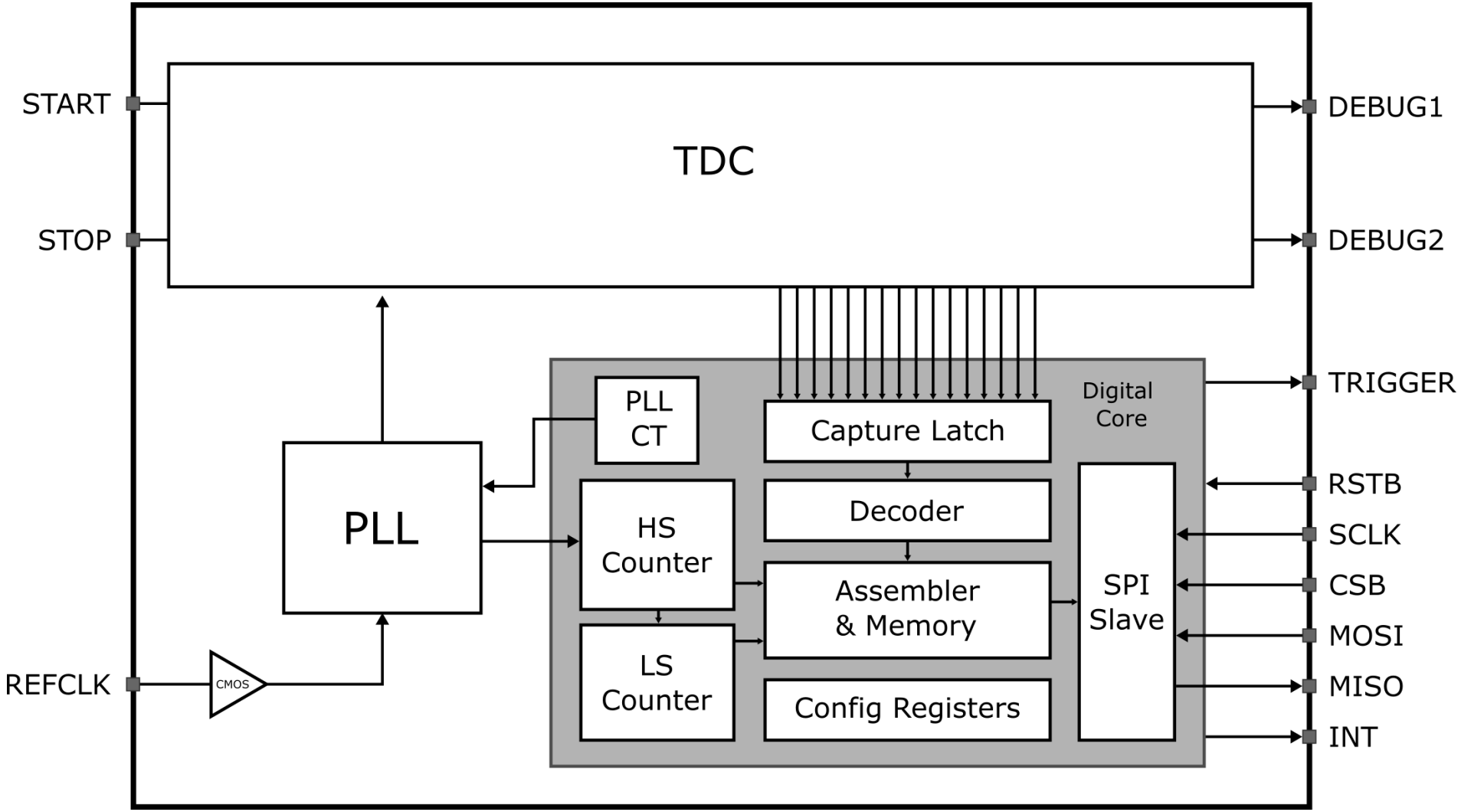
High linearity



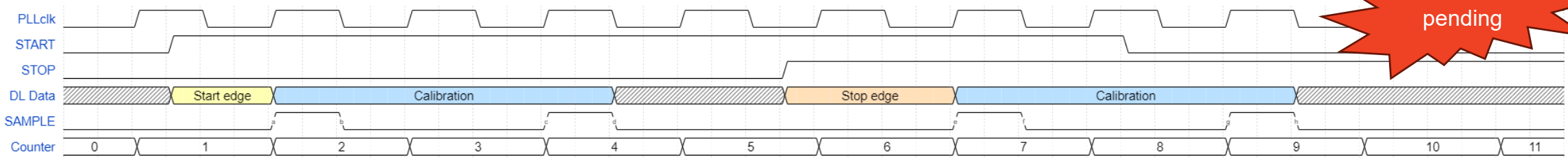
ITAR free

Applications Flexibility

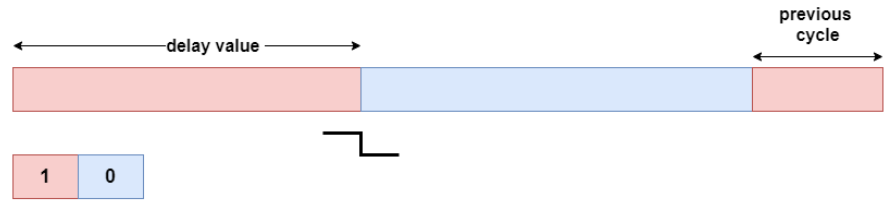
TDC architecture

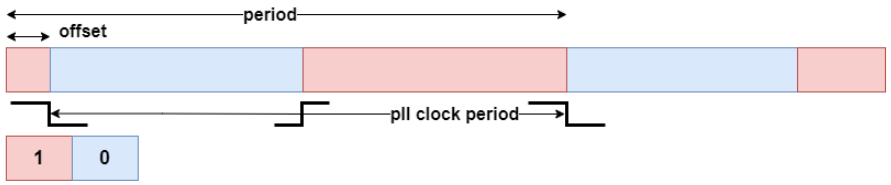


TDC architecture



Patent pending





$$LSB_{start} = \frac{T_{ref}}{START\ BIN\ CAL\ PERIOD - START\ BIN\ CAL\ OFFSET} = \frac{800 * 10^{-12}}{110 - 8} = 7.843\ ps$$

$$LSB_{stop} = \frac{T_{ref}}{STOP\ BIN\ CAL\ PERIODn - STOP\ BIN\ CAL\ OFFSETn} = \frac{800 * 10^{-12}}{110 - 9} = 7.921\ ps$$

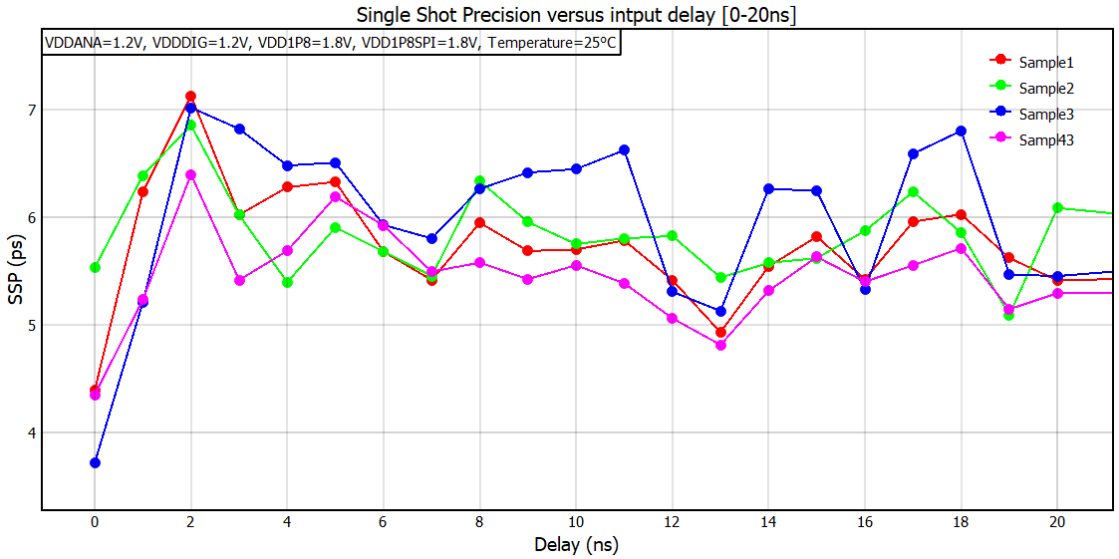
$$COUNT_n = STOP\ CNT_n - START\ \ CNT = 14 - 4 = 10$$

$$TOF_n = (LSB_{start} * START_{DEL}) - \left(LSB_{stop} * STOP_{DELn}\right) + \left(COUNT_n * T_{ref}\right)$$

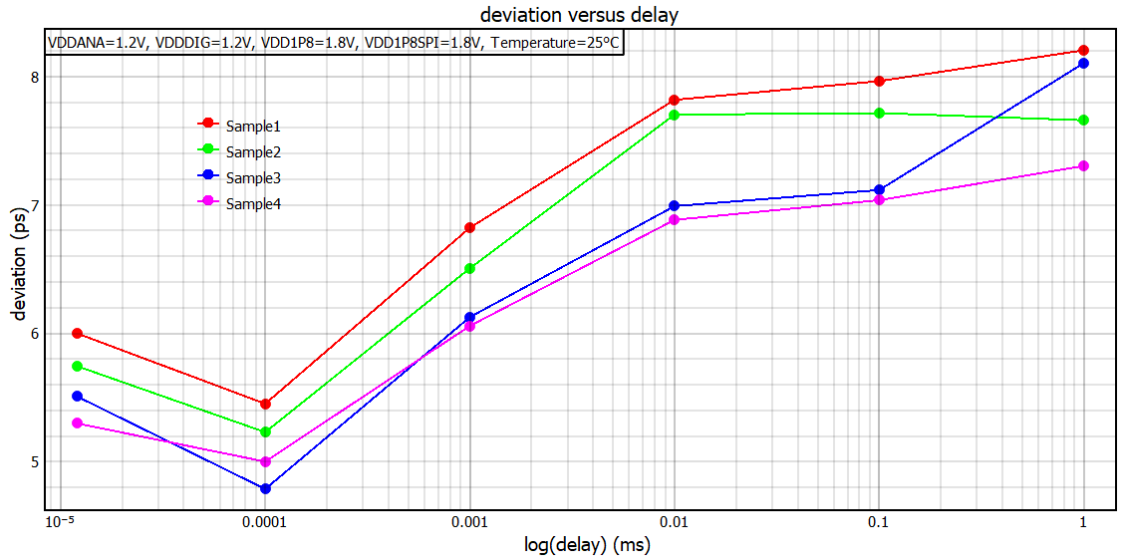
$$= (7.843\ ps * 121) - \ (7.921\ ps * 28\ ) + (10 * 800\ ps) = 8.727\ ns$$

Results: Single-Shot Precision

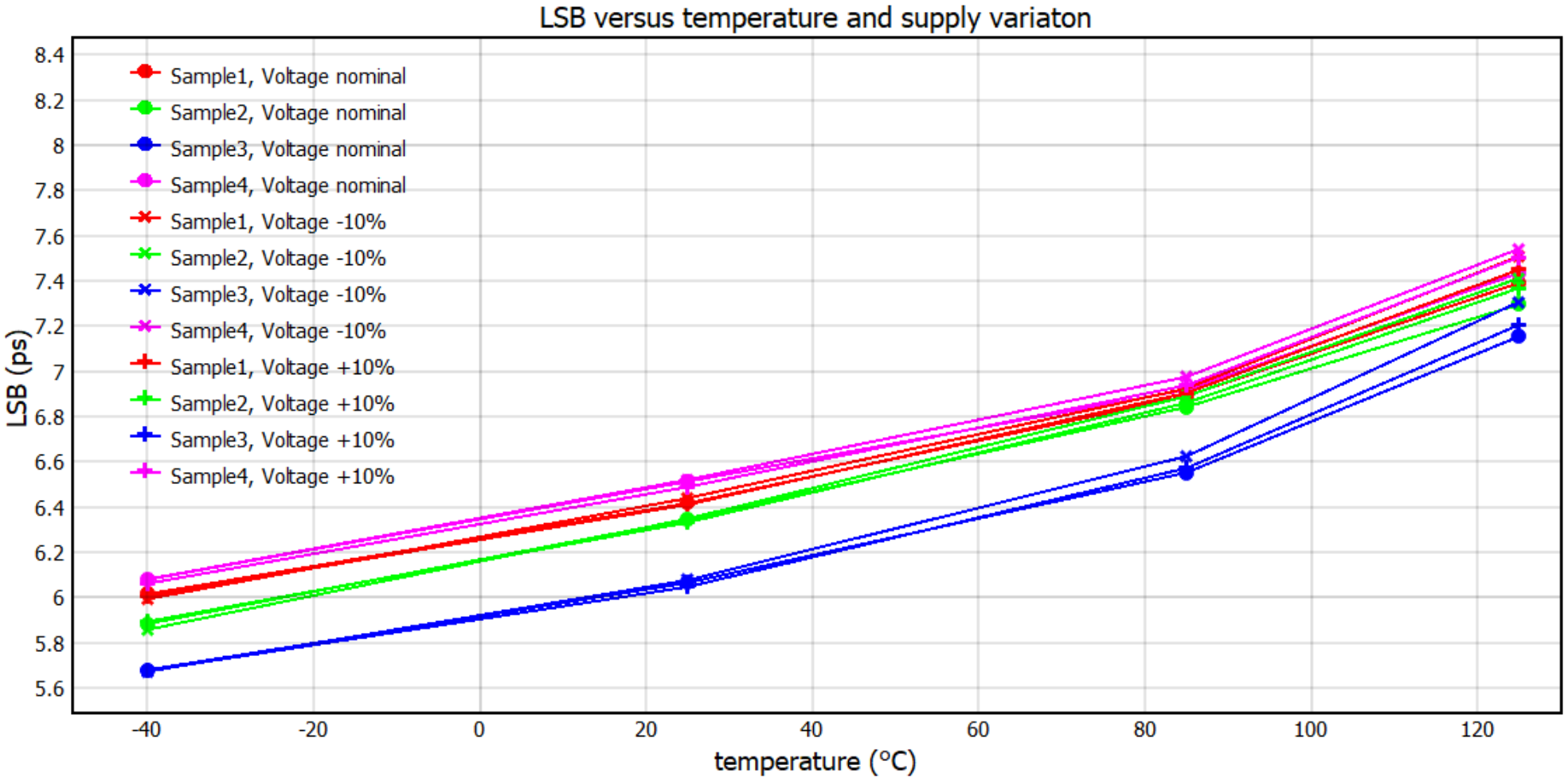
SSP vs Delay [0-20ns]



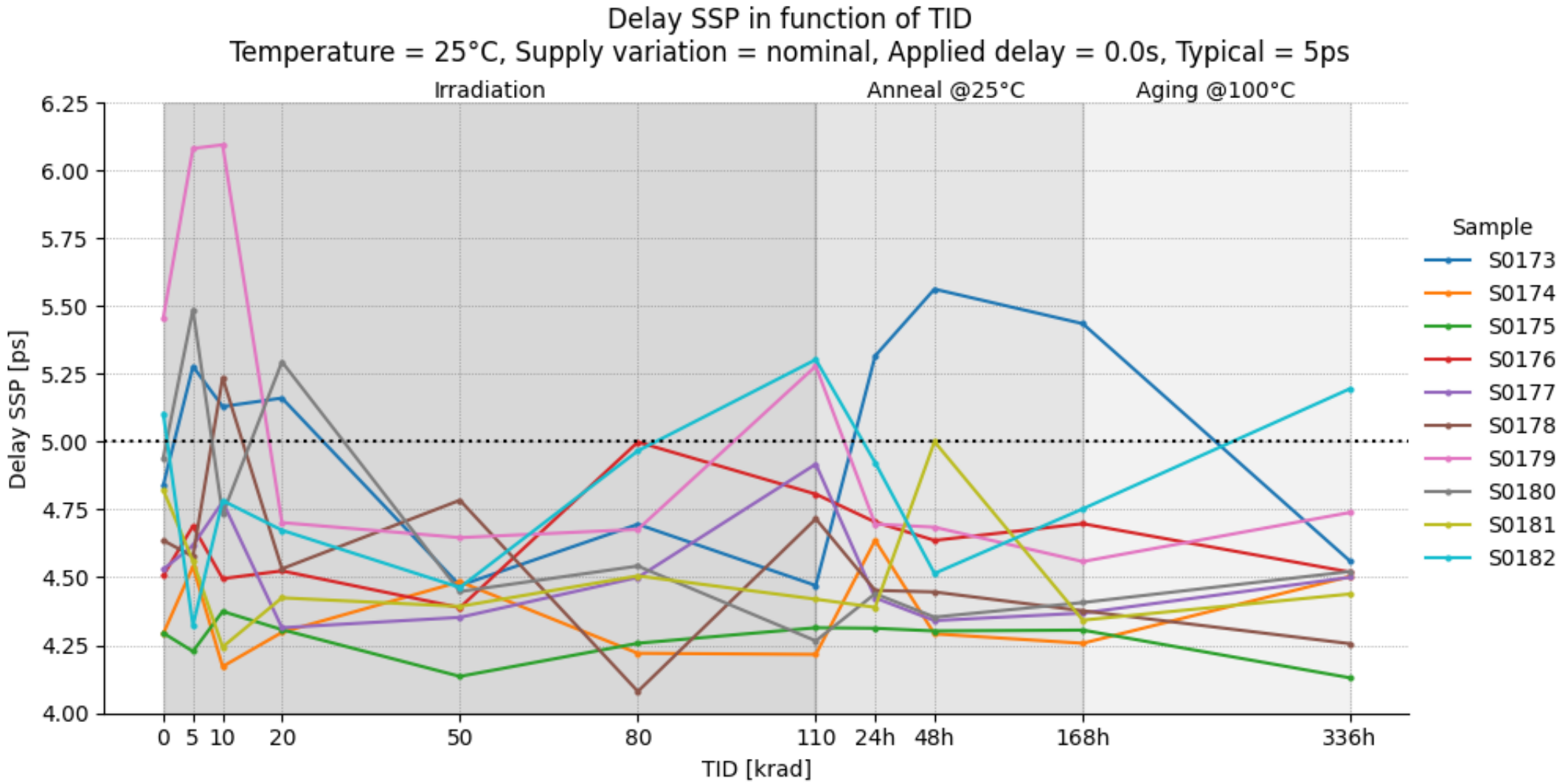
SSP vs log(Delay) [20ns-1ms]



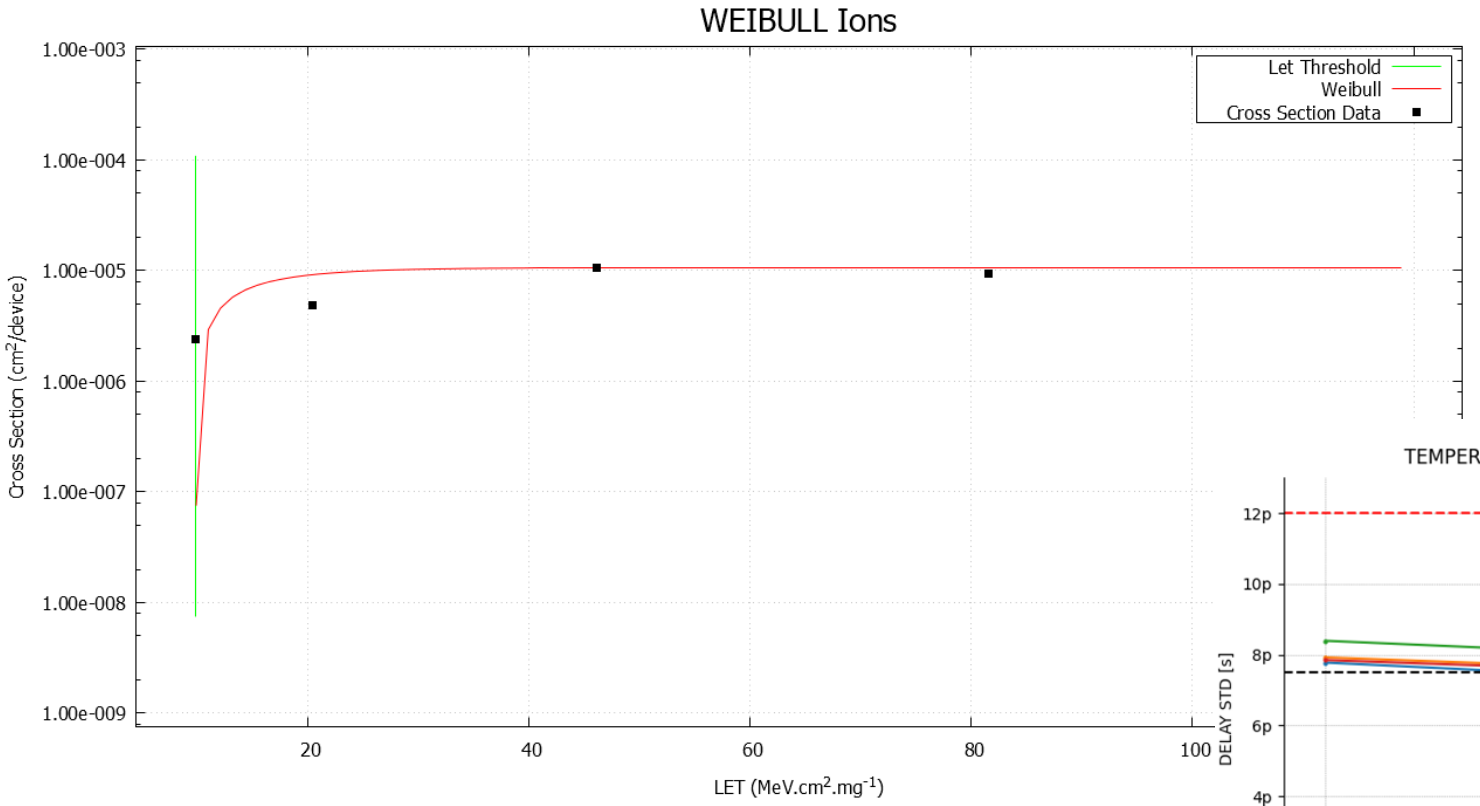
Results: Conversion step size (LSB)



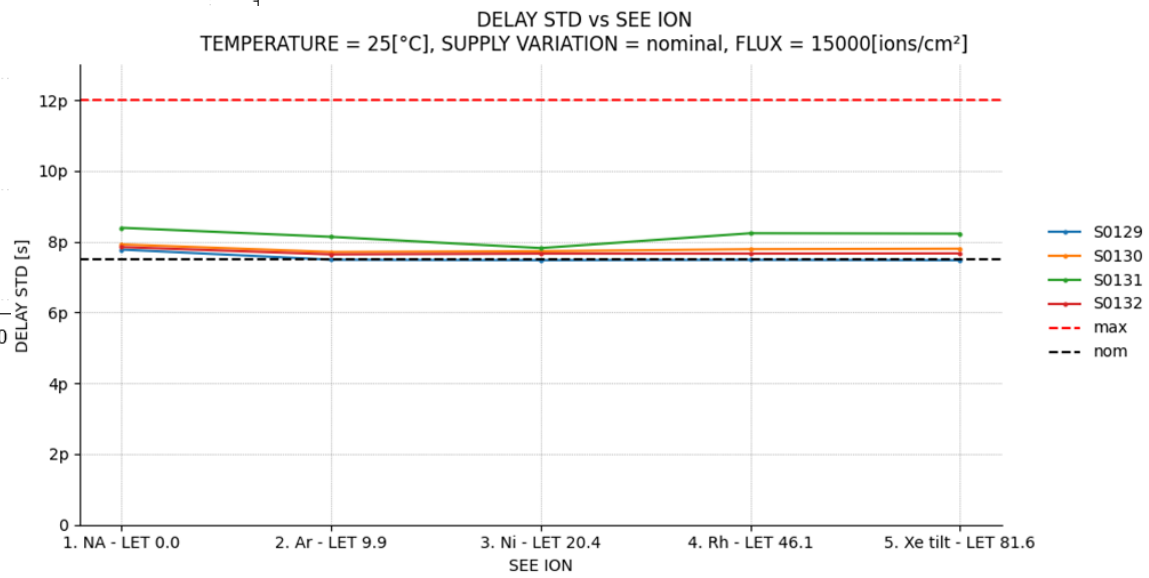
Results: Total Ionising Dose, SSP



Results: Single Event Effects, SET

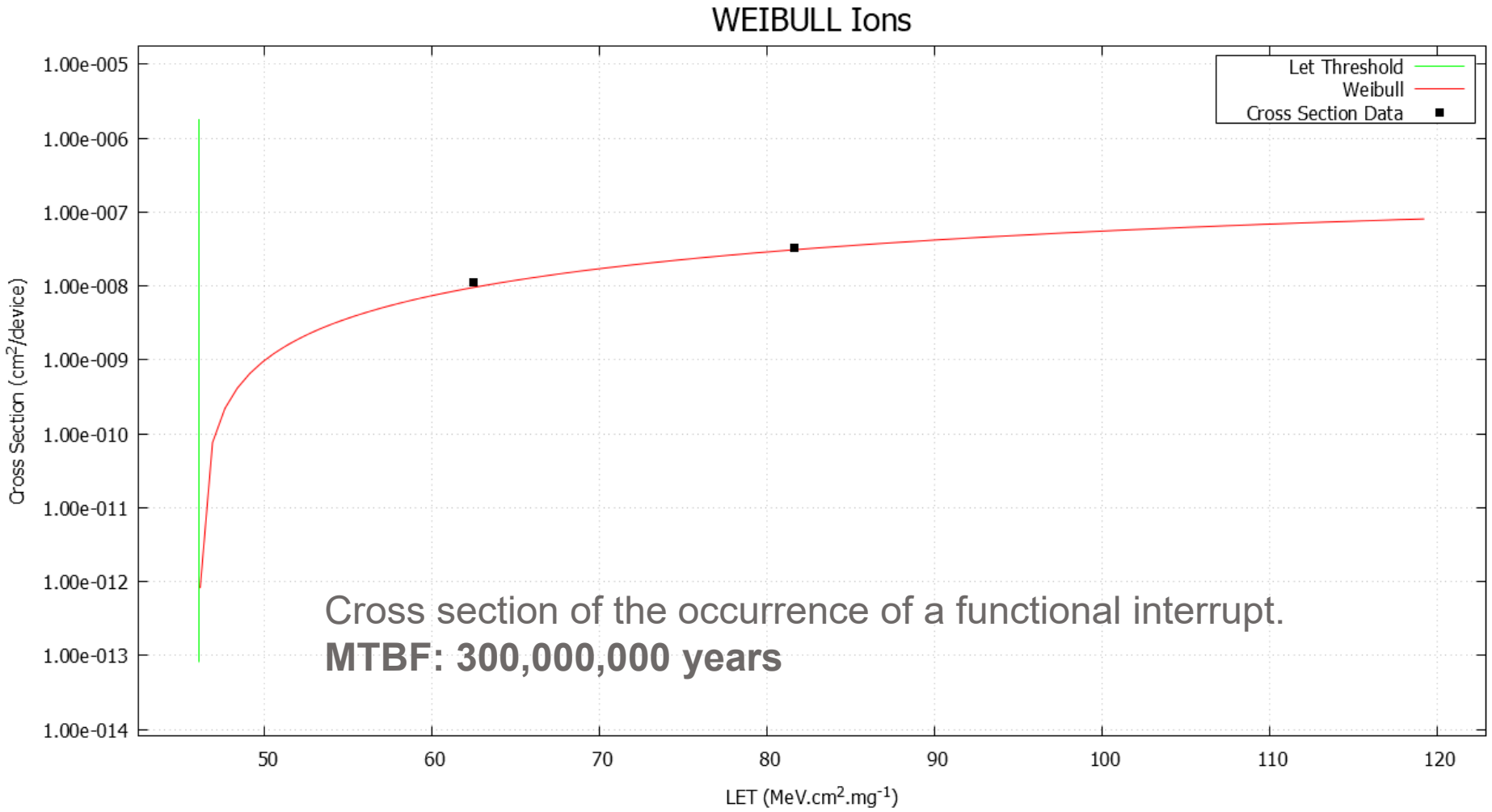


← Cross-section for the occurrence of an outlier > 50ps
5 events / day (GEO orbit)



Overall SSP during SET testing →

Results: Single Event Effects, SEFI

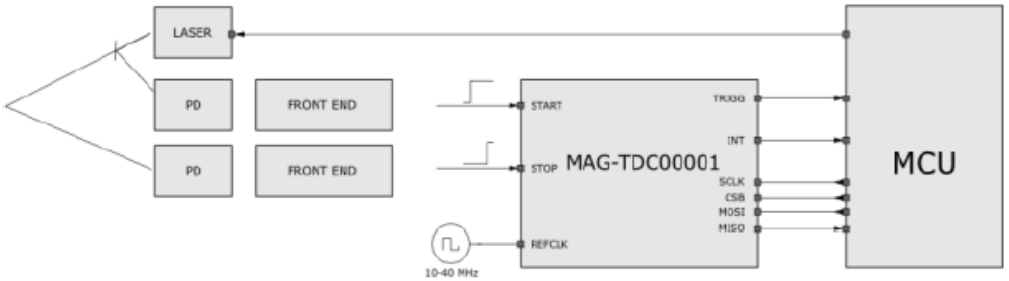


Cross section of the occurrence of a functional interrupt.

MTBF: 300,000,000 years

TYPICAL APPLICATIONS

START-STOP mode

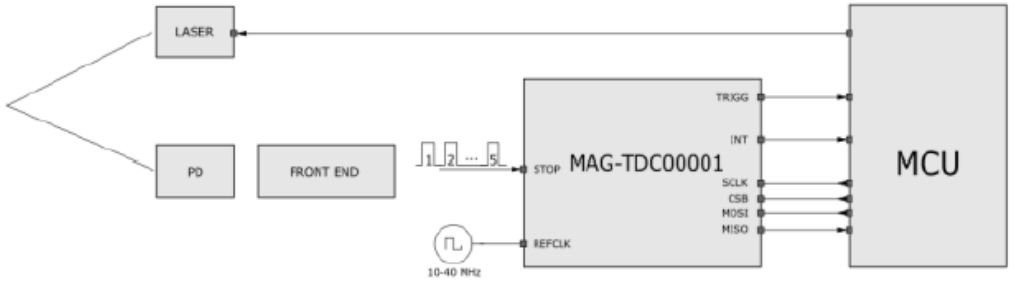


Zero Dead Zone in [0 ps; 3 s]

Applications:

Approaching, landing, docking, …

Multi-STOP mode

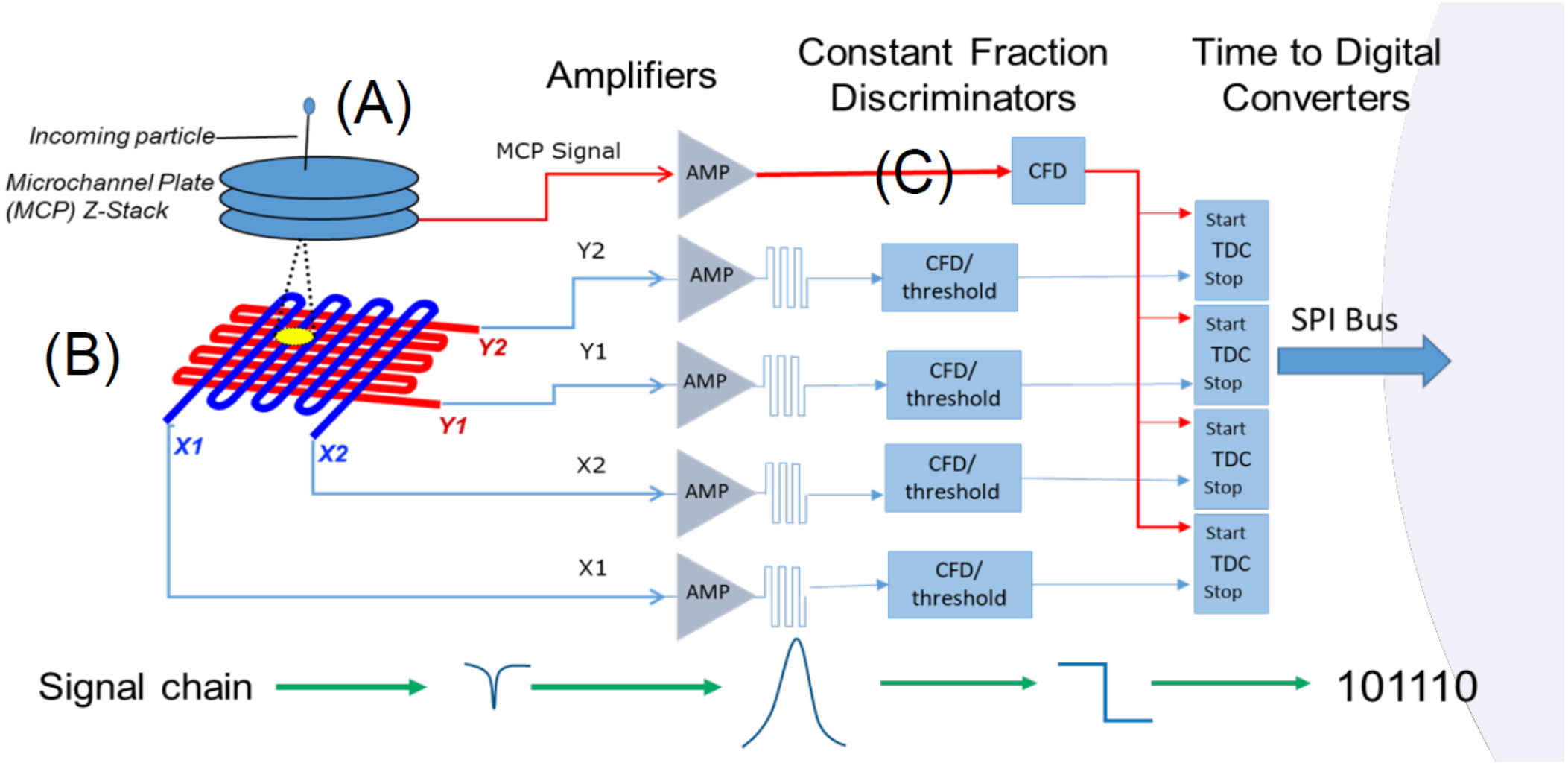


Up to 5 reflected pulses captured

Applications:

Highest throughput reachable, Time tagging

2D SPECTROSCOPY



Key performance metrics

Thanks to the support of ESA:

- **A fully functional prototype chip was designed and demonstrated in our lab**

The key requirements are met:

- **SSP <10ps for a range >100µs**
- **Zero dead-zone**
- **Multi-stop support**

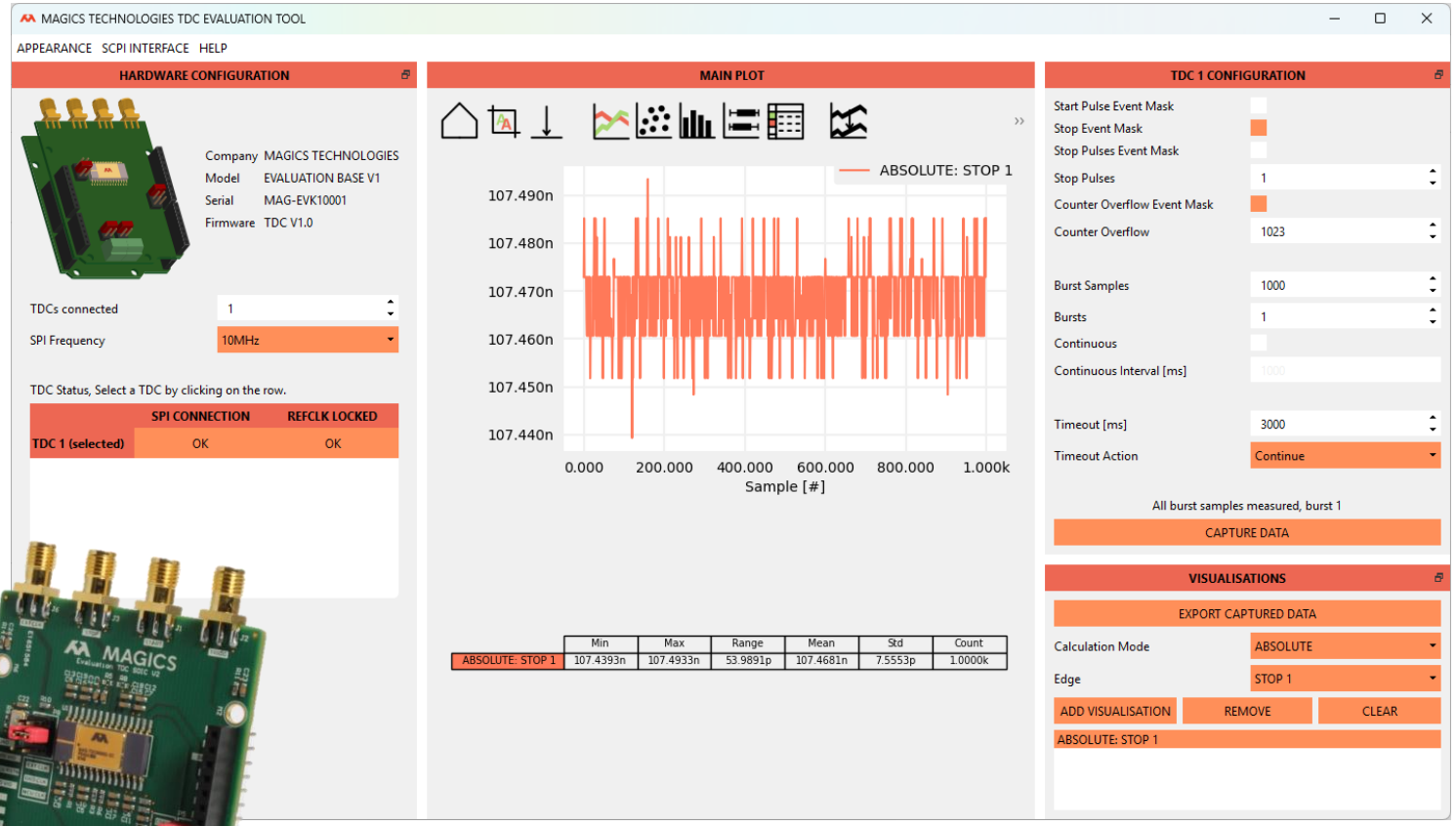
We see a nice potential for this chip in the space market.

Customers can build their applications with the Magics TDC already today.

Metric	Result
Measurement range	[0 ps; 3 s]
Conversion step size [LSB]	8 ps (typ)
INL/DNL (peak)	+/-2 LSB
SSP	8 ps
Core/ IO voltage	1.2 V/ 1.8-3.3 V
Operating Temperature	-40°C to 125°C
Power consumption	20 mW
Sample rate	500 kSps
Reference clock	10 - 20 - 30 - 40 MHz
TID	> 100 krad (Si)
SEE	> 62.5 MeV.cm^2/mg
ITAR free	

TDC Evaluation Kit

- Easy-to-use GUI
- Evaluation within a few hours
- Stackable up to 3 shields
- All key functionalities
- SCPI command interface



Multichannel TDC

- Follow-up chip
- support of ESA
- 16 individual channels
- High speed serial read-out

THANK YOU!