

THE MESA ACCELERATOR

Kurt Aulenbacher,
LEPP workshop,
Mainz, April 04, 2016



Cluster of Excellence Precision Physics,
Fundamental Interactions and Structure of Matter

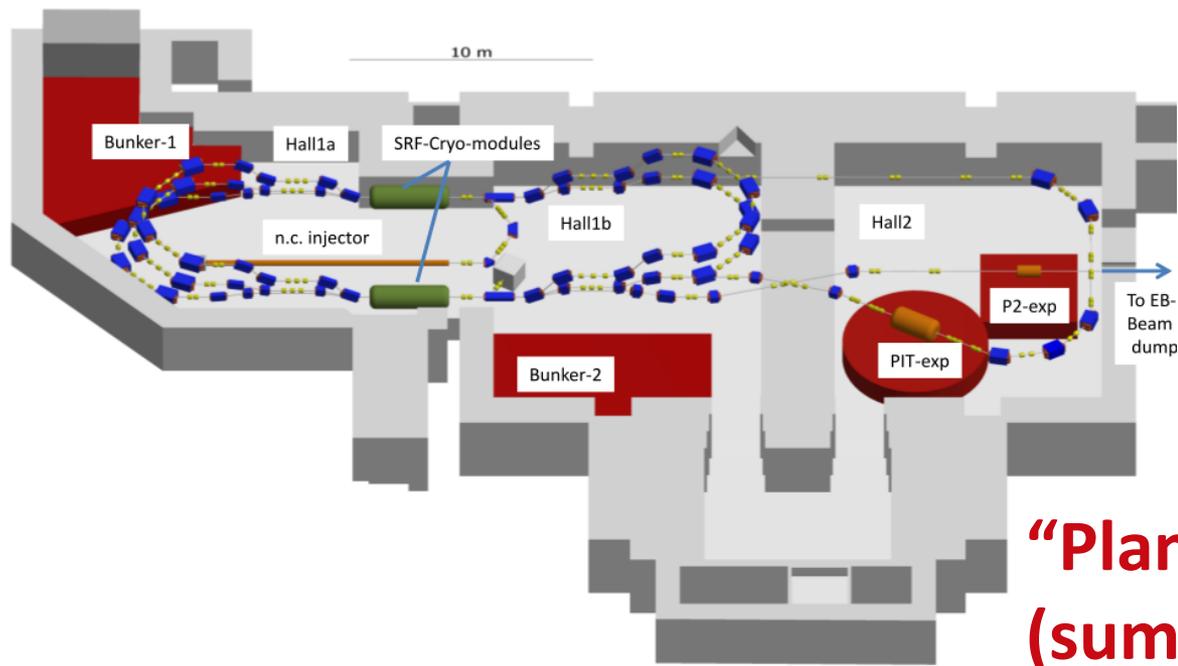
PRISMA

Outline

- Impact of CFP: new MESA lattice & timeline
- MESA assembly strategy

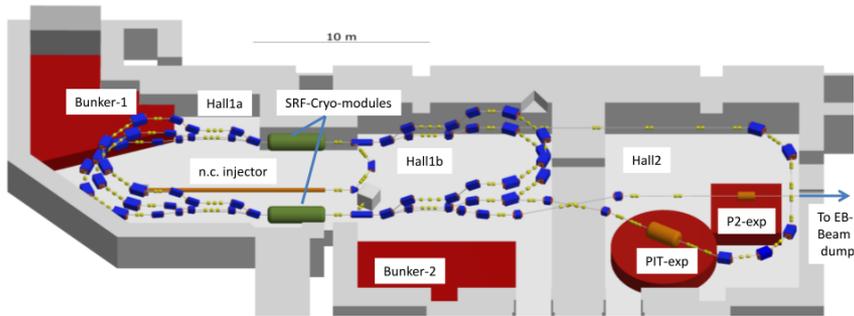
New challenges for the MESA facility....

Initial „Plan A“: Use existing building for 0.15mA 155 MeV polarized external beam (P2) and 1mA, 105MeV (later: 10mA) unpolarized beam for „pseudo internal“ windowless target experiment



**“Plan A”
(summer 2014)**

New challenges for the MESA facility



- **Today:** Accelerator parameters unchanged
BUT: increased number of proposed experiments, with also increased space requirements & additional boundary conditions
→ space extension (and change of accelerator lattice) almost unavoidable: „Plan B“

The new research buildings (Forschungsbau): “Centrum für Fundamentale Physik”, CFP



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UNIVERSITÄT MAINZ

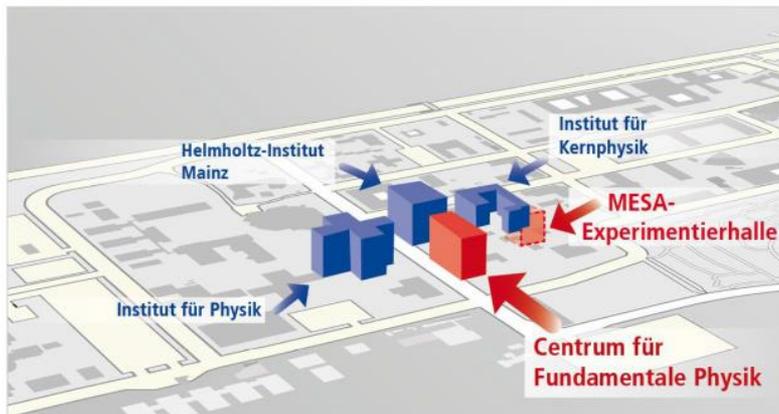


Antragsskizze
zur Begutachtung eines Forschungsbaus
gemäß Art. 91b Abs. 1 Nr. 3 GG

Förderphase 2016

Forschungsbau für das Centrum für Fundamentale Physik mit einer Experimentierhalle

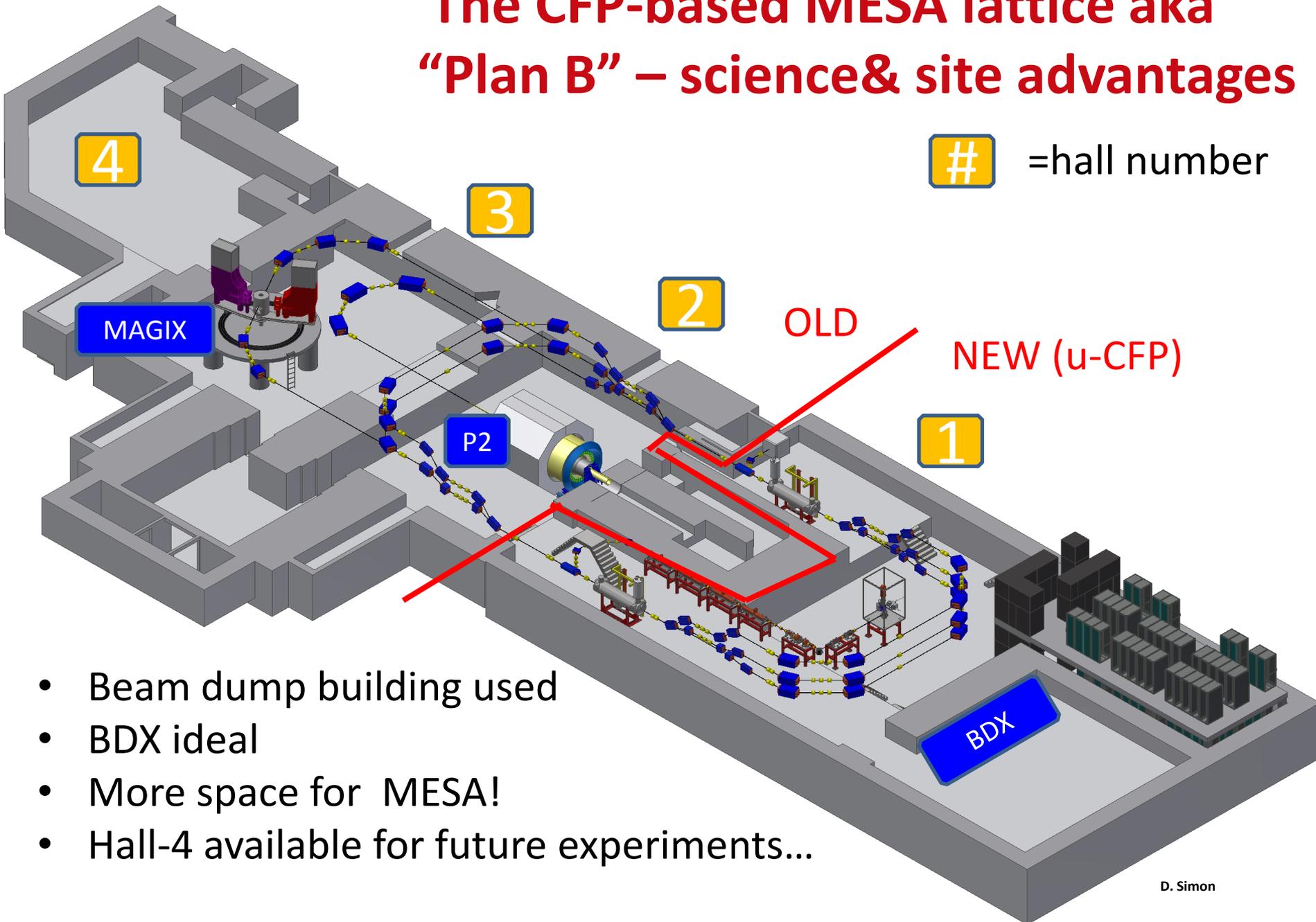
Johannes Gutenberg-Universität Mainz



- Plans and budget for underground building had been worked out April-November 2014.
- final CFP application submitted in 12/2014
- CFP-office/laboratory building, probably adjacent to HIM building
- CFP-Underground building extends MESA-facility („MESA Experimentierhalle-1“)
- Funding recommended by german science council („Wissenschaftsrat“)
- Official funding granted by federal government **end of June 2015**

The CFP-based MESA lattice aka “Plan B” – science & site advantages

= hall number



- Beam dump building used
- BDX ideal
- More space for MESA!
- Hall-4 available for future experiments...

D. Simon

PLAN "B" – interference & transport issues

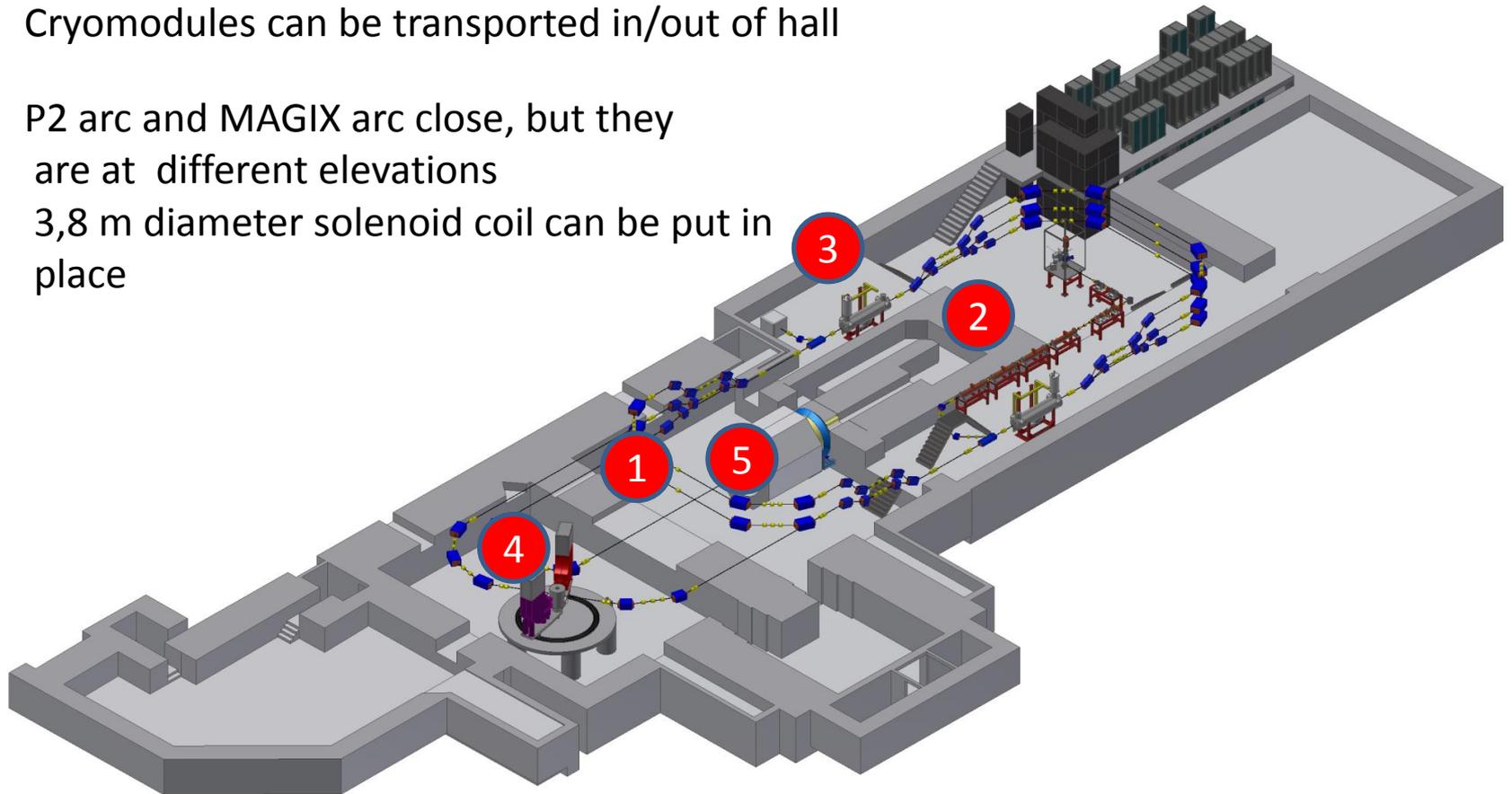
1 P2 does not interfere significantly with MESA-operation!

2 Beam dump shielding is strong enough

3 Cryomodules can be transported in/out of hall

4 P2 arc and MAGIX arc close, but they are at different elevations

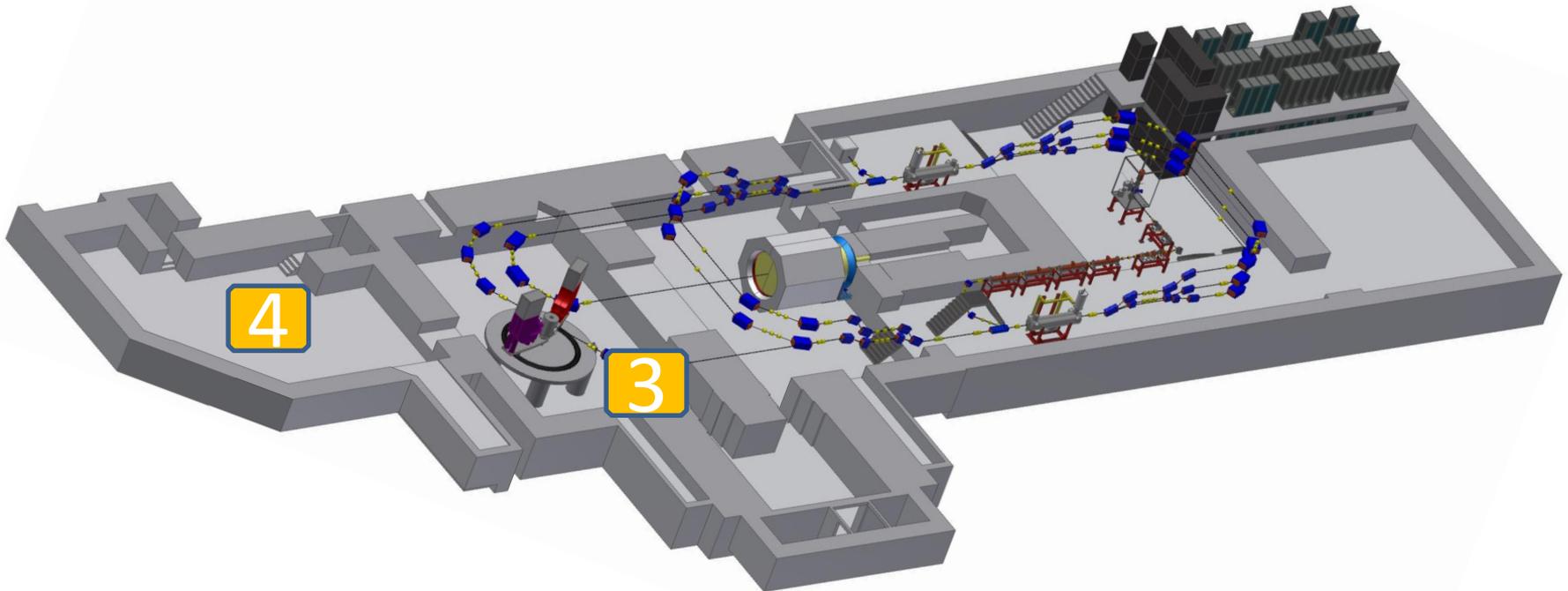
5 3,8 m diameter solenoid coil can be put in place



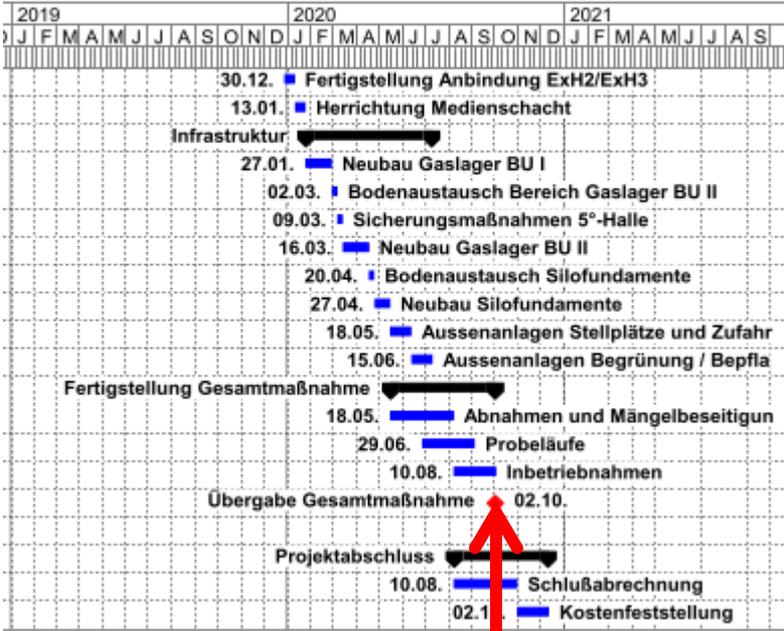
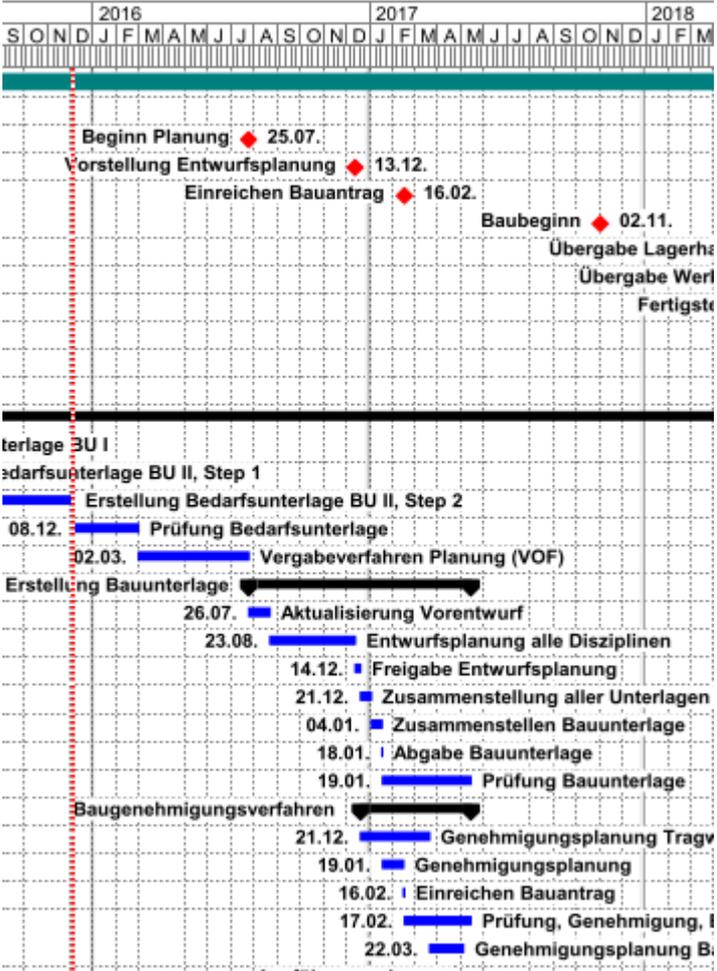
D. Simon

A few words concerning hall 4

- Hall 4 fire protection situation will be resolved when CFP ready
- No new breakthroughs in wall between halls 3 & 4 advisable...
- ...but can be used with external beams from MESA **AND** MAMI



Civil Construction: ...a very complex enterprise



Building „ready“

Quantum of solace...

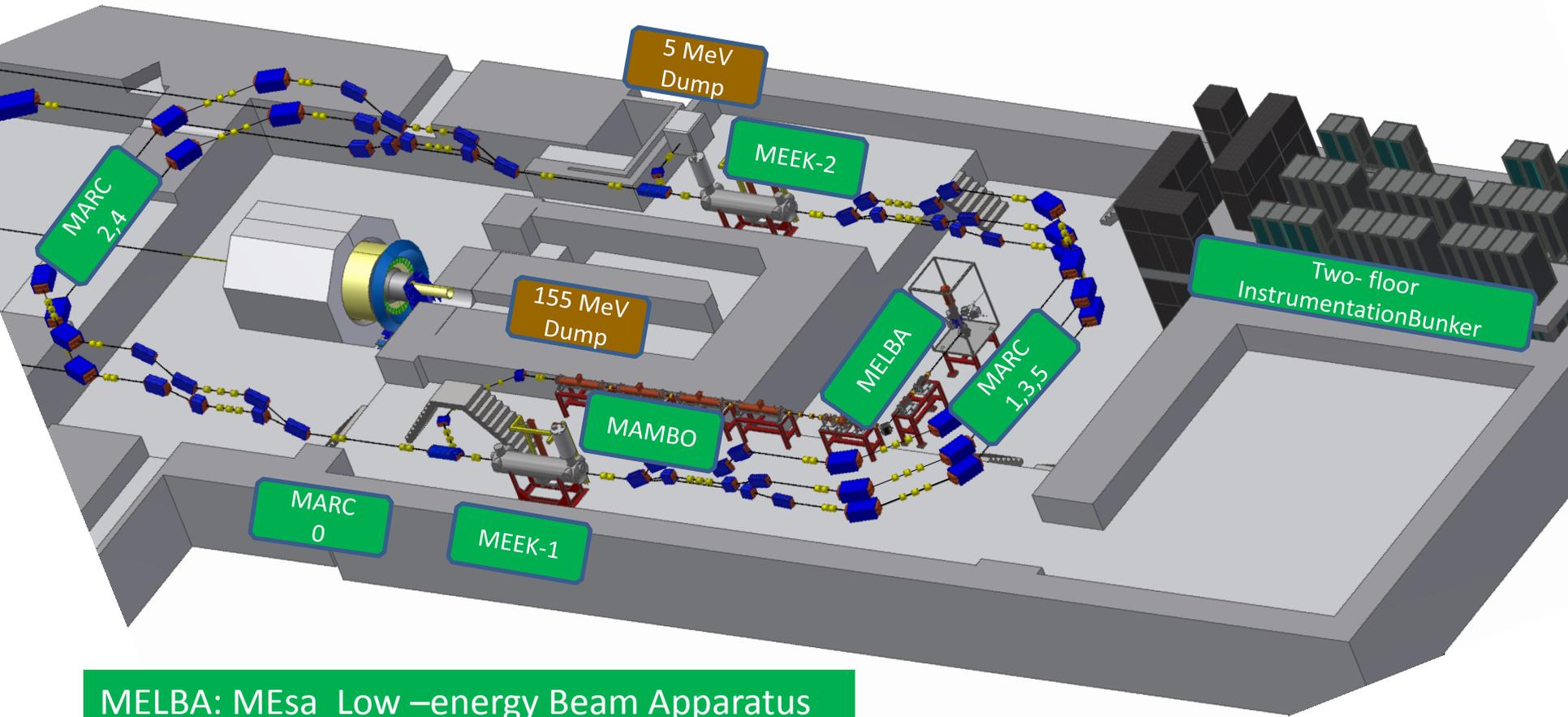


Extended time scale enables:

- More thorough design of „conventional“ components: lattice, magnets, vacuum system, control system, diagnostics amm)
- **This will not lead to project delay!**
- Project more stable wrt to lead time escalation
- Testing of components under realistic Conditions (even with $I_{\text{beam}} > 1\text{mA}$!) is **POSSIBLE!**
- Cryomodules can be tested at HIM experimental site (albeit without beam)!

→ „MESA Assembly Strategy“

PLAN "B" – accelerator components

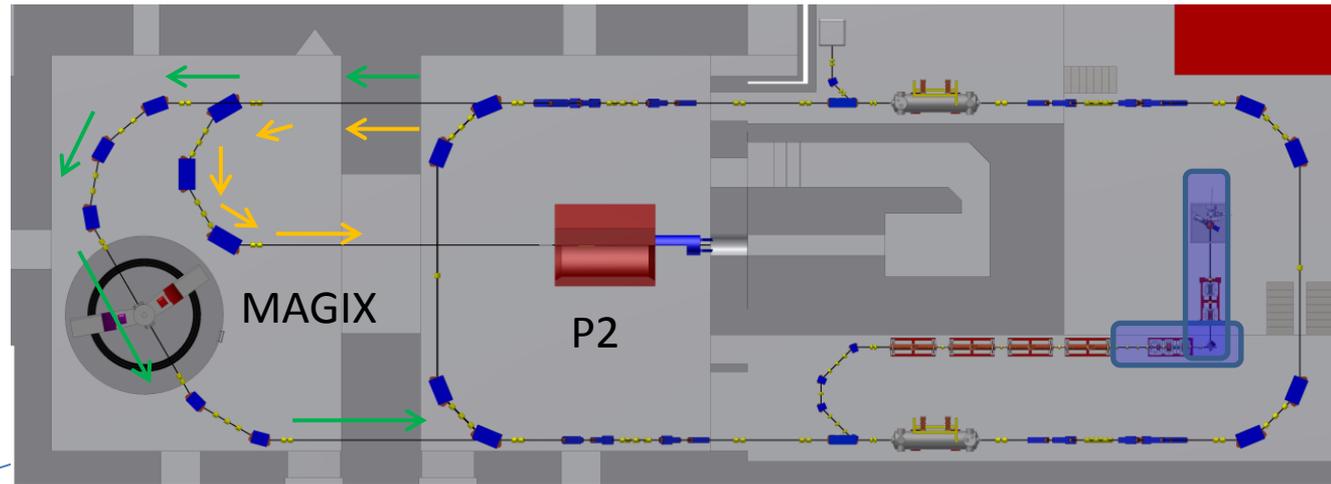


MELBA: MEsa Low –energy Beam Apparatus
MAMBO: MilliAMpere Booster
MEEK: Mesa Elbe-Enhanced-Kryomodule
MARC: MESA (recirculation) ARC

MESA assembly Strategy STEP-1: MELBA

Components to be operated with beam:

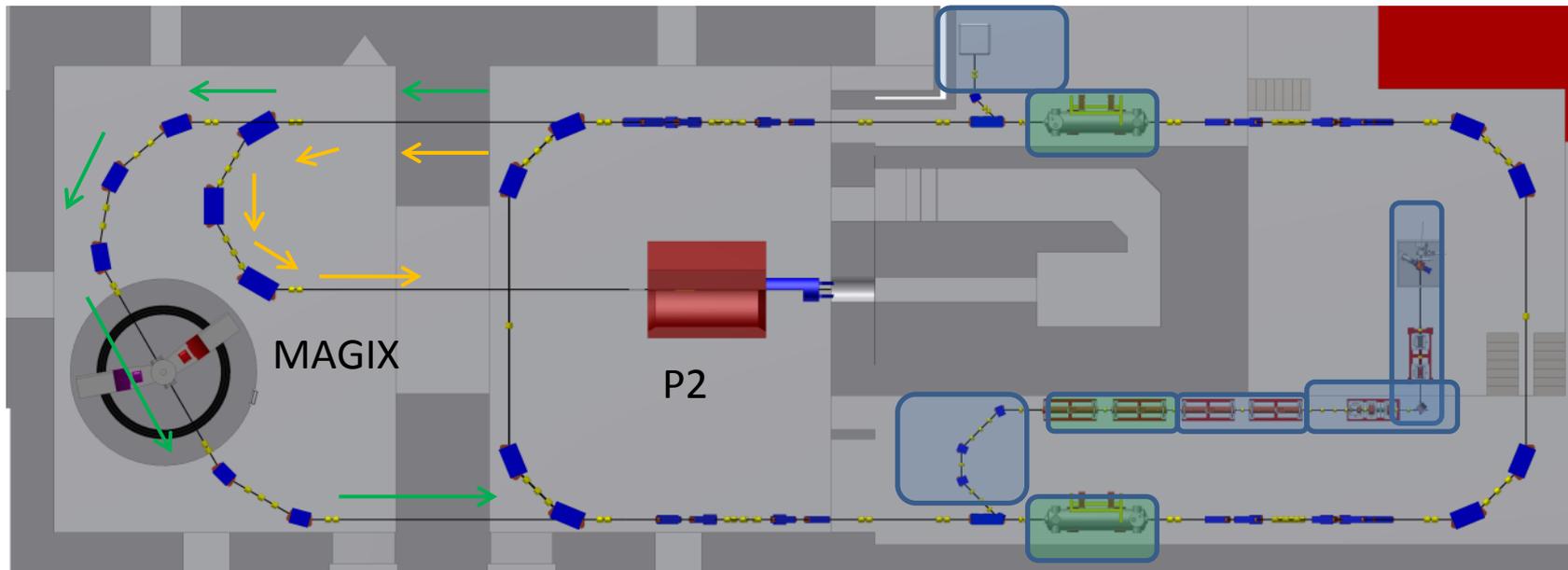
STEP-1: Assembly of MELBA (MEsa Low Energy Beam Apparatus) in 2016



Hall-3 is presently being made available for intermediate set-up!

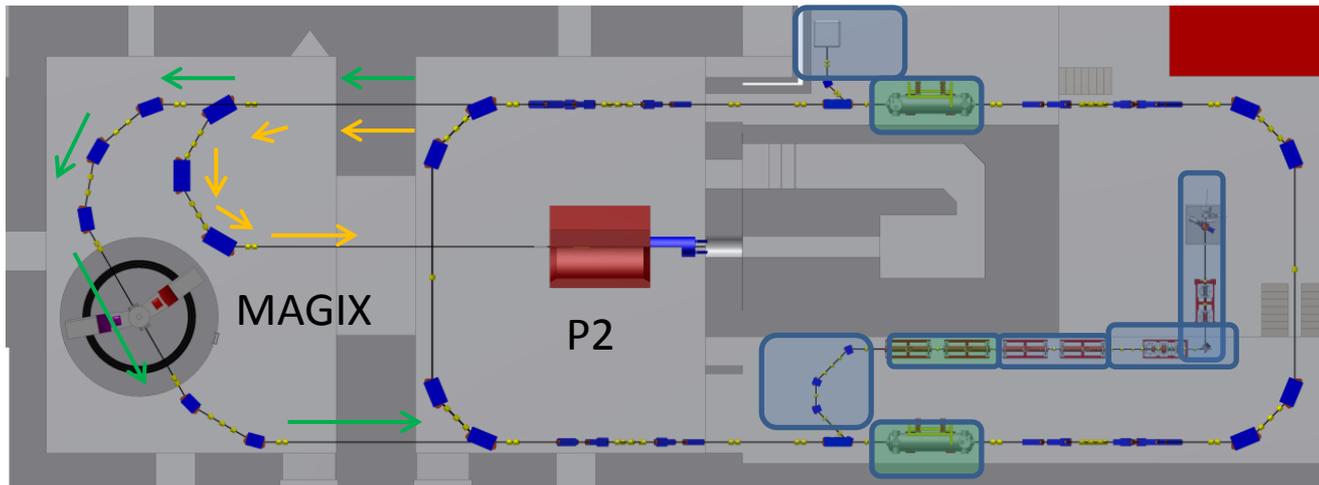
MESA assembly Strategy: Step-2: Operation of MAMBO

- „Milliampere Booster“ (MAMBO) → av. 2017
first two sections **operational** 2017, other two **tested**

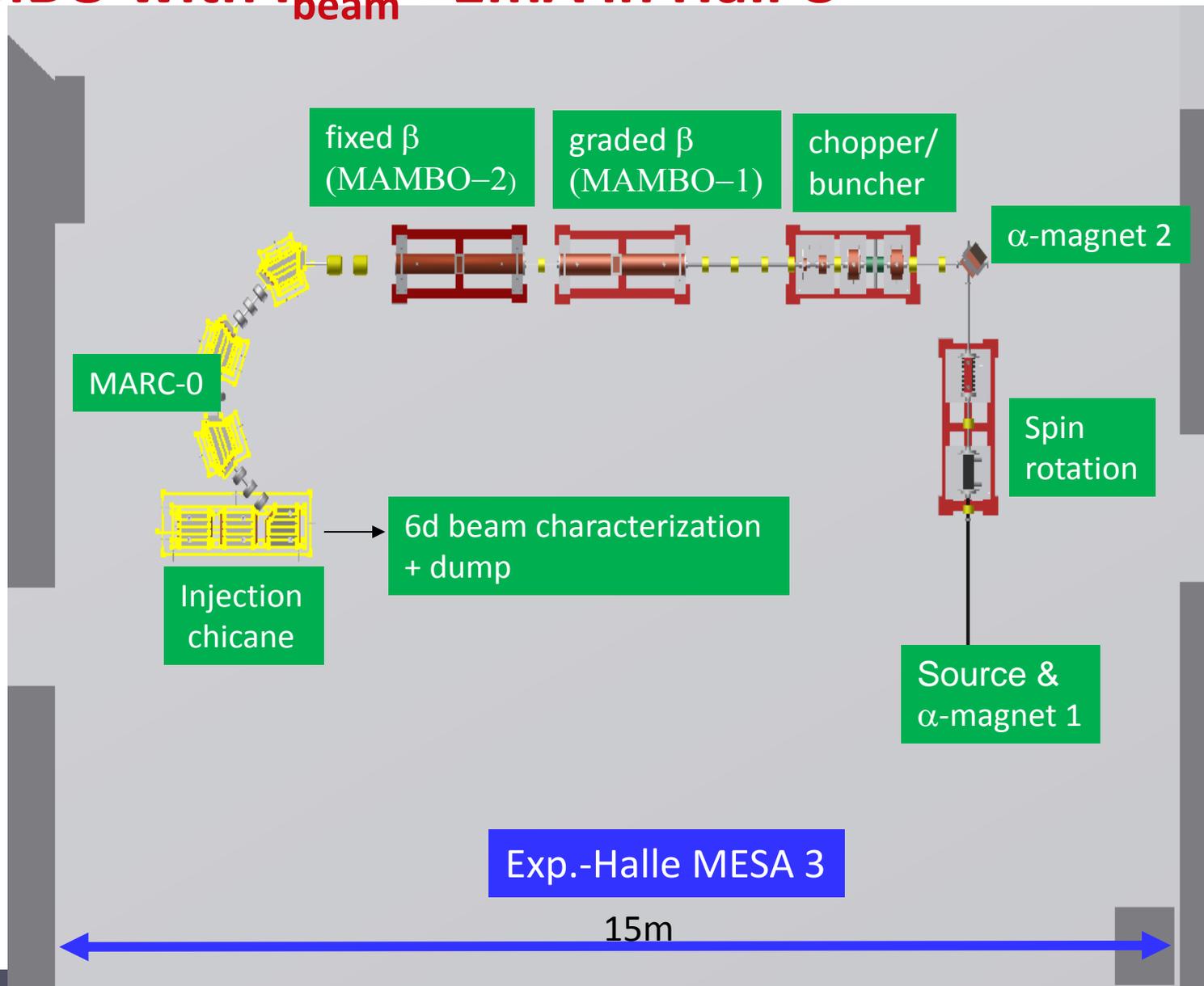


MESA assembly Strategy Step -3: Cryomodules

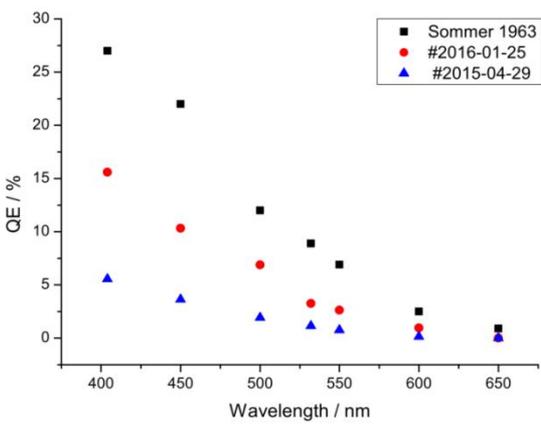
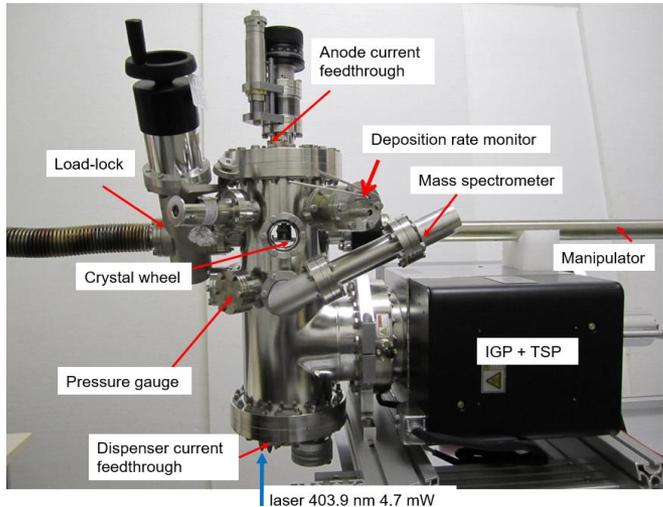
- **MEEK-Kryomodules** will be tested at HIM in 2017



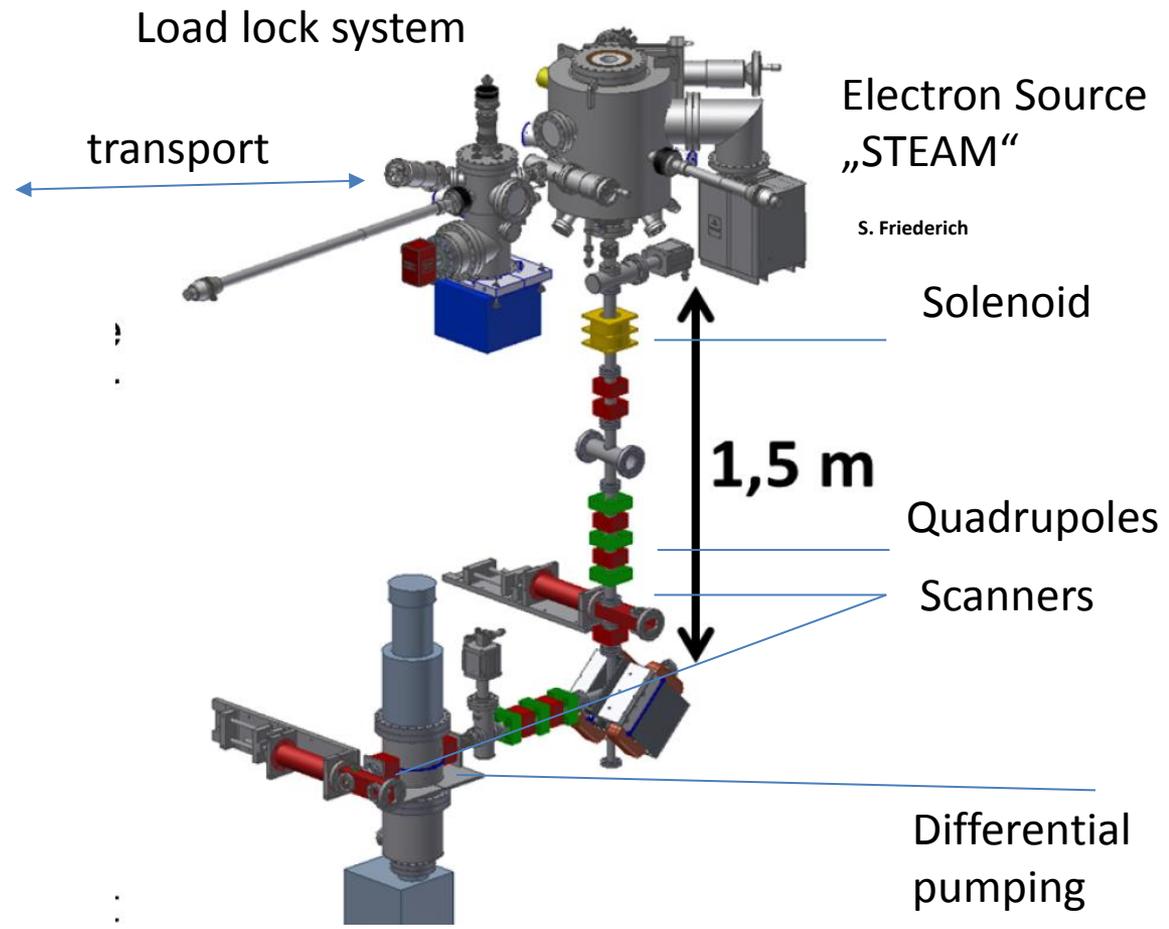
MESA assembly Strategy: Operation of MAMBO with $I_{\text{beam}} > 1\text{mA}$ in Hall-3



Assembly of MELBA (MEsa Low Energy Beam Apparatus) in summer 2016 (all parts shown in picture are in house)



V. Bechthold



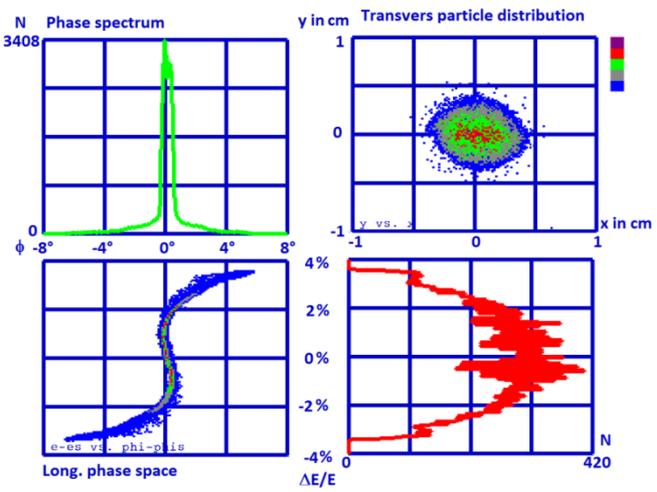
- Robust Photocathodes with QE=15% (45mA/Watt) at 400 nm: available!
→ 1mA can be generated with laser from a blue ray disc player

STEP-1: Assembly of MELBA (MEsa Low Energy Beam Apparatus) until early 2017

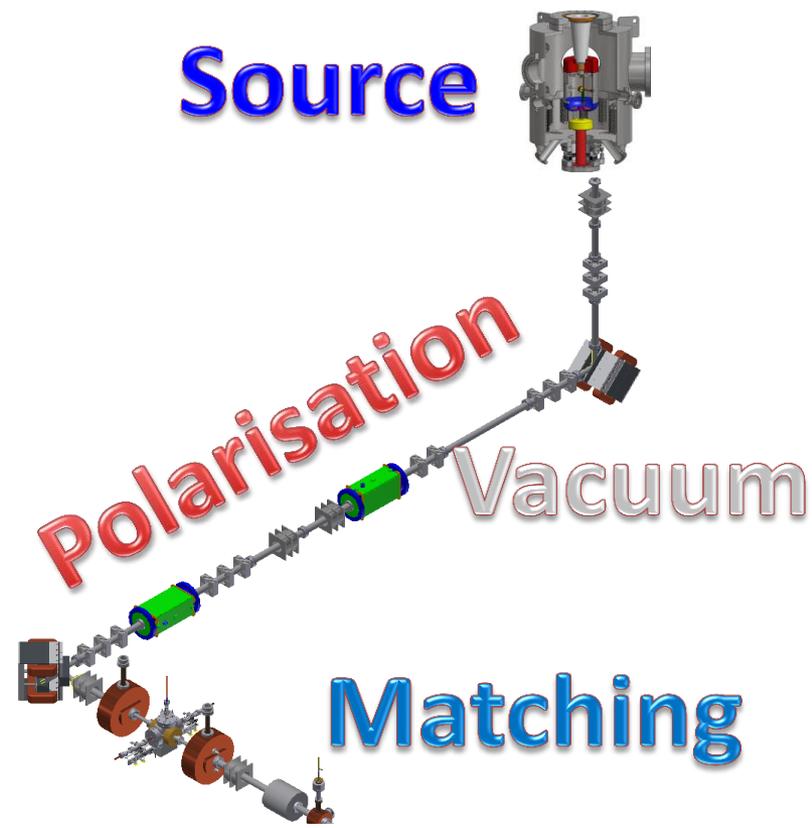
„Start to end“ Simulation predicts for 100keV beam:

- Compatibility with spin rotation
- Sufficient beam quality for injection into MAMBO with 1pC bunches (=1,3mA)

At the end of MELBA:



$\frac{\Delta E}{E}_{RMS}$ in %	$\Delta\phi_{RMS}$ in °	$\epsilon_{z,RMS}$ in °keV
1.7	1.3	1.576

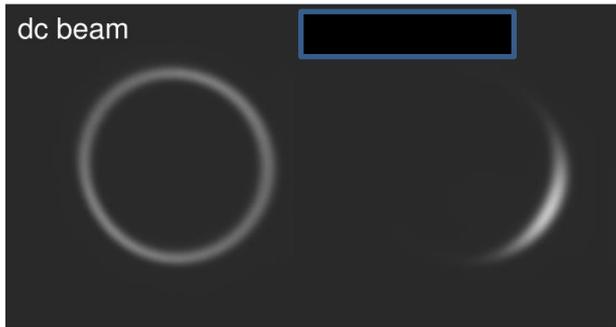


α_x	β_x in m	$\epsilon_{x,RMS,n}$ in μm	α_x	β_x in m	$\epsilon_{y,RMS,n}$ in μm
16.5	4.6	0.419	12.2	3.7	0.386

C. Matrejeck

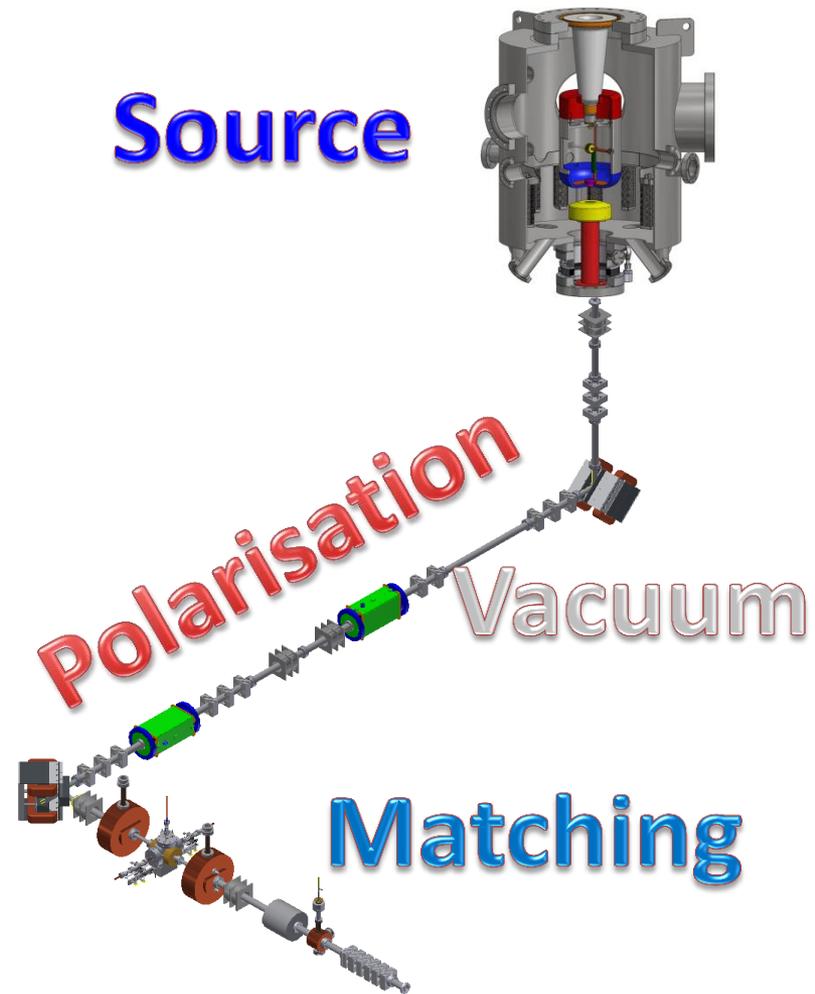
STEP-1: Assembly of MELBA (MEsa Low Energy Beam Apparatus) in 2016

Blue ray disc laser and longitudinal diagnostics
already tested....



I. Alexander

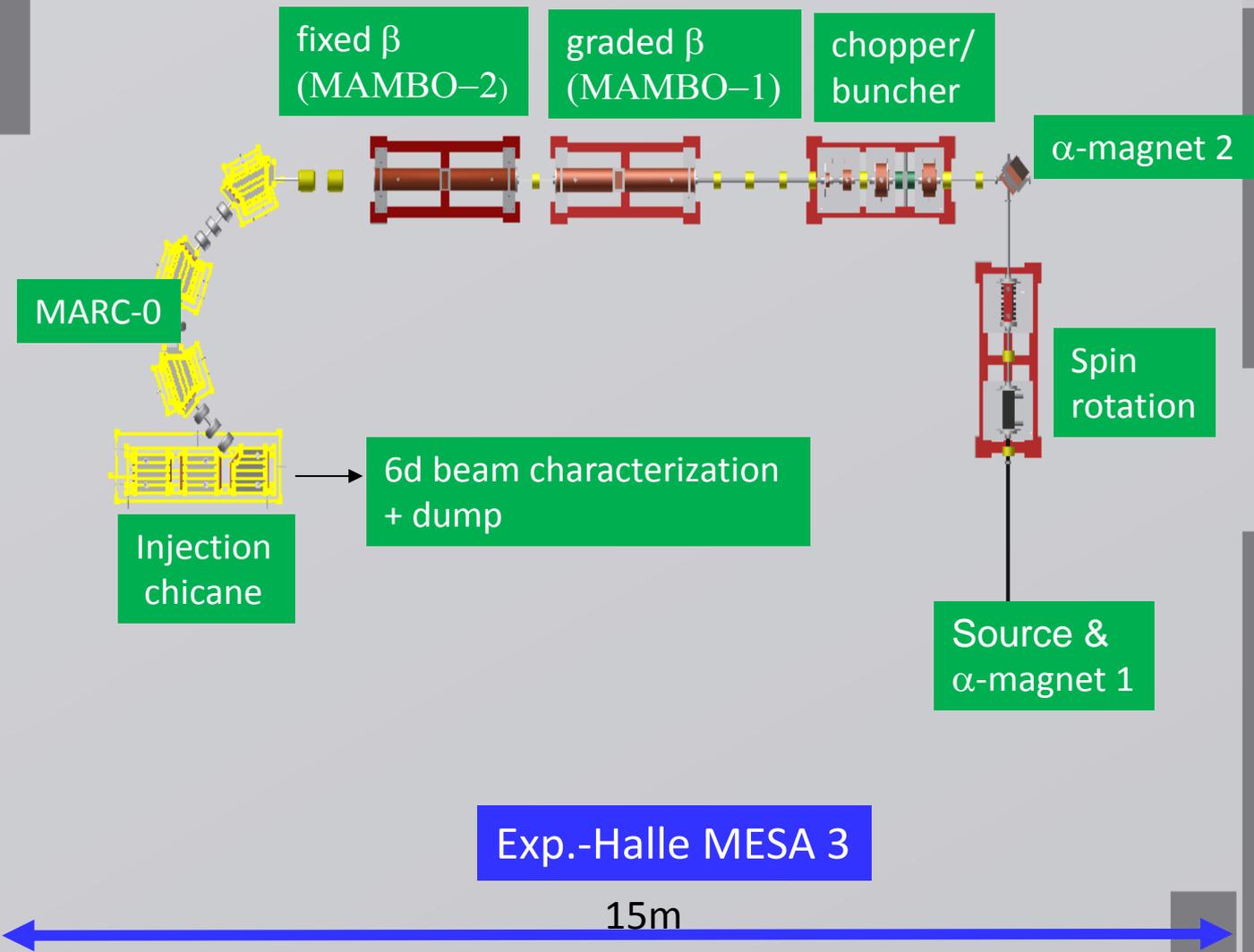
Longitudinal diagnostics at
Bunch charges corresponding to
> 1mA average current



Conclusion

- CFP building enables good conditions for initial experiments &
- enables new ones &
- Potential for completely new projects
- .. but considerable extension of timeline by ~ 3 years
- . Assembly strategy foreseen for accelerator components during time of civil construction,
- test with high intensity beam of preaccelerator planned
- Cryomodule tests in new HIM building

Thank you for your attention!





Task 3: add MEEK ????

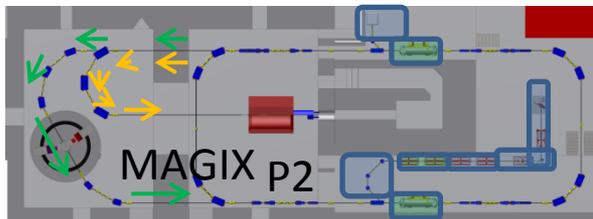
→ **Not favorized**, too small time window

Kryomodules will be tested after delivery
(without beam) at HIM site



MESA assembly Strategy Step -3

- HIM building ready for occupancy in 4/2016!
 - Large area clean room for cavity assembly
 - Großgeräteantrag (high pressure water rinsing, ultrasonic bath,...) of 1,6M€ submitted to DFG.
 - Helium transfer line from L280 to HIM is installed
 - Bunkered test stand will be installed, starting from 5/2016
 - 2K pump (SAC) (4g/s) tendering starts this month!
- Expect to be ready for testing in HIM in 5/17!



Possibility to visit HIM either in the Lunchbreak oder this evening!

Strategy & timeline 2015-2020:

- Use ExHall-3 until ~6/2018 : **demonstration of high current injector operation** (Full MELBA +two modules of MAMBO+ MARC-0)
- Test all other Rf/SRF components **with full field**
- Upgrade of L280 in 16/17 (cash-flow!)
- Use 16/17 for preparing tendering of MARC-Magnets and 8g/s SAC, (delivery 2019?)
- other conventional components (vacuum, support structure) also in 18/19
- Cryogenic line installation only after building ready!
- Virtually all components should be delivered and tested before CFP-building is ready!

Long range initiatives

MESA-Scientific staff, Post-Docs & PhD students

How to maintain?

Staff: K.Aulenbacher (project leader, MELBA,), F. Hug (MEEK, beam dynamics), R. Heine (MAMBO), M. Dehn (control, diagnostics), J. Diefenbach (radiation protection, feedbacks)

Post-Docs: L. Hein (Beam dynamics)

~~F. Schlander~~ (SRF, left 1/2016 to ESS) → n.n.

PhD students:

I Alexander MELBA High power Beam diagnostics

V. Bechthold Photocathodes

S. Friederich Electron source, high brightness operation

S. Heidrich: MESA Magnets, MARC-0

P. Heil: High bunch charge, MAMBO beam dynamics

R. Herbertz Beam stabilization, feedbacks

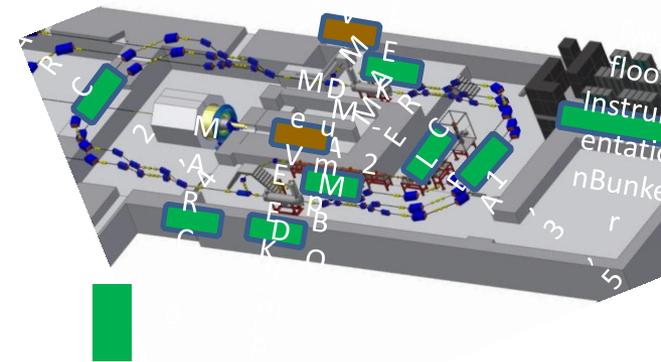
B. LeDroit (6/2016) Halo suppression

C. Matejcek MELBA beam dynamics and characterization

D. Simon – cryogenic operation of MEEK

T. Stengler MEEK-HOM damping

Ch. Stoll (6/2016): ERL related beam dynamics



Excellence cluster “PRISMA-2”?

- January 2016: „Imboden-Komitee“ presents its conclusions on results and possible continuation of excellence initiative to german research ministry BMBF
- ...Concludes that „Clusters“ are succesful concept and suggests BMBF to create possibilites for **new proposals**
- ...Proposes that existing clusters should be **extended until 2019**.

The latter recommendation, if accepted by government, probably allows to continue personell funding (invest?)

→ In additon, brainstorming for „PRISMA-2“ has started.

GRK-2128 “Accelence”

- Common application by TUD and JGU for graduate school.
- Accelerator science and technology for energy recovery linacs
- Application successful in 10/2015
- First funding period (4,5 years) starts in 4/2016, 4PhD positions for JGU.

GRK 2128 date: March 31, 2015

Accelence

Funding period: Apr. 2016 - Sept. 2020
Coordinating university: Technische Universität Darmstadt
Spokes-person: Prof. Dr. Dr. h.c. Norbert Pietralla

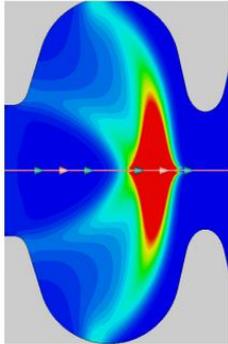
Proposal to Establish a Research Training Group (RTG) in
“Accelerator Science and Technology for Energy-Recovery Linacs”



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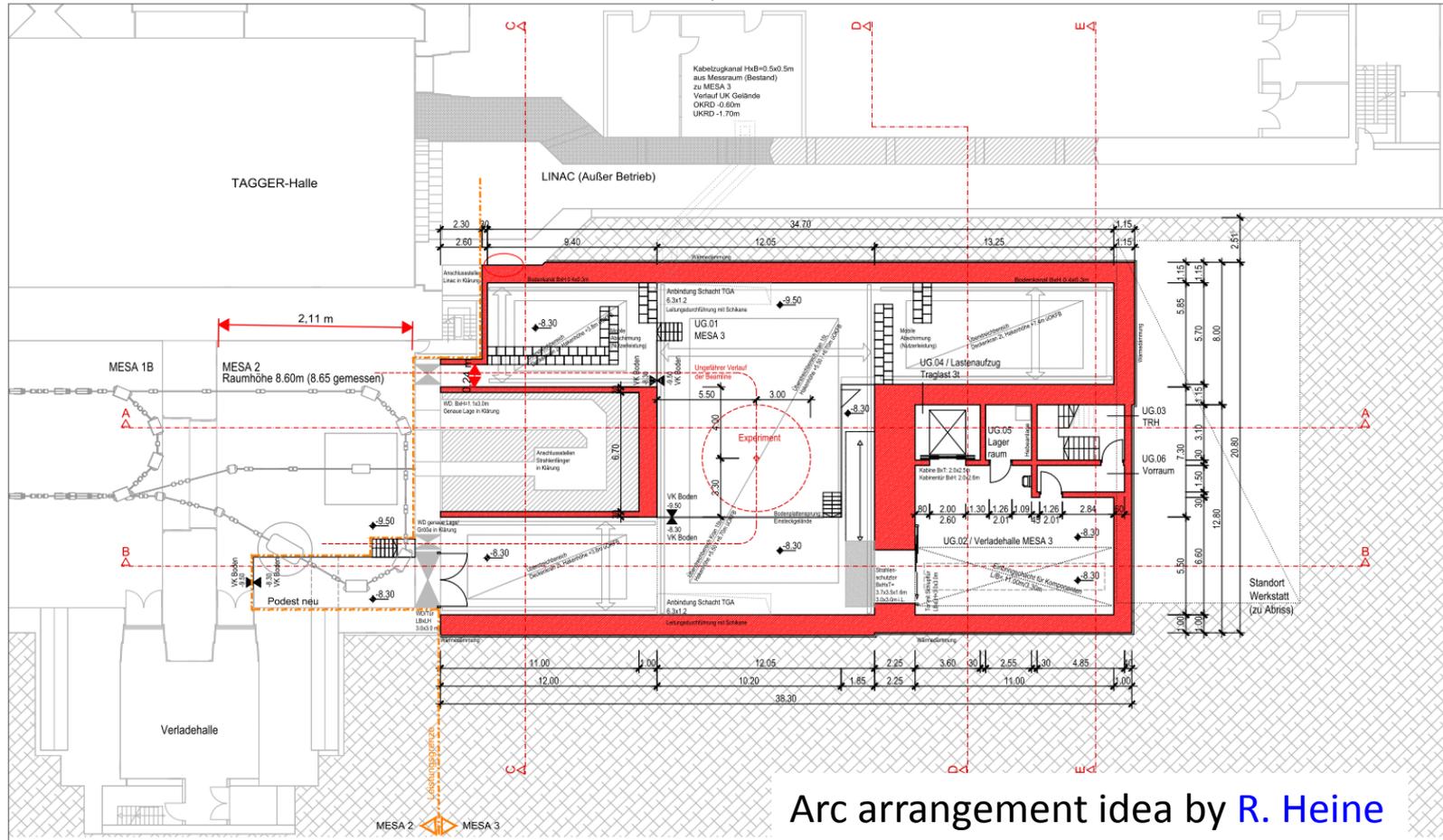
 ACCELENCE

 TECHNISCHE UNIVERSITÄT DARMSTADT



“Centrum für Fundamentale Physik”, CFP

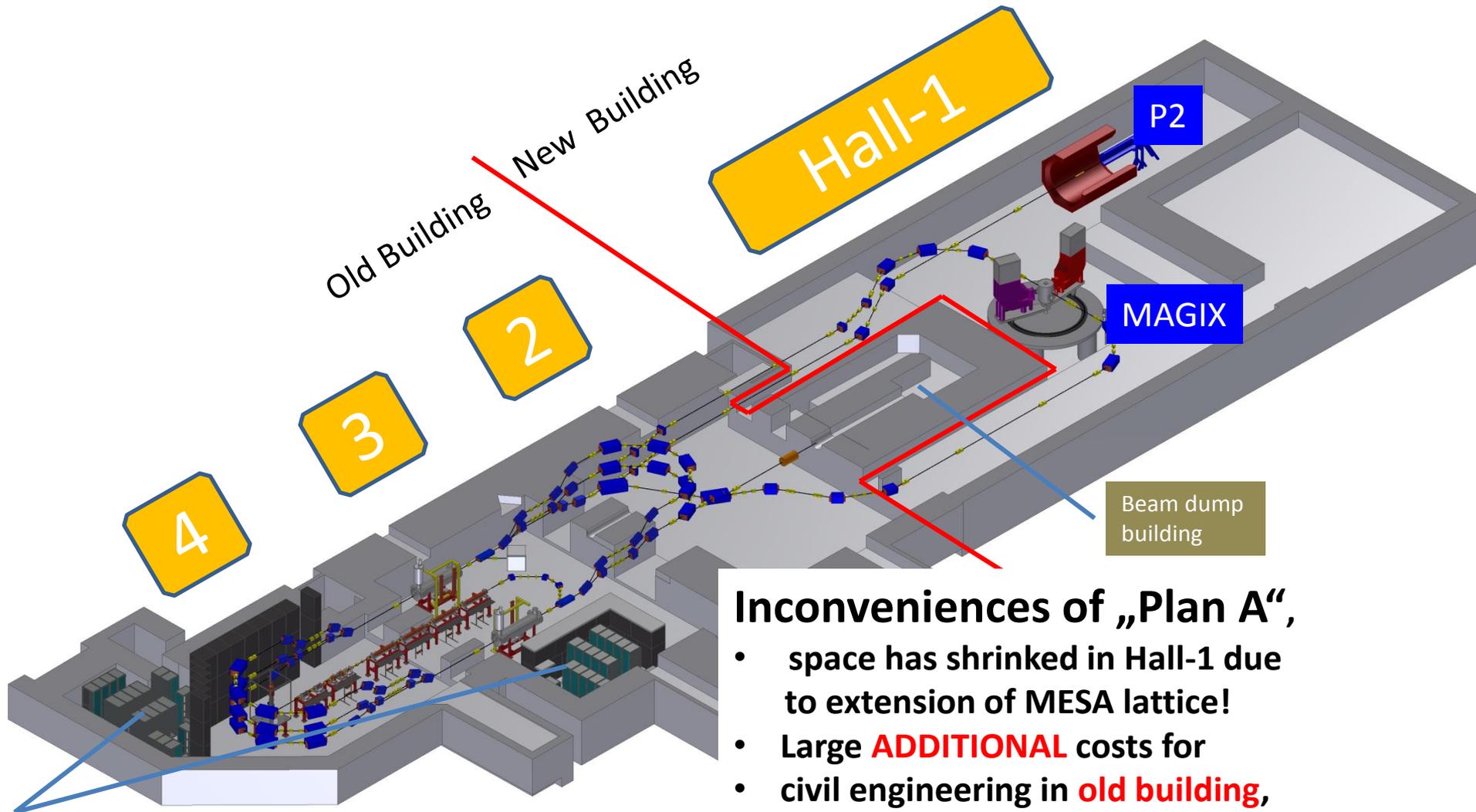
New underground building at KPH -some details



Arc arrangement idea by R. Heine

	<p>Johannes Gutenberg-Universität Mainz Unterirdische Erweiterung MAMI (MESA 3)</p>	<p>Konzept Machbarkeitsstudie</p>
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PLAN "A" (April 2015)

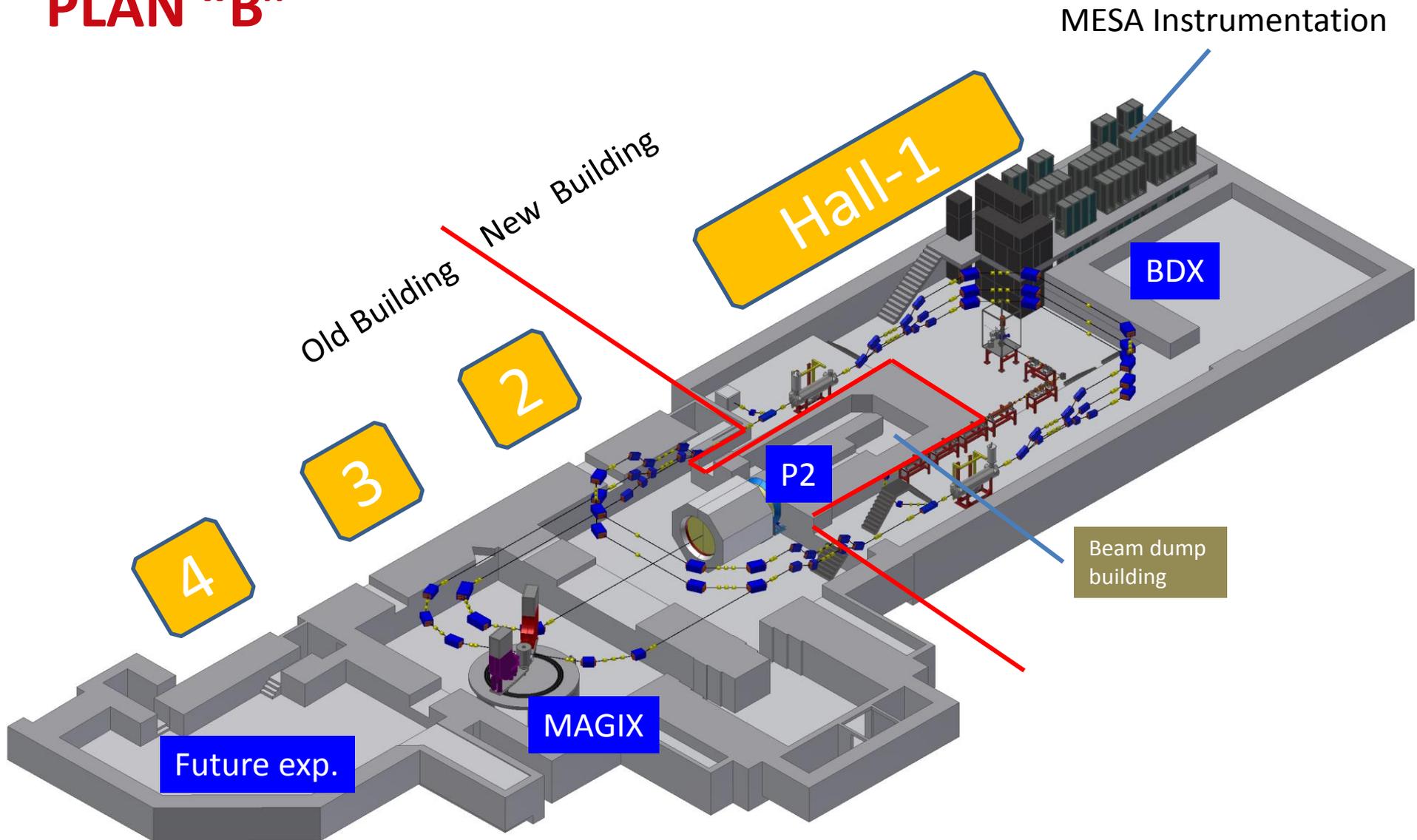


MESA Instrumentation

Inconveniences of „Plan A“,

- space has shrunk in Hall-1 due to extension of MESA lattice!
- Large **ADDITIONAL** costs for
- civil engineering in **old building**, in particular ventilation, ground-work (earth shield!) and five large breakthroughs

PLAN "B"



Step-3 (see talks by [Florian Hug](#))

- HIM building ready in spring 2016
- Bunkered test stand, 4g/s closed cycle, corresponding 16 mbar SAC
- Delivery of Cryomodules due in 2017 (first due date: 3/2017)
- Acceptance test of modules under realistic conditions

The team:

~~Dr. Felix Schlander (Kryomodul project management)~~

Jun. Prof. Dr. Florian Hug (LLRF, control, Kryomodul project management)

N.N. LLRF Post-Doc (succesor Felix Schlander)

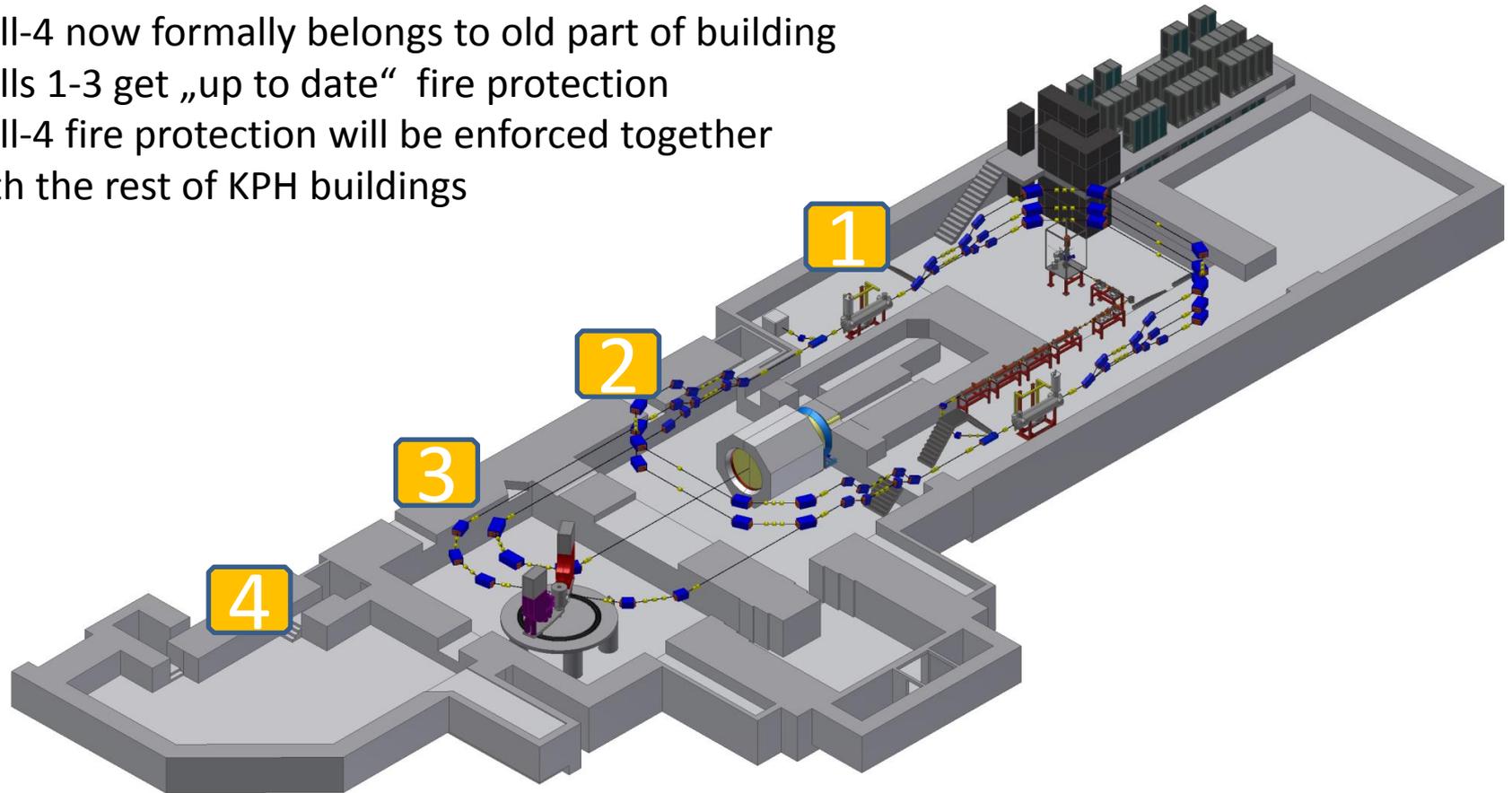
Dipl Phys. Daniel Simon - Cryogenics

M. Sc. Timo Stengler (Cryomodule characterization, in particular HOM thermal management)

Ba Sc. Philipp Weber (R.f. charecterization)

PLAN “B” – fire protection/cost reduction

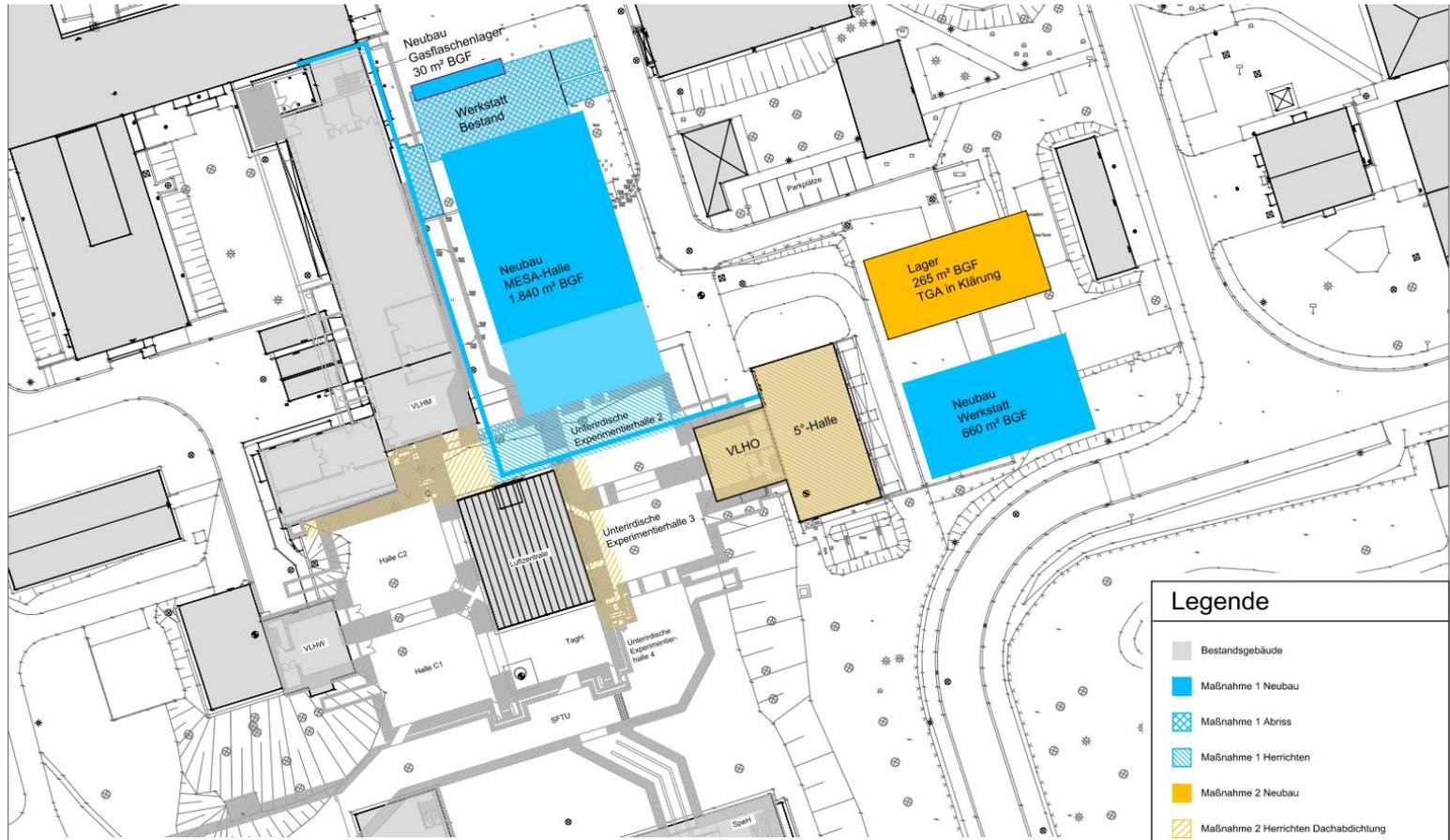
- Hall-4 now formally belongs to old part of building
- Halls 1-3 get „up to date“ fire protection
- Hall-4 fire protection will be enforced together with the rest of KPH buildings



- No breakthroughs, only circular holes → building stability issues solved
- Existing ventilating machine sufficient for Hall 2/3!
→ No significant groundwork over old halls, since no shafts for new ventilation required!
- Fire protection authority **accepts concept for halls 1-3** in September 2015,
→ Architects finalized concept until 12/2015, Science ministry is favorably impressed, begins Administrative procedures

PLAN "B" – Kryogenics & R.f.

See talk by [D. Simon](#)



Five degree Hall becomes „Cryogenic center“

PLAN "B" – Kryogenics & R.f.

See talk by [D. Simon](#)

