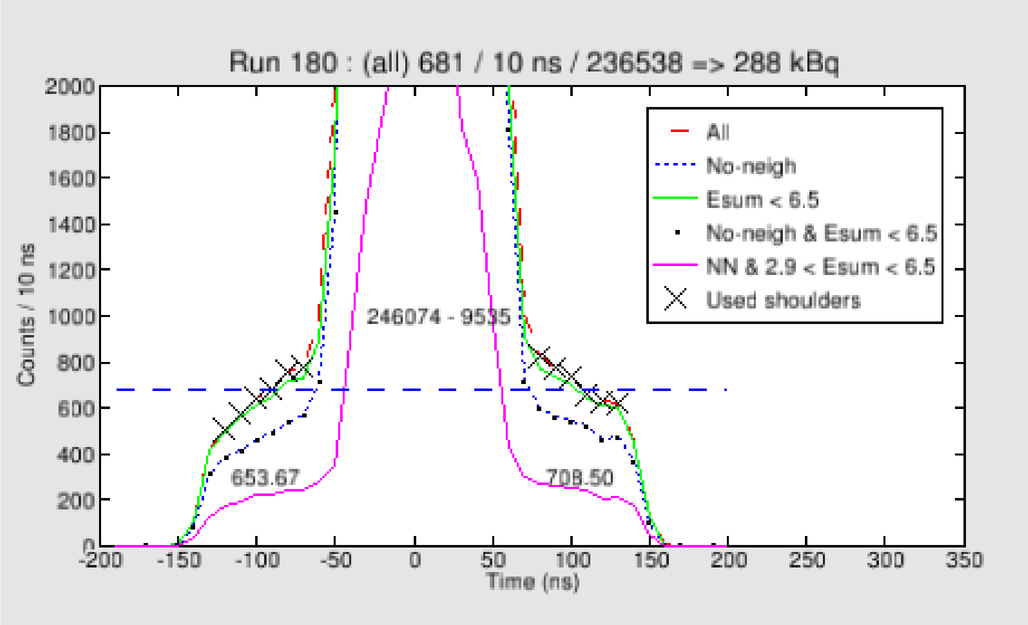
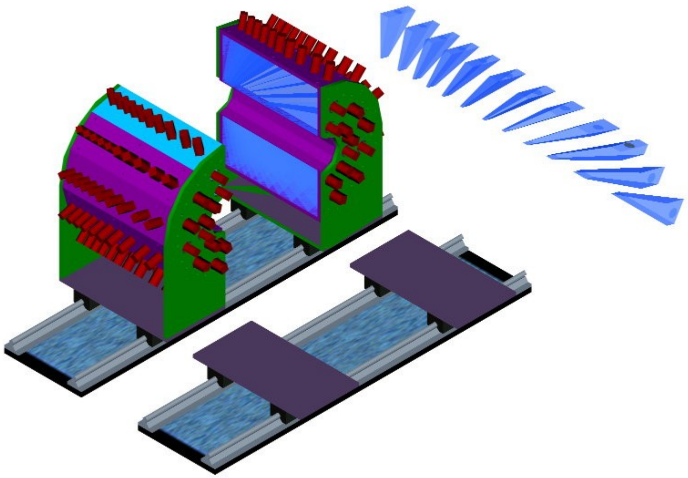
Fun with gammas II: Source activity



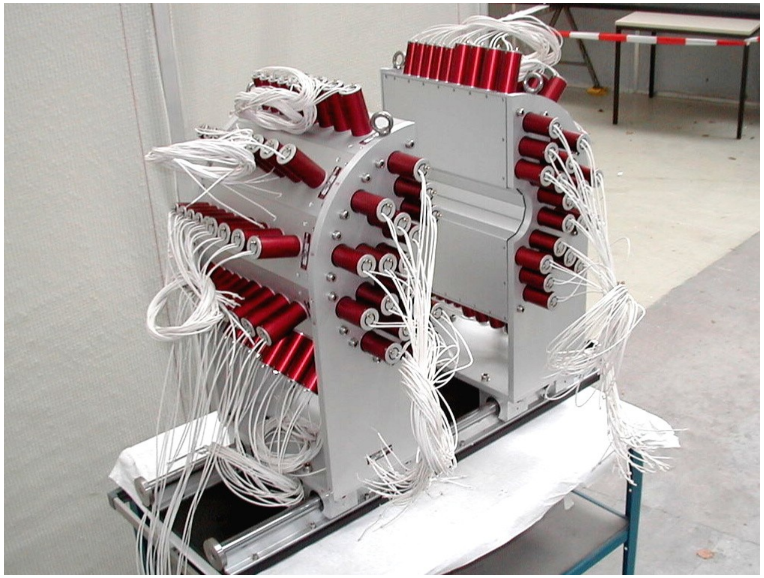
Håkan T. Johansson, Chalmers, Göteborg

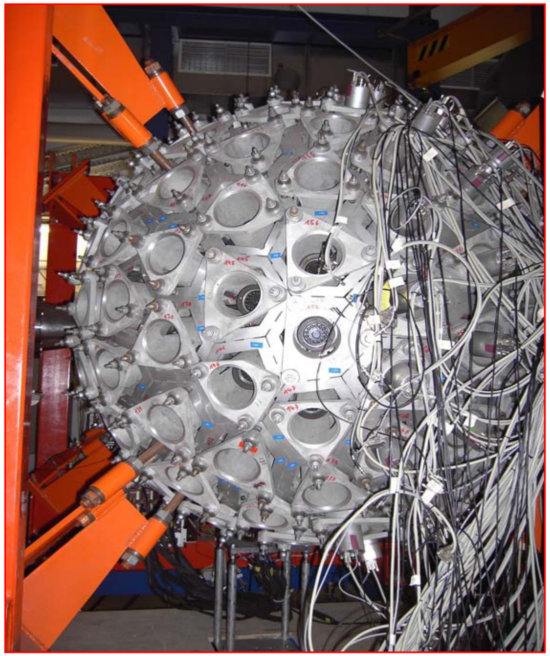
GSI, September 2012

Eh, what's the γ activity, doc?



When the activity / identity of the calibration source used is not known...





...it becomes difficult to compare with rate-dependent simulations.

Investigations Aug 2011 with O. Ershova
For the 2005 experiment S295, runs 180 (^{60}Co) and 181 (^{22}Na).

^{60}Co: ? Bq

^{22}Na: 154 kBq

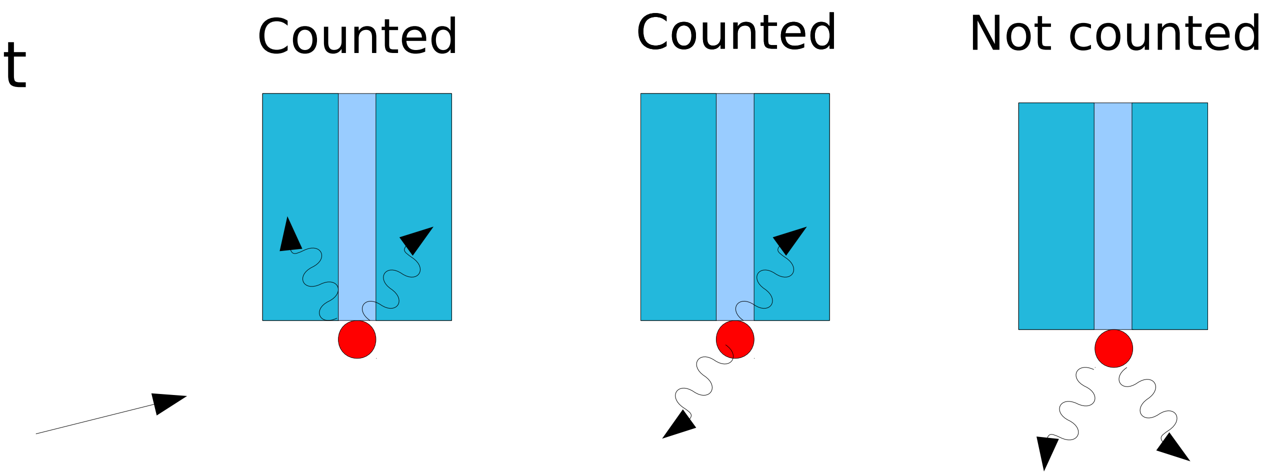
Plan A: trigger scalers

- Depends on trigger thresholds

- Geometry dependent

→ Source dependent:

^{60}Co – 1.332 MeV 1.173 MeV
in coincidence, only
small anisotropy



^{22}Na – 1.274MeV coincident with 2x .511 MeV – for the 90 % β^+ decays.
The two .511 MeV however back-to-back, so always seen by CSI
with source in target position...

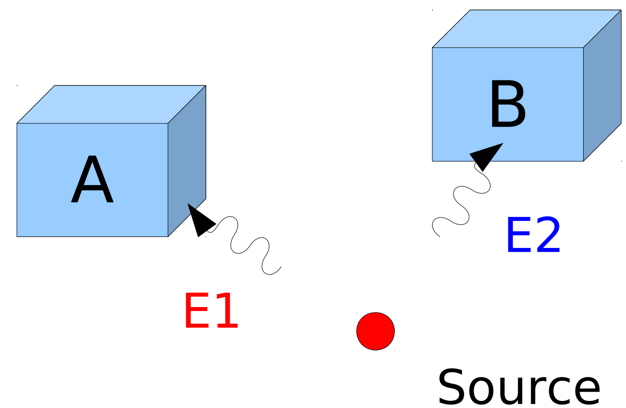
Preliminary: ^{60}Co run: 134 kHz triggers → 190 kHz (geometry) → ... kBq

Preliminary: ^{22}Na run: 115 kHz triggers

Background of ~ 10 kHz subtracted.

Plan B: time correlations (random coincidences)

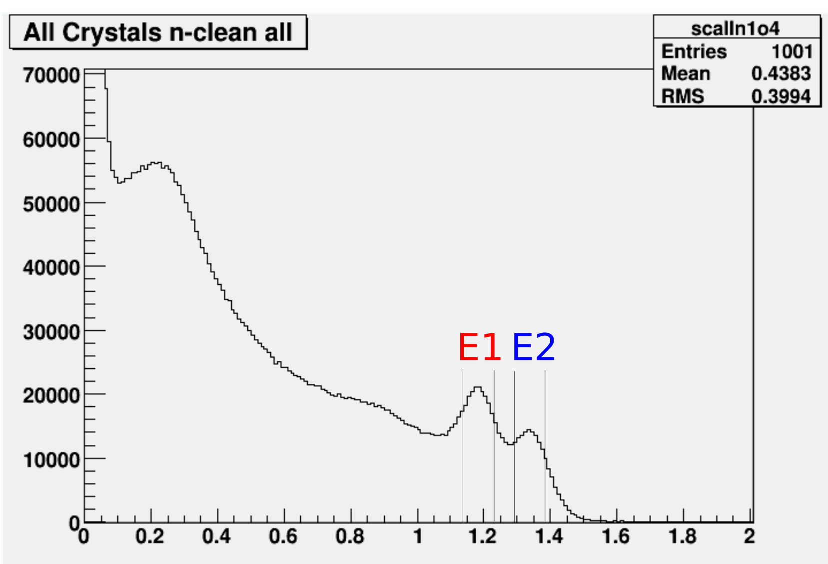
Source activity: *f* [Bq]

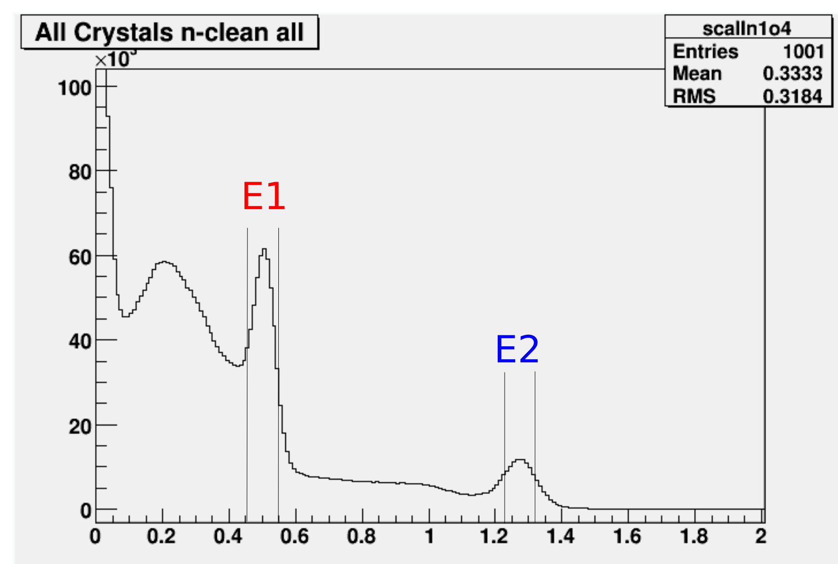


Detectors A and B

Photo-peak efficiencies $\varepsilon_{A,E1}$ and $\varepsilon_{B,E2}$, energy dependent.

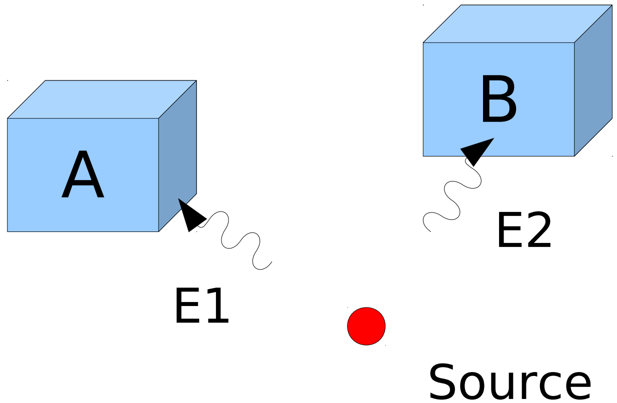
Solid angles Ω_A and Ω_B.





Plan B: time correlations (random coincidences)

Source activity: f [Bq]



Detectors A and B

Photo-peak efficiencies $\varepsilon_{A,E1}$ and $\varepsilon_{B,E2}$, energy dependent.

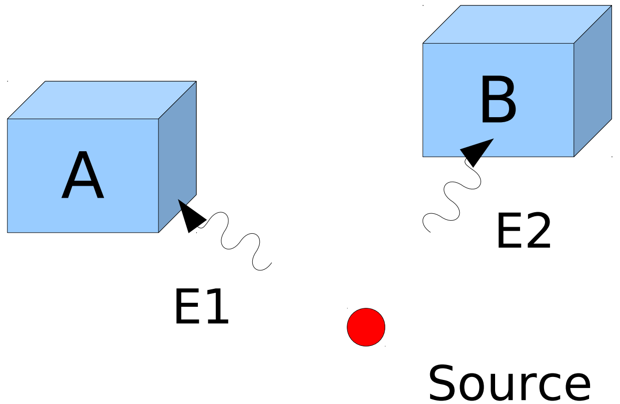
Solid angles Ω_A and Ω_B.

# of coincident E1 in A and E2 in B during collection time T:

$$N_C = T f \varepsilon_{A,E1} \frac{\Omega_A}{4\pi} \varepsilon_{B,E2} \frac{\Omega_B}{4\pi}$$

# of E1 in A during time T: $N_{A,E1} = T f \varepsilon_{A,E1} \frac{\Omega_A}{4\pi}$

Random coincidences

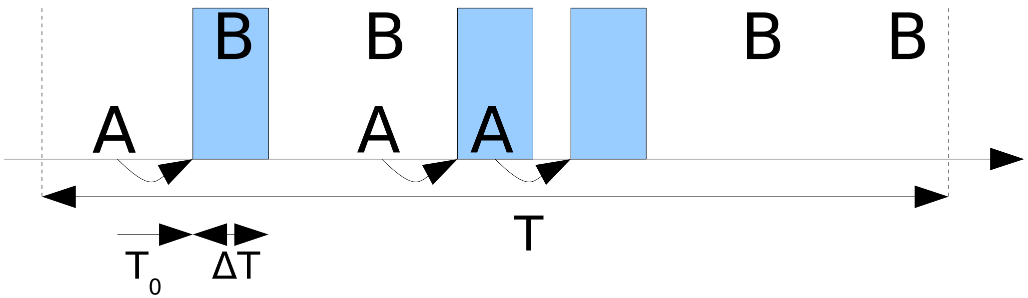


Source activity: *f* [Bq]

$$N_C = T f \varepsilon_{A,E1} \frac{\Omega_A}{4\pi} \varepsilon_{B,E2} \frac{\Omega_B}{4\pi}$$

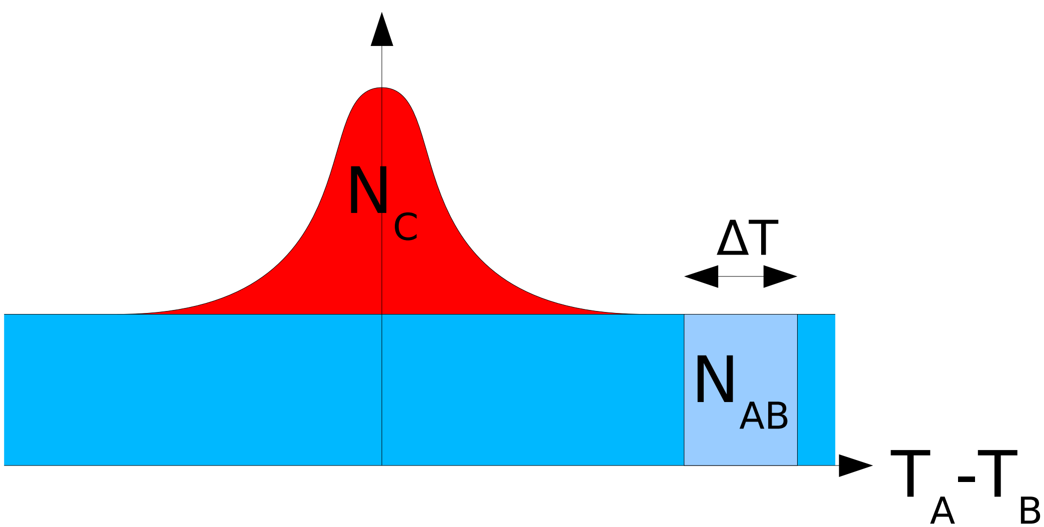
$$N_{A,E1} = T f \varepsilon_{A,E1} \frac{\Omega_A}{4\pi}$$

$$N_{B,E2} = T f \varepsilon_{B,E2} \frac{\Omega_B}{4\pi}$$



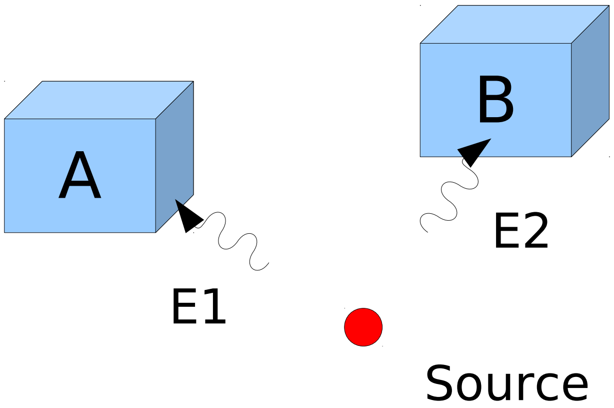
Random chance to detect E1 in A and E2 in B with time difference T_A-T_B within [T_0,T_0+ΔT]:

$$N_{AB} = N_{A,E1} \frac{N_{B,E2}}{T} \Delta T$$



Solve for *f*: $$f = \frac{1}{N_C} \frac{N_{AB}}{\Delta T}$$

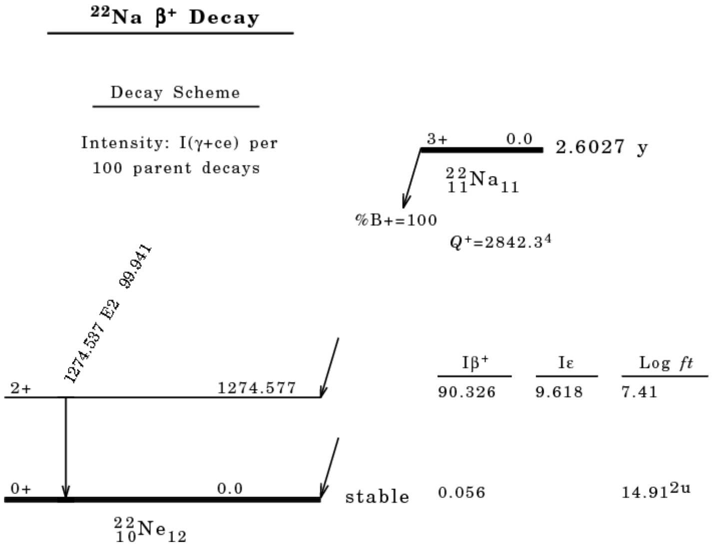
Requirements



Trigger thresholds well below E1 and E2.

E1 and E2 must be coincident, else N_{AB} / N_C ratio distorted, e.g. in ^{22}Na due to 10 % EC.

$$f = \frac{1}{N_C} \frac{N_{AB}}{\Delta T}$$



Implementation

gamma2 option: `GAMMA_COLLECT_RND_COINC`

Postprocess by `scripts/random_coinc.cc`

Plots by `scripts/plot_random_coinc.py`

^{60}Co – KE 565: 274 kBq ?

Time difference:

Peak: coincidences

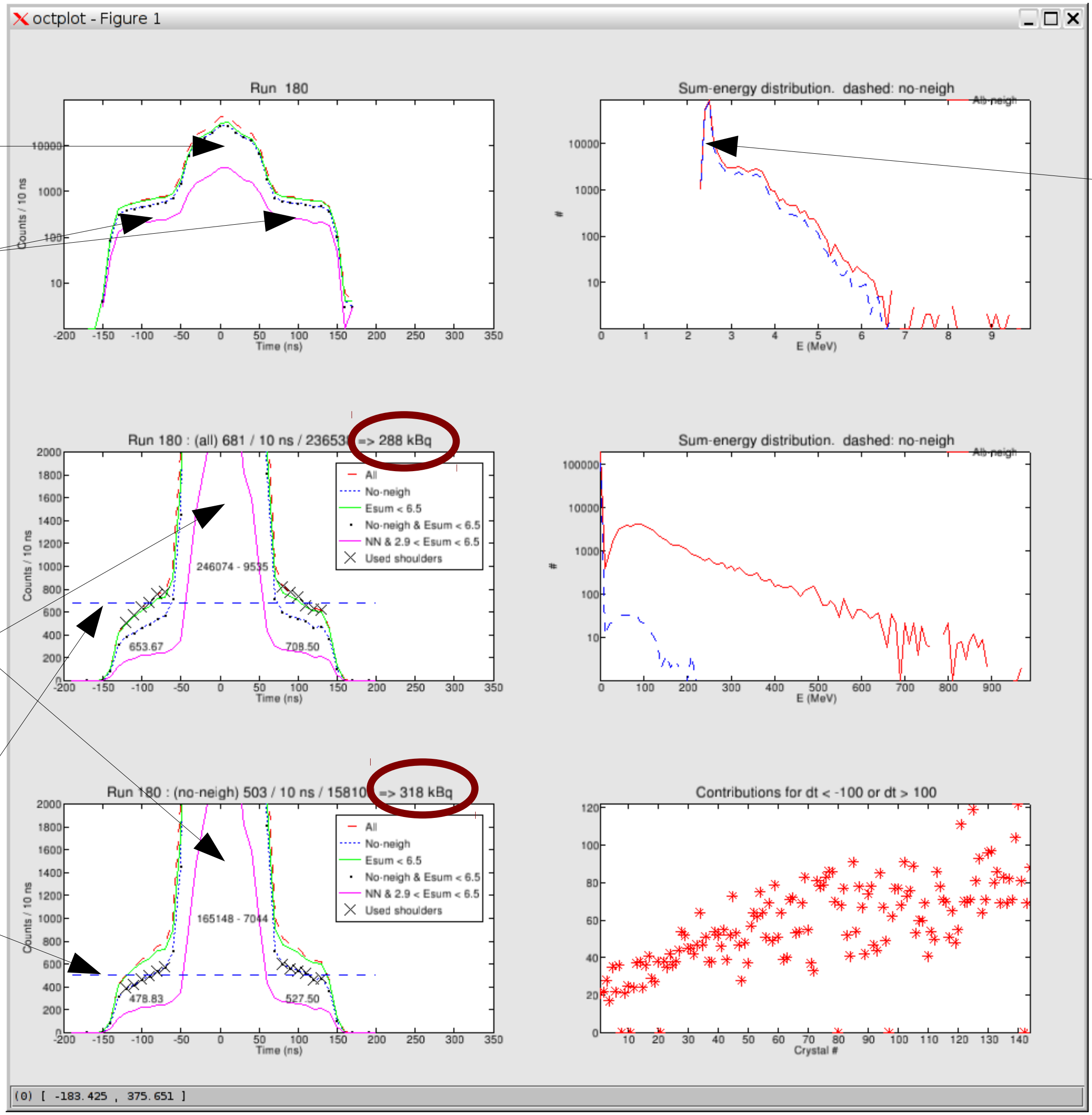
Shoulders: random coincidences

Different curves - varied cleaning cuts

Coincidences give normalisation (detector efficiency)

Randoms give source activity

All: 288 kBq
No-neigh: 318 kBq

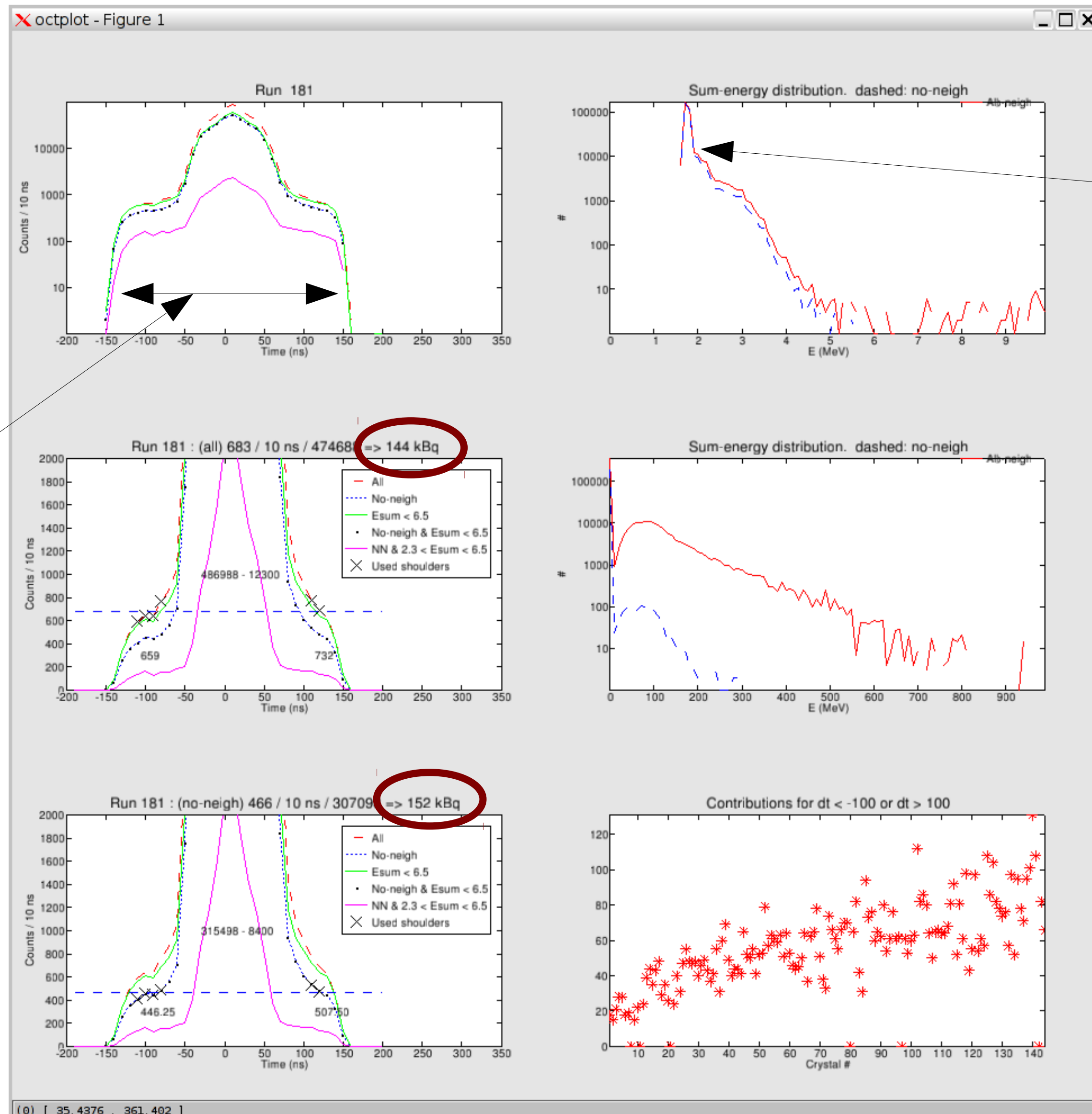


1.332 MeV + 1.173 MeV

Muons?
(too much energy)

Shoulder contributions per crystal
(offenders have been removed)

^{22}Na – KK 157 – 154 kBq



1.274 MeV + 0.511 MeV

FASTBUS TDCs time range: 200 ns

All: 144 kBq
No-neigh: 152 kBq

Multiply by 1/0.9 due to EC events.

Finale!

Thank you!

γ-FUN