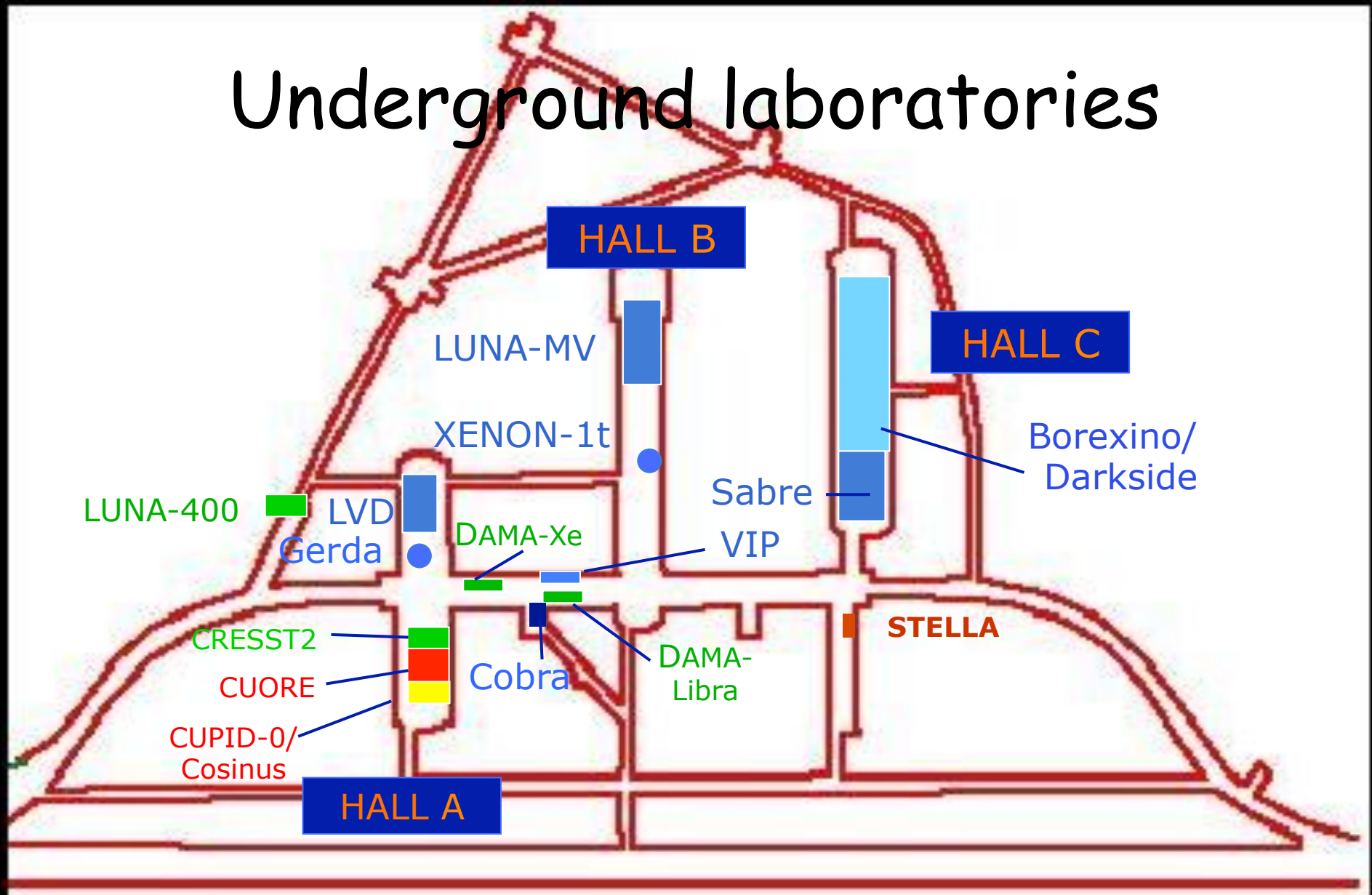


The Low Background Facility STELLA at the LNGS

Dr. Matthias Laubenstein
Laboratori Nazionali del Gran Sasso

DS-materials parallel meeting
Gran Sasso Science Institute
22 March 2019

Underground laboratories





March 22nd, 2019

DS materials - GSSI (Italy)



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HPGe detectors

shielding:

20 cm low activity lead ($^{210}\text{Pb} < 20 \text{ Bq kg}^{-1}$)

5 cm OFHC copper

5 cm acrylic and Cd foil on the bottom

Rn-suppression:

1 cm acrylic cover with continuous N_2 flow

material selection:

highly radiopure, (almost) no activation

Low background counting laboratory

STELLA = **S**ub**T**Erranean **L**ow **L**evel **A**ssay;
some of the 15 HPGe detectors:

type	volume [cm ³]	mass [kg]	rel. efficiency	FWHM [keV]
GeDSG (well)	170	0.905	40%	1.9
BEGe (BE)	114	0.607	30%	1.7
GsOr p-type	414	2.20	96%	1.9
GePaolo p-type	518	2.76	113%	2.0
GeCris p-type	465	2.48	120%	2.0
GeMPI4 p-type	402	2.14	100%	2.0

HPGe detectors

detector	total and peak background count rate [$\text{d}^{-1} \text{kg}^{-1}_{\text{Ge}}$]				
	60-2700 keV	609 keV	1332 keV	1461 keV	2614 keV
<i>GeDSG</i>	293 ± 3	3.1 ± 0.4	< 0.34	1.3 ± 0.2	0.6 ± 0.2
<i>BEGe</i>	738 ± 7	6.3 ± 0.7	< 0.25	0.7 ± 0.2	0.2 ± 0.1
<i>GsOr</i>	442 ± 5	2.0 ± 0.5	0.8 ± 0.4	4.2 ± 0.5	0.6 ± 0.1
<i>GePaolo</i>	222 ± 2	1.1 ± 0.3	0.3 ± 0.1	1.8 ± 0.2	0.22 ± 0.04
<i>GeCris</i>	77 ± 2	0.29 ± 0.22	< 0.13	0.9 ± 0.2	0.16 ± 0.04
<i>GeMPI4</i>	63 ± 1	< 0.07	< 0.06	0.17 ± 0.06	0.09 ± 0.04

Sensitivity

Method	Detection limit for U and Th [Bq/kg]
ULGS (non-destructive) γ emitters	$10^{-5} - 10^{-4}$
ICP-MS (destructive) primordial parents	$10^{-6} - 10^{-5}$
ULGS + NAA primordial parents	10^{-7}

$$1 \text{ Bq } ^{238}\text{U/kg} \cong 81 \times 10^{-9} \text{ g/g}$$

$$1 \text{ Bq } ^{232}\text{Th/kg} \cong 246 \times 10^{-9} \text{ g/g}$$

$$1 \text{ Bq } ^{40}\text{K/kg} \cong 32 \times 10^{-6} \text{ g/g}$$

Activities

- material screening (e.g. GerDA, DS, CUORE, Xenon, LEGEND)
- CELLAR
- environmental radioactivity
- small fundamental physics research projects
- meteorite measurements
- "yearly" intercomparison tests with IAEA
- round-robin tests within CELLAR activities

CELLAR

Collaboration of European
Low-level **underground**
LaboRatories



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LSCE IRMM

PTB



IRSN



VKTA



LSC



MPI-K



LEGOS

IFIN-HH



IAEA-MEL

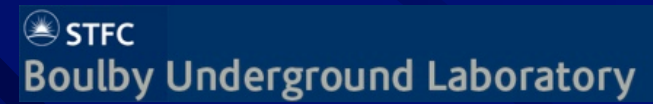
LSM



LNGS



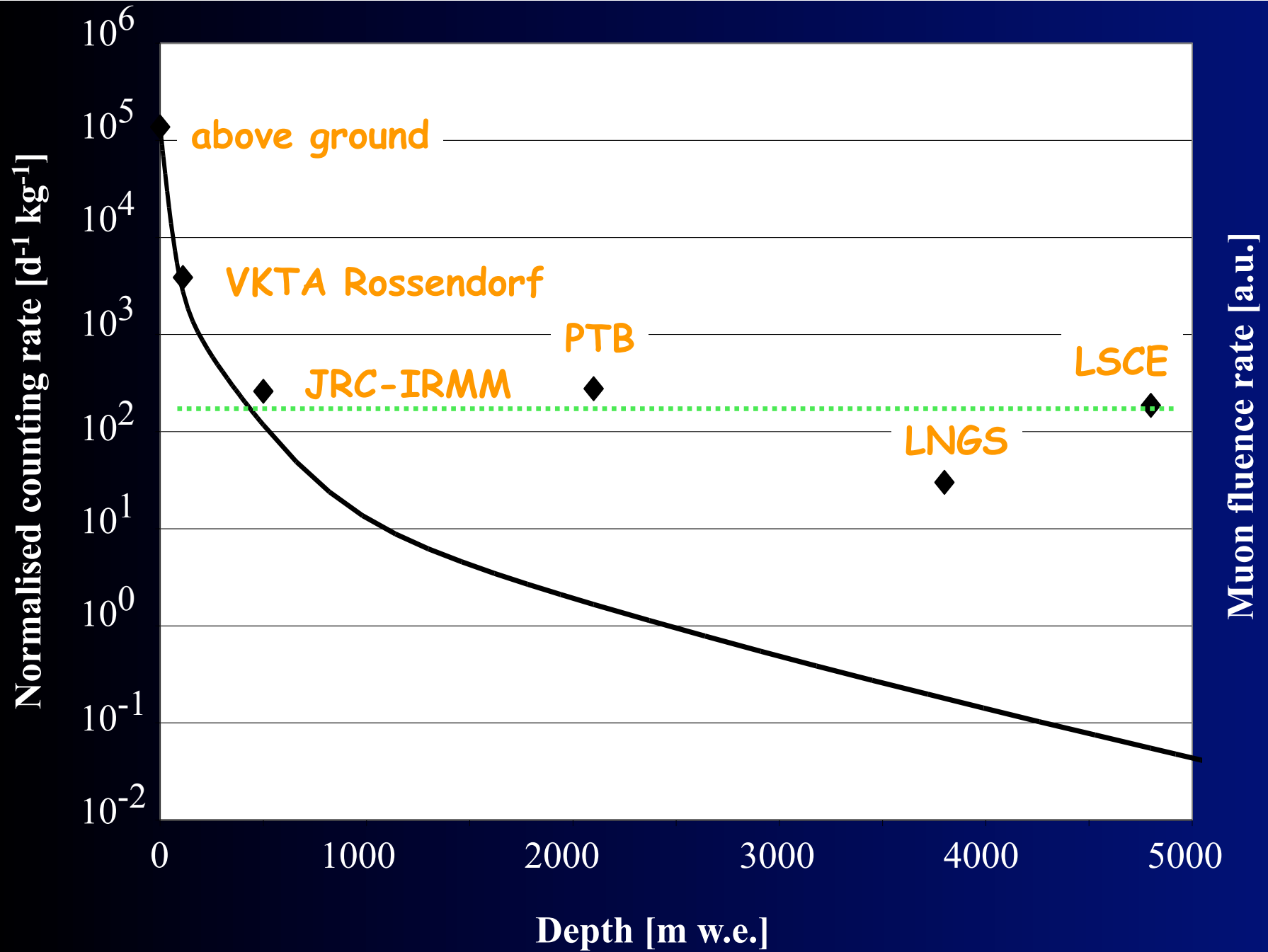
Boulby



Some of the partner laboratories:

MPI-Heidelberg - Germany	(~ 8 m \cong 15 m w.e.)
IAEA-MEL - Monaco	(~ 14 m \cong 30 m w.e.)
VKTA - Germany	(~ 50 m \cong 110 m w.e.)
LEGOS - France	(~ 80 m \cong 180 m w.e.)
IRMM - EU - Belgium	(~ 225 m \cong 500 m w.e.)
LSC - Spain	(~ 850 m \cong 2450 m w.e.)
Boulby - Great Britain	(~ 1100 m \cong 2850 m w.e.)
LNGS - Italy	(~ 1400 m \cong 3800 m w.e.)
LSCE - France	(~ 1750 m \cong 4800 m w.e.)

(m. w.e. = meter water equivalent, the height of water equivalent to that of the actual shielding material)



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Conclusions

- reorganization and optimization of existing screening facilities, because they are costly and measurement times can be rather lengthy
- harmonization of how to report data and intercomparison programs for ultra low-level measurement techniques