
Upcoming Experiments at the SPS

What to Expect and the Impact on Operation

E. Gschwendtner EN/MEF

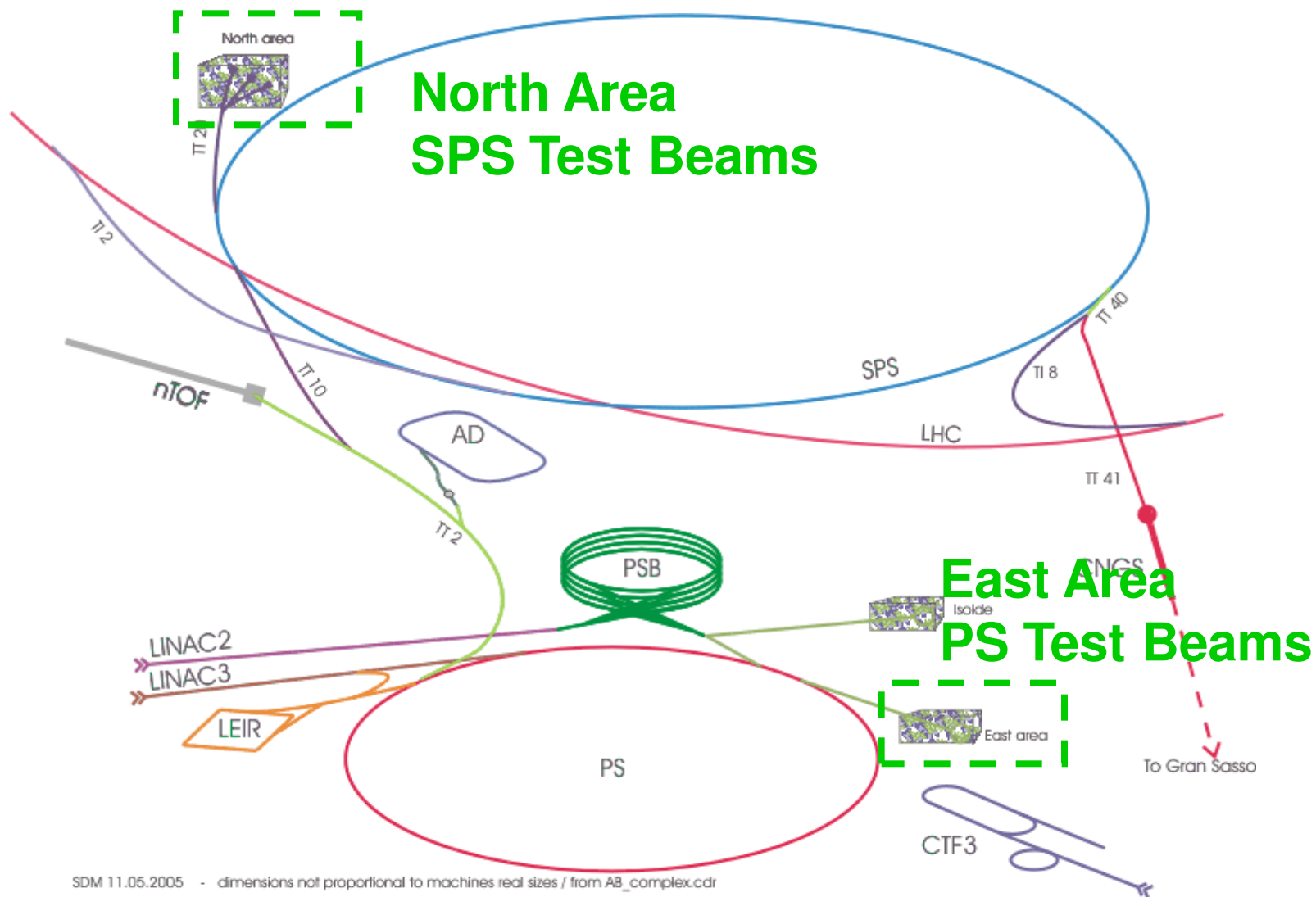
Many thanks to

A. Blondel, H. Breuker , F. Butin , A. Ceccucci,
I. Efthymiopoulos, L. Gatignon, M. Gazdzicki, L. Linssen,
G. Mallot , S. Maury, A. Rubbia, U. Uggerhoj

Outline

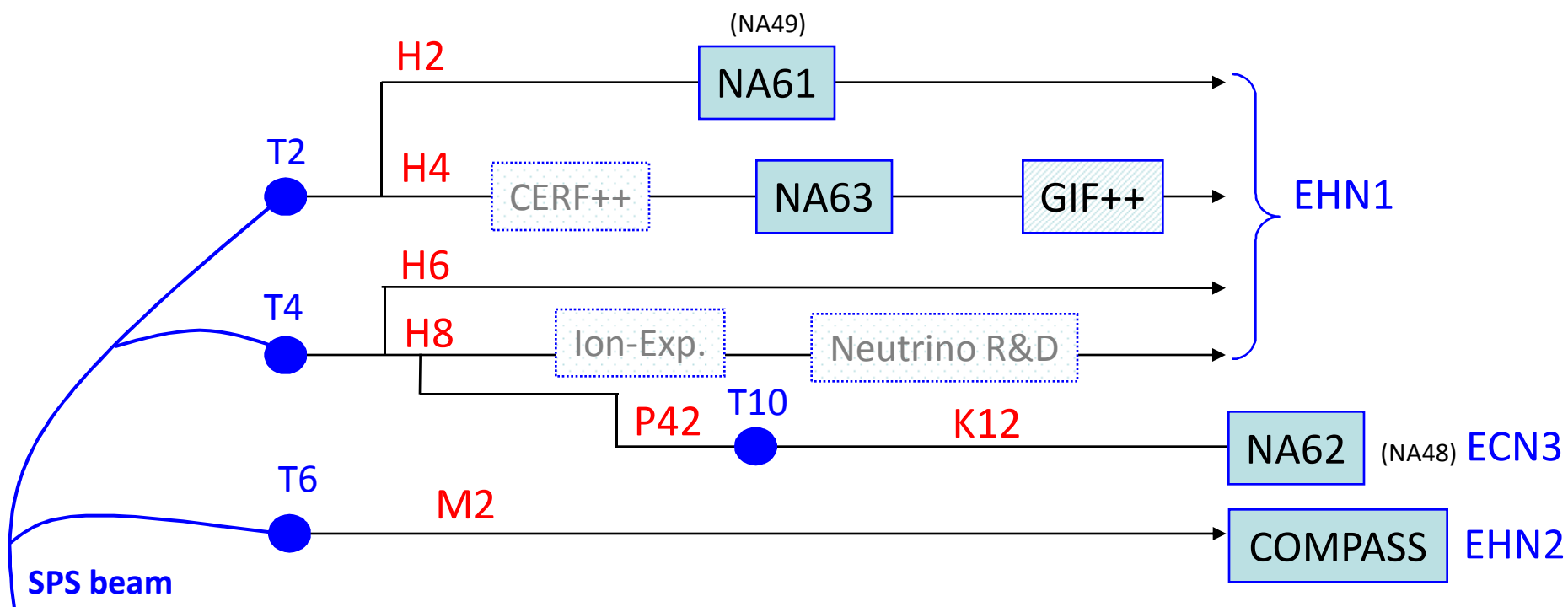
- Introduction
- Approved experiments at SPS
 - **NA61** (ion-physics, successor of NA49)
 - **NA63** (QED in strong crystalline fields)
 - **NA62** (rare Kaon decays, successor of NA48)
 - **COMPASS** (QCD, hadron structure)
- In pipeline for approval
 - Irradiation Facilities: **GIF++**
 - Neutrino Detector R&D
- Summary

Beam Facilities at CERN



The North Experimental Areas at the SPS

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

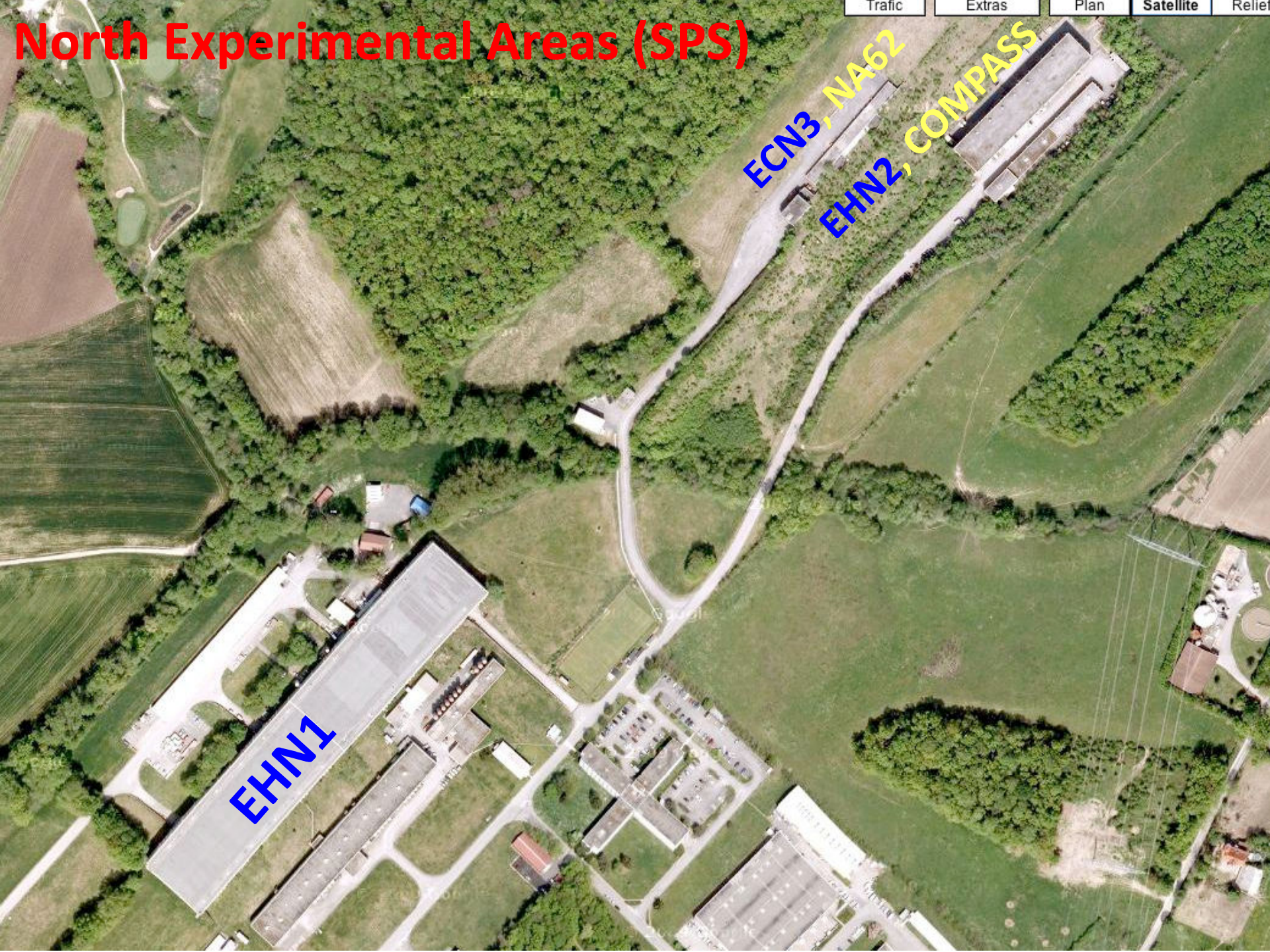


North Experimental Areas (SPS)

EHN1

ECN3, NA62

EHN2, COMPASS

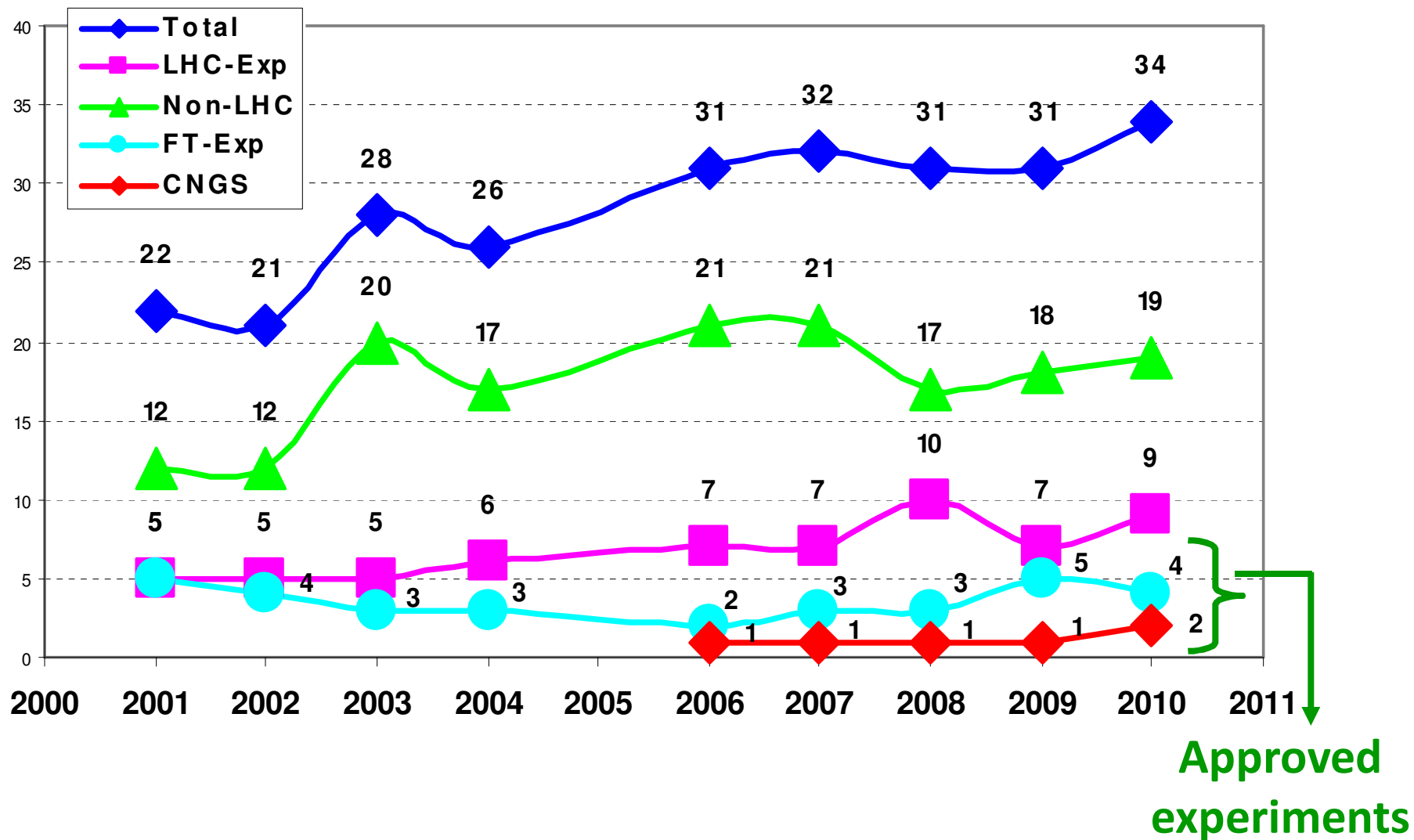


North Area Beam Characteristics

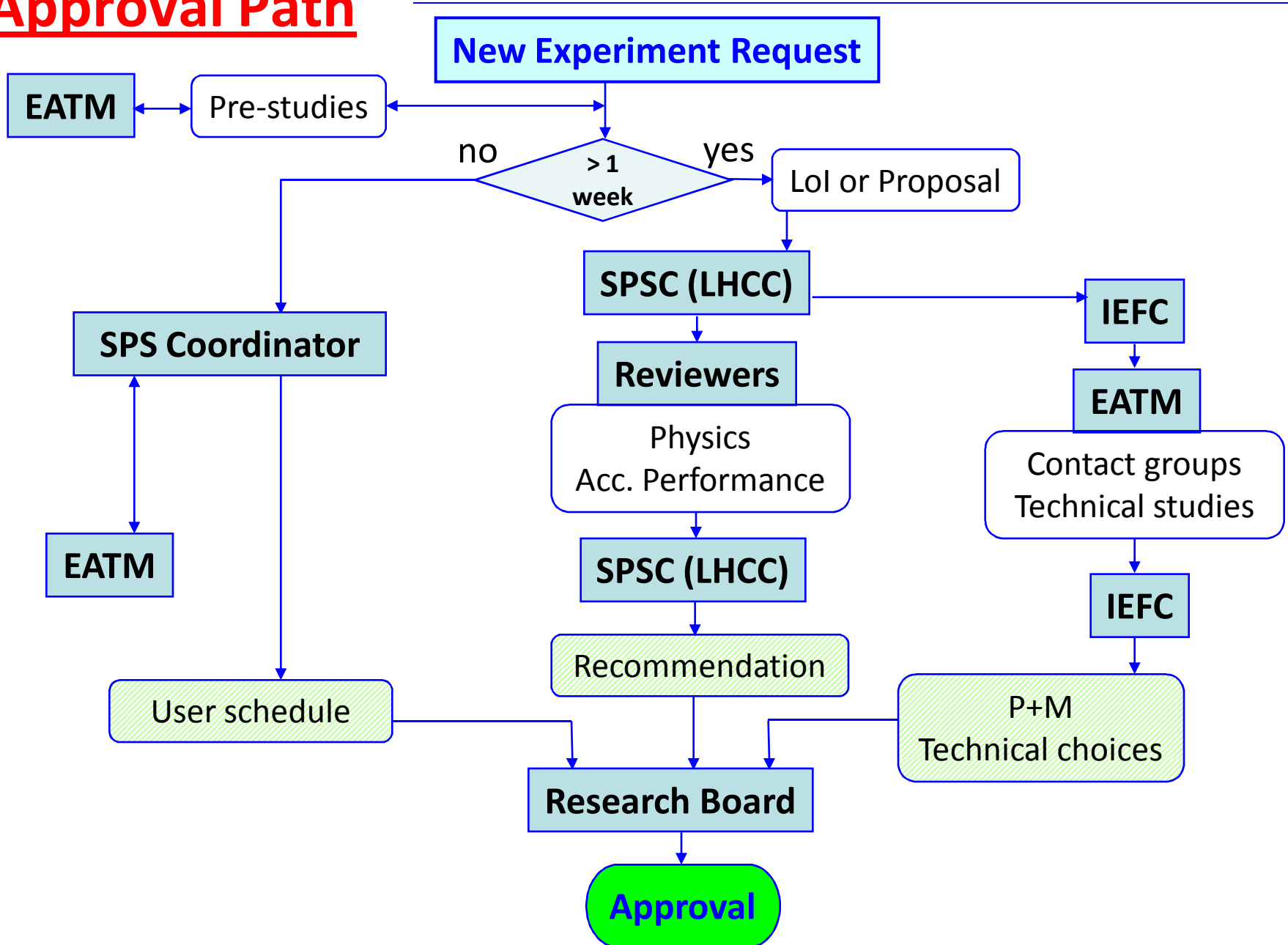
- H2, H4, H6, H8 (EHN1)
 - 10 – 400 GeV/c (H6: 205 GeV/c)
 - VLE extension in H2, H8: 1-9GeV/c
 - Attenuated primary proton beam at 400 (450) GeV/c for H2, H4, H8
 - electrons, hadrons, muons, photons
 - secondary target → tertiary beam
 - max. $2 \cdot 10^8$ particles per spill for secondary beam
 - $< 1 \cdot 10^{11}$ particles per spill for primary protons if proper shielding (H4)
- M2, COMPASS (EHN2)
 - High intensity (polarized) muon beam
 - Typically $4 \cdot 10^8$ muons at 160 GeV/c for $2.4 \cdot 10^{13}$ protons on T6 target
 - secondary hadron beam up to 280 GeV/c
- P42/K12, NA62 (ECN3)
 - Primary proton beam to target T10
 - ‘Kaon beam’ (mixed beam with 6% K^+) up to ± 75 GeV/c

User Requests for SPS

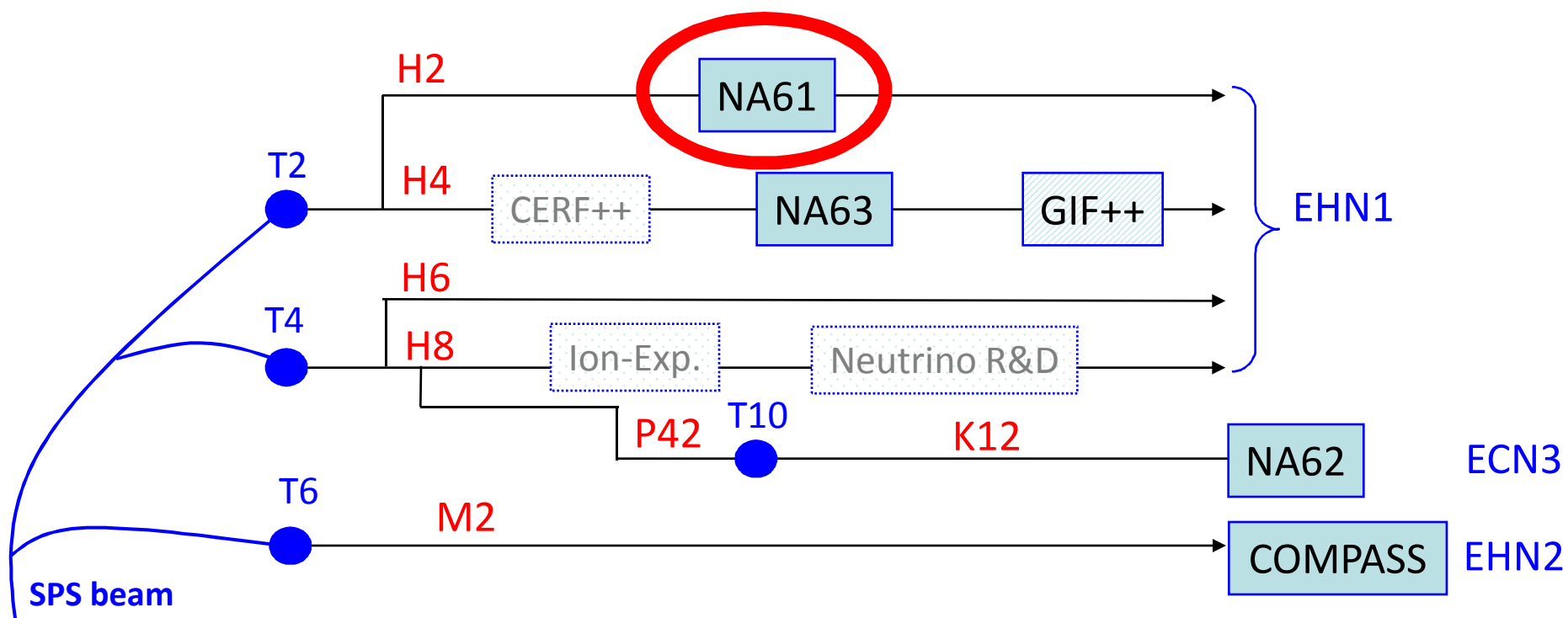
SPS Secondary Beams – Experiments and Tests



Approval Path



NA61, successor of NA49

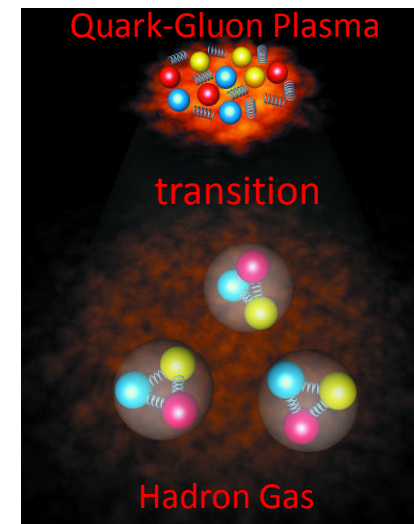


NA61/SHINE

SPS Heavy Ion and Neutrino Experiment

Study of hadron production in hadron nucleus and nucleus-nucleus collisions.

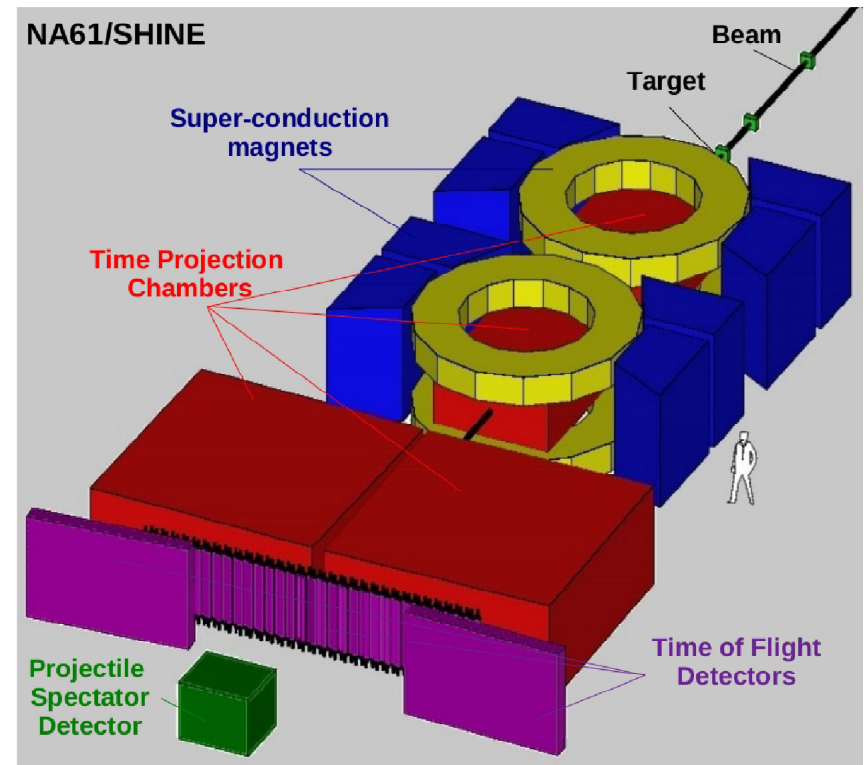
- Search for critical point of strongly interacting matter
 - Detailed study of the onset of deconfinement in nucleus-nucleus collisions
 - Measure hadron production at high transverse momenta in p+p and p+Pb collisions as reference for Pb+Pb results
- Data for neutrino and cosmic ray experiments
 - Hadron production reference measurements in p+C interactions needed for neutrino (T2K) and cosmic-ray (Pierre Auger Observatory) and KASCADE experiments
 - Hadron production measurements in the T2K target



NA61/SHINE

2010 Run

- Test runs in May in H2 and T9
- Physics run (18 weeks) in H2 with p+p at 158GeV/c and 10GeV/c and p+T2K target at 31GeV/c



- Test of secondary boron ion beam at 20GeV/c and 80 GeV/c in September/October 2010

➔ Beam instrumentation: pulse height analyzer to identify boron ions

For each energy (20, 80, 100? GeV/c) :

➔ 1 MD to set energies in SPS and extraction

➔ 1 MD to setup beam-line and data taking

➔ Test extraction and beam quality @ 10GeV/c

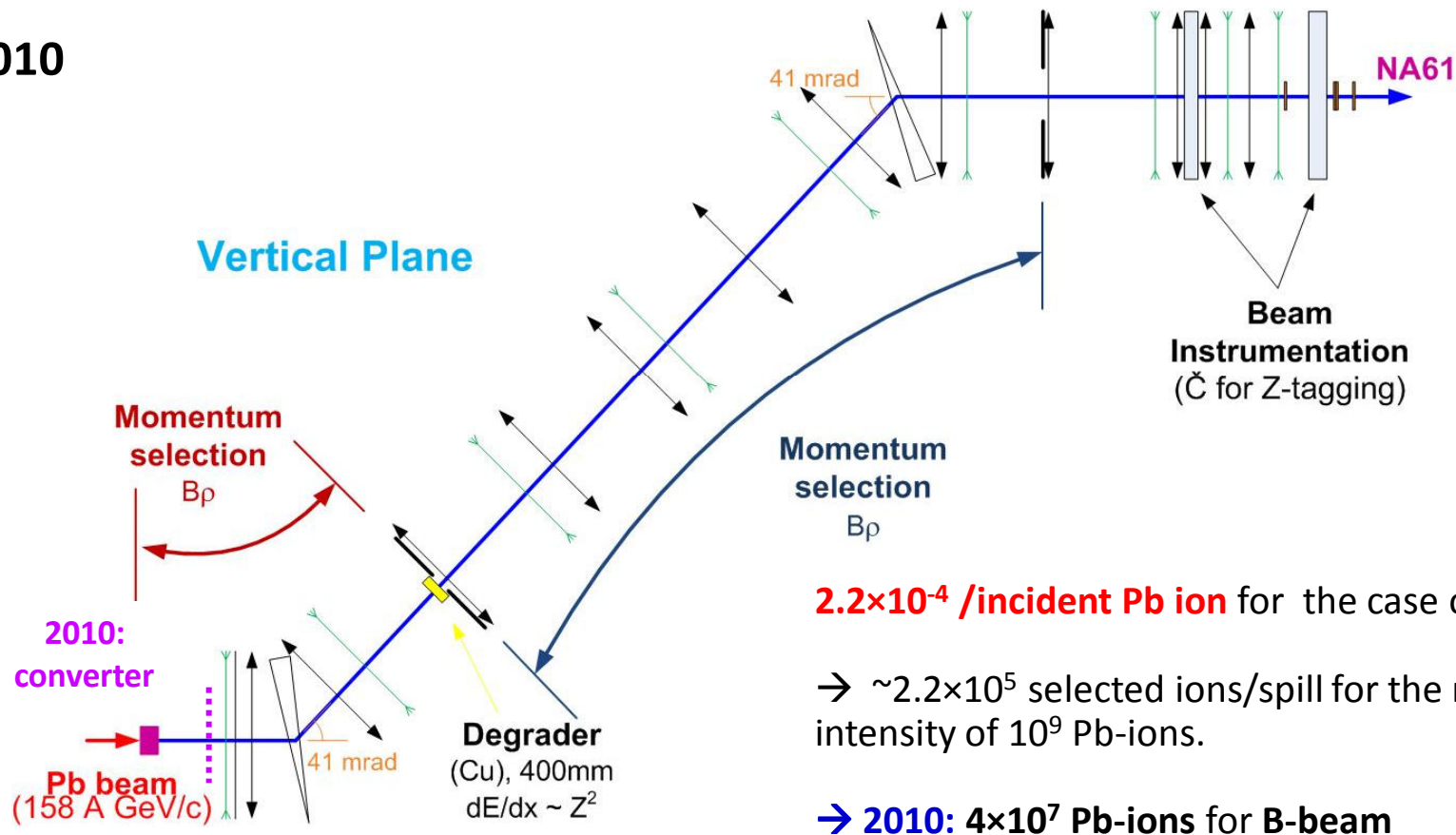
5-7 MDs

NA61 Fragmented Ion Beam

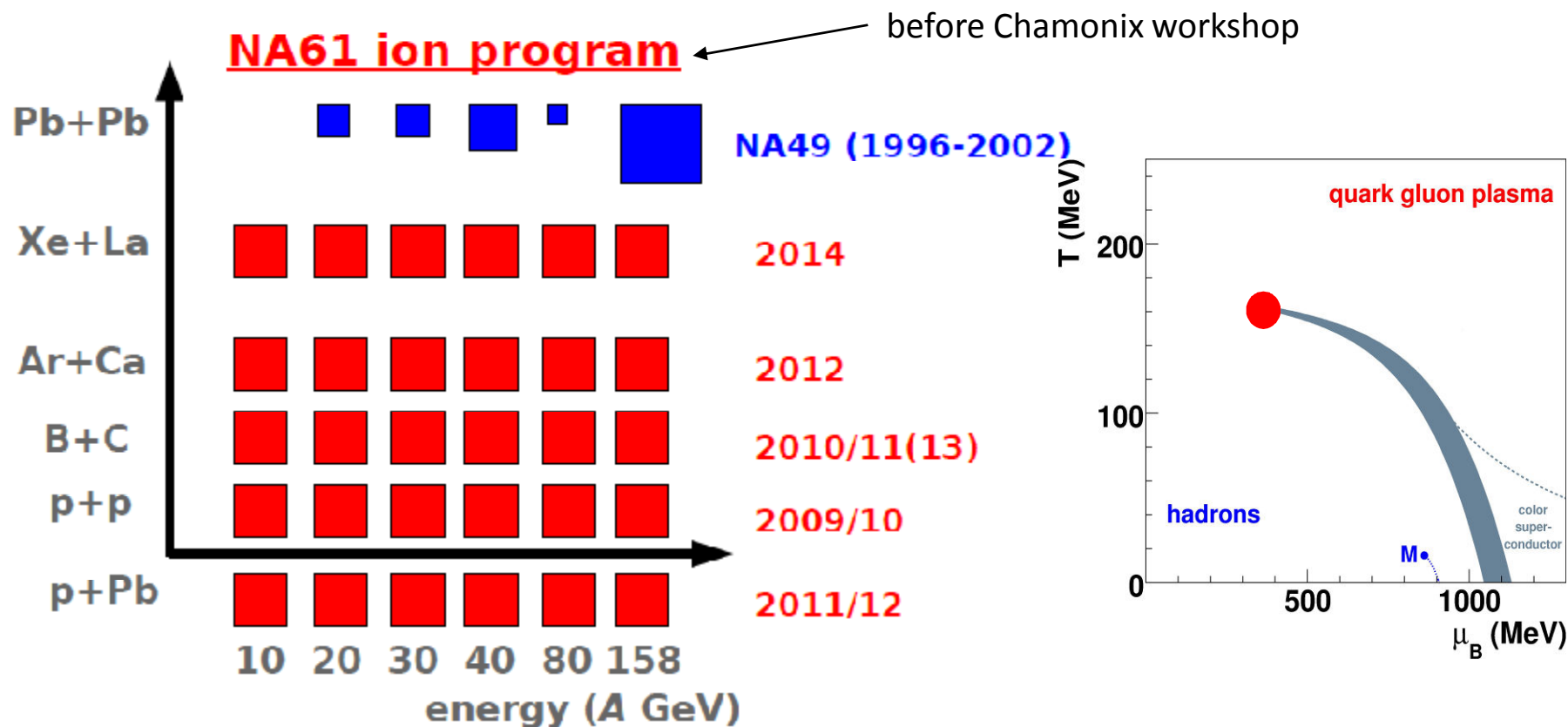
Beam line: double spectrometer with 0.04% resolution that helps to separate the ion fragments corresponding to a selected magnetic rigidity : $B\rho$

H2 Beam Line for Fragmented Ion Beam

2010

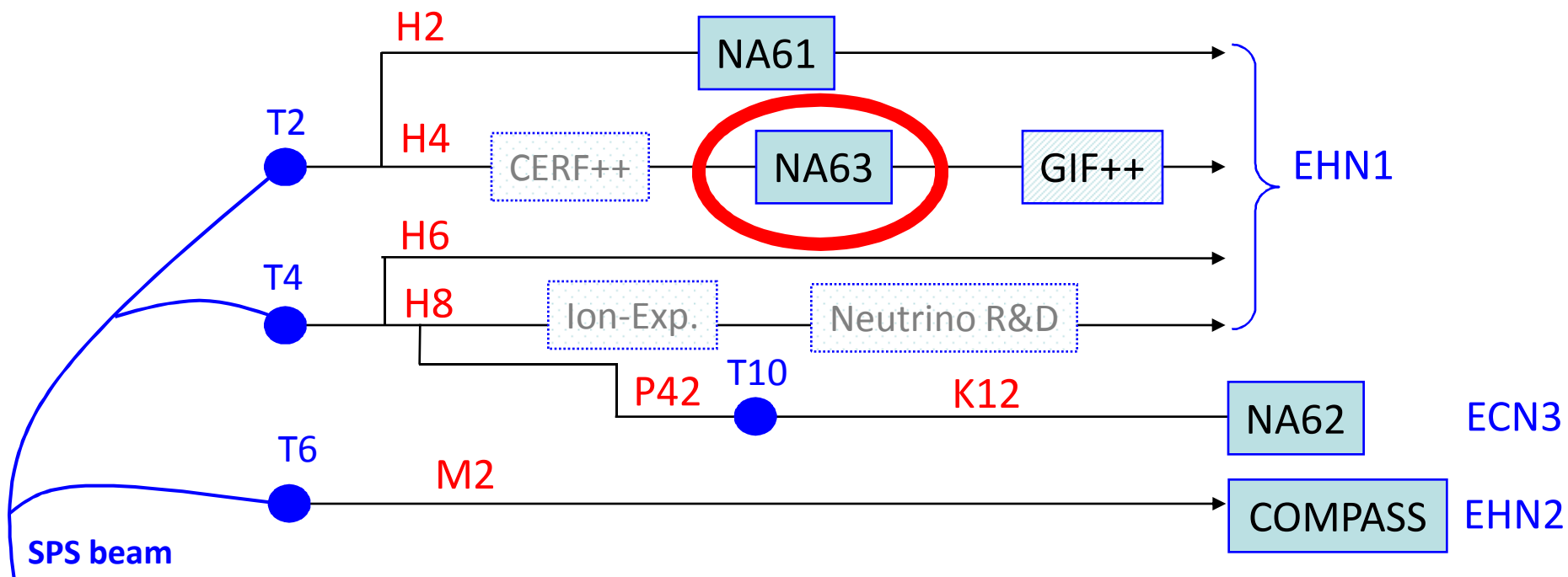


NA61 Program Plan for >2011



- ➔ Fragmented beam: 2010 feasibility study
real test (target and detector) + data taking: 2011,...
- ➔ 158 GeV requires transformer in SPS (extraction only when $1 \cdot 10^9 < N < 2 \cdot 10^{11}$)

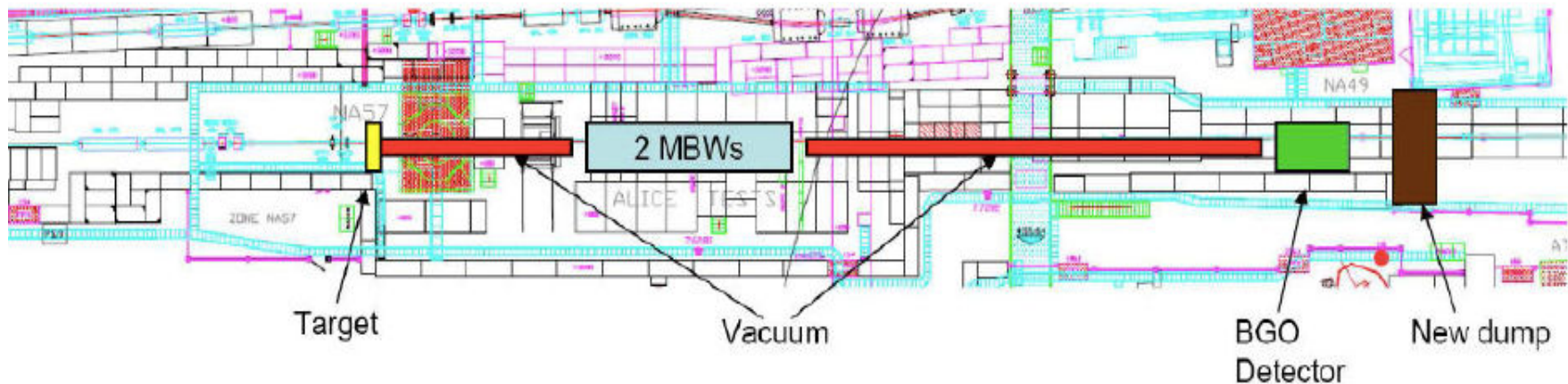
NA63



NA63

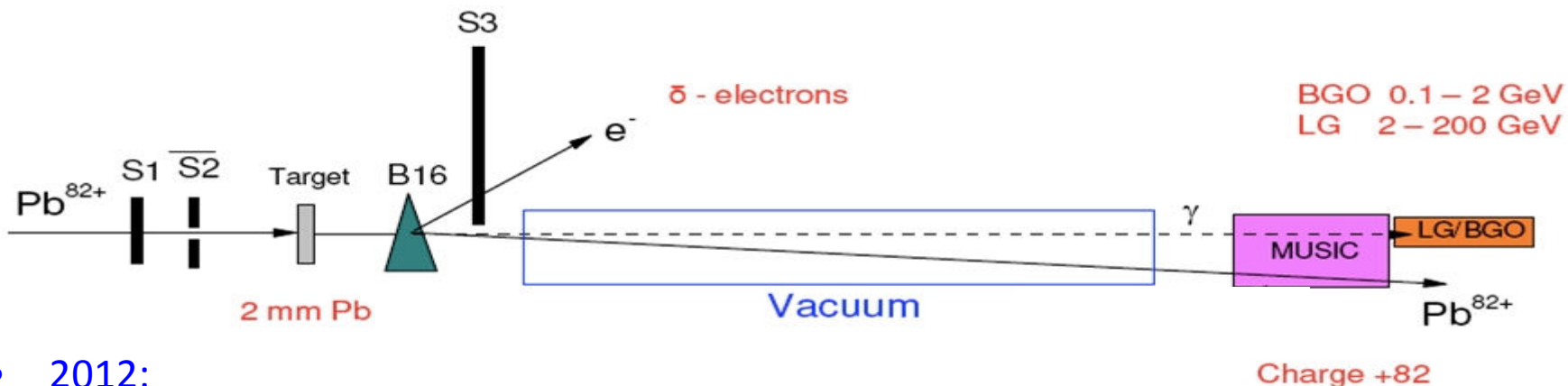
Electromagnetic Processes in Strong Crystalline Fields

- 2010 program approved:
 - 10 days in H4
 - low-Z LPM (Landau-Pomeranchuk-Migdal) study related to low-Z targets
- Proposals for > 2011
 - 2011: 2 weeks in H4
 - Studies of magnetic suppression of incoherent Bremsstrahlung
 - ➔ MBWs available, requires area and layout studies and modifications



NA63

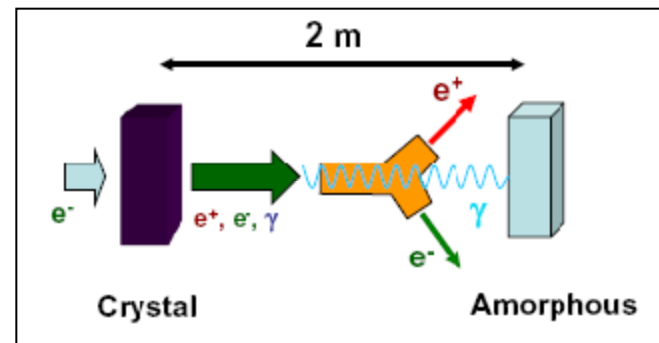
33 TeV $Pb^{82+} \rightarrow Pb^{82+}$
 $\gamma = 170$



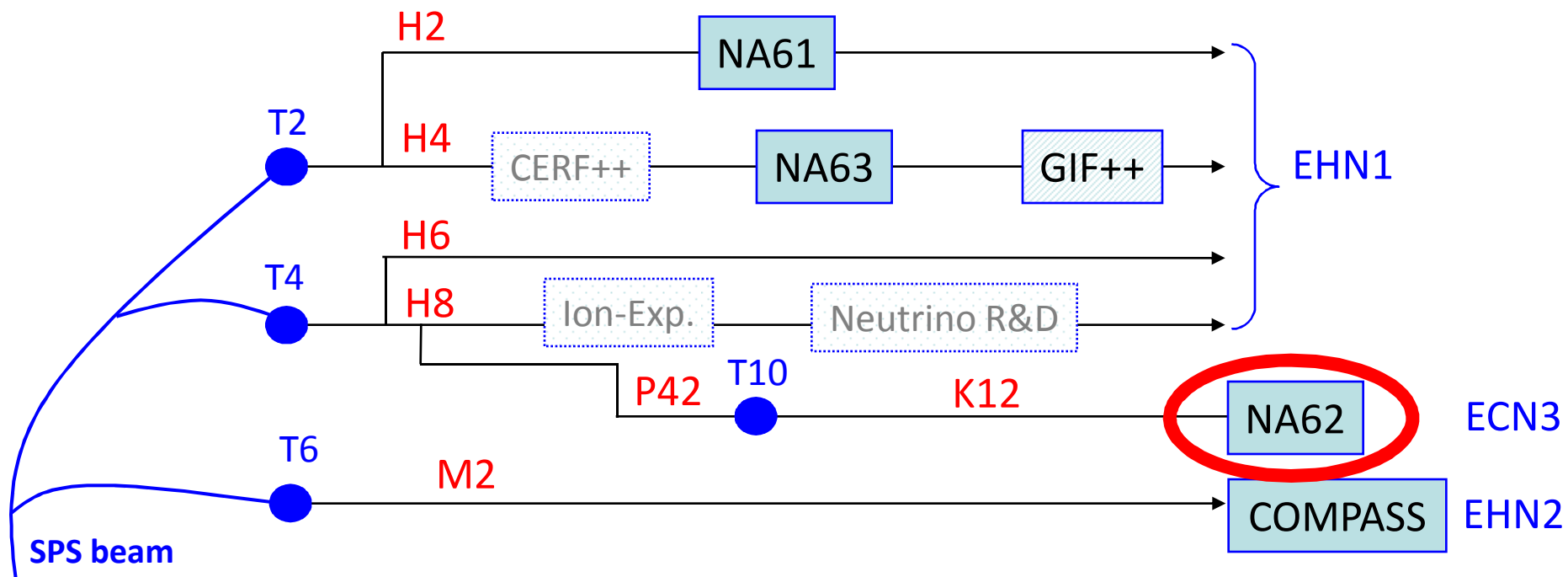
- 2012:
 - 2 weeks in H4 with ion beam for heavy ion bremsstrahlung studies when fully stripped Pb ions penetrate amorphous targets
 - ➔ ion beam with 158 GeV, so needs transformer in SPS
 - ➔ Not possible to have ion beam in both H2 and H4 at the same time, so NA63 request is in addition to NA61 request

- Plans for beyond 2012:

- Strong interest in positron production studies with aligned crystals to be used e.g. in CLIC
- Application for funding in preparation (FP7)



NA62, successor of NA48



NA62 (P326)

Sensitivity to new physics and possibility to determine CKM matrix elements in processes not affected by new physics

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

- Branching ratio of 10^{-10}
- Extract a 10% measurement
- Sensitivity of 55 events/year with 13-17% background

Approved for 2 years 2012/2013

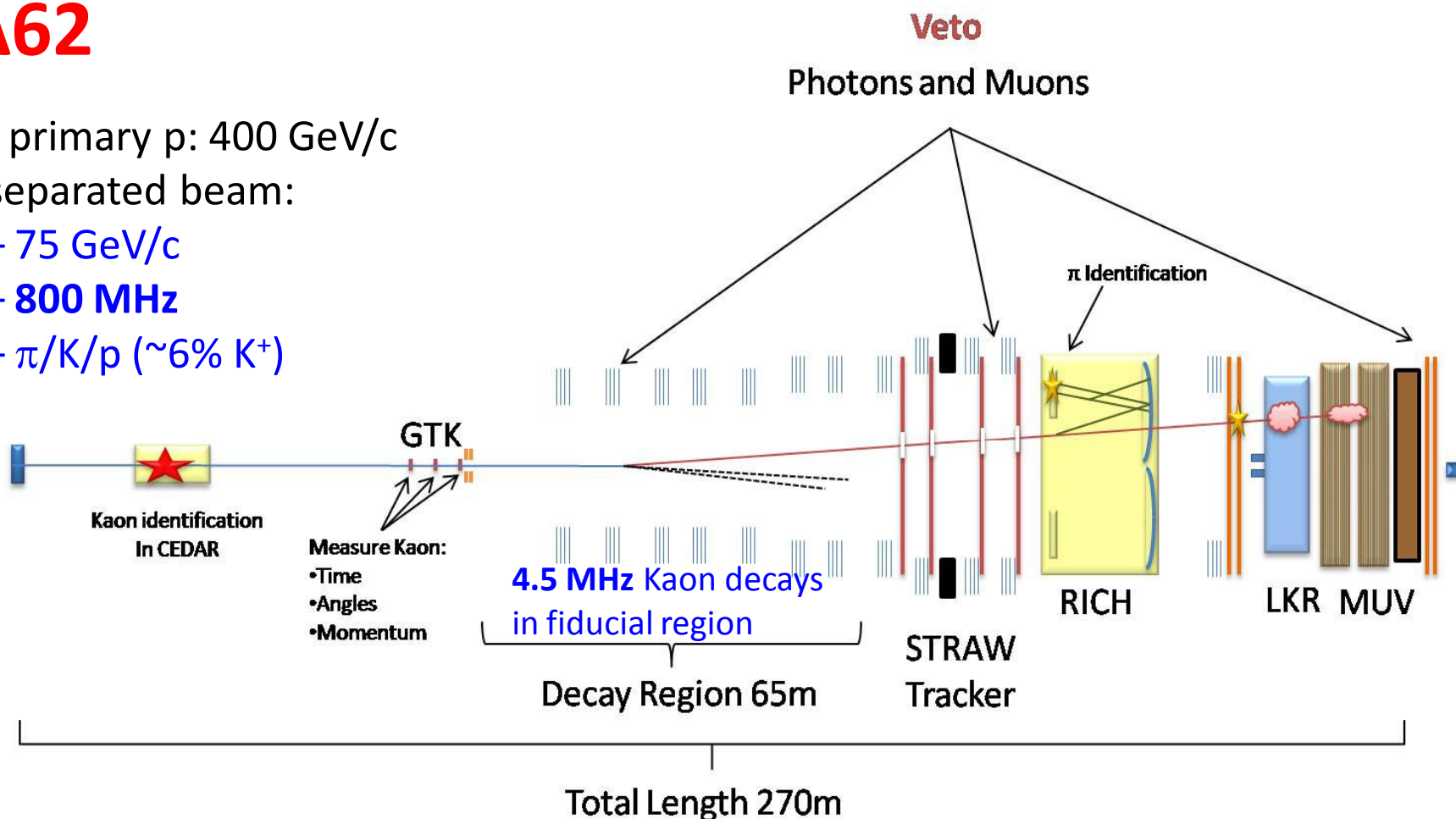
For > 2014:

→ Measure $K_L^0 \rightarrow \pi^0 \nu \nu'$

- Branching ratio of $\sim 10^{-12}$

NA62

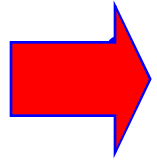
- SPS primary p: 400 GeV/c
- Unseparated beam:
 - 75 GeV/c
 - **800 MHz**
 - $\pi/K/p$ ($\sim 6\% K^+$)



➡ Dismantling NA60, NA48

➡ New beam-line

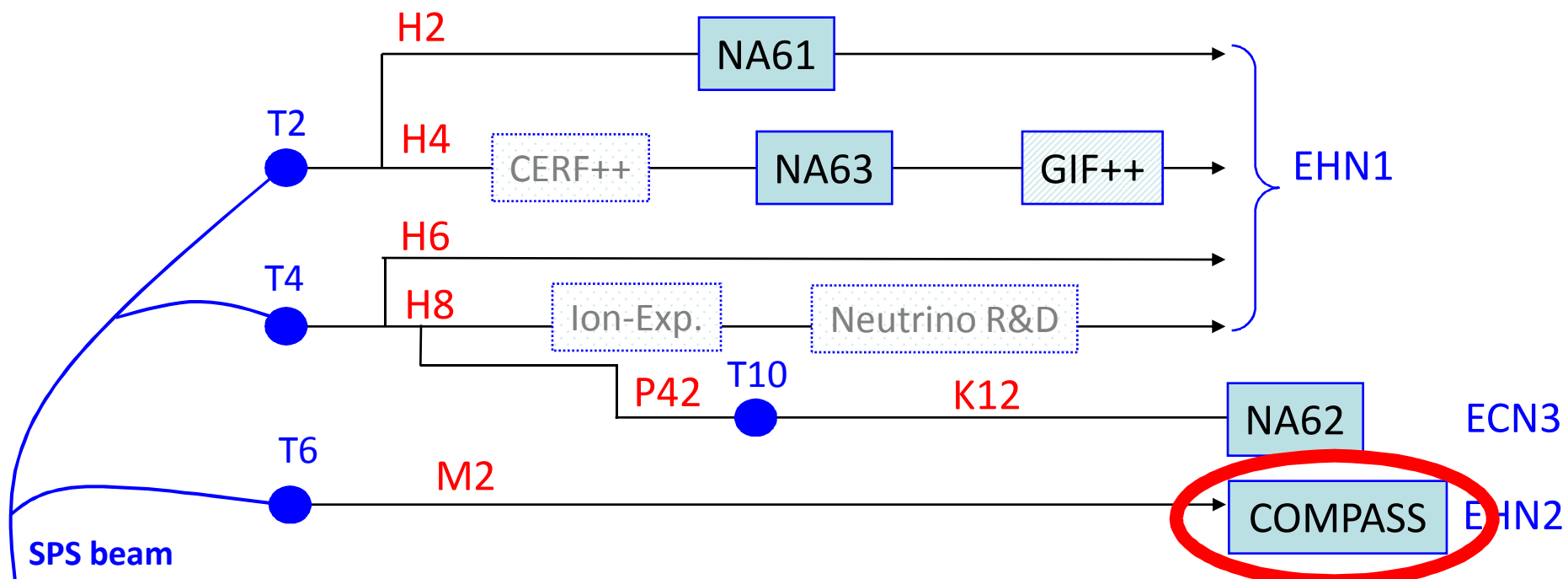
NA62: Schedule



Very tight schedule!

- NA60, NA48 dismantled by mid 2010
 - Beam survey in early 2012
 - Beam to be rebuilt
 - Costing under way, work packages being defined and discussed
 - First full data taking expected in 2012
-
- 2010: test- beam
 - Large Angle Veto (T9, 3 weeks, June)
 - Gigatracker (T9, 2 weeks, September)
 - Straws (H6, 3 weeks, June)

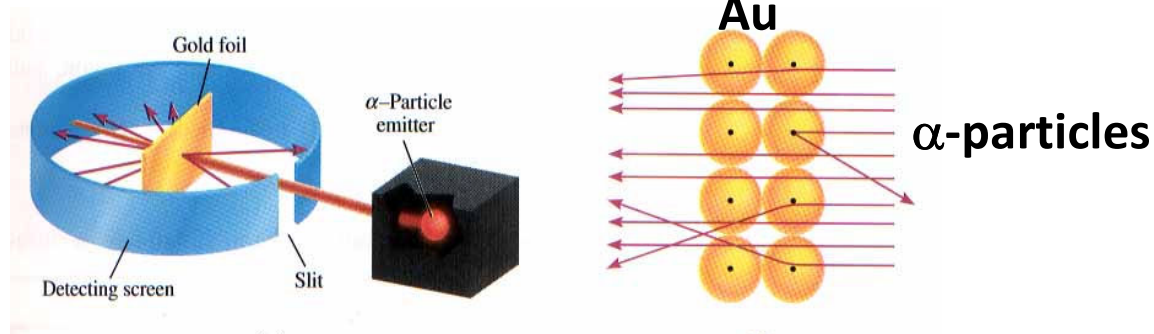
COMPASS



COMPASS (NA58)

→ **1910:** Rutherford:

study **atomic structure** with **alpha particles**

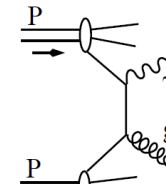
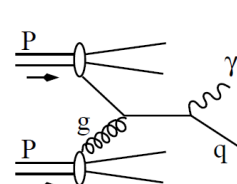
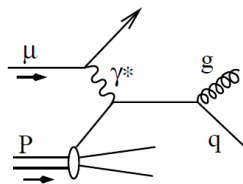
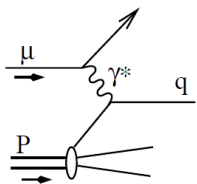


→ Planetary model of atoms!

nucleus with whole positive charge and atom's mass, electrons circling

→ **2010:** COMPASS:

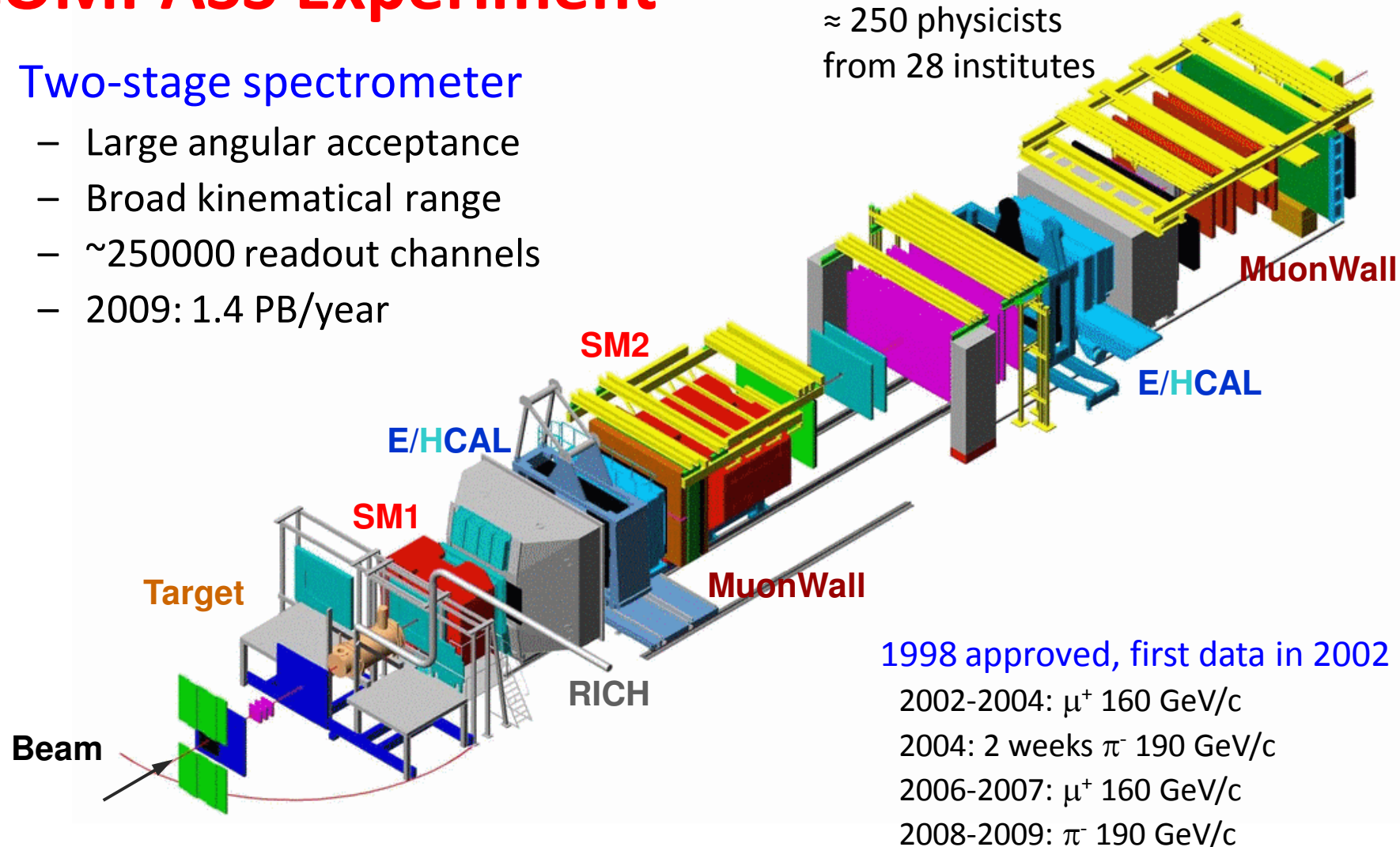
Study the **hadron structure** and **hadron spectroscopy** with high intensity **muon** and **hadron beams**.



COMPASS Experiment

- Two-stage spectrometer
 - Large angular acceptance
 - Broad kinematical range
 - ~250000 readout channels
 - 2009: 1.4 PB/year

≈ 250 physicists
from 28 institutes



1998 approved, first data in 2002

2002-2004: μ^+ 160 GeV/c

2004: 2 weeks π^- 190 GeV/c

2006-2007: μ^+ 160 GeV/c

2008-2009: π^- 190 GeV/c

➔ Polarized beam (~75%) and target (~50%)

COMPASS Program

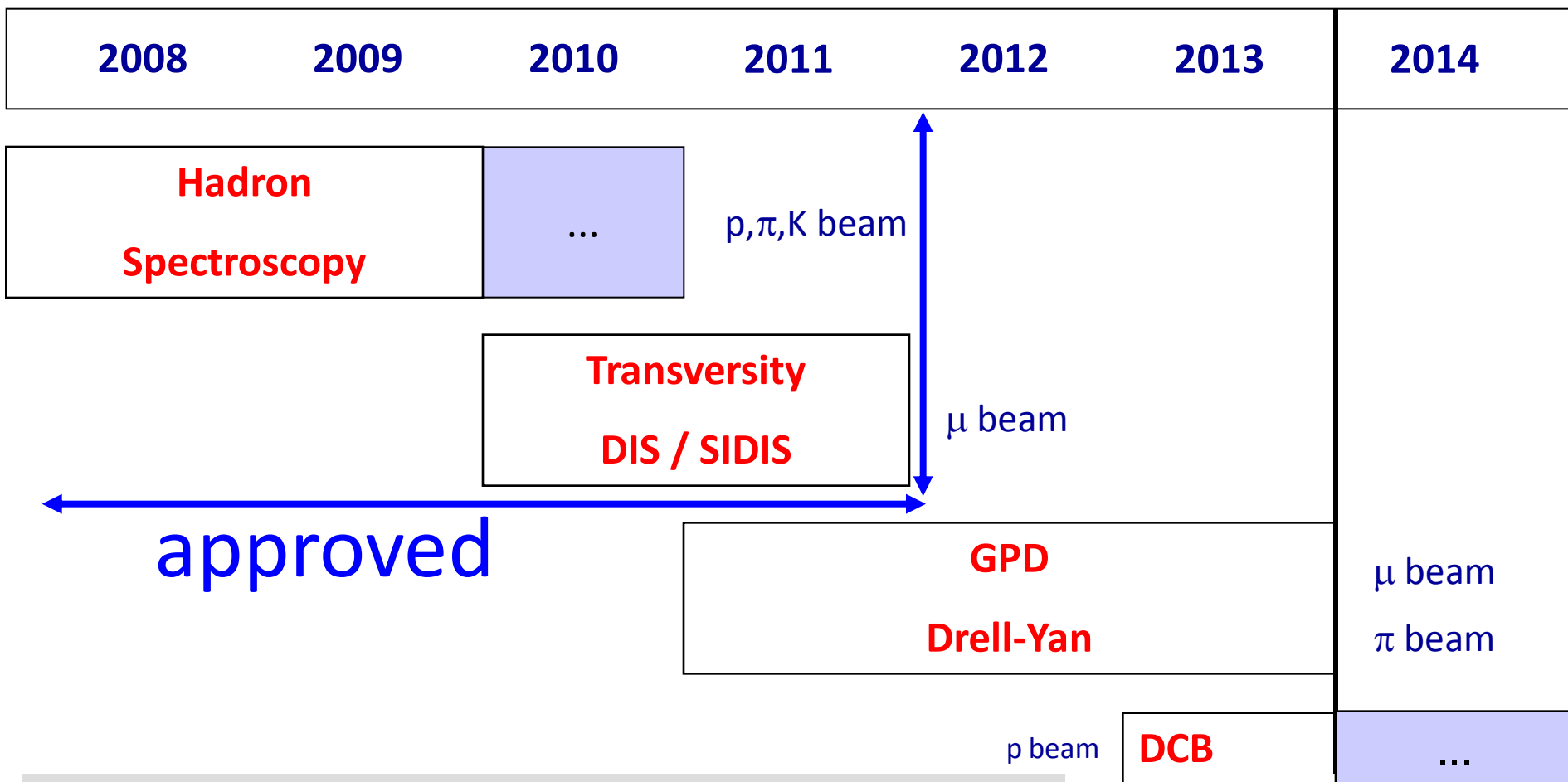
Approved for 2010/2011

- Longitudinal structure function
- Transverse spin structure
 - ➔ muon beam, intensities as now, i.e. as high as possible

Proposals

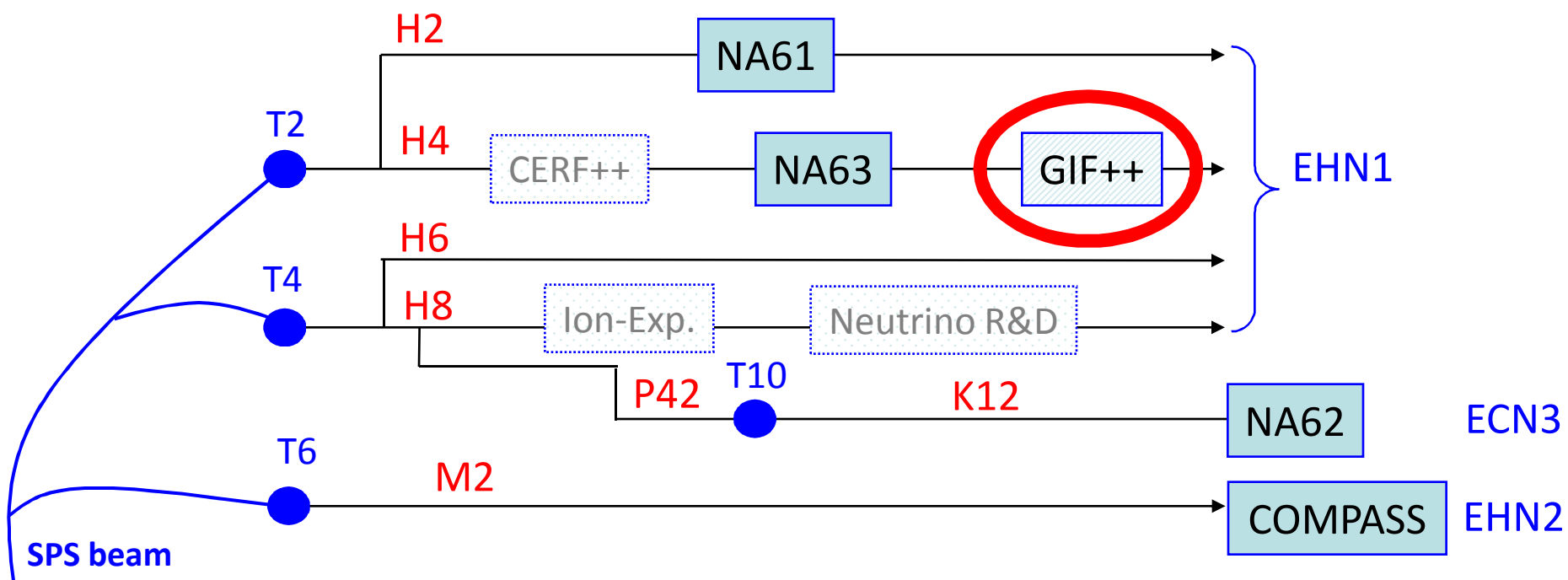
- Generalised Parton Distribution (GPD)
 - ➔ 2012 positive and negative beams, minor upgrade
 - ➔ 2014 only positive beam, new transversely polarized NH3 target
 - ➔ 4 x higher luminosity?! (upgrade of M2 beam-line) → unrealistic!
- Drell-Yan
 - production of lepton–antilepton pairs in hadron collisions
 - ➔ secondary hadron beam 50-200 GeV/c
 - ➔ higher intensities, absorbers after target
 - ➔ two year data taking
 - ➔ RF separated antiproton beam in a second phase? (later)
- Double Charged Baryons
 - ➔ 450 GeV/c proton beam
 - ➔ needs design and rebuilt of complete M2 beam line

COMPASS Future Plans



COMPASS submitted Lol, **common proposal** to follow
Strong wish to involve **new groups**


GIF++



Radiation Facilities

- CERN wide irradiation facilities working group (DG, PH, BE, TE, EN)
- 2008: Survey on future needs
 - Memorandum on ‘status report and conclusion’ to management in December 2008
- Identified needs from survey:
 - High-energy and high-intensity proton (ion) irradiations → **HiRadMat**
 - High-intensity proton irradiation → **PS East Area**
 - Mixed field irradiations → **CERF++**
 - Gamma irradiations with beam → **GIF++**

Gamma Irradiation Facility GIF++

- GIF++
 - Powerful photon source (Cs137) to irradiate detectors and other equipment for performance, radiation and ageing studies
 - In addition: presence of particle beam to check detector performance on top of a photon background
- GIF: Present installation in Bat 190
 - Phased out due to dismantling of the West Area → no beam
- Users
 - Muon trackers of LHC experiments, detector or accelerator electronics components, beam diagnostic equipment
- Proposal submitted to SPSC in September 2009
- Proposal presented to Research Board in December 2009
 - Presentation to the IEFC to be prepared in order to evaluate the exact location of the GIF++ area
- On hold to find budget; conditioned with new LHC upgrade schedule?
 When approved: ~1.5 years for installation

GIF++ Impact on Beam and Facility

- ➔ Annual running of 48 weeks with gamma source
- ➔ Beam request: 6-8 weeks/year
 - Mainly muon beam with 100 GeV/c
- ➔ Source
 - ^{137}Cs , $\sim 1\text{TBq}$, 662 keV photons, 30 y half-life

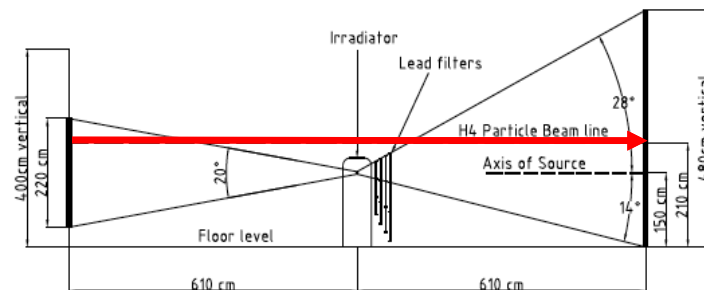
Max. expected doses at sLHC	Equivalent time at GIF++ ($\sim 50\text{cm}$ from source $\rightarrow 2\text{Gy/h}$)
Si-trackers: $\sim \text{MGy/y}$	\gg years
Calorimeters: $\sim 20 \text{ kGy/y}$	< 1 year
Muon systems: $\sim 0.1 \text{ Gy/y}$	\sim minutes

➔ Irradiation area is Prohibited Area

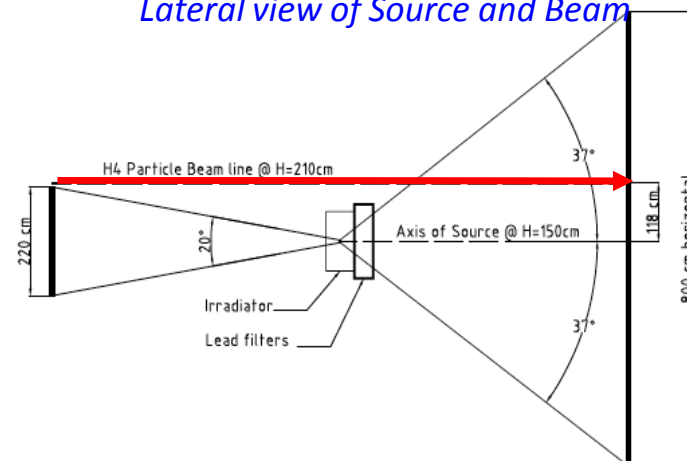
- $\sim 10\text{Sv/h}$ at distance of 30cm
- ➔ adequate side and roof shielding

➔ EHN1 is Supervised Area

- $< 3\mu\text{Sv/h}$ at permanent workplaces
- $< 15\mu\text{Sv/h}$ in low occupancy areas
- \rightarrow limits to achieve outside the shielding

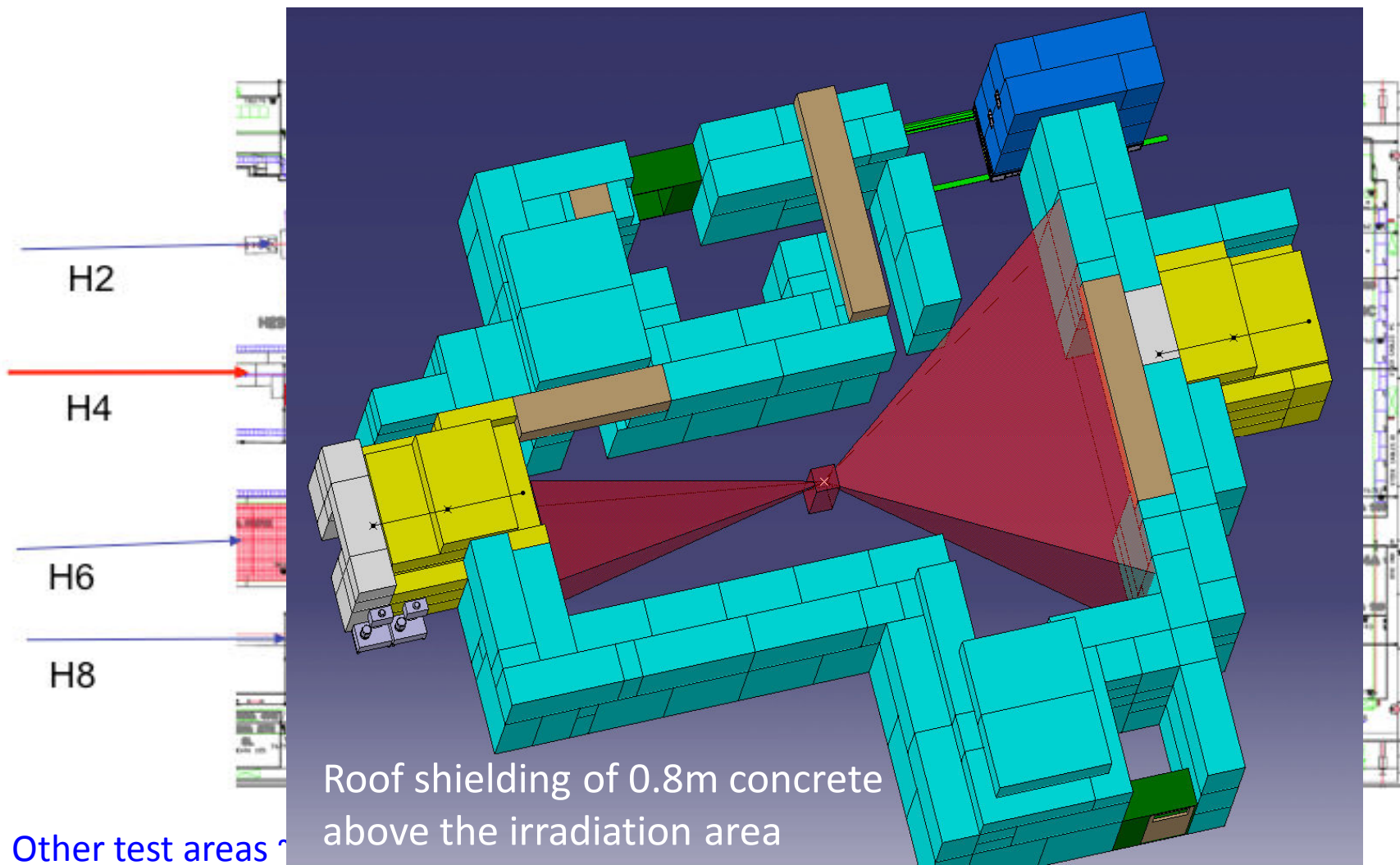


Lateral view of Source and Beam



Top view of Source and Beam

GIF++ in North Area/H4 beam line



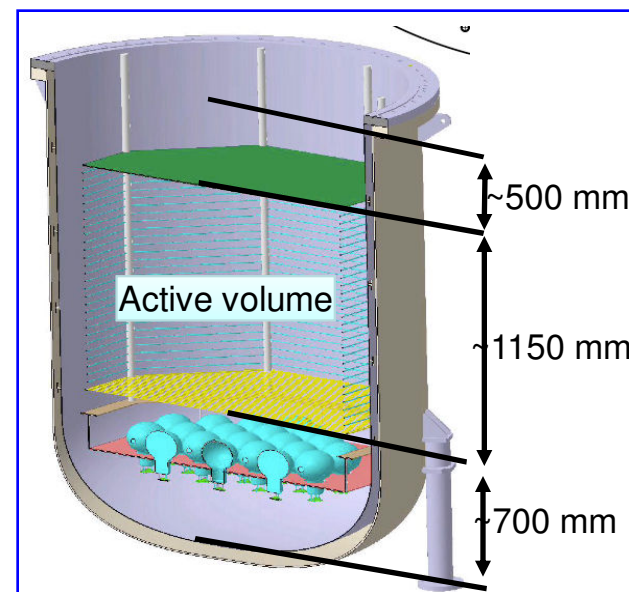
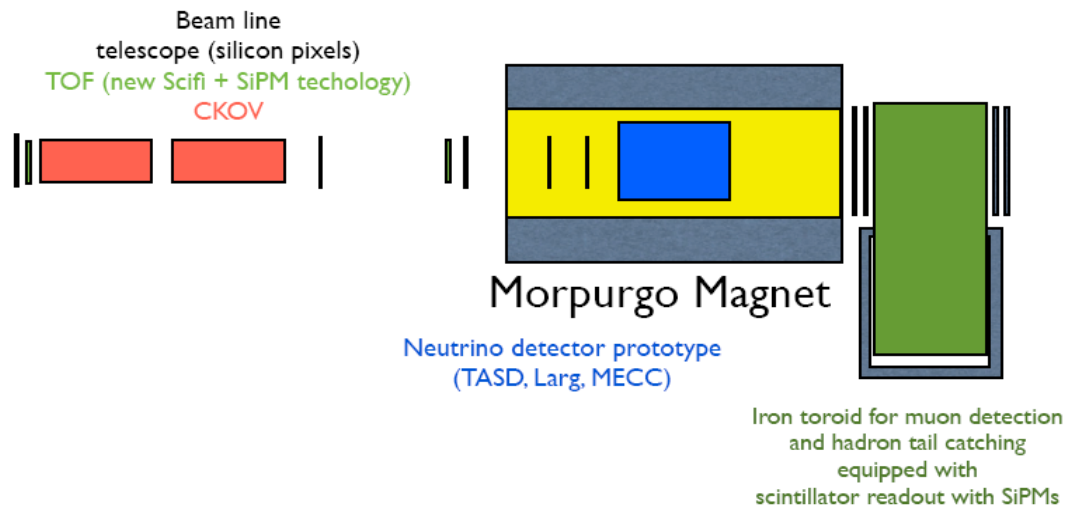
Other test areas

e.g. NA63, RD51, COMPASS-Calo, CALET, INSURAD, CMS-ECAL/BCM, LHCf, SiTRD

Other (Semi-permanent) Facilities in the Pipeline

- Neutrino Detector R&D Projects

large area Mmegas chambers(Saclay)



Liquid Argon TPC Detector

→ beam: sub GeV – 20 GeV/c,
modifications needed

→ Large magnet

→ low intensity (1kHz)

→ Liquid Argon infrastructure

H8

Duration: >2 years

- Ion Experiments (NA60-Future,....), CERF++, DREAM, Linear Collider...

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 booked
 - List of priorities for requests might be needed
- Very broad Fixed Target program
 - Lifetime >10 years
- Many more proposals in pipeline
 - Large objects
 - Looking for more permanent installation
 - Additional infrastructure (magnets, cryogenics)

 **Consolidation**

Additional Slides

CERF++

Mixed field irradiations:

- Study impact on system components exposed in radiation fields
- Primary use: LHC accelerator and detector components (SEE studies), radiation monitoring calibration

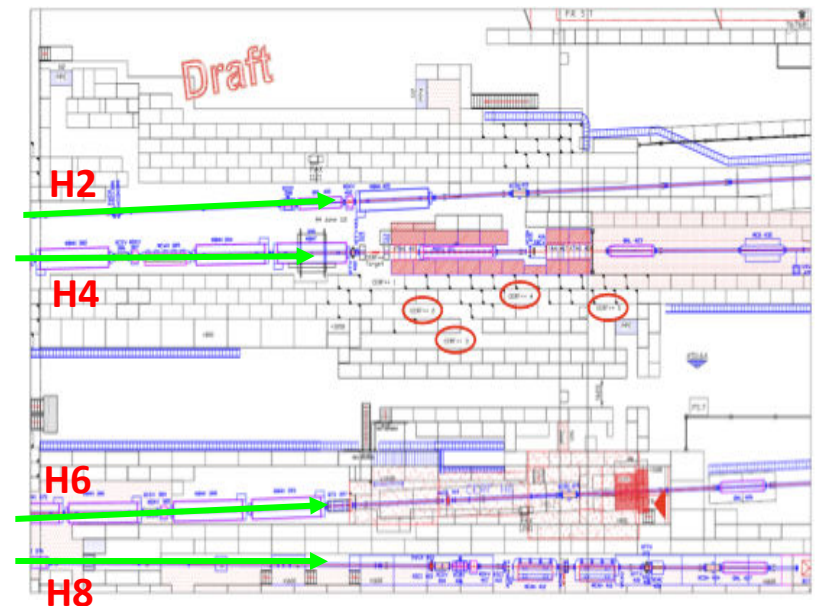
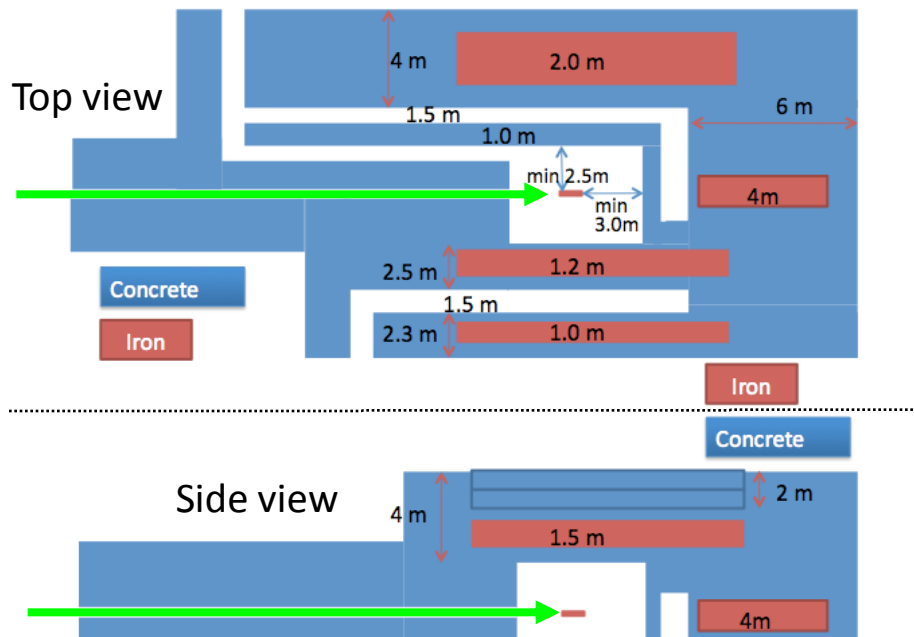
Today: CERF

- SPS H6 secondary beam, 120 GeV/c hadrons
 - Max 10^8 protons/pulse
 - In operations since 1991, 1-2 weeks/yr
 - Test/calibration of passive and active detectors for dosimetry or radiation monitoring
 - FLUKA benchmarking, beam loss monitor studies
- **but:** limited dose rate, muons from TCC2

CERF++ Mixed Field Irradiation Facility

- Beam intensity : $<1 \times 10^{11}$ p/spill
- Transport attenuated proton beam in H4 up to the entrance of the EHN1 hall
 - (Feature last used for NA31 in 1986)
- measurement locations around the thick target

Implementation studies for this facility are just starting (450GeV/c, 24GeV/c, 4GeV/c)



→ Pending funding, more mature proposal needed