East Area Renovation Celebration Event
Group Picture
### Master Schedule

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<td>TE-ACE</td>
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<td>Change beam line layout + vacuum beam pipe</td>
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<td>All</td>
<td>Commission new facility</td>
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11/03/2022

East Area Renovation Celebration Event
History and Path towards Consolidation

Lau Gatignon
Why is the East Area Important

The East Area is one of the oldest experimental areas at CERN. Most of the equipment dates from the early 1960’s. However, the area is still very important.

It is the unique place at CERN where flexible test beams are provided in the momentum range between 0.5 and 10 GeV/c (initially 15 GeV/c). These momenta are very relevant for collider experiments, including at the LHC.

It also housed the DIRAC experiment up till the end of 2012 and a small irradiation facility.

About a decade ago the CLOUD experiment started operation in the T11 beam and makes very important contributions to climate research.

It is clear that the unique aspects of the East Area will remain of crucial importance for many years to come.
Some History

Up to 2004 the East Area contained 5 beam lines out of which four operated simultaneously. This was possible thanks to a splitter magnet that sent part of the primary proton beam to a common North production target for the T9, T10 and T11 test beams and the rest into the South branch. The South branch could be switched on a spill-by-spill basis to serve either DIRAC or the T7 test beam. In the primary proton beam a proton irradiation facility was available (T7-IRRAD). All this was possible thanks to the splitter magnet, almost immediately followed by a septum magnet: MNP23.
Towards the end of the 2004 run, the MNP23 magnet failed. Five spares were produced during the long 2005 stop. Unfortunately the new magnet failed before the first beam and three more failed almost immediately as well. Unfortunately the South branch could no longer be operated at all in 2006.

After many discussions at high level, it was decided to operate the North and South branches in alternation and replace the MNP23 septum magnet by a C-shaped pulsed dipole (MCB).

In addition to this major problem, there were frequent magnet problems in the heavily shielded primary zone, which took a long time to repair (radiation, removal of many metres of roof shielding).

Willy Kalbreier summarised the critical magnet situation at the ABOC/ATC days in 2007. Based on this, the management asked for a consolidation of the East Area with priority for the magnet situation.
One Example of a Magnet Replacement

Many layers of concrete and iron to be removed and put back. Due to staggered block locations, a large trapezoidal hole had to be made (and put back). Radiation cooldown was necessary, but could partly overlap with the roof dismantling.
The First Thoughts

A first conceptual consolidation proposal was presented in 2009 (ATOP) and 2010 (IEFC workshop). Priorities were to: reduce the number of magnet types (there were 22 types for 63 magnets, several without spares), provide easy access to the most radioactive magnets (in particular around the North target) and improve the radiation situation significantly.

It was also considered important to minimise the cost to the strict minimum (→ 2.8 MCHF!). It was then realised that such an investment would only make sense if the East Area as a whole would be consolidated, including power converters, electrical and cooling/ventilation and even the building structure and so forth. A first more complete proposal was made in 2011 and validated by the user community and technical groups at the East Area Day in 2012.

The idea was still that DIRAC would continue operation for a number of years.

This concept was agreed upon as a starting point for detailed implementation studies.
The 2011 Proposal

Cloud would move to behind the T9 test zone. No more T11 beam.

T9 and T10 would be served from two different targets (giving better access to ‘hot’ magnets).

Protons would be dumped just after the targets (reducing radiation and roof shielding).
The LS1 Consolidation – Phase 1

In 2012 it was decided that DIRAC would stop at the end of that year and that it should prepare for a timely dismantling. Its place would be taken by a large combined proton and mixed field irradiation facility (CHARM and IRRAD), for which the detailed design had not even started. It should be operational by the end of LS1. This led to a crash program which was completed just in time.

The studies for the North branch and general consolidation were suspended during that time. The new irradiation facility was highly appreciated. In parallel some basic infrastructure consolidation was performed in the south half of the East Hall. Surely this was also an important element for getting final support for phase 2.

At the same time, CLOUD changed its priorities and insisted that they wanted to stay in their zone in the T11 beam, although with an enlarged area.

A new (shorter) T11 beam line, starting from the new T10 target (in a different position) and ending at the existing CLOUD chamber location, was designed and added to the proposed layout.
CHARM and IRRAD
Inside CHARM and IRRAD
Towards the Project

Once the CHARM and IRRAD facilities were completed, work was restarted to prepare for the main consolidation project approval.

The layout was finalised and the project approved in June 2016.

Then the real work started!
The East Area Renovation Project

Sebastien Evrard
A long story until FC on June 2016!

Project mandate, Edms No. 1715122
“The renovation project shall also be promoted as a good example of energy optimization and sustainability effort at CERN and shall therefore foresee a final report on energy savings after consolidation.”

Energy balance of the East Area and possible improvements

Jonathan Cottet / ENS Cachan Bretagne
2012 summer student within TE/EPD

Presented by Jean-Paul Burnet
Scope of the renovation

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East Area Renovation Celebration Event

18
Main challenges for the project team

- B.157 Civil engineering refurbishment during facility operation in 2018
- Primary area air tightness
- Massive shielding and B.157 floor loading
- COVID pandemic
B.157 Civil engineering

- Worksite achieved during facility operation in 2018
- Vertical co-activity requiring RP declassification of top volume
- All façades renovated and/or insulated
- Roof completely renewed
  - 4500 m² suspended scaffolding
  - Asbestos remediation
- Improvement of thermal performance → OCEN incentives

Courtesy C. Gasnier
The primary area volumes are underpressurized to avoid activated air release. Ensuring the airtightness of such a large volume was a major technical challenge:

- Walls completely sealed and painted
- First layer of shielding packed with a plastic sheet, allowing the roof to remain removable for beam lines equipment maintenance or replacement
- Tailor-designed syphons
- Dedicated primary area ventilation

With the minimum extraction fan flow rate, the underpressure values measured across the ventilation controls supervision are

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Primary Zone bunker</th>
<th>T08a bunker</th>
<th>T08b bunker</th>
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<tr>
<td>Underpressure [Pa]</td>
<td>-29</td>
<td>-24</td>
<td>-25</td>
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All bunkers had an underpressure value lower than -20 Pa then satisfying the HSE requirement.
Massive shielding and B.157 floor loading

- The East Area is the unique surface area at CERN receiving the full primary proton beam; in this case $5 \times 10^{11}$ protons/spill. The other target areas (ISOLDE, nTOF, AD, TCC2, TCC8, AWAKE) can be considered as underground areas. → Strong radioprotection justification for a massive shielding

- The new loading scheme (10,000 t) exceeds working loads for the floor (30 t/m²)

- Where standard safety approaches are impossible, HSE advised on the Safety approach to be taken to ensure an equivalent level of Safety. HSE/OHS requested a back analysis for the new layout. This was carried out by SCE. The result has indicated a number of areas that have a residual risk of material damage to the structure of the building but no risk to personnel

Courtesy of R. Fernandez
Massive shielding and B.157 floor loading
Massive shielding and B.157 floor loading
Massive shielding and B.157 floor loading

- In order to mitigate this risk, a campaign of monitoring and visual inspection of the structure has been put in place. Ensuring that any damage is detected early and further mitigation measures taken as required.
- Natural movement of the building probably more important than deformation under load: no differential sagging has been identified at 100% loading. Maximal deformation = 2.5 mm.
- New shielding layout to reduce peak loads (12m long concrete beams) + Full beamline re-alignment mandatory.
COVID pandemic

Schedule
- Work methods have been adapted successfully (risk mitigation) → activity slowdown
- Some complications due to preventive quarantines for some contractors and CERN staff
- Some difficulties with supplier outside CERN (late delivery, M200 magnet assembly repatriated to CERN)
- A new schedule baseline was validated at LS2C in June 2020, expecting initially a 3 month-delay which could hopefully be reduced to two months
  - restart of Physics for Irrad and Charm – T8 primary beamline on September 20th, 2021 (8 weeks operation)
  - restart of the secondary beam lines on October 18th, 2021 (4 weeks operation)

Cost
Reduced scope of activity for some teams funded by M2P (Survey, transport, installation team,...)
Therefore, services still needed in 2021 but not entirely funded and thus requiring additional budget.
Overall Budget & Cost Drivers

30.9 FTE (P: 4.7 MCHF) + (M: 27.3 MCHF) = CtC 32 MCHF

- Cooling and Ventilation: 16%
- Electrical systems: 12%
- Civil Engineering: 10%
- Magnets: 19%
- Power converters: 24%
- Other: 19%

Courtesy E. Delachenal

Material M to P Personnel Total

- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

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Material Budget – Spending Profile

East Area Renovation Material Expenses

Material Budget in kCHF 27,265

- Charges
- Total commitments
- MTP budget

CSR1 12/2016
CSR2 04/2018
CSR3 10/2019
CSR4 02/2021

Steering committees

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Procurement

Q120 C magnets from France, Finland and Germany

Q100L and Q200L magnets from UK
- Coils from UK
- Yokes from Spain

M100L and M200L magnets:
- Coils from UK
- Yokes from Spain

HVAC from Italy and Spain

CR200 magnets from Cyprus, Finland and Germany

Sirius power converters from Romania, France and Japan

Civill Engineering works:
- Scaffolding & asbestos removal from Switzerland
- Walls and roof from Italy
Training opportunities

• Training opportunities: 6-month internships → MSc dissertation
  • J. Meignan, TCX design, MScEng Degree awarded in June 2017
  • A. Watrigant, Cloud Run in 2019, MScEng Degree awarded in June 2018
  • B. Lamaille, Energy savings, MScEng Degree awarded in September 2018
  • R. Vanhoutte, Plug-in supports, MScEng Degree awarded in June 2018
  • A. Hariri, B.251 Integration and Mechanical supports, Trainee from Lebanon.
  • A. Filinis, Plug-in support design, Trainee from Greece.

• Training opportunities for young graduates
  • Fellows
  • VIA’s
    • C. Gasnier, F. Carvalho, Q. Bouirek, A. Alonso
Energy savings

• Before LS2, power was supplied to the magnets on a continuous basis, with only 7% of it actually being used during beam time.

• After LS2, power supply to the new laminated magnets is achieved on a cyclical basis, with an energy recovery stage between each cycle.

• The energy returned by the magnets during their de-magnetisation is now stored in capacitor banks connected to the new power converters and immediately reused during the next cycle to re-magnetise the magnets.

From 11 GWh/year to around 0.6 GWh/year (> 90% reduction)

EAR has been granted with two important incentives

• B.157 renovation (thermal insulation): 600 kCHF by OCEN

• New magnet cycled powering scheme (energy savings): 800 kCHF by OFEN

Courtesy K Papastergiou
The Team

Heartful thank you! It has been a great achievement!
Overview of Contributions from Different Groups

Giulia Romagnoli on behalf of EVERYONE!!
Dismantling
- ALARA3 intervention
- Collective dose achieved 4.4 person.mSv
- Radioactive waste ~40 m³

RP Assessment
- FLUKA simulations prompt & residual radiation
- Air activation & environmental impact
- New shielding design
- New radiation monitor layout

Shielding commissioning
- 27 radiation monitors +2 mobile stations during commissioning
- All scenarios successfully tested at maximum intensity

Prompt radiation for beam impacting on T9 and T10/11 targets

EA Renovation RP team:

Before/After dismantling
Integration

2nd step : reality

What’s new? ALL, except red area !!! Beam lines, shielding, services, experimental areas, ...

Thanks to: D. Brethoux BE-EA-DC
New Beam Instrumentation

The XBPF, a scintillating fibre profile monitor to replace the ageing multi-wire proportional chambers.

Cherenkov Threshold for particle identification:
• Can operate with many types of gas, including refrigerants, up to 16 bars of pressure
• Has a gas recovery system to avoid environmental contamination

Beam loss monitors, to improve operation efficiency and reduce radiological risks.
Beam Stoppers Mechanical Design - Constraints

- Pneumatic actuator (4 bar)
- Flange-to-flange distance of 780 mm
- >10k cycles
- Actuation time <2 s
- Flexibility to install in different PS complex technical areas
- Positioning plug-in system
- Commercial material selection to withstand up to 1 MGy (no electronics nearby)

Courtesy E. Grenier-Boley, M. Dole, D. Baillard
4-jaws Collimator XCHV & 2-jaws Collimators XCSV/H

Complete refurbishment of 5 4-jaws collimators:
• 4 installed
• 1 spare

Fidutialisation with BE/GM

New production of 3 2-jaws collimators & complete refurbishment of 1
• 3 installed
• 1 spare

2-jaws EDMS node
Vacuum tank production at CERN workshop (EN-MME)
BE-CEM Beam Intercepting Devices Control Systems

- **32 motorized axes**: collimators and converters (XCHV, XCSH/V, XCON)
  - Precise positioning
- **20 Beam stoppers** (beam lines F61, T08, T09, T10 and T11)
  - Safety device linked to the personal protection system (PPS)
- **2 Multitargets** (F61, F62)
  - Precise positioning

Motorized DC axes Controls (collimators and converters)

Multitargets Controls

Beam Stoppers Controls

11/03/2022 East Area Renovation Celebration Event
Vacuum Installation

- 4 primary vacuum sectors
- NEW 14 pumping groups
- NEW DESIGN: 14 new electrical control box
- 18 vacuum gauges

Thanks to:
Vacuum hardware (BE-EA): V. De Jesus, P. Boisseaux-Bourgeois
Vacuum software (TE-VSC): A. Gutierrez, J. De La Gama Serrano
Magnet System: 64 magnets of 12 different designs

New magnet designs
2 Q74 – 5 Q120 C – 5 Q100 L – 5 Q200 L – 2 M100 L – 5 M200 L – 9 MDX L – 5 CR200

Refurbished magnet designs to
9 QFS – 4 QFL – 5 QDS – 8 MCB
EAR: Survey Activities

- Network design, installation and measurement w.r.t. PS ring
- 3D scan
- Metrology and fiducialisation of components
- Tracing, alignment after installation, smoothing
- Support for experiments
- The SURVEY team with Laure, Philippe, Camille, Alexandre, Alban, Benoit, Elisabeth, Pedro, Bastien, Clément and many others...
Configuration Management

- East Area lines are in Layout Database!

- Hardware Baseline EDMS Folder CERN-0000171687

- Official Naming Convention for East Area lines 1723747

- Panoramic Pictures of all beamlines

Thanks to: G. Romagnoli, J. Buesa, E. Harrouch, T. Birtwistle, P. Leroux, A. Alonso
Warm Magnet Interlock Controller (WIC)

WinCC_OA supervision

Magnet Widget

Interlock boxes installed on magnets & flow-switches

Power converter Widget

Rack in bldg. 157

Rack in bldg. 251

Thanks to Adrian Miranda Fontan (PL)
Design team
Javier Parilla Leal (ES)
Sebastian Maestri (AR)
Stefano Rossini (CH)
Guillermo Navarro (ES)
Pedro Carrio (ES)
Christophe Mutin (FR)
Olivier Michels (FR)
Nicolas David (FR)
Kostas Papastergiou (GR)
Miguel Cerqueira (PT)
Quentin King (UK)
Gilles Le Godec (FR)

Commissioning Team
Stephane Reignier, Olivier Rossignol, Pierre Zelazny & TeamTE11, Emilien Coulot, Anthony Dillenschneider & team

Participating Firms from Romania, Germany, France, Italy, Denmark, UK, Switzerland, Sweden, Japan, Netherlands
EN/EL Rénovation de la Distribution Electrique Zone Est

- Remplacement de 7 vieux transformateurs huile par 4 transformateurs sec.
- Remplacement de 5 tableaux principaux et 12 armoires électriques divisionnaires.
- Nouvelle distribution 48Vdc.
- Alimentation des 65 convertisseurs SY/EPC du bâtiment 251.
- Rénovation des zones primaires, mixtes et zones expérimentales T9, T10 et T11 CLOUD.
- Eclairage de sécurité entièrement rénové.
- Remplacement de toutes les chaines d’arrêts d’urgence généraux.
EN/CV Contribution to East Area Renovation

Primary Zone HVAC + DemiWater Skid

B157 – 2021

Thanks to:

EN/CV
- Pablo Ariel ALVAREZ
- Anders ANDERSEN
- Michele BATTISTIN
- Roberto BOZZI
- Mariano BUISAN NAVARRO
- Massimo CHIODI
- Xavier DECRAND
- Serge DELEVAL
- Sebastien EVRARD

- Daniel GATAO
- Frederic JUBAN
- Frederic KILLING
- Sabri MASRI
- Pierre Mondon
- Mauro NONIS
- Louis Alfred OUALID
- Gabor PETRIKA
- Guillaume RAIMONDI
- Nicolas ROGET
- Diego ZAMBELLI

Group collaboration
- BE/EA
- BE/CS
- EN/EL
- EN/HE
- HSE/OHS
- HSE/RP
- IPT/IP
- TE/MSC
- SCE/SAM
- SY/EPC

Companies:
- Arceclima
- COMSA
- DAIKIN
- GF Aspirazioni
- Ouvaroff
- RAM Power
- SADES
Gas in East Area

BE-EA-AS Gas Team provides several type of gases and mixes in East Area:

- High purity neutral gases: N2 and O2 stocked in dewars → CLOUD Experiment

- Gases and mixes on request of EA Users during Beam period: N2, CO2, He, Ar, SF6, C2H2F4, C2F8, H2 + mixes → T9, T10 & CHARM

The whole Gas Area was also renovated and upgraded to allow maintenance intervention without stopping the gas flow, implement remote monitoring and control with UNICOS framework, improve safety by flammable gas detection and renewed infrastructure.

Total length of pipes: a bit less than 1km.
Fire Detection - Evacuation - Beam Imminent Warning

Fire detection:
- Primary area
- Charm
- Irrad
- Cloud
- Barracks

Evacuation:
- Global

BIW:
- Primary area
- Charm
- Irrad

Interlocks:
- Ventilations
- Hot smoke extraction

Layout:
WP16: Personnel Protection Systems

WP16.1 - PPS Primary zones: EA1 new access sectors to minimize radiation doses of personnel, interlock with new ventilation and EIS-Beam, EA1-EA2 inter-machine door

WP16.2 - PPS Experimental Areas: new T09-10, new end-zone door in CLOUD, re-location of T9, T10 & T11, remote veto management and chains test from CCC

Access Control of B157 buffer zones, storages and control rooms
IT-CS Achievements

- Consolidation of the main IT Starpoint

- Upgrade of the GPN switches to the new model Ruckus ICX 7150

- Upgrade of the ancient Wi-Fi infrastructure to the ARUBA 802.11ac technology and extension of the coverage to T9, T10 and T11 areas

- Substitution of the copper structured cabling by an optical-fiber-based network at T9, T10 control rooms and CLOUD experiment

- Category 6a network cabling pulled at buildings 157 and 251 for a total of 4.1 Km

- 50 m of GSM radiating cable inside F63 and mixed area

11/03/2022

East Area Renovation Celebration Event

The team:

- Leszek BORAKIEWICZ (IT-CS-DO)
- Jose RENDÓN MOLINA (IT-CS-DO)
- Marc-Antoine DENIS (IT-CS-DO)
- Adam SOSNOWSKI (IT-CS-CE)

And special thanks to the COMSA technicians for the fantastic job done
CLOUD Experiment, T11

2009 – 2019

CLOUD during beam run in 2017

2020 - 2021

East Area Renovation with CLOUD Upgrade

New and improved

Big thanks to all CERN service & support groups involved in BE, EN, EP, HSE, IT, SCE

2022 –

- Enlarged T11 beam area
- Larger platforms and better accesses
- Control + Rack room & Chemistry lab
- Gas system
- Electrical power and IT networks
- HVAC systems

2020 – 2022

Big thanks to all CERN service & support groups involved in BE, EN, EP, HSE, IT, SCE
From November 2018 to August 2021 only 15 safety events have been reported, where only 1 was an occupational accident.

In February 2021 a total of 109 electrical non-conformities (which dates back for a long time) have been identified and have been properly addressed by the groups concerned.

Ground load situation under surveillance – so far, no significant deformation has been detected.

Safety File is currently in the hands of the PS-CSAP for final approval.

Safety clearance for the XCET in the final steps. Only need to release the access procedure for the zone of the high-pressure vessels.

The project has the Safety Clearance from HSE.

Some actions to be followed-up.
Physics Overview

Johannes Bernhard
Our users’ needs:

**Experiments (CLOUD, P349)**
- require stable and reliable beams

**Test beams for detector R&D**
- require wide range of beam momenta, ideally overlapping with North Area
- require different particle types (e, h, µ)
- require easy access

**Users of irradiation facilities IRRAD and CHARM**
- require high flux and variable radiation fields

**Outreach (Beamline for Schools)**
- requires plug and play infrastructure

Re-design of beam lines with
- Overlap of momenta ranges with the North Area, up to 15 GeV/c
- more destinations for better flexibility
New Beams

- T8 beam renovation and new facilities already during LS1 for Irradiation Facilities → Added more instrumentation and more steering elements
- Secondary Beams T09/T10: Electron, Hadron and Muon Beams with high purity now available, more instrumentation, user areas free from beam line elements, dedicated targets for optimum particle production choice
- Beam for CLOUD: New instrumentation and optimisation of spot size on the chamber, much larger user area
- More centralised controls and integration in control software, easy to use
- Yellow Report: CERN-2021-004
Running-in of the New Facility

• Quick running-in time due to excellent work of all technical teams
• Commissioning of primary and secondary beams within a few weeks, allowing first users to have four weeks of physics in 2021
• Successful user runs in the irradiation facilities
• High purity beams available and were already successfully used in T09 and T10
• First beam seen for CLOUD, final commissioning from next week
Taking First Beams: IRRAD

- **24 GeV/c p**+ **400ms spills**
- **~1×10^{16} p/cm^2/5days**
  - beam spot: 12x12mm^2 FWHM
- **1 shuttle system** (small samples)
- **9 irradiation tables**
  - 6x room temperature
  - 2x cold boxes (-25°C)
  - 1x cryogenic setup (1.9K)
- **~200 samples** irradiated in 2021

Radiation test of inner-detector components, electronics (DD, SEE), materials (radiation hardness) for HL-LHC
Taking First Beams: CHARM

- 6 weeks of operations and 2 days of commissioning
- 6 users scheduled; 15 system level tests
- ATS (TE-VSC, SY-EPC, SY-BI, SY-BMI, BE-CEM)
- RCS (CMS)
- External Users from space company SkyLab
- Several components testing by BE-CEM-EPR
- Three days given for the ions beam preparation for CHIMERA projects
Towards the Future

• Many new users have arrived and the new facility will be well-booked in the coming years
• New ideas and experimental tests are reaching us nearly every week, so the interest in the East Area is even growing
• Example: Water Cherenkov Test Experiment (WCTE), a 50-ton instrumented water tank, to be installed for running in the next year
• The experiment includes a new, short tertiary beam and will be a challenging exercise for our new user area
• Already approved by the Research Board, the scientific committees have asked to look into the possibility of having a more permanent test facility $\rightarrow$ enlarging T9?
Towards the Future

• CHIMERA: heavy ions in T8 for electronics testing for space and accelerator applications, in the scope of the ESA/CERN collaboration

• 2021: 2-day run, focused on beam characterization though existing and ad-hoc beam instrumentation, plus variable intensity extraction

• 2022: 2-week run in December, including commissioning, calibration, and first external user run (from ESA)

• We look forward to serve our users and have now the right tools to follow the demands of the physics community!


https://indico.cern.ch/event/1107452/contributions

Spill time profile
The PS and the East Area

a long-standing history & a bright future

Rende Steerenberg
11 March 2022
A bit of History

• **1959**: The PS started physics with internal thick targets in SS01
A bit of History

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- **1959**: Proposal to replace thick target with thin target - A first form of slow extraction of 10 ms. (F. Krienen)
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A bit of History

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- **1961**: Proposal for resonant extraction as only way to long-pulse extracted beam. (H.G. Hereward)
- **1962**: Construction of the East Hall
A bit of History

- **1959:** The PS started physics with internal thick targets in SS01
- **1959:** Proposal to replace thick target with thin target - A first form of slow extraction of 10 ms. (F. Krienen)
- **1961:** Proposal for resonant extraction as only way to long-pulse extracted beam. (H.G. Hereward)
- **1962:** Construction of the East Hall
- **1963:** The first real slow extraction was in operation, using 1st order resonance
A bit of History

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- **1959**: Proposal to replace thick target with thin target.
- **1961**: Proposal for resonant extraction as only way to long-pulse extracted beam. (H.G. Hereward)
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• **1992:** The present Slow Extraction to the East Area was made operational.
The Basics of Slow Extraction

P.S. Main field

T start

350 - 450 ms

time

T end

Extracted beam

Resonance area

Δp/p = 0.1%

Δp/p = 0.3%

P₀ = Average momentum, 24GeV/c

Resonance area

→ p

← Q

11.03.2022

Rende Steerenberg | The PS & East Area

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The Basics of Slow Extraction

$P_0 = \text{Average momentum, 24GeV/c}$
Efficiently Providing Beam to Multiple Users

Sharing beam between East and nTOF:

- **nTOF**: $7 - 9 \times 10^{12}$ ppp in 20 ns ($4\sigma$)
- **East**: Up to $5 \times 10^{11}$ in ~ 400 ms

Bunch rotation, a key ingredient:
PS & East Area
.. a bright future ahead

Improvement are being investigated:

• RF empty bucket channelling to improve spill structure
• Phase space folding, using octupoles to reduce losses
• Improved modelling and control of the PS machine and the slow extraction process

Possible beams:

• Slow extracted proton beams over ~400 ms at 24 GeV/c
• Single or multi-bunch fast extracted proton beam
• Slow and fast extracted Pb ion beams at different energies

Feasibility of additional requests are always considered and can be investigated
Thank you for your attention!