Measurement of the Proton Electromagnetic Form Factors via the Spin Transfer Reaction $^1H(\vec{e}, e'\vec{p})$ (Experiment 01-109)

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Outline

- Polarization transfer
- Goals for 01-109
- New equipment in Hall C
- FPP concept, design, performance
- BigCal concept, design, performance
- What has been done so far
- Reconfiguration of TestLab G$_{Ep}(III)$ area
- What will be done next
- Background in Hall C with protoCal
- Summary

Polarization Transfer

$$\begin{cases} P_n = 0 \\ \pm P_t = \mp 2\sqrt{\tau(1+\tau)} G_E G_M \tan\left(\frac{\theta_e}{2}\right) / I_0 \\ \pm P_l = \pm (E_e + E_{e'}) {G_M}^2 \sqrt{\tau(1+\tau)} \tan^2\left(\frac{\theta_e}{2}\right) / m_p / I_0 \end{cases}$$

for beam helicity of 1

$$\begin{aligned} \tau &= Q^2 / 4 m_p^2 \\ I_0 &= {G_E}^2(Q^2) + \frac{\tau}{\epsilon} {G_M}^2(Q^2) \end{aligned}$$

with $\epsilon = \frac{1}{1+2(1+\tau)tan^2\frac{\theta_e}{2}}$

The azimuthal distribution measured by the polarimeter:

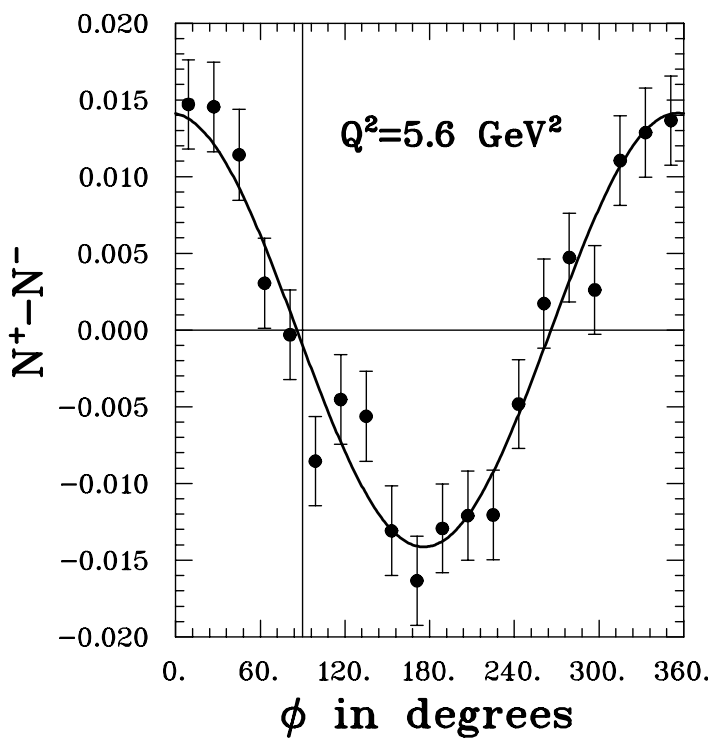
$$N^{\pm}(\theta,\varphi) = N_0^{\pm}(\theta) \Big[1 + \left[\mp A_y(\theta) P_n^{fpp} + b_i\right] \cos\varphi + \left[\pm A_y(\theta) P_t^{fpp} + a_i\right] \sin\varphi \Big]$$

- $A_y(\theta)$ analyzing power (CH_2), a_i and b_i instrumental asymmetries

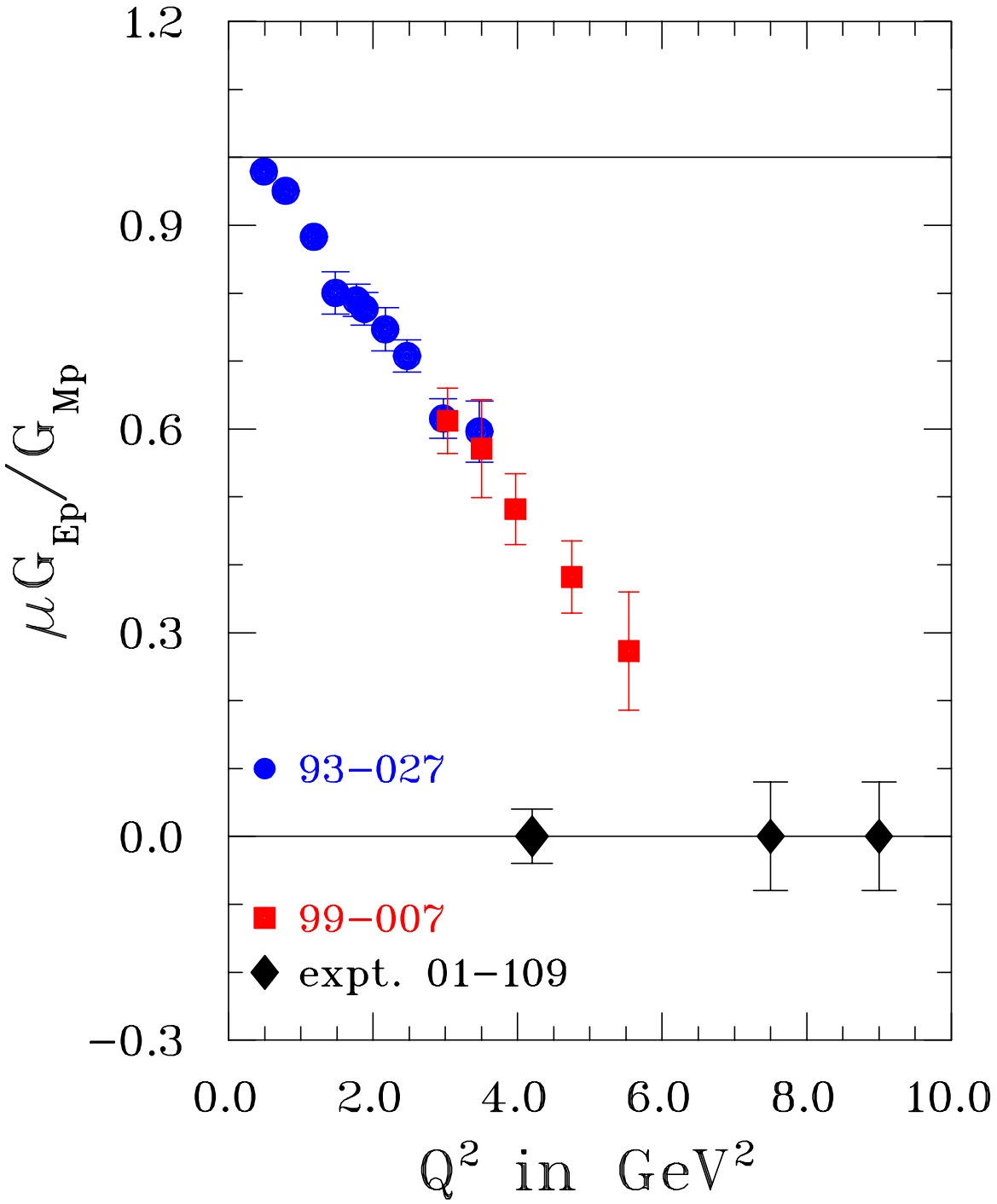
- P_n^{fpp} and P_t^{fpp} the physical asymmetries
- at target $P_\ell = P_n^{fpp}/sin\chi$, $P_t \sim P_t^{fpp}$, χ precession angle
- the polarimeter does not measure P_ℓ^{fpp}
- The f.f. ratio is obtained from target P_t and P_ℓ:

$$\frac{G_{Ep}}{G_{Mp}} = -\frac{P_t}{P_\ell}\frac{E_e + E'_e}{2m_p} tan\frac{\theta_e}{2}$$

- $$\frac{F_2}{F_1} = \frac{1 - G_{Ep}/G_{Mp}}{\kappa_p(\tau + G_{Ep}/G_{Mp})}$$



Expected results for 01-109



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New Equipment in HallC

- focal plane polarimeter (HMS-FPP)

  analyzing power at 5.3 GeV/c; efficiency of 2 FPPs in series

  technical requirements for drift chambers: 0.5 mr and 164x132 cm^2

  prototype being made in Dubna, delivery early Spring, test in EEL building.

  then start construction of 4 chambers in Dubna

  manufacture of frame at JLab

  installation on detector rails in HMS hut at Čerenkov's location

- large size, fine spatial resolution calorimeter (BigCal)

  1744 lead-glass bar calorimeter, 32 H x 56 H

  detect Cerenkov; insensitive to non-showering particles

  frontal area 2.8 m^2 or 30 square feet

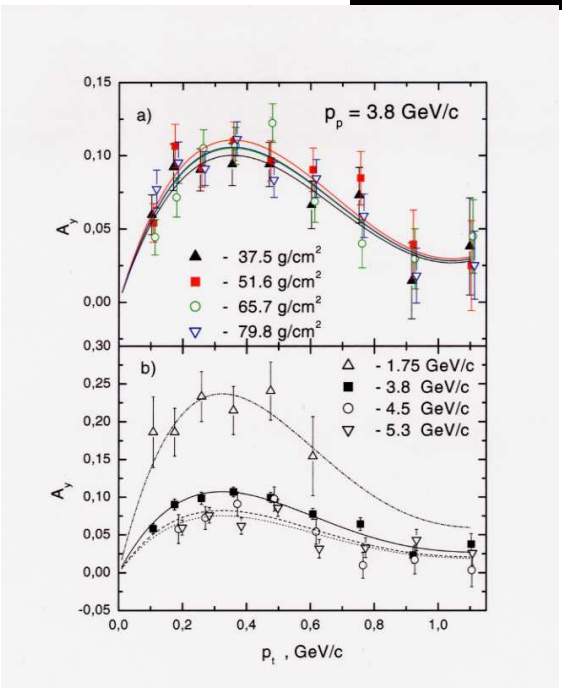
  granularity 4x4 (3.8x3.8) cm^2

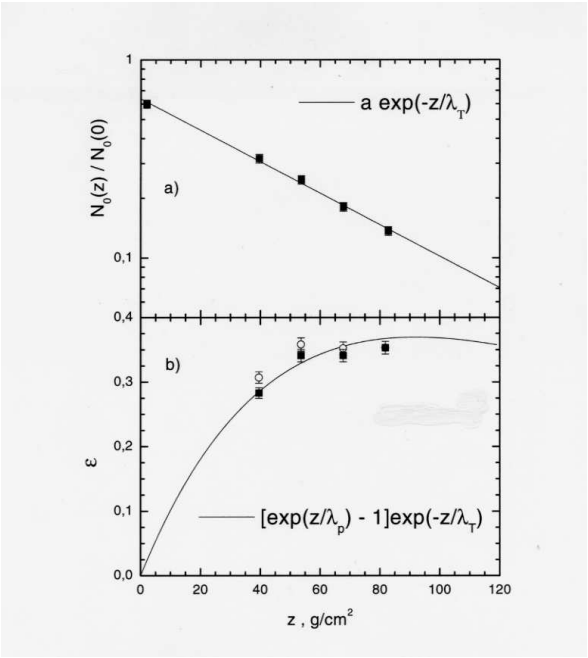
  16 times finer than for G_{Ep}(II) in Hall A

  distance to target half: rate per bar 1/4th, all things being equal

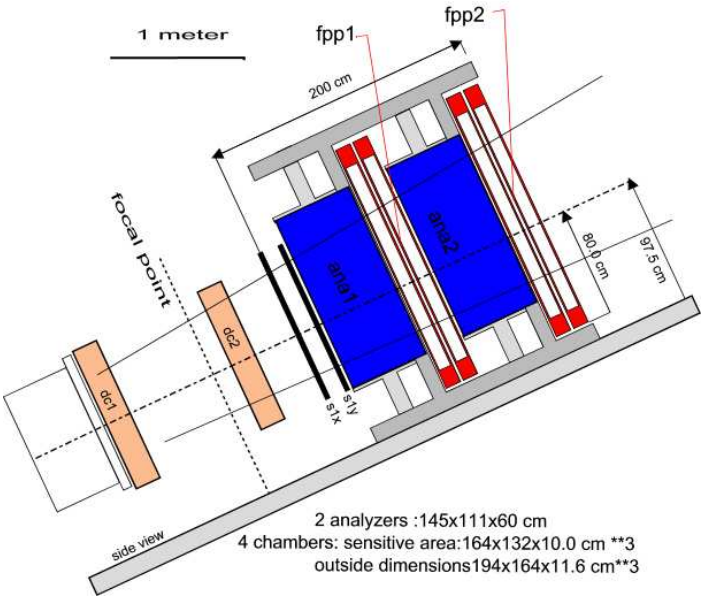
  1024 bars from Protvino, 720 bars from Hall A RCS calorimeter

Dubna calibration

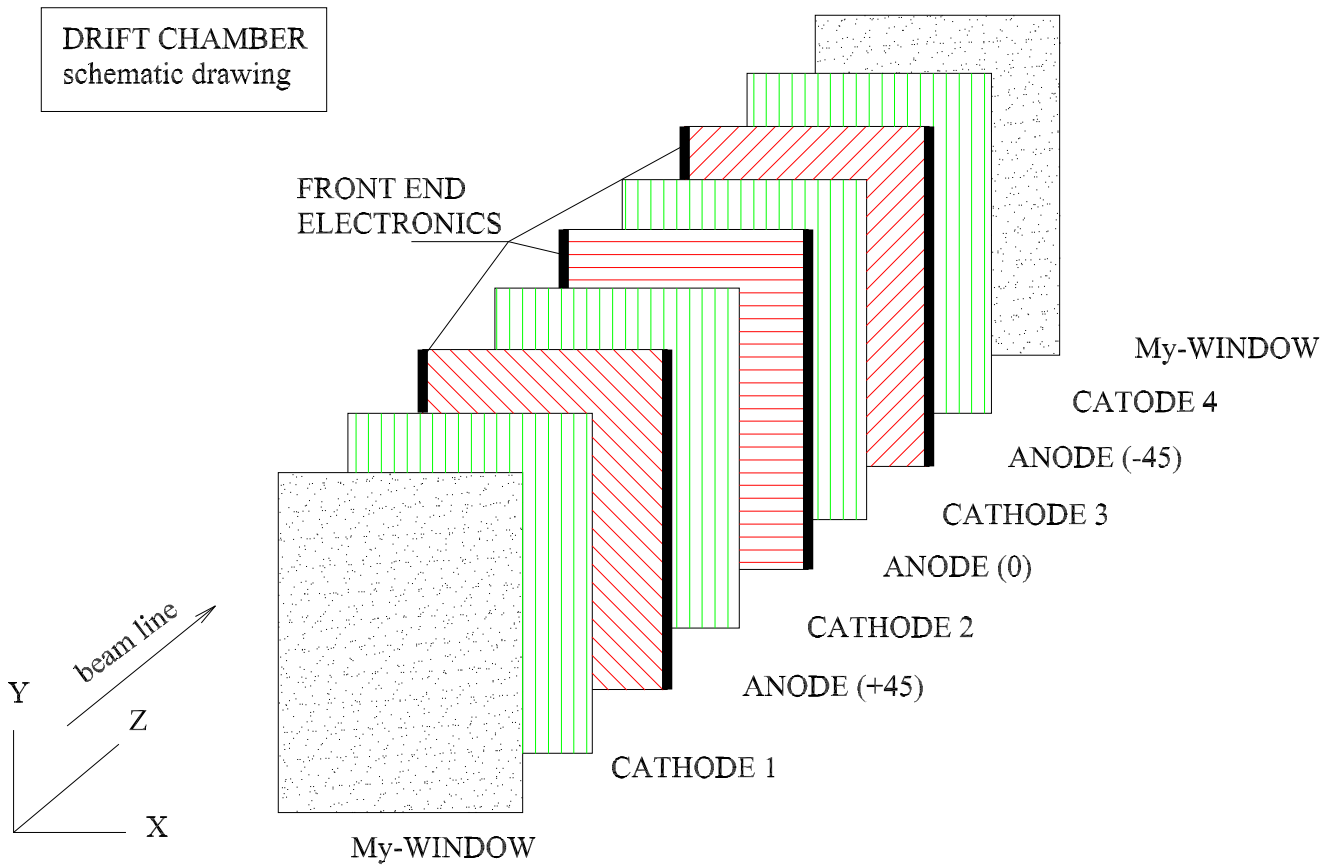




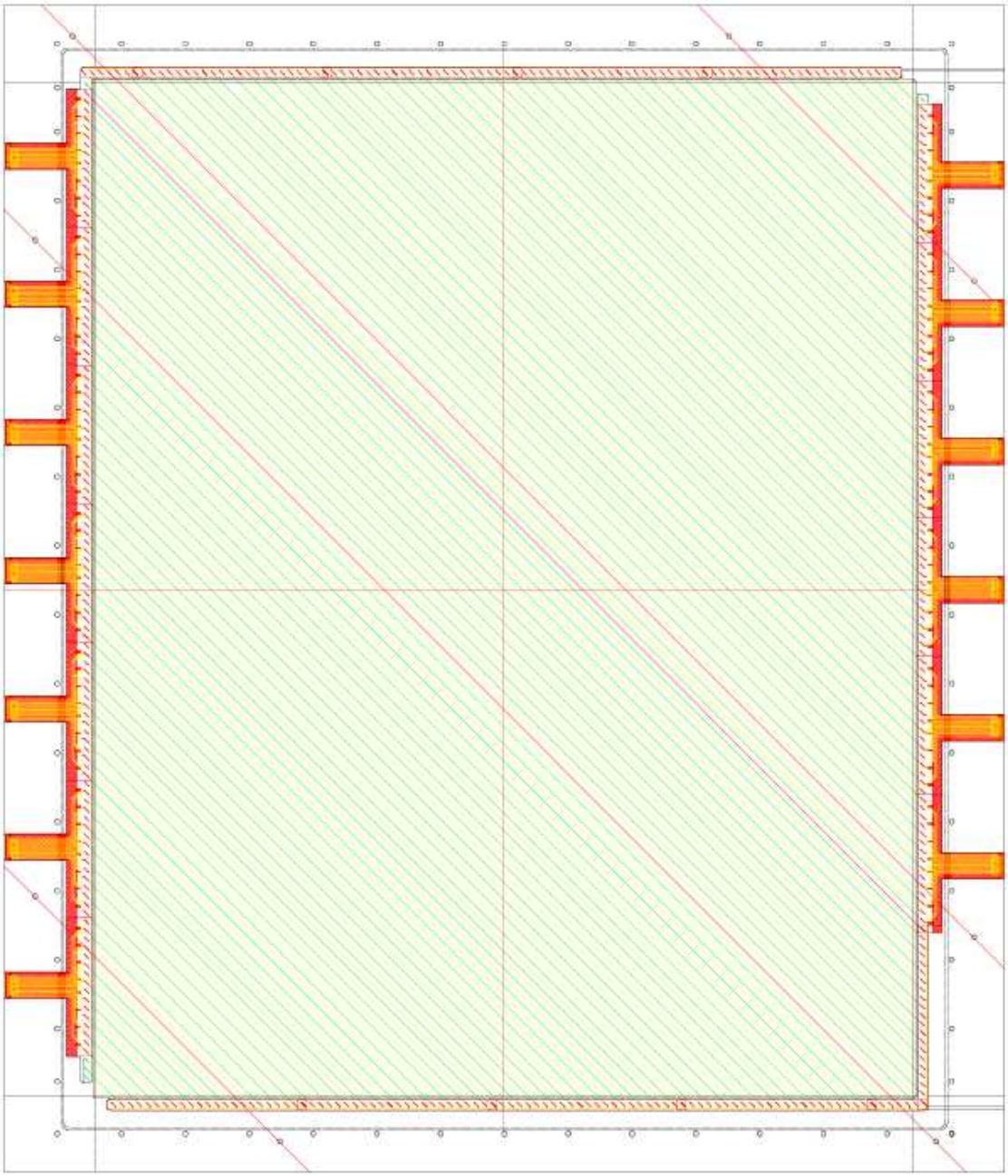
FPP for 01-109 in Hall C



drift chamber configuration

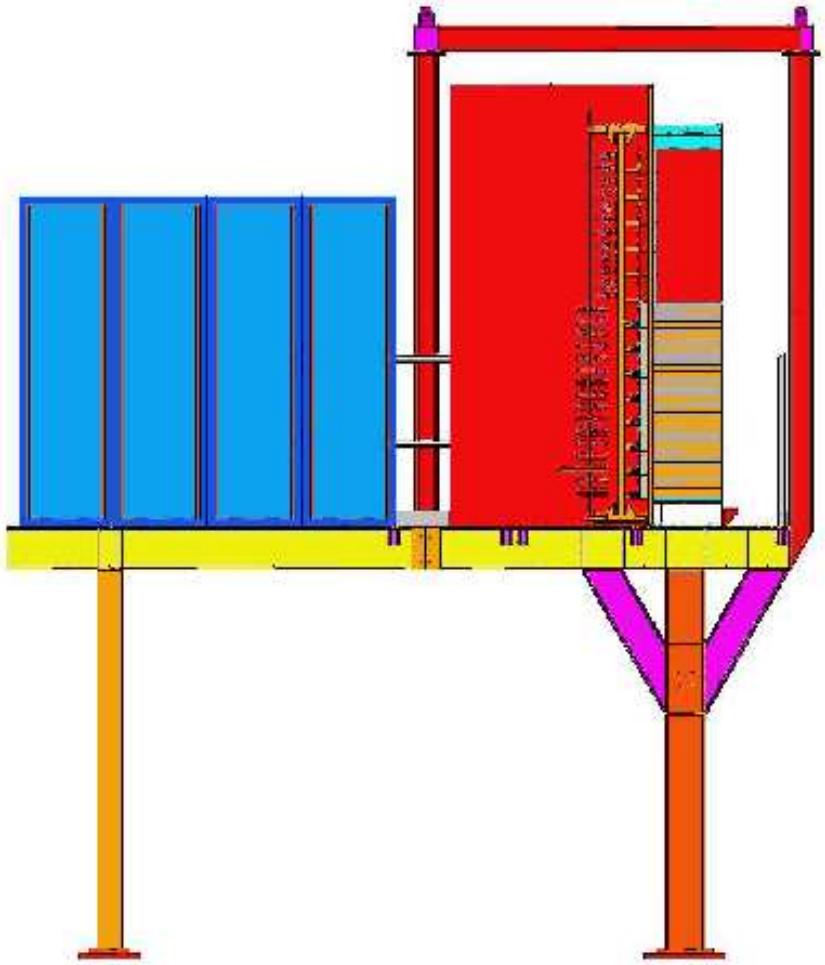


drift chamber wires FPP-HMS

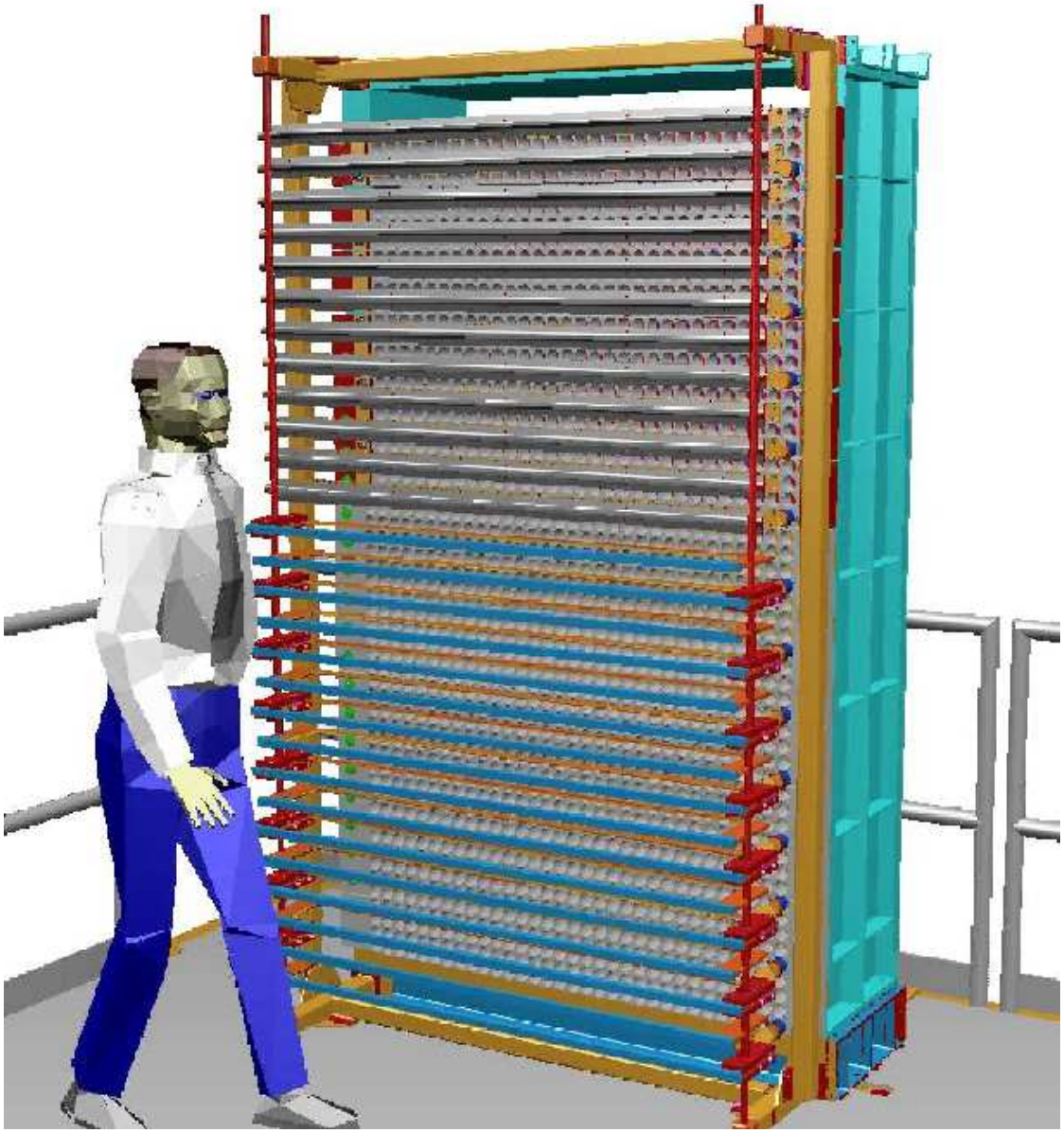


ANODE PLANE (+45) of the CHAMBER

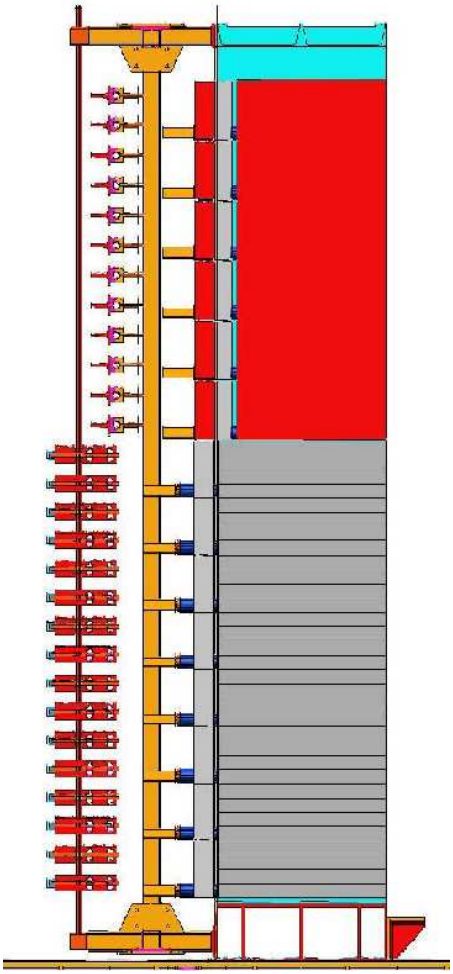
BigCal, side view/section



BigCal, top view/iso



BigCal, side view/cut



What has been done sofar

- Calorimeter, preparation

  all Protvino glass bars measured

  all Protvino bars wrapped in aluminized mylar, stacked on marble table

  all Protvino PMs and PM bases tested

  18 Protvino patch panels (16 ch. each) tested

  modified mechanics of Protvino patch panels

  built black-box, measured bar-to-bar cross talk (negligible), and

  light transmission with and without grease (grease required)

- Calorimeter prototype

  prototype for background measurements in HallC

  contains 5x5 array of Protvino glass bars

  uniformity of light source: plastic plate fed by LEDs along edge

  established readout and trigger for prototype, using RCS ADCs and

  HV

  goal: test prototype in Hall C in Spring 2003, using SOS cabling

Done sofar continued

- Calorimeter design

  preliminary design of calorimeter and platform

  real design by Mike Fowler, ready in part for construction

  design of signal cable storage for test lab and HallC

  modification of Protvino PM attachment designed

  1100 signal cables (100 m each) made (Joe Beaufait)

  design of multiplexing electronics (Rutgers and Novosibirsk)

- The people

  Yuri Melnik, Leonid Soloviev (Protvino) Lubomir Pentchev (WM and Sofia)

  Walter Kellner and Mike Fowler (Hall C)

  Phil Townsend (grad. WM) and James Younkins (undergrad. WM)

  Monique Haythe (undergrad. NSU), Juan Cornejo (undergrad. CalStateLa)

  Mark Jones, Vina Punjabi, CFP and Ed Brash

  Bogdan Wojtsekhowski, Valeri Koubarowski, Ron Gilman

Next, in Test lab

- **Reorganize area**

  see new floor plan

  platform with glass frame in early February

  build signal cable storage rack by late Spring

  reconfigure (RCS) electronic platform

  install 8 racks on calorimeter platform

- **When platform in place**

  start stacking Protvino glass

  continue with RCS glass

  freeze design of PM attachment cross bars or plates

  mount PMs with their attachment

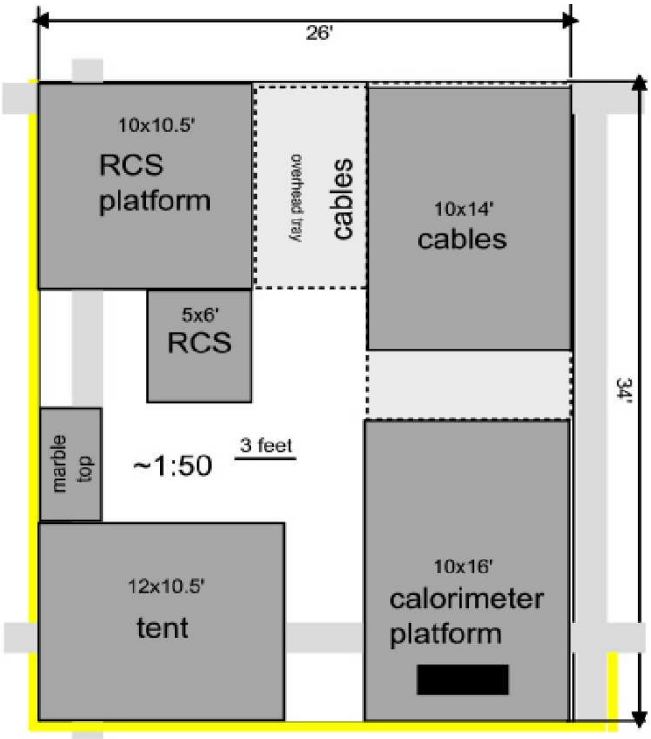
  install PM patch boards

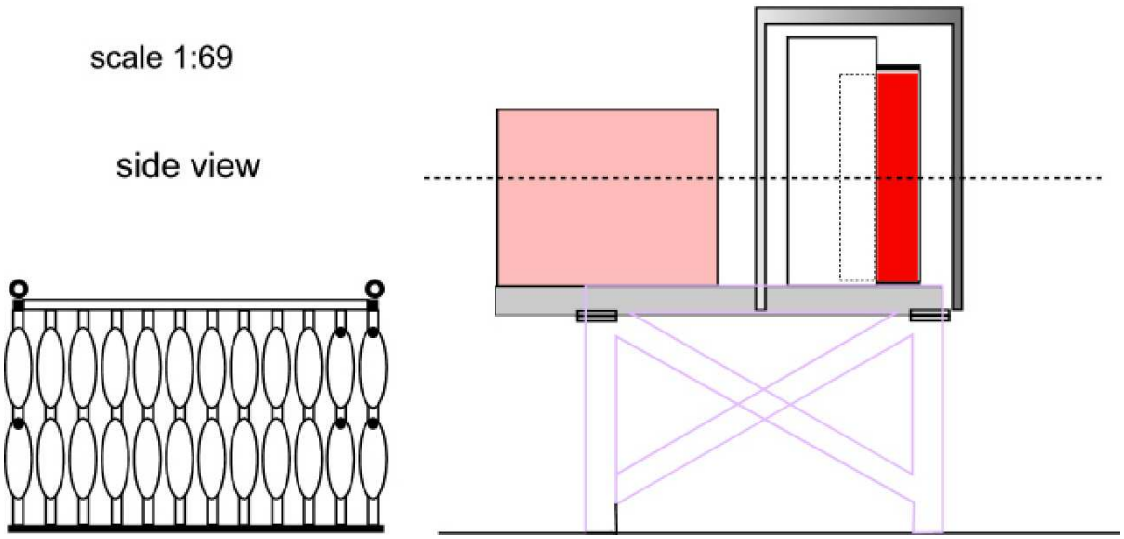
  route HV cables to their patch boards route signal cables to racks

  install fastbus/controllers on platform

  cabling to electronics platform

Test lab floor plan 2003





Larger picture

- In test lab

  Complete assembly of calorimeter end of 2003

  take cosmics and do rough calibration early 2004

  design and assemble frame for FPP by end of 2003

  receive and mount 4 drift chambers in Fall 2004

  take cosmics with FPP chambers, late 2004

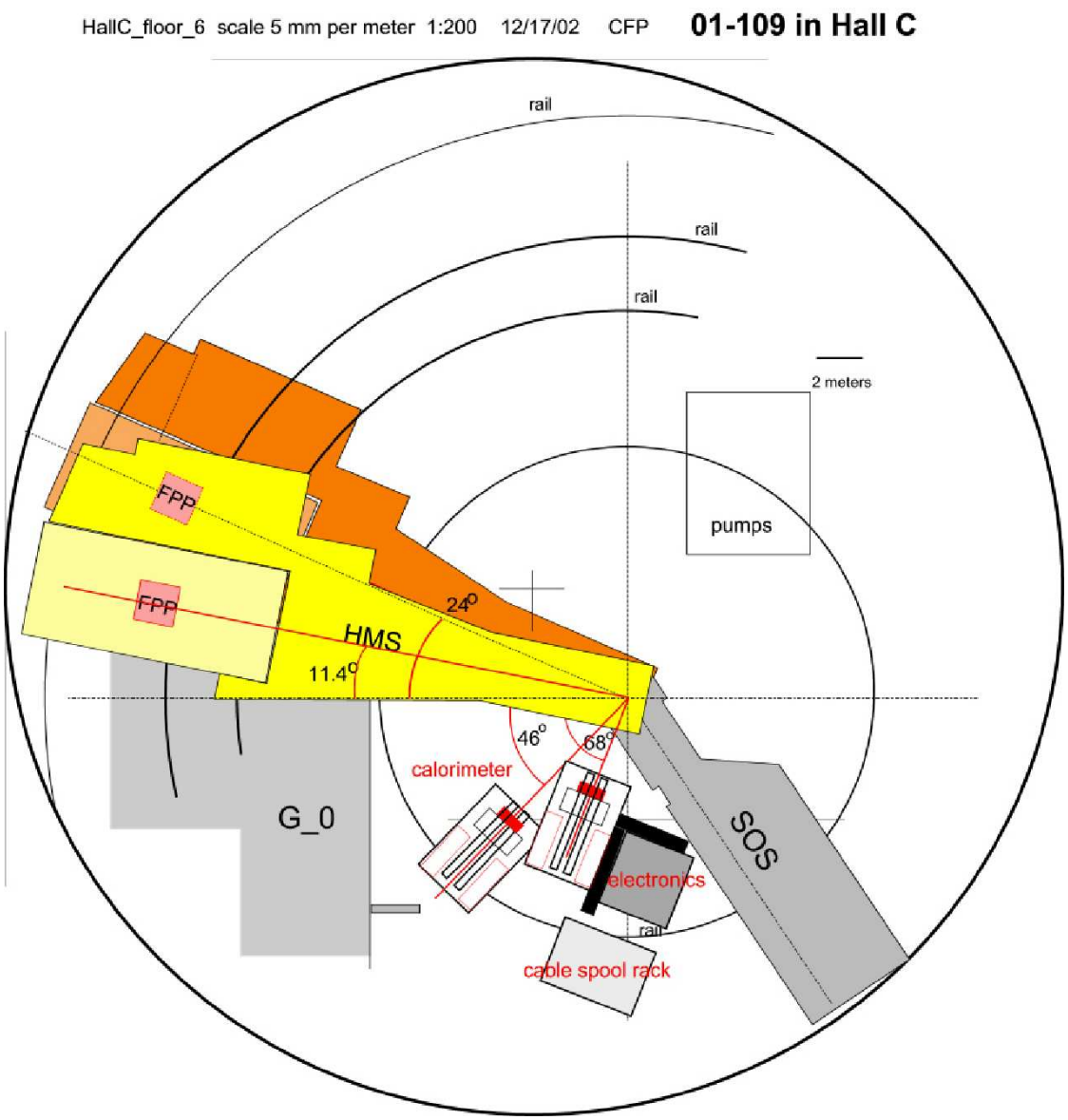
- in Hall C

  local HMS trigger in hut, trig. sup. in Hall

  G$_{Ep}$ data acquisition independent of standard DAQ

  establish all HV connections

  develop all acquisition/analysis softwares

ready for experiment in 2005

Hall C floor plan 2005