

ECP-2008-EDU-428037



## Fully integrated experiments and virtual laboratories

<b>Deliverable</b>	<i>D4.2</i>
<b>Dissemination level</b>	<i>Public</i>
<b>Delivery date</b>	<i>2 December 2011</i>
<b>Status</b>	<i>Final</i>
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**eContentplus**

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a multiannual Community programme to make digital content in Europe more accessible, usable and  
exploitable.

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<sup>1</sup> OJ L 79, 24.3.2005, p. 1.



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## 1. Introduction

Library of Labs (LiLa) is a project of eight European universities and three enterprises co-funded by the EU programme eContentplus. During the project duration, LiLa has implemented a portal that integrates remote and virtual laboratories and experiments. For the success of the LiLa portal it is evident that the content is present in the portal, can be easily found by students and teachers and can be easily used in the portal or applied to the learning management system (LMS) of the teacher's school or university. This task, the integration of content, as it is closely connected to the success of the project, is anchored in work package 4. Nevertheless, the integration of content depends heavily on a number of portal functionalities, as for example the search engine or the booking system.

## 2. D4.2 - Outcome

The deliverable **D4.2** has been fully delivered, with a delay of six month. An additional 37% of content (220 items instead of 160) was integrated into the portal by the consortium. Due to the diversity of the underlying content, the deliverable could have been delivered on time with cuts, as described in **Section 3.1** and in the progress reports, namely progress report no. 5. Especially the single sign-on functionalities and the booking functionalities of the LiLa portal (delayed due to security reasons) were reckoned as being very important for the integration of content and therefore for the LiLa project as a whole.

## 3. Underlying Content

In the description of work (DoW) partners from the University of Stuttgart, the Berlin Institute of Technology, the University of Cambridge, Computational Modelling Cambridge Ltd., the Aristotle University of Thessaloniki, the University of Basel and the Linkoeping University agreed to submit content, as summarized in section "4.1 Underlying Content" of the DoW. In **Table 1** we present an updated list of the content actually integrated into the LiLa portal. Most of the underlying content had been submitted as LiLa Learning Objects (LLOs) when the deliverable D4.2, "Fully integrated experiments and virtual laboratories M21", was due (see also previous progress reports). The remote experiments from Berlin, for example, were already prepared as SCORM compliant LLOs in December 2009 and submitted to the internal repository. At that time, however, the LiLa booking system and the single sign-on functionalities still needed to be developed. In the next sub-section we will give a more detailed view on the difficulties encountered during the integration of content. All remote experiments, virtual experiments and the additional content in the portal are now annotated with applicable metadata.

Table 1: Content published by LiLa partners on the LiLa Portal ([www.library-of-labs.org](http://www.library-of-labs.org)).

	Name	Type	Scientific Field	Content Provider	License
1	Nanotechnology Remote Laboratory	Remote Experiment	Physics	Aristotle University Thessaloniki	Creative Commons BY-NC-ND
2	Animation Video of Nanoeducator	Media File	Physics	Aristotle University Thessaloniki	Creative Commons BY-NC-ND
3	Experimental Guide Nanoeducator	Media File	Physics	Aristotle University Thessaloniki	Creative Commons BY-NC-ND
4	SFM Data Answersheet	Media File	Physics	Aristotle University Thessaloniki	Creative Commons BY-NC-ND
5	SFM Experiment Worksheet	Media File	Physics	Aristotle University Thessaloniki	Creative Commons BY-NC-ND
6	STM Data Answersheet	Media File	Physics	Aristotle University Thessaloniki	Creative Commons BY-NC-ND
7	STM Experiment Worksheet	Media File	Physics	Aristotle University Thessaloniki	Creative Commons BY-NC-ND
8	srm websuite - advanced internal combustion engines	Virtual Experiment	Engineering	CMCL	Creative Commons BY-NC-ND
9	srm websuite - diesel engine performance lab	Virtual Experiment	Engineering	CMCL	Creative Commons BY-NC-ND
10	srm websuite - diesel engines lab manual	Media File	Engineering	CMCL	Creative Commons BY-NC-ND
11	OMWeb Student Client	Virtual Experiment	Computer sciences	Linkoping University	Creative Commons BY-NC-ND
12	OMWeb Teacher Client	Virtual Experiment	Computer sciences	Linkoping University	Creative Commons BY-NC-ND
13	Wonderland Test	Remote Experiment	Physics	MathCore AB	Creative Commons BY-NC-ND
14	Beambending	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
15	Bipolar	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
16	Coupled Pendula	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
17	Diffraction on Double Slite	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
18	Diffraction on single slit	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
19	Download Remote Farm Data	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
20	Hysteresis of Iron Core	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
21	LC Circuit - Resonance	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
22	Live Stream Diffraction I	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
23	Live Stream Diffraction II	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
24	Live Stream Doppelpendel	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
25	Live Stream Hysteresis	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
26	Live Stream Oscillating Circuit	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
27	Live Stream Radioactivity I	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
28	Live Stream Radioactivity II	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
29	Live Stream Raman	Remote Experiment	Physics	TU Berlin	Creative Commons

		Experiment			BY-NC-ND
30	Live Stream Solar Cell	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
31	Live Stream Spectral Composition of Light	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
32	Live Stream Teltron Tube I	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
33	Live Stream Teltron Tube II	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
34	Live Stream Thermodynamics II	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
35	Live_Stream_Capacitor	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
36	Live_Stream_Coupled_Pendula_II	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
37	Live_Stream_Thermodynamics_I	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
38	OnPREX modern - Youtube Video	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
39	Parallel Plate Capacitor	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
40	Pendulum	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
41	Radioactivity	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
42	Raman	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
43	RE Oscillator - Youtube Video	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
44	RE Thermodynamics - Youtube Video	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
45	Screening of Radioactivity	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
46	Solar-Cell	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
47	Spectral Composition of light	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
48	Teltron Tube	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
49	Thermodynamics - Cycle Process	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
50	Thermodynamics - isothermal process	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
51	UTS example	Remote Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
52	Cinderella - Colored Shadows	Virtual Experiment	Physics	TU Berlin	Creative Commons BY-NC-ND
53	Book - Ein Jahr für die Physik	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
54	collection of exercises on the classical physics (Vol. I)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
55	collection of exercises on the classical physics (Vol. II)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
56	collection of exercises on the classical physics (Vol. III)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
57	collection of exercises on the classical physics (Vol. IV)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
58	collection of exercises on the classical physics (Vol. V)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
59	collection of exercises on the classical	Media File	Physics	TU Berlin	Creative Commons

	physics (Vol. VI)				BY-NC-ND
60	collection of exercises on the classical physics (Vol. VII)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
61	collection of exercises on the classical physics (Vol. VIII)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
62	collection of exercises to the modern physics (Vol. I)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
63	collection of exercises to the modern physics (Vol. II)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
64	collection of exercises to the modern physics (Vol. III)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
65	collection of exercises to the modern physics (Vol. IV)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
66	collection of exercises to the modern physics (Vol. V)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
67	collection of exercises to the modern physics (Vol. VI)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
68	collection of exercises to the modern physics (Vol. VII)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
69	collection of exercises to the modern physics (Vol. VIII)	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
70	Exercise-Book - Ein Jahr für die Physik	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
71	script on plate capacitors	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
72	script on coupled pendulum	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
73	script on diffraction	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
74	Script on electromagnetic Radiation	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
75	script on forced oscillatory circuit	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
76	script on magnetic hysteresis	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
77	script on radioactivity	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
78	script on Raman Spectroscopy	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
79	Script on solar cell	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
80	script on Thermodynamics	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
81	Skript über Beugung am Spalt	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
82	Skript über elektromagnetische Strahlung	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
83	Skript über Gekoppelte Fadenpendel	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
84	Skript über magnetische Hysterese	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
85	Skript über Plattenkondensator	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
86	Skript über PN kontakten und Transistoren	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
87	Skript über Radioaktivität	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
88	Skript über Raman Spektroskopie	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
89	Skript über Schwingkreis	Media File	Physics	TU Berlin	Creative Commons

					BY-NC-ND
90	Skript über Solarzelle	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
91	Skript über Thermodynamik	Media File	Physics	TU Berlin	Creative Commons BY-NC-ND
92	A real friction lab	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
93	Dipole AFM	Virtual Experiment	Chemistry	University of Basel	Creative Commons BY-NC-ND
94	Ein richtiges Reibungs-Labor	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
95	Electrochemistry Module	Virtual Experiment	Chemistry	University of Basel	Creative Commons BY-NC-ND
96	Elektrochemie Applet	Virtual Experiment	Chemistry	University of Basel	Creative Commons BY-NC-ND
97	Friction Expert Module	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
98	Friction Module	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
99	image 3D	Virtual Experiment	Computer sciences	University of Basel	Creative Commons BY-NC-ND
100	Imaging Module	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
101	Konfokaler Muster Generator	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
102	Reibungsmodul	Virtual Experiment	Chemistry	University of Basel	Creative Commons BY-NC-ND
103	Reibungsmodul für Fortgeschrittene	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
104	The Tomlinson's Mechanism	Virtual Experiment	Physics	University of Basel	Creative Commons BY-NC-ND
105	Electrochemistry Pit	Media File	Chemistry	University of Basel	Creative Commons BY-NC-ND
106	Electrochemistry Summary	Media File	Chemistry	University of Basel	Creative Commons BY-NC-ND
107	Electrochemistry Terrace	Media File	Chemistry	University of Basel	Creative Commons BY-NC-ND
108	Electrochemistry Terrace 2	Media File	Chemistry	University of Basel	Creative Commons BY-NC-ND
109	Elektrochemie Übersicht	Media File	Chemistry	University of Basel	Creative Commons BY-NC-ND
110	Island 1	Media File	Chemistry	University of Basel	Creative Commons BY-NC-ND
111	Island 2	Media File	Chemistry	University of Basel	Creative Commons BY-NC-ND
112	Reactor Weblab	Remote Experiment	Engineering	University of Cambridge	Creative Commons BY-NC-ND
113	Belusov-Zhabotinsky Reaction	Virtual Experiment	Chemistry	University of Cambridge	Creative Commons BY-NC-ND
114	3x3 Gaussian low pass filter	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
115	3x3 Laplacian Filter	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
116	3x3 Sobel Filter	Virtual Experiment	Engineering	University of Stuttgart	Creative Commons BY-NC-ND
117	Addition in Z_n with star-shaped neighborhood	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
118	Banks' Rule	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
119	Belousov Zhabotinsky Reaction	Virtual	Mathematics	University of	Creative Commons

		Experiment		Stuttgart	BY-NC-ND
120	Billard Computing	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
121	Brian's Brain	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
122	Canonical Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
123	Canonical Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
124	Canonical Ising Model with Heat Bath and Field	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
125	Canonical Model for Image Reconstruction	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
126	Color depending Diffusion	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
127	Configurable boundary-only micro-canonical Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
128	Configurable Dual Layer Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
129	Configurable four-layer Ising model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
130	Configurable Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
131	Configurable Ising Model with Free Bounds	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
132	Coupled scalar differential equations	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
133	Critters	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
134	Delannoy Number Generator	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
135	Dendrite Growth	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
136	Dendrites	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
137	Diffusion Limited Aggregation	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
138	Diffusion of Network Goods	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
139	Dynamics of Languages	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
140	Edge-based Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
141	Edge-based microcanonical Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
142	Expansion and Extinctions of Languages (2)	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
143	Fire Flies	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
144	Game of Life	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
145	Gauss low-pass filter	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
146	Generic Convolution	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
147	Heat equation in fixpoint representation with rounding	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
148	Heat equation with adjustable rounding	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
149	HPP Gas with Borders	Virtual	Physics	University of	Creative Commons



		Experiment		Stuttgart	BY-NC-ND
150	HPP gas with borders and marked particles	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
151	HPP gas with borders in two planes	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
152	HPP gas with velocity adjustment	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
153	HPP-Gas with Borders	Virtual Experiment	Physics	University of Stuttgart	Creative Commons BY-NC-ND
154	Image Degradier	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
155	Image reconstruction by nonlinear filtering	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
156	Isotropic linear differential equation	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
157	Isotropic linear partial differential equation with random noise	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
158	Kawasaki Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
159	Kawasaki-Model with walls	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
160	Laplace-Filter mit Moore-Nachbarschaft	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
161	Lichens	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
162	Margolus Neighbourhood Demonstrator	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
163	Microcanonical edge-based Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
164	Microcanonical Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
165	Microcanonical Ising Model with Diffusion and Energy Banks	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
166	Micro-canonical Ising Model with Echo	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
167	Microcanonical Ising Model with Energy Store	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
168	Microcanonical Ising model with local energy store and boundaries	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
169	Microcanonical Model of Image Reconstruction	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
170	Modifizierter Tillman-Automat	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
171	Neighbourhood Count	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
172	Neumann Neighbourhood Demo	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
173	OpenModelica Student Client	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
174	Parity Flip	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
175	Pascal Triangle Generator	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
176	Pattern Generator B from Scientific American	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
177	Pattern Generator D from Scientific American	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
178	Pattern Generator from Scientific American	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
179	Pattern Generator from Scientific	Virtual	Mathematics	University of	Creative Commons

	American	Experiment		Stuttgart	BY-NC-ND
180	Predator-Prey Simulation	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
181	Predator-Prey simulation with food resources	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
182	Random Walk and Diffusion	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
183	Scalar Oscillator Equation	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
184	Shift by two	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
185	Sobel-filter based image reconstruction	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
186	Sobel-filter based statistical image reconstruction	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
187	Spreading of Rumors	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
188	Spreading of Rumors	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
189	Sticky Kawasaki Dynamics	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
190	Stochastic HPP Gas with Borders	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
191	Stochastic Image Reconstruction With Simple Edge Detection	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
192	Stoichastische Bildrekonstruktion mit Gradienten-Hamiltonian	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
193	Test of the Laplace Distribution Random Generator	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
194	The Addition in the Ring $Z_n$	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
195	The BZ Oscillating Reaction	Virtual Experiment	Chemistry	University of Stuttgart	Creative Commons BY-NC-ND
196	The Canonical Ising Model	Virtual Experiment	Physics	University of Stuttgart	Creative Commons BY-NC-ND
197	The Harmonic Oscillator	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
198	The Heat Equation	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
199	The Kirsch-filter, a diagonal edge-detection filter	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
200	The Wave Equation	Virtual Experiment	Physics	University of Stuttgart	Creative Commons BY-NC-ND
201	Three-state canonical Ising Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
202	Three-state Ising Spin Model	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
203	Tillmann's Automaton	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
204	Time Tunnel - an invertible automaton	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
205	Trivial non-ideal image reconstruction without edge detection	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
206	Tube Worms	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
207	Wave Equation	Virtual Experiment	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
208	Wavelet Filter	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND

209	Wire world	Virtual Experiment	Engineering	University of Stuttgart	Creative Commons BY-NC-ND
210	Zuse Particels	Virtual Experiment	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
211	Diffusion Limited Aggregation and Phase Transition	Media File	Physics	University of Stuttgart	Creative Commons BY-NC-ND
212	Experiments on the Wave Equation	Media File	Physics	University of Stuttgart	Creative Commons BY-NC-ND
213	Image Denoising by Geman and Geman	Media File	Computer sciences	University of Stuttgart	Creative Commons BY-NC-ND
214	Magnetism and the Ising Model	Media File	Physics	University of Stuttgart	Creative Commons BY-NC-ND
215	Predator Prey Dynamics	Media File	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
216	Proving by Complete Induction	Media File	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
217	Reflexion of Waves	Media File	Physics	University of Stuttgart	Creative Commons BY-NC-ND
218	Refraction of Waves	Media File	Physics	University of Stuttgart	Creative Commons BY-NC-ND
219	Scalar Linear Differential Equation	Media File	Mathematics	University of Stuttgart	Creative Commons BY-NC-ND
220	The Ideal Gas	Media File	Physics	University of Stuttgart	Creative Commons BY-NC-ND

### 3.1. Integration Process

The integration of content depends strongly on the functionalities of the developing portal including security issues on the content providing side which needed to be considered. For different reasons some content could not be fully integrated as scheduled (M21 or M24 of the extended period).

Amongst others the following problems caused delays:

1. The very strict network security policy of the University of Cambridge (see WP 4 section of progress report no. 5).
2. The Remote – Atomic Force Microscope, which is a very expensive and sensitive setup, needed to be reprogrammed with additional security features, preventing the user from destroying the atomic-sharp cantilever-tips.
3. The single sign-on functionality in connection with the booking-system used in all Remote Experiments from Berlin, developed by WP2, raised possible security issues on the Berlin experiment side. These problems could be solved during and in the period after the Lila-conference in Cambridge in April 2011. The solution had to be implemented mainly after the termination of the “Online Practical Course with Remote Experiments” in September 2011. During the last project meeting in Stuttgart (24.-25- October 2011) some minor bugs connected to the single sign-on and the booking system could be resolved. All LLOs had to be re-packaged and uploaded to the portal.
4. Much time had to be spent on the re-integration and checking of media, because major crashes of the LiLa portal during development caused loss and corruption of data.

## 4. Additional Content

During the term of the LiLa project content has been made available by the LiLa consortium in addition to that mapped in the Description of Work. This additional content is listed in **Table 2** carrying on the numbering from **Table 1** (221 through 322).

Table 2: Additional content integrated into the LiLa portal.

	Name	Type	Scientific Field	Content Provider	License
221	Basket Ball	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
222	Basketball with Charge	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
223	Central Force Field	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
224	Chaotic Pendulum	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
225	Charged Particles	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
226	Elastic Impact and Momentum	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
227	Forces in a Bridge	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
228	Gekoppelte Pendel	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
229	Gekoppelte Pendel mit Oszilloskop	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
230	Golden Gate	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
231	Momentum on a Path	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
232	Momentum Pendulum	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
233	Optics Construction	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
234	PhysikH1	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
235	Planetary Motion	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
236	Simple Pendulum	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
237	Spring Pendulum	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
238	Sun Lab	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
239	Toss with Friction	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
240	Toss without Friction	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
241	Unstable Orbits	Virtual Experiment	Physics	Cinderella - PH Karlsruhe	Creative Commons BY-NC-ND
242	Alpha Decay	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND

243	Balloons & Buoyancy	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
244	Balloons & Buoyancy	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
245	Balloons and Static Electricity	Virtual Experiment	Engineering	PhET - University of Colorado	Creative Commons BY-NC-ND
246	Balloons and Static Electricity	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
247	Band Structure	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
248	Battery Voltage	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
249	Battery-Resistor Circuit	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
250	Beta Decay	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
251	Blackbody Spectrum	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
252	Calculus Grapher	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
253	Capacitor Lab	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
254	Charges and Fields	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
255	Circuit Construction Kit (AC+DC)	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
256	Circuit Construction Kit (DC Only)	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
257	Color Vision	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
258	Conductivity	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
259	Conductivity	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
260	Curve Fitting	Virtual Experiment	Mathematics	PhET - University of Colorado	Creative Commons BY-NC-ND
261	Davisson-Germer: Electron Diffraction	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
262	Density	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
263	Double Wells and Covalent Bonds	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
264	Electric Field Hockey	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
265	Electric Field of Dreams	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
266	Energy Skate Park	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
267	Est	Virtual Experiment	Mathematics	PhET - University of Colorado	Creative Commons BY-NC-ND
268	Faraday's Electromagnetic Lab	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
269	Faraday's Law	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
270	Forces in 1 Dimension	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
271	Fourier: Making Waves	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND

272	Gas Properties	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
273	Generator	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
274	Geometric Optics	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
275	Gravity Force Lab	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
276	John Travoltage	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
277	Ladybug Motion 2D	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
278	Ladybug Revolution	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
279	Lasers	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
280	Lunar Lander	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
281	Magnet and Compass	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
282	Magnets and Electromagnets	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
283	Masses & Springs	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
284	Maze Game	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
285	Microwaves	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
286	Models of the Hydrogen Atom	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
287	Molecular Motors	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
288	Motion in 2D	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
289	My Solar System	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
290	Neon Lights & Other Discharge Lamps	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
291	Nuclear Fission	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
292	Ohm's Law	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
293	Optical Tweezers and Applications	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
294	Pendulum Lab	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
295	PhET - E-Field	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
296	PhET - Faraday Electromagnetic Lab	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
297	Photoelectric Effect	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
298	Projectile Motion	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
299	Quantum Bound States	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
300	Quantum Tunneling and Wave Packets	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND

301	Quantum Wave Interference	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
302	Radio Waves & Electromagnetic Fields	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
303	Reactions & Rates	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
304	Resistance in a Wire	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
305	Reversible Reactions	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
306	Rotation	Virtual Experiment	Engineering	PhET - University of Colorado	Creative Commons BY-NC-ND
307	Rutherford Scattering	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
308	Semiconductors	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
309	Semiconductors	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
310	Signal Circuit	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
311	Simplified MRI	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
312	Sound & Waves	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
313	States and Matter	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
314	Stern-Gerlach Experiment	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
315	Stretching DNA	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
316	The Greenhouse Effect	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
317	The Moving Man	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
318	The Ramp	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
319	Torque	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
320	Vector	Virtual Experiment	Mathematics	PhET - University of Colorado	Creative Commons BY-NC-ND
321	Wave Interference	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND
322	Wave on a String	Virtual Experiment	Physics	PhET - University of Colorado	Creative Commons BY-NC-ND

#### 4.1. External Content

Even though the LiLa-portal was still in development during most of the run of the project, some external partners joined the project by giving their content for free. The Lila-Learning-Objects (LLOs) were then prepared within the LiLa-consortium and are now available for use in the portal or as download. This process was very helpful for the evolution of the LiLa project, as the diversity of the content grew. This should make it easier for future content providers to integrate their content into the Library of Labs.





The **PhET project at the University of Colorado** (<http://phet.colorado.edu/>) provides serious games, interactive, research-based simulations of physical phenomena. The Library of Labs hosts at the moment 67 examples from the fields electricity, energy, light, math, motion quantum physics, thermodynamics and waves.

The interactive geometry software "**Cinderella**" (<http://www.cinderella.de/>) contributes 21 applets covering subjects in physics.

The University of Technology in Sydney contributed six prototypical examples of their large **LabShare** rig collection (<http://www.labshare.edu.au/>), which are currently offline for technical reasons and therefore not listed.

During the project duration several requests to join the LiLa project have been handed in. One example that reached the partners in Berlin came from the Indian Institute of Technology in Kharagpur, offering to integrate their Remote-Experiments in the field of electronics (rectifiers, operational amplifiers). Consequently, the integration of content will continue after the end of community funding.