GERDA Project Review 2011

Fabiana Cossavella for the GERDA group

Max-Planck Institut für Physik, München

20 December 2011

Director: Allen Caldwell
Project leaders: Béla Majorovits (GERDA)
Postdoc: Fabiana Cossavella, Josef Janicsko (02/11), Christopher O'Shaughnessy, Oliver Schulz
PhD: Neslihan Becerici-Schmidt, Oleksandr Volynets
Diplomand: Aaron Michel, Alexey Shevelev
Group engineer: Hans Seitz, Franz Stelzer
Engineering: Sven Vogt

Many thanks to Reinhard Sedlmeyer, Dominik Wamsler, Alex Wimmer, Günter Winklmüller and the colleagues from electronic & mechanic departments

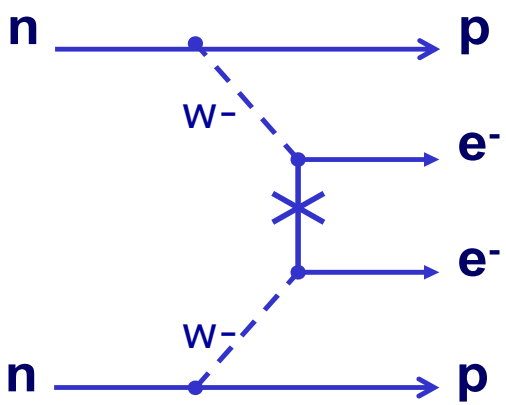
The collaboration

GERDA collaboration picture,
GERDA meeting; Zurich- June 2011

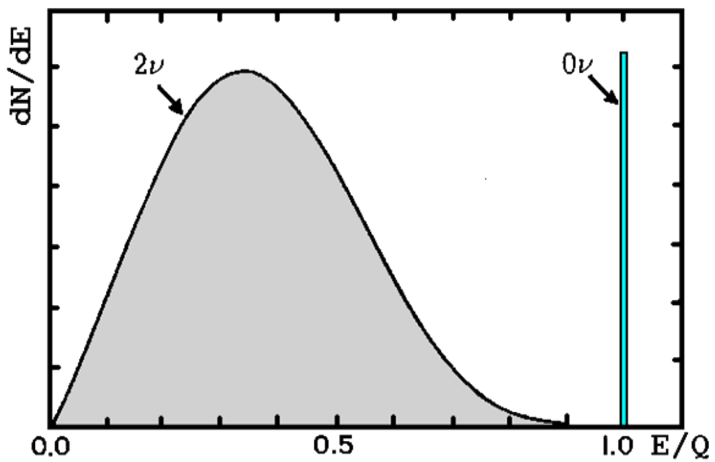
Search for $0\nu\beta\beta$ decay

Unknowns about Neutrinos:

- Nature of the Neutrino (Dirac - Majorana?)
- Absolute mass scale? Inverted/normal hierarchy?
- CP phases?



$\Delta L=2$, beyond SM



If neutrinoless double beta-decay is observed:

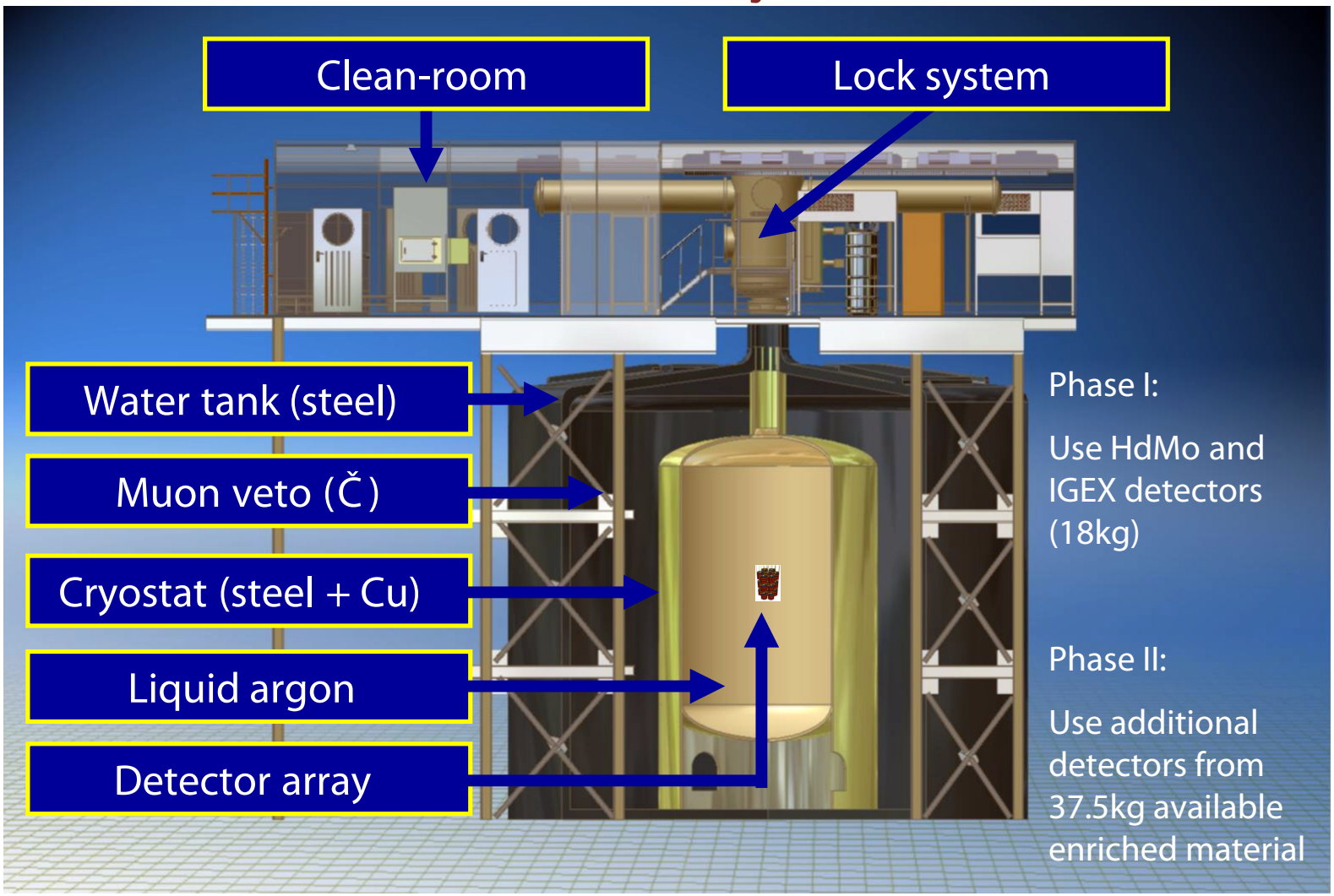
→Neutrino is a Majorana particle

→Information on absolute mass scale

$$1/\tau = G(Q,Z) \; |M_{nucl}|^2 \; \langle m_{ee} \rangle^2$$

$0\nu\beta\beta$ Decay rate	Phase space factor	Matrix element	Effective Majorana Neutrino mass

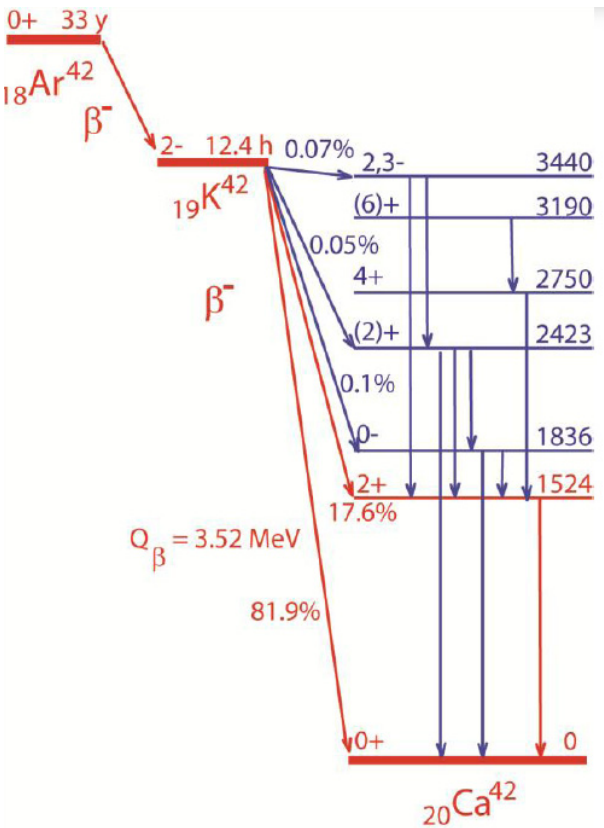
The Germanium Detector Array

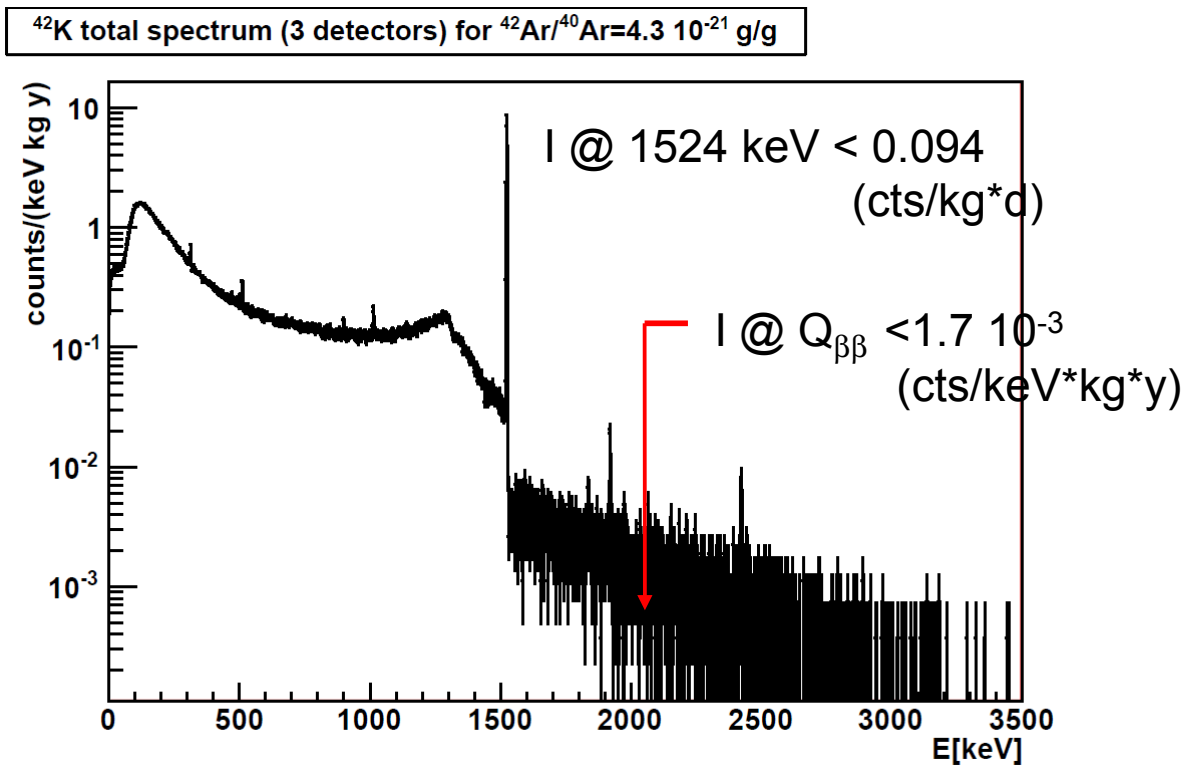


Looking for $0\nu\beta\beta$-decay of ^{76}Ge

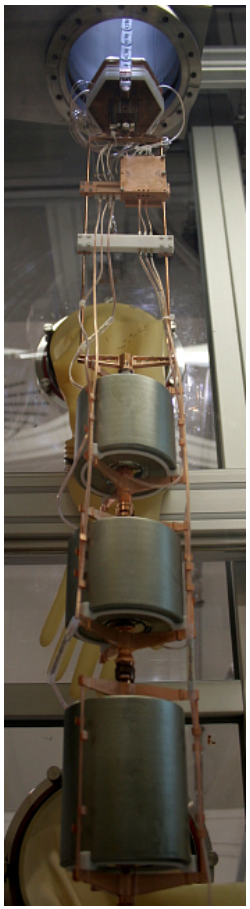
Commissioning runs : the ^{42}Ar

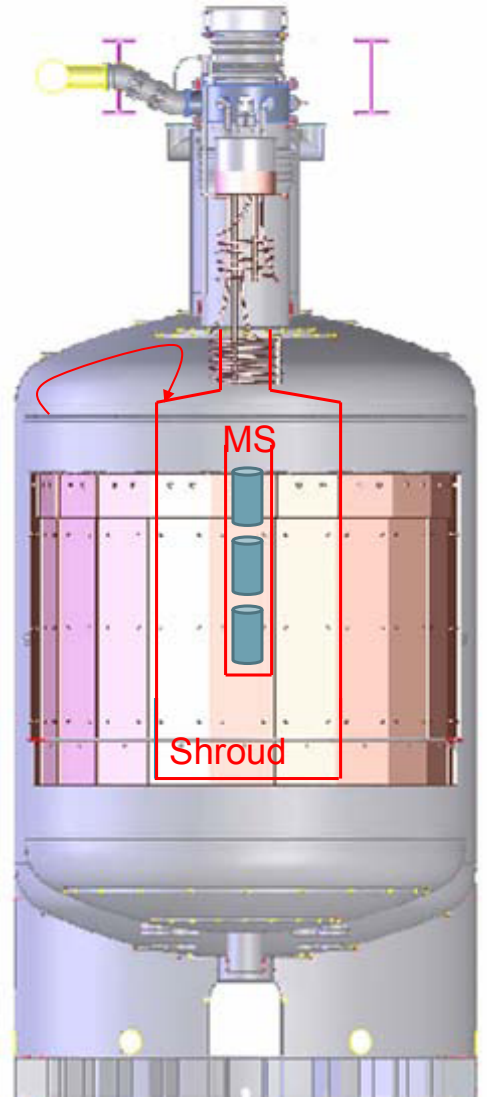
- production: ^{40}Ar(α,2p)^{42}Ar reaction in atmosphere and fall-out from atmospheric nuclear explosion





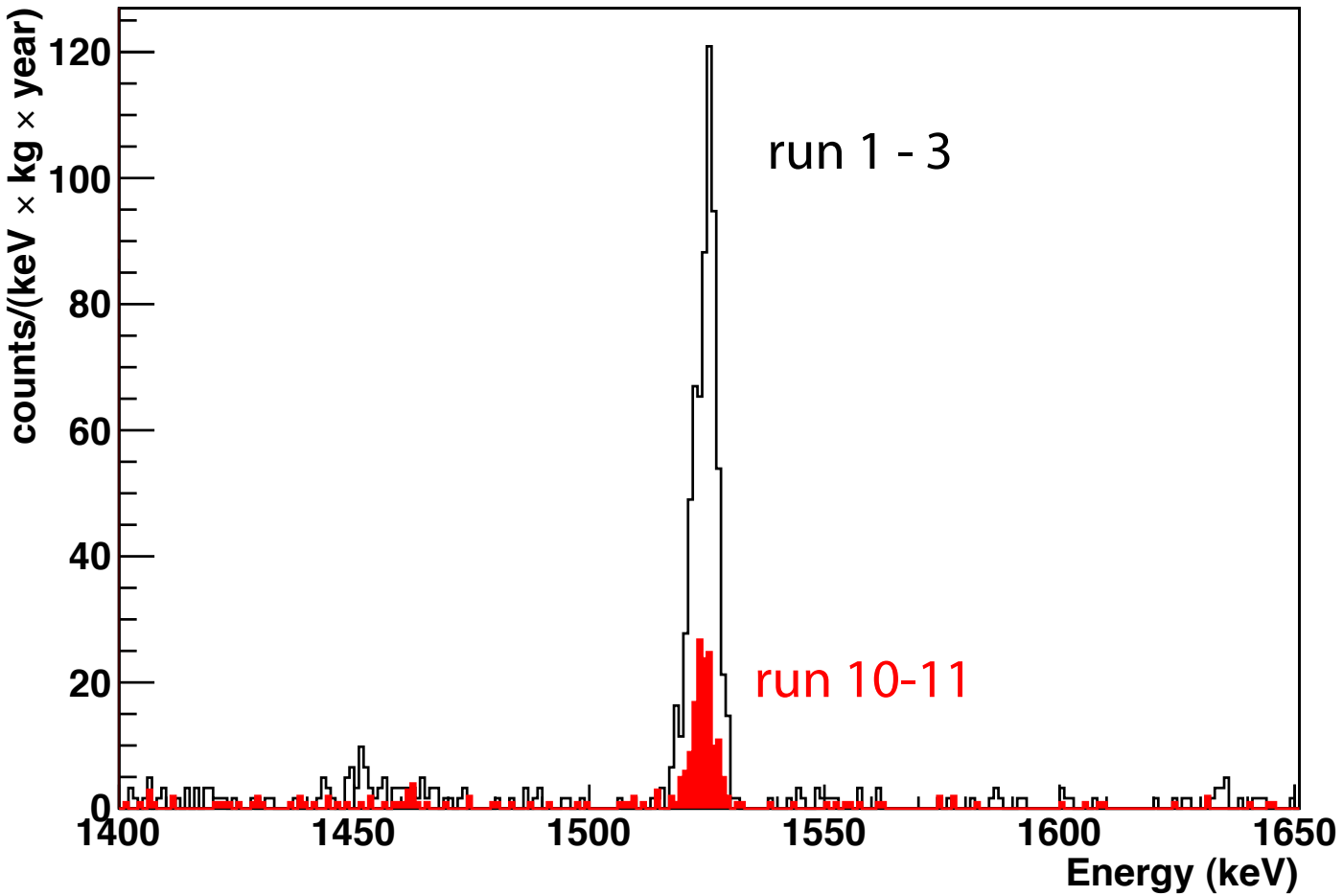
GERDA background with mini-shroud





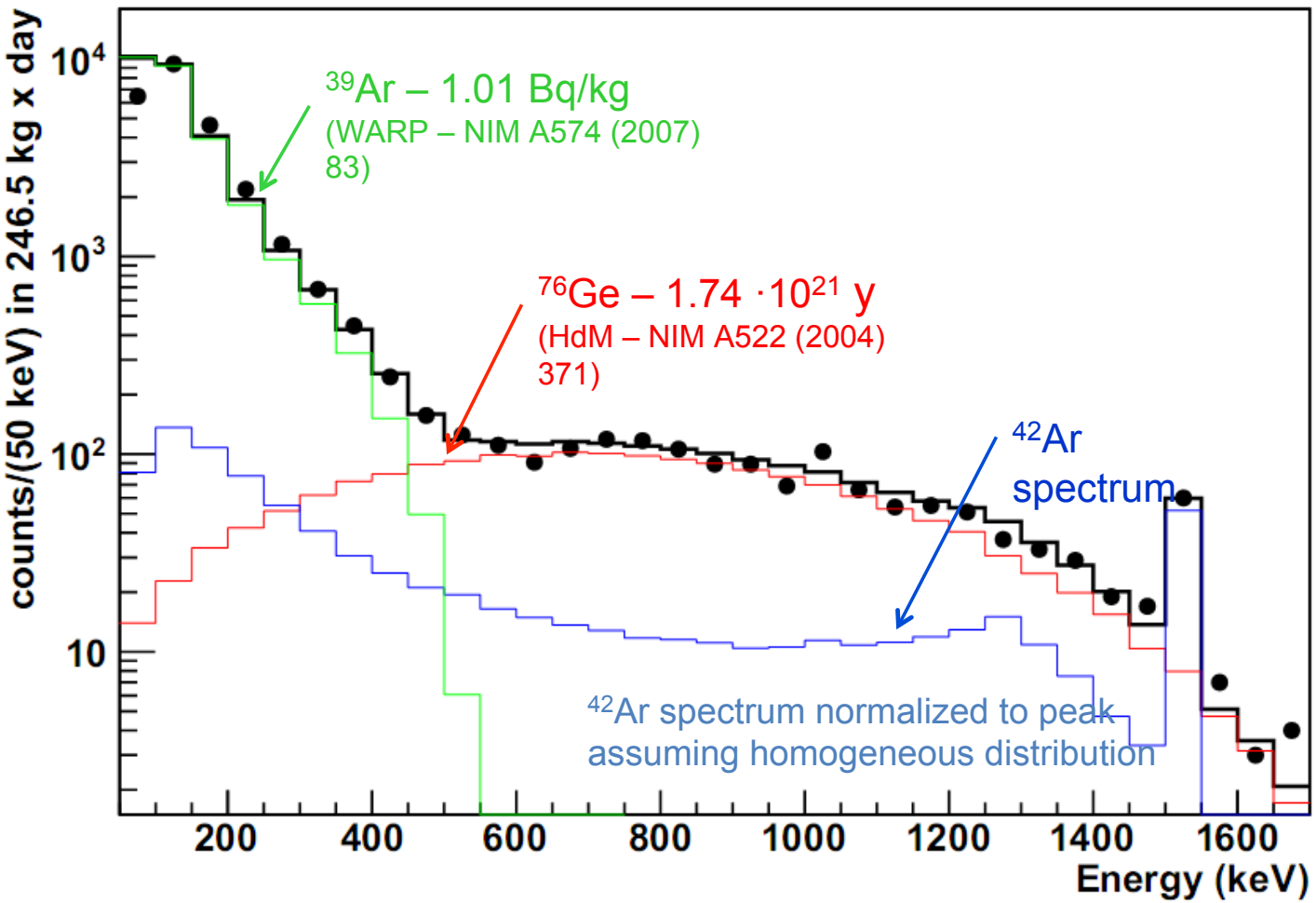
Observed : $I_{measured} > 10\ I_{expected}$
Tested different electric field configuration by biasing shroud and mini-shroud

GERDA background with mini-shroud

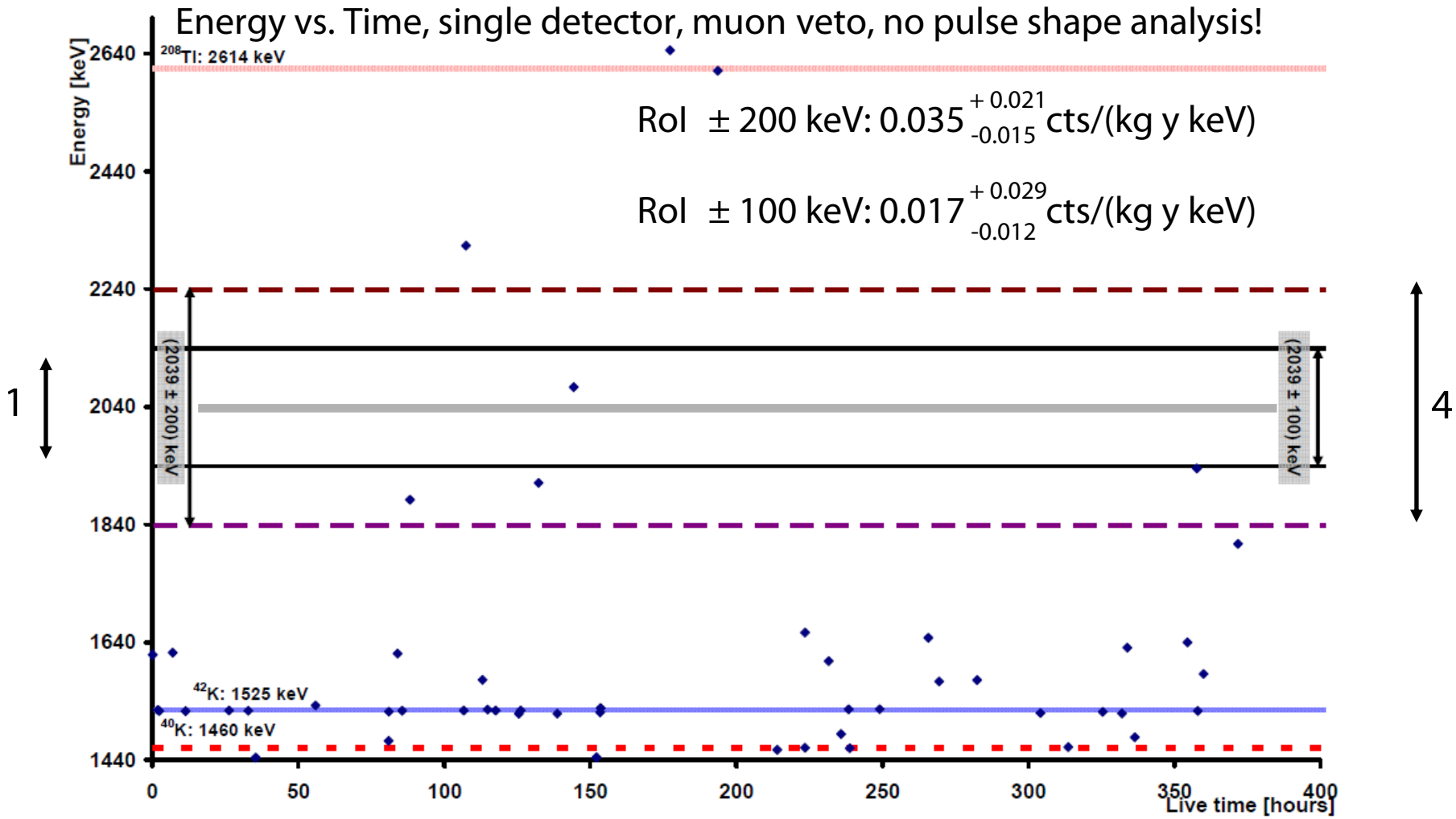


First $2\nu\beta\beta$ spectrum

June 2011: first string of enriched detectors in GERDA



Background index



3 enriched detectors: 6.7 kg 0.29 kg y

Getting ready to deploy all enr. detectors: the 3 string arm

- 2 arm build and tested at MPI Munich in winter
- delivered and successfully mounted at LNGS in spring 2011
- sligthly modified design to host up to 9 detectors
- test runs with $^{\mathrm{nat}}$Ge detectors in summer 2011
- background index consistent with measurement performed in the 1-string arm

GERDA Phase I

Phase I started on November 1st

- 8 enriched detectors + 1 $^{\mathrm{nat}}$Ge detector mounted on the 3-string arm
- 2 $^{\mathrm{nat}}$Ge detector on the 1 arm
- energy resolution of $\approx 4 - 5$ keV
- 17.67 kg of enriched material
- 7.59 kg of natural germanium

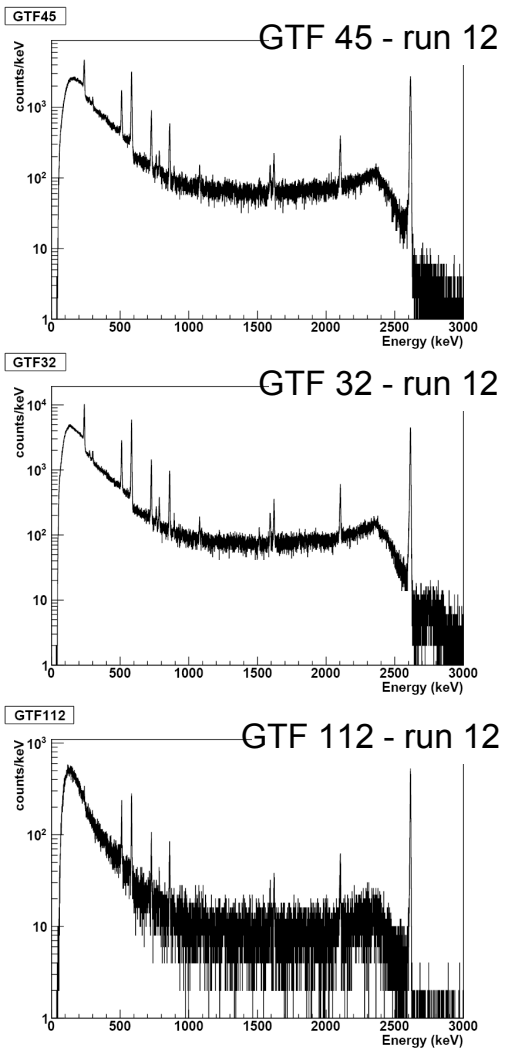
Preparing Phase II: production of new enriched detectors

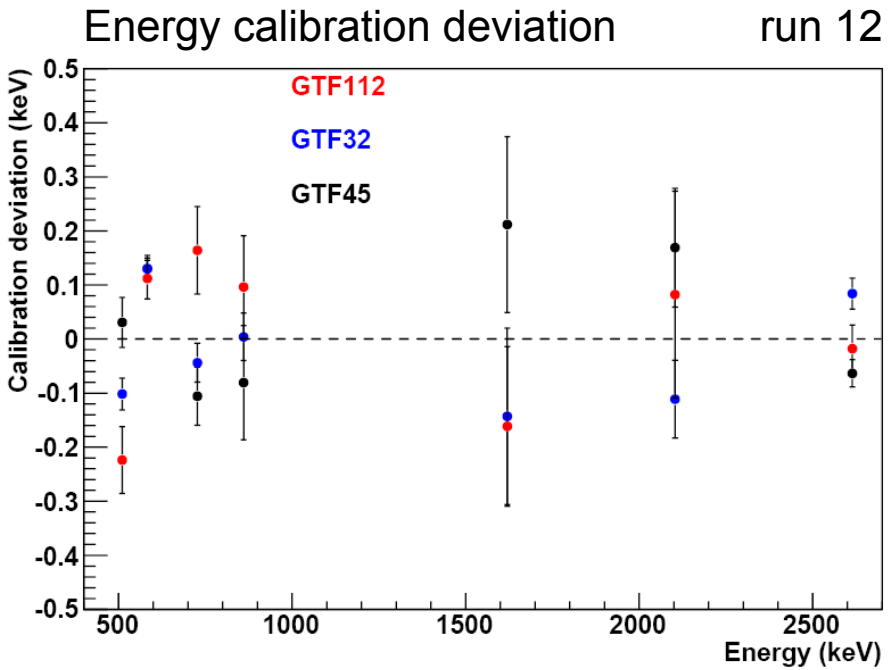
- transport container to shield against CR built at MPI Munich
- enriched material shipped to USA on October 2nd
- material processing for crystal production started at CANBERRA (Oak Ridge) on 17th October 2011
- pulled 4 crystals of about 4 kg each, 3 within specification for BEGe production
- January 2012 - 4 crystal slices will be sent to CANBERRA (Olen) for detector production
- construction of Phase II lock system suitable for deployment of the newly produced enriched detectors in GERDA

Conclusions

- GERDA infrastructure finished in spring 2011: setup working stable
- GERDA background runs completed
- Background rate of ^{42}K is E-field dependend and can be reduced
- First string with 3 enriched germanium detectors deployed $\rightarrow$ first GERDA $2\nu\beta\beta$ spectrum measured
- BI in ROI ($\pm$100 keV) for enriched diodes is $0.017^{+0.029}_{-0.012}$ counts/(keV kg y): significantly better than previous experiments, getting closer to the GERDA Phase I specifications
- All existing enriched detectors deployed
- Crystal pulling and phase II detector production started

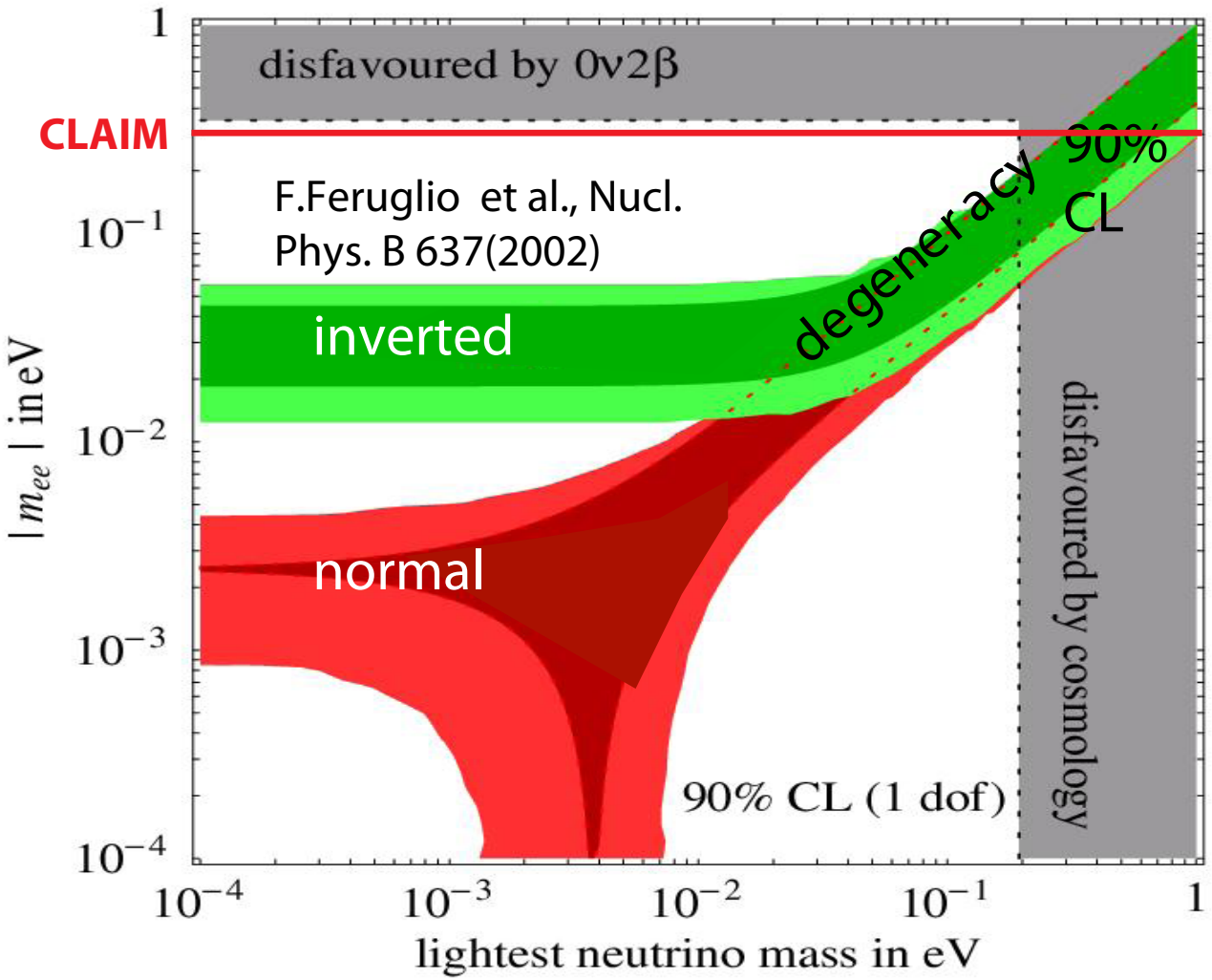
Commissioning runs





Measured energy resolution (FWHM)

- Coaxial (Phase I): (3.8-4.6) keV at 2.6 MeV
- BEGe (Phase II): 2.8 keV at 2.6 MeV


disfavoured by 0ν2β
CLAIM
F.Feruglio et al., Nucl. Phys. B 637(2002)
inverted
normal
degeneracy
90% CL
90% CL (1 dof)
disfavoured by cosmology
$|m_{ee}|$ in eV
lightest neutrino mass in eV
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}

GERDA background with mini-shroud