# The GERDA Experiment

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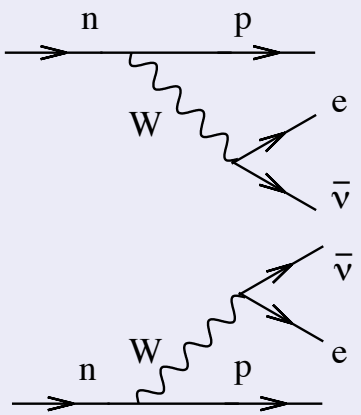
# Double Beta Decay

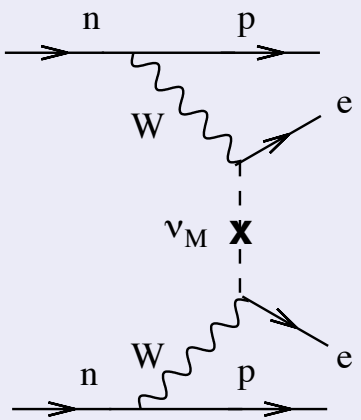
## $2\nu\beta\beta$

- $(Z, A) \rightarrow (Z+2, A) + 2e^- + 2\bar{\nu}_e$
- $\Delta L = 0$
- $\left|T^{2\nu}_{1/2}\right|^{-1} = G^{2\nu}(Q_{\beta\beta}, Z)\,|M_{2\nu}|^2 \sim 10^{20}\text{y}$




## $0\nu\beta\beta$

- $(Z, A) \rightarrow (Z+2, A) + 2e^-$
- $\Delta L = 2$
- $\left|T^{0\nu}_{1/2}\right|^{-1} = G^{0\nu}(Q_{\beta\beta}, Z)\,|M_{0\nu}|^2\,\langle m^2_{\beta\beta}\rangle \sim 10^{25}\text{y}$



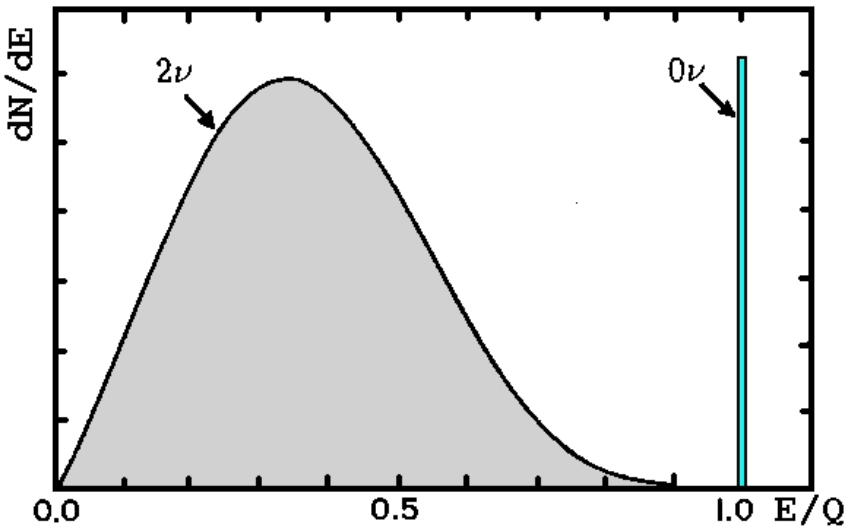
# Signature

## Measuring the energy of both electrons

- $2\nu\beta\beta$: Continuous energy spectrum
- $0\nu\beta\beta$: Sharp peak at Q value of decay

$$Q = E_{e1} + E_{e2} - 2m_e$$

- Background reduction essential because of small half lives
- Schechter & Valle (1982): Measuring $0\nu\beta\beta \Rightarrow \nu$ Majorana particle



# Heidelberg-Moscow Experiment

## The Claim

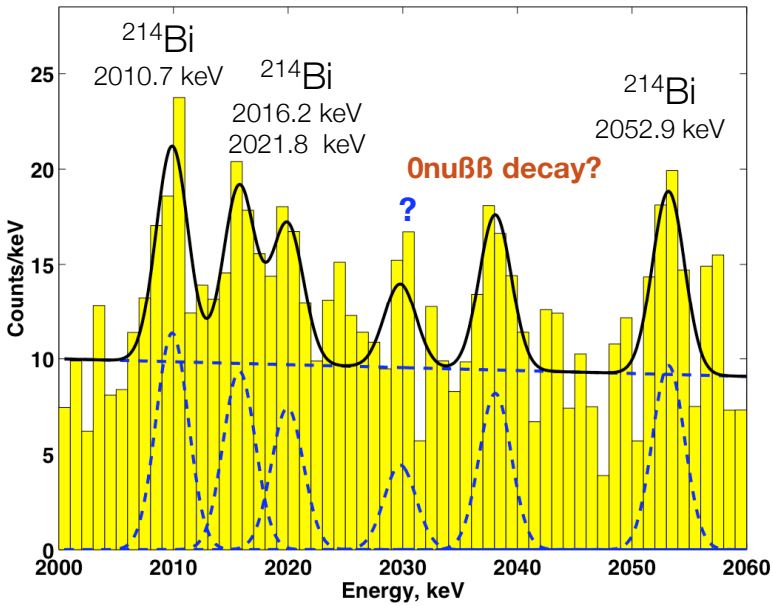
- 5 HPGe crystals with 71.7 kg y
- Peak at Q value:

$$T_{1/2}^{0\nu} = 1.2 \times 10^{25} y \quad (4\sigma)$$
$$\langle m_{\beta\beta} \rangle = 0.44\,\text{eV}$$

- Problem: Confidence depends on background model and energy region selected for analysis

$\Rightarrow$ New experiments with higher sensitivity needed

H.V.Klapdor-Kleingrothaus et al., Phys. Lett. B 586 (2004) 198



# The GERmanium Detector Array (GERDA)

Naked high purity $^{76}$Ge crystals placed in LAr

## Phase I

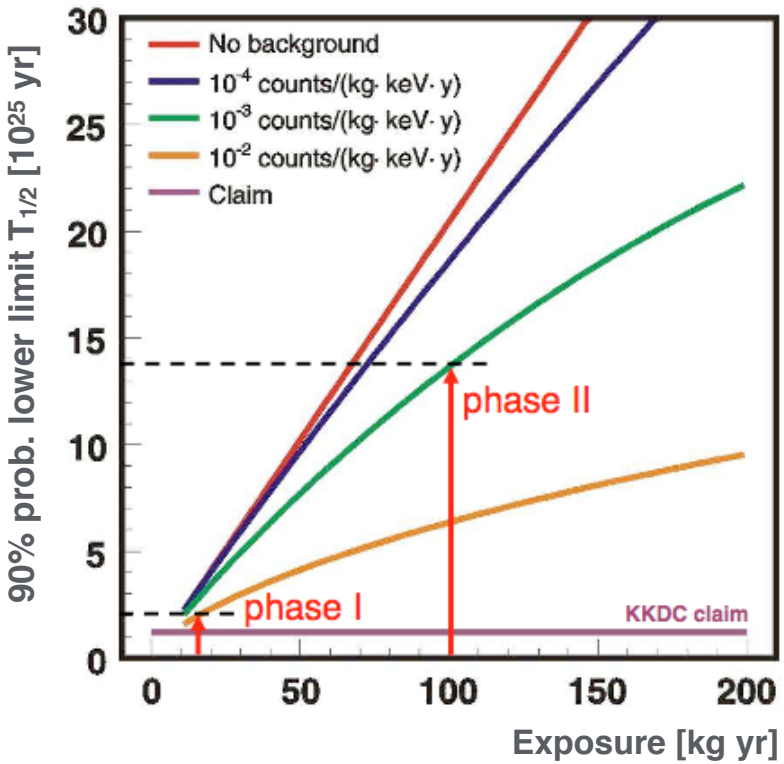
- 8 Hd-Mo & IGEX crystals (15 kg y)
- Background goal: $10^{-2}$ cts/kg/keV/y

$$\Rightarrow \quad T^{0\nu}_{1/2} > 2.0 \times 10^{25}\,\text{y}$$
$$\langle m_{\beta\beta} \rangle < 0.33\,\text{eV}$$

## Phase II

- Phase I + 14 new segmented crystals (100 kg y)
- Background goal: $10^{-3}$ cts/kg/keV/y

$$\Rightarrow \quad T^{0\nu}_{1/2} > 14 \times 10^{25}\,\text{y}$$
$$\langle m_{\beta\beta} \rangle < 0.13\,\text{eV}$$



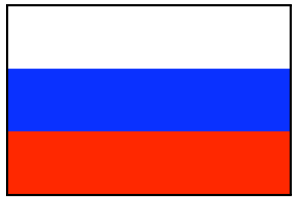
# The Collaboration

**ITALY**
INFN LNGS, Assergi
Univ. di Milano Biocca e INFN
Univ, di Padova e INFN

**GERMANY**
MPI Heidelberg
MPI München
TU Dresden
Universität Tübingen

**BELGIUM**
IRMM, Geel

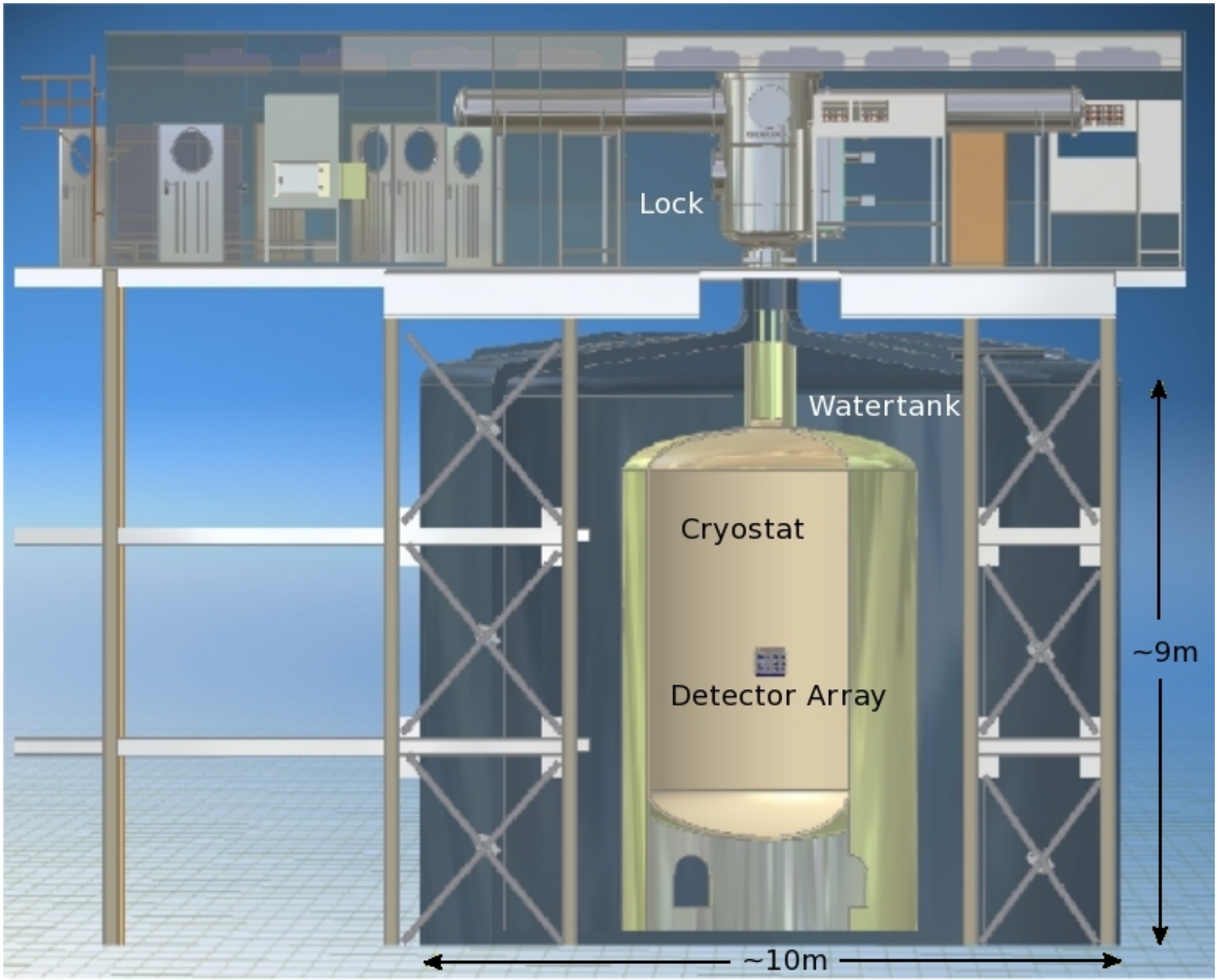
**RUSSIA**
INR, Moscow
ITEP Physics, Moscow
Kurchatov Institute, Moscow
JINR Dubna



**POLAND**
Jagiellonian University, Cracow

**SWITZERLAND**
University of Zurich

# Overview



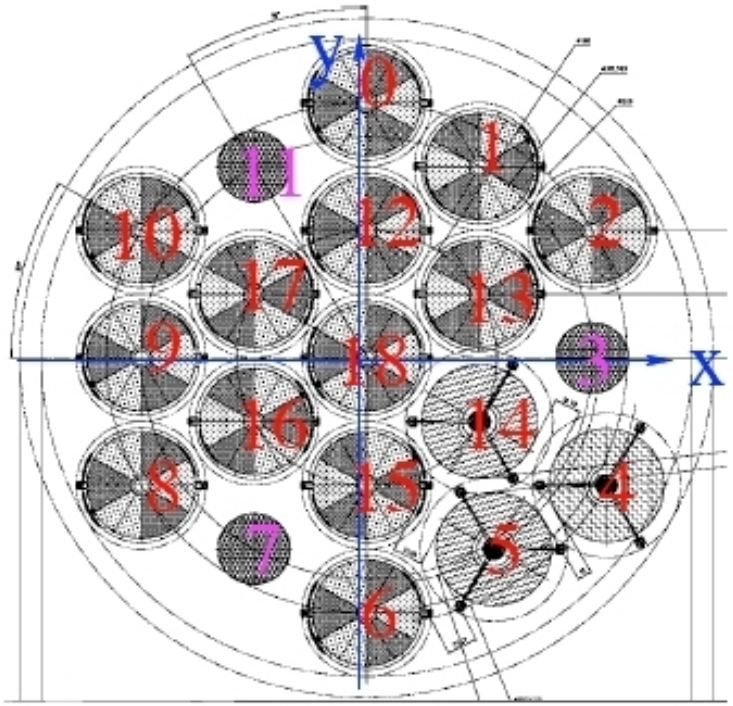
# The Calibration System
## UZH Contribution

### Boundary Conditions

- Fixed positions of the sources
- Maximum radius $\sim$ 4cm
- Minimum weight $\sim$ 4kg
- Park position in the lock of the detector

### Goals

- Sort and strength of calibration sources
- Collimator material and geometry
- Efficiency of energy deposition in each detector
- Efficiency of pulse shape analysis



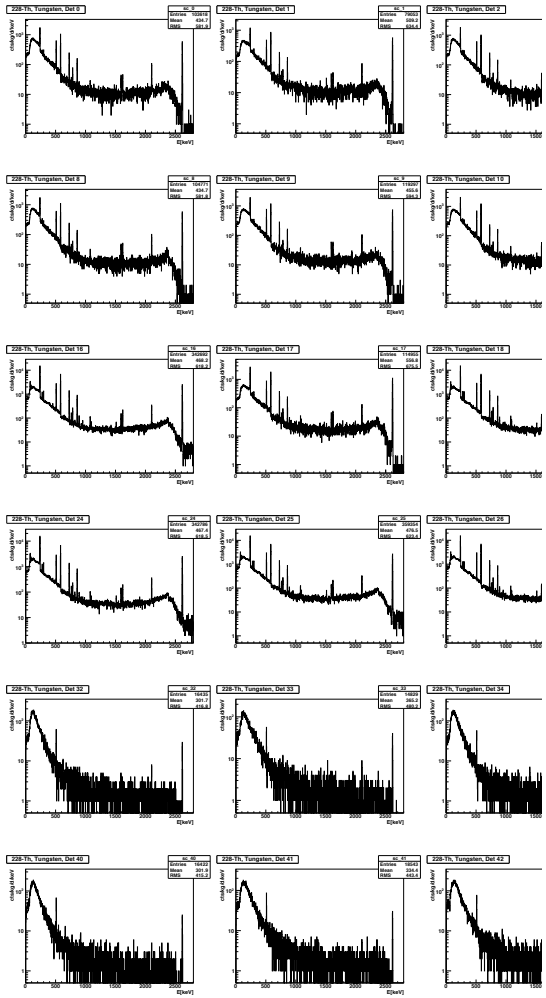
# Progress & Plans

## Status of Calibration

- Monte Carlo Simulations with MaGe
- Simulations with different collimator geometries and the naked source in parking position running
- Single detector analysis
- Most promising: $^{228}$Th or $^{56}$Co as source and Cu or W as collimator material

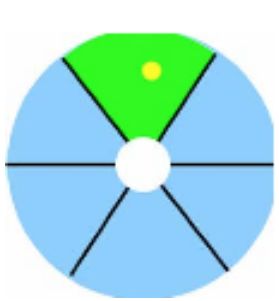
## Future Plans

- Comparison of Monte Carlo results with measurements at a test facility in Zurich
- Installing and testing system at LNGS

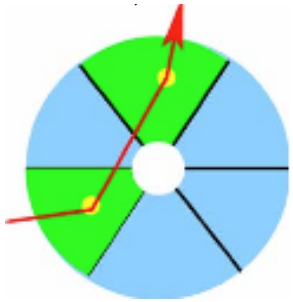


# Phase II detectors
## The Zurich Test Facility

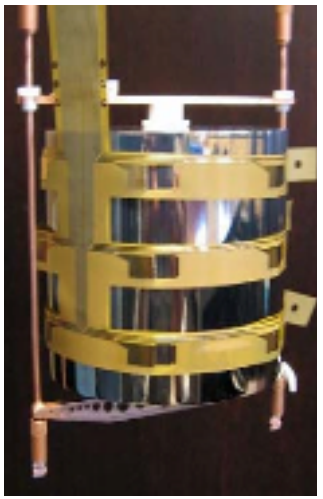
- 18 fold segmentation: $6(\phi) \times 3(z)$
- Possibility to distinguish between single site events (signal) and multi site events (background)
- First spectra taken with core and all 18 segments
- Test facility in Zurich under construction

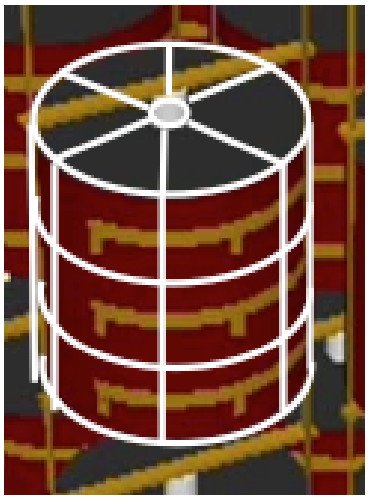


SSE

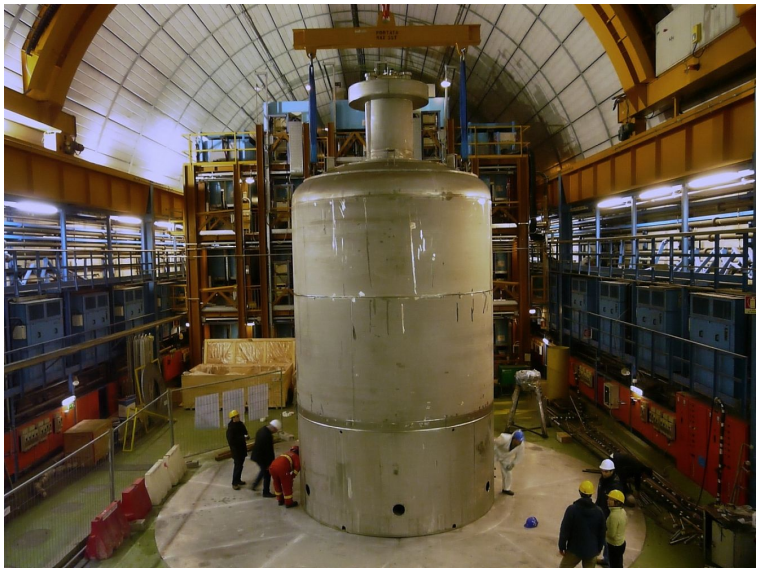


MSE





# Status of the Experiment



# Timetable

| | Phase I | Phase II |
|---|---|---|
| September 2008 | | Purification of enriched Ge |
| January 2009 | Myon veto | Tests for crystal growing (IKZ, Berlin) |
| April 2009 | Clean room and lock | |
| Juli 2009 | **Start data taking** | Natural Ge test detectors |
| December 2009 | | Crystal growing of enriched Ge |
| March 2010 | | $^{76}$Ge detectors (Canberra, France) |
| Juli 2010 | | **Start data taking** |