

Status of STT Activities in Jülich

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Outline

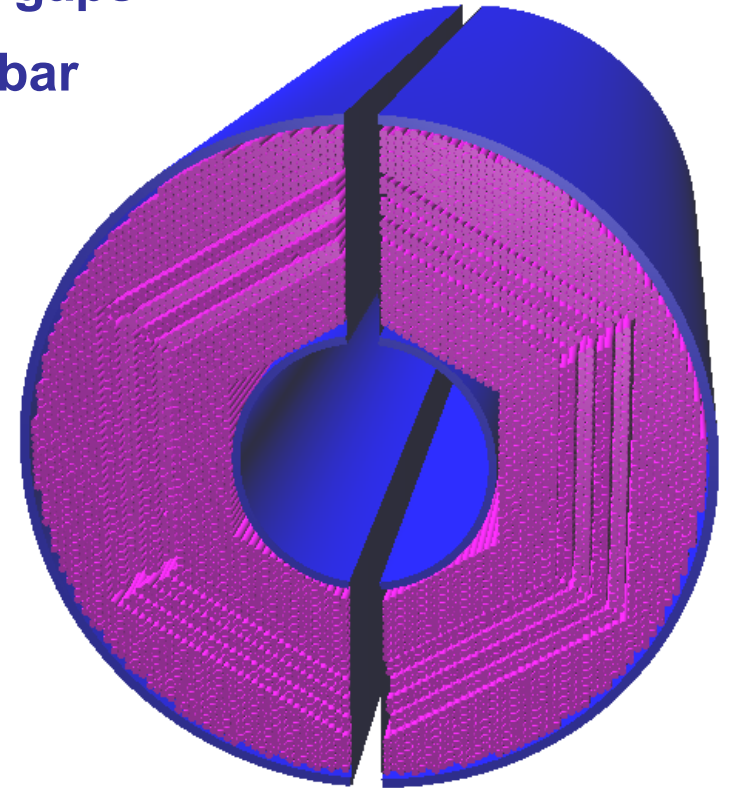
- **STT design**
- **Prototype construction**
- **Readout**
- **High rate test (reminder)**

STT Design

4200 straws

- 20-26 planar layers, close-packed with $15\mu\text{m}$ gaps
- **high mechanical rigidity & precision** at $\Delta p=1\text{bar}$
- **8 skewed layers** ($\pm 3^\circ$) for 3d-reco
- Ar/CO₂ at $p \sim 2\text{ bar}$
- $\sigma_{r\phi} \sim 150\mu\text{m}$, $\sigma_z \sim 2.9\text{ mm}$
- $X/X_0 \sim 1\%$

- **high efficiency** ($N_{r\phi} > 12\text{ hits}$, $N_z \sim 8$)
- **dE/dx capability** ($\Sigma Q / 23\text{straws} \times 8\text{mm gas}$)



STT Prototype Development

Full scale prototype

- simplified mechanical frame structure (flange)
- check straw layer layout
 - mechanical properties
 - skewed straw layers
 - mounting & assembly method
 - attachment to frame
- gas supply scheme
- electric connection
- input for final STT design

➡ **Juelich: 1200mm straw tube length**
Frascati: 1500mm tube length

Straw Layer Technique

Measurements

- Straw (outer) diameter
 - 10.085mm at $\Delta p=1\text{bar}$
 - 10.055mm at $\Delta p=0\text{bar}$
- Straw distance 10.1mm
- **15 μm gap between adjacent straws**

Layer technique

- old: straws glued to double-layer
- new: straws glued to 4-fold layer with increased rigidity
- still possible to exchange single (faulty) straws



block of 6 straw layers
glued together

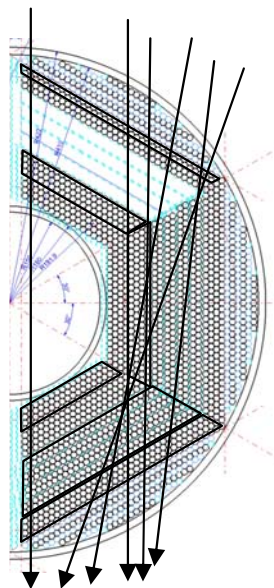
➡ High rigidity & precision of straw layer block

STT Prototype (1)

- 1 full hexagon sector with 26 layers
- 1 sector w/o outer 6 layers
- all straws w/o wire

- next: assembly of straw layers with wire
- 700 new straws
- add to setup
- precision test with reconstructed tracks

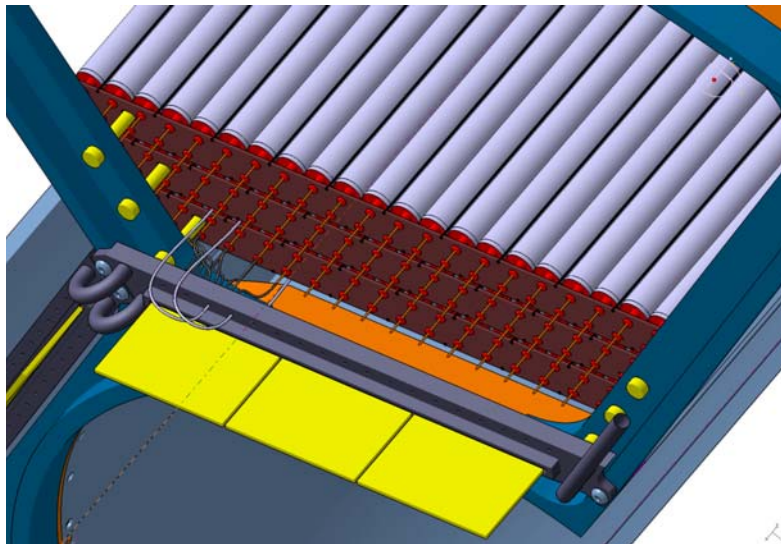
wired
straws
in red



STT Prototype (2)

- Straw double-layers attached by 2×2 pins to mechanical frame
- innermost and outermost (thin) alignment rings later
- 6 outer layers (barrel shape), glued together

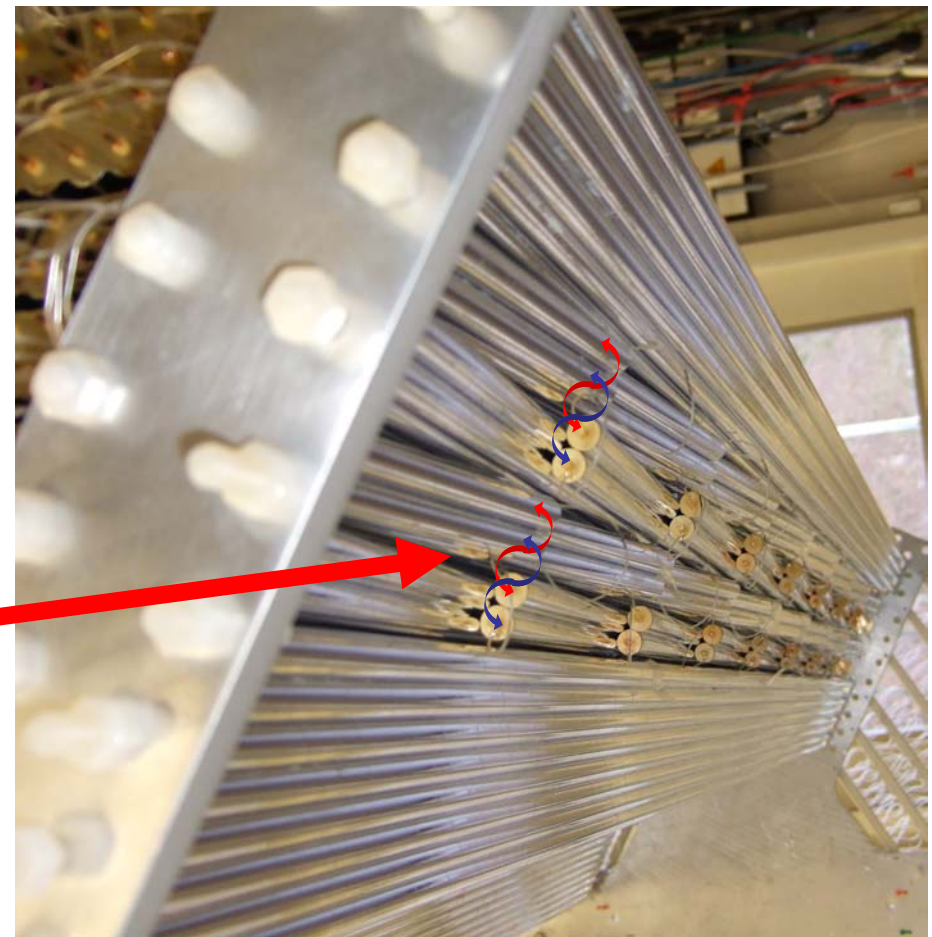
Dario's CAD drawing



Skewed Layers

8 Skewed layers:

- skew angle $\pm 3^\circ$
- 2×5 short straws per layer (total: 480)
- **rohacell spacers** at corners and between last skewed & next axial layer
- **additional material (plugs, ..)** to be included in simulation ($X/X_0 \sim 1\%$)
- electric wire, grounding & gas **connection between short straws** in same sector
- disentangle by software offline



Gas Supply

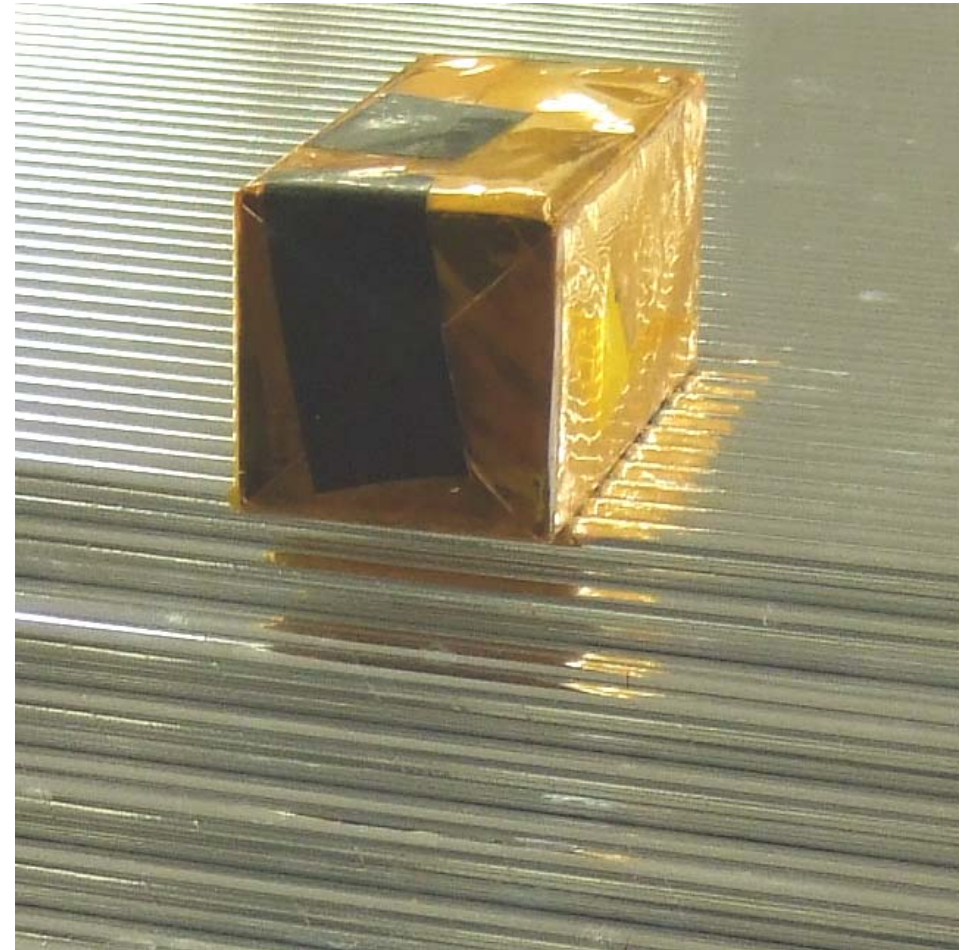
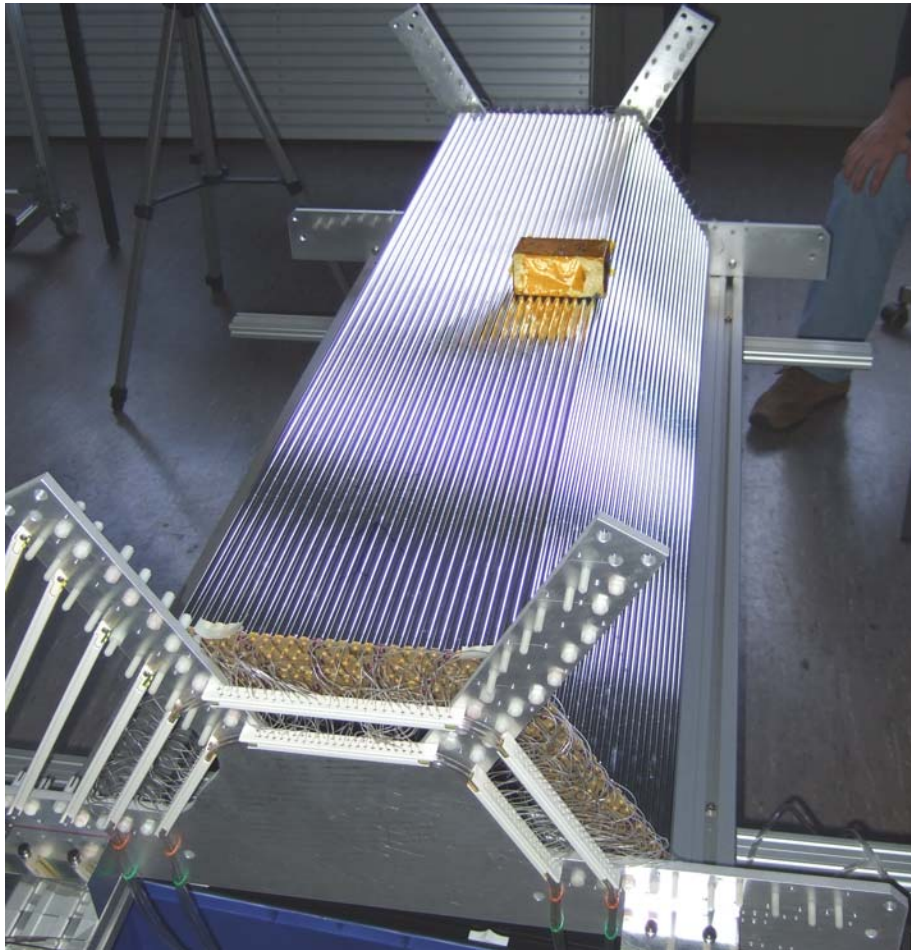


Manifolds

- 6× per 26 straw layers, 4 straws connected in series (even no of straws)
- $X/X_0 \sim 0.9\%$ (max.), $\sim 0.5\%$ (mean) ($\pi \times 1$ mm nylon)
- electric connection difficult through gas lines

➡ **Optional: Gas manifolds at forward end of STT**

Self-Supporting Straw Layers



- ➔ **Strong rigidity of close-packed, pressurized straw layers**
(3kg Pb on 30 μ m mylar film tube)

PANDA STT Readout

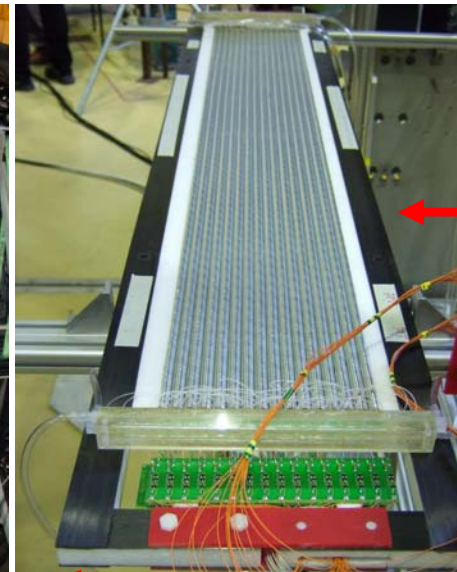
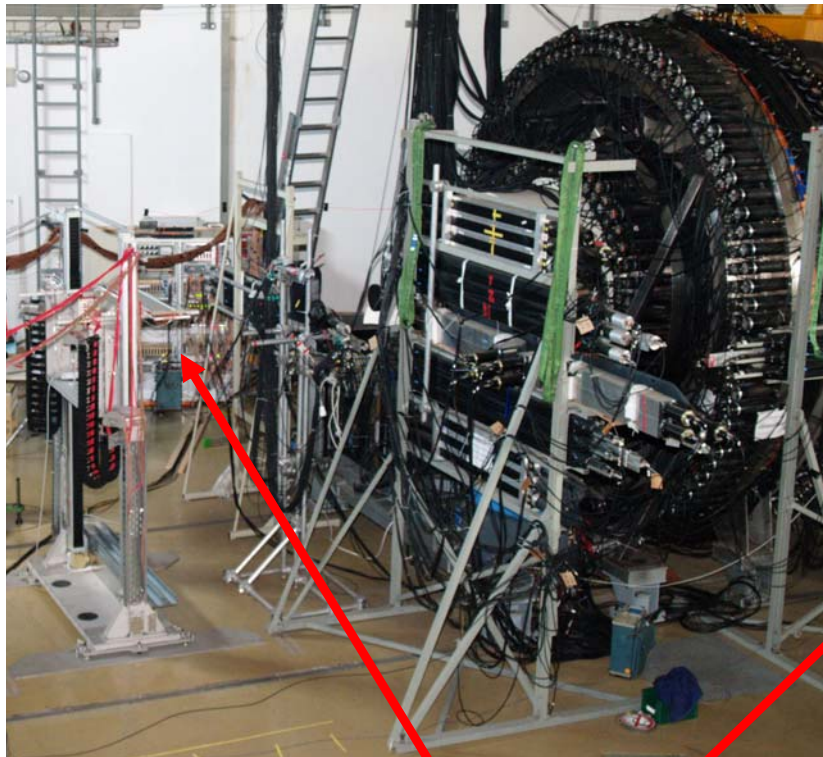
Readout concept

- investigate new dE/dx capability
- first results with (standard) electronics promising (K.Pysz, V.Serdyuk)
- **challenge: combine dE/dx with ~1ns time resolution**
- new readout development (2010 ➡)
- resolution measurements: dE/dx \leftrightarrow Δt
- decide on strategy

- experience from COSY-STT (2700 straws)
 - discr.+TDC readout
 - calibration & resolution

Beam Test in Jun 07

COSY-TOF beam area



**p-beam, 3GeV/c,
2.3×10⁶ s⁻¹ cm⁻²,
10days**

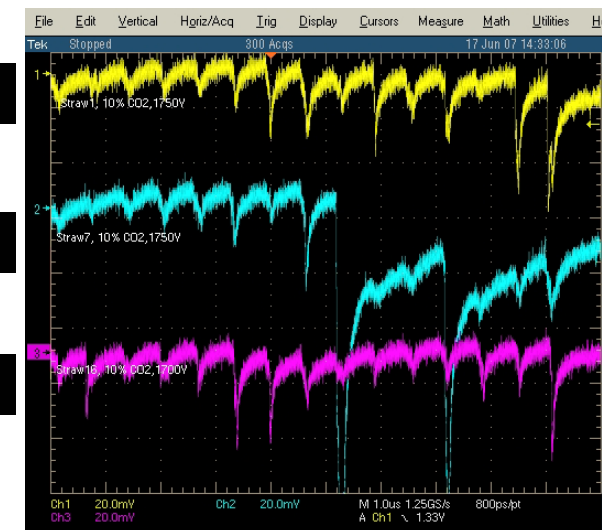
Single straw rates ~ 2 MHz

**Straw setup
(2x16 straws)**

18 peaks /10μs

18 peaks /10μs

17 peaks /10μs

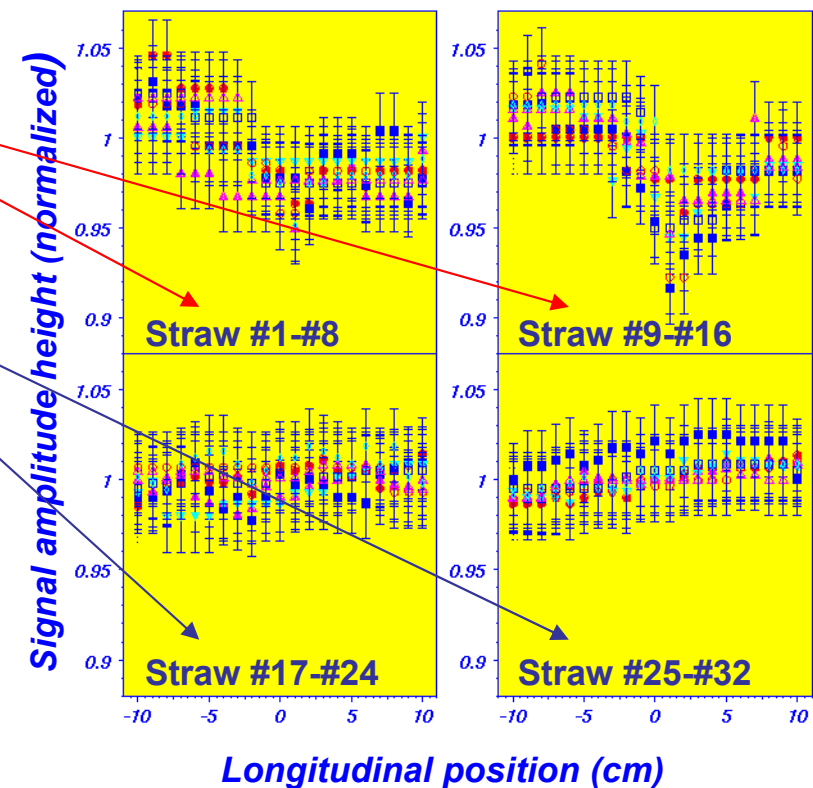


Straw Aging Results

- after beam time straws exposed to ^{55}Fe source along tube
- measure gas gain (reduction = aging) by signal amplitude height

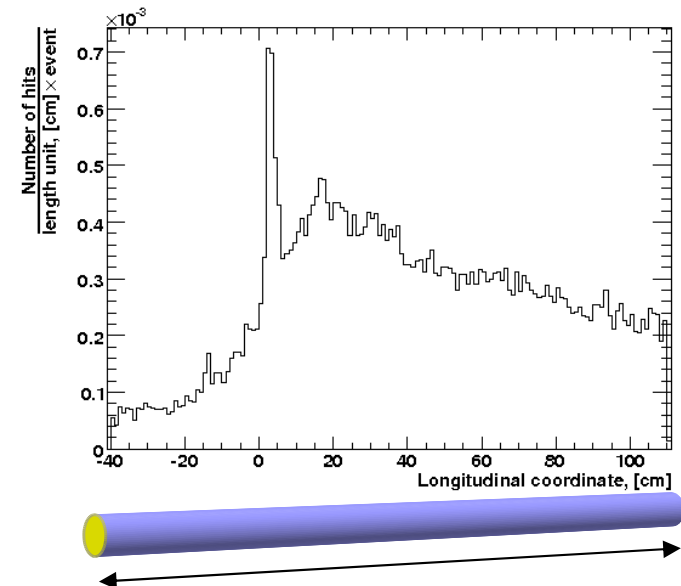
Straw no	Gas mixture @ 1.65 bar	ΣQ (C) in 199h	Aging seen $\Delta G/G$
1 – 8	Ar/ CO ₂ (10%)	0.72	< 3%
9 -16		0.58	< 7%
17 – 20	Ar/ CO ₂ (30%)	1.23	no
21 – 24		0.79	no
25 - 32	Ar/ C ₂ H ₆ (10%)	0.87	no

- no loss for straws with highest charge load
- max. 7% efficiency loss for some, not all straws
- localized efficiency drop strongly correlated with beam intensity profile



PANDA STT Rate Numbers

- p(bar)p simulation (Andrei Sokolov)
- event rate $2 \times 10^7 \text{ s}^{-1}$
- additional MVD material (supports) not included
- all numbers for innermost straw layer (worst case)
- 3% decrease for every next layer



	Peak Rate (z=2cm) kHz/cm	Mean Rate kHz/cm	Rate / Straw kHz	Peak ΣQ C/cm	Mean ΣQ C/cm	Aging seen $\Delta G/G$	
p(bar) p - Simulation	14	6	700	0.8	0.15		Ar/CO ₂ (20%)
measured @ COSY	2300				0.7	<3%	Ar/CO ₂ (10%)
					0.6	<7%	
					1.2	none	Ar/CO ₂ (30%)
					0.8	none	
					0.9	none	Ar/C ₂ H ₆ (10%)

STT Strategy

PANDA operation years (1/2 year live-time)

- **no general aging** expected up to 8 years
- **localized ($z=2\pm 2\text{cm}$) aging may appear** after 2 years
 - **benefit from high number of layers**
 - **replace some straws after few years**
- **Ar/CO₂ (20-30%)** preferable
- **results confirm aging tests by other groups (dry Ar/CO₂ aging-free)**