



# Digital Examination Spaces – 3<sup>rd</sup> Generation

# E-Examinations – Introduction

## Intentions

- Efficiency: remedy for increased amount of exams (qua Bologna)
  - Rationalization: Reducing the required amount of time for the grading process<sup>1</sup>
- Effectivity: Wholististic E-Learning up to the Exam
  - Didactics: Avoid media discontinuity<sup>2</sup>
- Organization: Foundation for university wide institutionalization<sup>3</sup>
  - Legal: Clarification of legal conditions for computer based examinations
  - Technology: safe, secure and scalable examination software solutions
  - Logistics: Provision of spatial capacities



<sup>1</sup> vgl. Schulz & Apostolopoulos (2011)

<sup>2</sup> vgl. Schulz (2016)

<sup>3</sup> vgl. Schulz (2017)

# STRUCTURE

<b># 1st Generation (2007-2012):</b>	<b>BYOD-Pools</b>
# 2nd Generation (2013-2018):	EEC
# 3rd Generation (from 2019):	EEC <sup>2</sup>
# Literature	

# Digital Examination Spaces – 1st Generation

## Requirements 1st Generation

- Volumen for as many participants as possible (>150)
- Sufficient space for every participant
- Sufficient bandwidth for examinations with large cohorts (>150ptcps)
- Low investment and operating costs for the university
- Hybrid operational concepts as lecture- and examination-hall

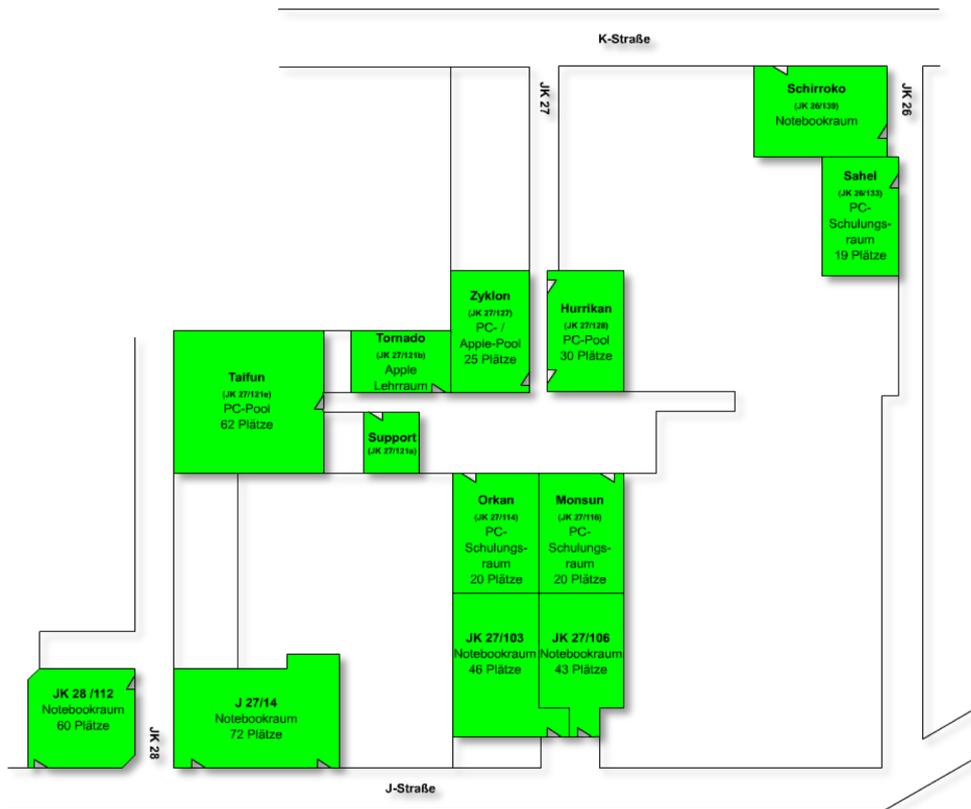
# Digital Examination Spaces – 1st Generation

## Project FU E-Examinations – Digital Lecture- and Examination-Hall

- Trial: Use of student laptops as BYOD-Scenarios
- Create: Infrastruktur for BYOD-Scenarios
- Evaluate: scalable examinations software solutions or LMS for examinations
- Create: Foundations for university wide institutionalization
- Cooperate: with laptop manufacturers for cheapened offers

# Digital Examination Spaces – 1st Generation

## Floorplan BYOD-Halls and classic PC-Halls of computing center



Pic Source: CeDiS, FUB

Capacities	
<b>Total</b>	<b>417 places</b>
BYOD	221 places
Central PC-Halls	196 places
<b>Divided into</b>	<b>12 rooms</b>

# Digital Examination Spaces – 1st Generation

BYOD-Hall (Exam in Statistics Summer Semester 2008 in Room J27/14)



Pic Source: CeDiS, FUB

# Digital Examination Spaces – 1st Generation

BYOD-Halls (JK28/112 und JK27/103)



Pic Source: CeDiS, FUB

# Digital Examination Spaces – 1st Generation

## Lessons Learnt (a)

- (+) BYOD-Halls account for *low* investment costs (ca. 50.000€)
- (+) Digital Exams *reduce* the grading time of examinations<sup>1</sup>
- (+) (-) Digital Exams are demanded by lecturers, who are otherwise *not* involved into using E-Learning tools in their lectures
- (-) total 12 exam-halls (4 x BYOD and 8 x central PC-halls) require *too much* technical (and didactical) personnel for supervision
- (-) high preparation time between exams (75-90min)
- (-) Laptop offers too expensive in comparison to normal retailers (albeit cooperations)

<sup>1</sup> vgl. Schulz & Apostolopoulos (2011)

# Digital Examination Spaces – 1st Generation

## Lessons Learnt (b)

- (-) BYOD technical<sup>1</sup> and thus legally *unsafe* (and heterogeneity of BYOD increases demand for support)
- (-) missing air conditioning and bad ventilation of halls (esp. in summer) legally highly problematic
- (-) bad acoustic conditions
- (-) inclusion or integration of disabled persons in BYOD-Halls complicated
- (-) only *few* matured examination software solutions available on the market
- (-) LMS: *missing* functions, *missing* technical safety

<sup>1</sup> vgl. Dawson (2016)

# STRUCTURE

- # 1st Generation (2007-2012): BYOD-Pools
- # 2nd Generation (2013-2018): EEC**
- # 3rd Generation (from 2019): EEC<sup>2</sup>
- # Literature

# Digital Examination Spaces – 2nd Generation

## Requirements 2nd Generation (a)

- Volumen for as many participants as possible (>150)
- Sufficient space for every participant
- Sufficient amount of places for inclusion of disabled persons
- Redundant network infrastructure in examination hall
- Moderate operating costs for the university
- Operating concept as genuine examination hall

# Digital Examination Spaces – 2nd Generation

## Requirements 2nd Generation (b)

- Reducing of preparation times between examinations
- Redundante examination servers
- Air condition, ventilation and glare shields
- Automatized system control (whole hall and PCs)
- Acoustic optimization (to increase focus/concentration on exam)
- (Tiny) zone for technical administration

# Digital Examination Spaces – 2nd Generation

## Working Area at CeDiS: FU E-Examinations

- Use: University owned PCs under automatized system control
- Create: sustainable and redundant infrastructure for e-exams
- Evaluation: Operating concept (and concept for use of the hall)
- Create: Legal foundation within examination regulations
- Cooperations: with further educational institutions and universities in Berlin

# Digital Examination Spaces – 2nd Generation

2012: Setting up the E-Examination Center



Pic Source: Gewers und Pudewill Architects

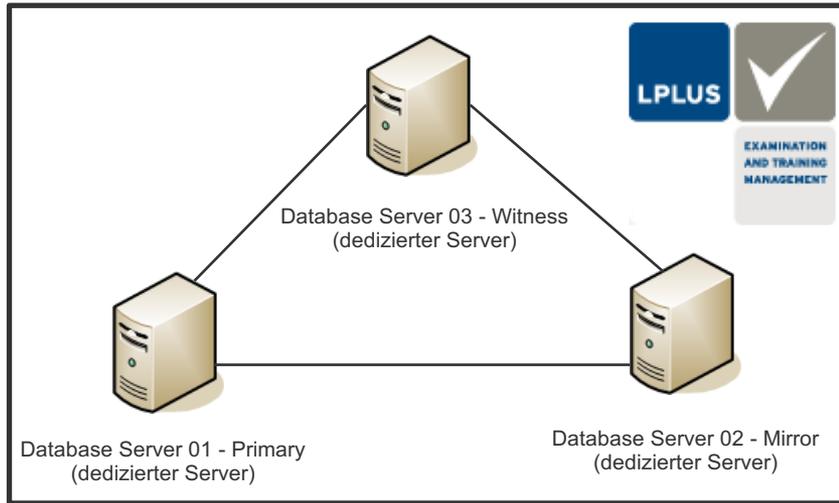
# Digital Examination Spaces – 2nd Generation

2013: First exam in the E-Examination Center



Pic Source: CeDiS, FUB

# Digital Examination Spaces – 2nd Generation



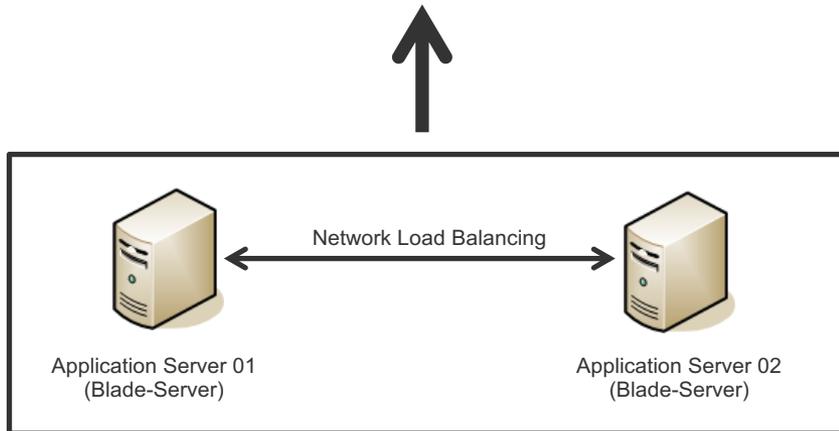
**Exams-Servers as high availability cluster**

**Production (physical):**

2 x application servers  
3 x database servers

**Test- and Staging-System (virtualized):**

2 x application servers  
3 x datenbank servers  
i.e. for update testing,  
reproducing of bugs etc.



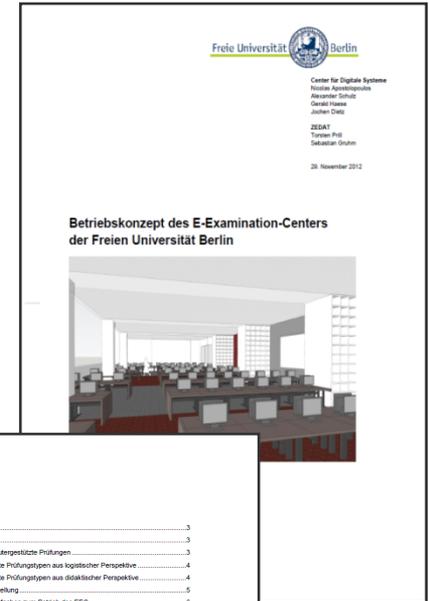
# Digital Examination Spaces – 2nd Generation

Example: July, 11th 2019	
09:15 – 09:30h	Admission of Students
<b>09:30h</b>	<b>Start Exam 1: DaZ K1 (Deutsch als Zweitsprache)</b>
10:30h	End of Exam, Students let out, Prep Time
10:45 – 11:00h	Admission
<b>11:00h</b>	<b>Start Exam 2: DaZ K2</b>
12:00h	End of Exam, Students let out, Prep Time
12:15 – 12:30h	Admission of Students
<b>12:30h</b>	<b>Start Exam 3: DaZ K3</b>
13:30h	End of Exam, Students let out, Prep Time
13:45 – 14:00h	Admission of Students
<b>14:00h</b>	<b>Start Exam 4: Arbeitspsychologie</b>
16:00h	End of Exam, Students let out, Prep Time
16:15 – 16:30h	Admission of Students
<b>16:30h</b>	<b>Start Exam 5: Mathematikdidaktik</b>
17:30h	End of Exam, Students let out, Tidy

# Digital Examination Spaces – 2nd Generation

## Operational concept of the E-Examination Center

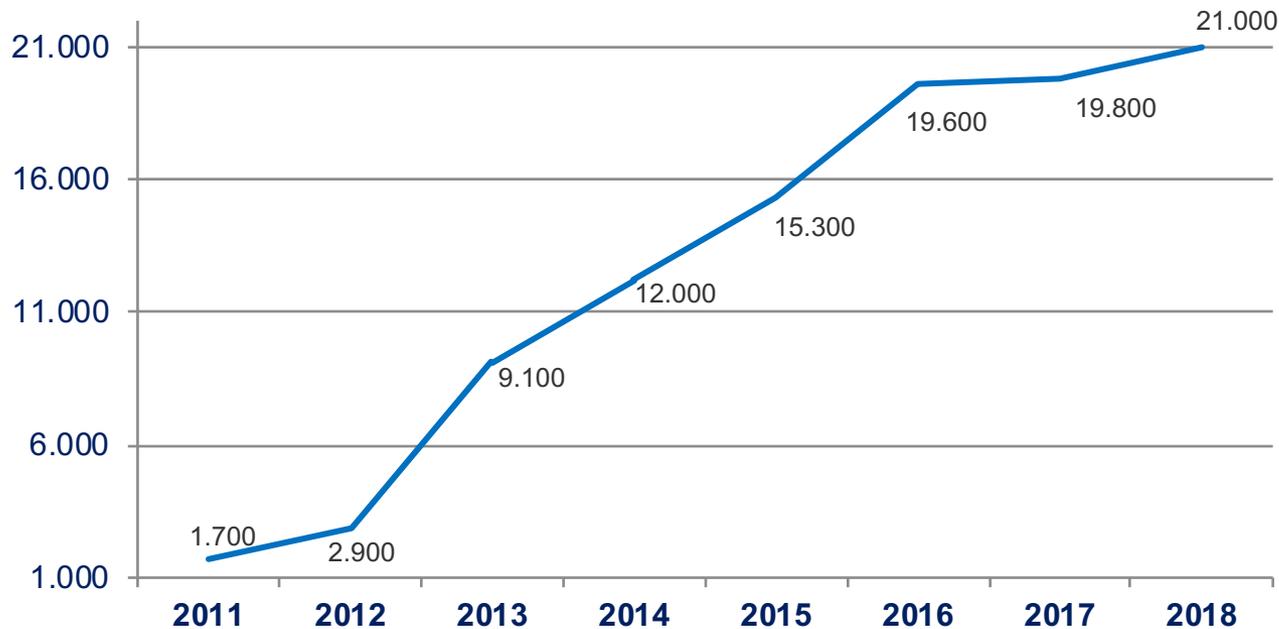
- 151 x PC-Places (incl. 6 x inclusion)
- Zones for up to 4 x parallel examinations
- First exam hall in Berlin region
- Use as genuine exam hall
- Personnel 2013: 1 x FTE, 4 x students
- Personnel 2018: 1,7 x FTE, 6 x students
- Yearly capacity for up to 40,000 single tests
- Normative foundation in FUB's study and examination regulations (Rahmenstudien- und -prüfungsordnung => RSPO of FUB)



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# Digital Examination Spaces – 2nd Generation

## Single tests (~participants)



Jahre*	EP*
2011	1.700
2012	2.900
2013*	9.100
2014	12.200
2015	15.300
2016	19.600
2017	16.700
2018	21.000

\* from 2013 incl. external clients

Between taking into operation of EEC in feb 2013 and nov. 2019 more than 105,000 single tests (~ participants) have been conducted.

# Digital Examination Spaces – 2nd Generation

## Lessons Learnt (a)

- (+) EEC reduces preparation time between exams down to 30mins
- (+) in EEC only few technical (and didactical) supervision required
- (+) (Automized) air condition and ventilation absolutely required esp. in summer
- (+) optimized acoustic conditions
- (+) Inclusion possible on up to 6 x places
- (+) Homogenic university owned infrastructure is technically easy to administrate and thus legally safer than BYOD

# Digital Examination Spaces – 2nd Generation

## Lessons Learnt (b)

- (-) EEC has *high* initial costs of investment (~1,3 Mio €)
- (-) Alarm and anti theft is required
- (-) University owned PCs need renewal every 5 yrs - require follow up investment
- (-) EEC focussed on participants, not on supervision personnel
- (+) (-) Versatility of EEC besides exams is low

# Structure

- # 1st Generation (2007-2012): BYOD-Pools
- # 2nd Generation (2013-2018): EEC
- # 3rd Generation (from 2019): EEC<sup>2</sup>**
- # Literature

# Digital Examination Spaces – 3rd Generation

## Requirements 3rd Generation

- All reqs from 2nd generation and:
  - Operational concept as „Self Contained Examination Workspace“ with separated examination, training and backoffice work areas
- Touch-PCs for newer question types (currently under eval.)
- Capacities for distant oral exams in international study courses

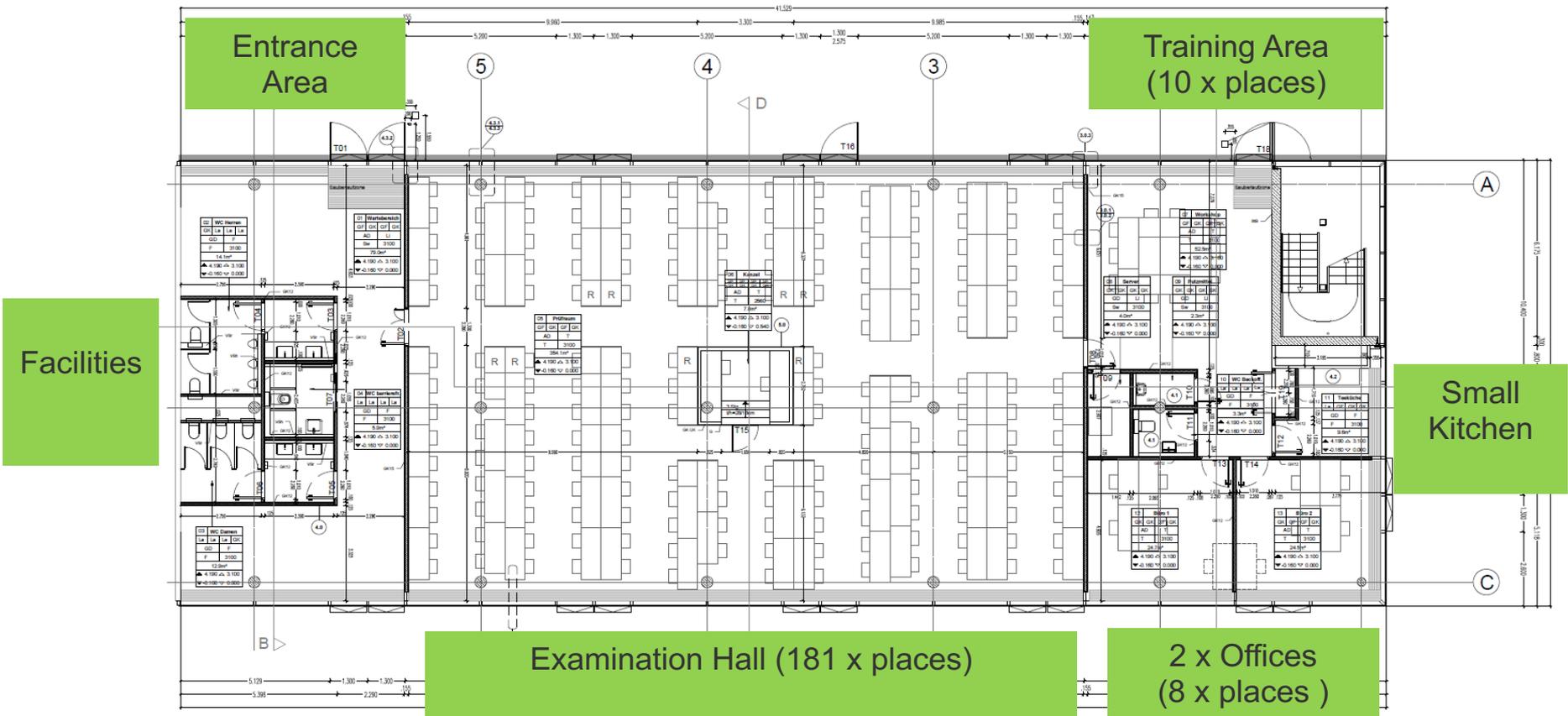
# Digital Examination Spaces – 3rd Generation

## Working Area FU E-Examinations

- Operative personnel directly at place
- Evaluation: extended operational concept (and room concept) and new question types
- Cooperation: Cooperations: with further educational institutions and universities (Berlin University Alliance – Electronic Assessment Alliance => BUA EA<sup>2</sup>)

# Digital Examination Spaces – 3rd Generation

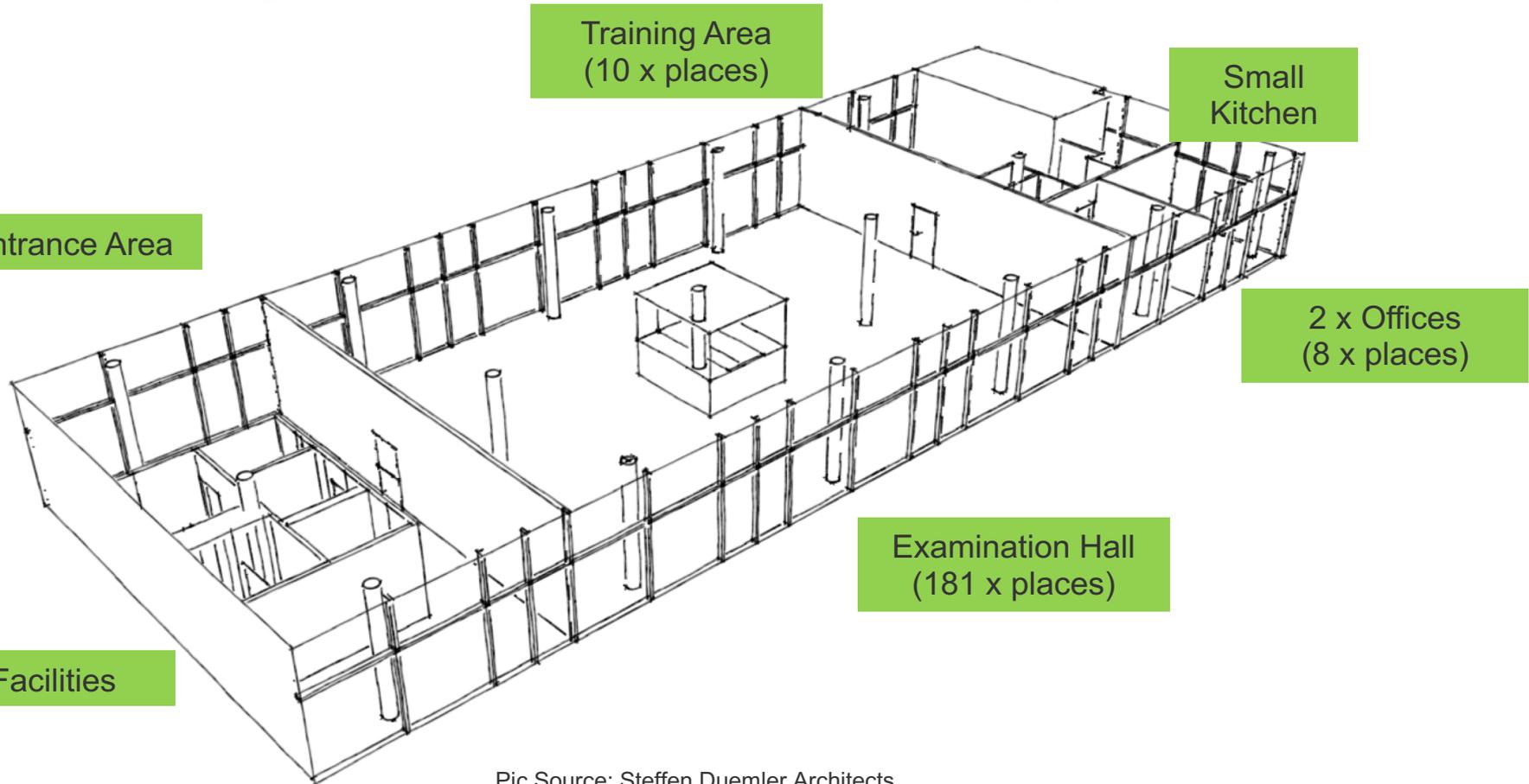
## 2018: Setting up of EEC<sup>2</sup> as Self Contained Workspace (a)



Pic Source: Steffen Duemler Architects

# Digital Examination Spaces – 3rd Generation

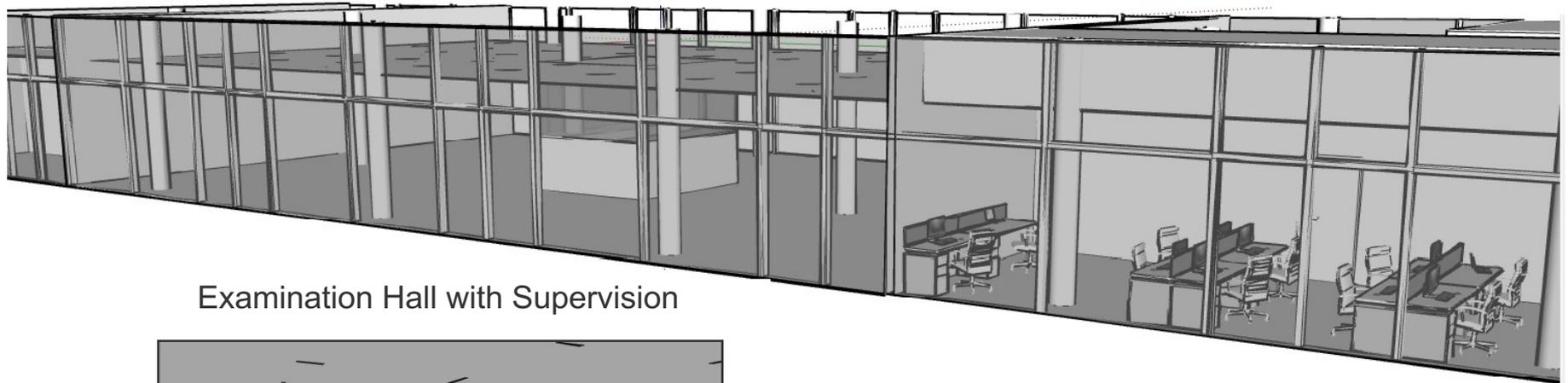
## 2018: Setting up of EEC<sup>2</sup> as Self Contained Workspace (b)



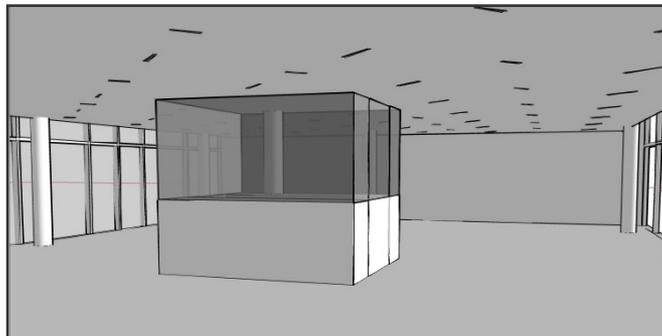
Pic Source: Steffen Duemler Architects

# Digital Examination Spaces – 3rd Generation

2018: Setting up of EEC<sup>2</sup> (Simulations)



Examination Hall with Supervision



2 x Offices



Pic Source: Steffen Duemler Architects

# Digital Examination Spaces – 3rd Generation

2018: Setting up of EEC<sup>2</sup>



Pic Source: CeDiS / FUB

# Digital Examination Spaces – 3rd Generation

2018: Setting up of EEC<sup>2</sup>



Pic Source: CeDiS / FUB

# Digital Examination Spaces – 3rd Generation

2019: First Exam on July, 22nd 2019



Pic Source: CeDiS / FUB

# Digital Examination Spaces – 3rd Generation

2019: First Exam on July, 22nd 2019



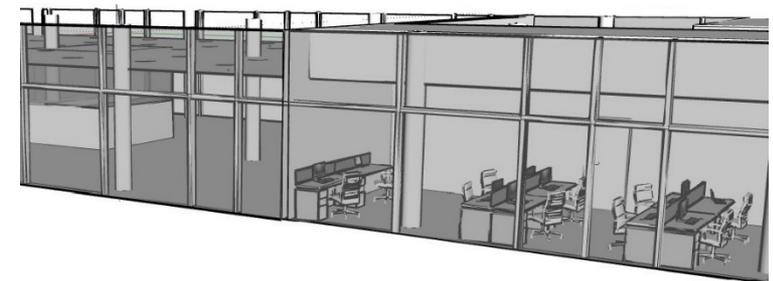
Pic Source: CeDiS / FUB

# Digital Examination Spaces – 3rd Generation

## Operational concept: EEC<sup>2</sup> as Self Contained Workspace

- 181 x places (incl. 8 x inclusion)
- Zone for 2 x parallel exams
- Separated training area (to be used as extended area for integration of disabled persons) up to 10 x places
- Largest examination hall in Berlin region
- Use as genuine exam hall
- Personnel 2019: 2 x FTE, 7 x Students
- Capacity for up to 45.000 single tests

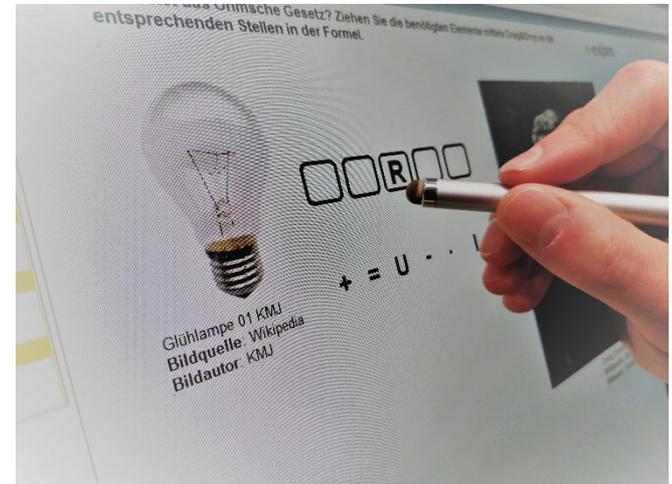
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# Digital Examination Spaces – 3rd Generation

## Perspective

- Extension of question types qua availability of touch displays:
  - Editing of mathematic and chemical formulas
  - Drawing, sketches, marking etc.
- Increase of amount of formative assessments
- Distant oral examinations (for international study courses)
- Parallel operation of both EECs at latest in 2022
- possibly more cooperations with further educational institutions and universities in Berlin



# Structure

# 1st Generation (2007-2012): BYOD-Pools

# 2nd Generation (2013-2018): EEC

# 3rd Generation (from 2019): EEC2

## # Literature

# Literature

- Dawson, P. (2016): Five ways to hack and cheat with bring-your-own-device electronic examinations. In: British Journal of Educational Technology 47 (4), S. 592–600. DOI: 10.1111/bjet.12246
- Schulz, A. (2017): „E-Assessment-Center im Vergleich - Voraussetzungen und Kosten für die Einrichtung verschiedener E-Assessment-Center im Vergleich“, TU Dresden: Medienzentrum, online im Internet: [http://www.qucosa.de/recherche/frontdoor/?tx\\_slubopus4frontend%5bid%5d=urn:nbn:de:bsz:14-qucosa-224532](http://www.qucosa.de/recherche/frontdoor/?tx_slubopus4frontend%5bid%5d=urn:nbn:de:bsz:14-qucosa-224532) (last access: 25.11.2018)
- Schulz, A. (2016): „E-Examinations – Zur Computerisierung des Prüfungswesens an deutschen Hochschulen“, in: Hochschulzeitschrift „Forschung und Lehre“ Ausgabe 03/2016, Wissenschaftsportal „Wissenschaftsmanagement-Online“, online im Internet: [http://www.wissenschaftsmanagement-online.de/system/files/downloads-wimoarticle/1603\\_WIMO\\_E-Examinations\\_SCHULZ.pdf](http://www.wissenschaftsmanagement-online.de/system/files/downloads-wimoarticle/1603_WIMO_E-Examinations_SCHULZ.pdf) (last access: 25.11.2018)
- Schulz, A. & Apostolopoulos, N. (2011): „E-Examinations Put To Test - Potenziale computergestützter Prüfungen“, in: „Hamburger eLearning Magazin - #07 eAssessment auf dem Prüfstand“, Online im Internet: <https://www.uni-hamburg.de/elearning/hamburger-elearning-magazin-07.pdf> (last access: 25.11.2018)

# Thanks for your attention :-)

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