# Triggering schemes for SuperCDMS

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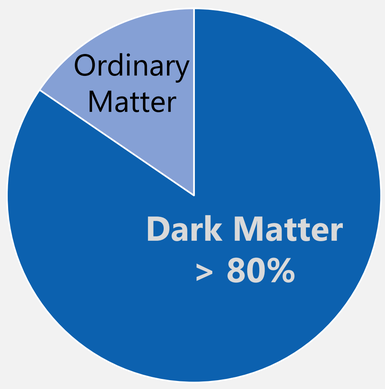
## Matter of the Universe




## SuperCDMS experiment

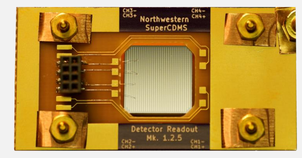
Cryogenic Dark Matter Search
Searching for:

**Weakly Interacting Massive Particles**
- Requires low background,
- low noise trigger rate,
- high exposure

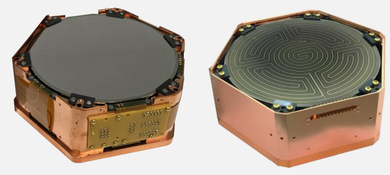
**Low-Mass Dark Matter**
- Requires low threshold

## SuperCDMS detectors

**HVeV**
- Si R&D detector
- 10 x 10 x 4 mm$^3$
- Operated at R&D facilities

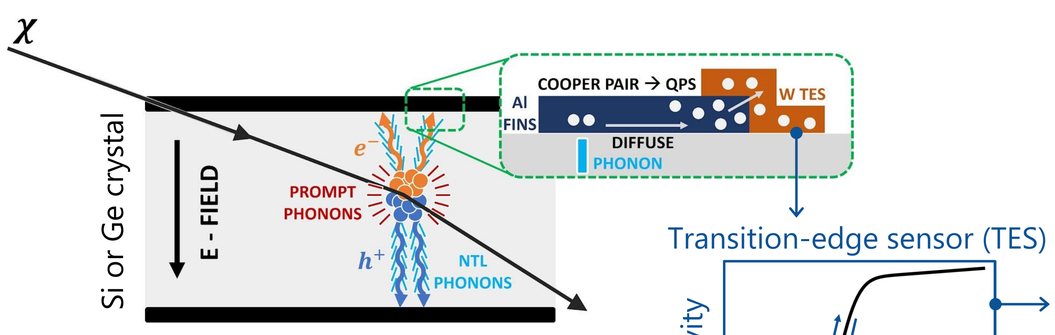


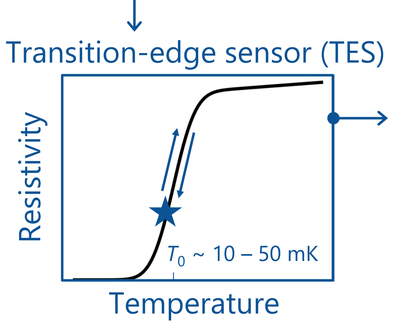

**HV and iZIP**
- Si or Ge
- Ø100 x 33 mm$^3$
- At SNOLAB, Canada
- 2100 m underground



## Detection principle

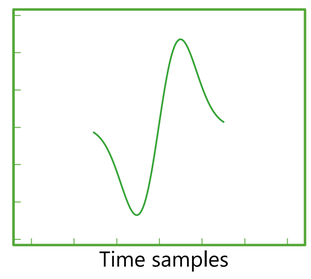
Neganov-Trofimov-Luke (NTL) amplification




## Gaussian Derivative Filter

- Better resolves closely lying pulses
- Used in HVeV detectors on data with "bursty" backgrounds

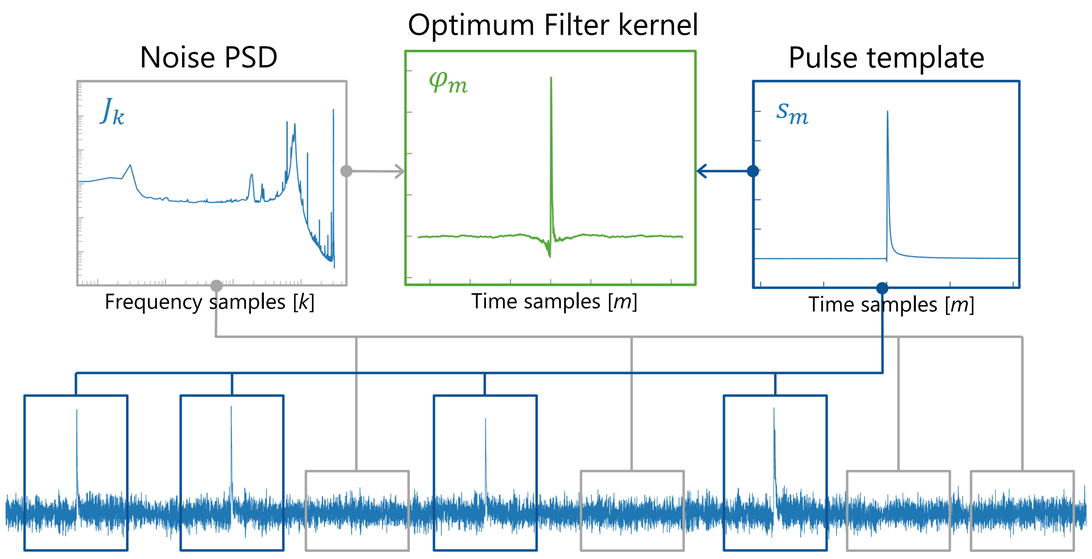






## Optimum Filter

- Optimized to provide the best amplitude resolution
- Used in HV, iZIP and HVeV detectors to achieve lower threshold




$J_k$ – noise Power Spectral Density (PSD)
$V_k(v_m)$ – raw trace in frequency (time) domain
$S_k(s_m)$ – pulse template in frequency (time) domain

$$\underset{A\in\mathbb{R}}{\text{minimize}}\left(\chi^2=\sum_k\frac{|V_k-AS_K|^2}{J_k}\right)$$

$$A=\frac{1}{N}\Re\mathrm{e}[\textstyle\sum_k\Phi_k^*V_k]\overset{\text{Fourier Transform}}{\longleftrightarrow}\frac{n}{N}\sum_{m=0}^{n-1}\varphi_m v_m$$

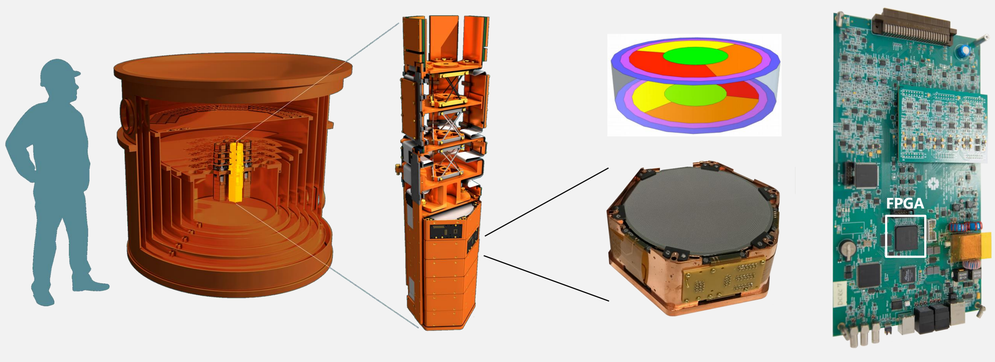
$A$ – best fit amplitude

$N=\sum_k\frac{|S_k|^2}{J_k}$ – normalization

$\Phi_k=\frac{S_k}{J_k}\overset{\text{Fourier Transform}}{\longleftrightarrow}\varphi_m$ – Optimum Filter kernel

## SuperCDMS@SNOLAB: online triggering

**Motivation for online triggering:**
- Up to 24 detectors, 12 phonon channels in each: 0.6 GB/s of raw data without triggering
- Readout induces noise




**Motivation for pulse shape discrimination:**
- Currently, the threshold is at 7σ of the baseline resolution
- Could push the threshold lower if the noise triggers are reliably identified