

CRC

Ricostruzione delle tracce dei muoni

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PID 2024

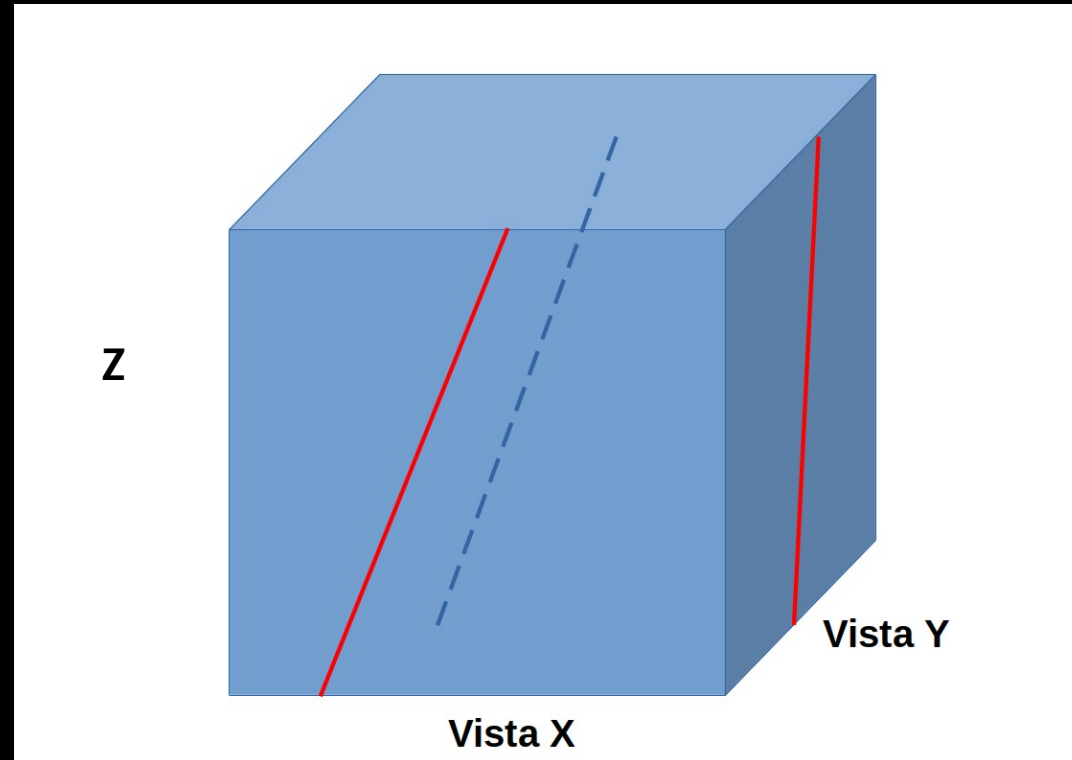
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La traccia del muone



Le due viste del CRC
(vista x, vista y)



La traiettoria 3D del muone è scomposta in due proiezioni sulle due viste del cubo (X e Y)

Ricostruzione della traccia a partire dai pixel accesi

Scelta del sistema di riferimento opportuno

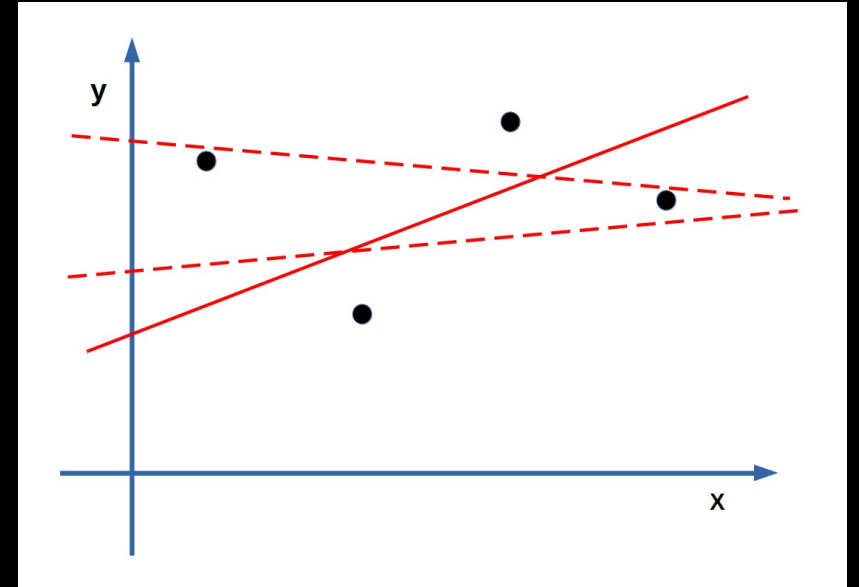
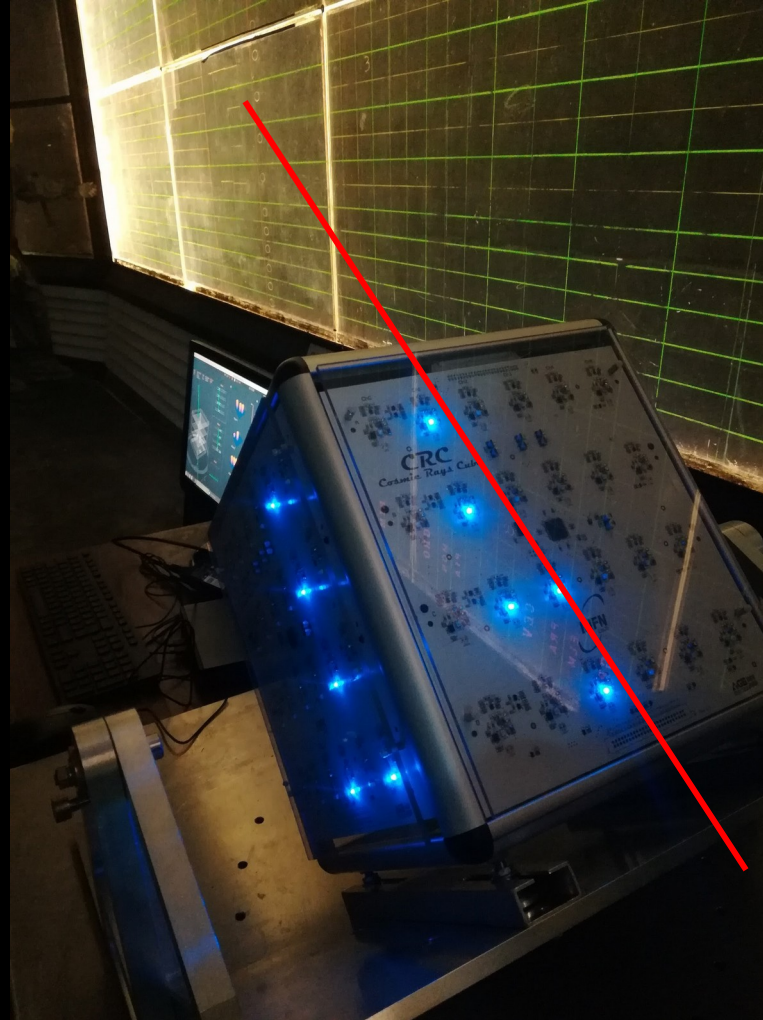
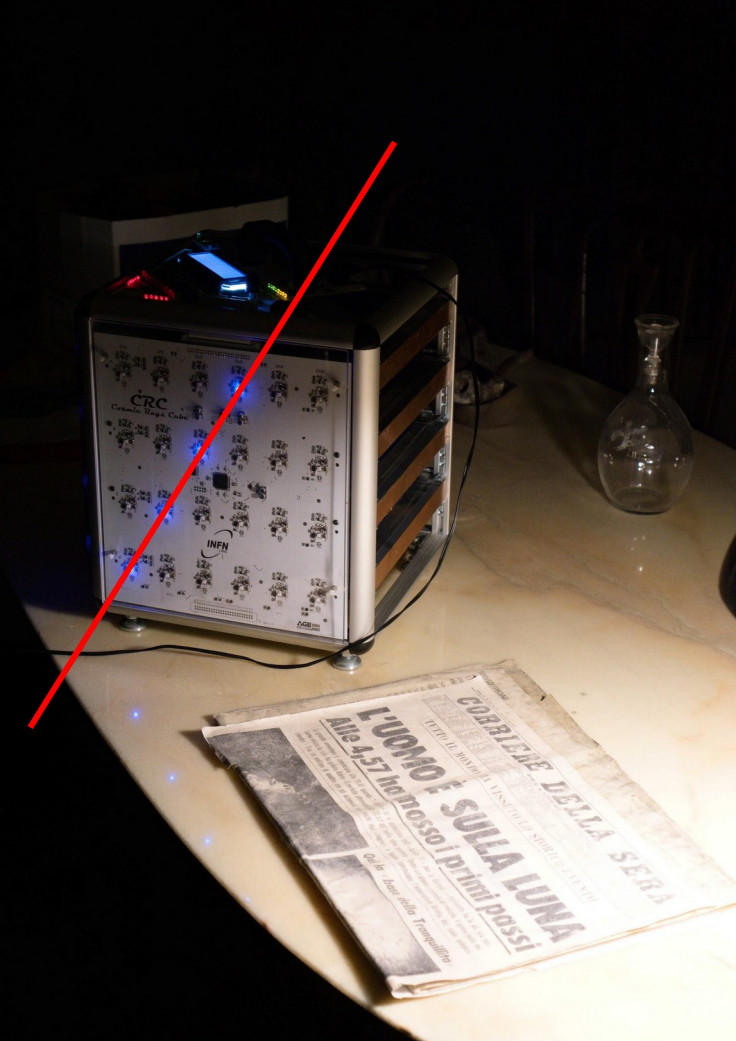
Parametri liberi: 4

- 2 coefficienti angolari
- 2 intercette

Equazioni delle rette

- $x(Z) = m_1 z + q_1$
- $y(z) = m_2 z + q_2$

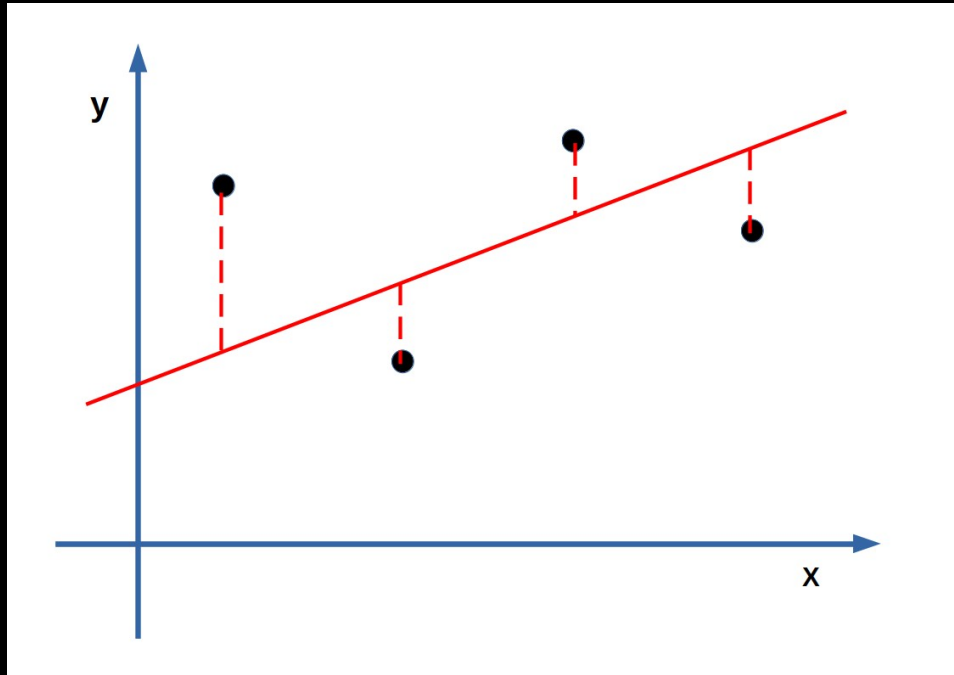
Risalire alla traccia



Qual è la migliore retta che passa per 4 punti non necessariamente allineati?

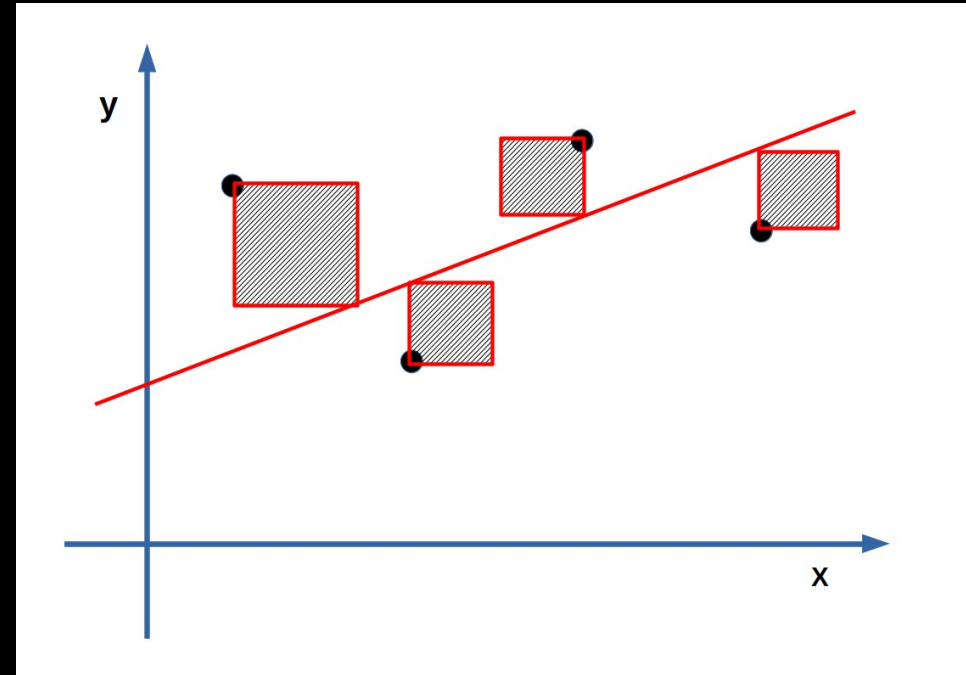


I minimi quadrati



Minimo della somma delle distanze?

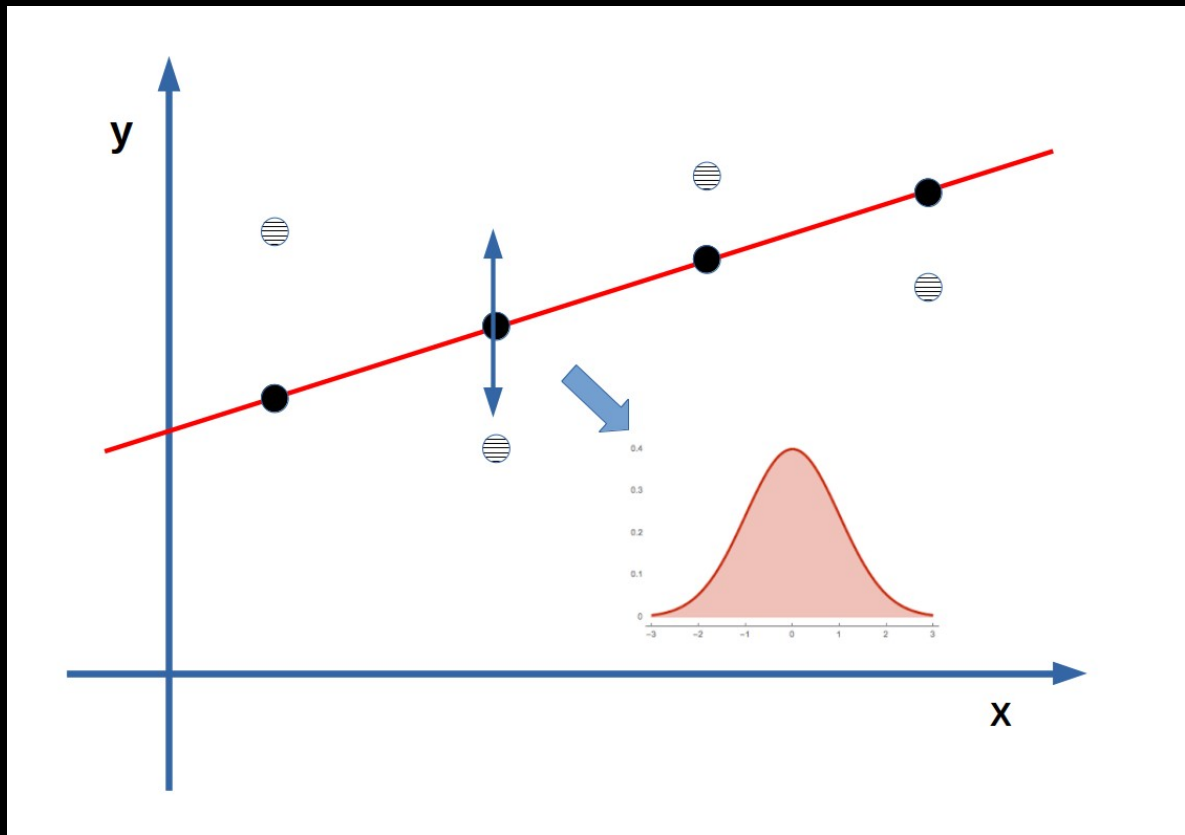
$$\mathcal{D}(m, q) = \sum_i^N |y_i - (mx_i + q)|$$



Minimo della somma dei quadrati!

$$\chi^2(m, q) = \sum_{i=1}^N (y_i - (mx_i + q))^2$$

Il minimo della parabola



Interpretazione del metodo dei minimi quadrati

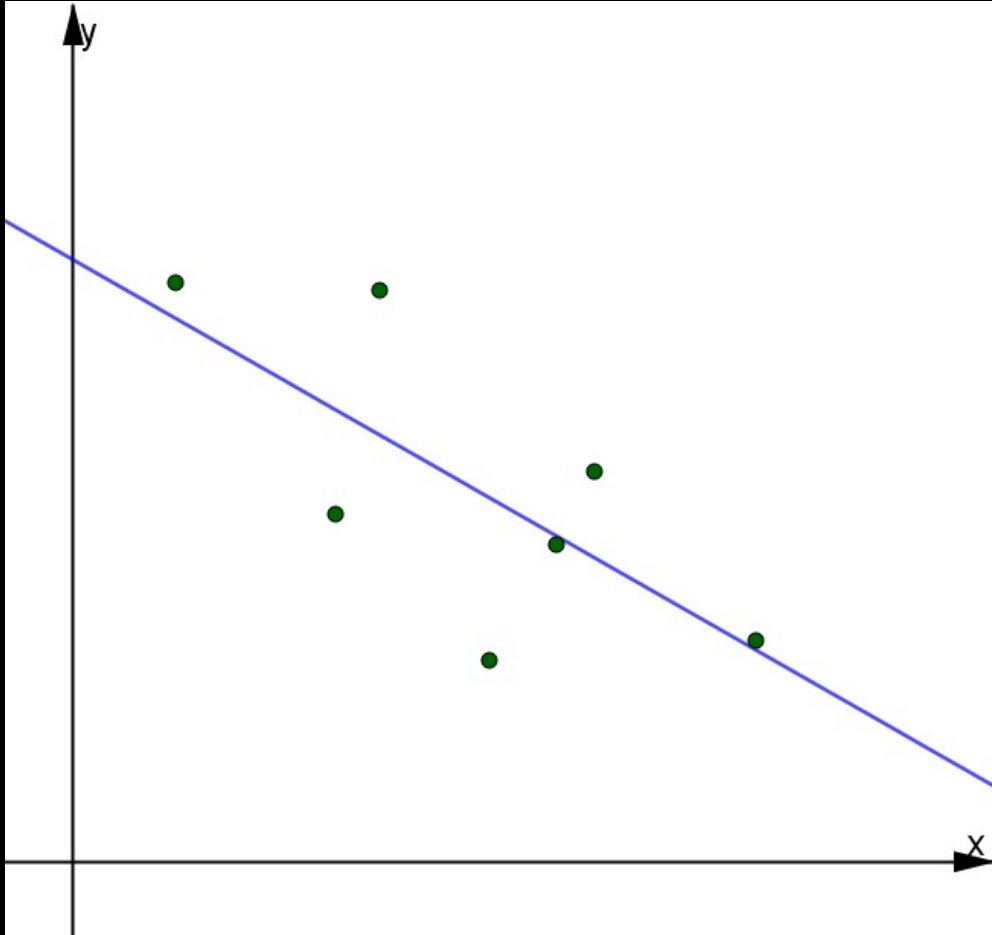
Riarrangiamento i termini del X^2

$$\chi^2(m, q) = \sum_{i=1}^N (y_i - (mx_i + q))^2 = Am^2 + Bq^2 + Cmq + Dm + Eq + F$$

$$m = -\frac{Cq + D}{-2A}$$
$$q = -\frac{Cm + E}{-2B}$$

Minimo simultaneo rispetto a m e rispetto a q

La formula finale



$$\bar{X} = \frac{1}{N} \sum_{i=1}^N x_i \quad \bar{Y} = \frac{1}{N} \sum_{i=1}^N y_i$$

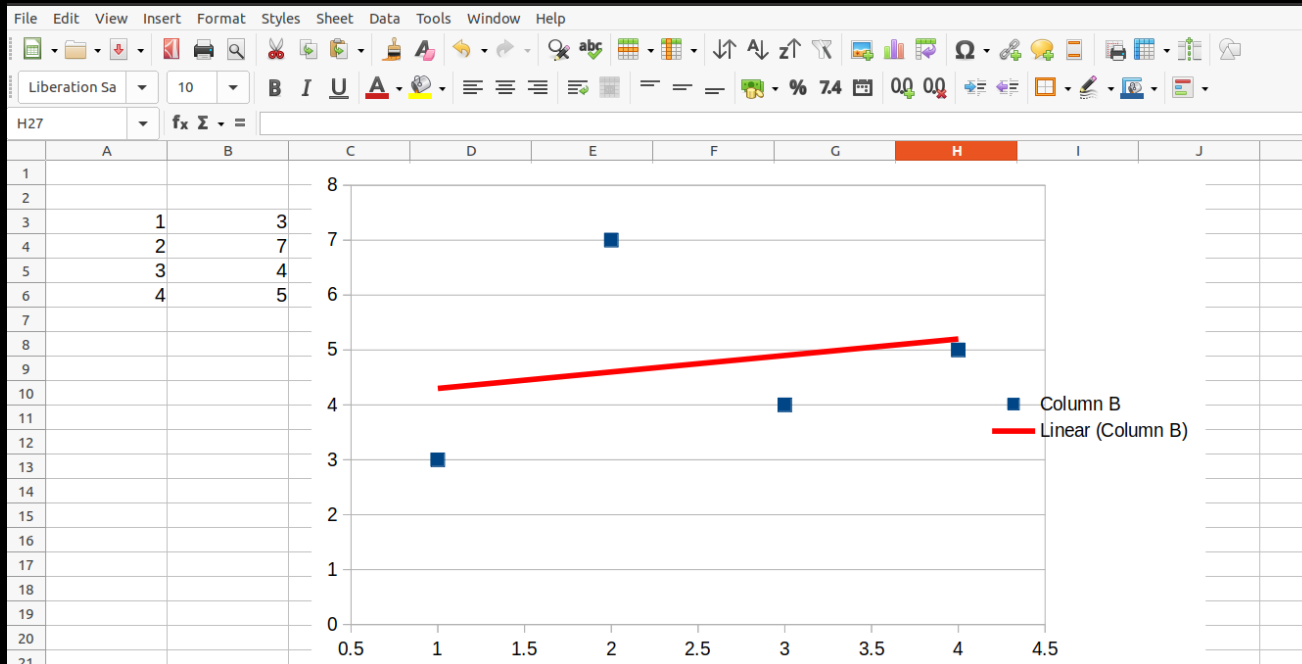
$$m = \frac{\sum (x_i - \bar{X})(y_i - \bar{Y})}{\sum (x_i - \bar{X})^2}$$

$$q = \bar{Y} - m\bar{X}$$

Costruzione manuale della linea di tendenza (regressione lineare o fit lineare).

Eseguibile per esempio tramite foglio di calcolo

Con foglio di calcolo



Dopo aver disegnato i punti, cliccando su un punto qualsiasi si sceglie trend, o linea di tendenza, e poi → fit lineare o regressione lineare, etc....

The dialog box shows the 'Type' tab with the 'Line' option selected. The 'Regression Type' section includes options for Linear, Polynomial, Logarithmic, Exponential, Moving Average, and Power. The 'Options' section includes checkboxes for 'Force Intercept', 'Show Equation', and 'Show Coefficient of Determination (R²)'. The 'X Variable Name' is set to 'x' and the 'Y Variable Name' is set to 'f(x)'.

Trend Line for Data Series 'Column B'

Type Line

Regression Type

- ☒ Linear
- ☐ Polynomial
- ☐ Logarithmic
- ☐ Exponential
- ☐ Moving Average
- ☐ Power

Degree: 2

Period: 2

Options

Trendline Name:

Extrapolate Forward: 0

Extrapolate Backward: 0

☐ Force Intercept

☐ Show Equation

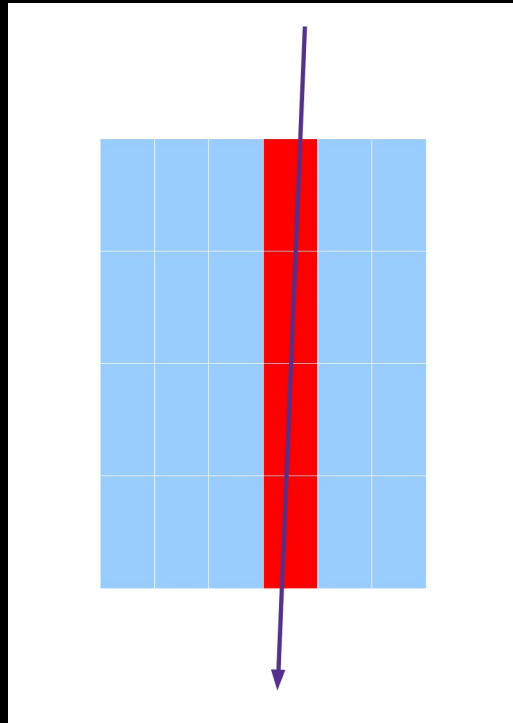
☐ Show Coefficient of Determination (R²)

X Variable Name: x

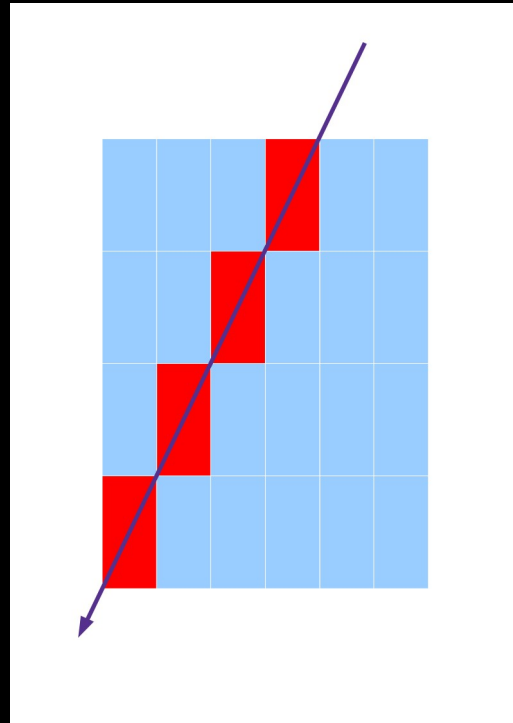
Y Variable Name: f(x)

Help Reset Cancel OK

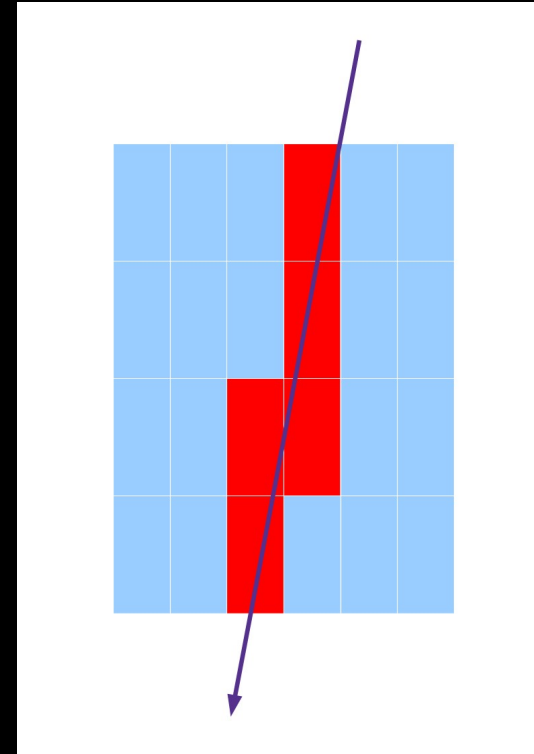
Esempi di eventi



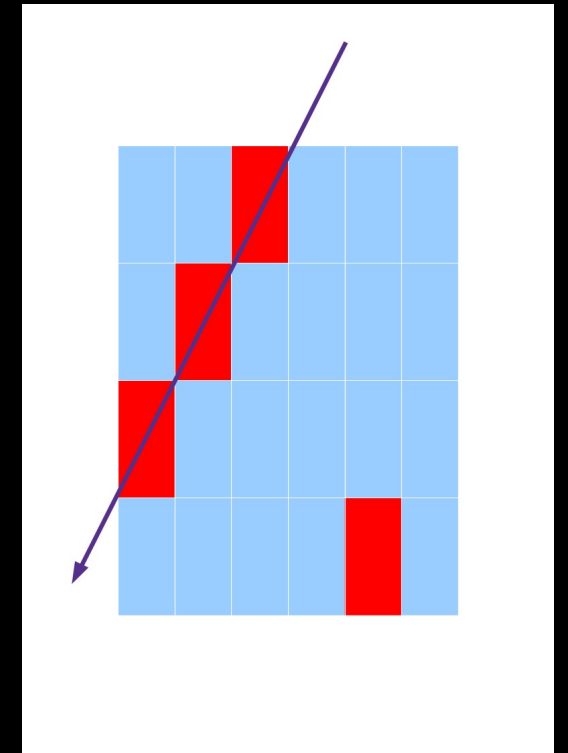
1



2



3



4

Un esempio di evento

Dall'esadecimale...

```

15:59 04-22-2020 15-33-37.tet
1249 03010901 02030101
1250 01010202 20202020
1254 02020201 02041020
1255 01020204 04020101
1256 0102040C 01010204
1257 02020408 01040820
1258 01010204 01010101
1259 08102020 20202020
1260 01010301 20201010
1261 01010101 02020404
1262 02020202 10101020
1263 10102020 10101020
1264 0E253D34 053B3D3B
1265 01010102 20202020
1266 01010101 20202020
1267 10101020 04040201
1268 05030202 20301030
1269 20180403 01030303
1270 10102020 20202020
1271 01040830 10080402
1272 01010204 01020408
1273 02020202 01010204
1274 02041828 20301010
1275 20080401 08080808
1276 10101010 20202020
1277 03141203 22011210
    
```

- 02 -> 000010
- 02 -> 000010
- 02 -> 000010
- 01 -> 000001

- 02 -> 000010
- 04 -> 000100
- 10 -> 010000
- 20 -> 100000

Z [cm] X [cm]

28 18

21 18

14 18

7 22

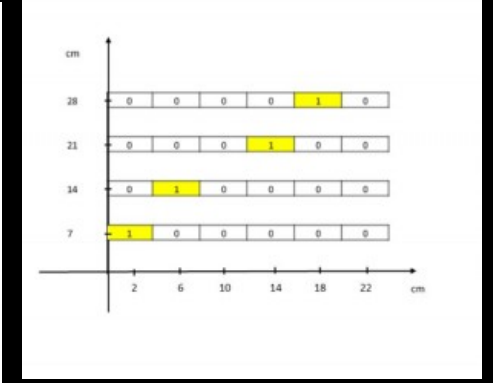
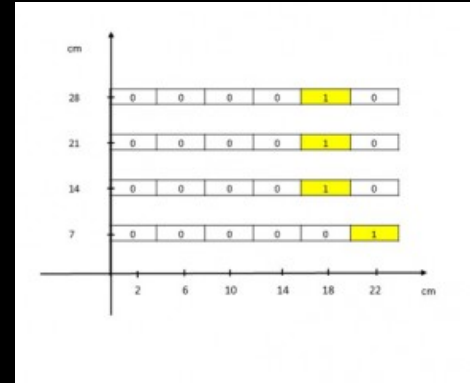
Z [cm] Y [cm]

28 18

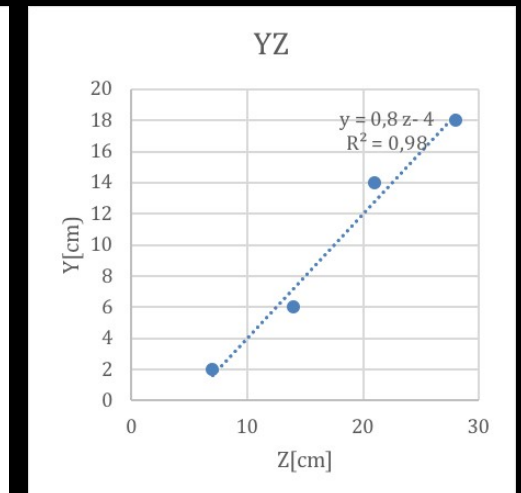
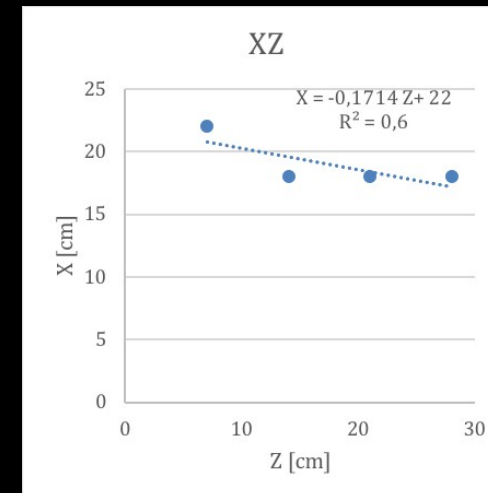
21 14

14 6

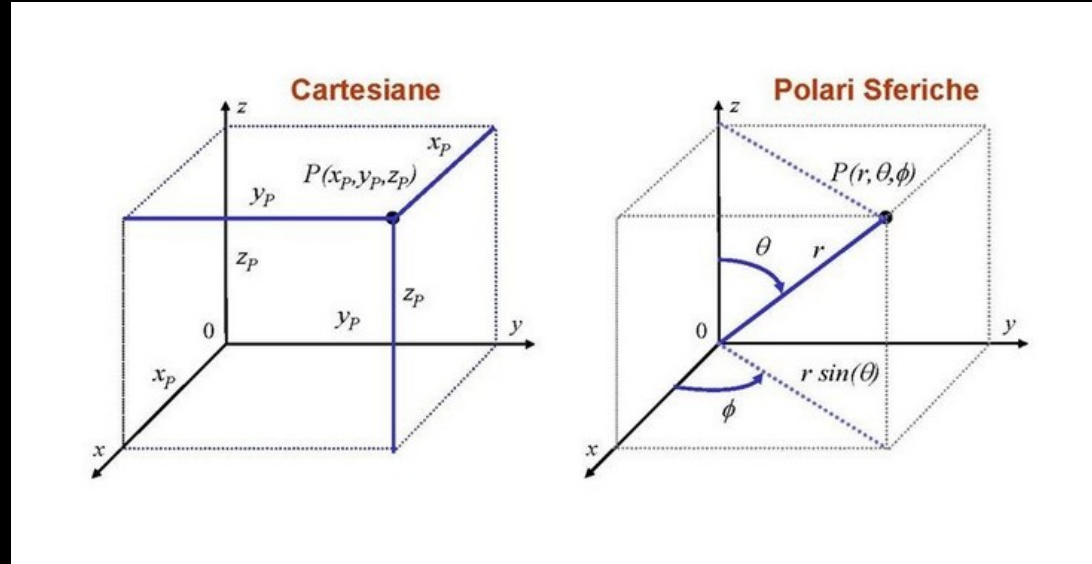
7 2



... alla traccia



Rappresentazione 3D



$$\cos \theta = \frac{V_z}{|V|}$$

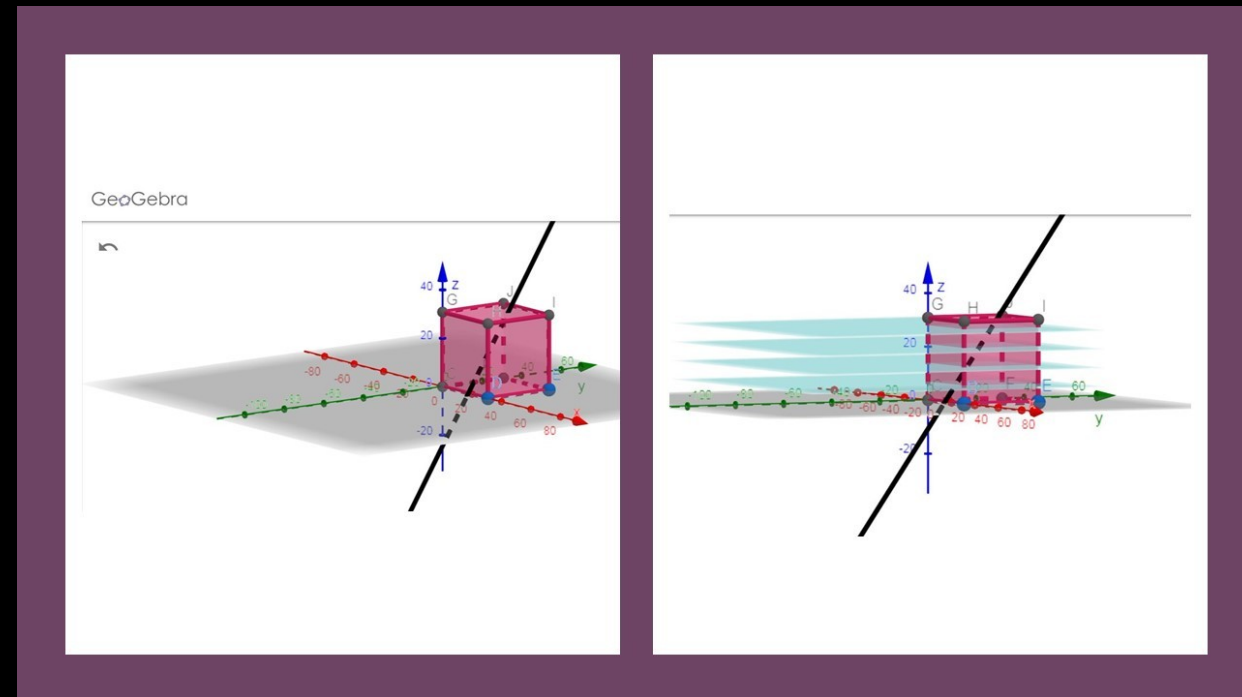
$$\tan \phi = \frac{V_y}{V_x}$$

$$x(z) = m_x z + q_x$$

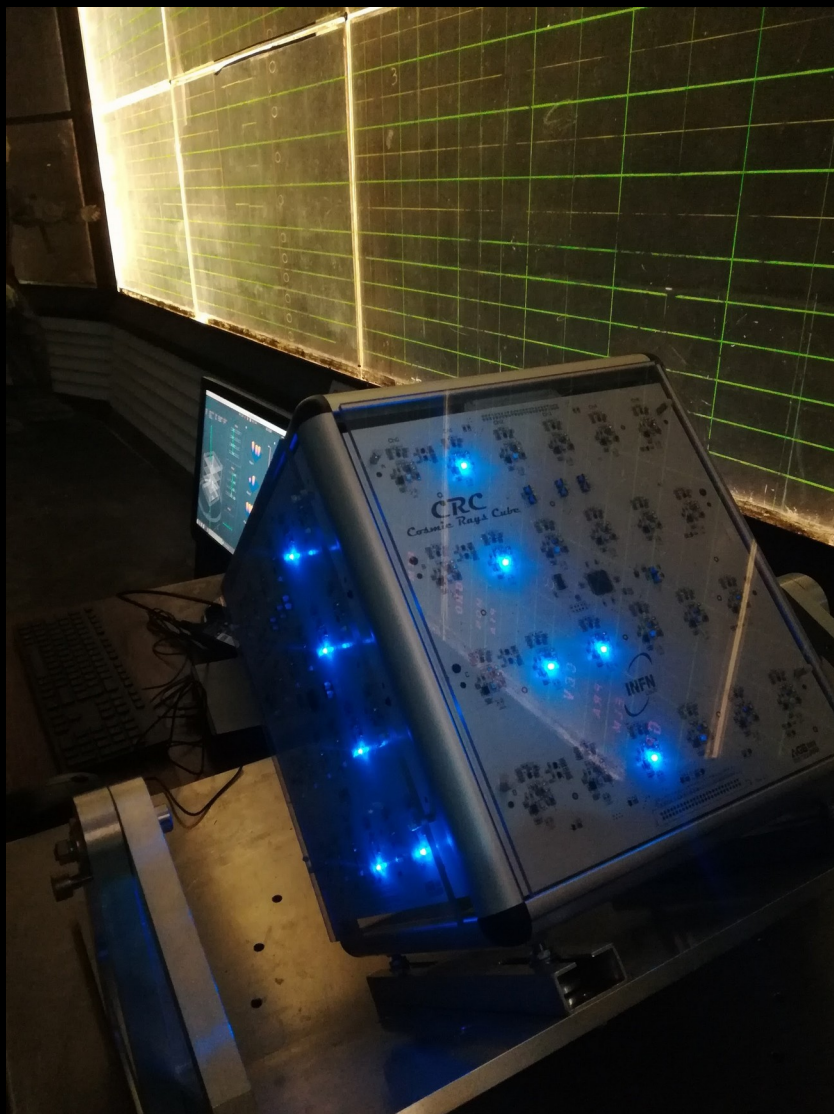
$$y(z) = m_y z + q_y$$

$$V = (V_x, V_y, V_z) =$$

$$(x(1), y(1), 1) = (m_x, m_y, 1)$$



Ricostruzione con Geogebra



Grazie per
l'attenzione!