Status of the Forward Tracker

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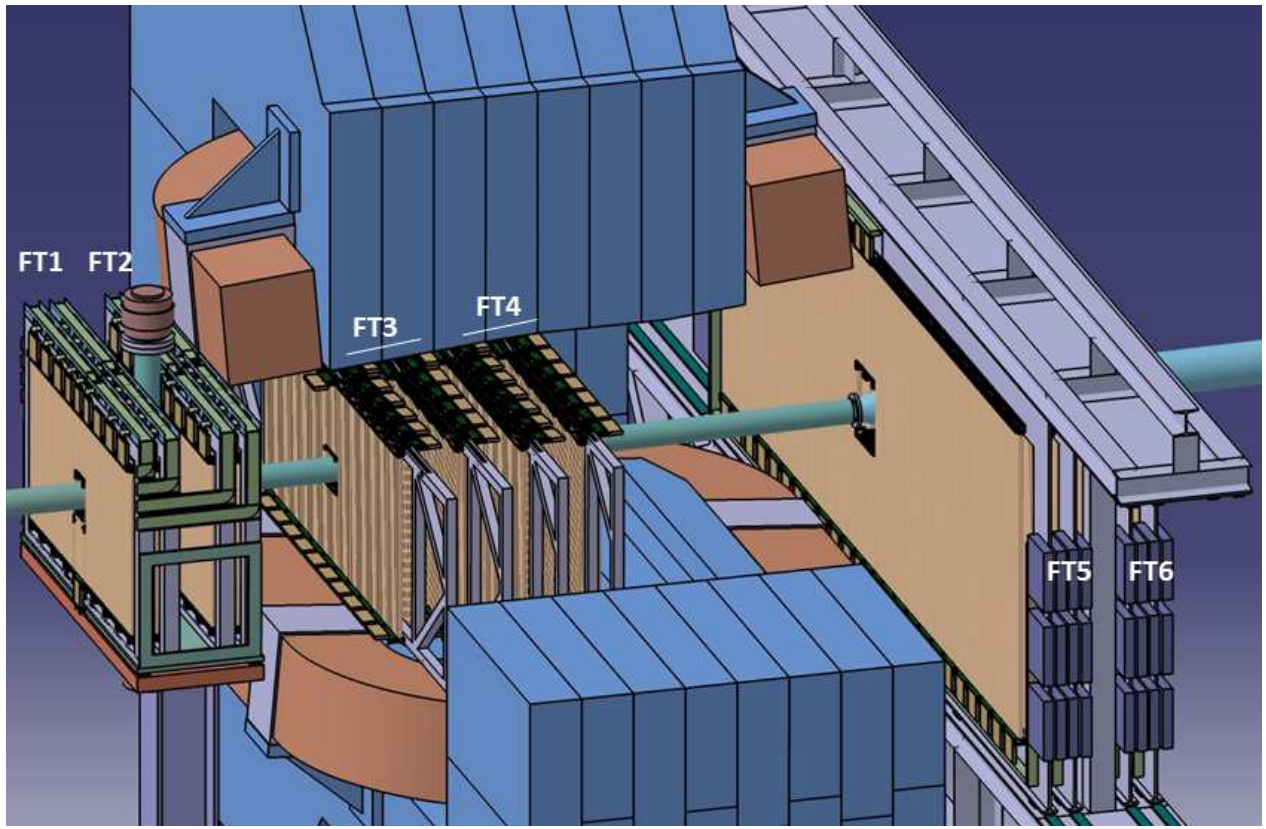
- Detector design
- Read out electronics
- Prototyping and tests
- Simulations
- TDR

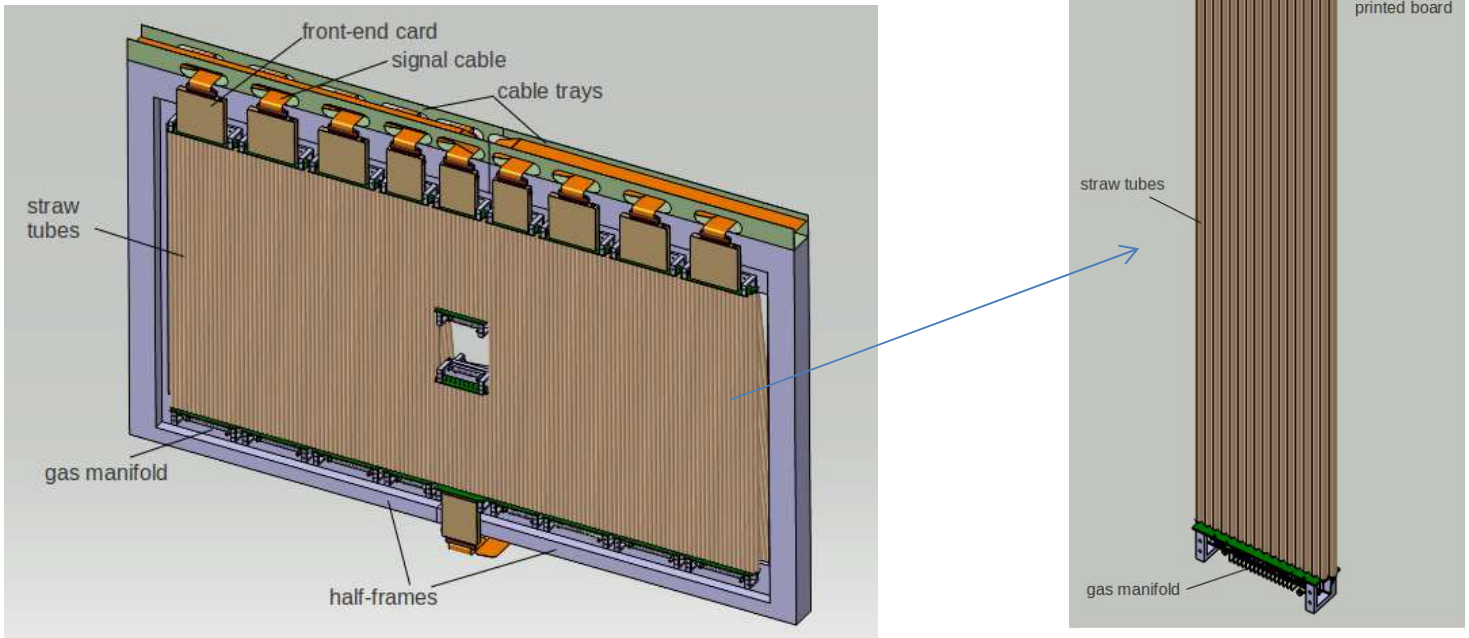
FT design



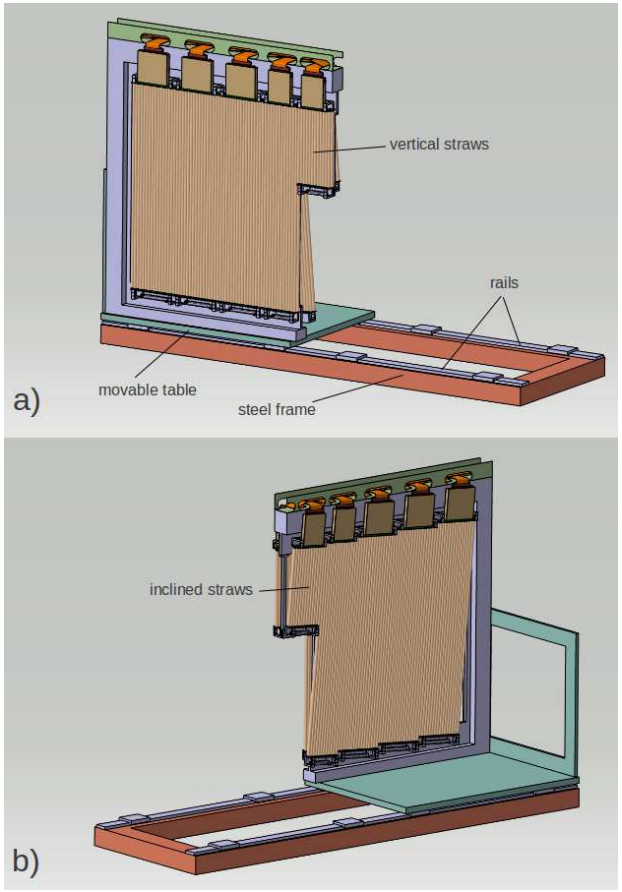
- Three pairs of tracking stations
- Tracking station: 4 double layers- 0°, -5 °, +5 °, 0 °

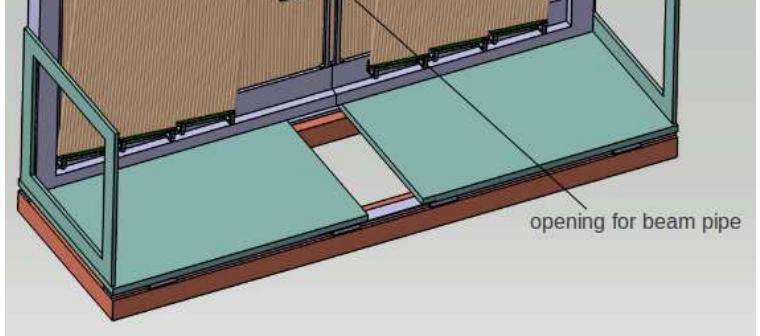
Modular construction

- One module: double layer of 32 straws ∅10.1 mm
- Full system: 400 modules (~12 000 straws)



Split frames FT1, 2 and FT5, 6

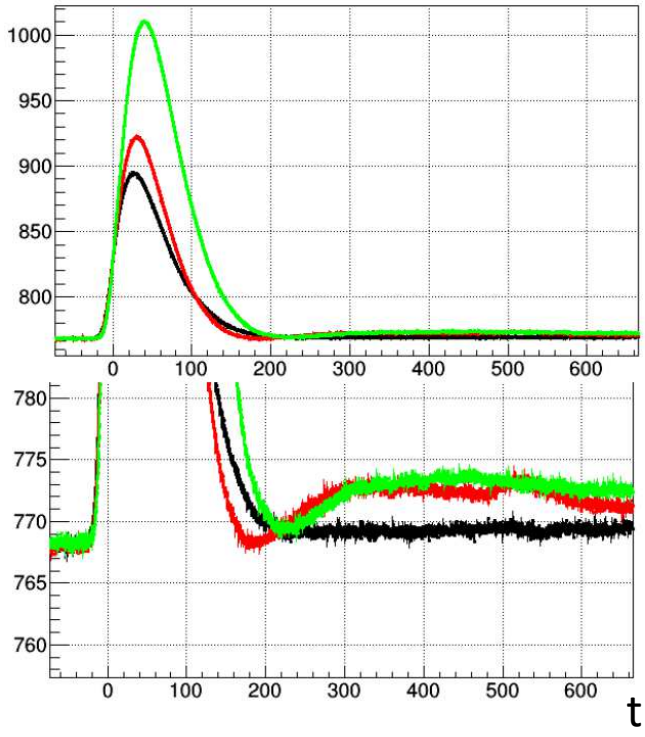


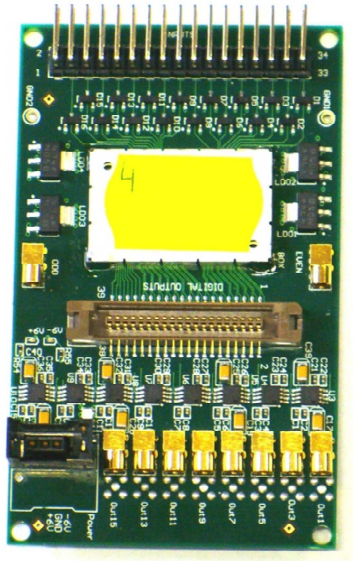


Front-end cards

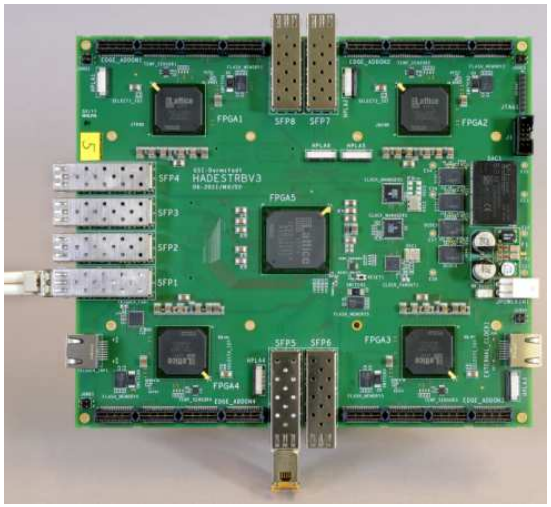
- **PASTTREC** chip v.2. (8 channels)
- **Programmable** gain, baselines, peaking time, tail cancelation parameters
- **Optimal settings identified** using ^{55}Fe pulses

  (see P. Strzempek, presentation at the Tracking Meeting)





TRB-v.3.

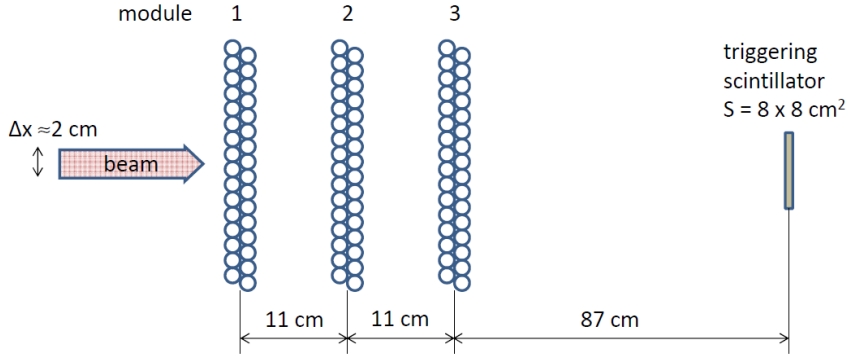


- **192 channels** (time + time-over-threshold)
- Ongoing work on **integration with SODA** (G. Korcyl)
- **Max. data rate limited** by the size of the internal buffers and the bandwidth of data transmission (GbE ~ 100 MB/s)

  e.g. at **100 kHz/channel** (= data rate 150 MB/sek)

  about 67% of data processed and transmitted
- Improvements in the max. data rate possible (*see talk of P. Strzempek at the Tracking Meeting*)

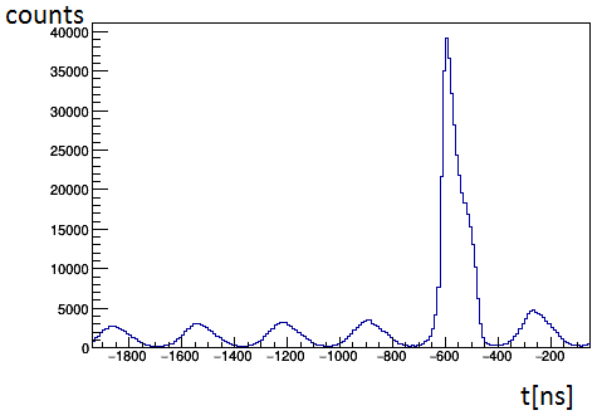
Three prototype modules for FT1



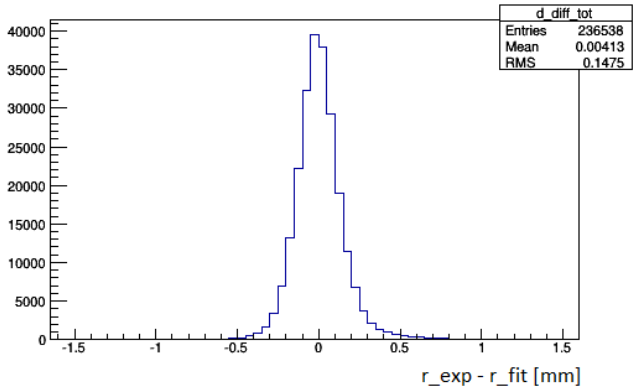
- External proton beam from COSY:
- Momenta: 3.0 and 0.6 GeV/c
- Beam intensity ~500 kHz
- Instantaneous rate: up to ~ 800 kHz/straw
- Read out: PASTTREC+TRB-v.3.

Track reconstruction

Drift time spectrum



Residuals from reconstruction of the 0.6 GeV/c proton tracks

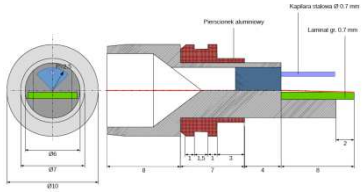


- Position resolution σ = 0.15 and 0.21 mm for the 0.6 and 3 GeV/c protons, respectively

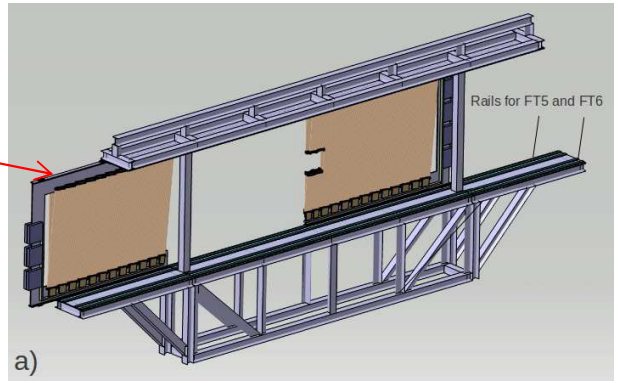
- Track reconstruction efficiency: 83% and 78% for the 0.6 and 3 GeV/c protons, respectively

Ongoing prototyping
(to be finished in 2016)

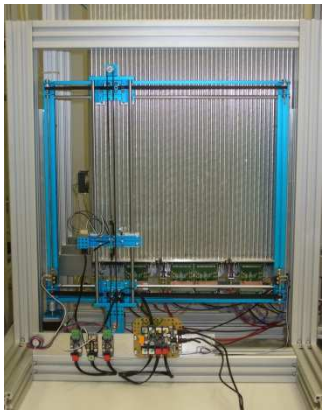
- New end-plugs



- 14 modules for FT5 mounted on half frame

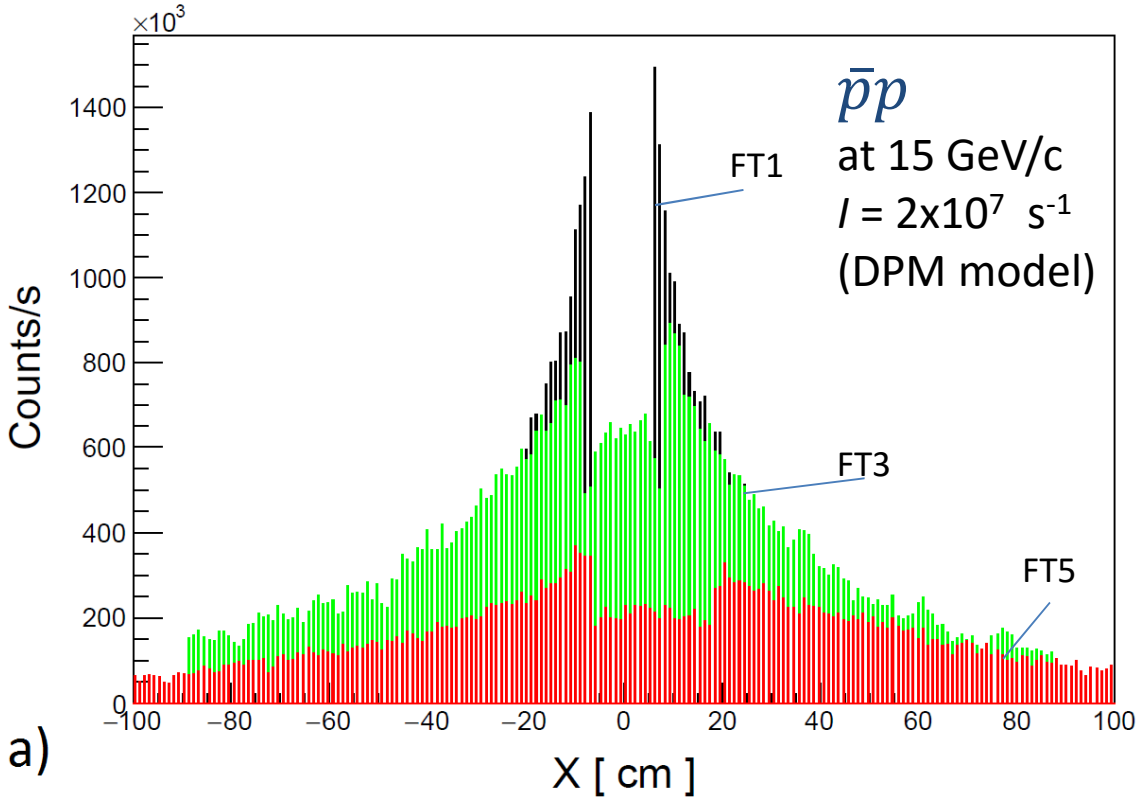


- X-ray scanner with a range x × y= 100 x 120 cm^2 for quality tests of the straw modules



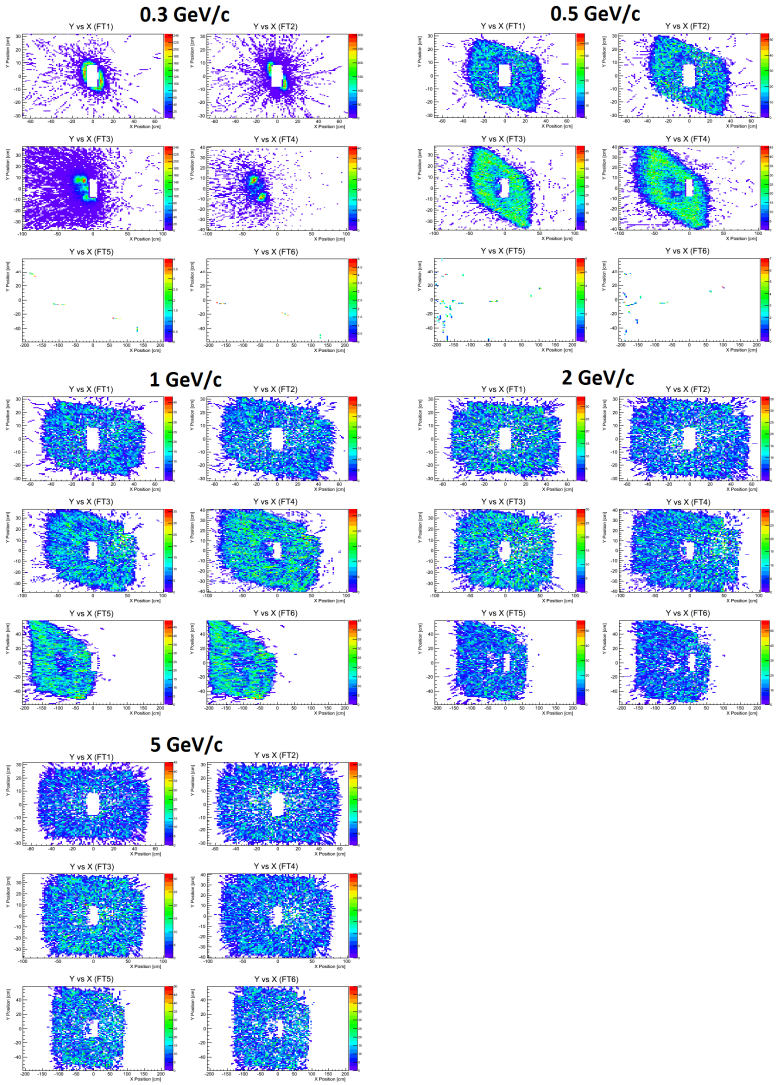
Small scale prototype (x×y= 30x30 cm^2)

Simulations: expected rates



Simulations: optimization of the FT

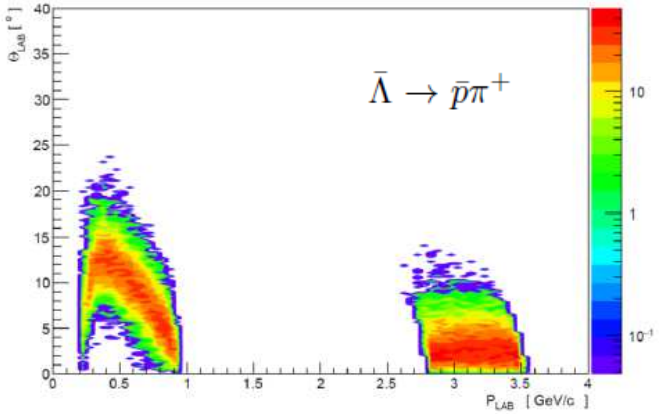
Required active areas:
intensity distributions of pions
with momenta 0.3, 0.5, 1, 2, 5 GeV/c
at the positions of the six FT stations



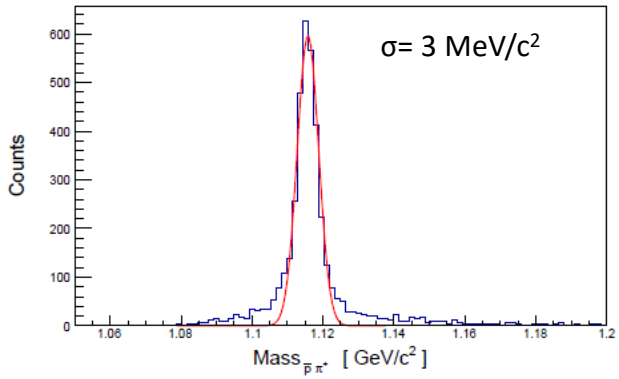
Physics channels analysis

$$\bar{p}p \to \Lambda\bar{\Lambda} \to p\pi^-\bar{p}\pi^+$$

at 4 GeV/c

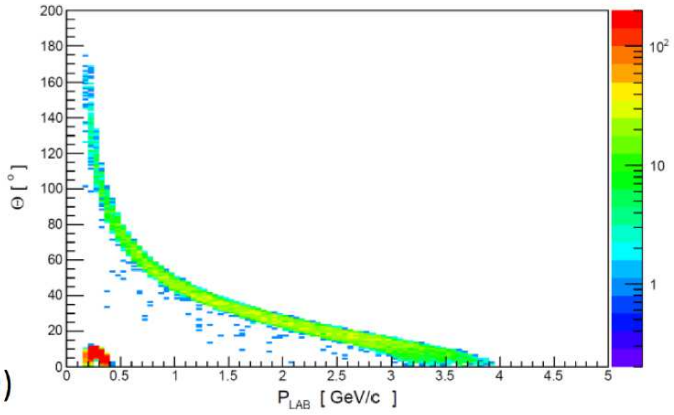


Reconstructed $\bar{\Lambda}$ mass

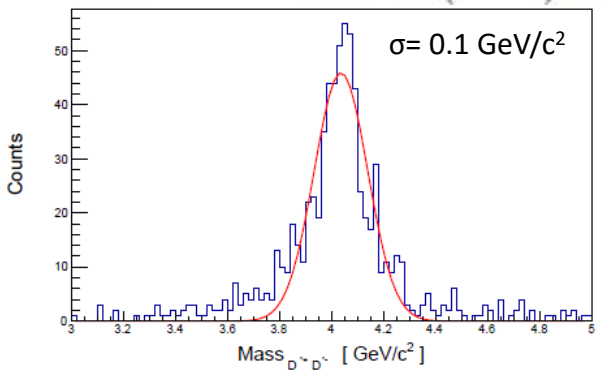


$$\bar{p}p \to \Psi(4040) \to D^{*+}D^{*-} \to$$
$$D_0\pi^+\bar{D}_0\pi^- \to K^+K^-\pi^+\pi^-\pi^+\pi^-$$

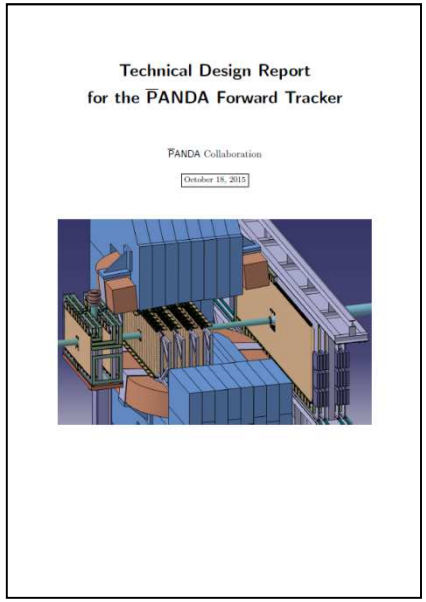
a)



Invariant mass of the $\Psi(4040)$ meson



FT-TDR



- Draft of FT-TDR written with exception of the section on simulations of the tracking performance with included pattern recognition

Thank you

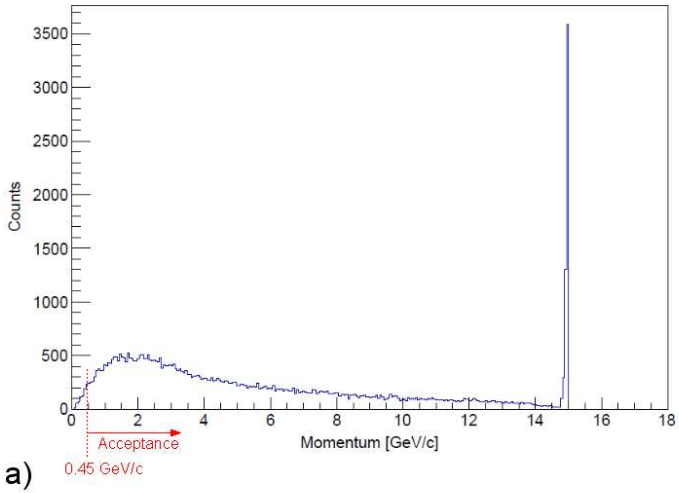
Three prototype modules

Performance requirements

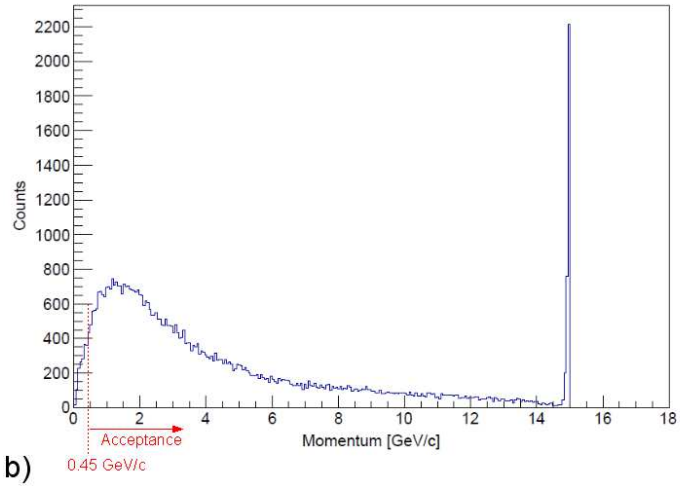
- Angular range: $\theta_h = \pm 10°$, $\theta_v = \pm 5°$
- Momentum acceptance: $p > 3\%\ p_{beam}$
- Momentum resolution: < 1.5 % *(comparable or better than in STT)*
- High rate capability
- Low aging: 10 years with data taking period of 6 months/year

Momentum distribution of charged particles in FT

$\bar{p}p$
at 15 GeV/c
I = 2x10^{7} cm^{-2} s^{-1}
(DPM model)



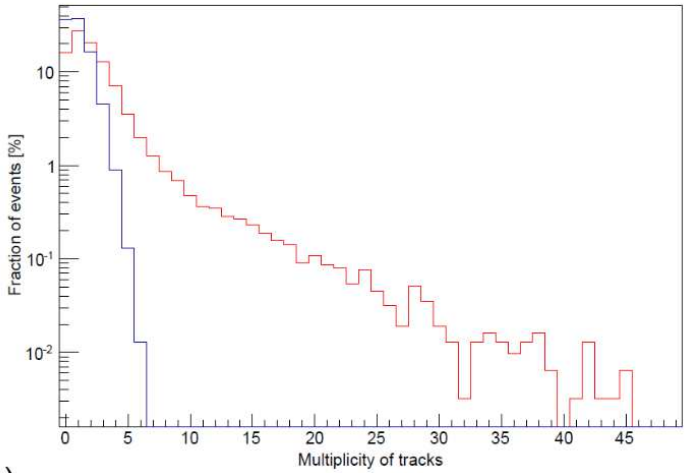
$\bar{p}$N
at 15 GeV/c
I = 10^{7} cm^{-2} s^{-1}
(UrQMD model)



Multiplicity of tracks

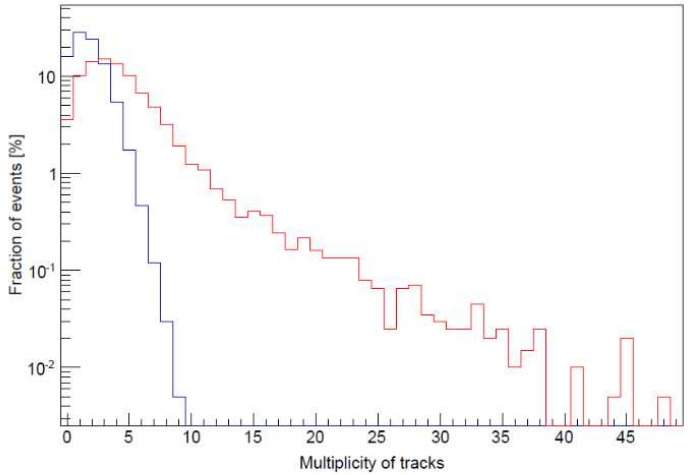
- Primary tracks (blue), primary + secondary (red)

$\bar{p}p$
at 15 GeV/c
I = 2x10^{7} cm^{-2} s^{-1}
(DPM model)



a)

$\bar{p}$N
at 15 GeV/c
I = 10^{7} cm^{-2} s^{-1}
(UrQMD model)

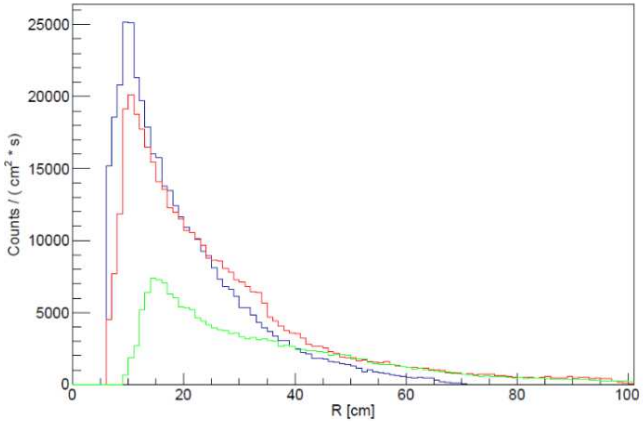


b)

Particle fluxes

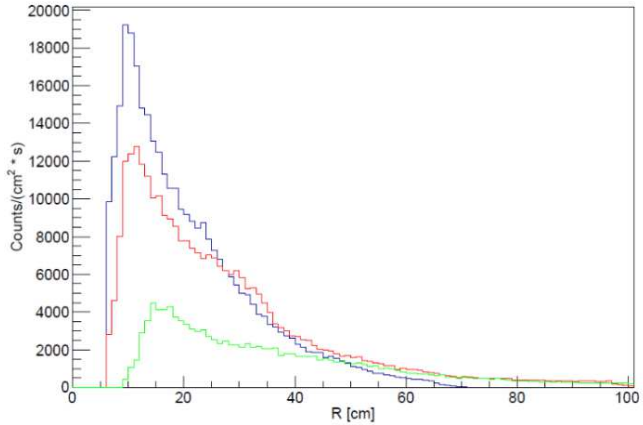
- Fluxes at z = 2594 mm (blue), 3945 mm (red) and 6075 mm (green)

$\bar{p}p$
at 15 GeV/c
I = 2x10^{7} cm^{-2} s^{-1}
(DPM model)



a)

$\bar{p}$N
at 15 GeV/c
I = 10^{7} cm^{-2} s^{-1}
(UrQMD model)

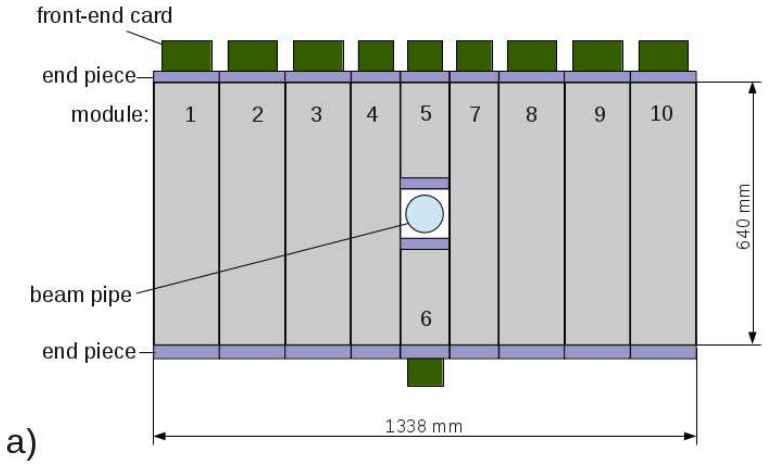


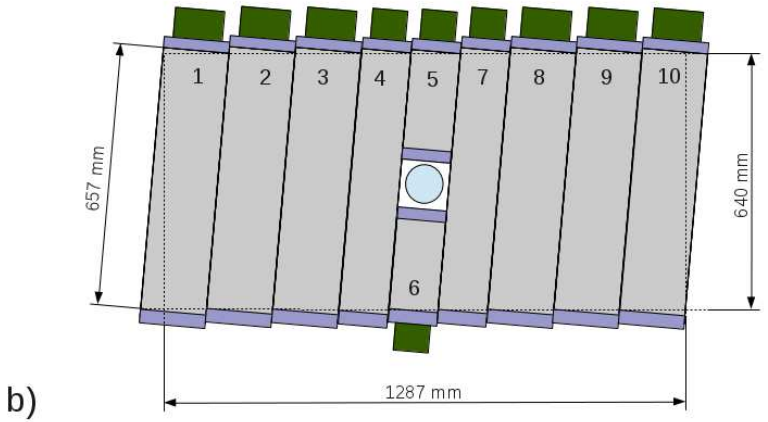
b)

- <u>Fluxes up to 25 000 cm^{-2} s^{-1} before dipole magnet close to beam pipe</u>

Arrangement of modules in FT1, FT2

- Modules 1, 2, 3 and 8, 9, 10 – standard ones (2x16 straws)
- Modules 4, 5, 6, 7 – narrow ones (2x12 straws)

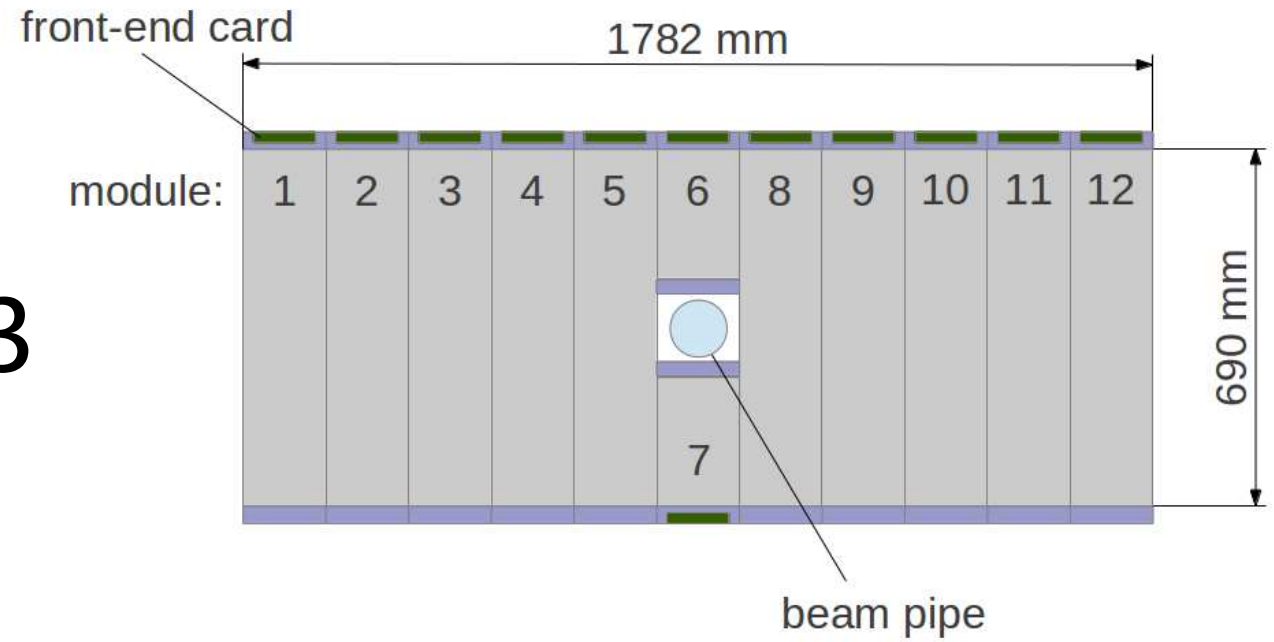




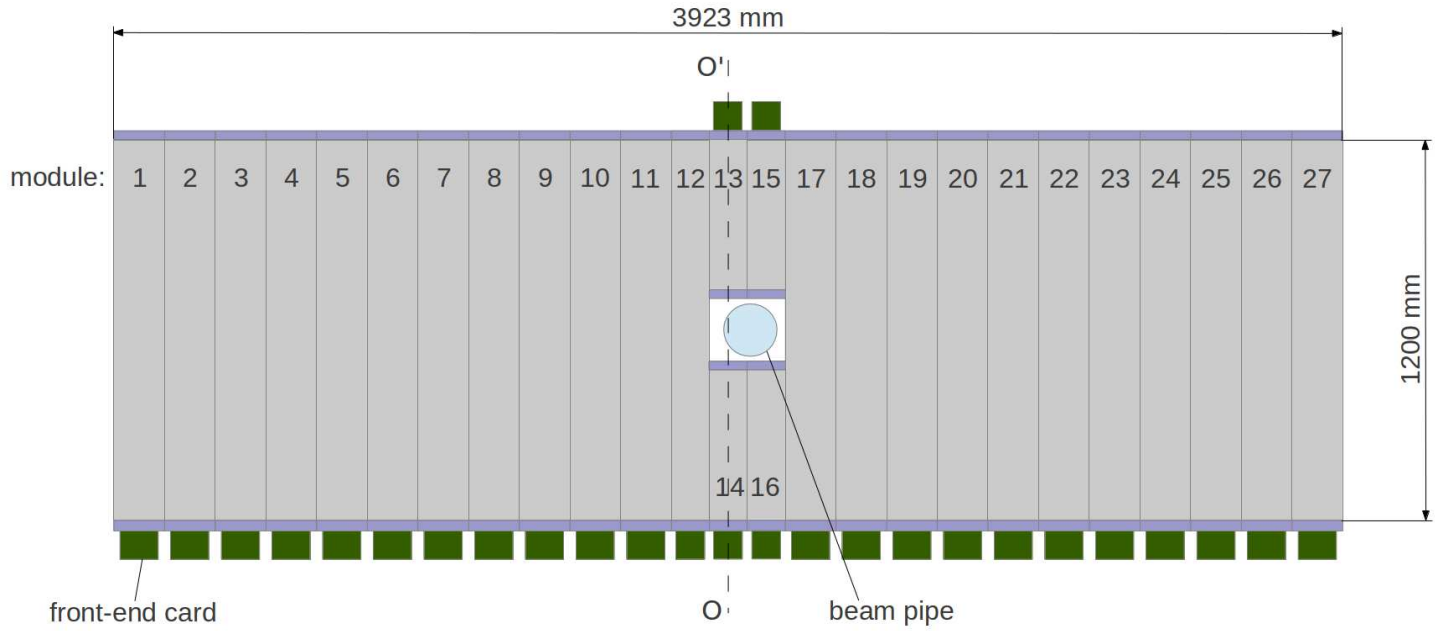
Arrangement of modules in FT3 and FT4

- One detection plane of FT3 comprises 12 modules and of FT4 -14 modules

FT3



Arrangement of modules in FT5, FT6



- Detection planes are symmetric under rotation by 180 around the z-axis
- Modules 12, 13, 14, 15, 16 are narrow ones

Basic parameters of the FT stations

Tracking station	$z_{min} - z_{max}$ [mm]	Active area		Number of modules	Number of straw tubes
		w [mm]	h [mm]		
1	2954-3104	1338	640	4x10=40	4x288=1152
2	3274-3424	1338	640	4x10=40	4x288=1152
3	3945-4245	1782	690	4x12=48	4x384=1536
4	4385-4685	2105	767	4x14=56	4x448=1792
5	6075-6225	3923	1200	4x27=108	4x824=3296
6	6395-6545	3923	1200	4x27=108	4x824=3296

- Total number of modules (straw tubes): 400 (12224)