Detecting landmines

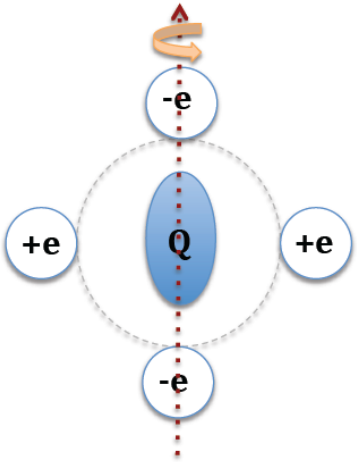
Andreas Jakobsson

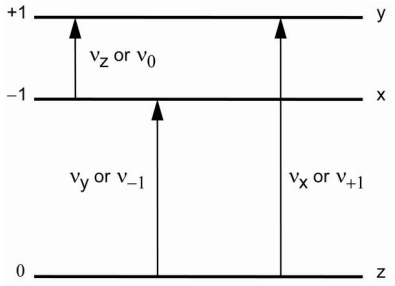
Who cares about landmines?

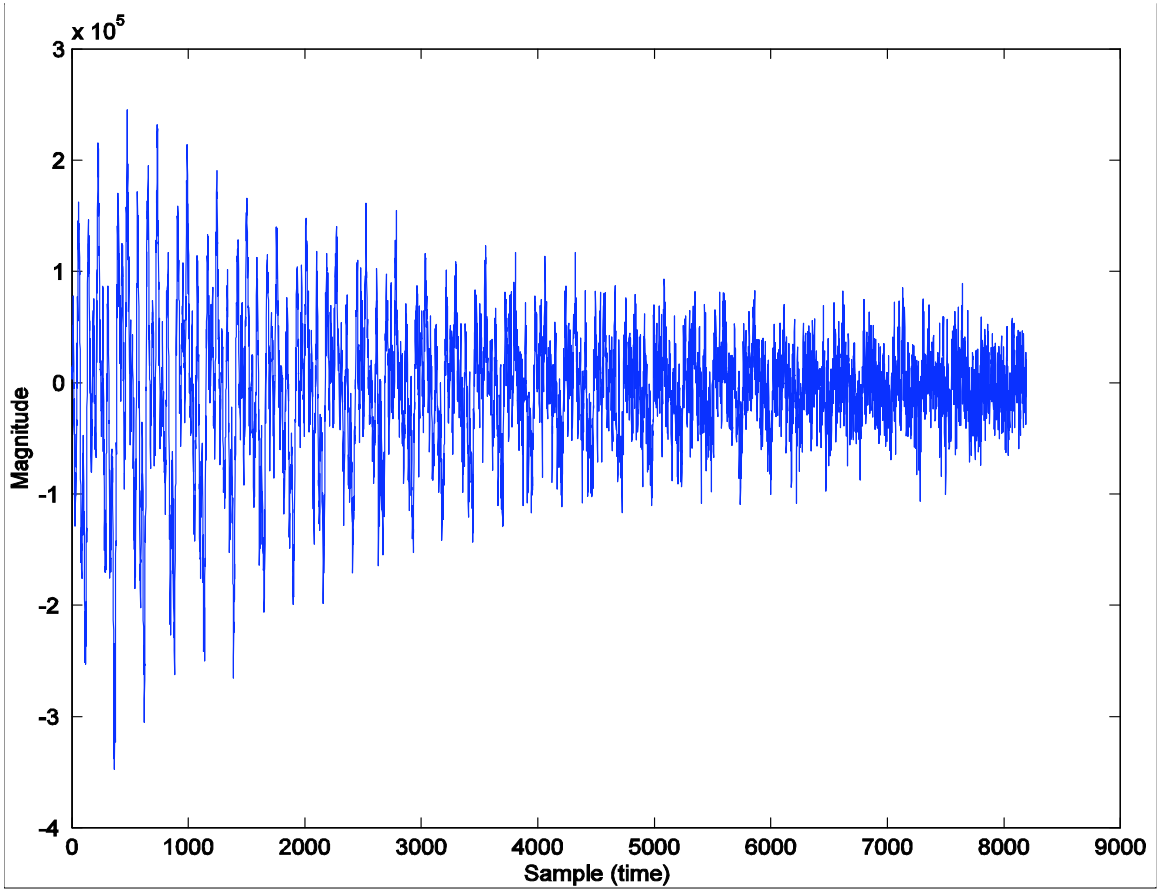
Worldwide, there are about 110 million landmines places, every day killing or maiming about 70 persons, most of them civilian, many of them children.

Every year, many more mines are placed than are being cleared.

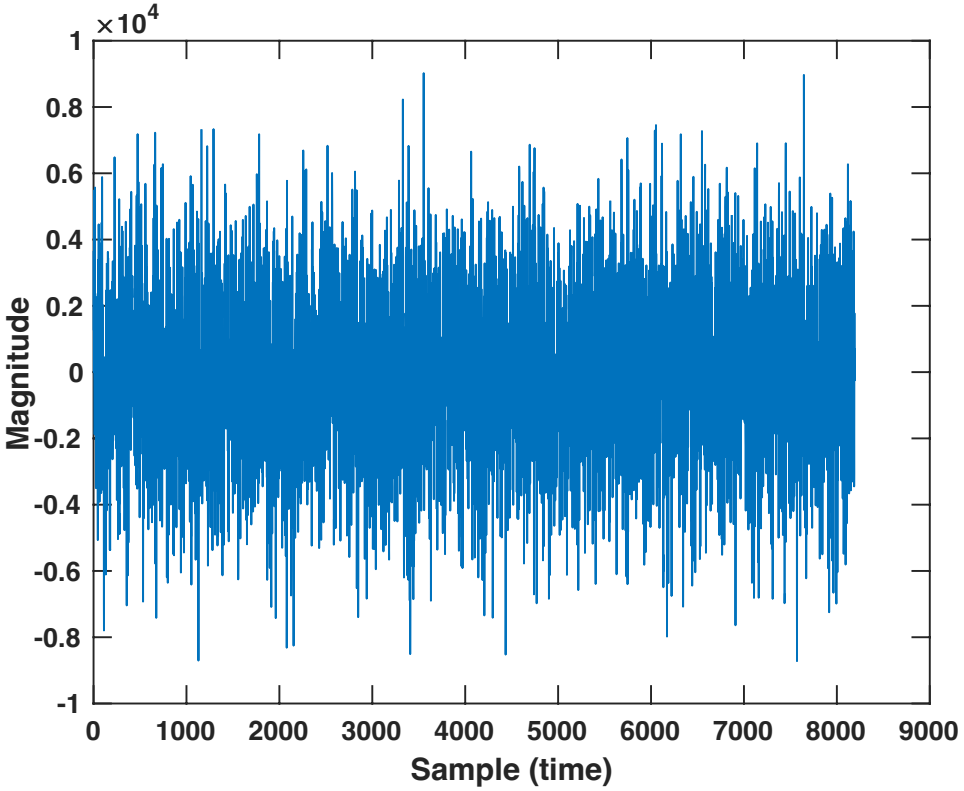
Nuclear quadrupole resonance

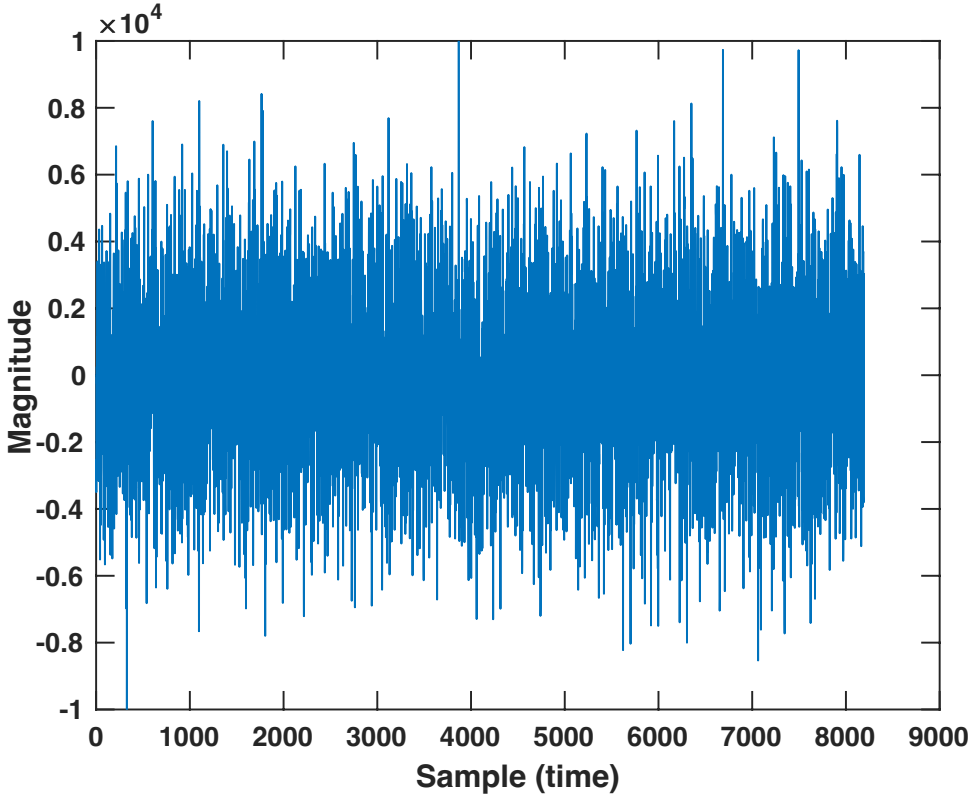




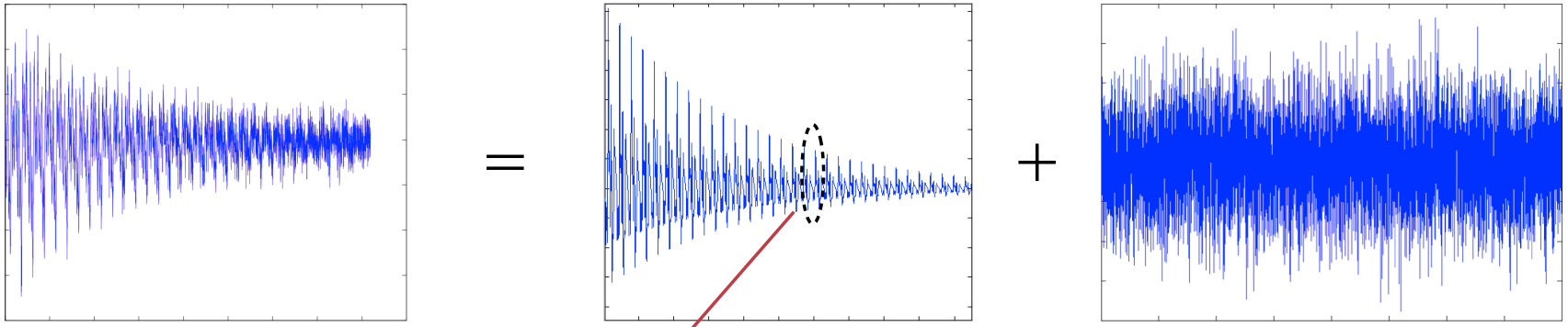


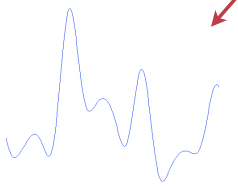
Nuclear quadrupole resonance



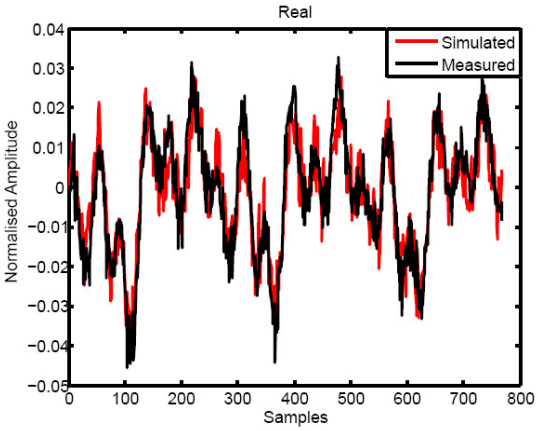


Nuclear quadrupole resonance

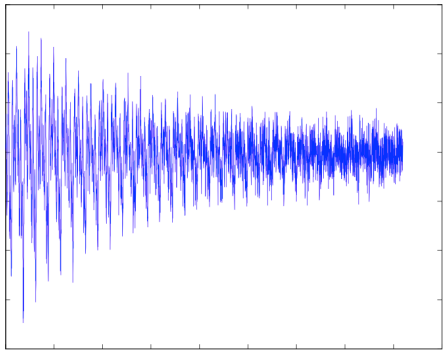




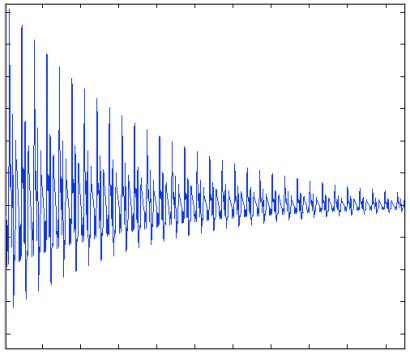
$$y^m(t) = \sum_{k=1}^{d} \tilde{\alpha}_k e^{i\omega_k(T)t} e^{-\eta_k(t+m\mu)} e^{-\beta_k|t-t_{sp}|}$$



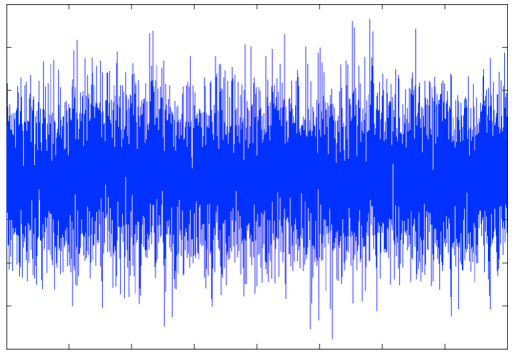
Nuclear quadrupole resonance



$=$



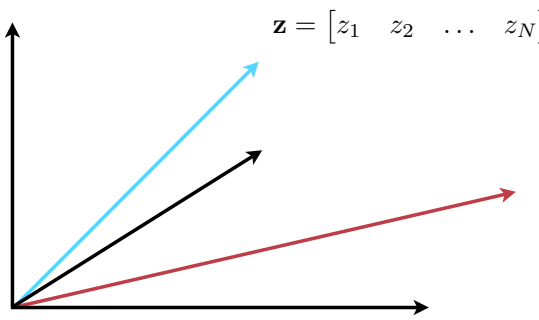
$+$



$$\mathbf{z} = \begin{bmatrix} z_1 & z_2 & \dots & z_N \end{bmatrix}^T$$

$$\mathbf{y}_{\boldsymbol{\theta}} = \begin{bmatrix} y_1 & y_2 & \dots & y_N \end{bmatrix}^T$$

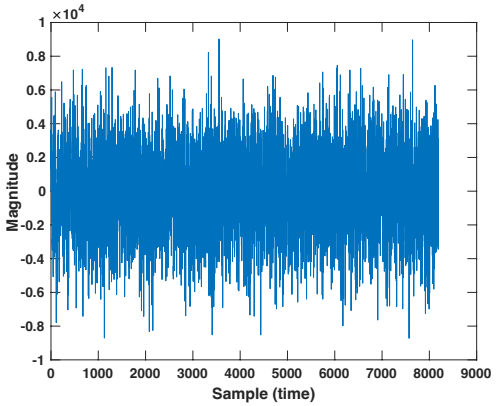
$$\boldsymbol{\theta} = \left\{ T, \tilde{\alpha}_k, \eta_k, \beta \right\}_{k=1}^{d}$$

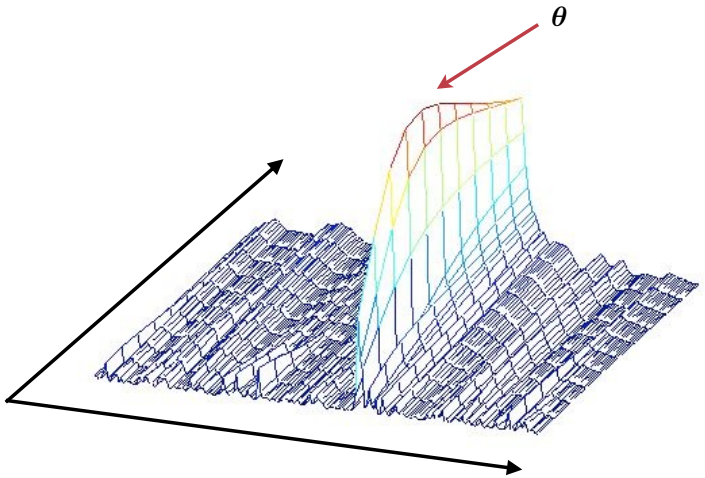


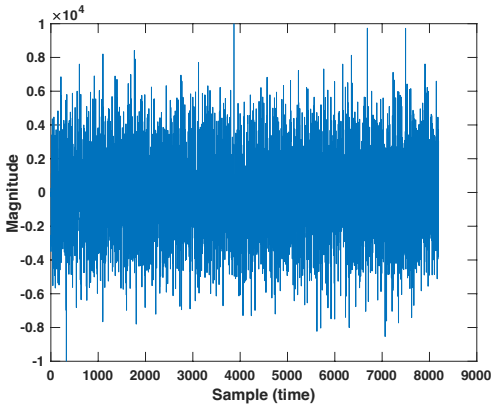
Minimize the distance between the vectors

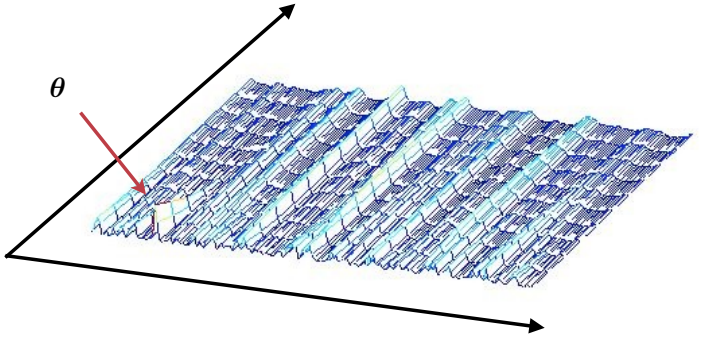
$$\min_{\boldsymbol{\theta}} \|\mathbf{z} - \mathbf{y}_{\boldsymbol{\theta}}\|^2$$

Nuclear quadrupole resonance



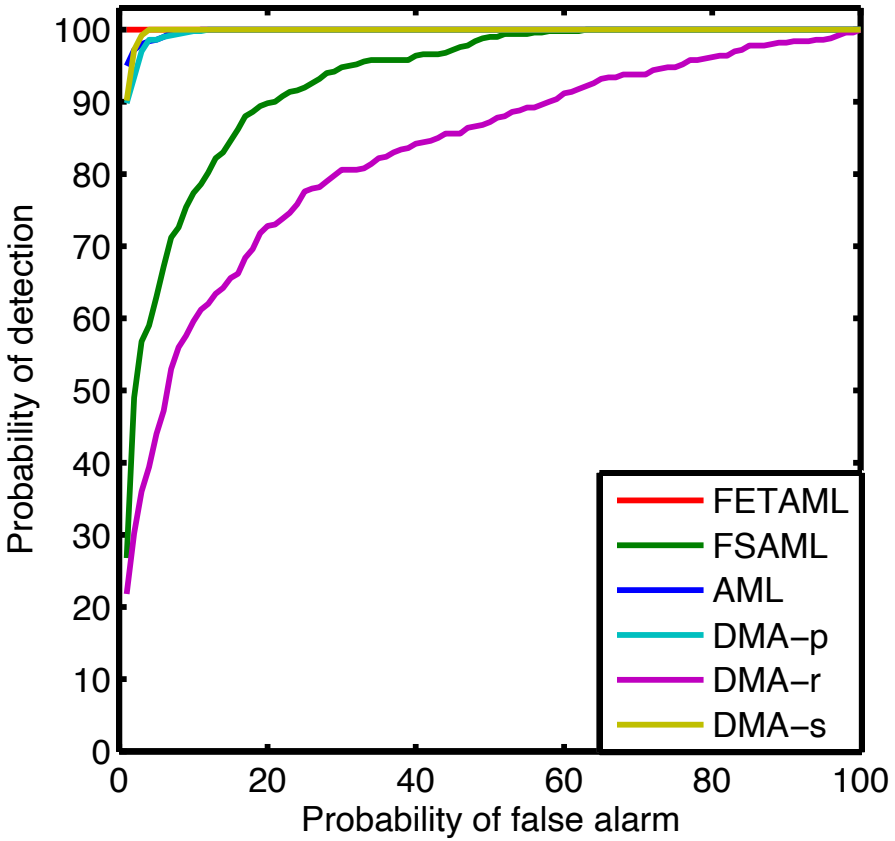




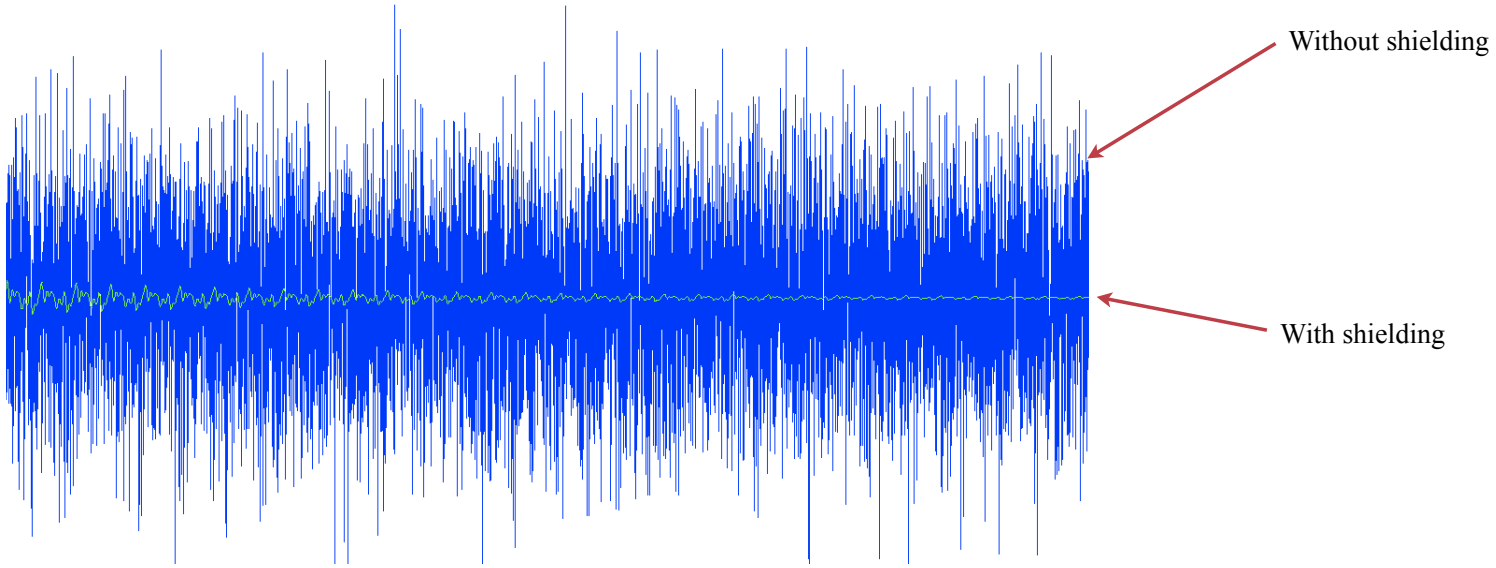


Compute the ratio between the projection onto the model and the projection orthogonal model, for the found parameters.

Nuclear quadrupole resonance



Interference



Regrettably, the NQR signal is weak and suffers from strong RF interference. It is not unusual that this is 10.000 times stronger than the NQR signal itself. How can one deal with that?