SPS Experimental Areas and CNGS

E. Gschwendtner EN/MEF

Many thanks to
Outline

- North Area User Requests
- Consolidation Status
  - Access system
  - Beam Obstacles and control
  - Power supplies and magnets
- Fixed target experiments at SPS
  - COMPASS (QCD, hadron structure)
  - NA62 (rare Kaon decays, successor of NA48)
  - Ion Experiments: NA61, NA63, UA9
  - CALICE
- CNGS
  - Water issue
  - Outlook for next years
The North Experimental Areas at the SPS

- The SPS proton beam (400/450 GeV/c) is slowly extracted to North Area
- Directed towards the three North Area primary targets T2, T4 and T6

IEFC workshop, 22 March 2011
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<thead>
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<th>Date</th>
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North Area Consolidation
- Power converters in operation since 1976
- Original analog & digital electronics
- Wire wrap technology
- Old control system (Databus)
- Power converter MTBF very low: ≈7000H
- 180 interventions by the first line team in 2010
- 100 electronic cards repaired each year

- Cabling ageing
- Obsolete components
- Split insulation
- Damaged gilded contacts

330 power converters in operation
50 spares
EA physicists want a better control of the current
Solution ➔ Suppression of Converter crate
New DCCT + FGC3

Short-term consolidation (Approved)

Replace Converter crate by FGC3 and install new DCCT, only for the bending magnets

- 70 power converters (type R21, R22)
- Schedule (already, 1 year of delay)
  - 2011 Prototype + purchasing
  - 2012 Electronic production + software development
  - 2013 installation during LS1
  - 2014 Start NA with 70 FGC3 for bending magnets
- Spending profile: 50kCHF (2011), 300kCHF (2012), 200kCHF (2013)
- Manpower: 6-10 FTE
- Fault reduction: 60% on bending magnets (30% in total)
TECHNICAL SOLUTIONS

- Replace 180 power converters (≤500A) by new switch-mode power converters.
  - C11 250A / 100V
  - R11 500A / 150V
  - R12 500A / 300V
- Renovate 150 thyristor converters.
  - R21 1000A / 300V
  - R22 1500A / 250V
  - R31 2500A / 255V
  - R41 6000A / 600V
  - D21 1500A / 200V
  - D31 2500A / 285V
- New electronic control (FGC3)

LONG-TERM CONSOLIDATION PLAN NEVER APPROVED

- Provisional schedule: 6 years
  - 1-2 years studies and contracts
  - Shutdown 2015-2016 and LS2 (Long Shutdown 2017)

Budget: ~20 MCHF
Manpower: 30 FTE
Magnets

- Interlock systems need consolidation.
  - no resources yet
- Zero field detector: spare sensors are needed
  - not yet started
- Improve connections between power cables.
  - ongoing, K12 already done.

Strategy: Careful monitoring of the magnet, notably during each technical stop, during the run. Magnet piquet is available in any case 24/24 h.

Cracked insulation on cables
- Risk of short circuit on the interlock electronic rack.
- Risk of "shunting" magnet securities.

Power cables connections
Obstacles Control

Scope:
Renovation of motorizations used in objects in North experimental area on the equipment inherited by BI (Collimators, Converter, Target Absorber, In/Out Dumps)
→ 76 AC Motors, 213 DC Motors

Objectives:
Replace old controls with a new solution based on PLC and FESA gateway fully supported by CO, solves severe operational problems experienced due to the limited bandwidth of the equipment bus.
→ 2009/10 shutdown (TAX)
→ 2010/2011 collimators (69 devices with 157 axes)
→ 2011/2012 scraper motors, dump motors and maintenance of local cabling and sensors for T6
T6 Target Motorization Cabling Renovation

Cables between panel and equipments to replace (26 cables)
Obstacles

• Movable obstacles mechanics in good shape
  – Yearly maintenance and covered by operational budget

• Target stations (T2, T4, T6, T10) in bad shape:
  – Rust, loss of oil, cable breaking, failure of switches
  \(\rightarrow\) Difficult to intervene, regular maintenance limited
  \(\rightarrow\) Operation of targets for more than 5 years would need complete renovation
  \(\rightarrow\) Renewal of the monitor drivers, target boxes and collimators plus two new spare chassis
  \(\rightarrow\) Consolidation budget for mechanics renewal of 750 kCHF over 5 years needed.
Access System

Installation of a new access system as the one installed in the PS experimental areas (i.e. PS AD and East Hall)

➔ Ready for 2011 run
  • In case of mode changes: need badge
  • EDH authorisation
  • New further zones will be created
    • H4IRRAD
    • GIF++
    • New Interlock mode ‘ION’ for 2012
  • For CNGS: renovation/replacement of ventilation doors
North Area

→ Prepare an upgrade plan for the infrastructure
  • started with BI, STI, access, power converters, magnets

  • next is CV → see Mauro Nonis’ Talk
    • study of system upgrade in BA80/BA81 already launched
    • then Experimental Areas

→ Put North Area to the consolidation plans
  • so far was left out due to the risk analysis.
Current and Future Approved Experiments
COMPASS-II

Study the **hadron structure** and **hadron spectroscopy** with high intensity **muon** and **hadron beams**.

**COMPASS:**

2011   Muon beam for transversity
2012   Proposal to SPSC in June

**COMPASS-II:** approved

2014-2016  2 years muon beam for GPD physics
           1 year Drell-Yan with hadron beams

→ Intention to continue for another decade at least (not yet approved).
→ A consolidation program of the facilities is being defined.
### COMPASS-II

<table>
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<tr>
<th>Item</th>
<th>Specific Cost [kCHF]</th>
<th>Cost covered otherwise [kCHF]</th>
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<tr>
<td>Civil engineering</td>
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<tr>
<td>Rectifiers SM1,SM2</td>
<td>650</td>
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<tr>
<td>Rectifiers beam line</td>
<td>&lt; 4000</td>
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<tr>
<td>Studies CV</td>
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<tr>
<td>CV consolidation</td>
<td>≈ 250</td>
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<tr>
<td>Recommended air-conditioning upgrade</td>
<td>≈ 1200</td>
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<td>Smoke detection</td>
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<tr>
<td>Working at height</td>
<td>160</td>
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<td>RP migration to ARCON</td>
<td>280</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>1775-1975</strong></td>
<td><strong>&lt; 4000</strong></td>
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<td><strong>(incl improved ventilation)</strong></td>
<td><strong>1775-1975 (~3075)</strong></td>
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</table>
NA62

Measure very rare kaon decay $K^+ \rightarrow \pi^+ \nu \nu'$

- Branching ratio of $\sim 10^{-10}$, Sensitivity of $\sim 55$ events/year with 13-17% background

$\Rightarrow$ Sensitivity to new physics

$\Rightarrow$ New beam-line, $\Rightarrow$ Dismantling NA60, NA48
NA62

Time line:
2011: Beam line
2011-2012: Detectors
End 2012: First beam
From 2014: Physics

New beam dump
April 2011: start excavation

IEFC workshop, 22 March 2011
NA61

→ Search for critical point of strongly interacting matter
2010: Light ion fragmented beam in H2 for NA61

Pb → Be → Pb fragments (double spectrometer
Fragment selection)

H2 Beam

Full spectrum:
... and with optimized beam setting and identification

Be beam
single isotope:
Z=4, A=7

C beam
two isotopes:
Z=6, A=11,
Z=6, A=12

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NA61, NA63, UA9 Ion Program

2011: Weeks 47-50: physics with fragmented ion beam
→ NA61: 2 weeks of testing and commissioning in week 45, 46
  → Improve H2 beam instrumentation
  → Prepare tunes for all requested energies (13-80 GeV)
→ UA9: Test in North Area and in SPS
→ NA63: need debunched beam → no ion beam request in 2011

2012:
→ NA61: physics with fragmented Pb ion beam at different energies (20, 40, 158 GeV)
→ NA63: physics with primary ion beam (need debunching)
→ UA9: Tests in North Area and in SPS

More details see Stephan Maury’s Talk
CALICE (Calorimeter for ILC)

- 330 physicists/engineers from 57 institutes and 17 countries.
- Linear Collider Calorimeter: compact-hermetic-high granularity (i.e. excellent jet energy resolution)

- Requested 20 weeks of test beam in 2011 in North Area
  - ILC: TDR in 2012
  - CLIC: CDR in 2011
    - Time constraints for CALICE requests
  - Approval of CALICE request allows linear collider detector R&D to be in phase with time scale of European strategy for particle physics
    - To be defined until the end of 2012

- 4 different calorimeter types to test different properties
- Scheduled for several periods in H2 and H8

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CNGS

CNGS Physics Run started on 18 March 2011

- **Expected POT** vs **Achieved POT**

- **4.7 E19 pot**

- **100% CNGS duty cycle**

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IEFC workshop, 22 March 2011
CNGS – Water Issue

Today: 324 Containers
→ Bat 954, BA4, EHN1

→ Ventilation modifications:
   → Keep under-pressure in target chamber
   → Water from TAG41 might possibly be disposed again via TI8
   → All containers will be transferred and stored in ISR

Total 2010: 116 containers

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IEFC workshop, 22 March 2011
CNGS - Outlook

Approved for $22.5 \times 10^{19}$ protons on target

i.e. 5 years with $4.5 \times 10^{19}$ pot/ year

→ Expect $\sim 10 \nu_\tau$ events in OPERA

2011, 2012: $4.7 \times 10^{19}$ pot
2013: 0 pot
2014: $2.3 \times 10^{19}$ pot
2015: $4.7 \times 10^{19}$ pot

→ Physics program would finish in 2015
CNGS: Future Proposal

MODULAr:

→ Off-axis CNGS neutrino beam; 400 GeV/c, 1.2E20 pot/yr
→ Improve $\nu_\mu \rightarrow \nu_e \theta_{13}$ mixing angle by ~factor 10 wrt to T2K.
→ 20kT liquid Argon TPC installed at shallow-depth at Gran Sasso with modular approach.
CNGS Facility: Intensity Limitations

- Design of secondary beam line elements, RP calculations
  - (Horn designed for 2E7 pulses, today we have 1.4E7 pulses → spare horn)
- Intensity upgrade from the injectors are being now evaluated within the LIU

<table>
<thead>
<tr>
<th>Intensity per PS batch</th>
<th># PS batches</th>
<th>Int. per SPS cycle</th>
<th>200 days, 100% efficiency, no sharing</th>
<th>200 days, 55% efficiency, no sharing</th>
<th>200 days, 55% efficiency, 60% CNGS sharing</th>
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<tr>
<td>2.4 × 10^{13} - Nominal CNGS</td>
<td>2</td>
<td>[prot./6s cycle]</td>
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<td>4.8 × 10^{13}</td>
<td>1.38 × 10^{20}</td>
<td>7.6 × 10^{19}</td>
<td>4.56 × 10^{19}</td>
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<tr>
<td>3.5 × 10^{13} - Ultimate CNGS</td>
<td>2</td>
<td>7.0 × 10^{13}</td>
<td>(2.02 × 10^{20})</td>
<td>(1.11 × 10^{20})</td>
<td>(6.65 × 10^{19})</td>
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- Design limit for target, horn, kicker, instrumentation
- Working hypothesis for RP calculations
- Design limit for horn, shielding, decay tube, hadron stop
- CNGS working hypothesis

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IEFC workshop, 22 March 2011
Summary

- CERN has a worldwide unique opportunity for versatile physics programs and detector tests
  - PS and SPS beam-lines
  - Technical support and infrastructure provided by CERN

- Facilities are heavily used, very popular
  - Always fully (over!) booked

- Very broad Fixed Target program
  - Lifetime >10 years

- Many more proposals in pipeline

- Add North Area to the consolidation plans