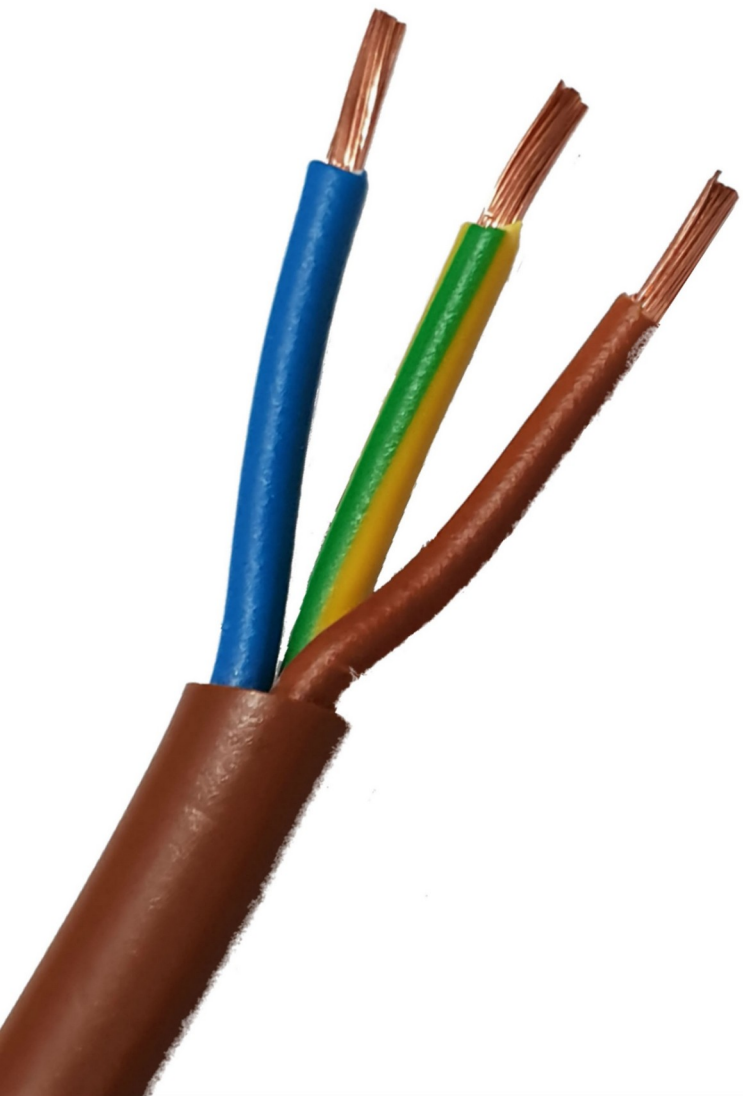


# Rivelatori di particelle



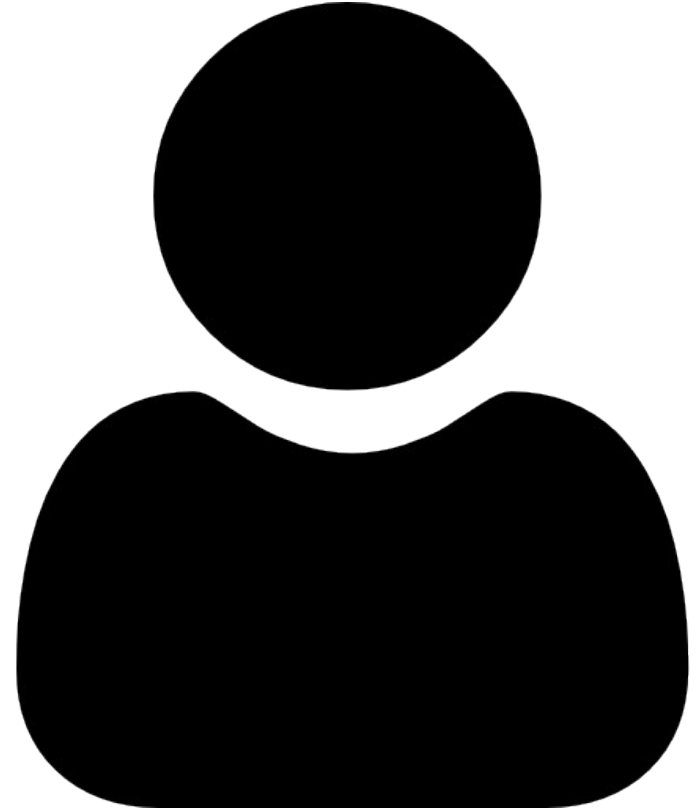
**R. Biondi, M. Caravati e N. Rossi**  
Laboratori Nazionali del Gran Sasso (INFN)  
***Evento IDM2024 per le scuole***  
***24 e 31 gennaio 2024***



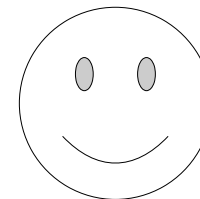
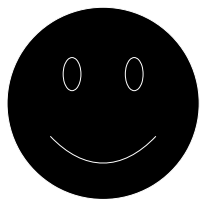
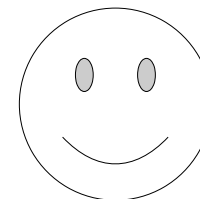
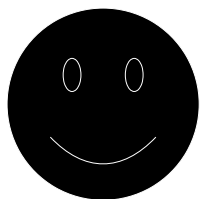


PROPERTY	VALUE
Composition	—
Statistics	—
Family	—
Generation	—
Interaction	—
Symbol	$\chi$
Antiparticle	—
Mass	$10^{-22} \text{ eV} \div 5 M_{\odot}$
Half-life	$\gtrsim 10^{10} \text{ y}$
Electric charge	$\lesssim 10^{-7} \text{ e}$ [at 1 GeV]
Self interaction	$< 0.5 \text{ cm}^2$ [at 1 GeV]
Magnetic Moment	—
Spin	—
Weak isospin	LH: —, RH:—
Weak hypercharge	LH: —, RH:—
Others	—

# Identikit

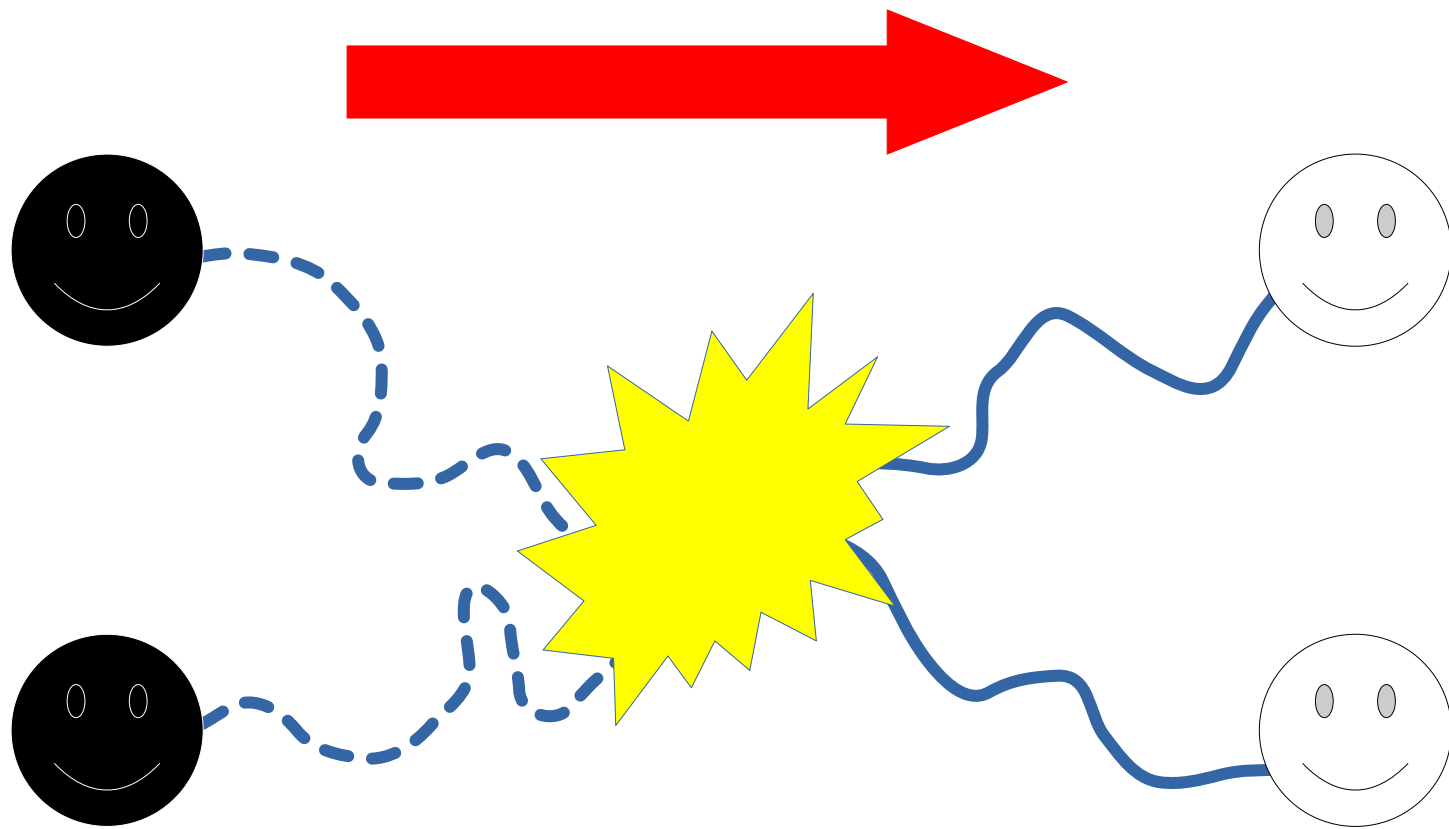






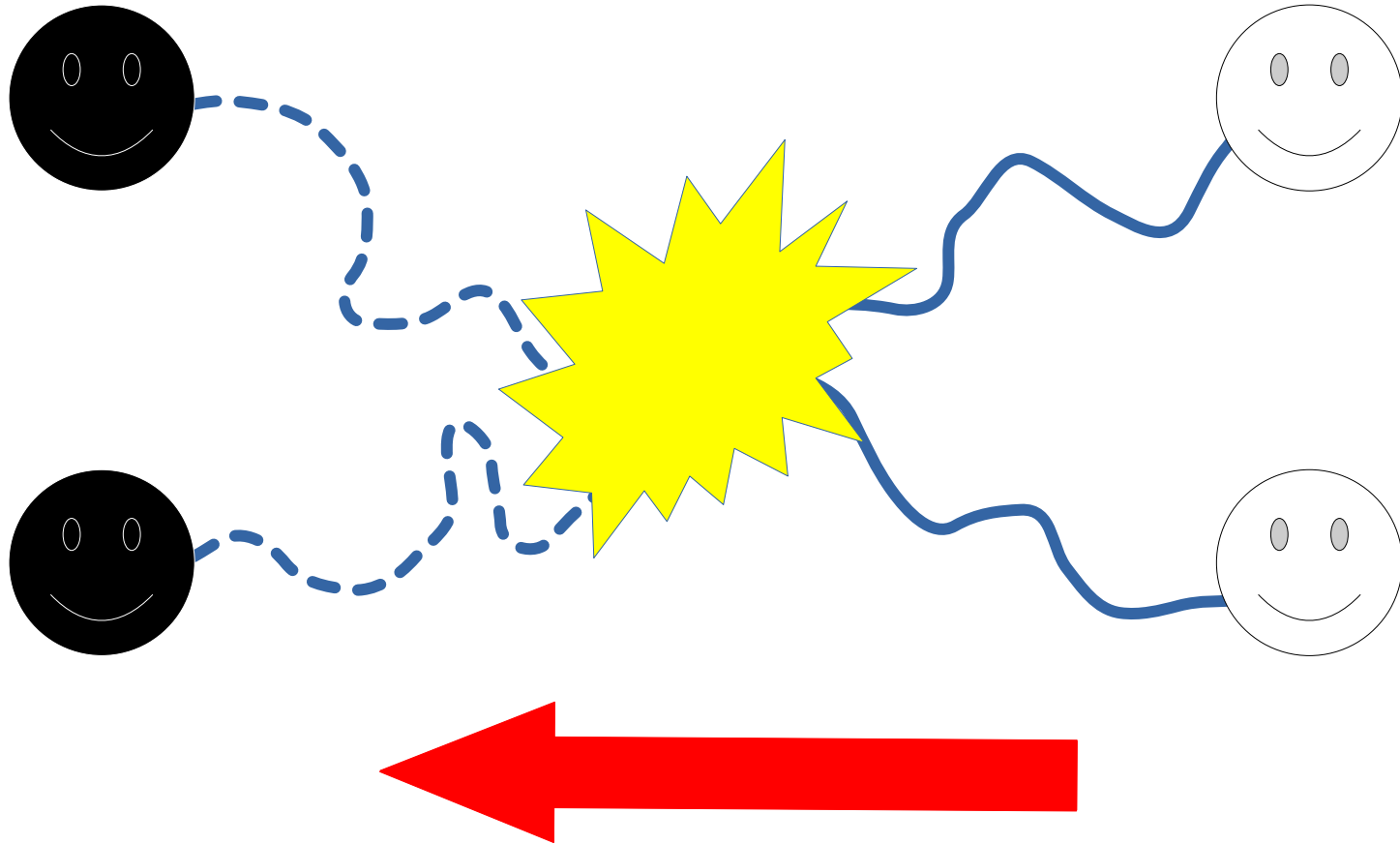
**Materia Oscura**

**Materia visibile**

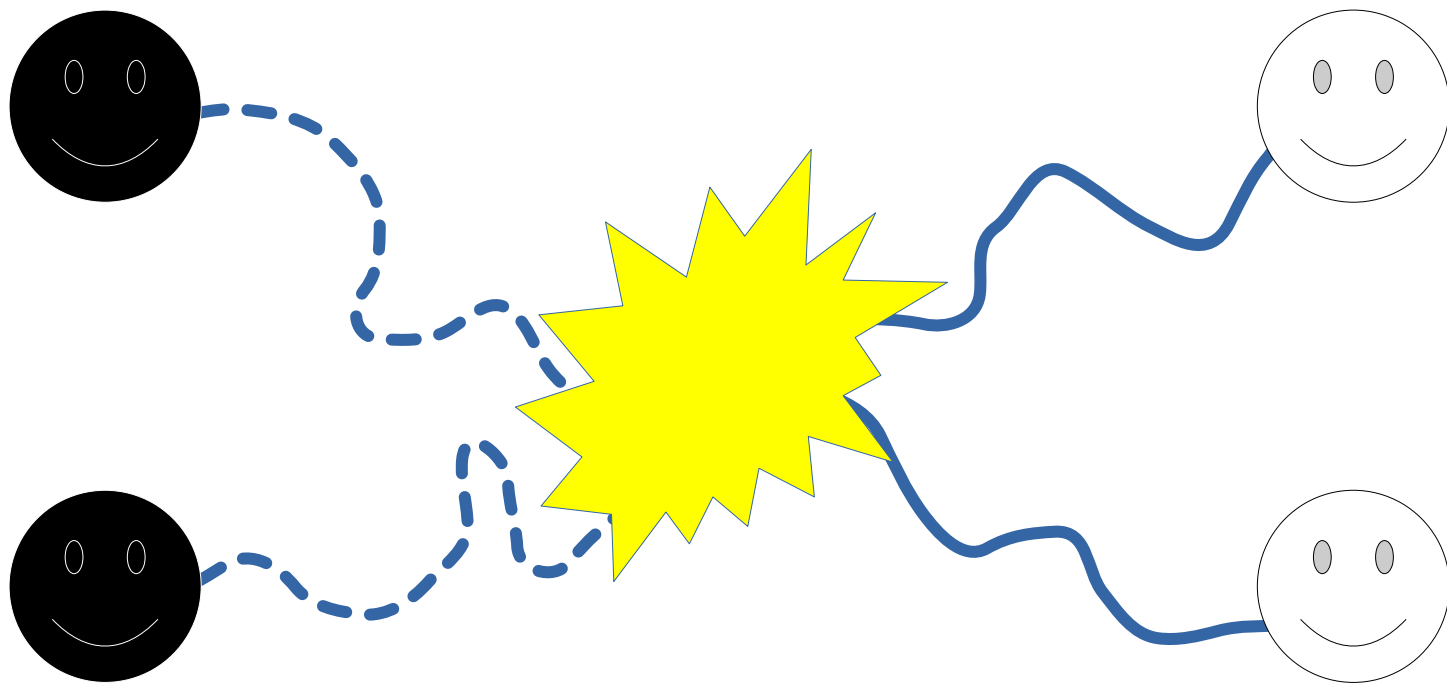


**Ricerca indiretta**

# Acceleratori







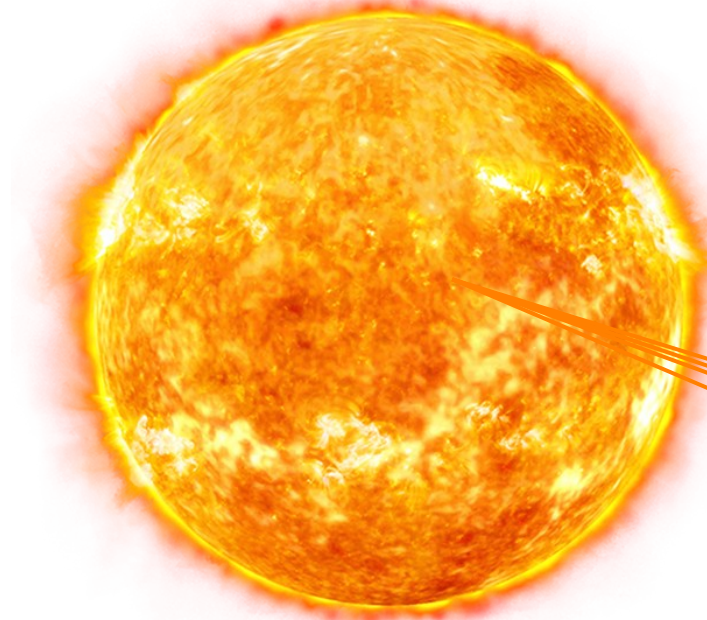
**Ricerca diretta**

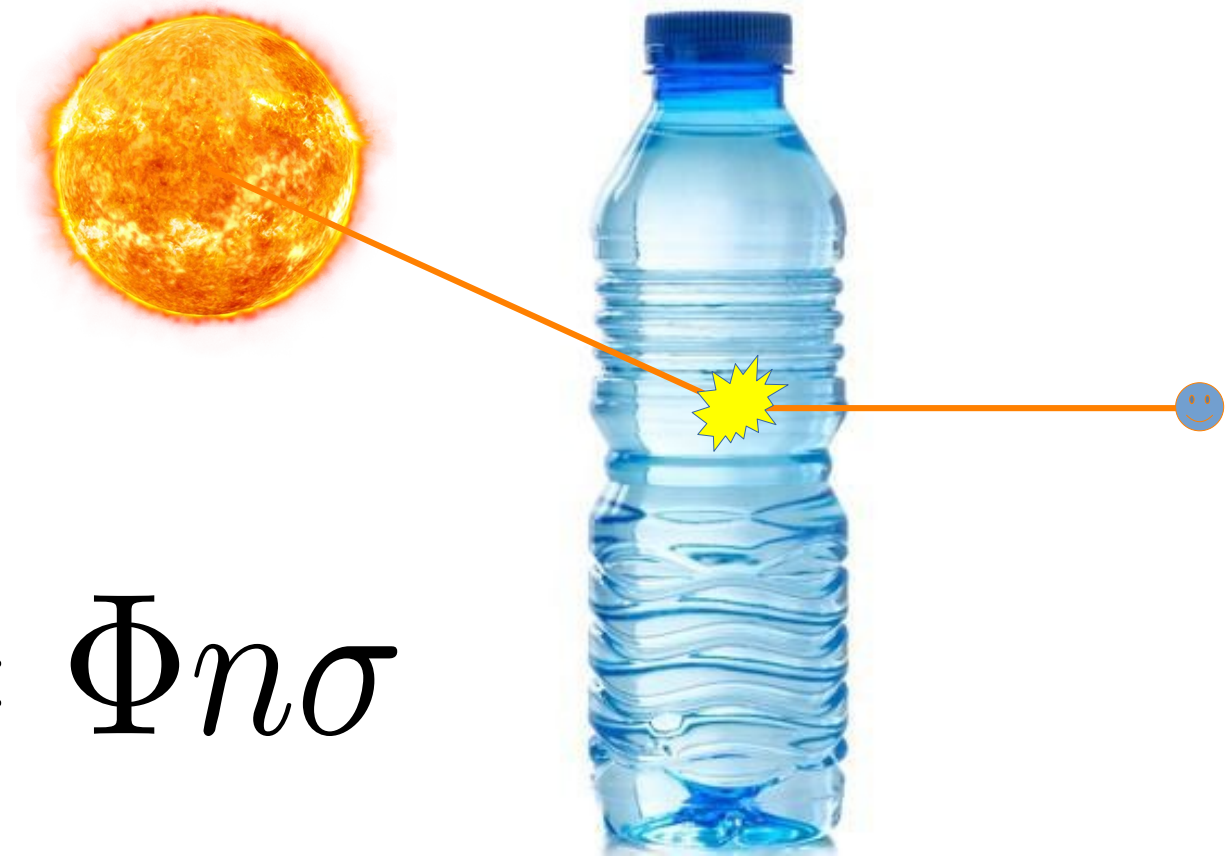




**Un esempio che  
conosciamo bene**

**NEUTRINI**





$$N_{\text{int}} = \Phi n \sigma$$

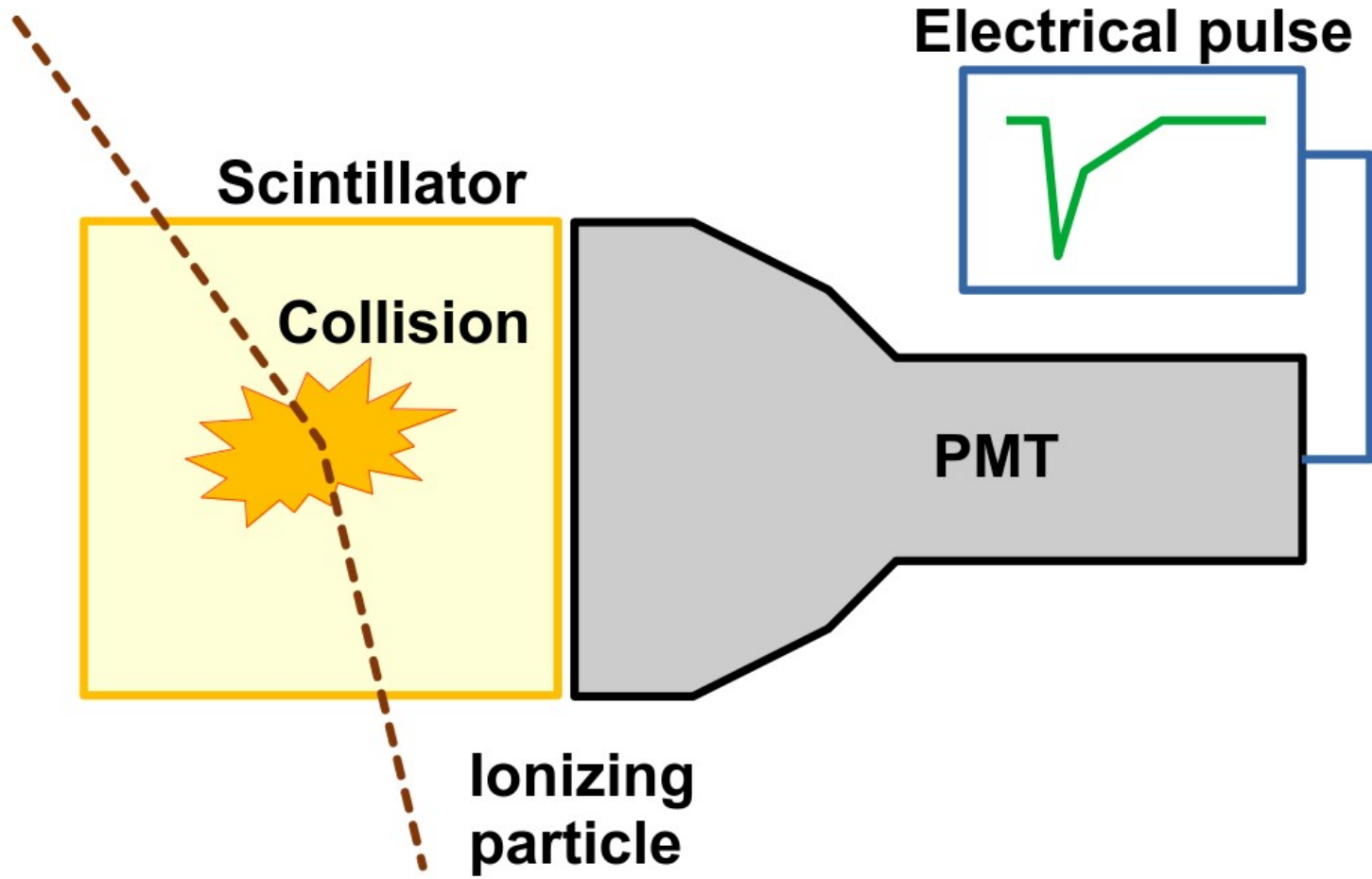
$$60 \cdot 10^9 \frac{\nu}{\text{cm}^2} \times 3 \cdot 10^{26} \times 10^{-45} \text{cm}^2 \times 3 \cdot 10^7 \text{s} \approx 1 \frac{\nu}{\text{y}}$$

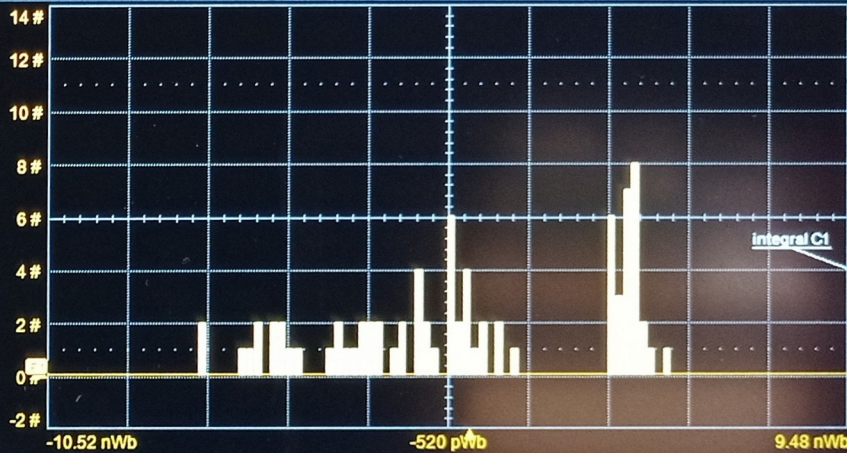
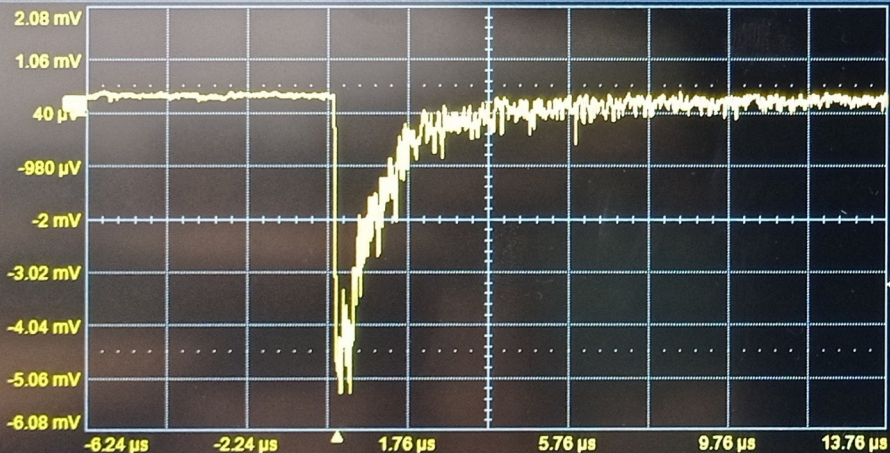
Flusso di neutrini

Elettroni  
Nella  
bottiglia

Dimensione del  
neutrino

Secondi in un  
anno





Measure	P1:area(C1)	P2:area(C1)	P3:(P2-P1)	P4:area(C2)	P5:pkpk(C1)	P6:area(F1)	P7:fall8020(C2)	P8:ampl(F1)
value	-3.189332687 nWb							
mean	-1.422 nWb							
min	-34.789706326 nWb							
max	4.950461888 nWb							
sdev	7.559 nWb							
num	83							
status	✓							

C1 F1 D50 F1 hist(P1)

1.02 mV/div 2.00 #/div +

2.0000 mV 2.00 nWb

79%

50 kS 2.00 μs/div Stop -3.28 mV

2.5 GS/s Edge Positive

Channel Setup C1 C2 C3 C4

Trace On

Vertical Scale Scale 1.02 mV Var. Gain

Offset Offset 2.0 mV Zero

Coupling 500 DC50Q

Bandwidth Bandwidth 200MHz

Attenuation Attenuation +1

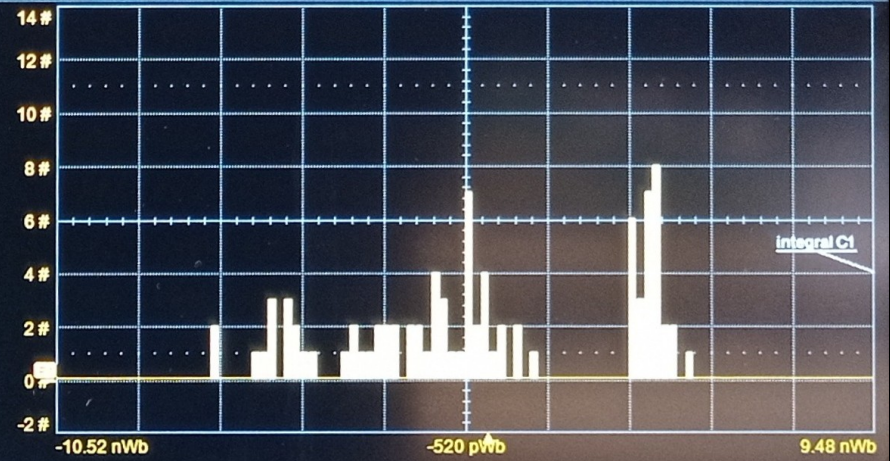
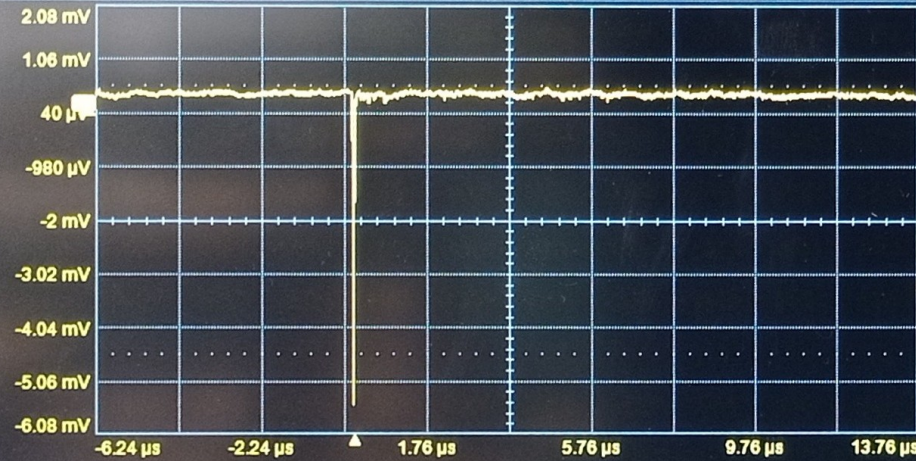
Rescale Vertical Unit V Units / V (slope) 1.000013 Add 0 μV

Pre-Processing Averaging 1 sweep Deskew 0 ps Invert

Interpolation Linear Noise Filter (ERes) +3 bits -3dB @ 20.00 MHz

Actions for trace C1 Measure Zoom f(x) Decode Store Find Scale Add / Edit Name Label





Measure	P1:area(C1)	P2:area(C1)	P3:(P2-P1)	P4:area(C2)	P5:pkpk(C1)	P6:area(F1)	P7:fall8020(C2)	P8:amp(F1)
value	4.543185413 nWb							
mean	-2.102 nWb							
min	-34.789706326 nWb							
max	4.950461888 nWb							
sdev	8.559 nWb							
num	93							
status	✓							

C1 **F1** D50 F1 hist(P1)  
 1.02 mV/div 2.00 #/div  
 2.0000 mV 2.00 nWb  
 87 #

C1 DC  
 2.00 μs/div Stop -3.28 mV  
 50 kS 2.5 GS/s Edge Positive

Channel Setup

C1 C2 C3 C4

CLOSE

Trace On

Vertical Scale

Scale

1.02 mV

Var. Gain

□

Offset

Offset

2.0 mV

Zero

□

Coupling

500

Coupling

DC50Ω

Bandwidth

Bandwidth

200MHz

Attenuation

Attenuation

+1

Rescale

Vertical Unit

V

Units / V (slope)

1.000013

Add

0 μV

Pre-Processing

Averaging

1 sweep

Deskew

0 ps

Invert

□

Interpolation

Linear

Noise Filter (ERes)

+3 bits

-3dB @ 20.00 MHz

Actions for trace C1

Measure

Zoom

f(x) Math

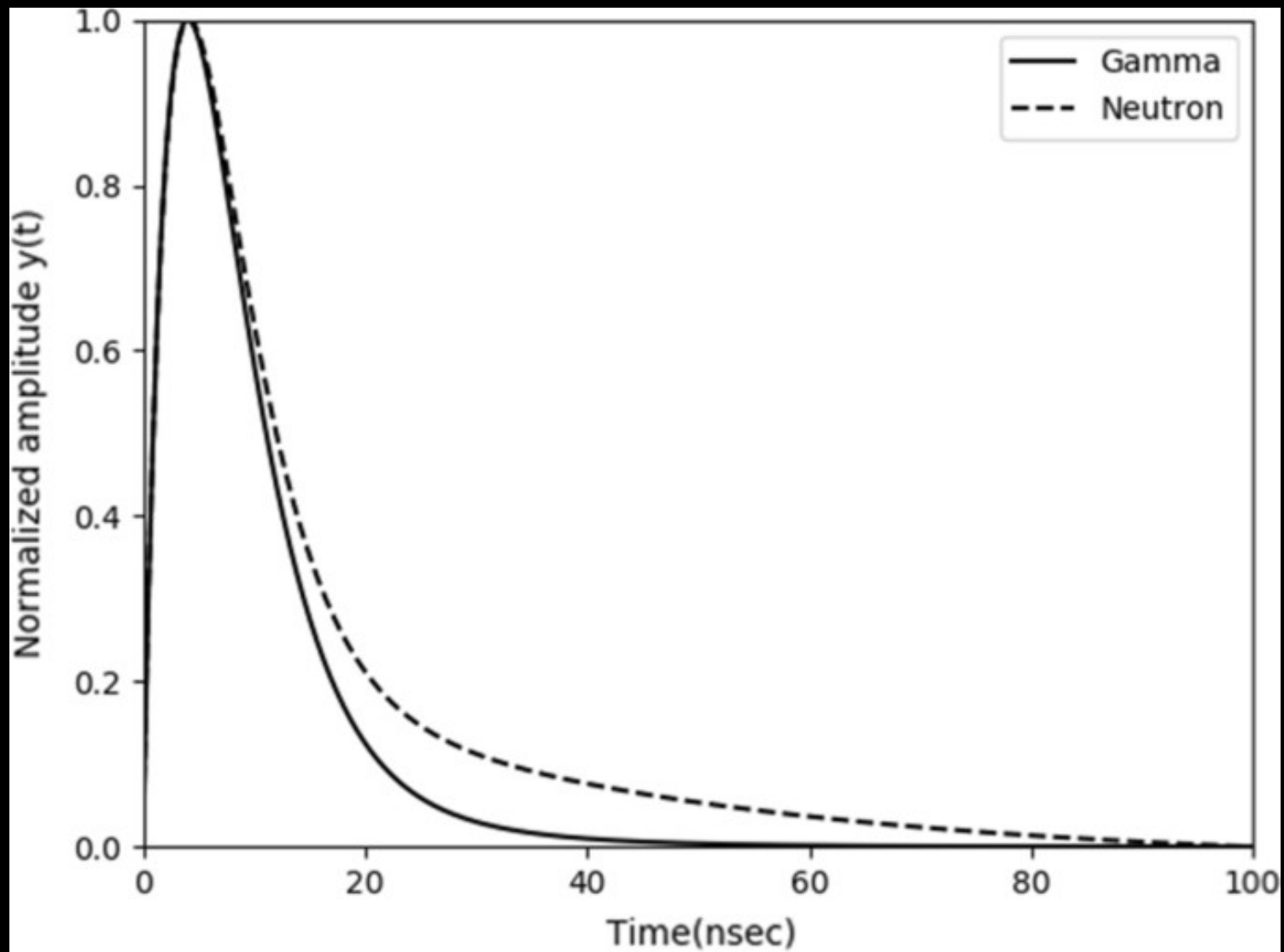
Decode

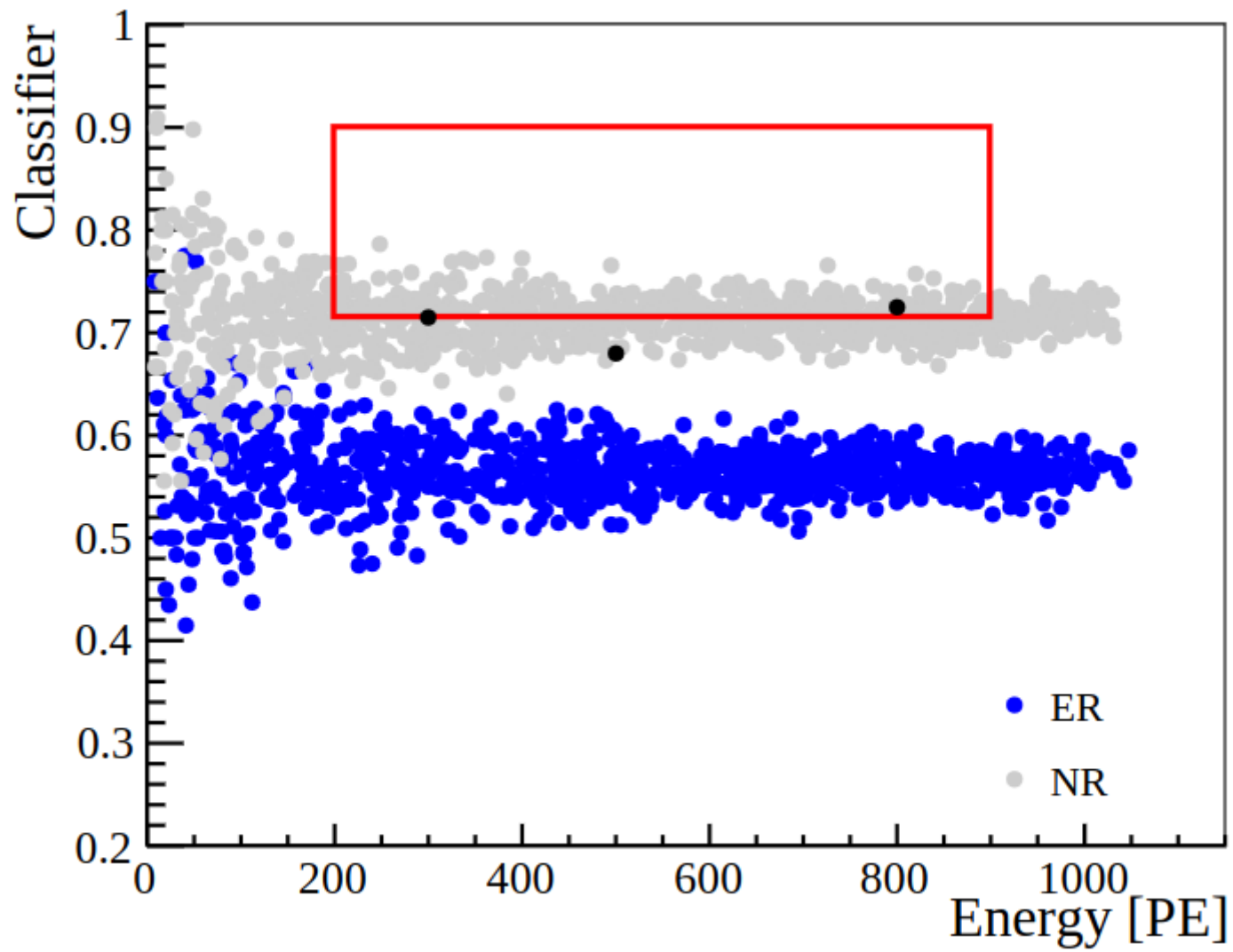
Store

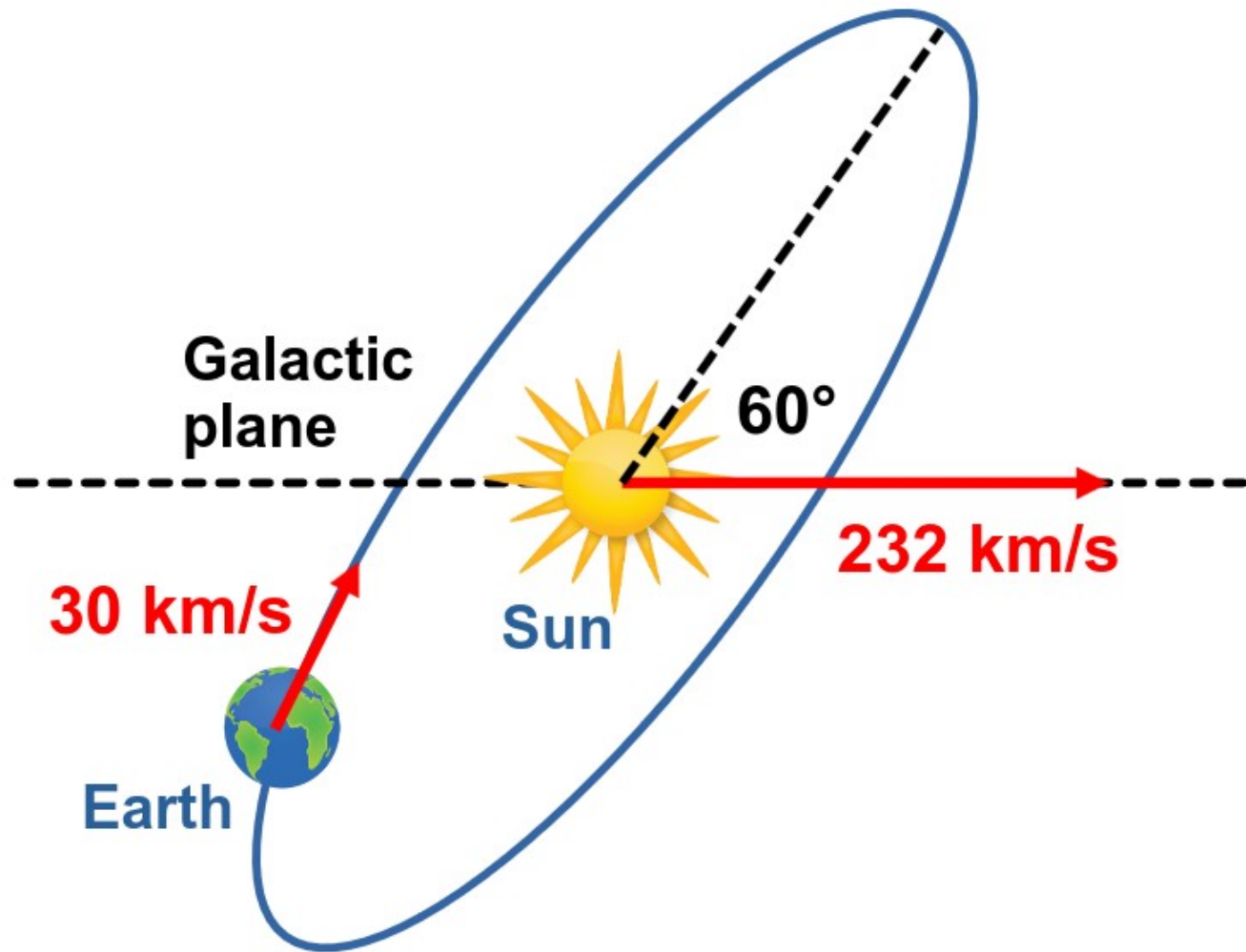
Find Scale

Add / Edit Name

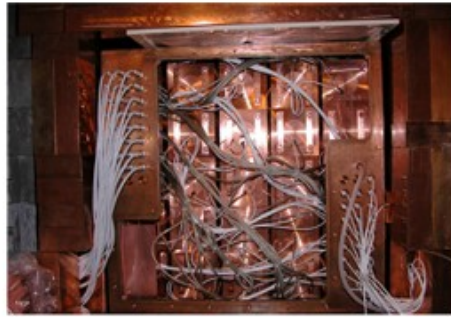
Label



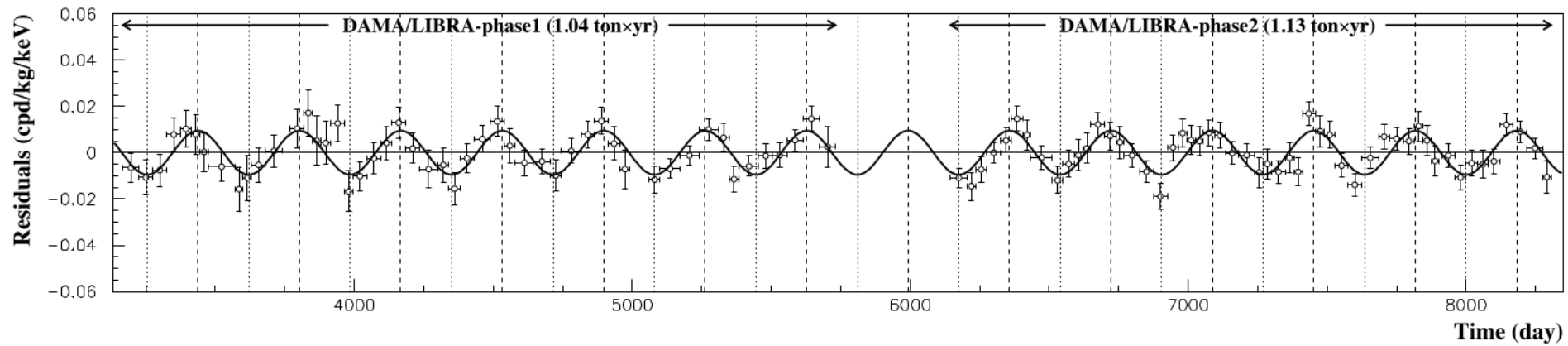


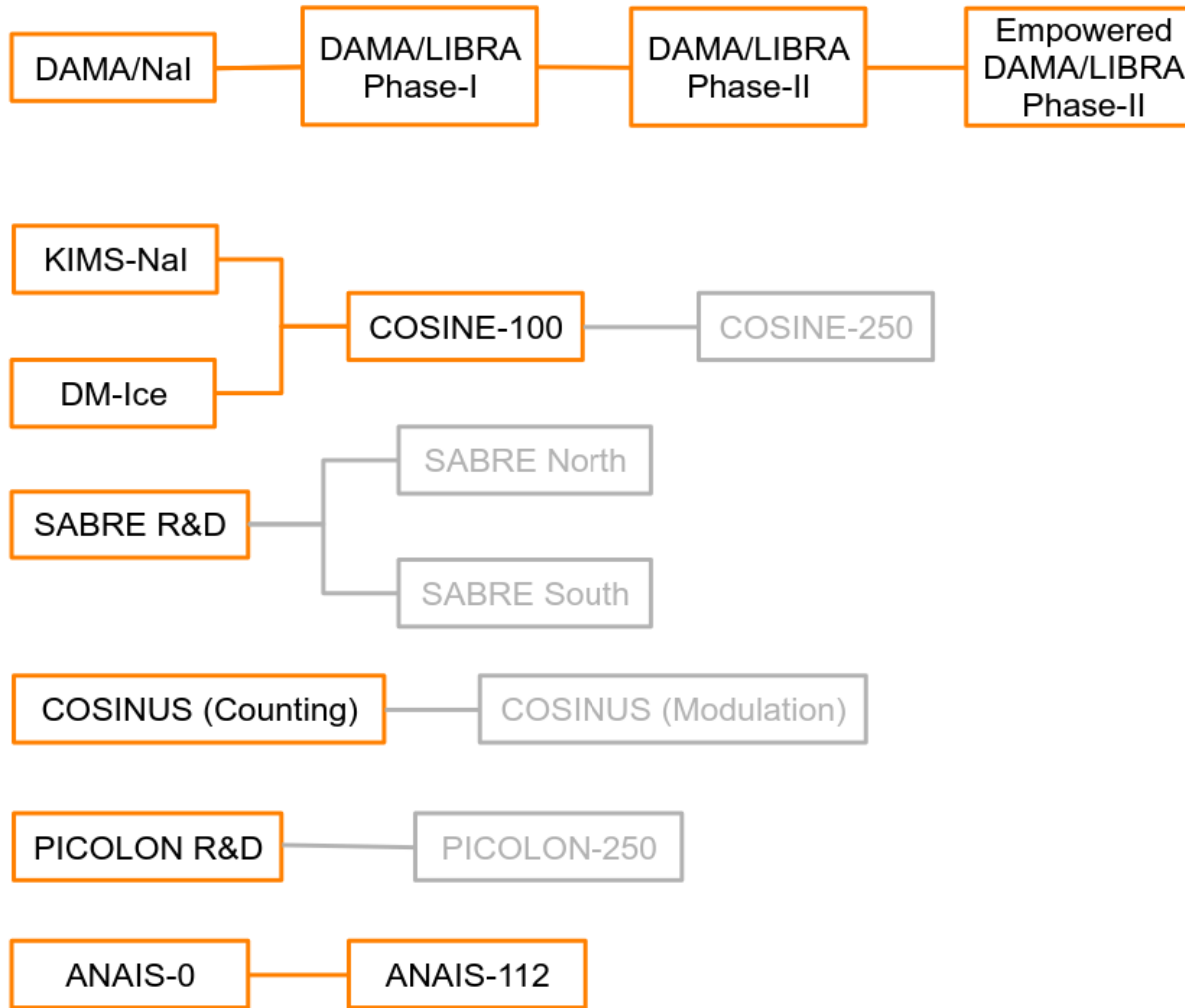


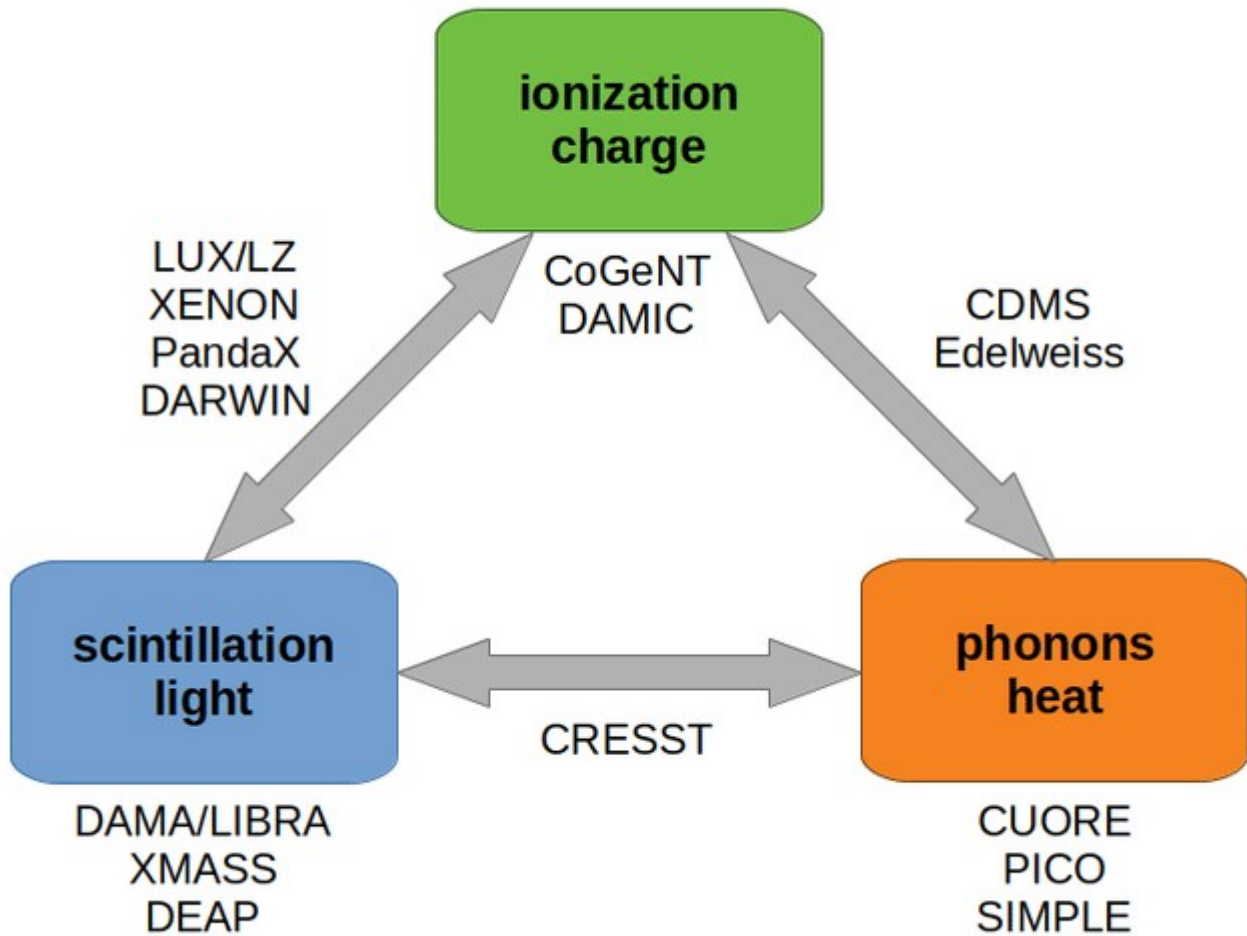
# DAMA



2-6 keV

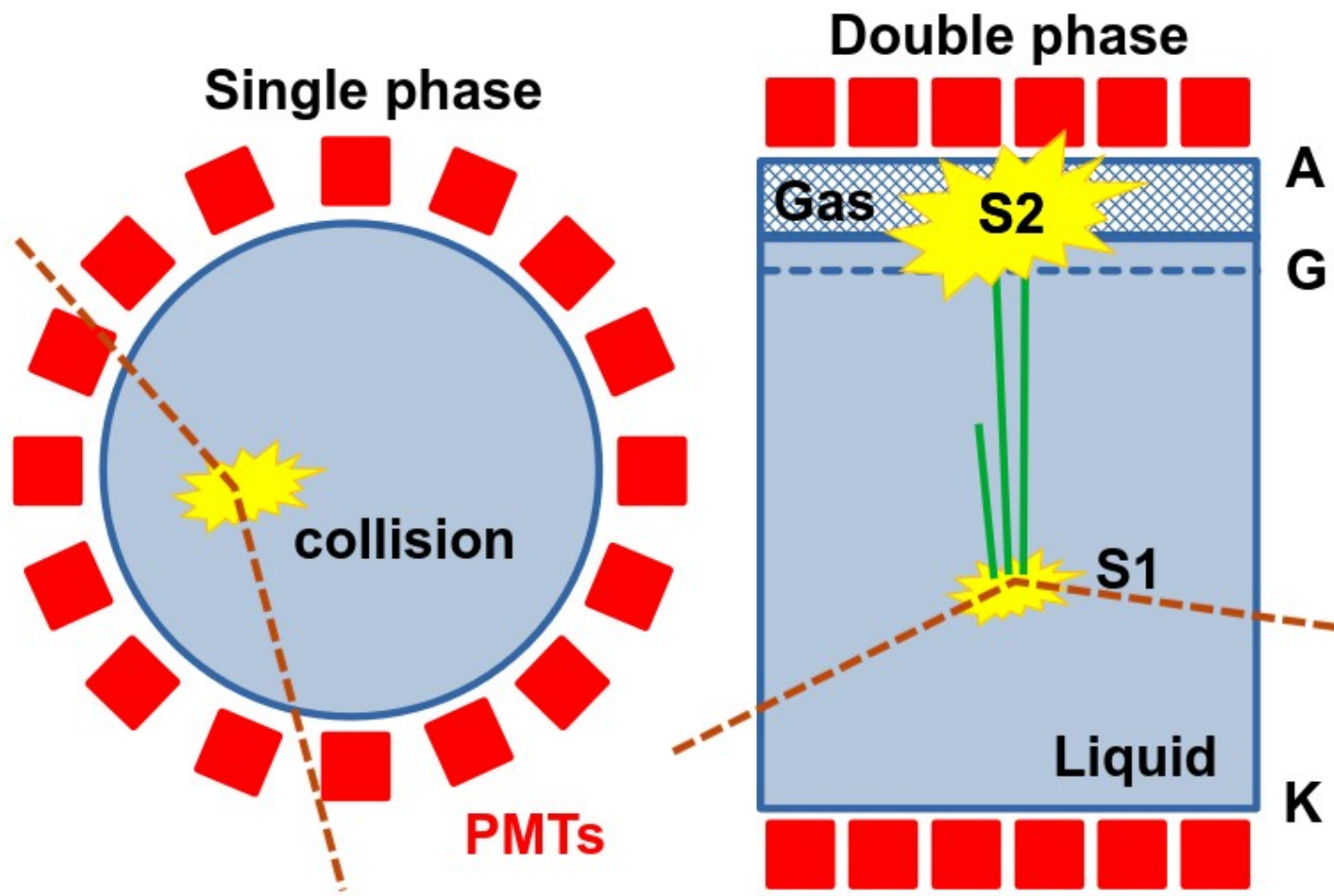




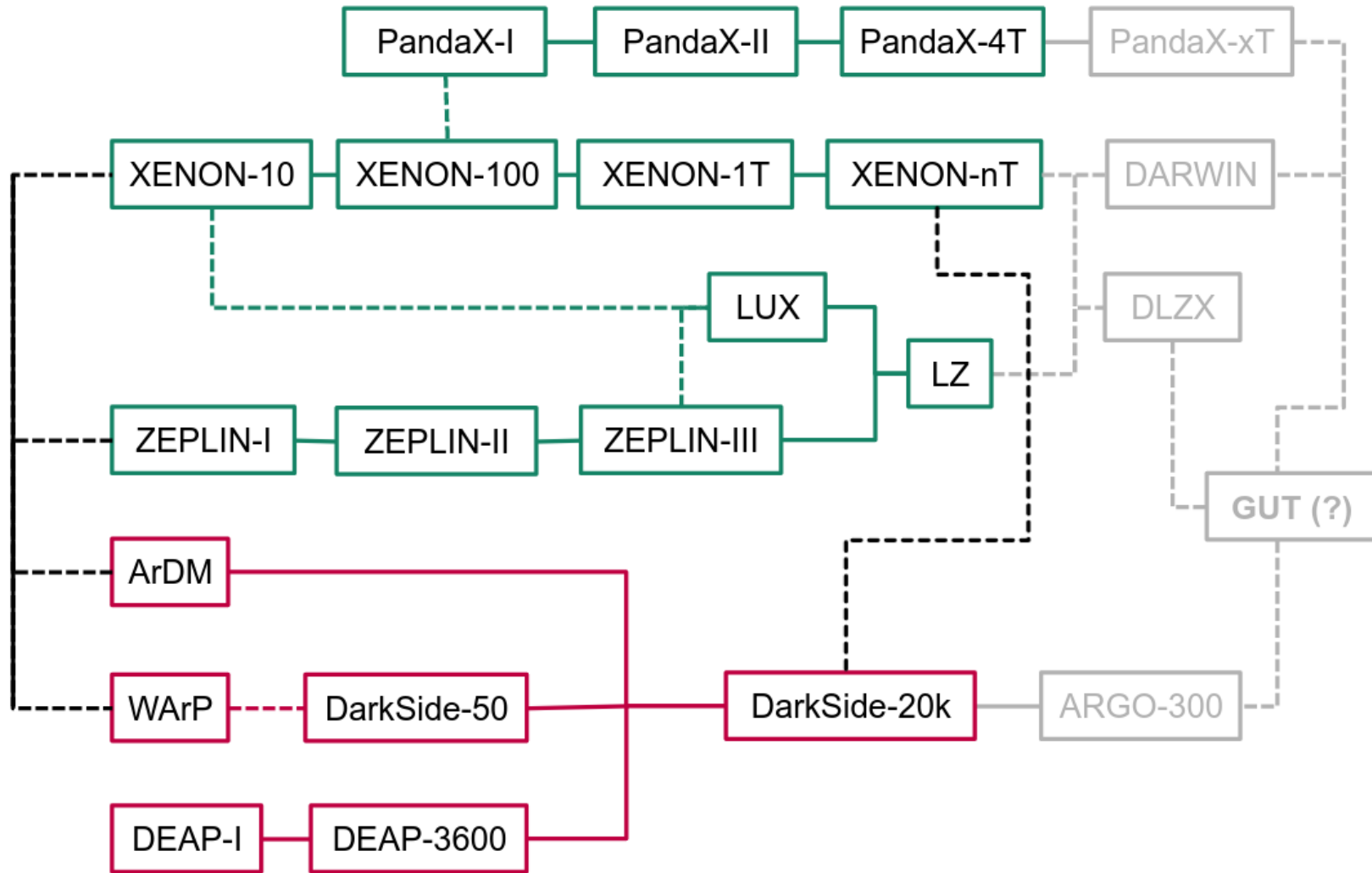




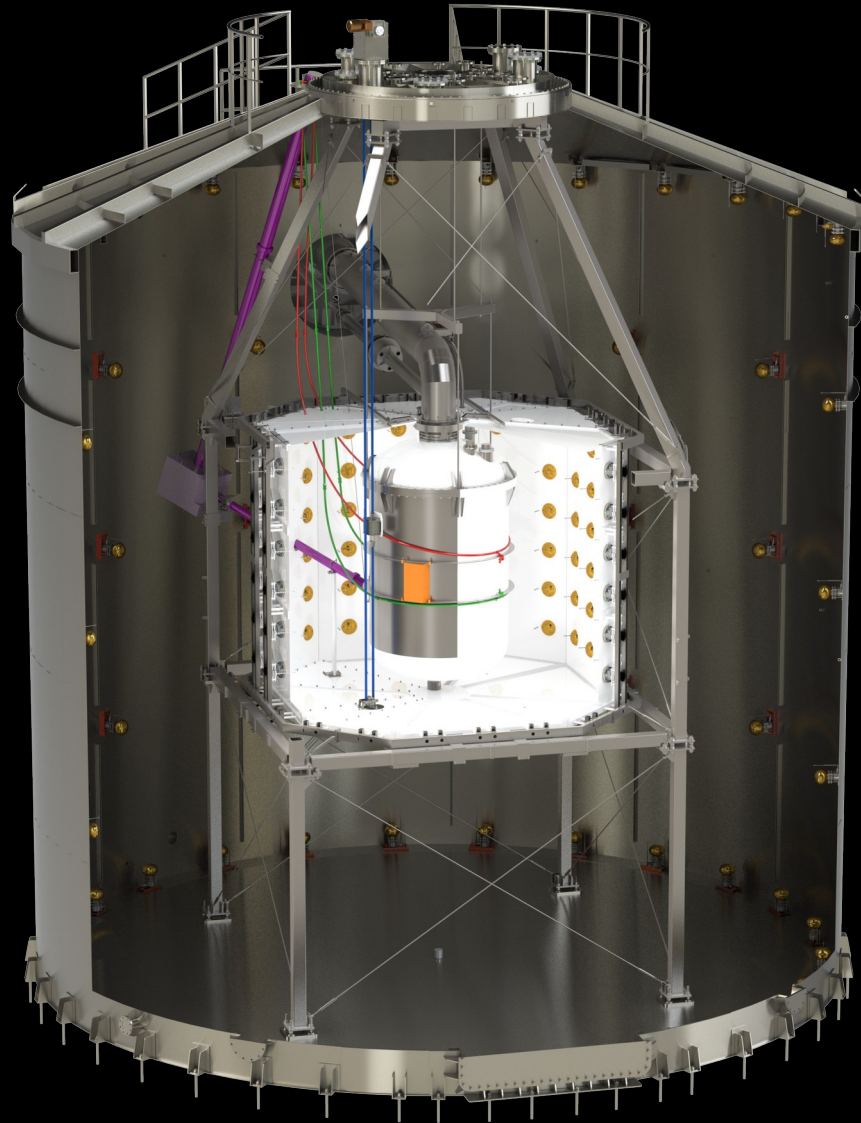




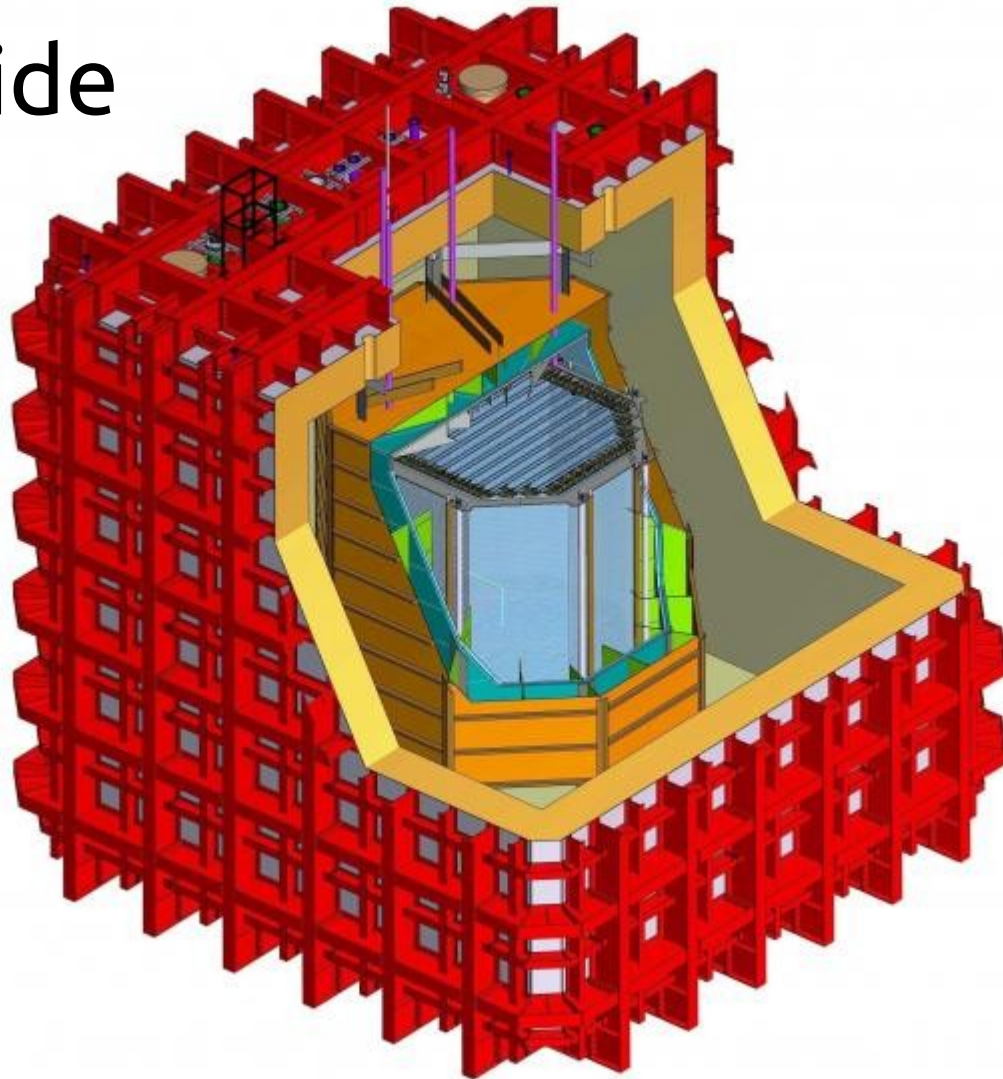
PROPERTY	ARGON	XENON
$Z$	18	54
$A_r$	39.9	131.9
$\rho$	1.4 g/cm <sup>3</sup>	3 g/cm <sup>3</sup>
$T_B$	87 K	165 K
$\lambda$	128 nm	178 nm
$\tau_{\text{fast}}$	6 ns	5 ns
$\tau_{\text{slow}}$	1.6 $\mu$ s	24 ns
LY	40 PE/keV	46 PE/keV
ER-NR Classifier	S1(t)	S2/S2



# XENON



# DarkSide



CRESST



