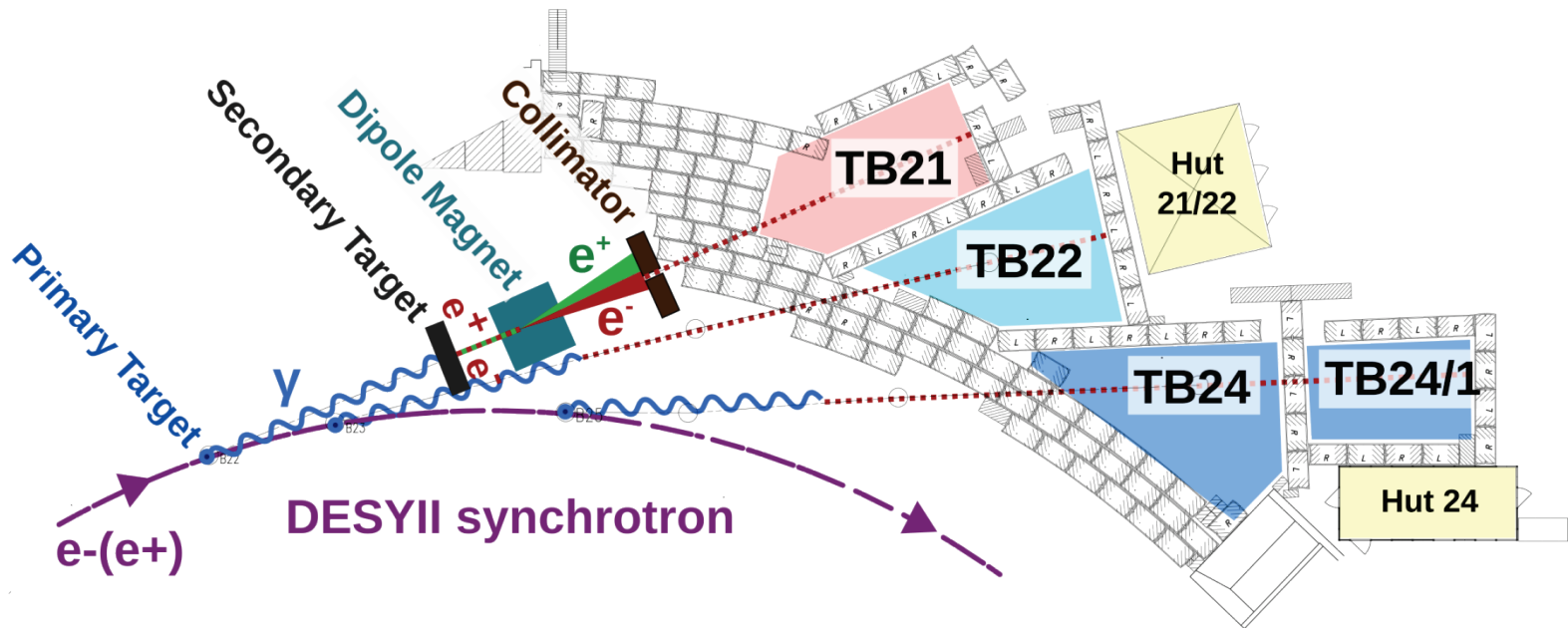
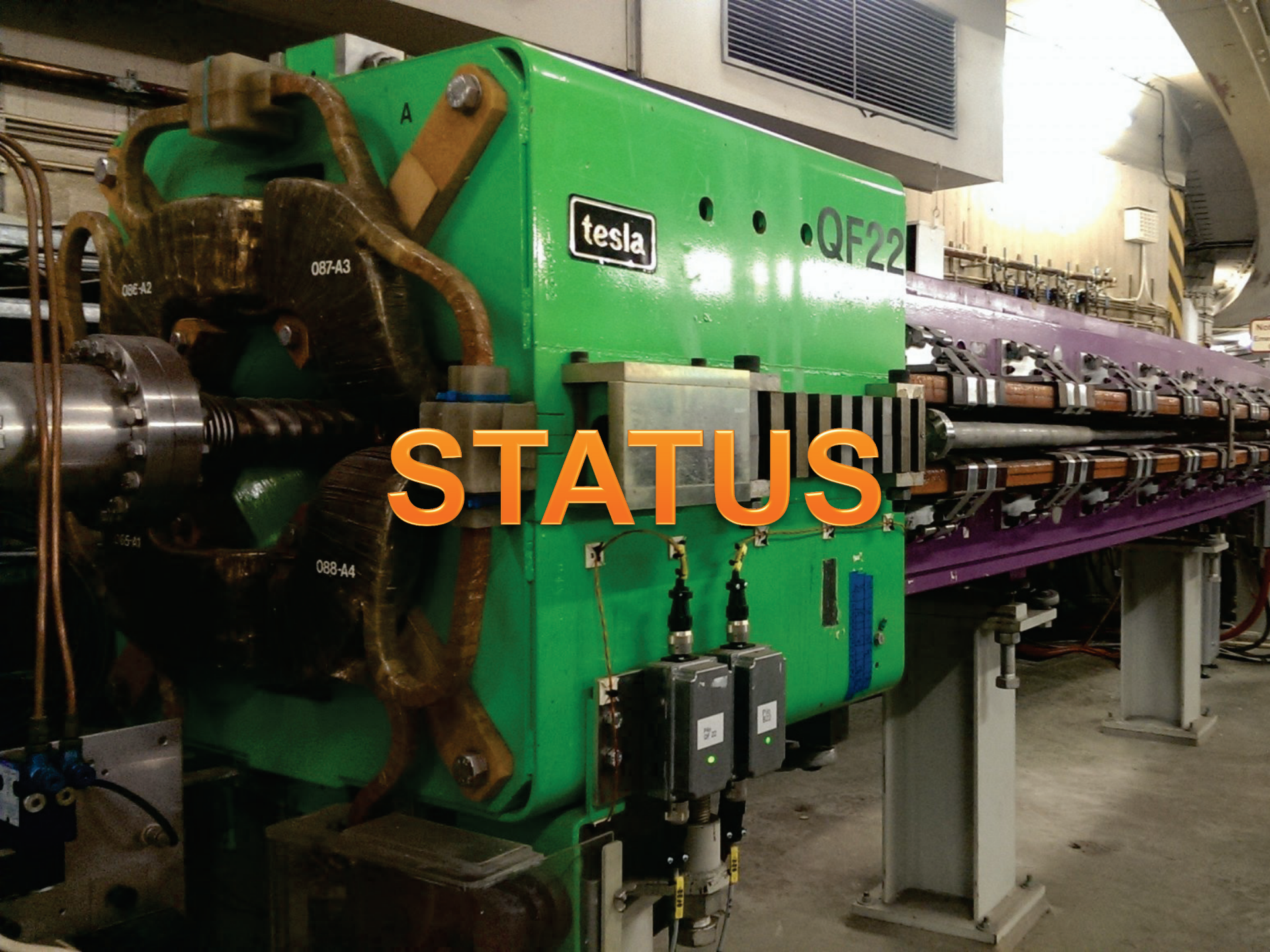


DESY II Test Beam Facility

Status and Plans



M. Stanitzki for the DESY Test Beam Team



tesla

QF22

STATUS

087-A3

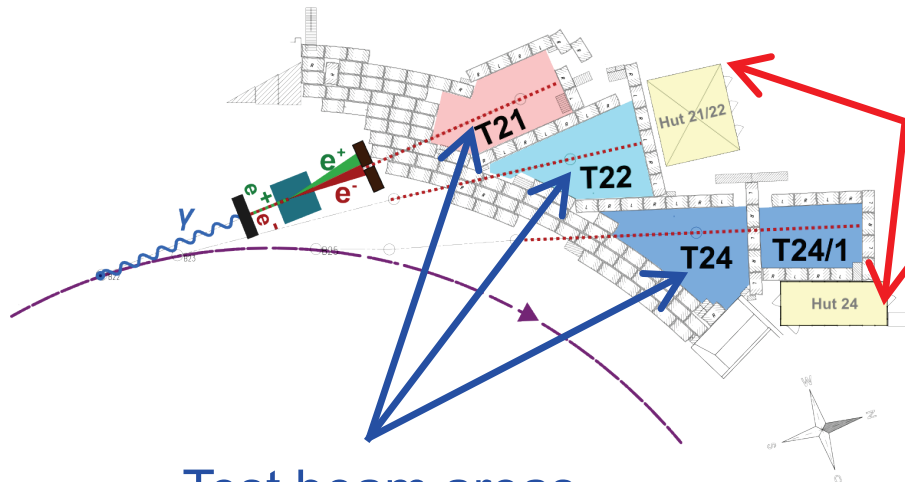
086-A2

088-A4

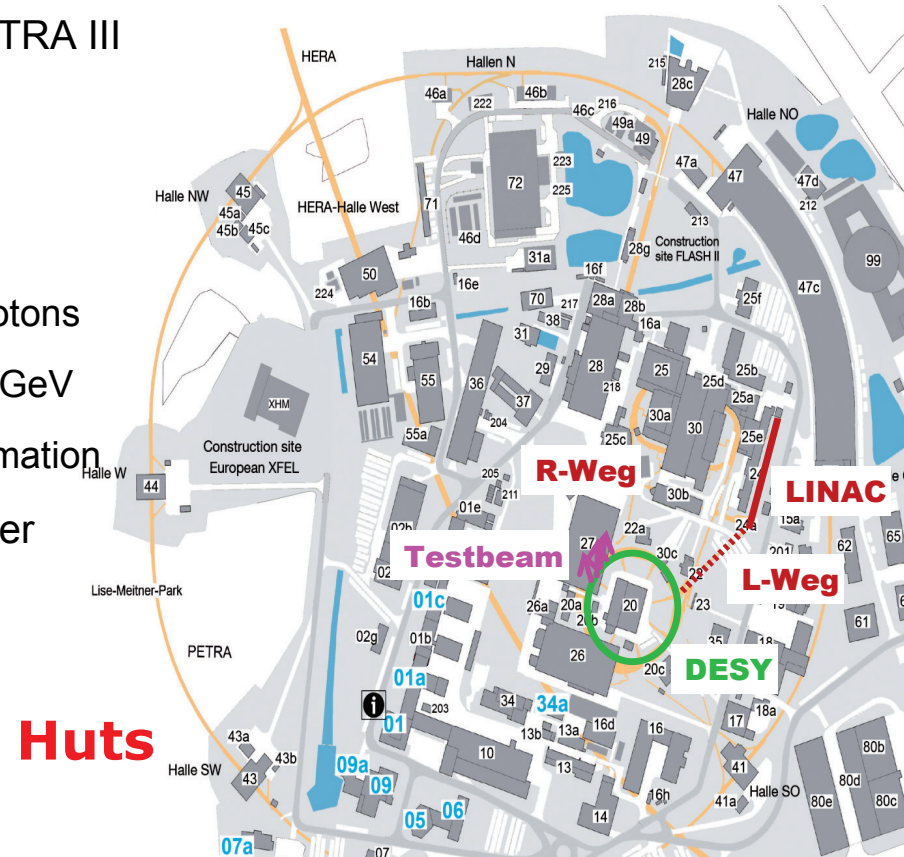
085-A1



- > Facility parasitic fed by DESY II synchrotron (PETRA III injector)
 - 1 bunch per fill, 30 ps, 1 MHz
- > Beam Generation & Properties
 - 3 carbon fiber targets generate bremsstrahlung photons
 - Conversion at target to e^+/e^- with energies up to 6 GeV
 - rates dependent on beam line, energy, target, collimation
- > Three individual beam lines, controlled by the user
 - Shutter, area interlock, momentum + collimation

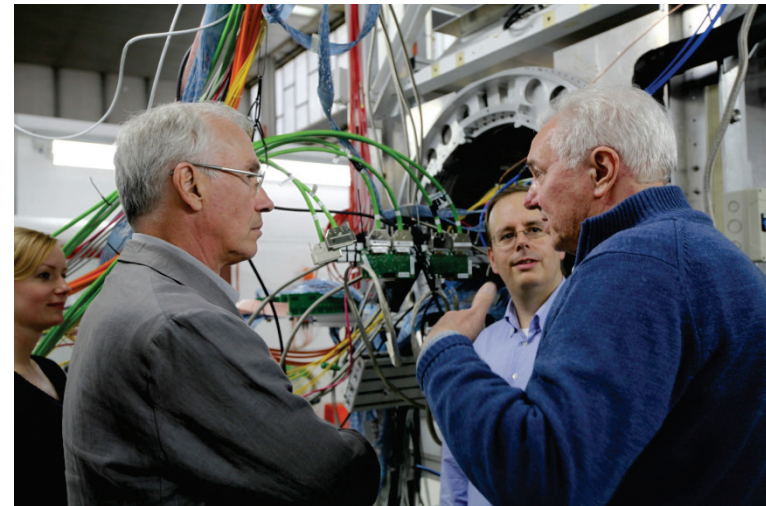


Test beam areas

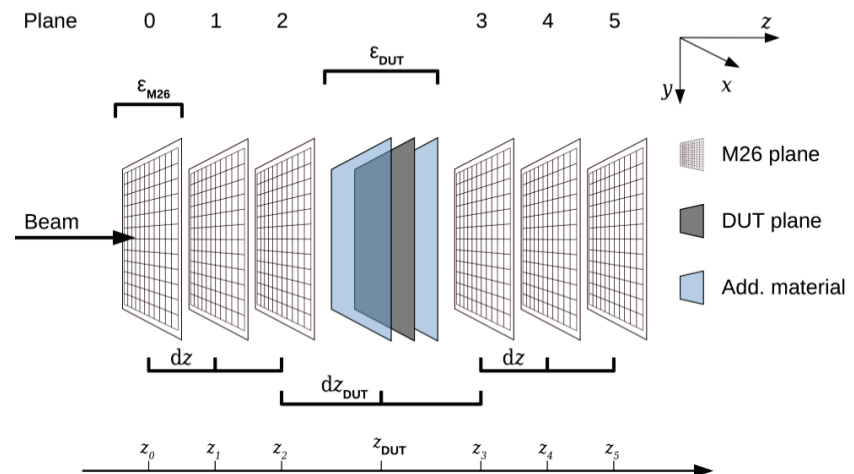
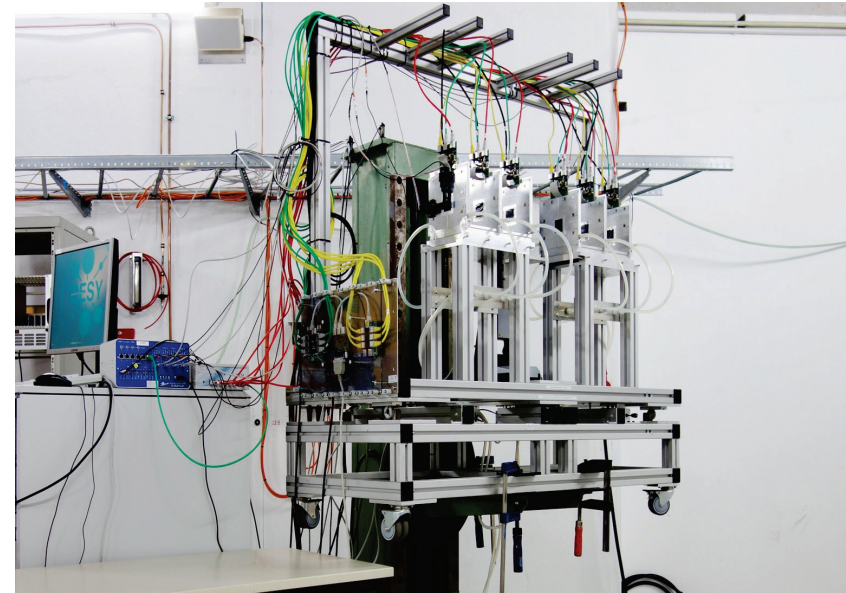


Huts

- Patch Panels, Ethernet, Fibers, Stages, Cameras, Laser Alignment
- Set of Control PC's for the beam lines and the telescopes
- New Gas System
- Since January
 - Gigabit Ethernet everywhere (92 Ports)
- Two Big Magnets
 - 1.4 T Dipole (BRM)
 - 1 T Solenoid (PCMAG)
- DESY Directorate support for continuous improvements to the facility



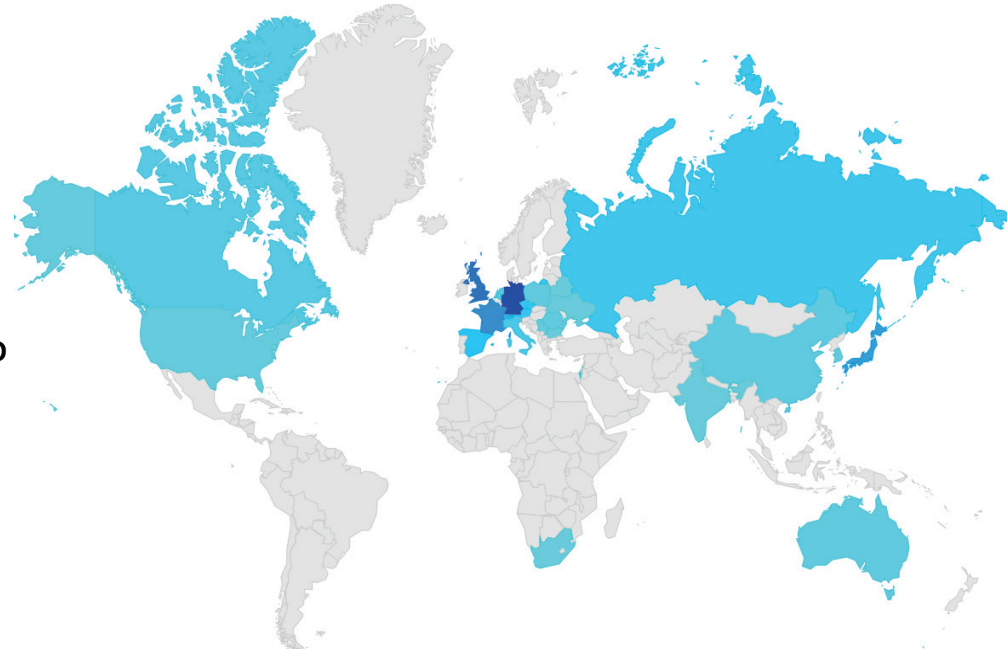
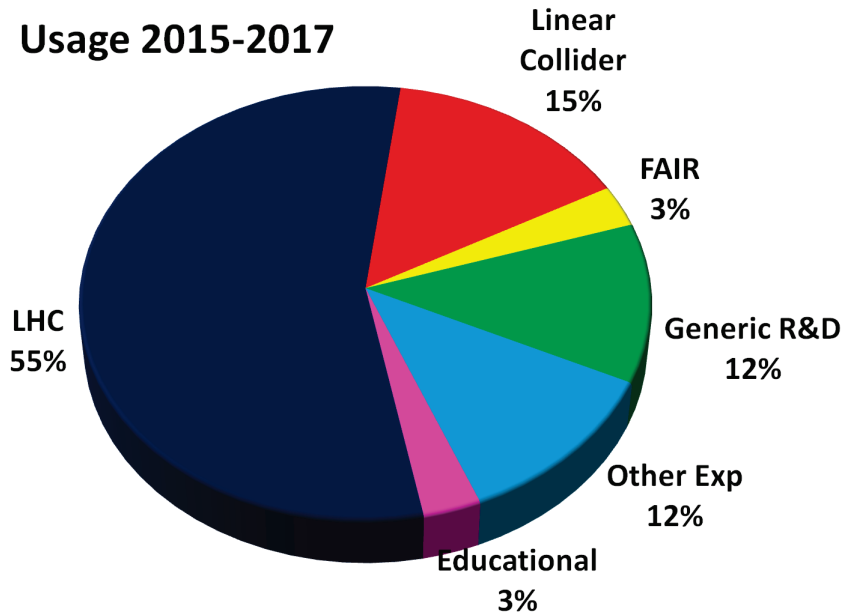
- Complete Package:
 - Hardware, trigger, software, dedicated support crew
- The telescope in numbers
 - Six Pixel planes: 2 x 1cm², 18.4 μm pitch
 - Trigger rates up to 3 kHz
 - Few micron tracking resolution
- Seven copies around the world
 - AIDA, ACONITE and AZALEA at CERN
 - DATURA and DURANTA at DESY
 - ANEMONE in Bonn
 - CALADIUM at SLAC
- Common DAQ Package EUDAQ/EUDAQ2
 - Allows for easy integration with User DAQ



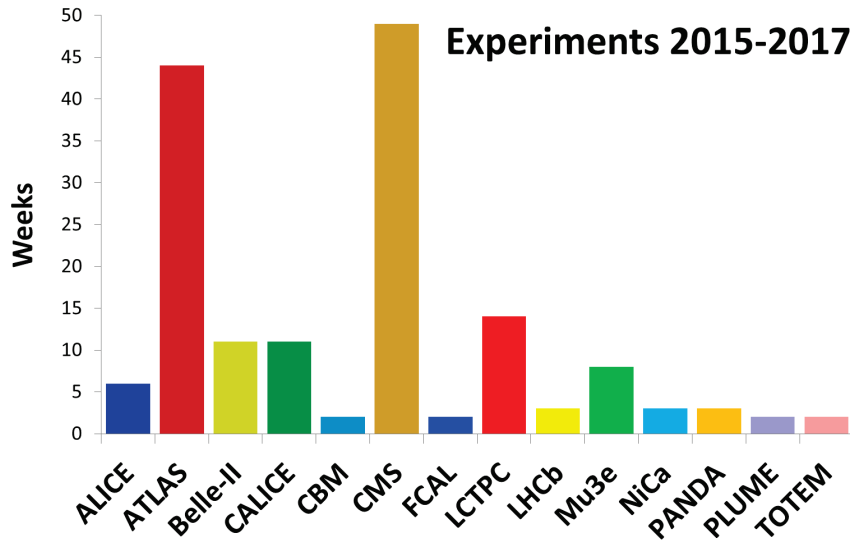
- The Test Beam has benefitted greatly from EU funding
 - EUDET FP6
 - AIDA FP7
 - AIDA2020 Horizon 2020
- Supported various new infrastructures
 - Pixel Telescopes
 - PCMAG
 - Strip Telescope
 - Common Slow Control System
- Transnational Access
 - Enables non-German groups to perform Test Beams at DESY
 - Very successful und huge beneficial particular for university groups



Usage 2015-2017



Experiments 2015-2017



> Key facts

- 200 weeks delivered
- Availability of DESY II > 99 %

> Users

- 800 users from 26 countries
- About 50% are students

> AIDA2020

- Transnational Access has supported many user groups

> Run 2018 – Status April

- 70 weeks currently requested (1 Slot = 1 Week)
- 63 % booked
- 170 Users (End of April)

> User Communities

- LHC groups remain largest user community

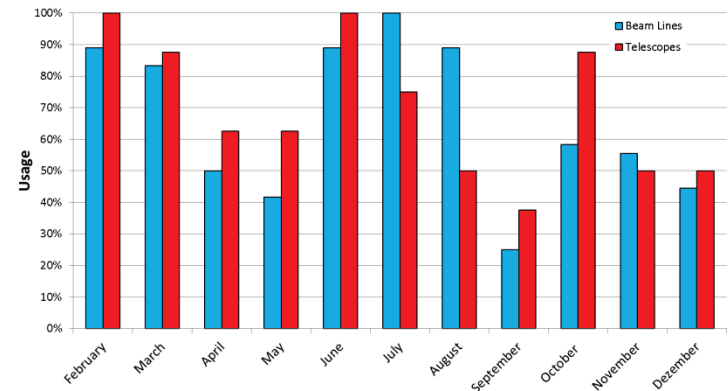
> Telescopes are a success story

- 3 out of four groups request one

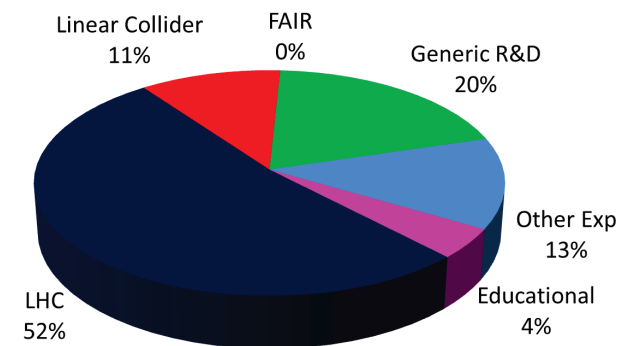
> Three Beam Lines are currently sufficient

- Enough capacity for the Community
- No real need for an additional Beam line with the same properties

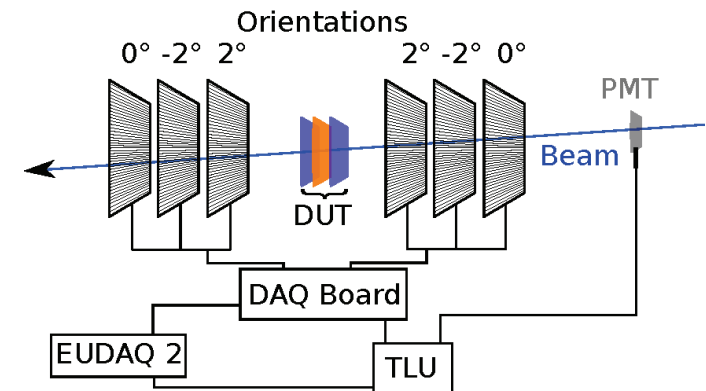
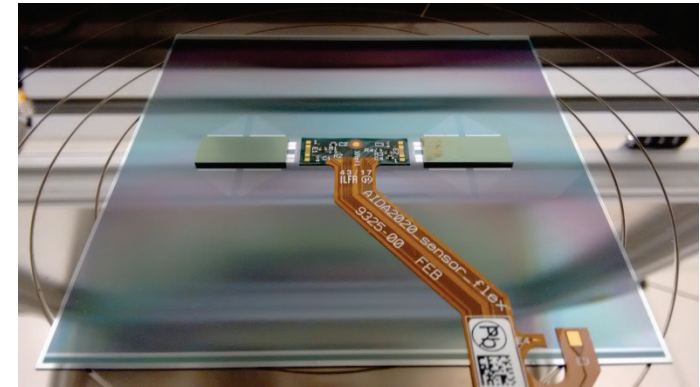
DESY-II Test Beam Facility
Usage 2018



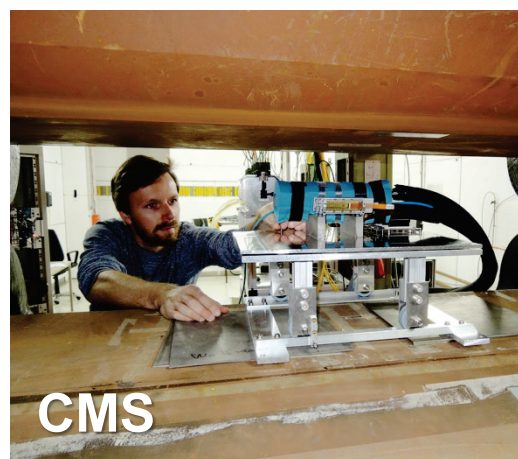
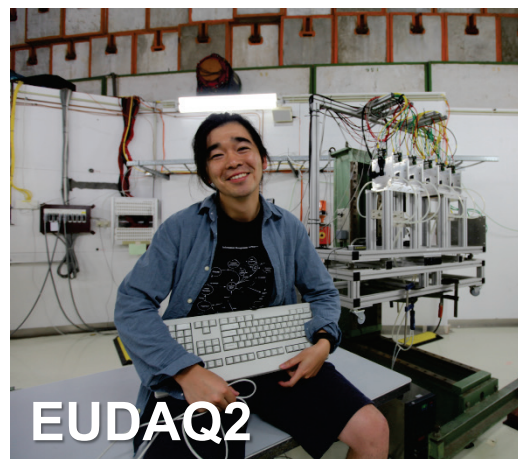
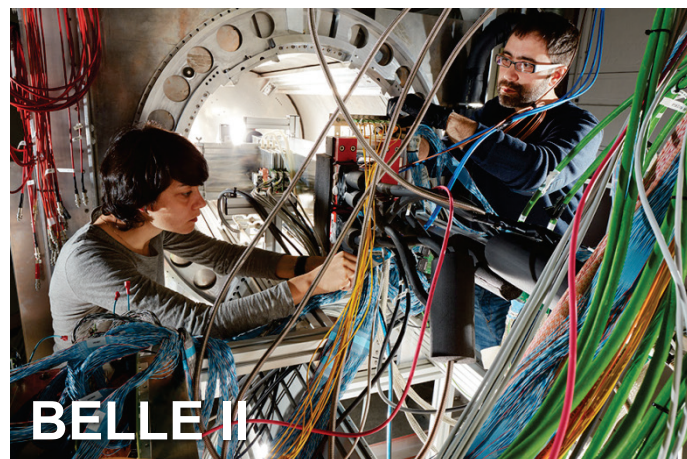
Projects 2018



- Installation of a Silicon Strip Telescope
- New Interlock System Installation
 - Replacing the old “DORIS-style” system
 - Very similar to the PETRA III system
 - Improved Safety and Reliability
- Work on new primary target system has started
 - Reduce maintenance and access needs
 - Common Components with other systems , benefit from XFEL work
- Maintenance and continuous upgrades of beam telescopes
 - EUDAQ version 2 for decentralized data taking
 - New Trigger logic unit providing a common clock for data synchronization
- Reference Paper on DESY II Test Beam Facility is almost complete
 - Plan to submit this month



- > The Test Beams at CERN (both SPS and PS) will be closed during the Long Shutdown 2 of the LHC
- > DESY will provide the only multi-GeV test beam in Europe
 - From the 2013 experience we know, that DESY will be in extremely high demand
- > Request from Test Beam & DESY II Coordination
 - Start DESY II User Run End January
 - 2-3 Week Summer Shutdown
 - End Run just before Christmas
 - Approx. 135 user weeks (25 % increase of run time)
- > Third telescope at DESY during LS2
 - Move one of the CERN telescopes to DESY
 - Make sure enough telescopes are available



SCHEDULING ? 2019/20 ?
SHORT TERM PLANNING (-2020) ?
LONG TERM PLANS (> 2020) ?

TELESCOPE SUPPORT ?
TELESCOPE UPGRADES ?
HIGHER RATES ?

HUT INFRA-
STRUCTURE ?
CONTROL SYSTEMS ?
SLOW CONTROL ?

DIRECT EXTRACTION ?
HIGH RATES @ FULL ENERGY

PLANS

PER BUNCH ENERGY
MEASUREMENT ?
FIBER SPECTROMETER ?
BGO CRYSTALS ?

DESY IV ?
FLAT TOP ?
ENERGY ? RATES ?
BEAM STRUCTURE ?

"DUMPED" BEAM AT "R-WEG" ?
6.3 GeV @ 12.5 Hz, $10^2 - 10^{10} e^-$
or $\pi O(10)$ @ 4 GeV μ, p, n
or electromagnetic irradiation...



Test Beam Workshop – First Summary of the User Requirements

- Workshop with representatives from the user community
 - Covering groups from LHC to Accelerator R&D
 - Very fruitful discussions and feedback
- DESY is an very good place to do test beams
 - Excellent availability and support
 - Two main wishes formulated by the community
- Electrons with maximum energy and/or high intensity
 - High Intensities (100 kHz or more)
 - Studies with 6.3 GeV monochromatic beam
- Pion/Muon Beam (Secondaries)
 - Improved testing capabilities for detectors, e.g. Particle-Identification (PID)
- Write-Up is available here
 - <http://arxiv.org/pdf/1802.00412.pdf>



FUTURE OPPORTUNITIES FOR TEST BEAMS AT DESY - 2017

Workshop and discussion on:

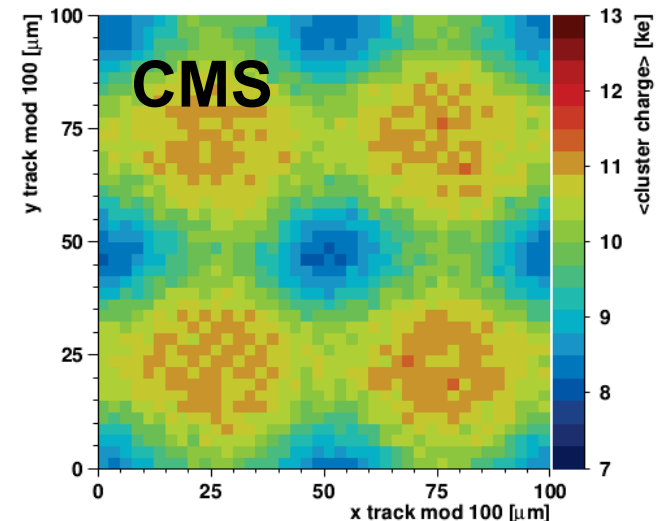
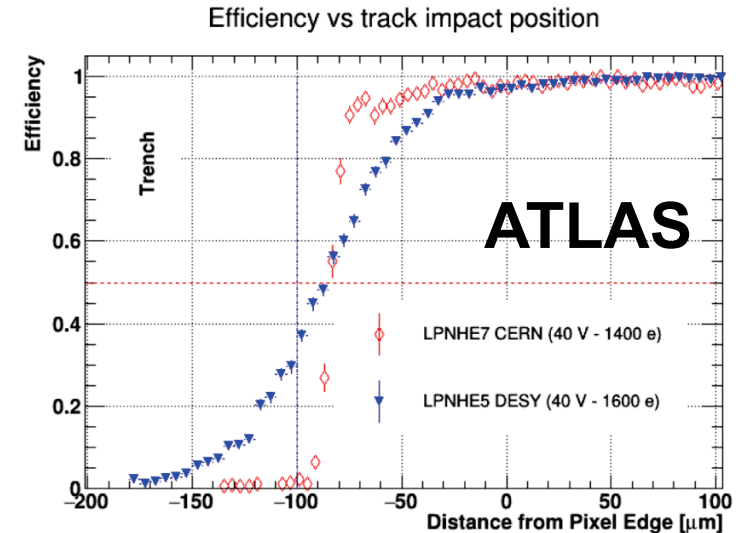
- Status and future developments of the DESY test beam
- User requirements and science case
- Near and long term beam time planning

DESY Hamburg, October 5. - 6. 2017
<https://indico.desy.de/event/TestbeamFuture2017>

Local organizing committee:
Claire Baerens, Ralf Dieder, Jan Christoph Eichmann,
Sven Diederichs, Frank Jansen, Richard Ketter,
Nikolaus Pleschinski-Kubik, Manuel Quasthoff



- The EUDET-Style pixel telescopes have led to a revolution in test beam usage at DESY
 - Micrometer track resolution for everyone
 - Open for users from all experiments
- Pre-telescope era
 - Test of Detector response e.g. Pixel (200 x 200 μm)
- Now
 - Detailed Study of detector performance in-pixel (3 μm resolution)
 - Understanding detector performance with an unprecedented level
 - Very useful for HL-LHC pixel detectors



Limiting Factors Today

- > Maximum Beam Rate is at 2 GeV
 - With a few kHz rate
- > Best Compromise for tracking studies is 5.4 GeV
 - Rate is $O(100)$ Hz
- > For tracking studies
 - Rates are becoming the limiting factor
 - Followed by the energy spread...

Possible Solutions

- > DESY II Multi-bunch operation
 - Very welcome improvement, higher rates for the entire energy range
 - Definitely something that is strongly requested by the users
- > A Beam with 6.3 GeV with ~ 100 kHz
 - Will enable completely new studies
 - Unique facility worldwide

> R-Weg

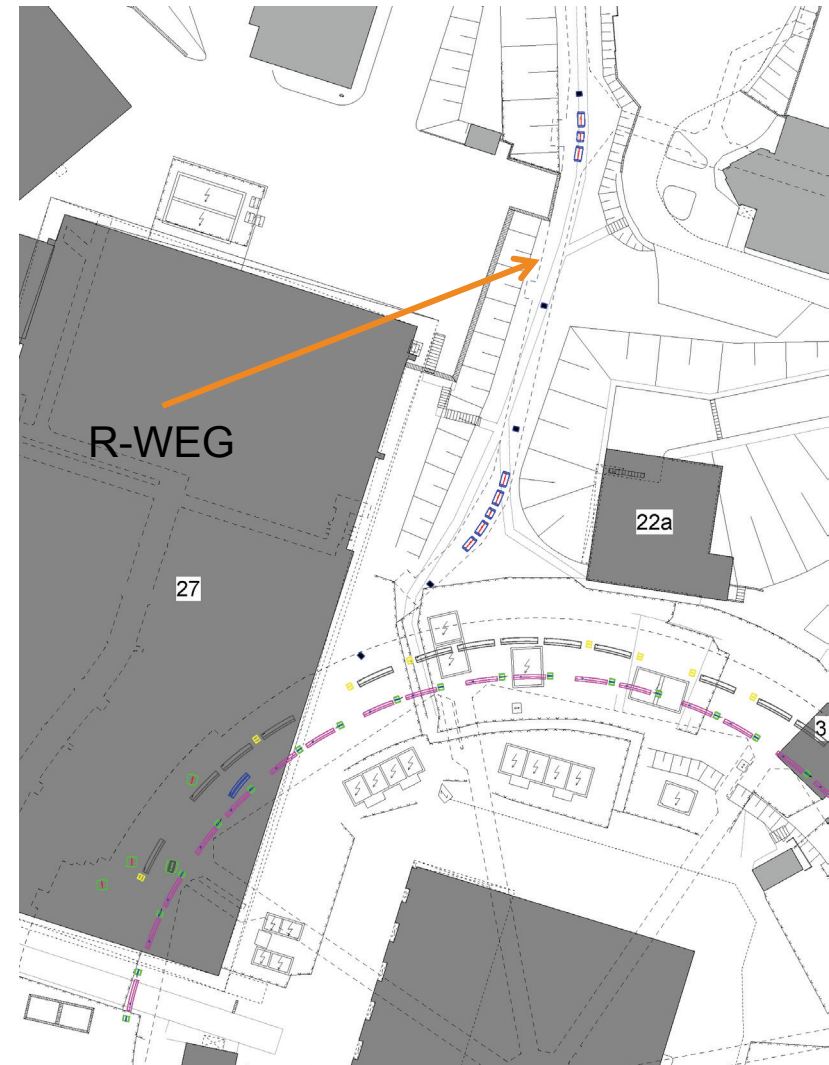
- Transfer line from DESY II to DORIS

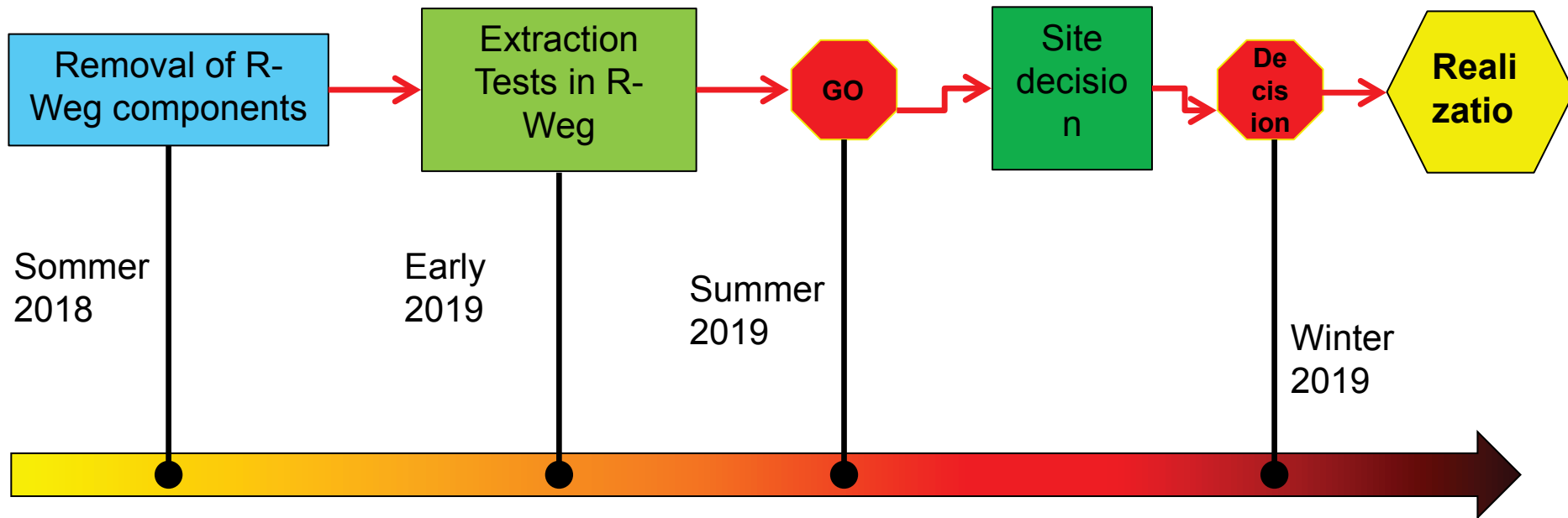
> Current Parameters

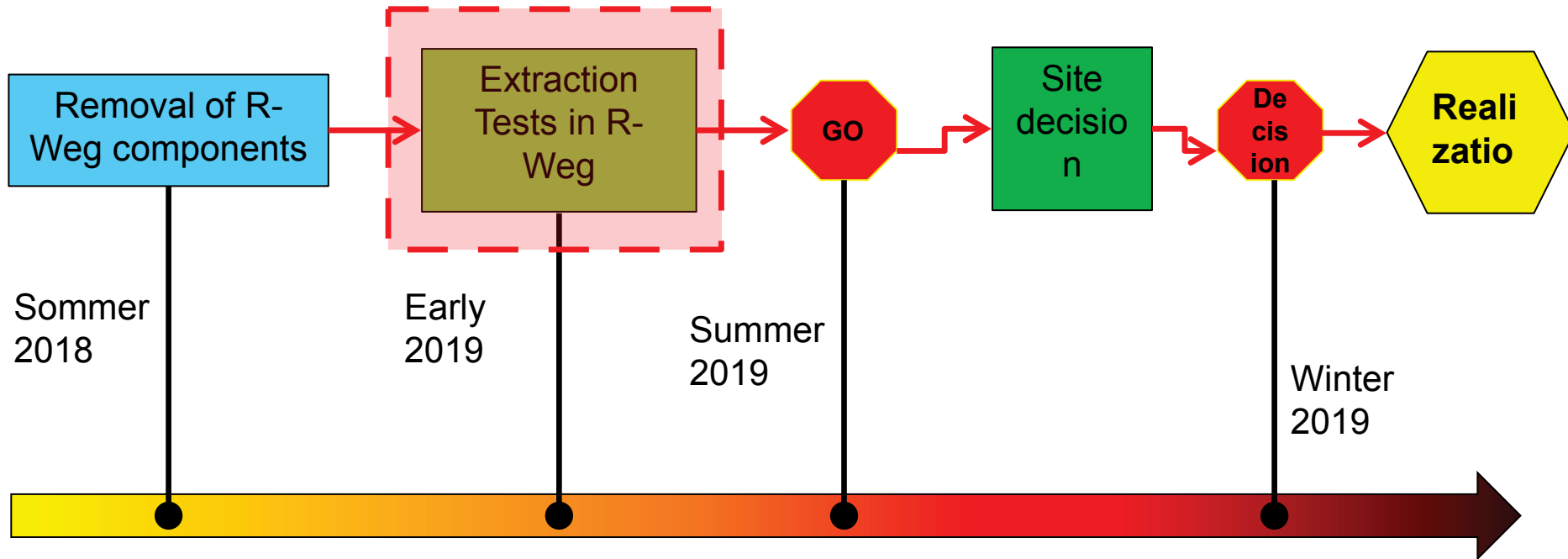
- Repetition rate up to 12.5Hz
- Max Intensity 2×10^{10} Particles/Bunch
- Min Intensity $> 1 \times 10^8$ Particles/Bunch
- Extraction energy 456 MeV - 6.3 GeV / 7 GeV

> Current Status

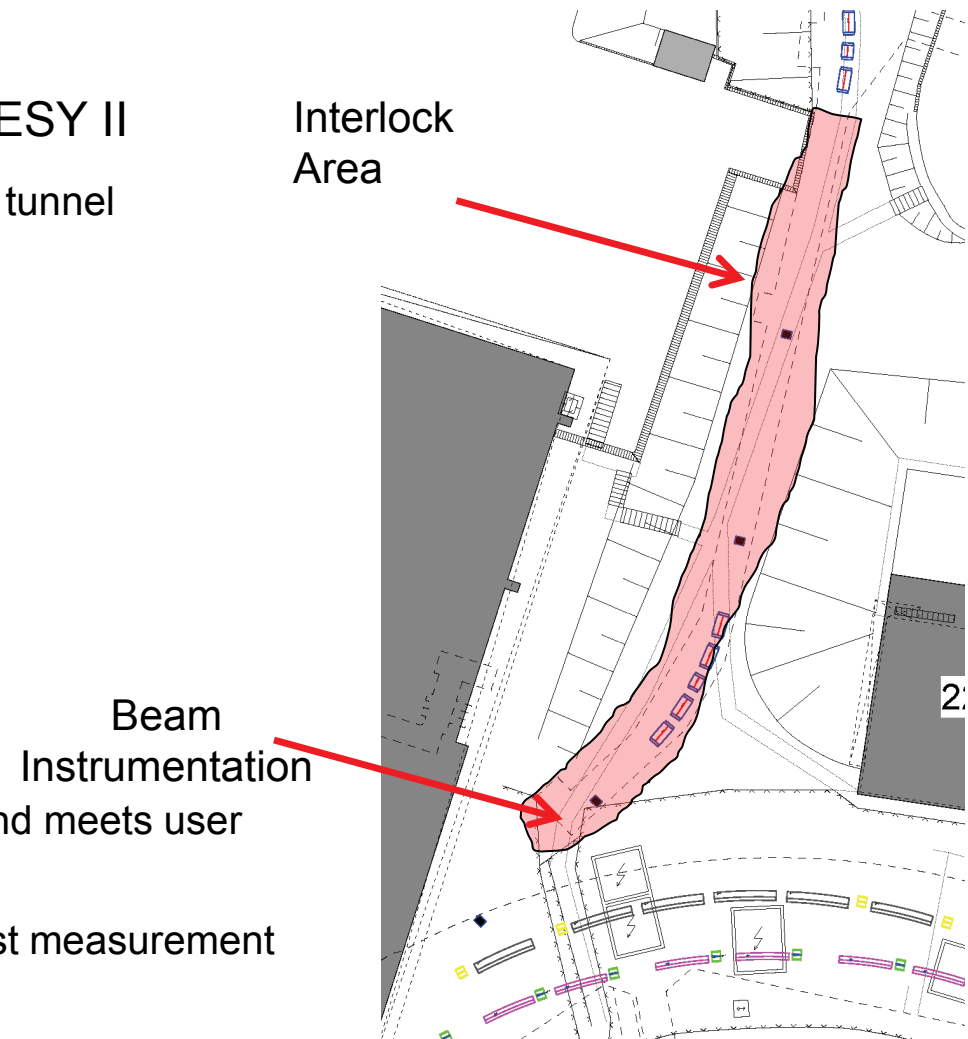
- Magnets defunct, Services old or defunct
- Assumption : Removal of all equipment required

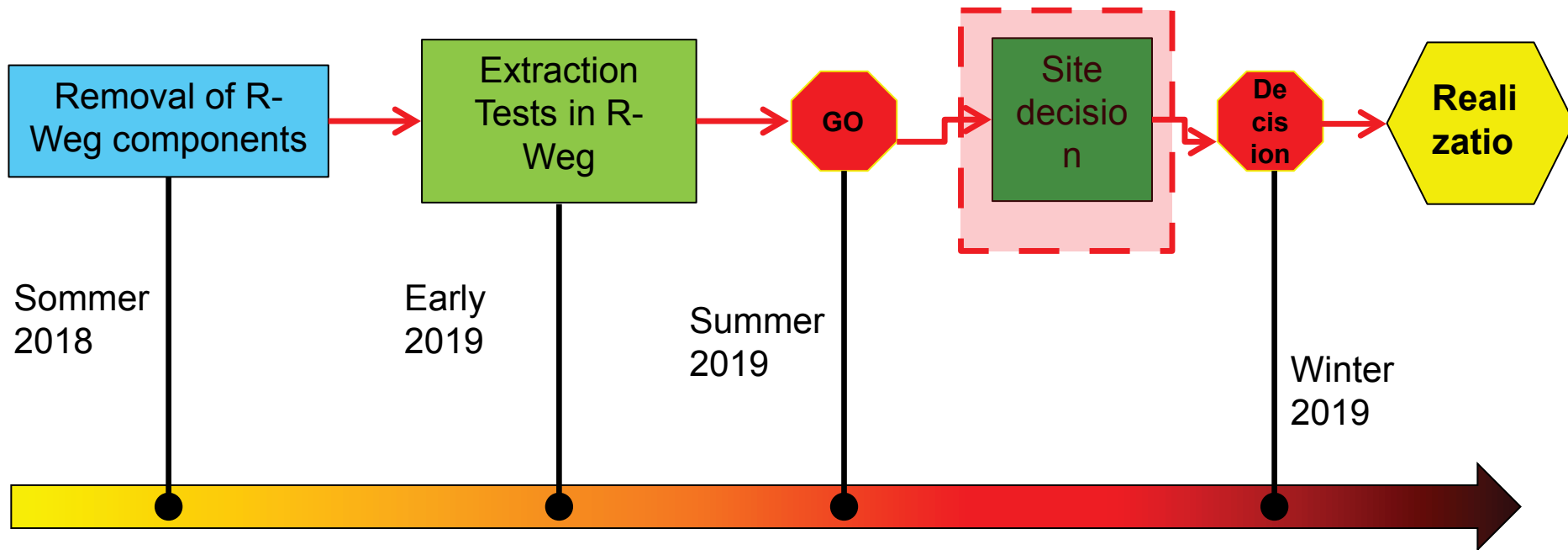






- R-Weg Clean up
- Re-enable R-Weg extraction in DESY II
 - Requires minor work in the DESY II tunnel
- Re-establish Interlock
 - Block access from DORIS
 - Enables beam again in R-Weg
- Set-up Beam instrumentation
 - Study beam properties
 - Test extraction schemes
- Goals
 - Primary beam extraction is viable and meets user requirements
 - Install a pilot detector setup for a first measurement
- Little investment cost needed

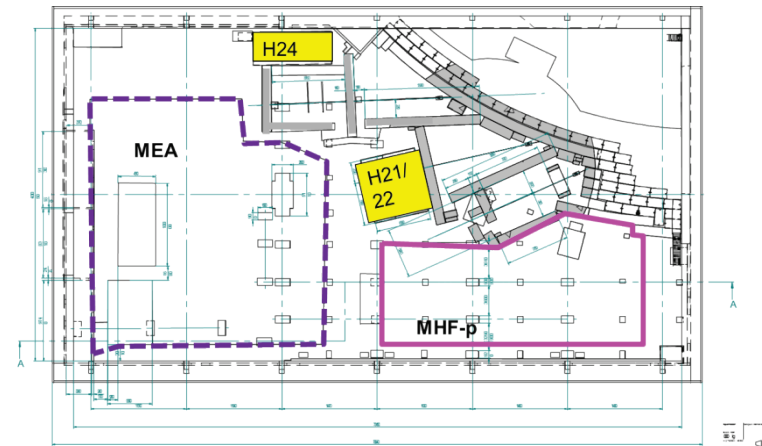




- Re-installing the transfer line
 - Requires new magnets, cooling
 - New cabling, piping
- New Beam Dumps
 - One before the user area
 - One after the user area
- Löwentor
 - rebuild for proper user access
- Experimental area
 - Location : Close to the Querkanal
 - Small, would be ok for a beam telescope
 - Access with equipment will be difficult
- Place of User Hut not obvious
- Health & Safety
 - Escape routes
 - Radiation from the dumps



- Several options currently studied
- Option A
 - Build a new small hall (10 x 15 m) adjacent to the R-Weg
 - From Scratch – rebuild all infrastructures
- Option B
 - Use the existing hall for the beam line and reuse existing infrastructures
 - Requires moving the extraction kicker (2 weeks work)
 - Hall Space is at a premium
- Site Discussion after successful proof-of-principle



- > Several Discussions with users in the last year
- > Status
 - EUDET-type telescopes: Crucial tool in detector R&D
 - Whole package: Hardware, DAQ, Analysis
 - Micron-level point resolution due to 50um thick Mimosas26 (low multiple scattering)
- > Needs
 - higher time-resolved track rate (100 kHz)
 - Sufficient pile-up separation
 - Better momentum resolution
- > Ideas
 - Telescope based on a new sensor: R&D for faster, and still thin and high granular pixel sensor
 - Magnet integration for energy reconstruction
 - Studies on new tracking methods
 - Improving monitoring with online track finding
- > In-house Kick-off meeting beginning of June.

> PETRA IV: “Ultimate” light source

- Driven by photon science community
- Timescale ~ mid-twenties
- Project evolving → CDRt 2019

> Initial approach: Use DESY II as-is as PETRA IV injector

- DESY II well over 30 years old
Refurbishment of nearly all components
- Effort probably nearly as high as for a new injector

> Other Options

> 6 GeV Linac

> 3 km Booster ring in PETRA IV tunnel

> DESY IV in existing DESY II tunnel + new LINAC IV:

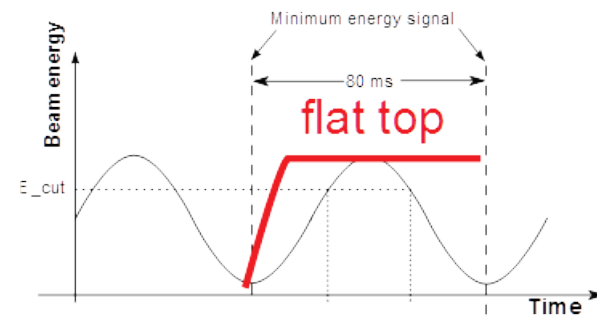
- Low emittance 6 GeV booster, ramped at 3 Hz
- ~ 320 m circumference
- Injection energy ~ 300 MeV

> Impact of DESY IV

- Dismantling of DESY II and current test beam setup
- Current beam generation would still work

> Interesting opportunities for the test beam facility

- Flat-top mode, multi-bunch mode → higher rates



> Resonant extraction of primary beam

- Energy independent rates & structured beam

> Strong Interest of the user community to have test beam at DESY in the PETRA IV age

A woman with glasses and a black jacket is working on a complex mechanical assembly in a laboratory. She is pointing towards a component. A man with glasses and a grey t-shirt is also working on the assembly, holding a white cable. The assembly is made of aluminum extrusions and has various wires and components attached. The background shows other laboratory equipment and a white wall.

Outreach Activities

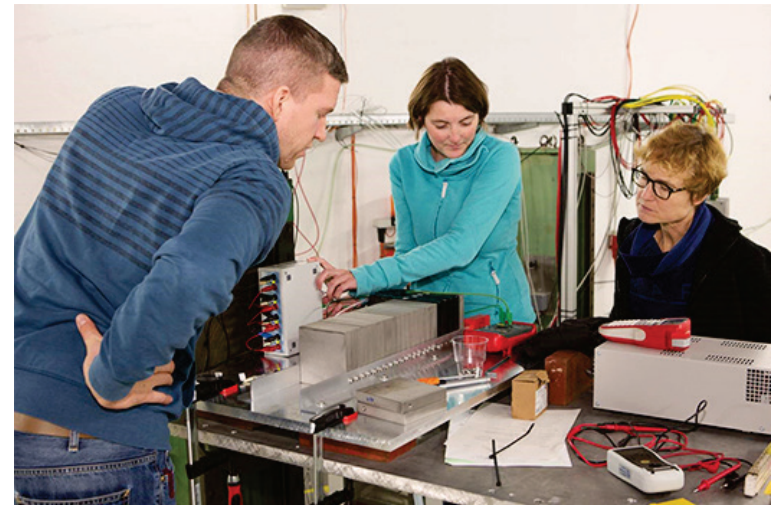
> Summer Students

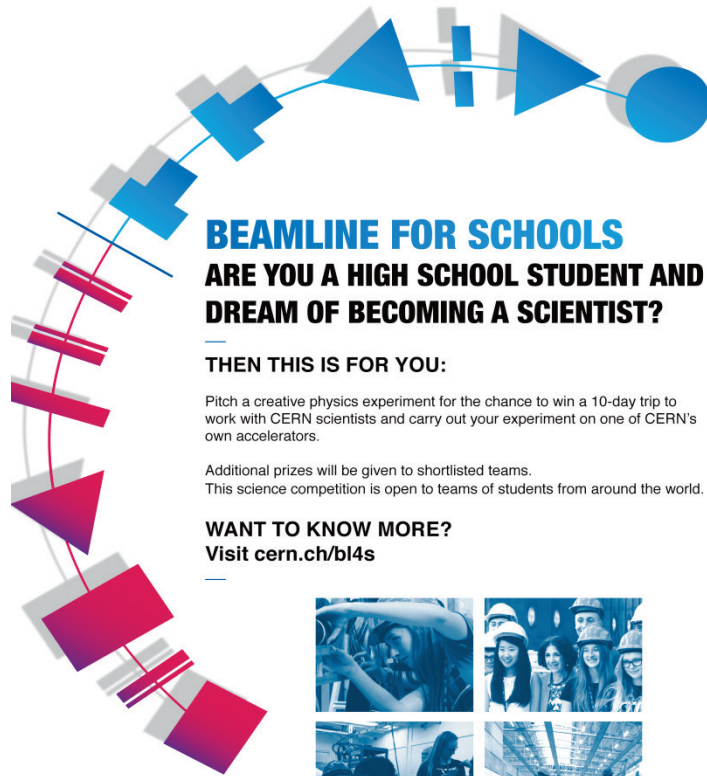
- Since several years very successful projects at the Test Beam
- Full life-cycle, Setup→Data Taking → Analysis
- Many to a PhD in particle physics

> Teachers

- EDU-SP Started a continuous education program “Particle Physics”
- Nation-wide and going in its third year
- Test Beam as one of the “lab experiments”

> Feedback very positive for both activities





BEAMLINER FOR SCHOOLS ARE YOU A HIGH SCHOOL STUDENT AND DREAM OF BECOMING A SCIENTIST?

THEN THIS IS FOR YOU:

Pitch a creative physics experiment for the chance to win a 10-day trip to work with CERN scientists and carry out your experiment on one of CERN's own accelerators.

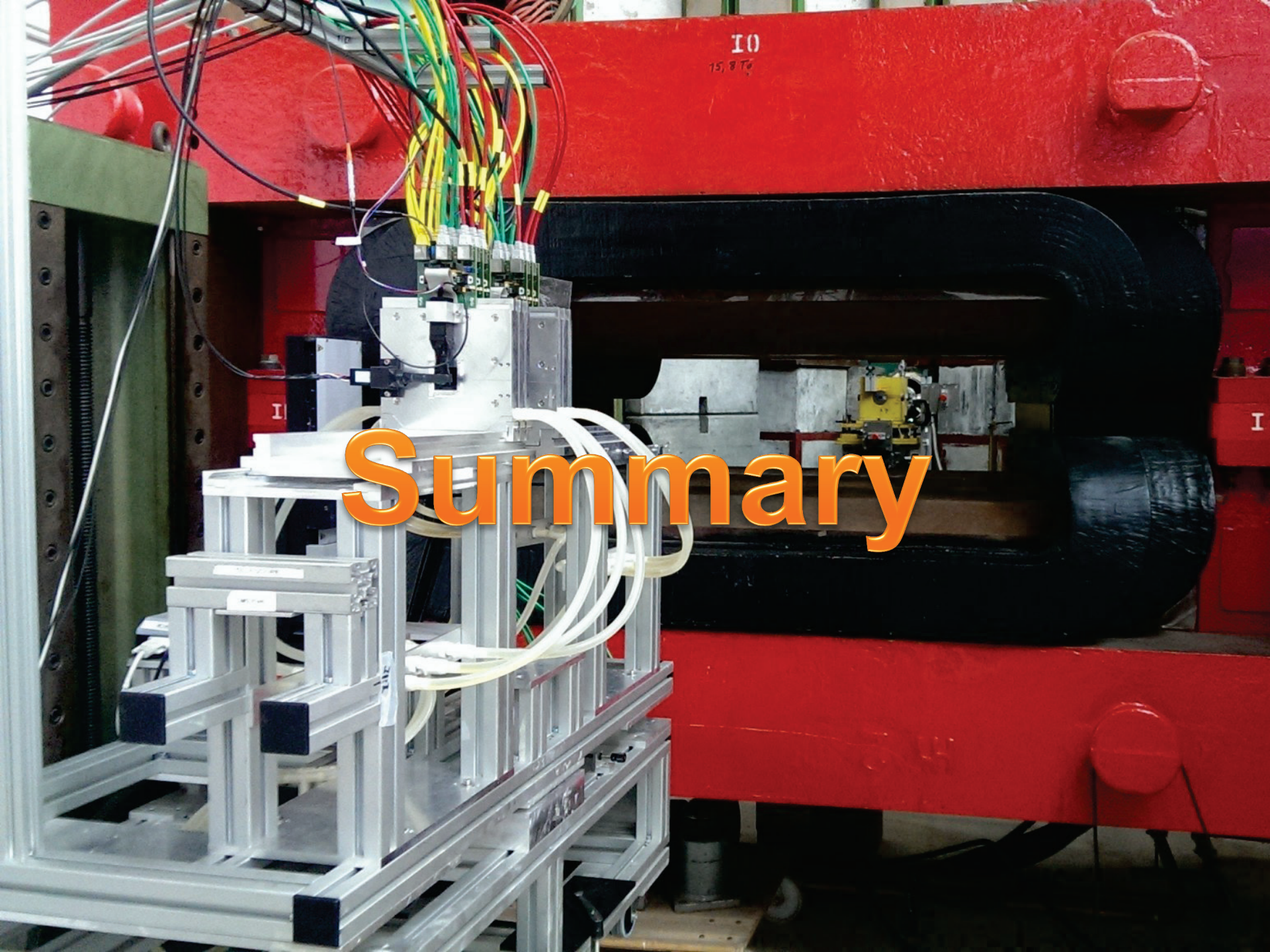
Additional prizes will be given to shortlisted teams. This science competition is open to teams of students from around the world.

WANT TO KNOW MORE?

Visit cern.ch/bl4s



- > Beam Line for Schools is a very successful project at CERN
 - Teams of High School Students can propose experiments at a CERN beam line
 - So far approx. 10000 Students have participated
 - 2 Winning Teams can perform their experiments at CERN supported by CERN scientists.
- > LS2 at CERN
 - DESY is going to host

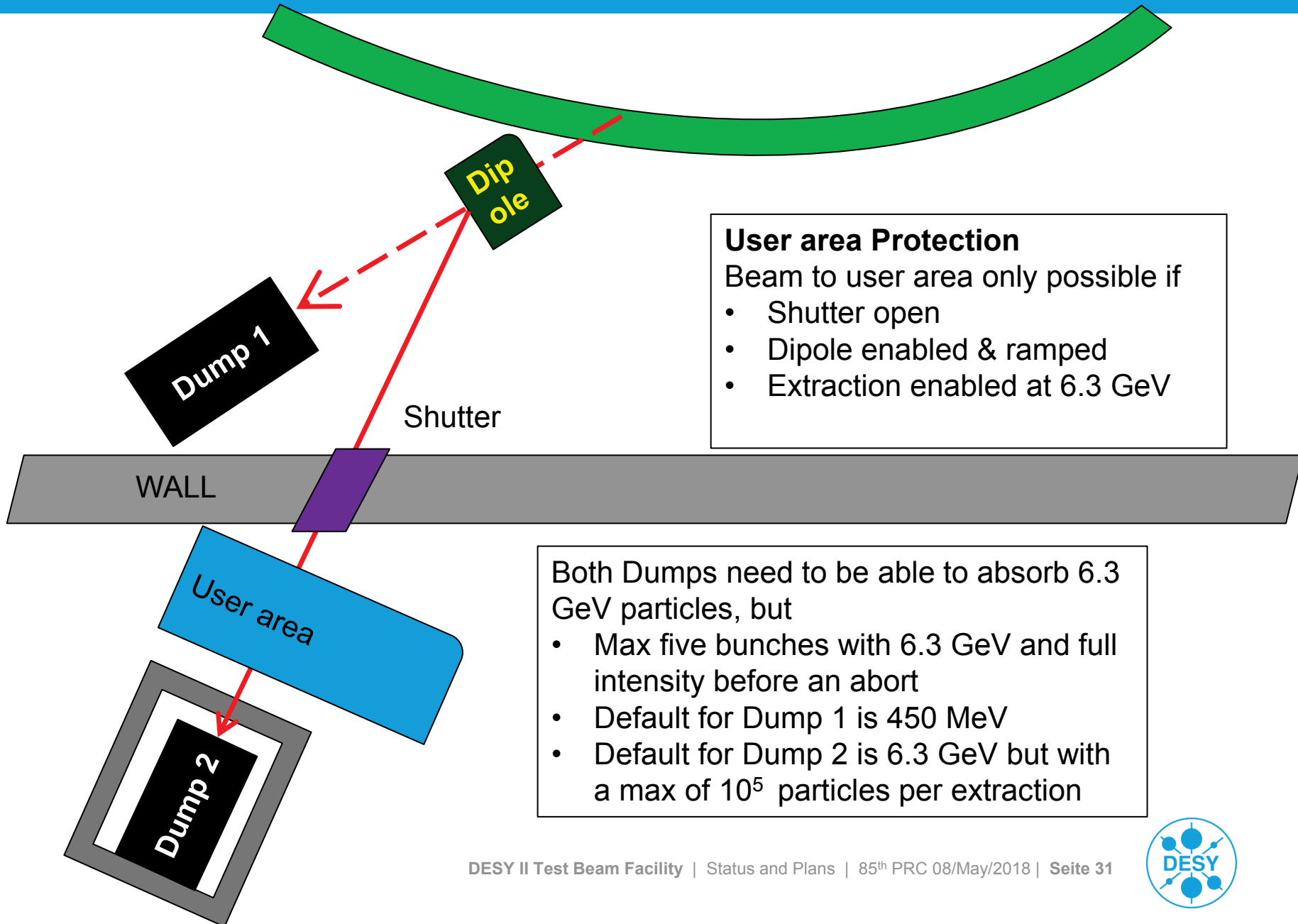


Summary

- > DESY II Test Beam Facility is running very well
 - Excellent feed back from user community
- > User requirements from recent Workshop
 - Higher rates / higher beam energies
- > Staged plan for High-rate Beam line
 - Evaluate feasibility and performance at minimal cost
 - Major expenditure only afterwards
 - Can extend this to produce e.g. secondary particles later
 - Instrumentation needs to grow with it Telescope 2025
- > Outreach Activities
 - Summer Student and Teacher Programme already established
 - Beam Line 4 Schools at DESY in 2019/2020
- > A Big thanks
 - The excellent performance of the DESY II Test Beam Facility would not be possible without the great support from the FH an M divisions and the DESY directorate



Backup



User area Protection
Beam to user area only possible if

- Shutter open
- Dipole enabled & ramped
- Extraction enabled at 6.3 GeV

Both Dumps need to be able to absorb 6.3 GeV particles, but

- Max five bunches with 6.3 GeV and full intensity before an abort
- Default for Dump 1 is 450 MeV
- Default for Dump 2 is 6.3 GeV but with a max of 10^5 particles per extraction