The NA62 experiment at CERN: towards the first physics run

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Outline

- The NA62 Collaboration
- Physics motivations
- The concept of the experiment
- The beam and the detectors
- Software
- Detector installation
- Run 2012

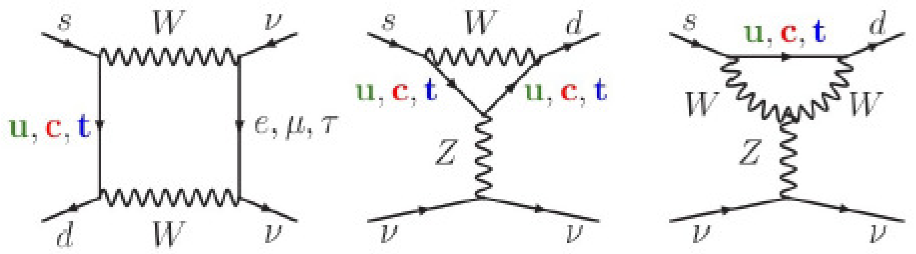
The NA62 collaboration

- Institutes
  - Louvain-la-Neuve, Sofia, Mainz, Ferrara, Firenze, Frascati, Napoli, Perugia, Pisa, Roma 1, Roma 2, Torino, San Luis Potosi, Bucharest, Dubna, Moscow, Protvino, Bratislava, CERN, Birmingham, Bristol, Glasgow, Liverpool, Fairfax, SLAC, Merced
- Spokesman: Augusto Ceccucci (CERN)
- Tech. Coordinator: Ferdinand Hahn (CERN)
- Project coordinators:
  - A. Antonelli (photon vetoes), R. Fantechi (LKr), M. Lenti (RICH), F. Marchetto (GTK), C. Lazzeroni (CEDAR), M. Sozzi (TDAQ), P. Valente (Computing), R. Wanke (Muon veto), H. Danielsson (Straw), A. Sergi (Software), G. Ruggiero (Physics), V. Falaleev (DCS)

Web page: http://na62.web.cern.ch/na62/
Technical Design Document: http://cdsweb.cern.ch/record/1404985

$K^+ \to \pi^+ \nu \nu$ in the Standard Model

- FCNC process forbidden at tree level
- Short distance contribution dominated by Z penguins and box diagrams
- Negligible contribution from u quark
- Small contribution from c quark
- Very small BR due to the CKM top coupling $\to \lambda^5$



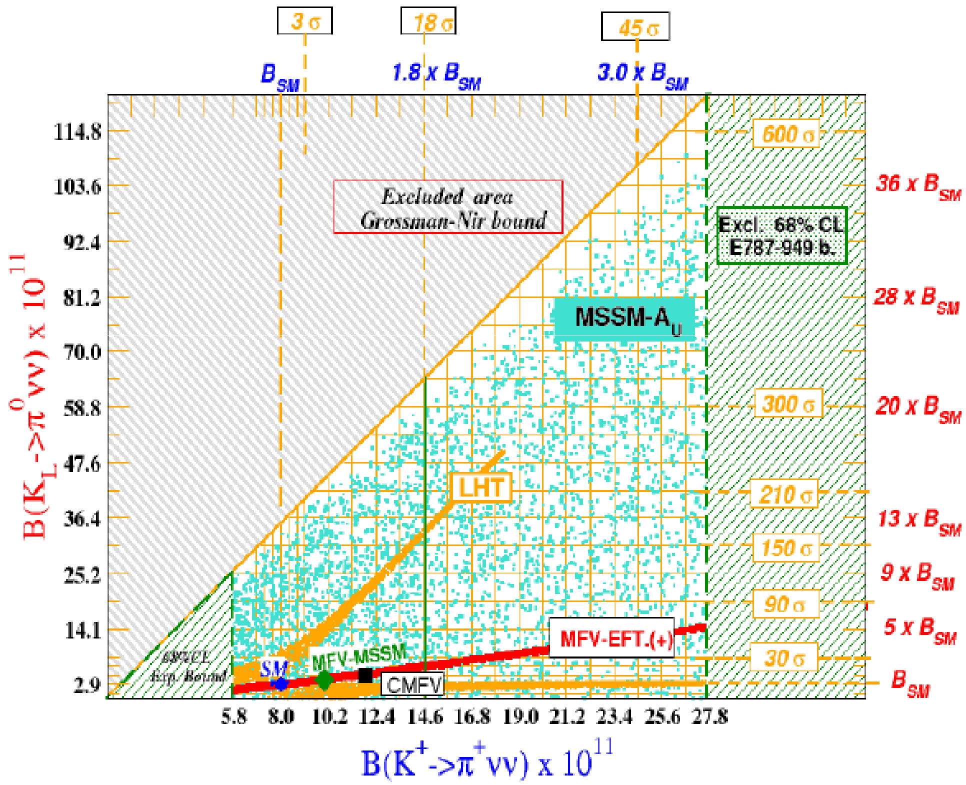
•Amplitude well predicted in SM (measurement of V_{td} without QCD inputs)
•Residual error in the BR due to parametric uncertainties (mainly charm contributions): ~7%

	Γ_{SD}/Γ	Irr. theory err.	BR x 10^{-11}
$K_L \to \pi\nu\nu$	>99%	1%	3
$K^+ \to \pi^+\nu\nu$	88%	3%	8
$K_L \to \pi^0 e^+ e^-$	38%	15%	3.5
$K_L \to \pi^0 \mu^+ \mu^-$	28%	30%	1.5

SM prediction
BR = $(8.5 \pm 0.7) \times 10^{-11}$

$K^+ \to \pi^+\nu\nu$ beyond the Standard Model

- Stringent test of the SM
- Several SM extensions predict a different value for the BR
- Possibility not only to identify new physics but also to distinguish among different models: *SUSY, MSSM (with or without new sources of CPV or FV) ….*



The only existing measurement is based on 7 events from E787/E949 at BNL

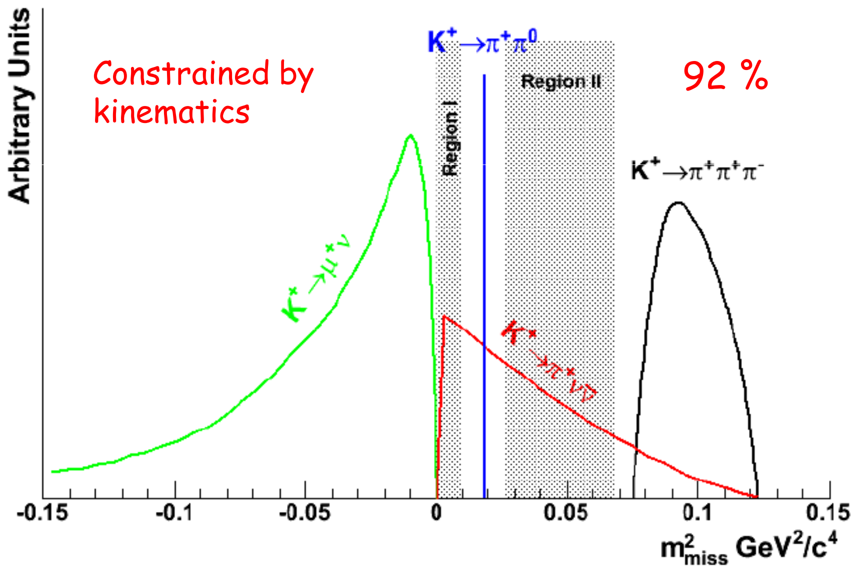
$BR = (1.73\,^{+1.15}_{-1.05})\times 10^{-10}$

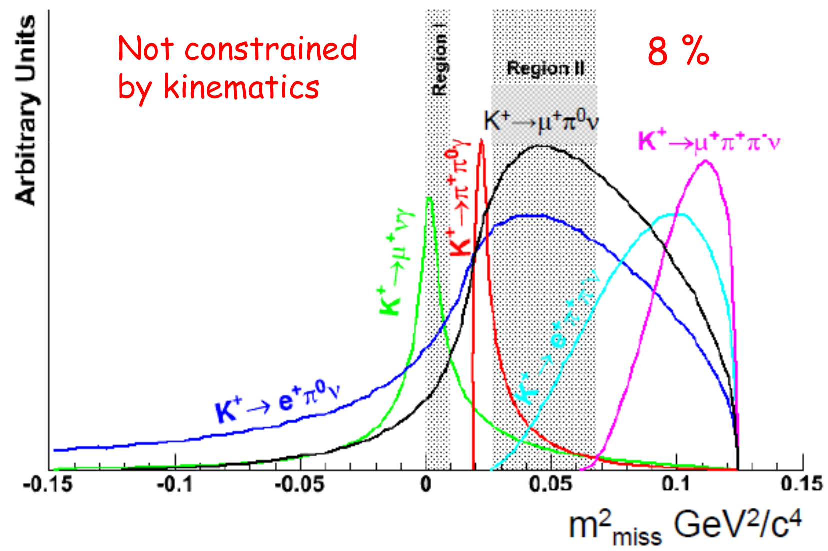
NA62 goals

- Collection of O(100) events in two years of running
  - This requires at least 10^{13} Kaon decays
  - 75 GeV beam helps in background rejection
    - i.e. $K_{\pi 2}$ decays have around 40 GeV of electromagnetic energy
- O(10^{12}) rejection factor of common K decays
  - Main contribution from $K_{\mu 2}$ (63%) and $K_{\pi 2}$ (21%)
  - Kinematics resolution
  - Efficient veto detectors
  - Particle ID
  - Precise timing
- Expected acceptance O (10%)

The measurement

Signature: one incident kaon, 1 charged output track
Missing mass distributions: $m^2_{miss} = (P_K - P_{track(hyp\ \pi^+)})^2$
Define two regions to accept candidate events





Photon and muon vetoes to reduce the background

Add particle ID

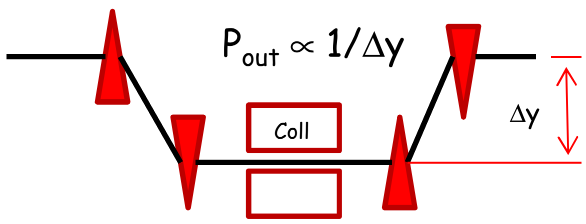
Guiding principles for the detectors

- Good tracking devices
  - Accurate measurement of the kaon momentum
  - Accurate measurement of the charged decay product
  - Reach $O(10^{-5})$ kine rejection factor on $K_{\mu 2}$, $O(10^{-4})$ on $K_{\pi 2}$
- Veto detectors
  - For photons to reduce the background of a factor 10^8
  - For muons add a rejection factor of $O(10^{-5})$
- Particle identification
  - Identify kaons in the beam
  - Identify positrons
  - Additional π/μ rejection [$O(10^{-2})$]
- Precise timing
  - To associate the time of the kaon with the detection of the decay products

The beam and the detector

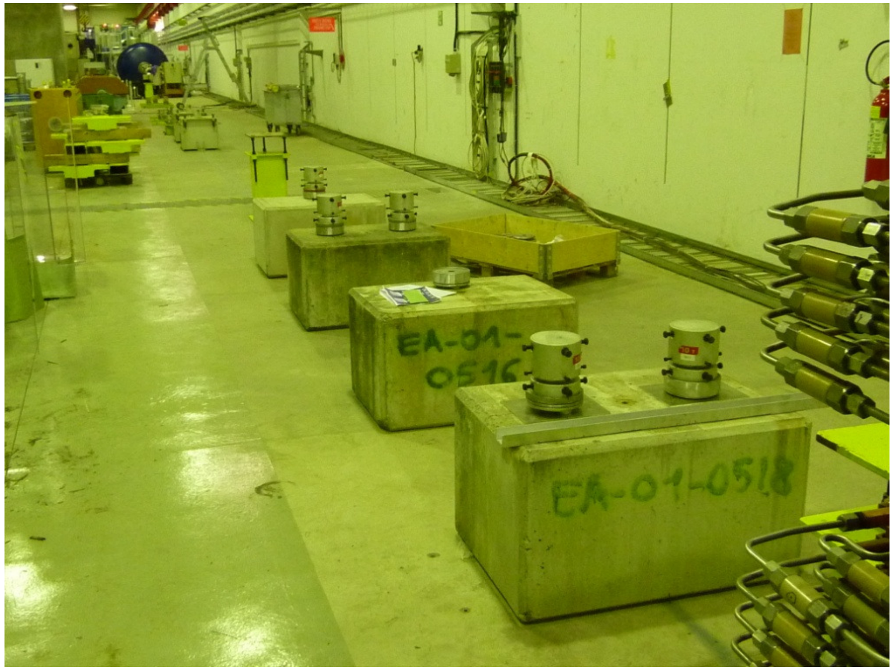
The beam

- New beam line under construction
  - Unseparated secondary charged beam
  - SPS primary protons at 400 GeV/c
  - $4.8*10^{12}$ Kaon decays/year
  - Average rate 750 MHz, kaon fraction 6%
- Small momentum spread
  - 75 GeV/c, $\Delta p/p \sim 1\%$
  - Defined with an achromat system
- Cleaning of the beam
  - Muon scraper
  - Positron free via tungsten radiators
- Final deviation of 1.2 mrad
  - Compensated later by the spectrometer kick to have the beam back on axis at the exit of the calorimeter
- Beam spectrometer installed in the final part
- Final note: the design of the beam line is such that, if needed, one can run with a neutral kaon beam



Beam installation

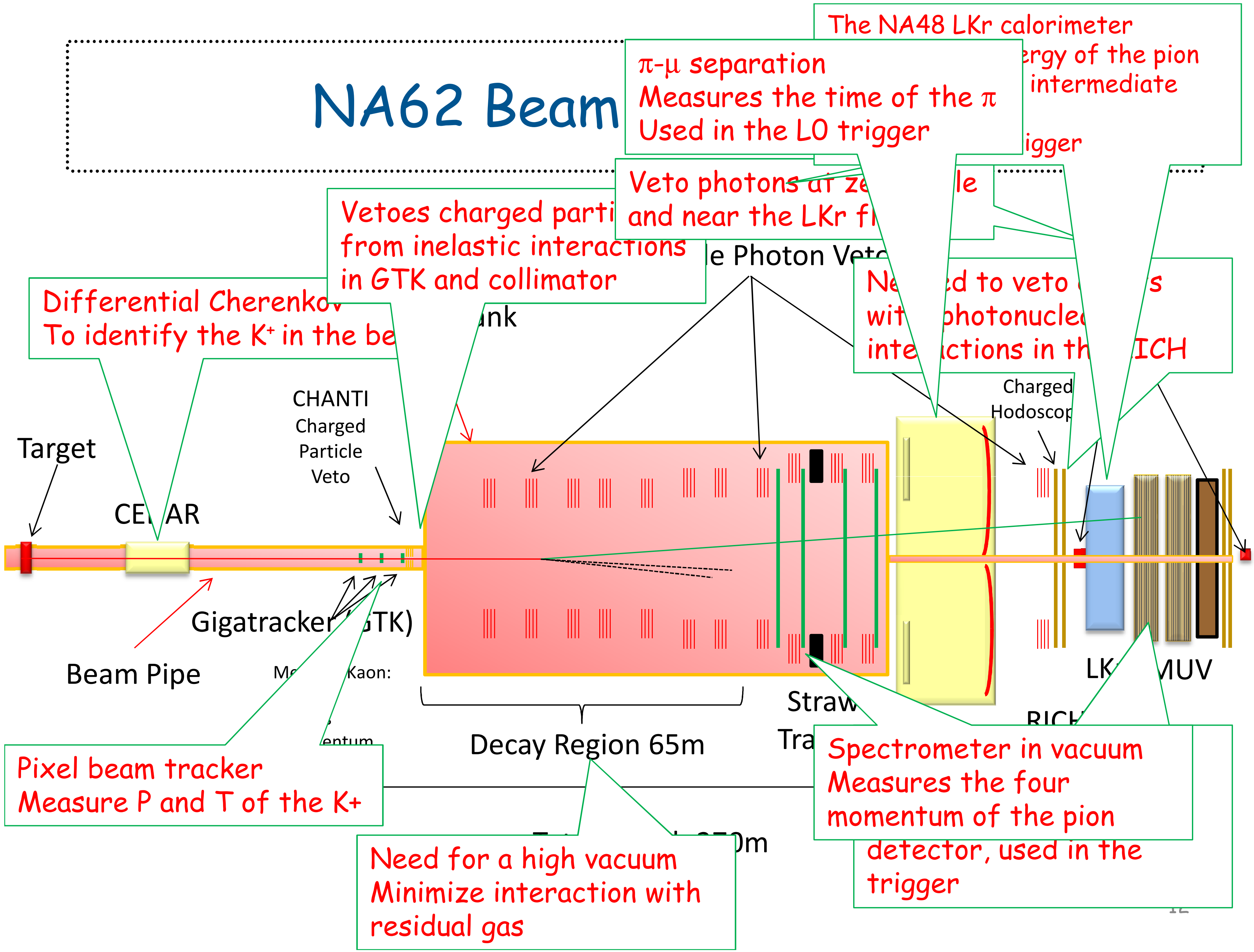
Started few weeks ago



Expected to be completed in spring

Commissioning up to the maximum intensity in autumn 2012

NA62 Beam



The NA48 LKr calorimeter
rgy of the pion
intermediate
igger
π-μ separation
Measures the time of the π
Used in the L0 trigger
Veto photons at ze
le
and near the LKr f
Vetoes charged parti
from inelastic interactions
in GTK and collimator
le Photon Veto
Differential Cherenkov
To identify the K+ in the be
nk
Ne
d to veto
s
wit
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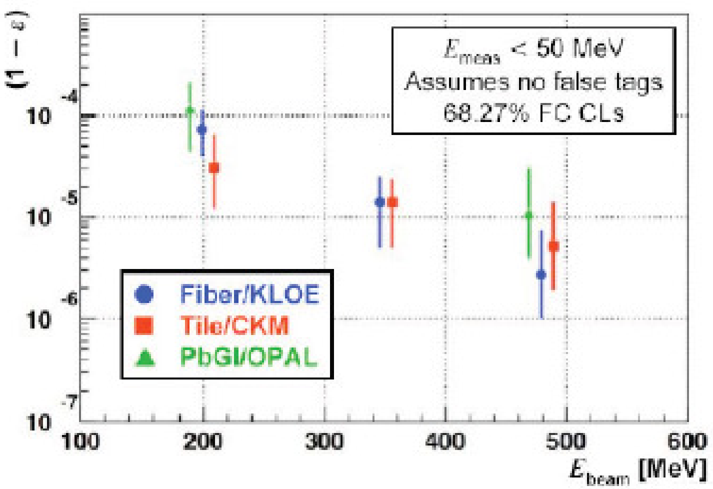
inte
ctions in th
ICH
Charged
Hodoscop
CHANTI
Charged
Particle
Veto
Target
CE
AR
Gigatracker
TK)
Beam Pipe
Kaon:
entum
Decay Region 65m
Straw
Tra
LK
MUV
RICH
Pixel beam tracker
Measure P and T of the K+
Need for a high vacuum
Minimize interaction with
residual gas
0m
Spectrometer in vacuum
Measures the four
momentum of the pion
detector, used in the
trigger

Photon Vetoes

- Designed to cover the solid angle up to 50 mrad
  - Very few low energy photons at larger angles
- Divided in three regions
  - Large angle vetoes (from 8 to 50 mrad)
  - The NA48 LKr calorimeter (from 1 to 8 mrad)
  - Small angle vetoes down to zero angle
- Global π^0 background rejection of 10^8
- Different technologies
  - Lead glass for the large angle vetoes
  - Liquid krypton ionization detector
  - Lead/scintillator shashlik for the small angle vetoes

Large Angle Vetoes

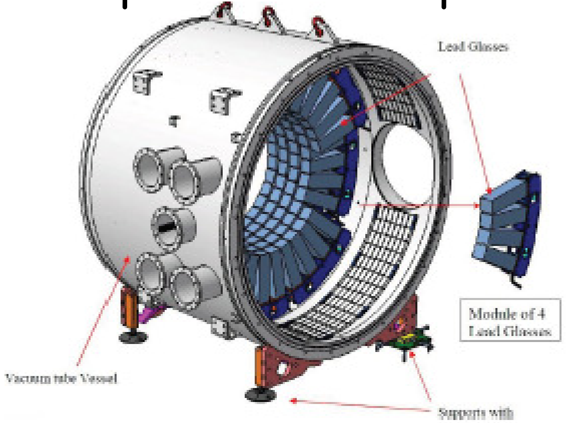
- 12 stations along the decay volume
- Creative reuse of 2500 lead glass blocks from the OPAL EM calorimeter
- Able to operate in vacuum
- Single block inefficiency < 10^{-4} for E_γ>200 MeV



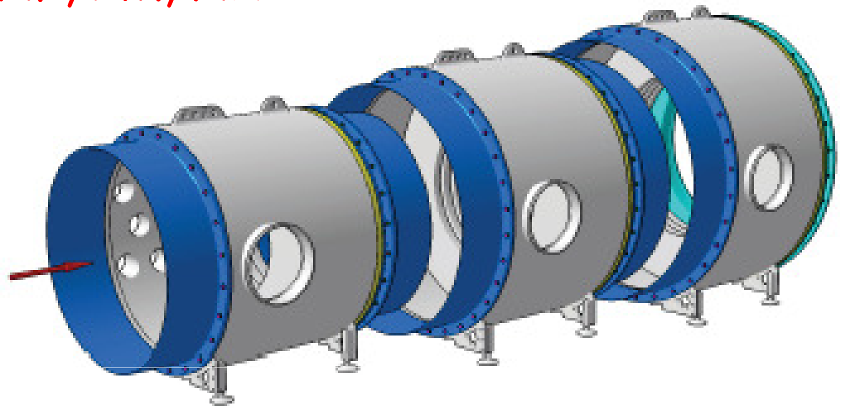
LAV mechanics

3 different sizes
Each detector has 4 or 5 staggered layers
32, 48, 60 blocks/layer

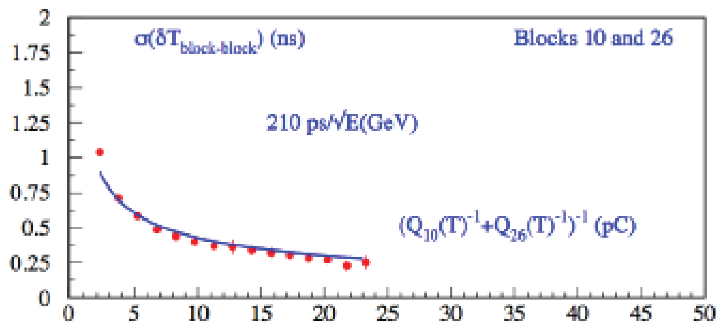
Readout with custom electronics + TEL62
Double threshold
ToT measurement, energy measurement at 10% level
Amplitude clamped to cover up to 10 V



Pisa, LNF, RM, NA



Time resolution from 2010 test beam



LAV installa

8 modules to be installed before summer 2012

Design of last LAV (in air) to be started

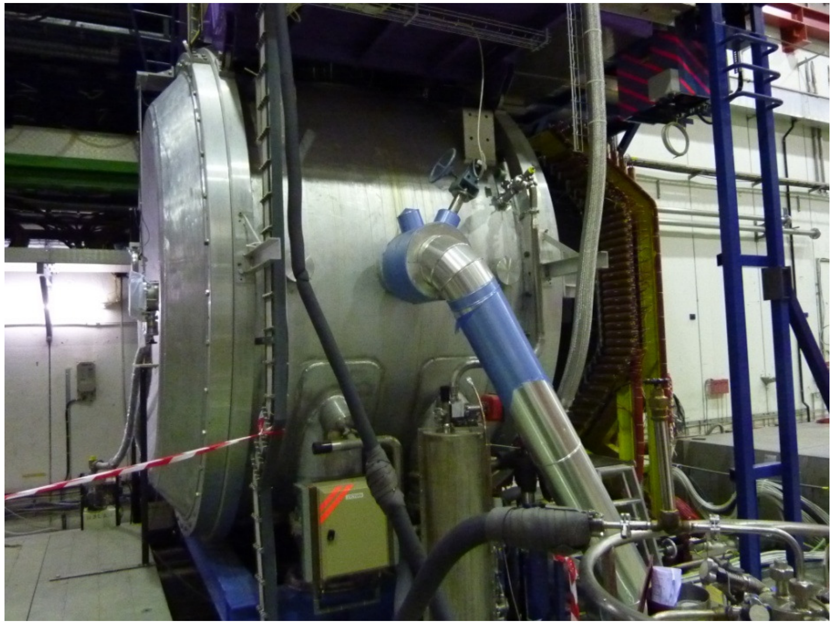
First trial mounting of one LAV module between two sections of the blue tube

Storage area of completed modules

LKr calorimeter

- Multiple functions
  - Photon veto in the intermediate angular region
  - Particle ID for positrons
  - Complement Muon Veto information for the discrimination π/μ

- Very good performance in NA48, keep them for NA62
  - Full of liquid krypton since spring 1998, without interruption!
  - But some intervention should be/has been done
    - Consolidation of the cryogenic infrastructure
    - The old readout electronics is not able to stand the rate, we need a new one
    - Several service electronics to be rejuvenated (calibration drivers, slow control)
  - Work done in the past years to consolidate the old readout
    - To be able to read at the actual rate the calorimeter during a test run like the one in 2012

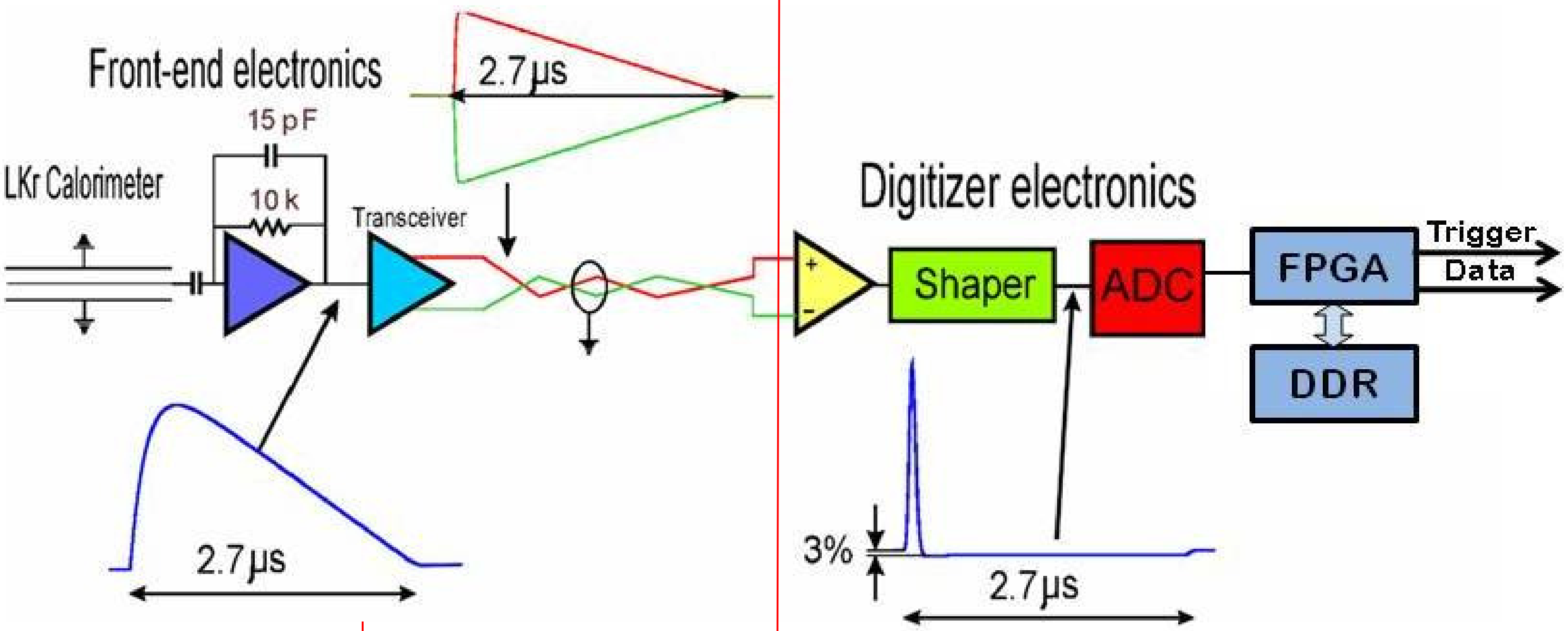


Brief excursus on new LKr readout

The LKr readout chain

Not changed

Readout upgrade

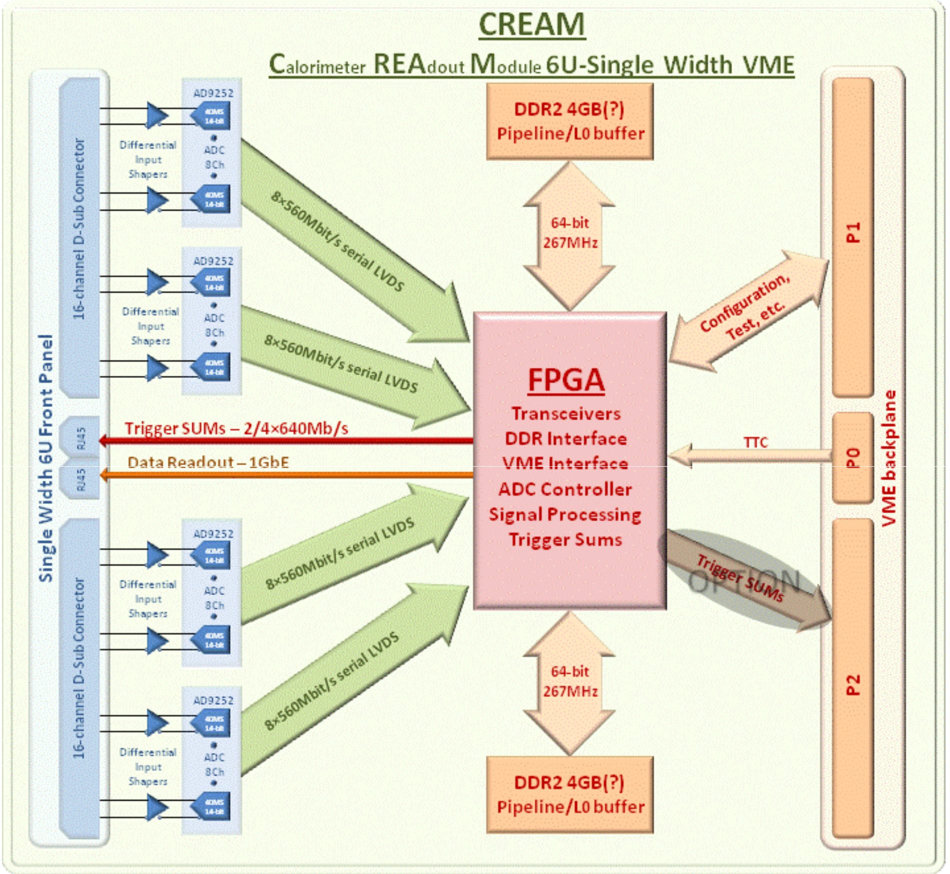


Inside LKr ←

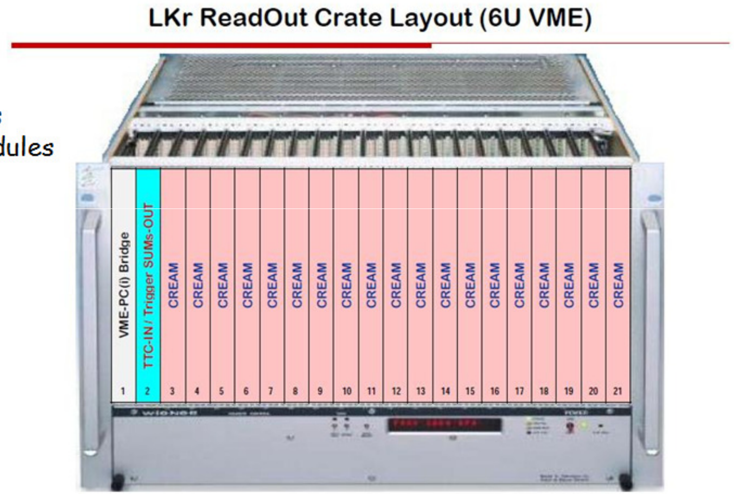
Existing electronics:

•10 KHz max rate
•Fastbus not supported any longer
•Gain switching

The CREAM system



28 crates
~440 modules



The CREAM board

- 8-channel, 14 bit, 50 MHz FADC
  - 4 chip serve 32 channels/board
  - Low power: 95 mW/channel
  - 1.8V operation, LVDS clock input, ENOB = 12 bit
  - No need of other external components
  - Plenty of diagnostic features
- FPGAs
  - One for VME interface, configuration, communication between internal blocks
  - One for the ADC connection and data handling in a DDR3 memory
    - Programming the ADC
    - Handling of the data transfer from the ADC to the memory
    - Handling of the DDR2 and of circular and linear buffer
    - Handling of the action related to L0 and L1 triggers
    - Zero suppression
    - Trigger sums to be sent to the LKr L0 hardware

The network

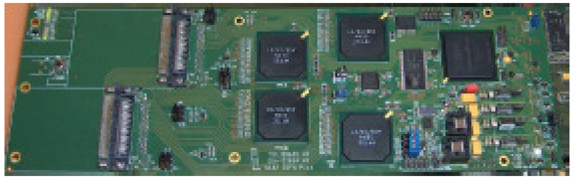
- Data readout
  - 1 Ethernet connection/CREAM
    - Readout at L1 rate of 100 KHz for 10 s, without ZS
    - The expected rate is O(400 Mb/s)
    - A safety factor of ~2
  - A concentrating switch for a crate could be installed between CREAM crates
    - 16 CREAMs (1 crate) to one 10Gb link
    - 28 10 GB fiber links to the main switching infrastructure in the surfave building
  - No limits on the network bandwidth to read NZS data at L1
  - Ability of handling NZS rate depends on the number*power of the PCs in the farm

Plans

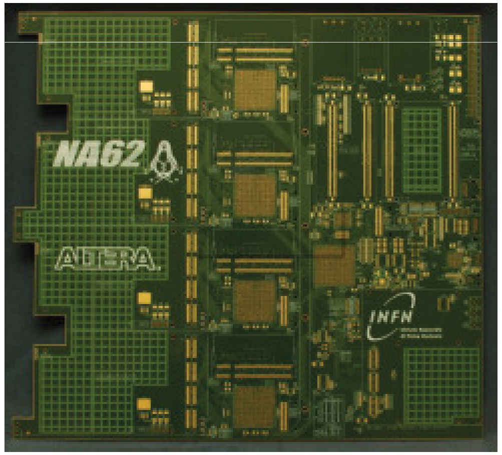
- Decision to build the modules outside CERN
  - Detailed specifications written for a tender procedure
  - The tender has been assigned to CAEN spa
- Tight contacts with CAEN designers
  - Several items under review
    - Analog shaper, layout, FPGA type, network protocol, etc.
- Plans for production
  - Two prototypes by July 2012
  - We should be ready then to test them
  - First half of the modules delivered January 2013
  - Second half June 2013
  - Installation and commissioning by the end of 2013

Trigger & data acquisition

- Readout electronics common to many detectors
  - TDC boards on TEL62
  - Time measurement
  - Time-Over-Threshold measurement for time walk corrections
  - FE provides LVDS signals
- TDC daughter board(128ch)
- TEL62 hosts 4 TDC boards
- Detectors with special solutions:
  - Gigatracker (too high rate)
  - LKr (too much data)
  - Straw (cheaper solution)



TDCBoard based on HPTDC



TEL62 refit of TELL1(LHCb)

Trigger

High trigger efficiency (> 95%)
Low random veto (< 1%)
Fully digital after FE

L0 Hardware + L1/2 Software
High data bandwidth (5GB/s)
1 MHz L0 trigger rate
O(100 KHz) L1 trigger rate

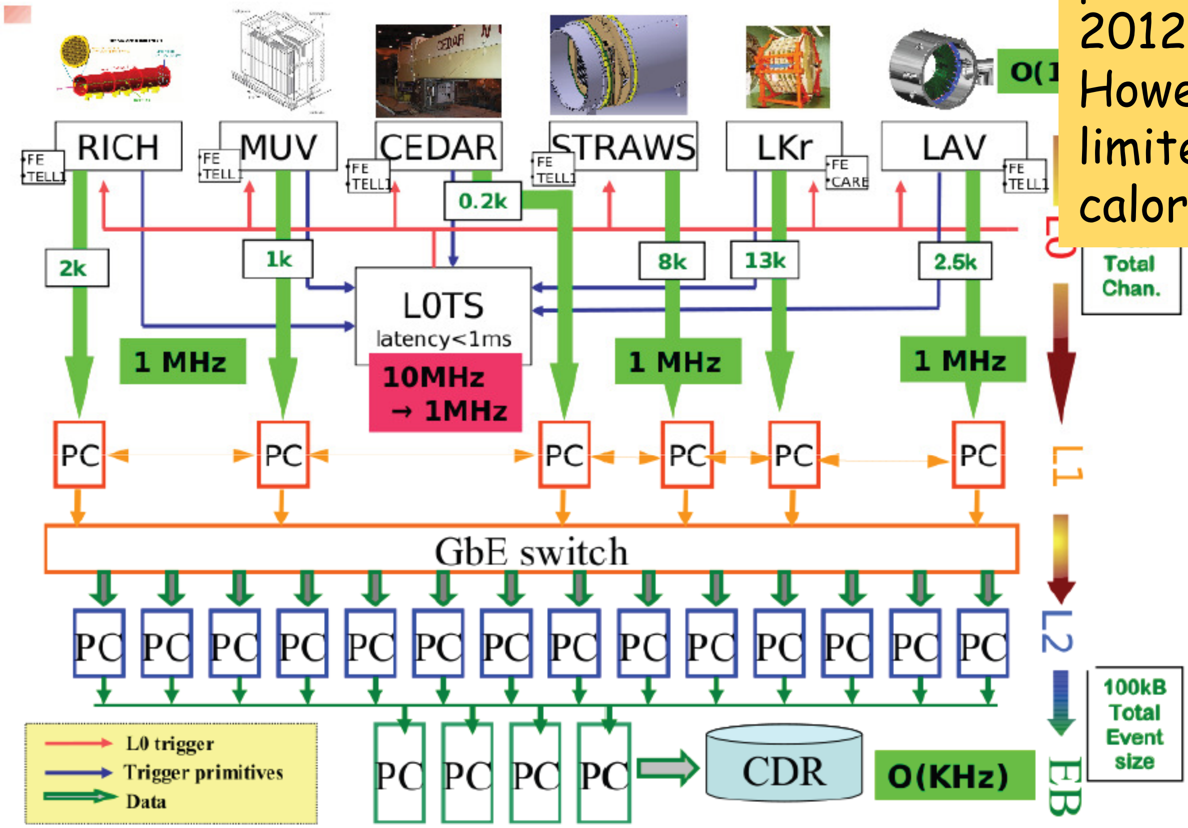
Estimation of L0/L1 rates

gradually add signals on top of the previous →

Preliminary	kHz	CHOD	* RICH	* MUV3	* LKR	* LAV_12	* LAV_ALL
$\pi\pi^0$	**1859**	1255	1128	1078	200	134	85
$\mu\nu$	5719	3786	3376	1	1	1	1
$\pi\pi\pi$	503	393	379	315	89	89	89
$\pi\pi^0\pi^0$	158	105	97	90	3	1	0
$\pi^0 e\nu$	456	265	243	243	41	28	20
$\pi^0\mu\nu$	301	195	178	1	1	0	0
TOT	**8998**	**5999**	**5400**	**1727**	**334**	**254**	**196**
$\pi\nu\nu$ (P,Z cuts) eff. %		93	82	77	75	75	75

Trigger and DAQ

Have the infrastucture (clock, network, proto-trigger processor) ready by Spring 2012
However, trigger rate will be limited by the actual calorimeter readout



detectors partecipating to the trigger

L1: Software level

"Single detector" PCs

L2: Software level

The informations coming from different detectors are merged together

The L0 is synchronous (through TTC). The input rate is ~10 MHz. The latency is order of 1ms. The trigger decision is based on information coming from RICH, LKr, LAV and MUV.

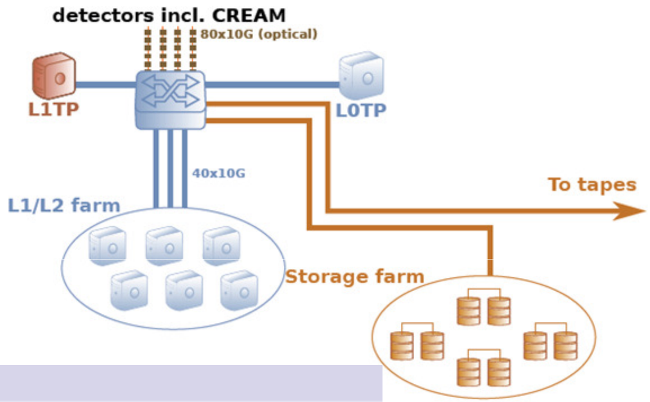
The L1 is asynchronous (through Ethernet). The input rate is ~1 MHz. The maximum latency is few seconds (spill length). The output rate is ~100 kHz.

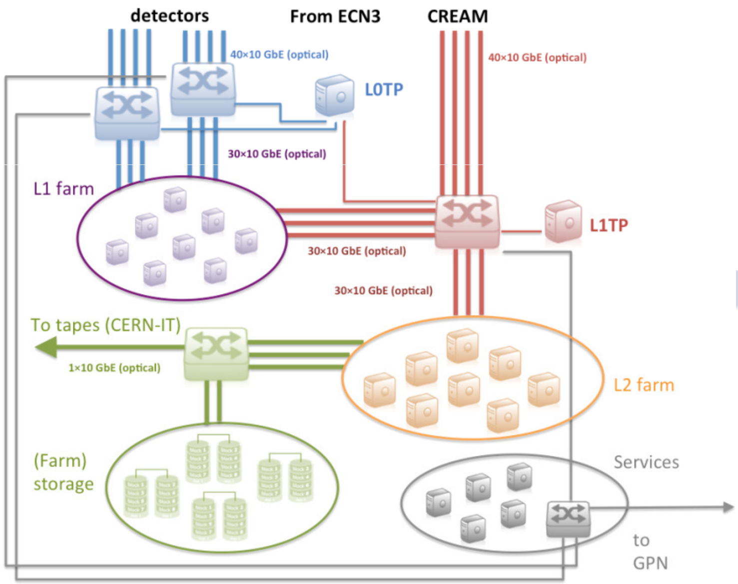
Network and farming

Previous slide showed logical structure

L1 data are muxed on 10 Gb/s links
The LKr has its set of 10 Gb/s links

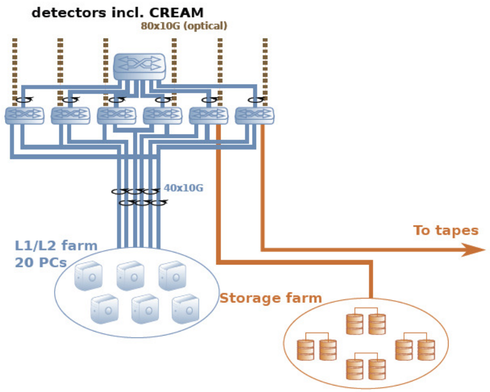
Second iteration: L1 and L2 on the same machines
Only one big switch





First network structure: L1 and L2 processing separate
Many big switches
Lot of transfer between PCs

Hexapus topology



Third scenario:
As above, but with smaller (cheaper) interconnected switches
Tradeoff between bandwidth and cost

R&D for GPU use in triggering

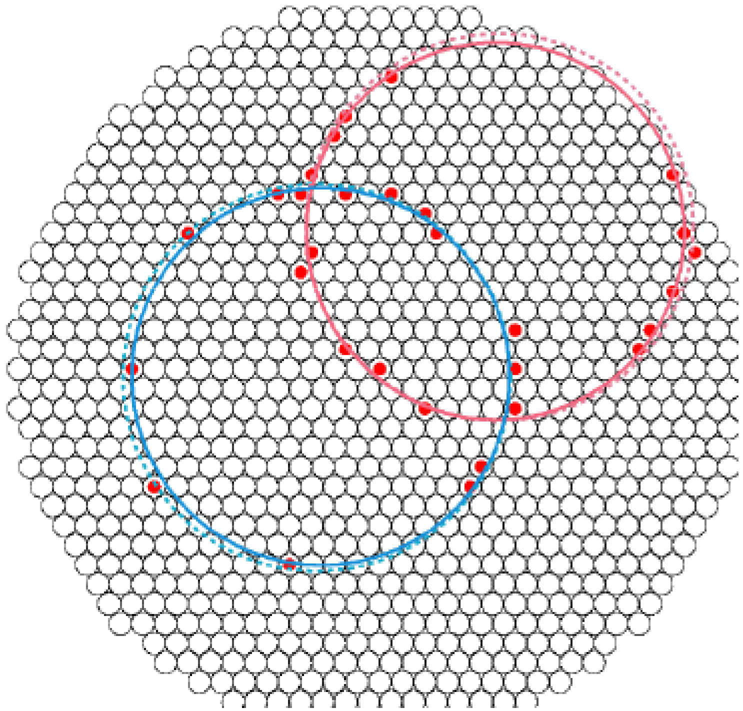
Graphics Processor Units have enough computing power to be used in on-line applications.

For NA62, investigations ongoing

• (L1/2) applications: easy, just put the video card in the PC and program it
Reduce the number of PCs

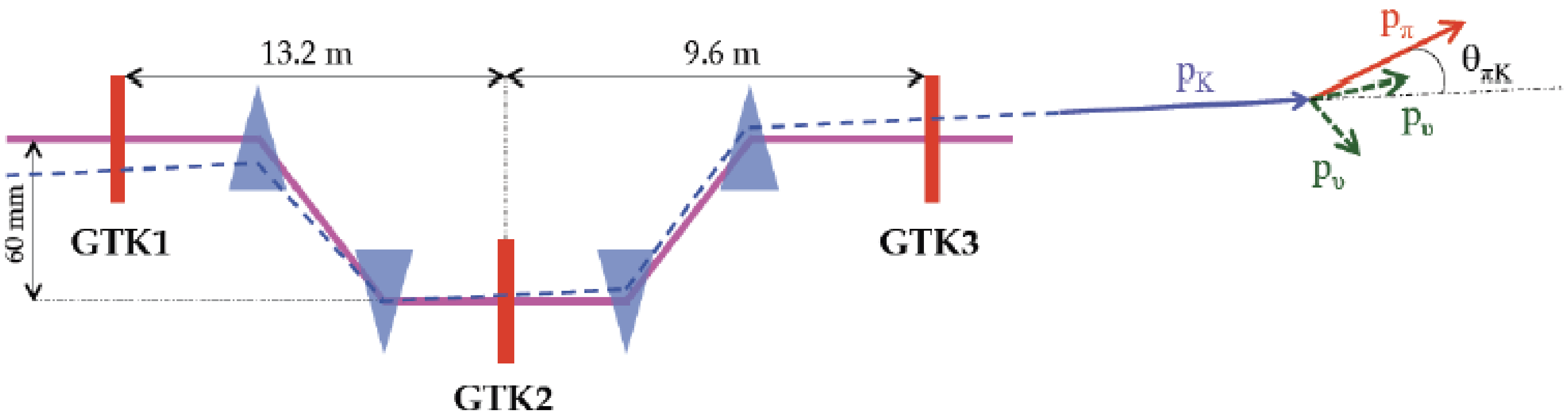
• L0 applications: challenging
Low latency, high rate, deterministic response
Moreover, up to now it is not possible to connect a GPU to readout HW (ie. TEL62). A PC is needed.

Study case: ring recognition in RICH



Several algorithms studied. Timing:
~50 ns per ring @L0
using a parallel algebraic fit (single ring)
~1.5 μs per ring @L1
using a refined algorithm (double ring)

Gigatracker



- Beam spectrometer
  - precise momentum, time and angular measurements (on all beam tracks)
  - high and non-uniform rate (~1.5 MHz/mm² in center, 0.8-1.0 GHz)
  - reduce multiple scattering and hadronic interactions

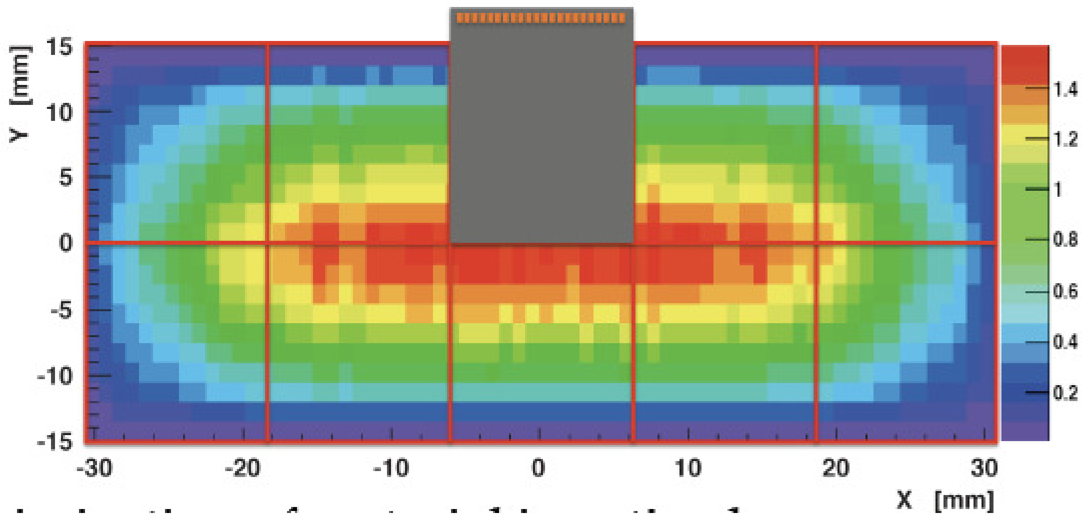
- X/X_0 <0.5% per station
- $\sigma(p_K)/p_K$ ~0.2%
- $\sigma(\theta_K)$ ~16 μrad
- pixel size 300 μm × 300 μm
- **σ(t) ~150 ps** on single track

Gigatracker

Installation in vacuum

High and non-uniform radiation levels:

~2*10^{14} (1MeV neq/cm^2) in the center for 100 days of operation



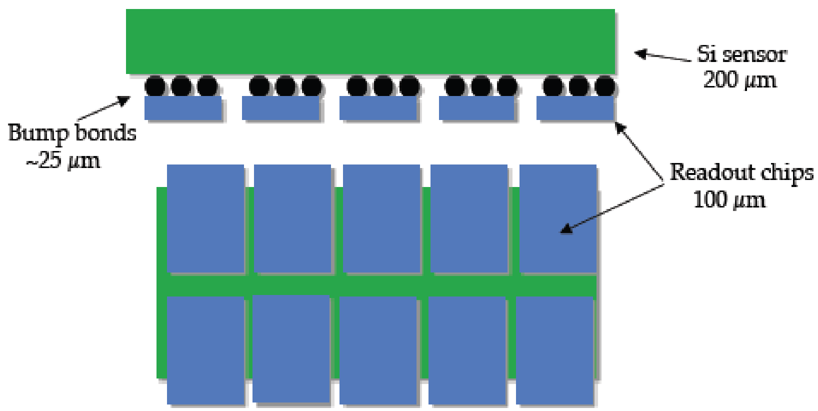
Operating temperature ~ -20 °C to limit radiation induced leakage current

Hybrid pixel detector
300μmx300μm pixels

Sensor 60x27 mm^2, bump bonded to 10 read-out chips

P-in-N sensor as baseline
Production at FBK, Trento

Over-depleted operation for σ_t<200 ps (rms) per station

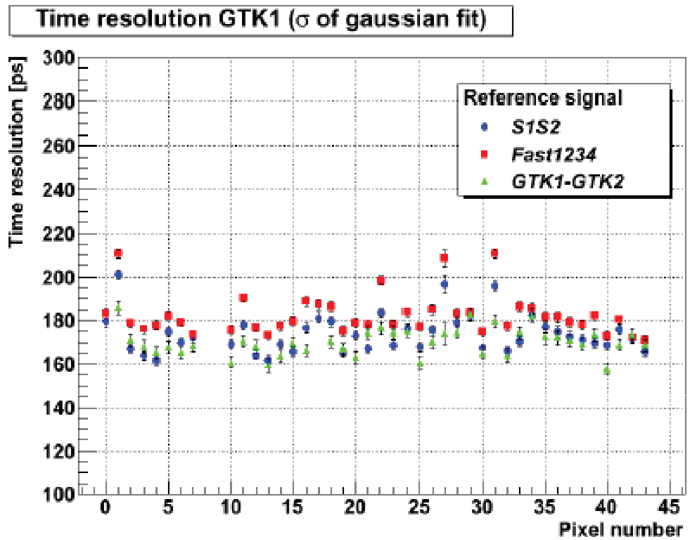


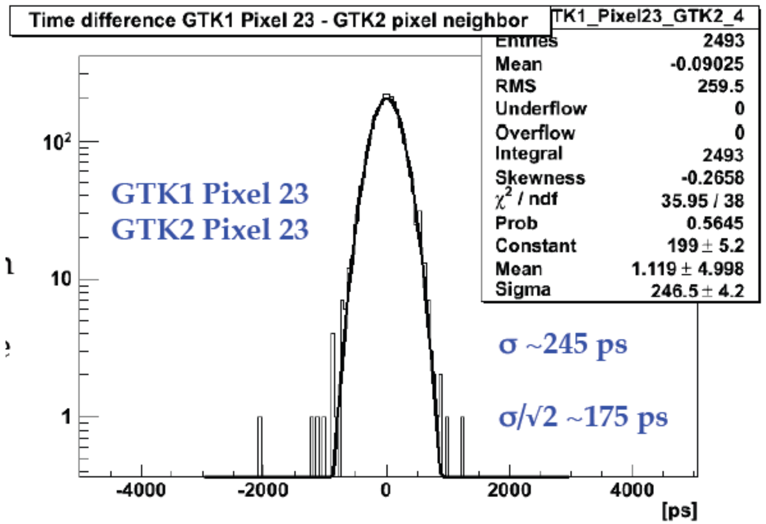
Test beam r

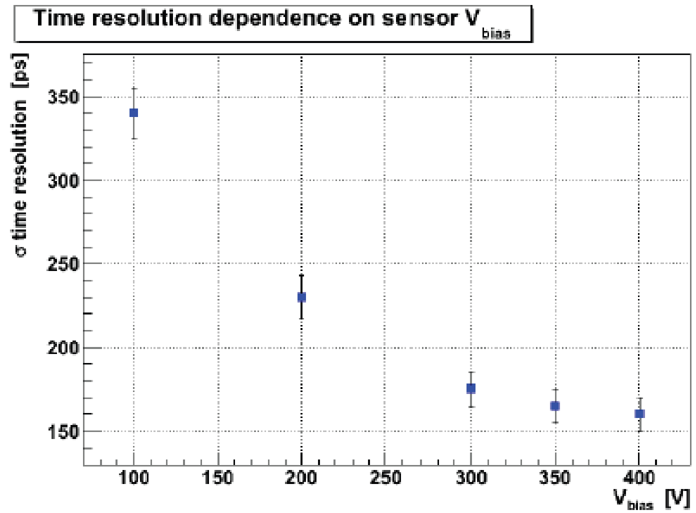
Expected for 2014

- Wafer with
  - Full final sensor
  - Single chip sensors
  - Prototype ASICs (EOC,p-TDC)

- 10 GeV/c p and π^+ beam
- 4 stations/ASIC prototype

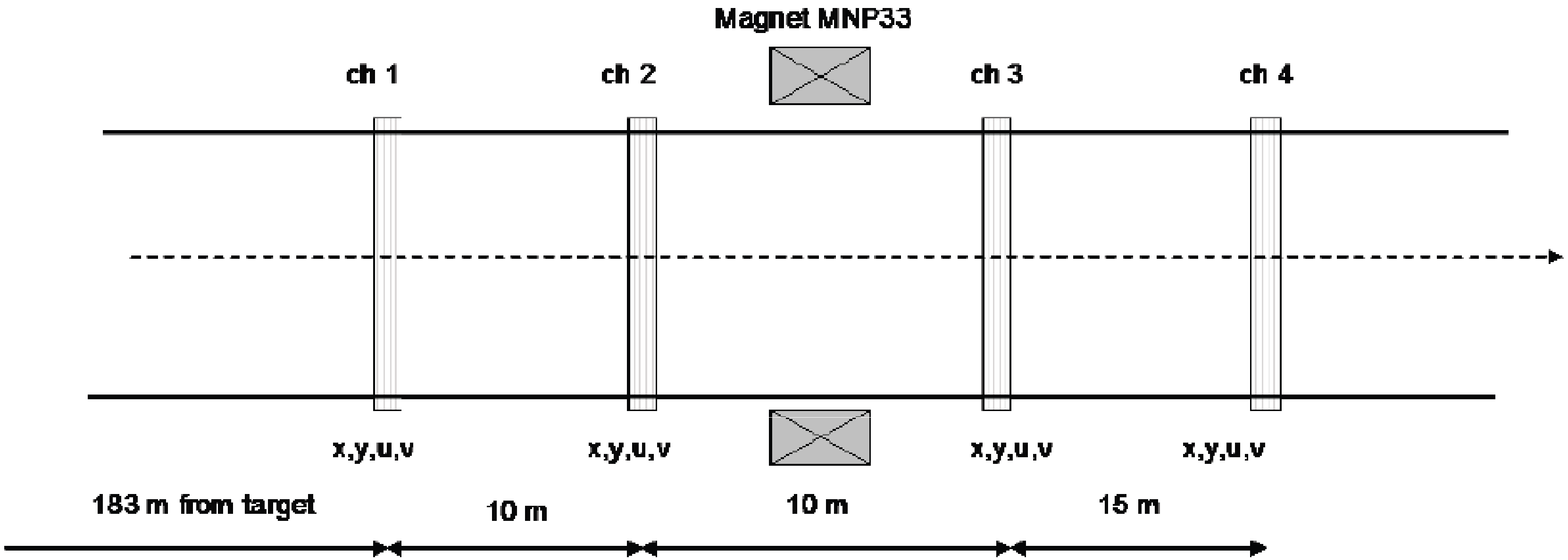






300 V bias, GTK info only (two stations)

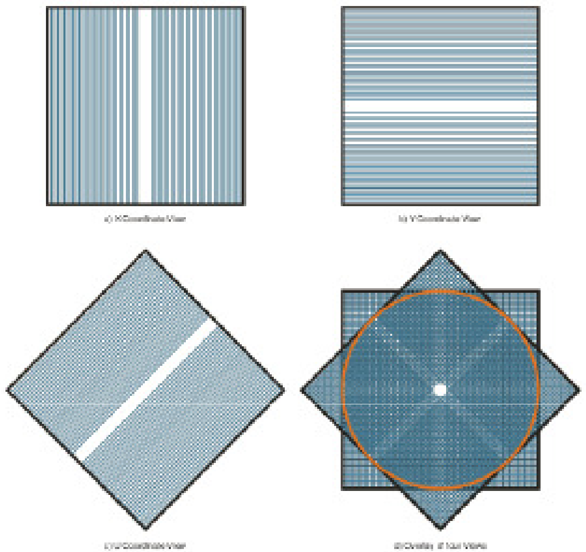
Spectrometer

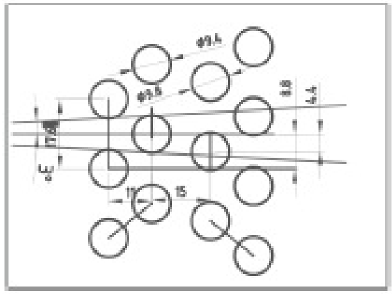


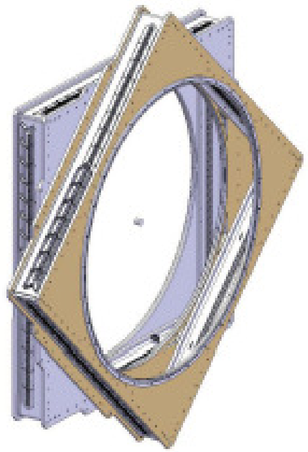
- Keep material at a minimum: straws in vacuum
- 7168 mylar straws in 4 chambers, <4*0.5% X_0
- ,Ar/CO_2 70%/30%, leakrate $<10^{-1}$ mbar l/s
- $\sigma_p/p < 1\%$, $\sigma_t < 60$mrad
- 270 MeV/c P_T kick

Structure of the chambers

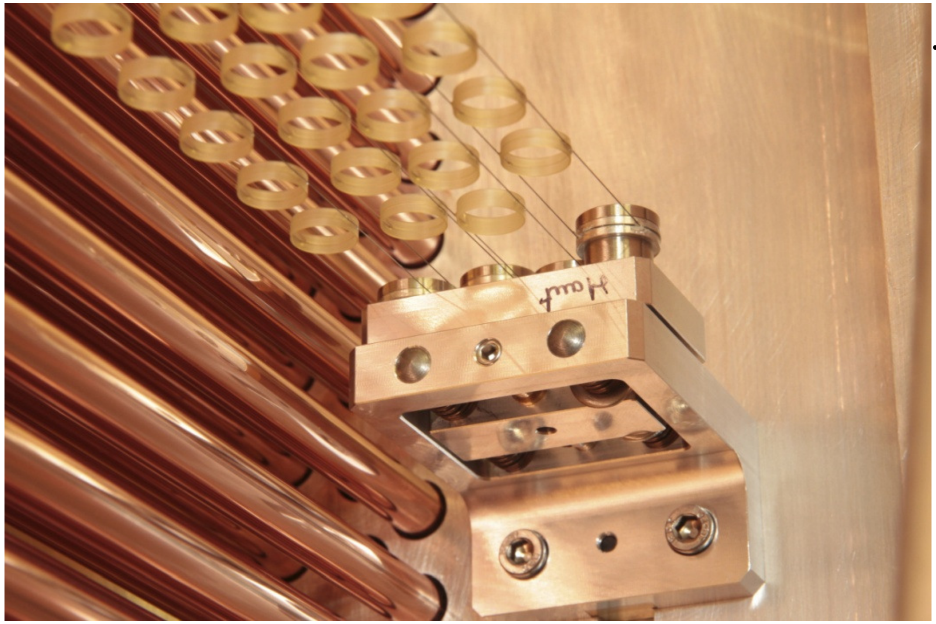
- 4 views (u,v,x,y)
- $\oslash = 2.1$m acceptance
- $\oslash \approx$12cm beam hole
- Track angle coverage $\pm 3^o$
- 30μm gold-plated W wire
- 100μm straw straightness
- 200μm wire position acccuracy
- $\sigma < 130\mu$m single view

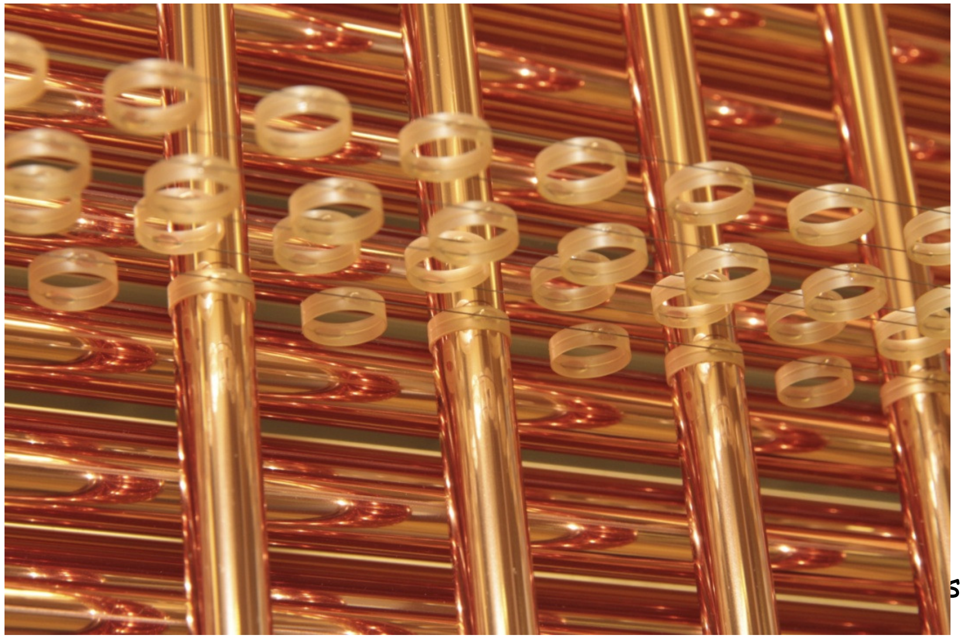






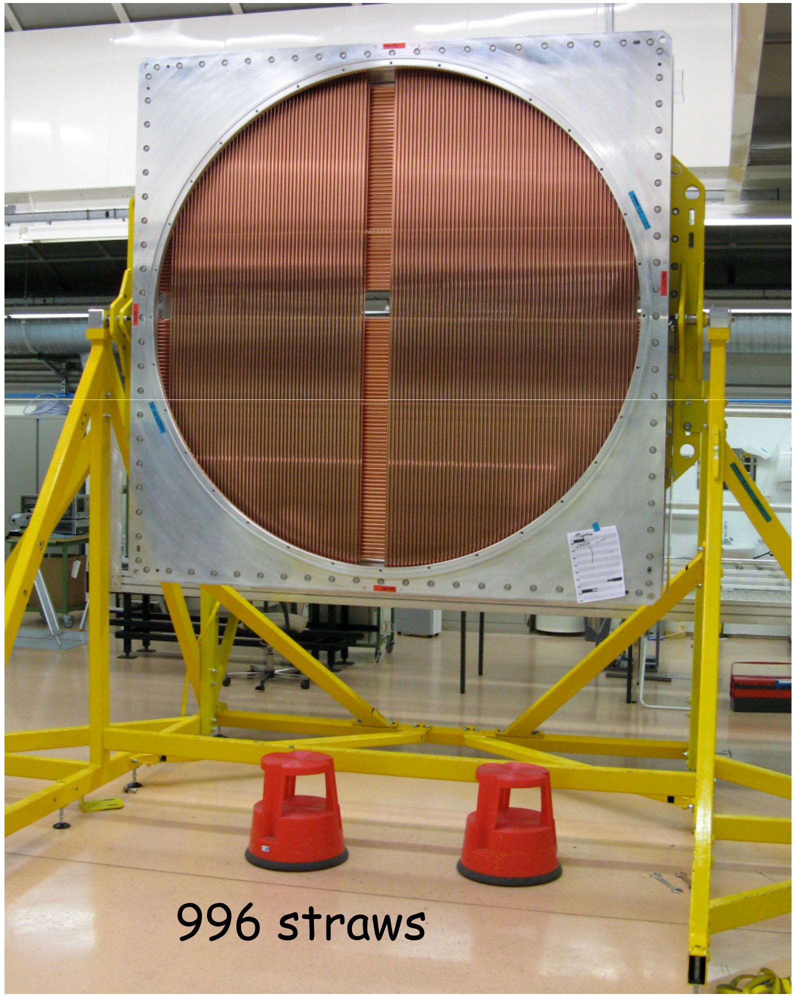
Module 0

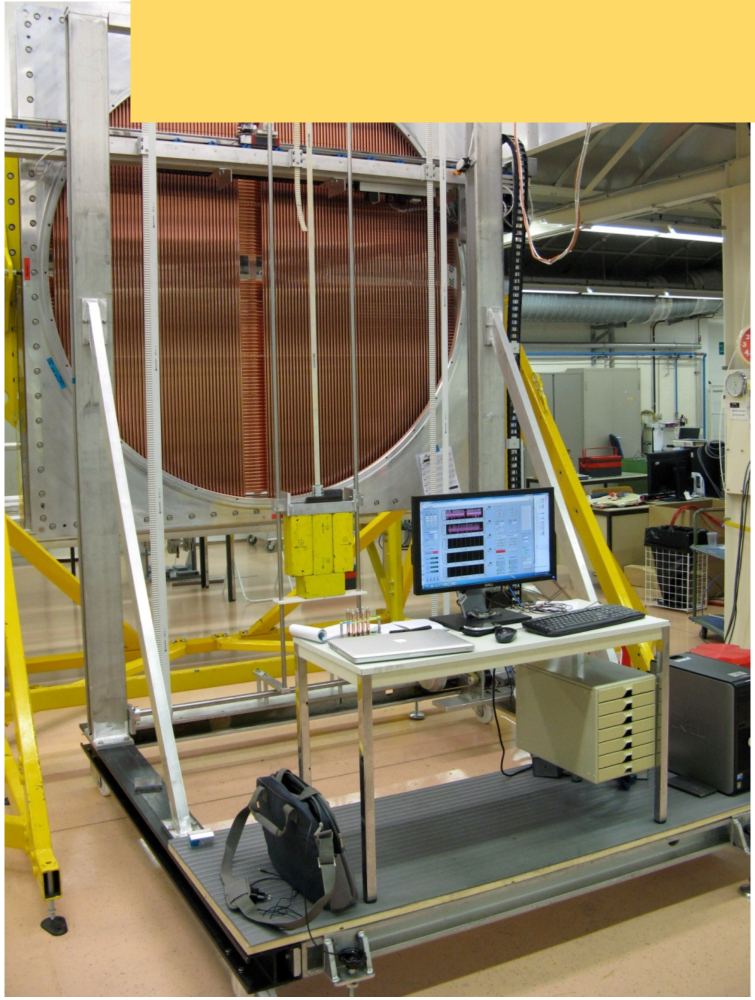




STRAW Mod

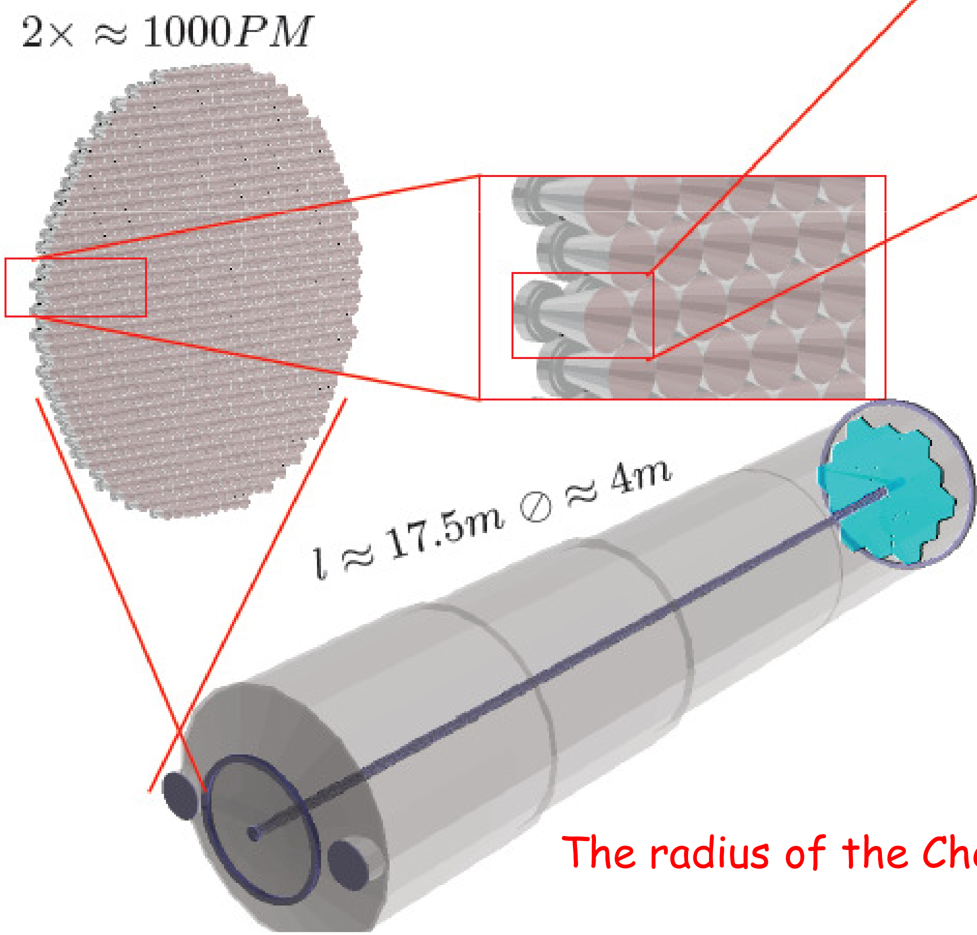
One complete chamber for
2012 run

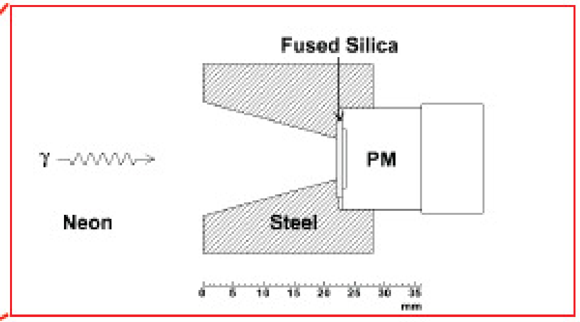




Rich

Additional rejection π/μ
Fast trigger signal
Precise measurement of event time





- Ne @ 1 atm ($\approx 5\% X_0$)
- Vacuum proof vessel
- 20 mirror segments ($\approx 20\% X_0$)
- $15 < \frac{p_{tr}}{GeV/c} < 35$
- Contamination of $\mu < 1\%$
- Level 0 Trigger
- $\sigma_t < 100ps$

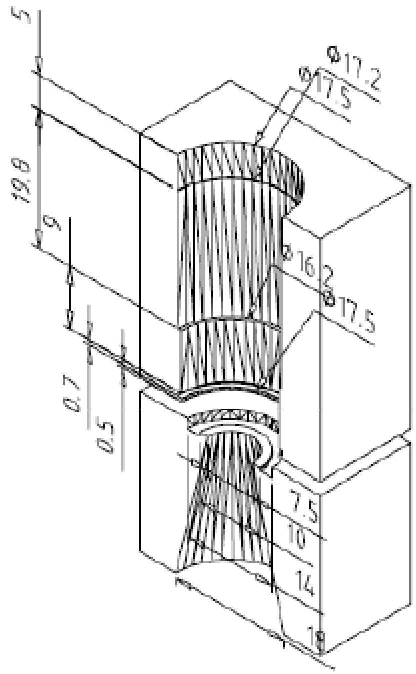
The radius of the Cherenkov ring on the PMs is related to β

Details of the optics

2 focal points
Individual hexagonal segment
R = (34.0±0.2)m   (f = 17m)

Reflectivity > 90% (195-650nm)

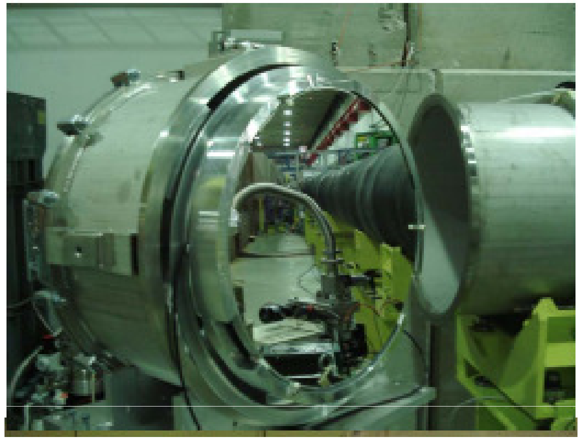
Thickness 2.5cm (glass)
Remotely orientable



Winston cones (Al-mylar)
Quartz windows Ne/air

Photomultiplier Hamamatsu
R-7400-U03
σ_{tt} ~300ps

Rich prototype



Mirror diameter = 50cm f = 17m

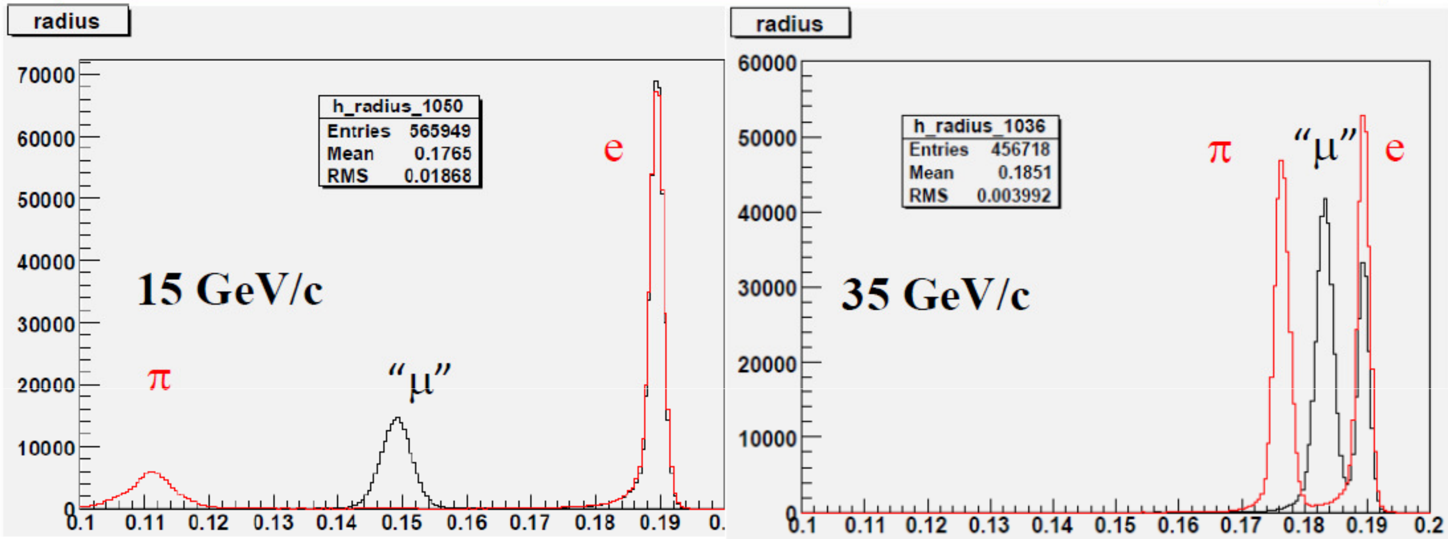
Test beam in 2007 to validate the principle, only 96 PMs

414 PMs in 2009: study π/μ rejection, validate cooling and readout with preampli + ALICE Nino + TDCB + TELxx

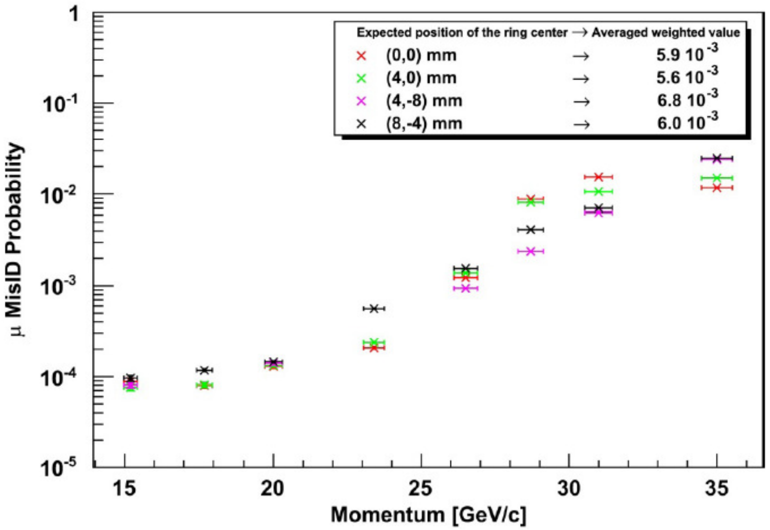
Rich prototype

Still working on the details of the vessel

Ready for 2014



μ simulated with π of the same β



Muon mis-id probability as a function of momentum

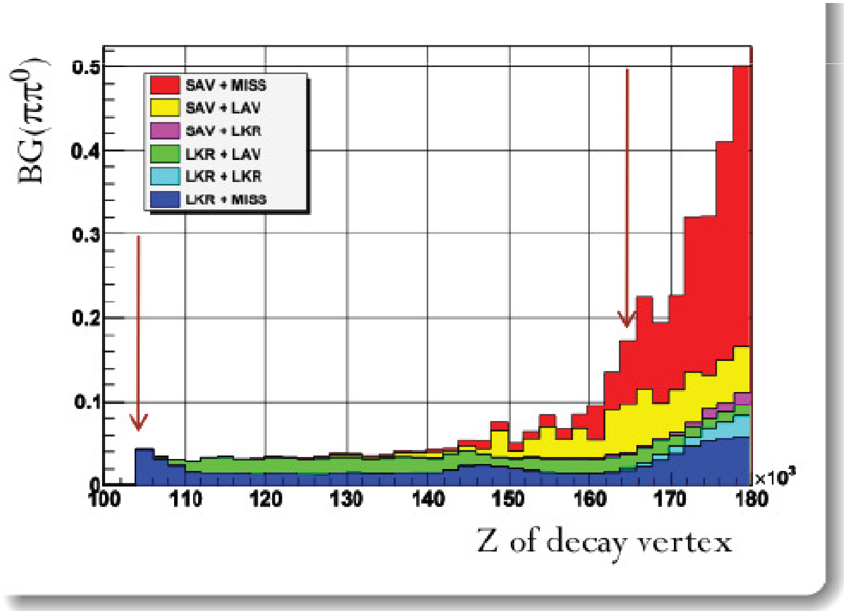
Software

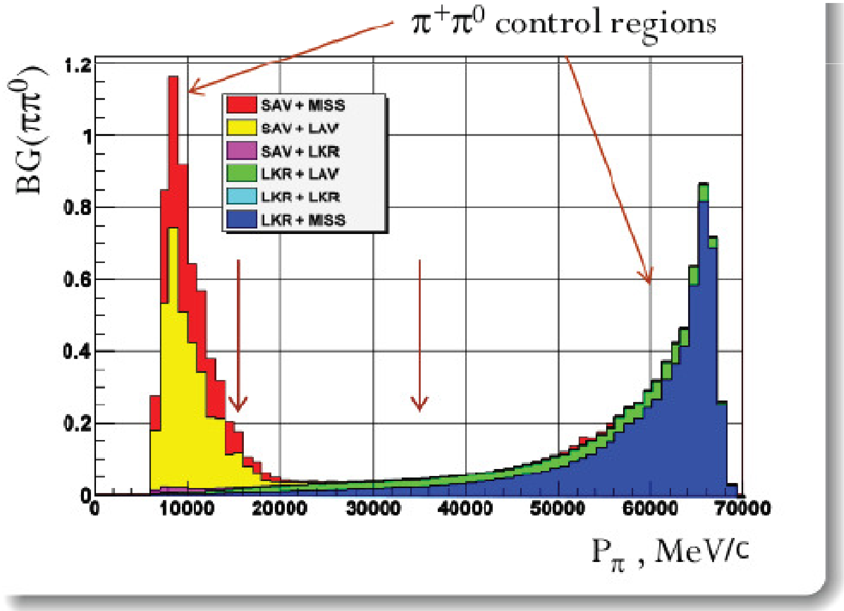
- Software framework based on GEANT4 and ROOT
  - Simulation package
  - Reconstruction
  - Event display
  - Analysis tools

  - Used for a lot of studies on backgrounds and sensitivity
    - See next slides
- Oracle DB being setup
  - Slow startup, first idea of detector requirements
- Online software
  - Being attacked now

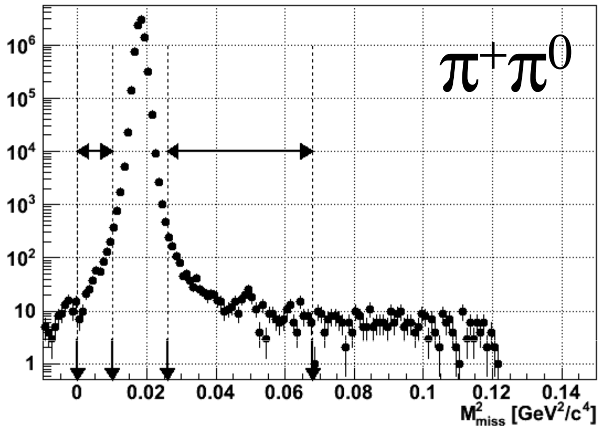
Simulation - $\pi^+\pi^0$ background

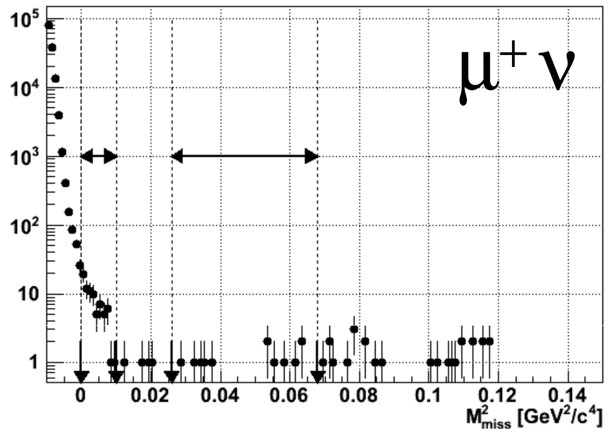
Study of $\pi^+\pi^0$ background
As a function of the longitudinal decay coordinate and of the charged pion momentum
Reference to optimize analysis cuts for bckg minimization

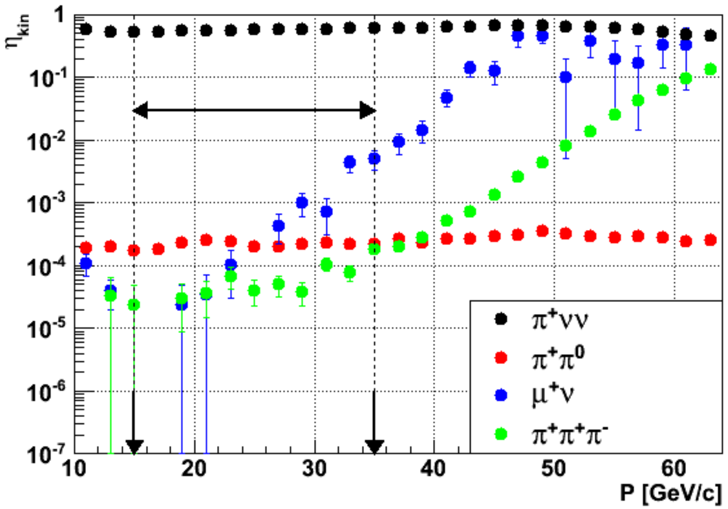




Simulation - Kinematics rejection





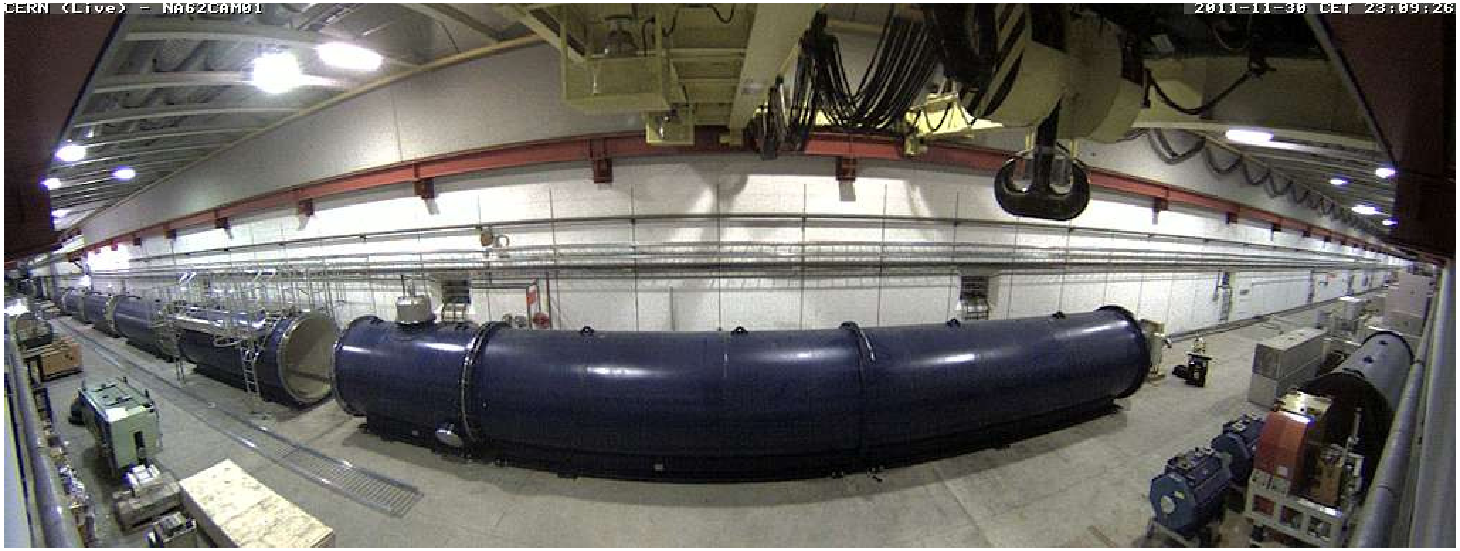


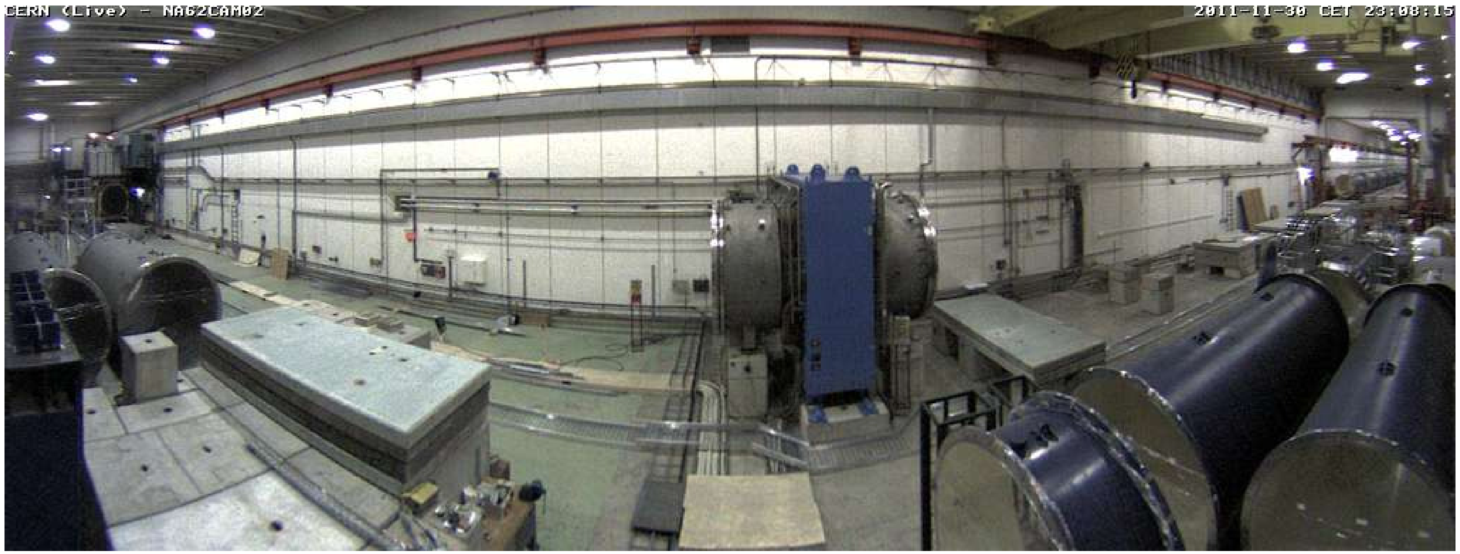
Channel	Rejection
$\pi^+\nu\nu$	~0.57
$\pi^+\pi^0$	$(2.2 \pm 0.5) \times 10^{-4}$
$\mu^+\nu_\mu$	$(0.7 \pm 0.1) \times 10^{-4}$
$\pi^+\pi^+\pi^-$	$(1.4 \pm 0.2) \times 10^{-4}$

Installation work

ECN3 – November 2009

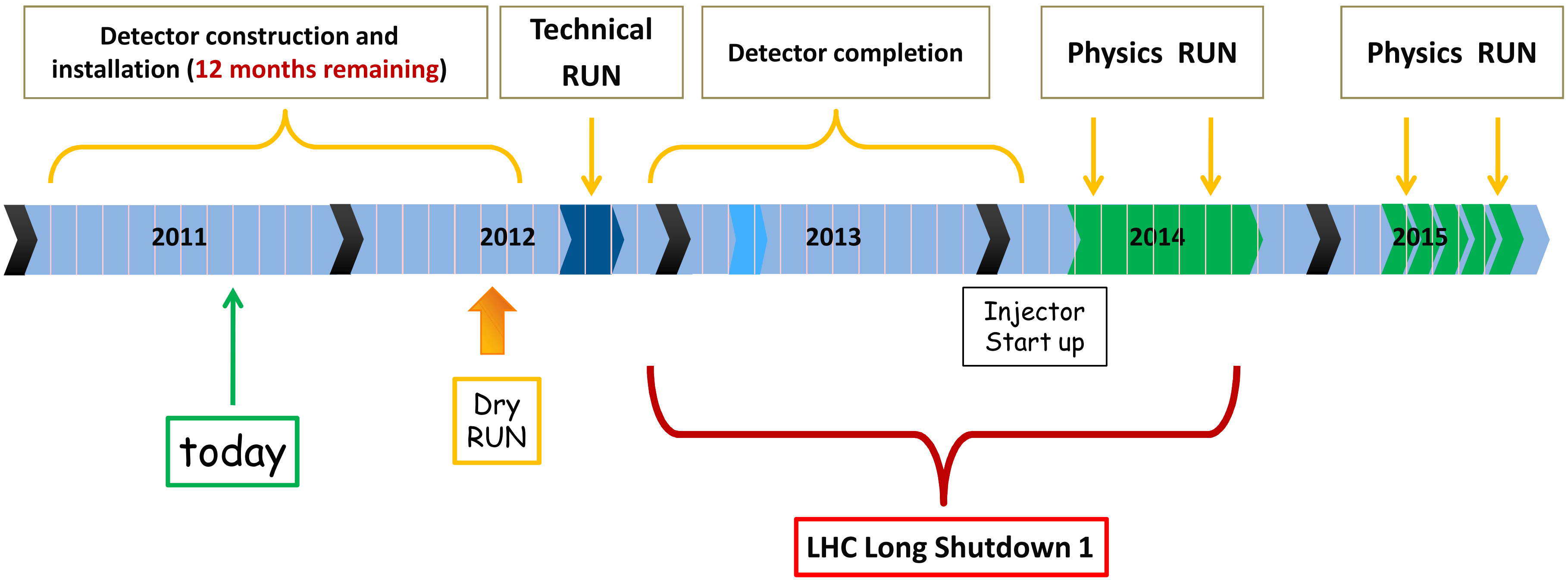
ECN3 camera view – 30.11.2011





Run 2012

2011 -2015

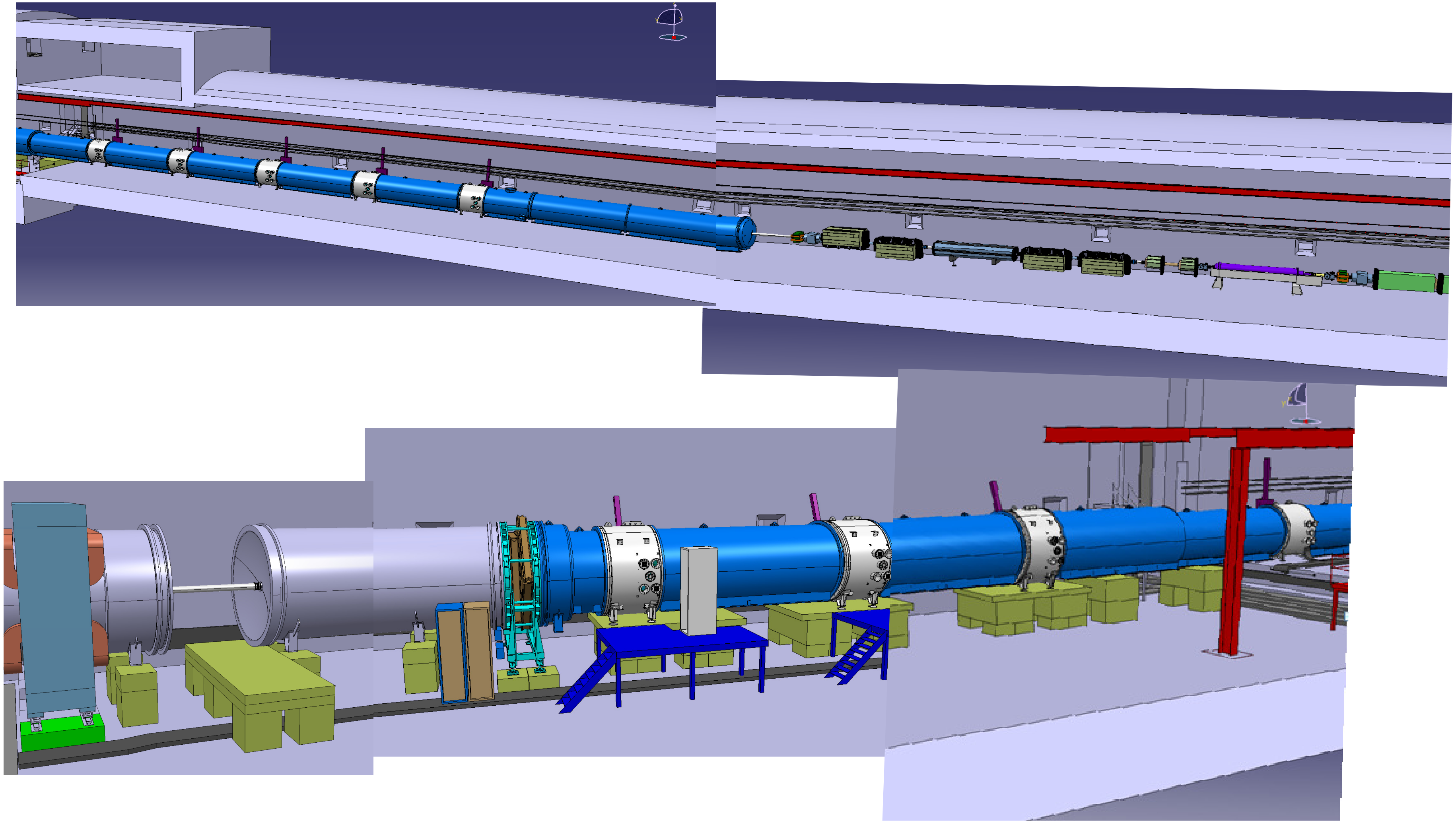


- Technical RUN 2012
  - Partially complete detector
  - Goal:
    - Running in, tuning of detectors and read-out
    - Sensitivity measurements
- Physics RUN 2014/15
  - Full detector installed
  - Start in 2014

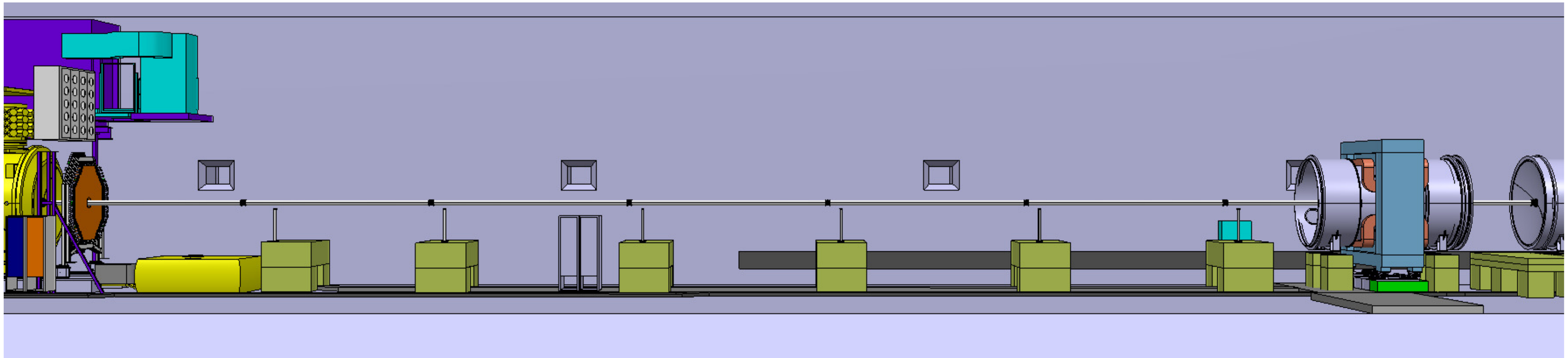
Run 2012

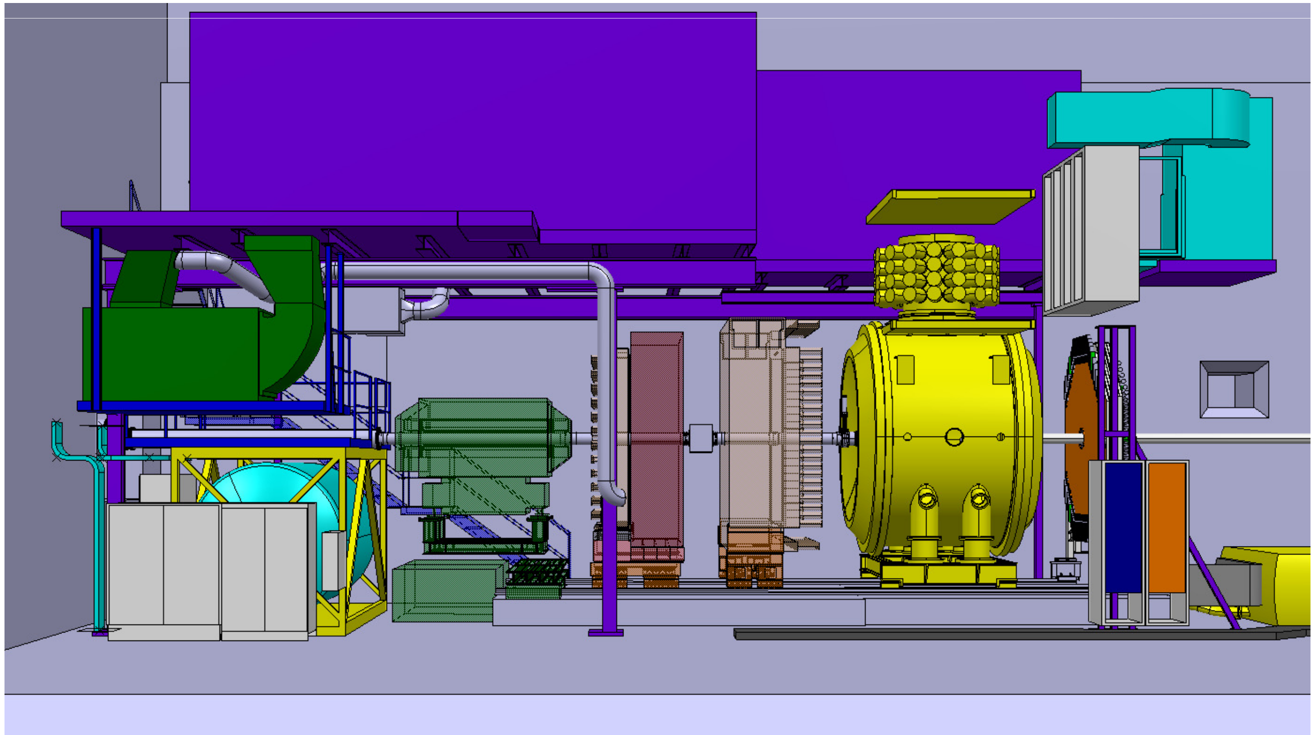
- Change gear to have a first round of data taking
  - Lot of effort to be put in “online” stuff
    - Computers, network, online software, event building, etc.
  - Complete the list of the detectors to be readout
    - Mainly to provide all the needed readout boards
- First “dry run” foreseen for middle July
  - Commissioning of all the readout with pulser data
- Beam request: 1 month starting middle October
  - Complete commissioning of the beam
  - Start looking at data in the real environment
  - Low rate due to the calorimeter
    - However high intensity runs possible switching it off
  - Possible preliminary sensitivity studies

2012 detector configuration - 1



2012 detector configuration - 2





LKr readout in 2012

- The new readout will not be ready for 2012
  - The old readout needs an interface to the old trigger distribution scheme
  - Approach: specific hardware to be put on TEL62
    - Use TEL62 to receive the "NA62" trigger info and convert to the "NA48" mode
  - Implement the first ideas to have a multifunction board
    - Add an FPGA
    - Add 5 Ethernet controllers
    - Add general purpose I/O
  - Many applications found
    - Calibration driver
    - Ethernet latency measurement
    - TEL62 functionality tests
    - Base for the setup of the CREAM test bench
    - Test bench for the development of L0 trigger processor functionalities

TALK board

Trigger Adapter for LKr readout

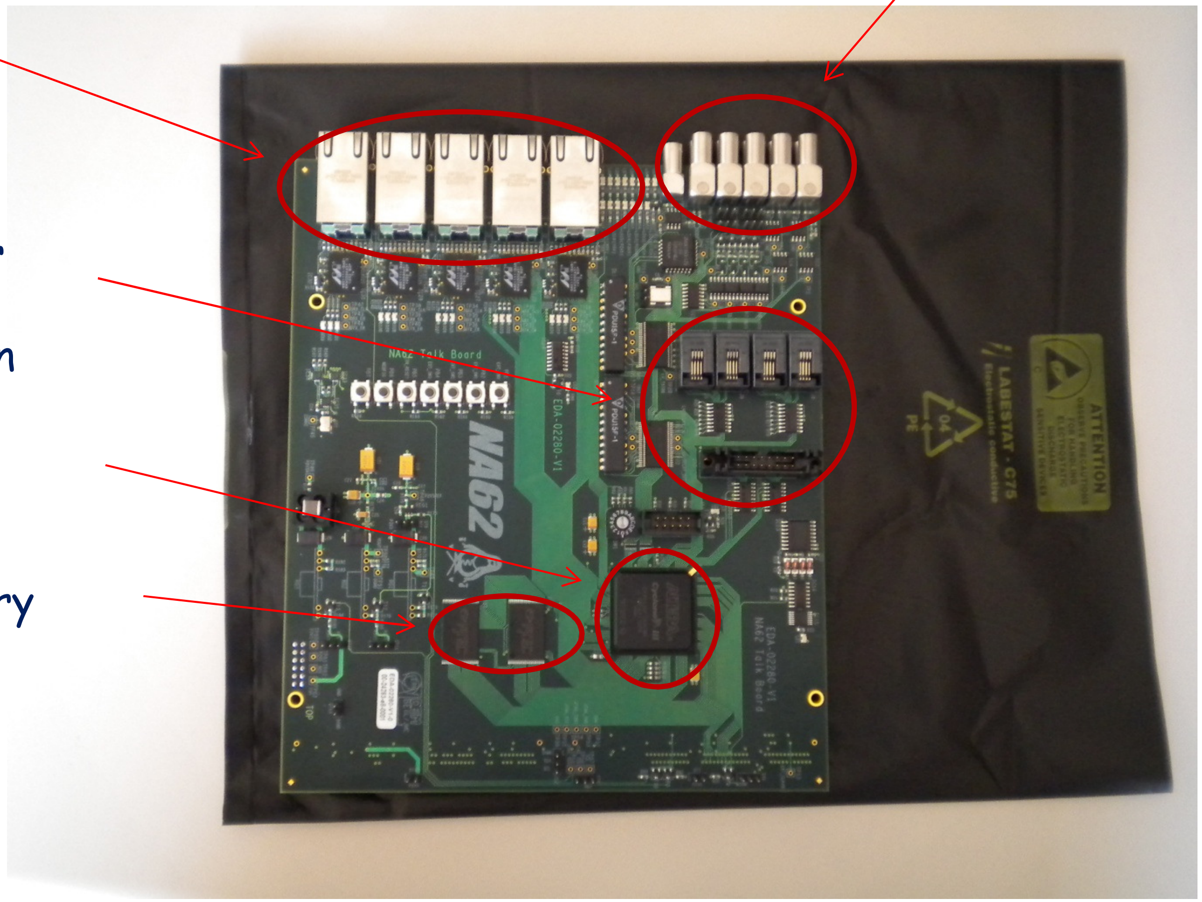
Nim I/O, Clk in, TAXI outputs

5 Ethernet I/F (1 Gb/s)

I/O connectors for connections to Trigger distribution

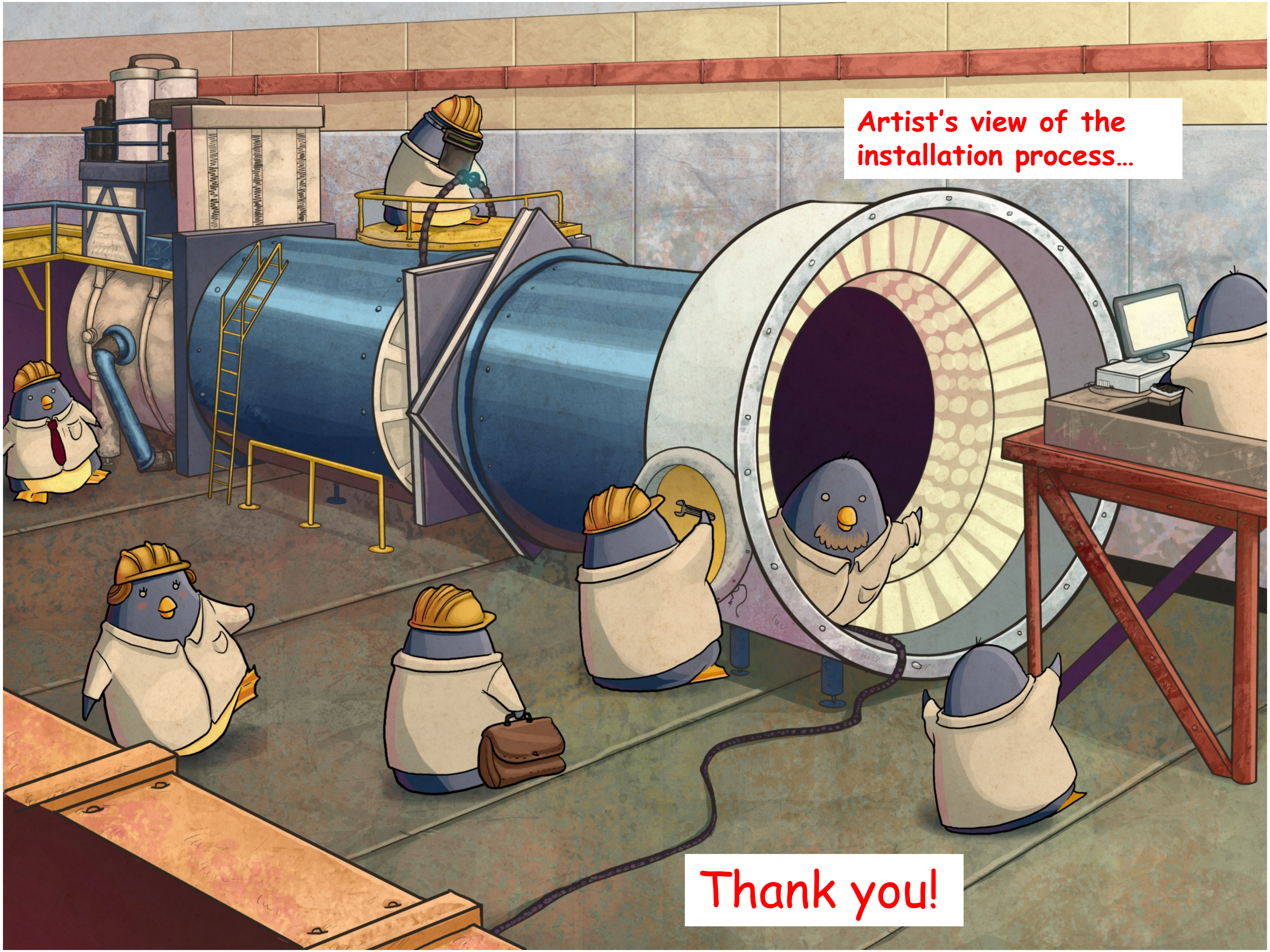
Cyclone III FPGA

1 MB SRAM memory



Conclusions

- NA62 is building and installing its detectors
  - NA48 has been dismounted
  - A first set of detectors to be installed in 2012
  - Commissioning of them and of the readout will be done in 2012
- During the long LHC shutdown the detector will be completed
  - Installation of 3 chambers, the RICH, the Gigatracker, the new LKr readout…
  - Complete the configuration of what has been there in 2012
- We expect to have full beam intensity in Spring 2014
  - Run at least in 2014 and 2015 to collect O(100) $K^+ \to \pi^+ \nu\nu$ decays
  - Long and delicate analysis


Artist's view of the installation process…
Thank you!

Spares

Installation activities

- Dismount NA60
- Dismount NA48 drift chambers
- Get rid of kilometers of cables
- Dismount the Hadron calorimeter
- Dismount the NA48 photon anticounters
- Remove all the section of th
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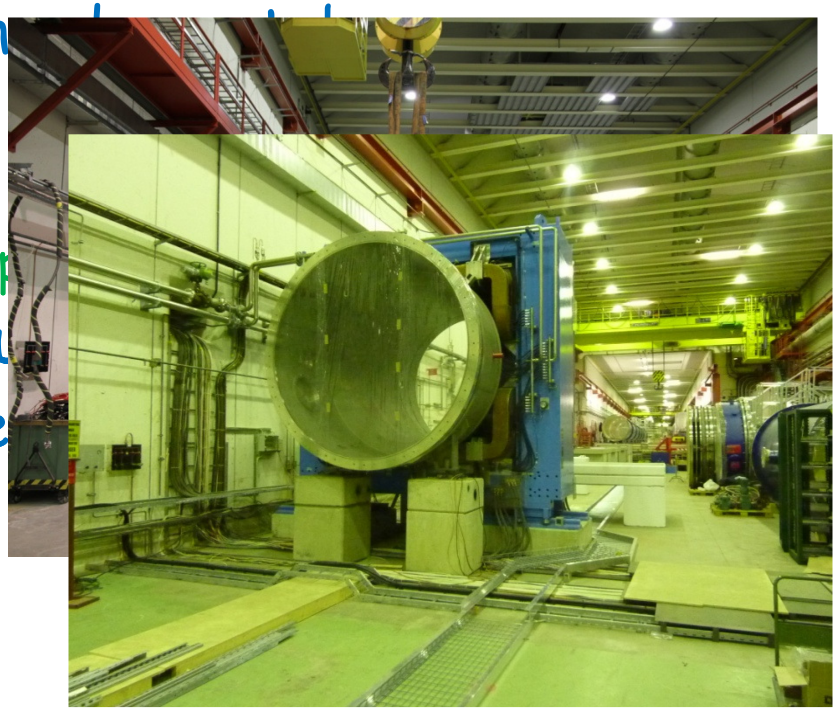


Infrastructure installation

- New electrical distribution in the area
- About 600 optical fibres for data transfer and trigger/clock distribution
- Improved ventilation for the target area
- New electrical, ventilation and network installation in the control room
- Definition of a PC-farm room to house all the PCs for L1, L2, data storage, DCS

- Create new beam dump + an extension of the cavern
  - Higher intensity, new radioprotection rules
  - Extension needed to house SAC out of the deflected residual charged beam
  - A huge civil engineering work

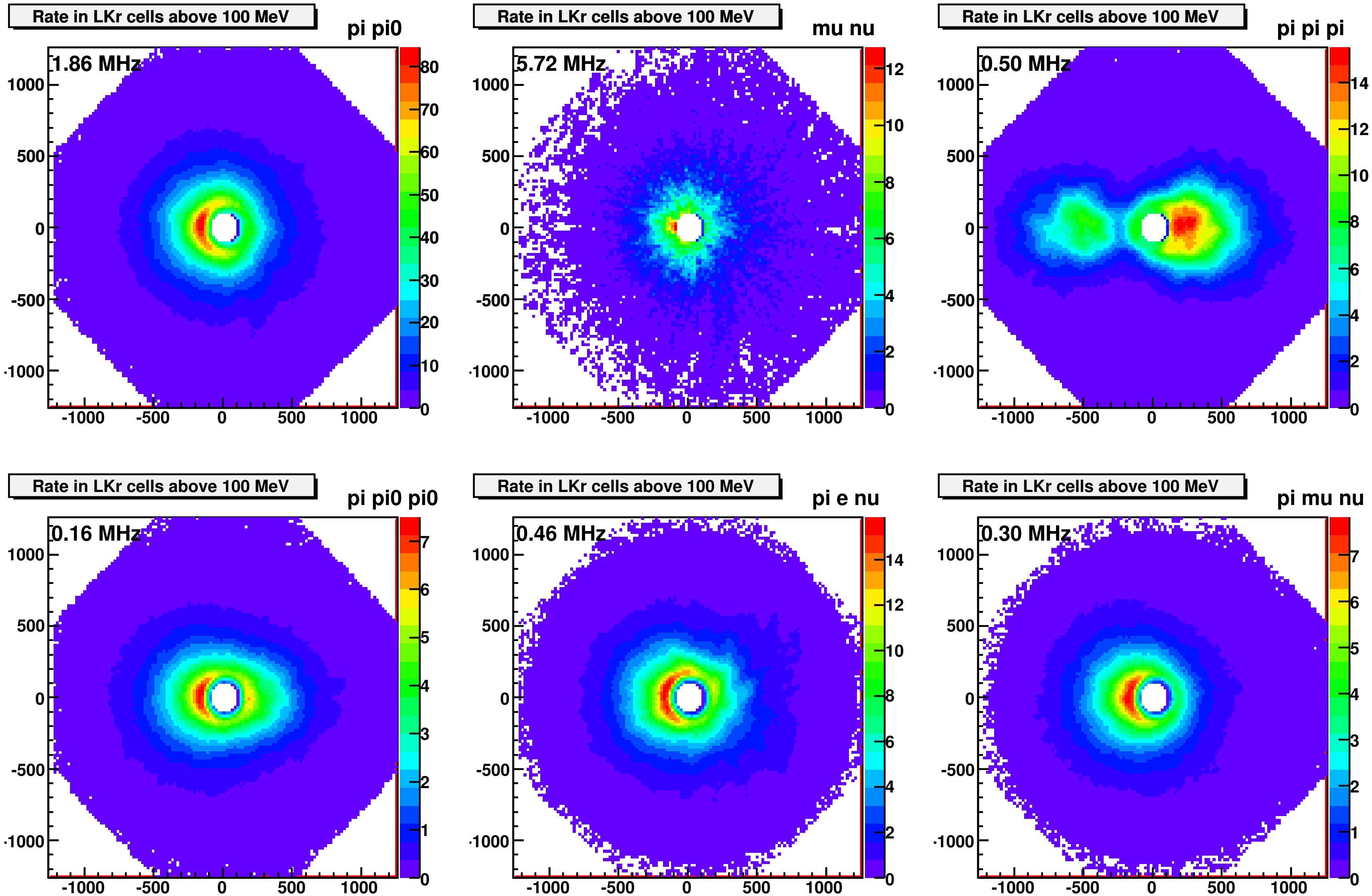
Beam dump setup - 1




Beam dump setup - 2

Beam dump setup - 3

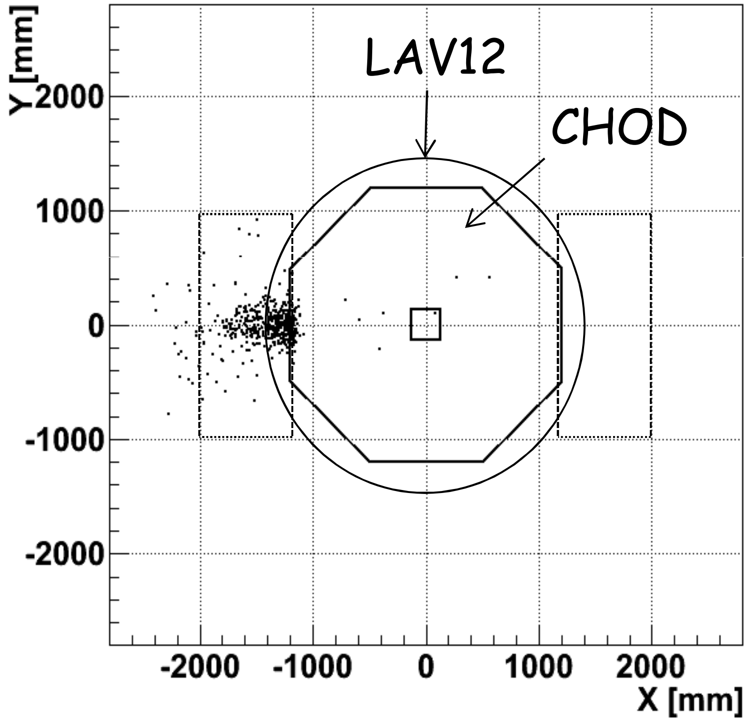
Simulation – Rate in the LKr



Simulation - 3 π

– *A type of background in 3 π events*

- P- decaying before the muon veto
- Illumination at Z_{chod}
- Shows the need of an extension of the hodoscope to catch the background

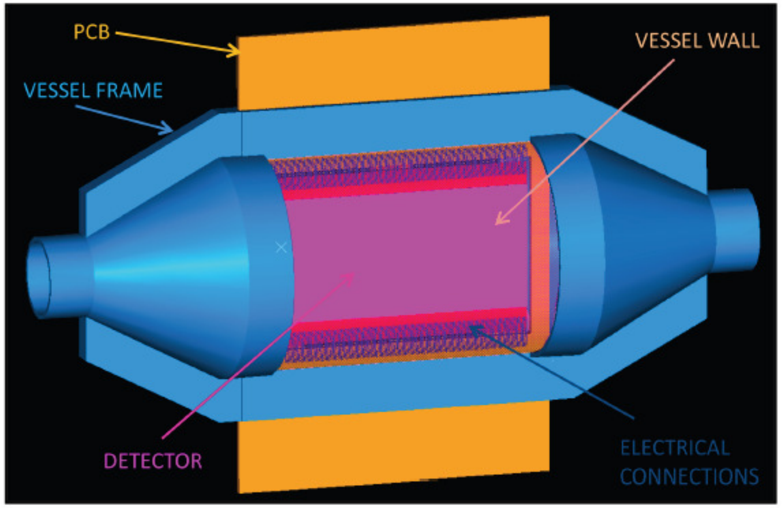


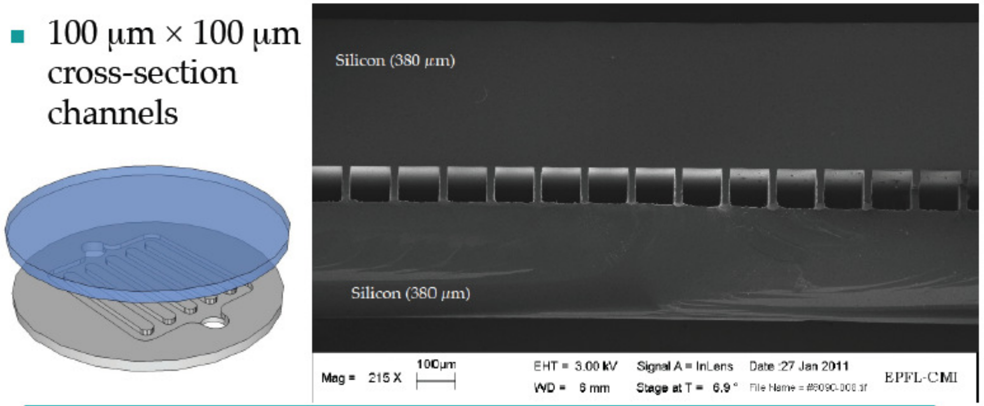
Gigatracker

Operating temperature ~ -20 °C to limit radiation induced leakage current

Dissipate 2 W/cm^2 from RO chips
32 W per station
Operation in vacuum
Minimum material budget on the beam axis

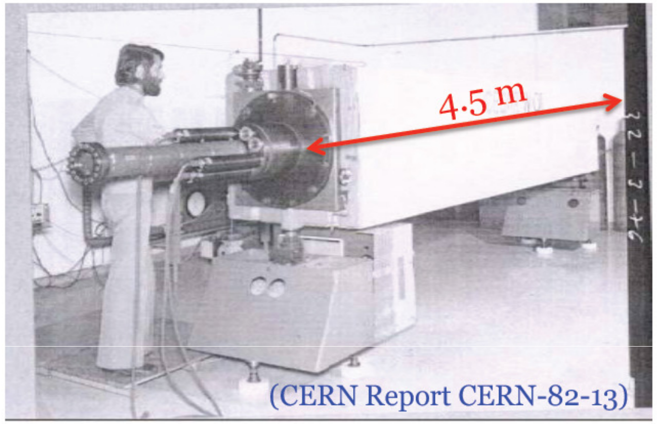
Two options under study:
•Cold N_2 cooling with 100 μm kapton windows
•Two bonded Si wafers (150 μm thickness) with etched channels (100μmx100μm cross section). Coolant C_6F_{14}
Decision to be taken soon





CEDAR

Identification of Kaon in the beam
Principle: Cherenkov light of wanted particles passes through a diafragm in the light path



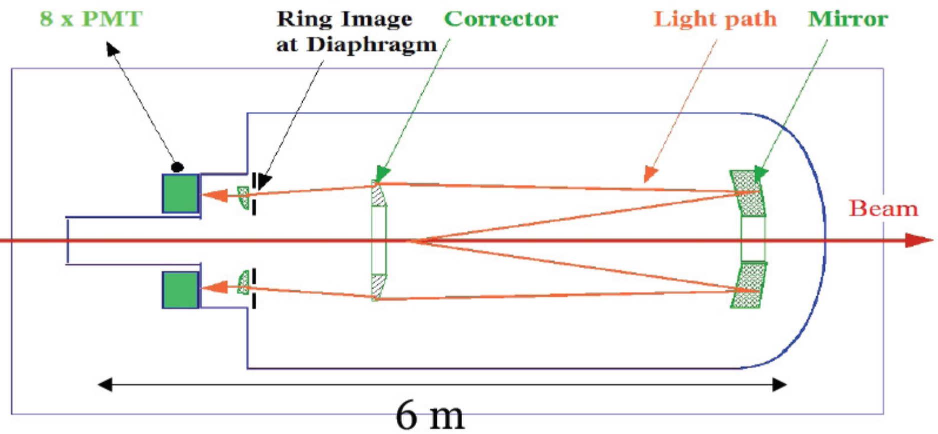
Built in the '80s for particle ID at the SPS beams
Rate capabilities not enough for NA62

Minimize material with H_2 at 3.86 bar

50 MHz K rate: need to divide the light onto O(250) PMs

Expected 3 MHz/PM
σ_t <100 ps

Beam divergence < 1mm

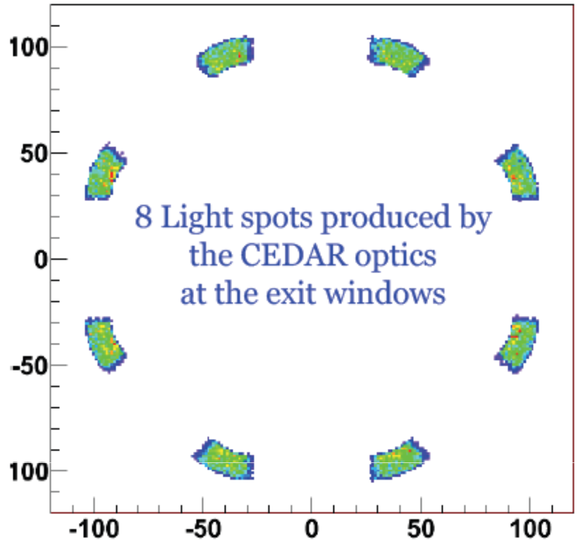


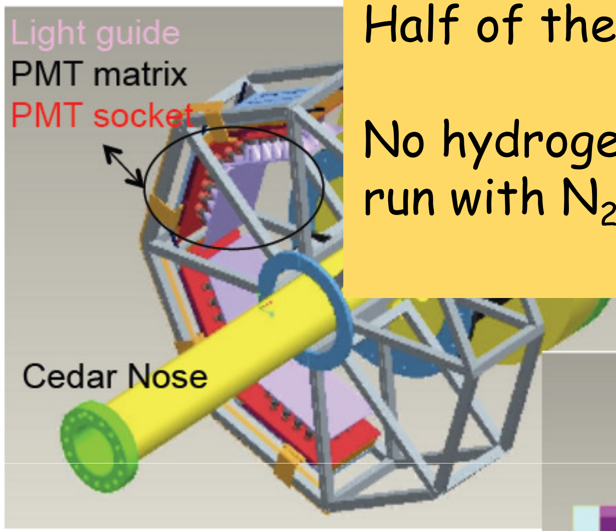
CEDAR

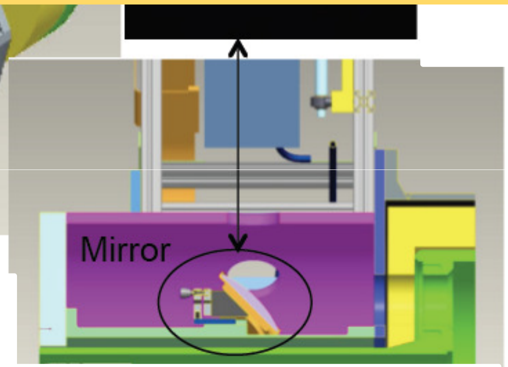
Installation foreseen in 2012 on the beam line

Half of the readout

No hydrogen infrastructure – run with N_2

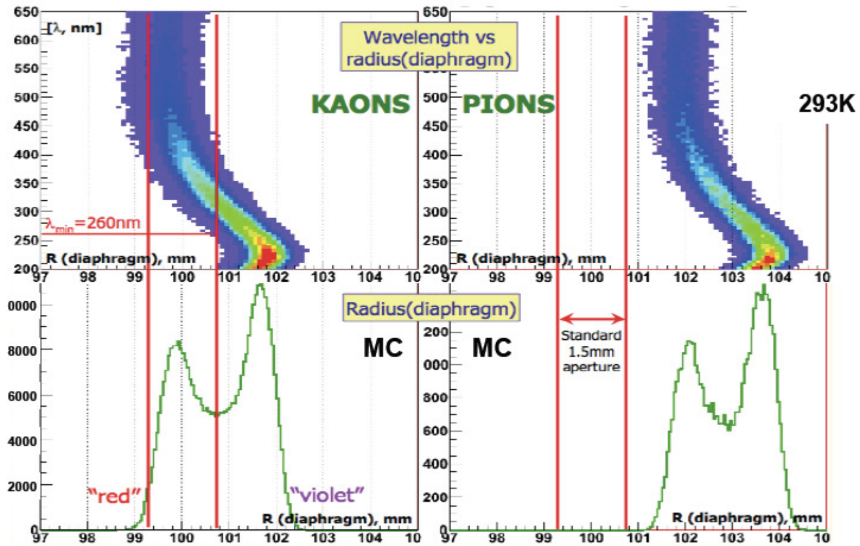






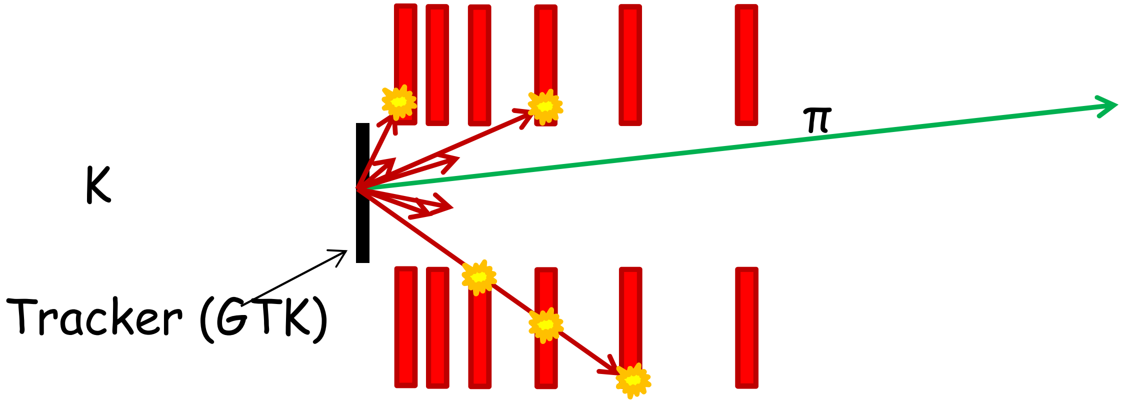
Light from the spots bent by a mirror and then enlarged with a lens

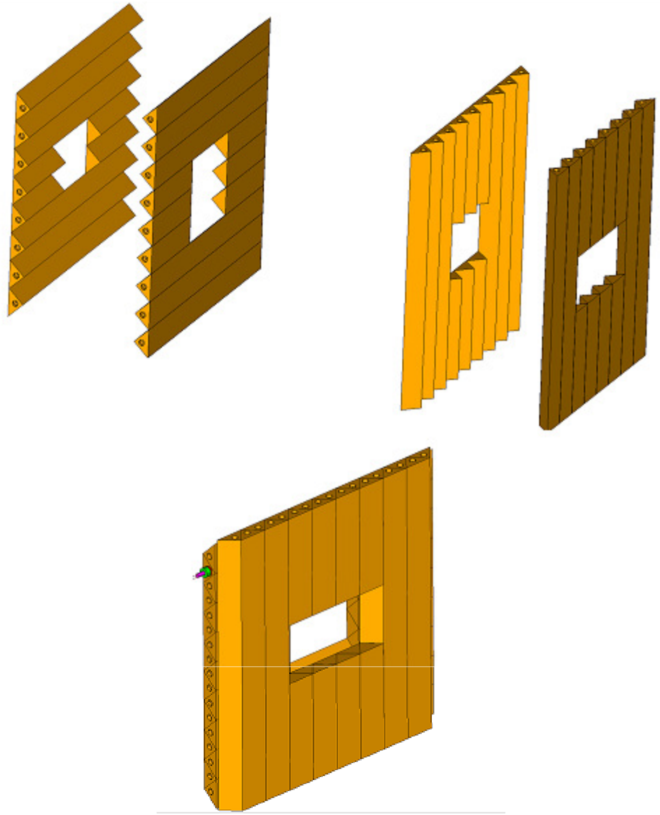
Casing around PMs and HV because of H2



Simulation of K/π separation

Chanti





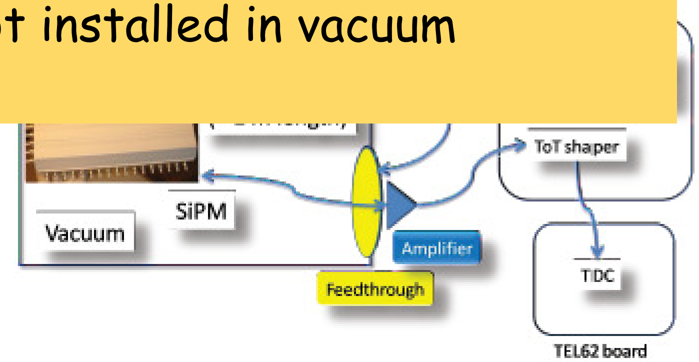
- Six "guard rings" to veto K inelastic interactions on GTK-3 (affecting ~10^{-3} of kaons)
- Staggered triangular scintillator bars coupled with fast WLS fibers with SiPM readout to form 6 xy planes
- In the same vacuum vessel as GTK 3
- G4 simulation: full detector rate O(2 MHz), vetoing efficiency ~99% dominated by acceptance

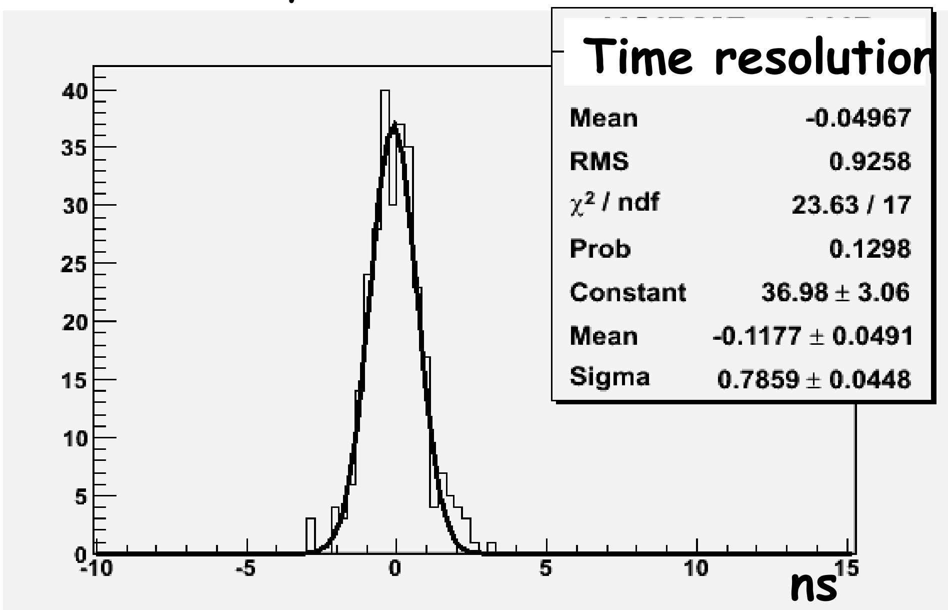
Chanti

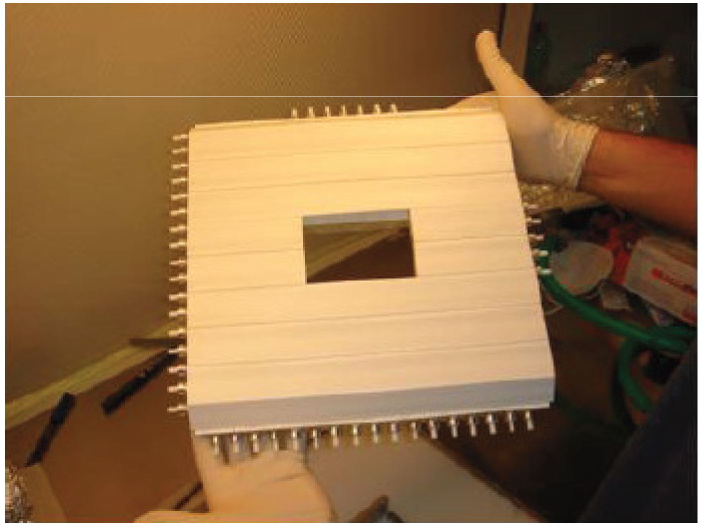
Prototype ready for 2012
Only few planes
Not installed in vacuum

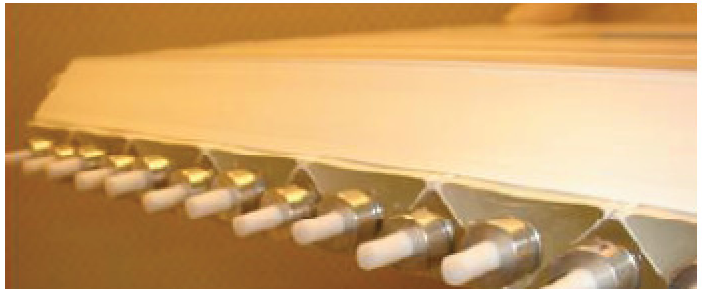
Prototype built in Napoli
Hamamatsu MPPC 13-50 type (1.3x1.3 mm^2, 50 μm pixel size) SiPM
Tested using prototype FEE for MIP response and time resolution
Results show O(100) pe/plane and O(1 ns) resolution.

Readout chain expected to be the same one of the LAV system, with minor mods





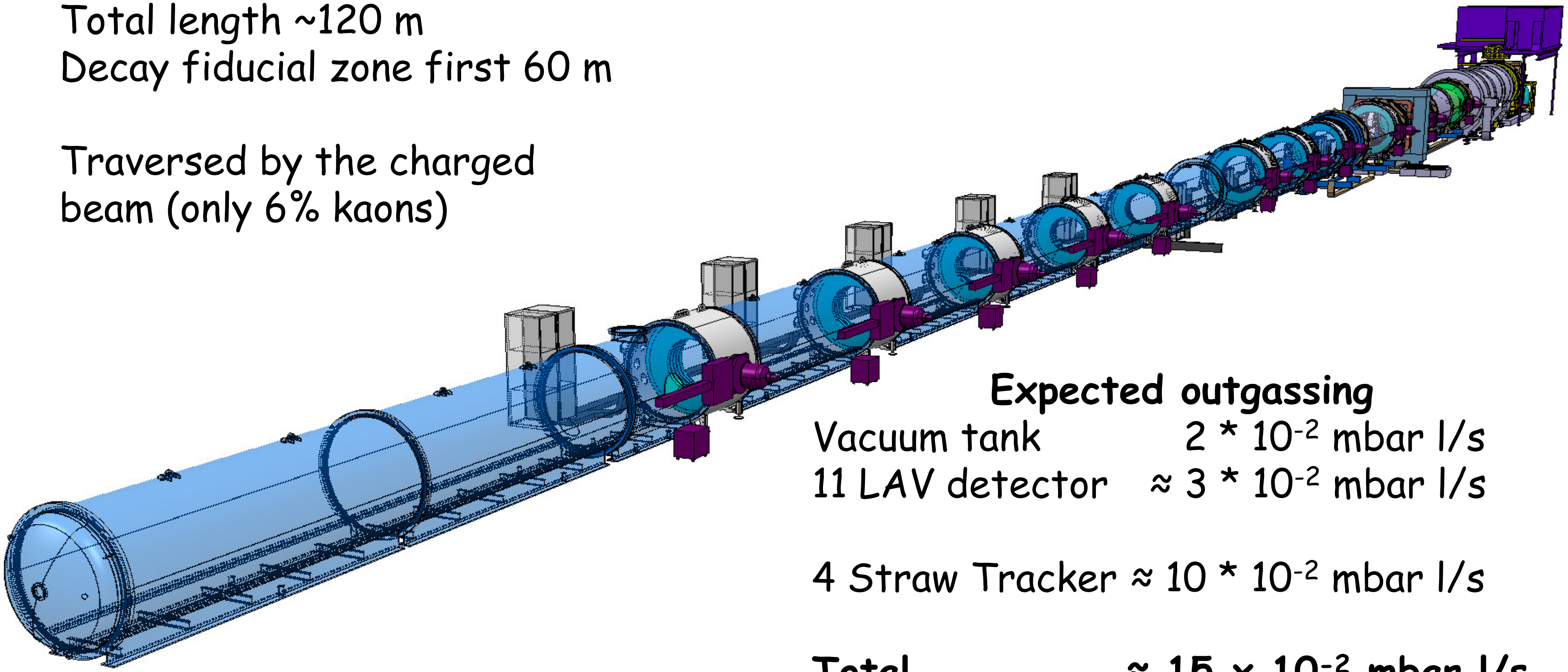




Decay volume

Total length ~120 m
Decay fiducial zone first 60 m

Traversed by the charged
beam (only 6% kaons)



Expected outgassing

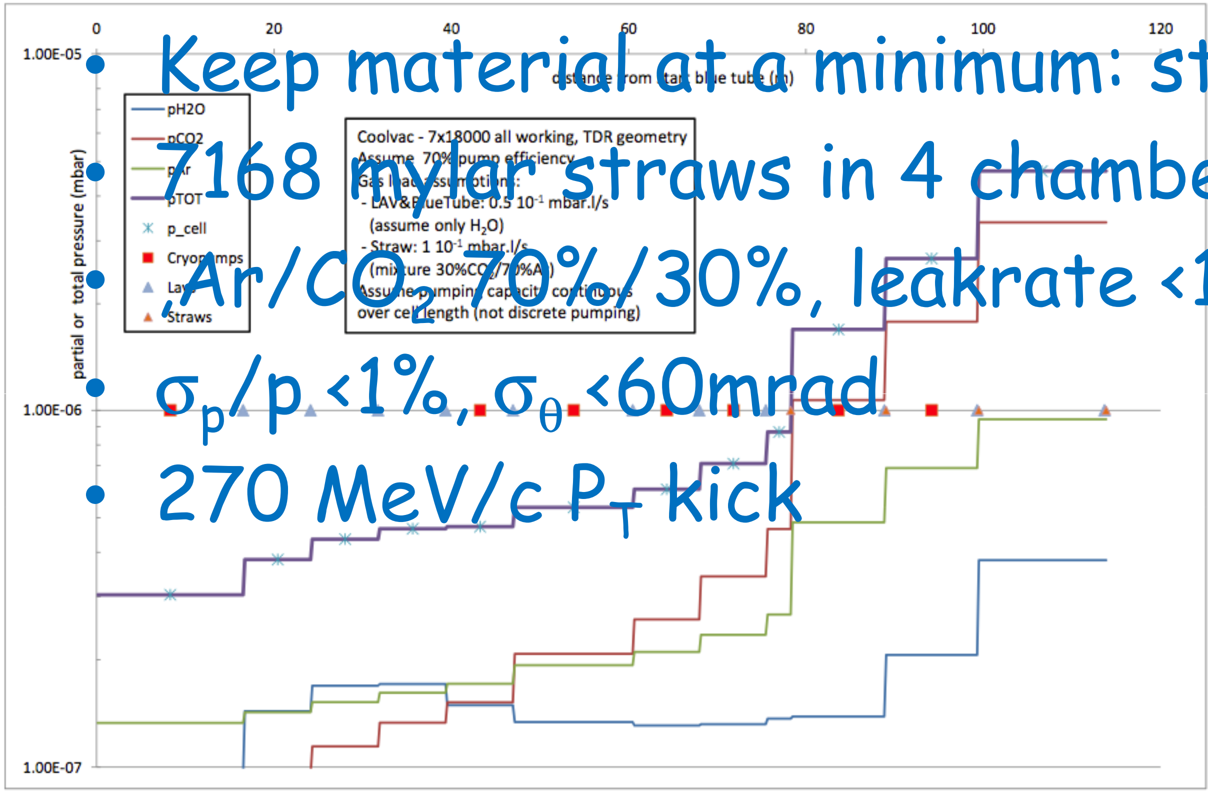
Vacuum tank	$2 * 10^{-2}$ mbar l/s
11 LAV detector	$\approx 3 * 10^{-2}$ mbar l/s
4 Straw Tracker	$\approx 10 * 10^{-2}$ mbar l/s
Total	**$\approx 15 \times 10^{-2}$ mbar l/s**

Need a vacuum of better than 10^{-6} mbar in the fiducial zone to
minimize the background due to beam interactions in the residual gas

Needed 10^{-8} without the CEDAR Kaon identification

Pumping system

- Keep material at a minimum: straws in vacuum
- 7168 mylar straws in 4 chambers, <4*0.5% X_0
- Ar/CO_2 70%/30%, leakrate $<10^{-1}$ mbar l/s
- $\sigma_p/p < 1\%$, $\sigma_\theta < 60$mrad
- 270 MeV/c P_T kick



Pressure profile with 7 pumps

7 cryopumps foreseen for 2014

4 pumps for 2012 run

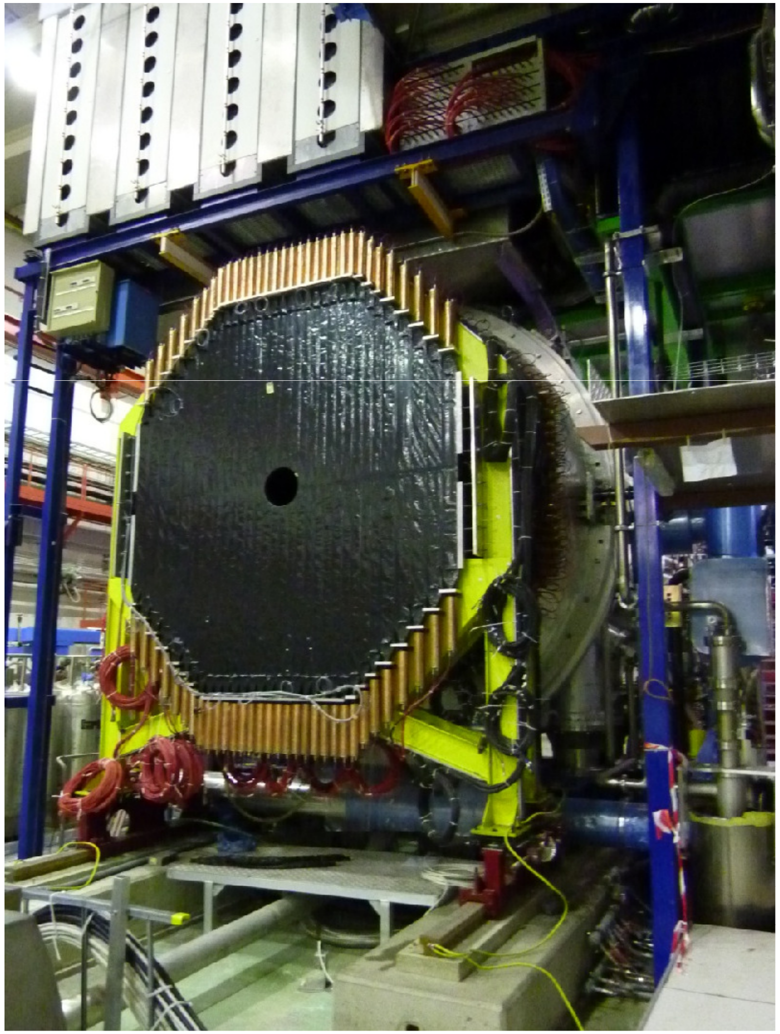
Pump tests starting now

Charged hodos

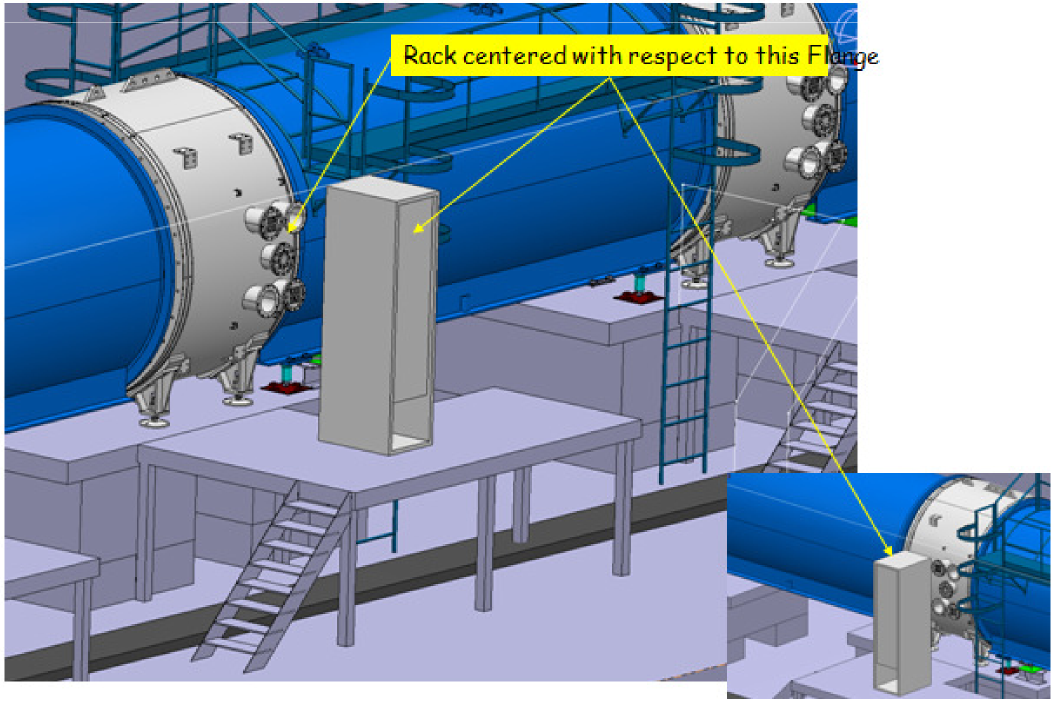
NA48 Chod for 2012

Design of the new one to be started

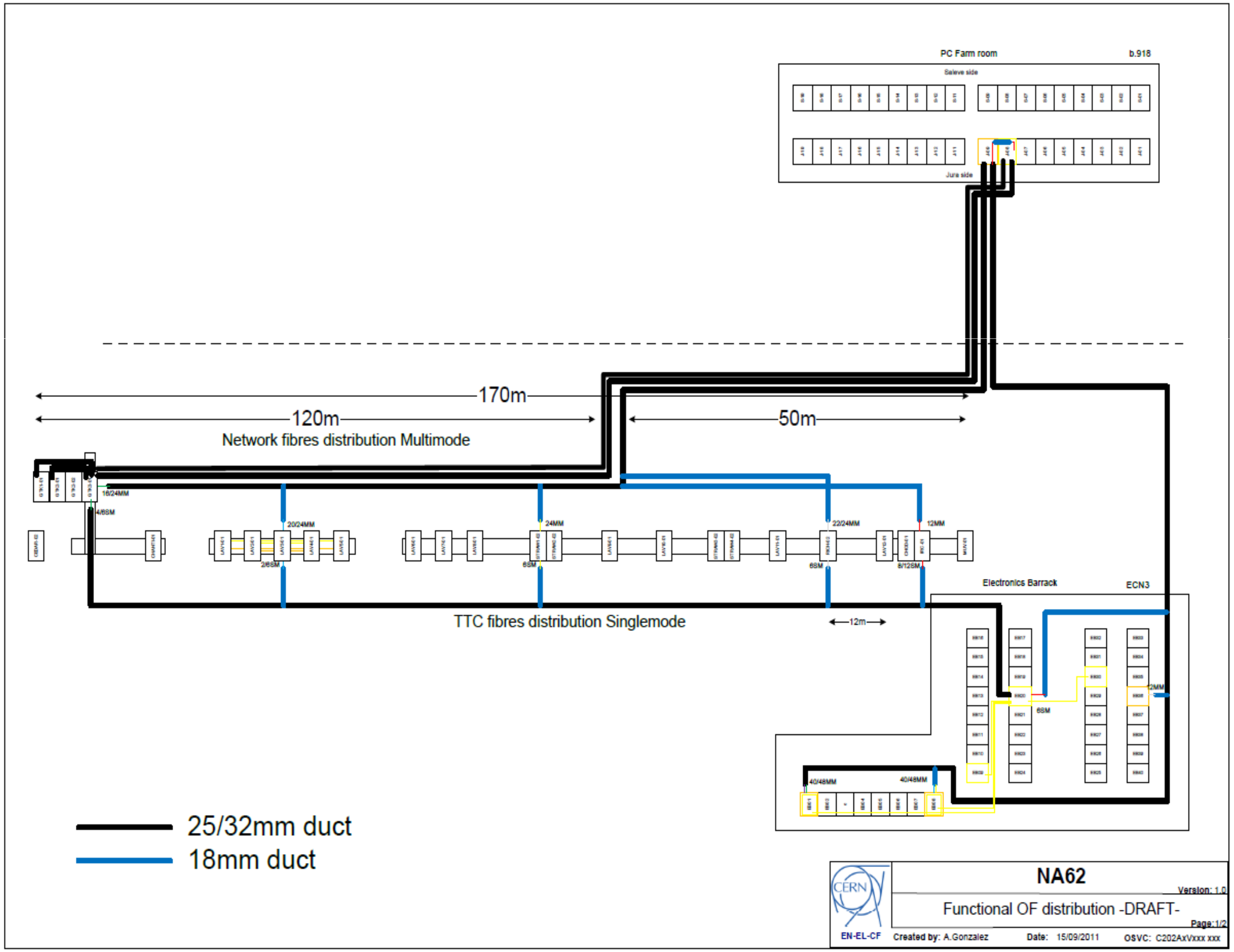
- Detect photonuclear interactions in the RICH
- Provisional use of the NA48 hodoscope
  - σ_t = 200 ps
  - Not for the full intensity
- New device under discussion
  - Could be similar to the old one but with shorter strips, grooved and readout via WLS fibers
    - Strip lengths different for areas of different illumination
    - Possibility to have intrinsic isochron signals
  - It will likely be with a kind of oval shape
    - To catch pions from 3π decays which go outside the actual diameter



Example: services around one LAV



Optical fibers layout



Muon vet

MUV1 being prepared in Mainz
MUV2 at CERN

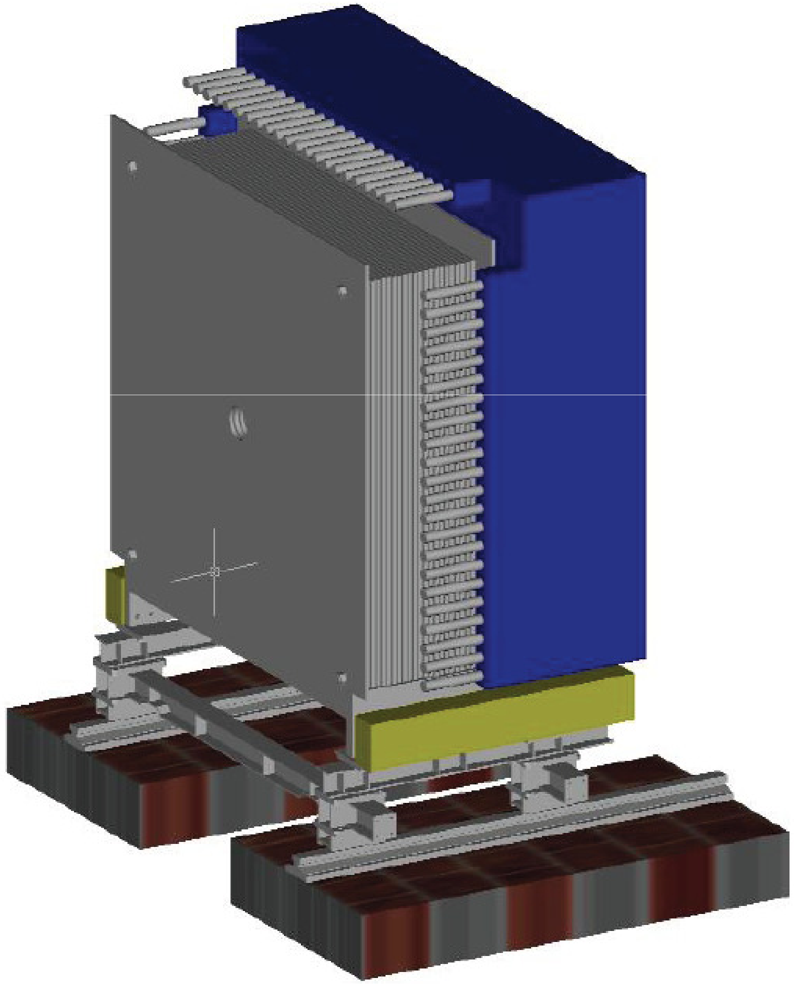
Only MUV2 installed for 2012

First part (MUV1):
24 planes
Iron/scintillator + WLS
6cm wide strips (in x and y)
(13 pe/MIP)

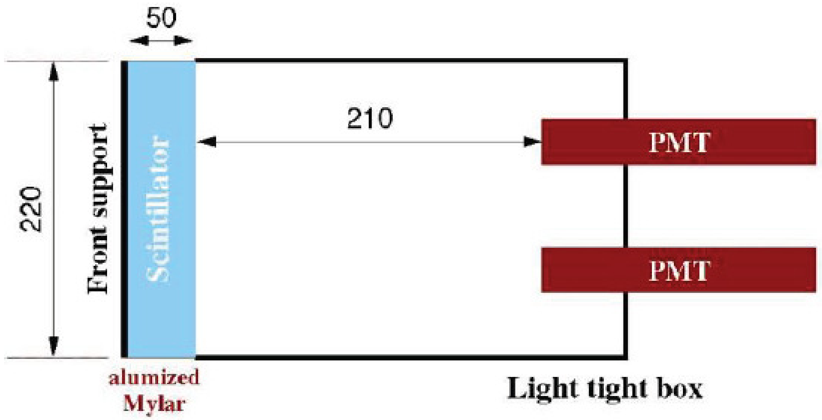
Second part (MUV2):
22 planes
Iron/scintillator + lightguides
The old first section of the NA48 HAC

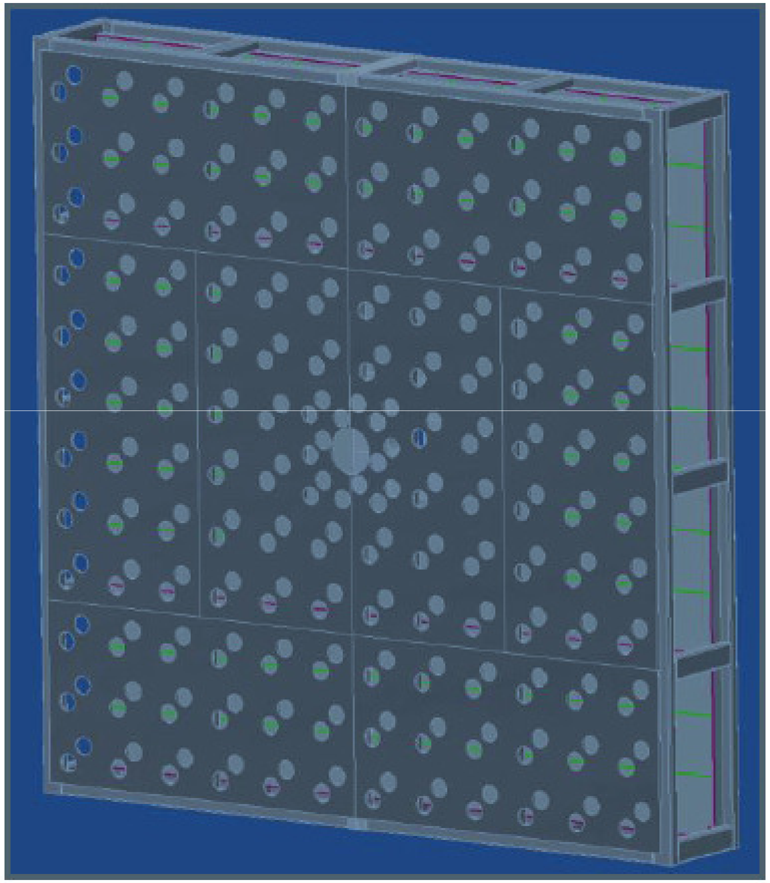
Segmentation to help separation of pion showers

μ suppression 10^{-5} (including the 3rd plane)



Muon veto – third plane





Matrix of 22*22 cm^2, 5 cm scintillator tiles
Direct light collection for each tile in a black box
Suppression of reflected light
20-25 pe
σ_t= 600ps (test beam)

Two PMs to separate Cherenkov light if the particle pass through the glass

Used in the L0 trigger to reduce the rate

Muon vet

Mechanics ready
First basic tests of few cells ongoing
PMs to be delivered at CERN

Installation foreseen for 2012

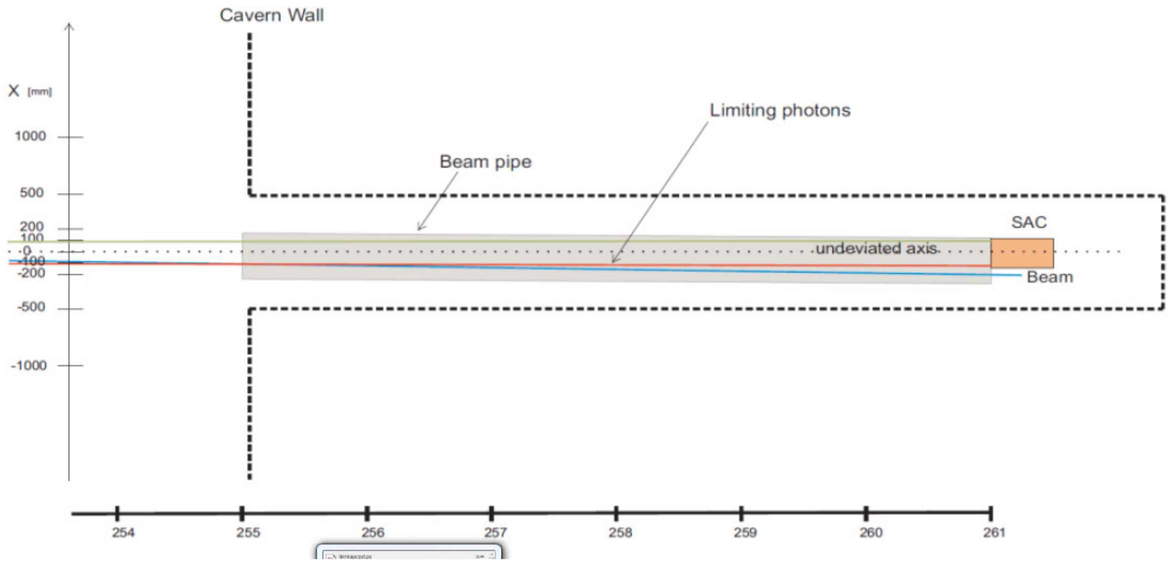
Mechanics of both halves ready

Next steps:

- Installation of PMs (ex NA48 AKL)
- Basic tests with cosmic rays
- Installation on the beam line
- Setup of the readout chain

The end of the ride

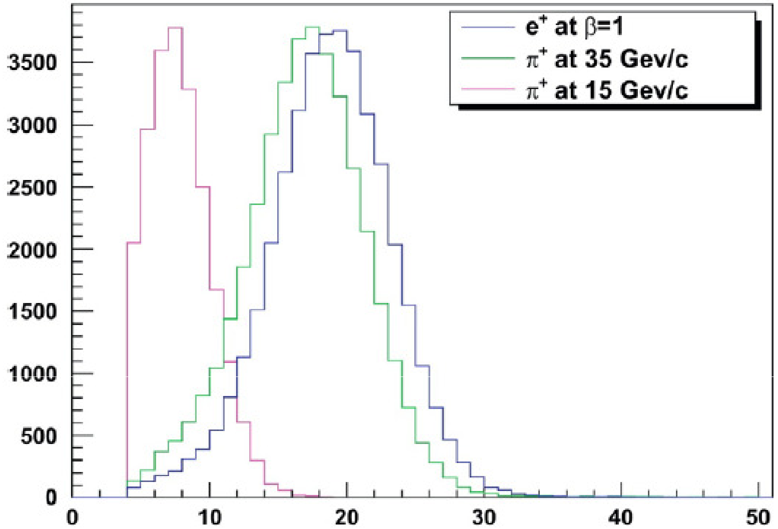
- The charged kaon beam is deflected by a magnet downstream of the MUV onto the beam dump
- Photons at very small angle go straight in the SAC detector
- An extension of ECN3 to install the beam dump and the SAC at a safe distance from the charged beam has been built

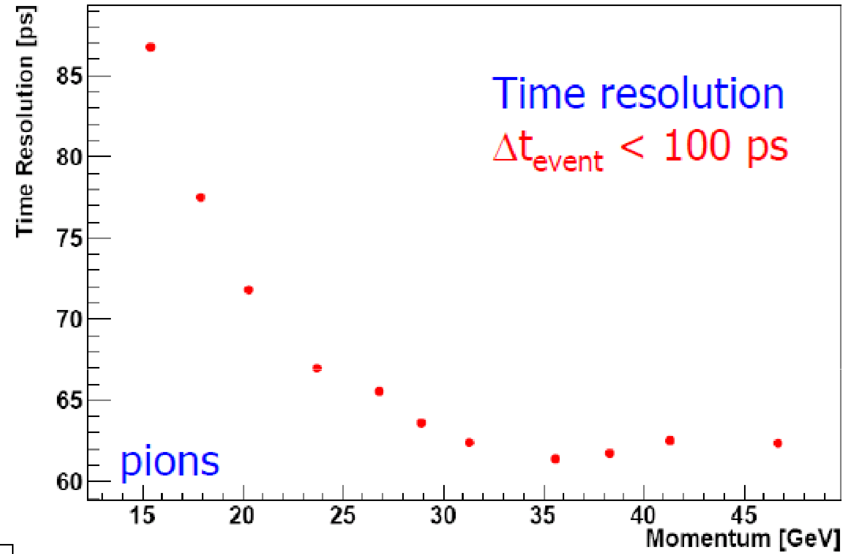


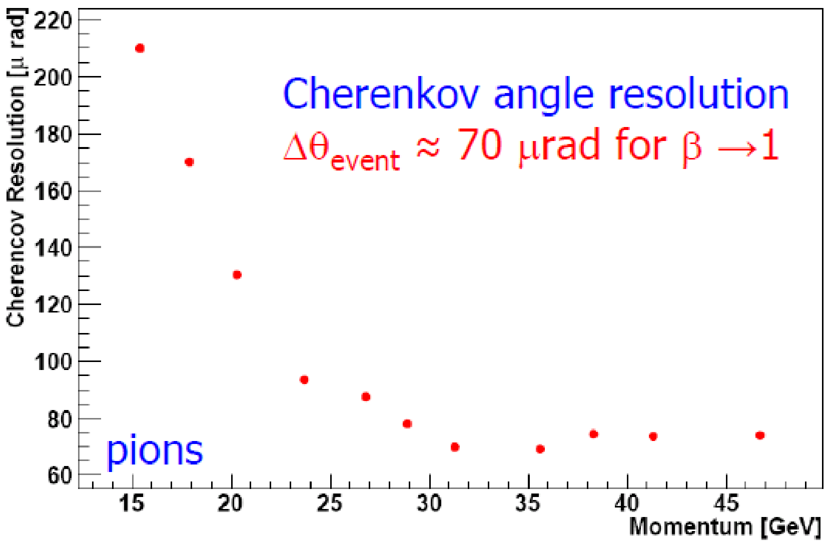
Rich prototype

Still working on the details of the vessel

Ready for 2014



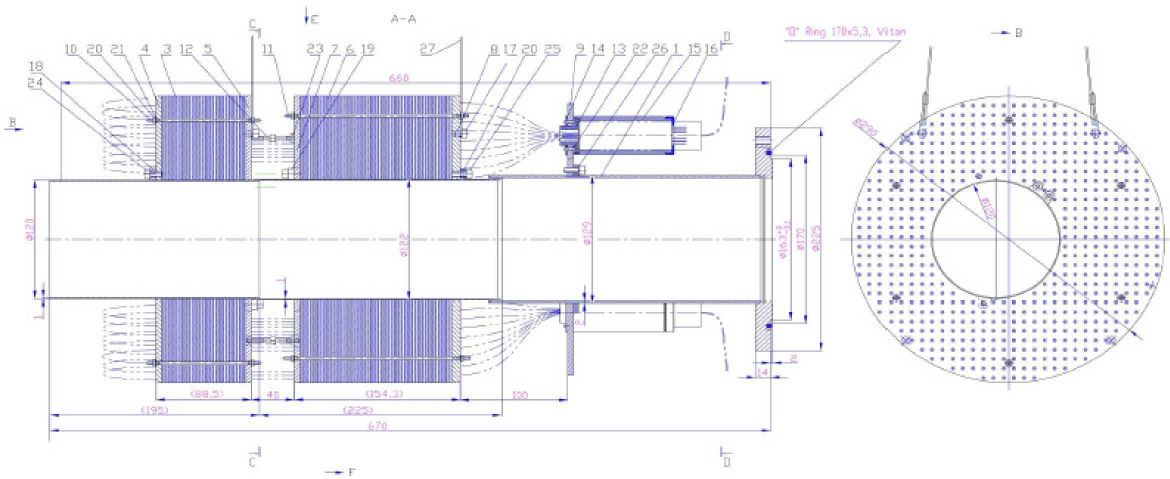




Installation foreseen for 2012

Small angle vetoes - IRC

- Needed to catch the photons passing through the calorimeter flange and those grazing the beam pipe in the RICH
- Works in conjunction with the calorimeter itself
- Asymmetric shape due to the spectrometer bending
- Mounted on a properly shaped section of the beam pipe
- 1 MHz decay rate + 5 MHz muon halo



Lead/scintillator shahslyk with WLS fibers

Installation foreseen in 2012

Small angle vetoes - SAC

- Shashkyk, 70 layers 1.5 mm Pb/1.5 mm scint, 1.2 mm WLS fibers
- Existing already, built as a prototype in 2006
- To be installed in the last part of the experiment
  - In a 60 cm diameter extension of the beam pipe, after the final deflecting magnet

- Both Small Angle Vetoes readout by TDCB and TEL62 boards