The Polarized Target for COSY-TOF

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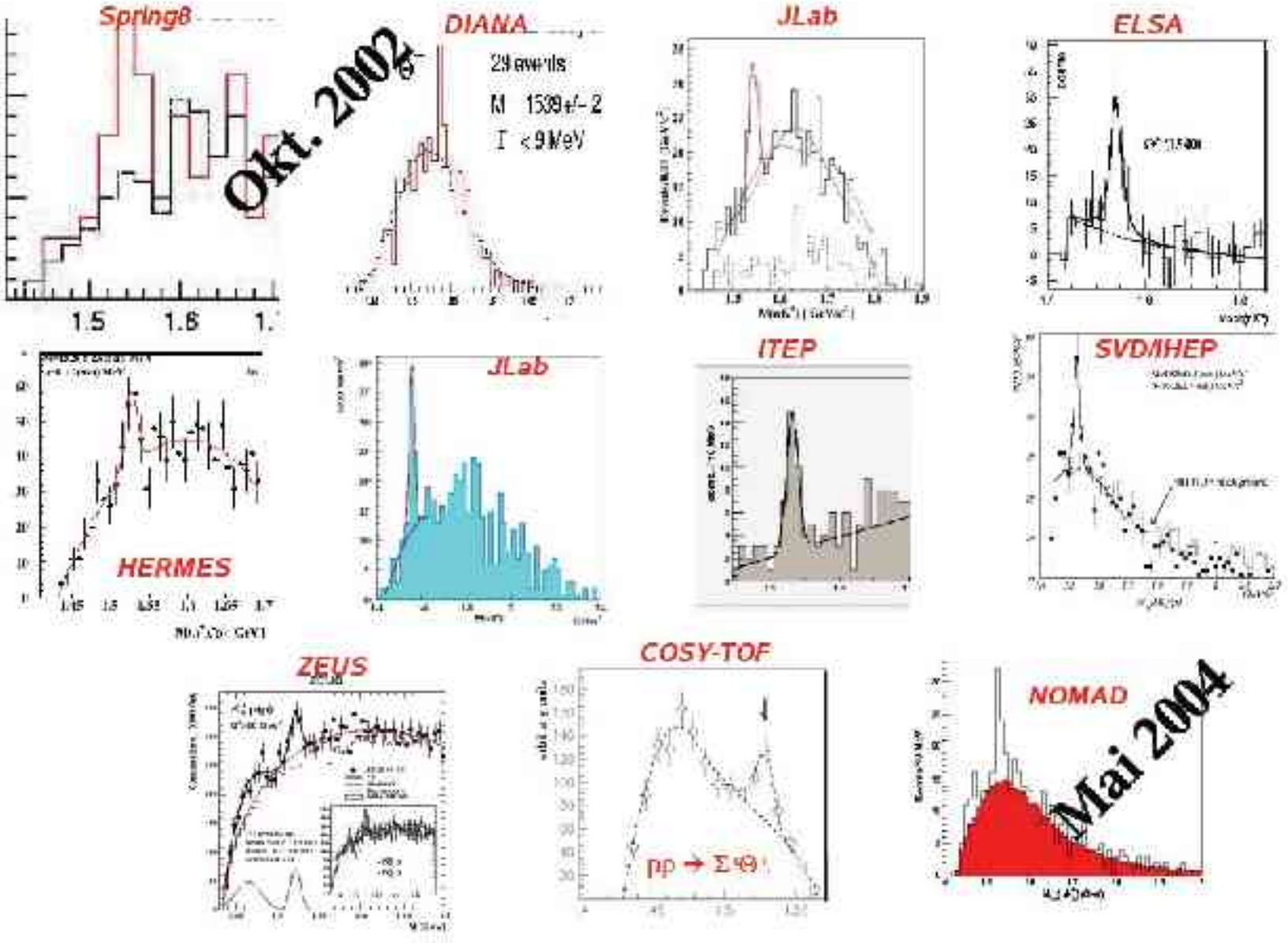
1st Meeting
Polarized Nucleon Targets for Europe
Ruhr-Universität Bochum
29-30 November 2004

Polarized Target Bochum

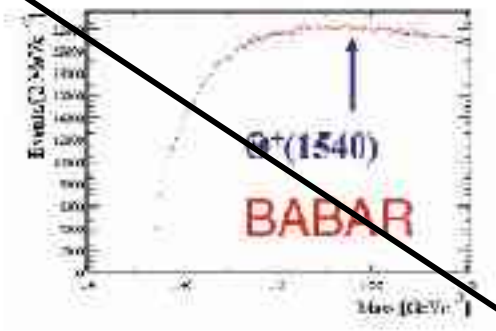
Setup of a polarized solid target system for the measurement of the Pentaquark $\Theta^+(?)$ parity at COSY-TOF

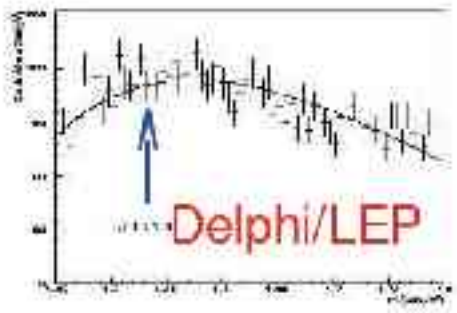
Indication of the existence of the Pentaquark $\Theta^+(1540)$

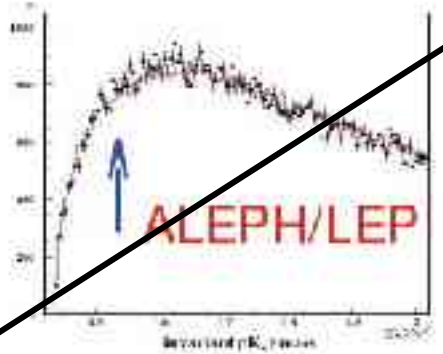


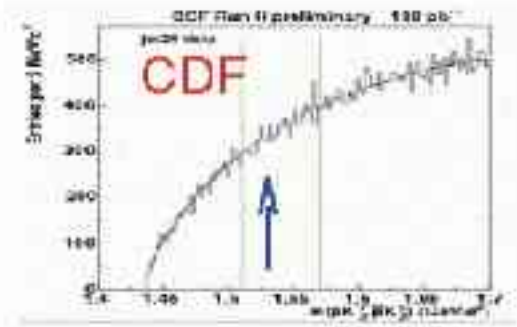
(Michael Ostrick, PI, Uni-Bonn)

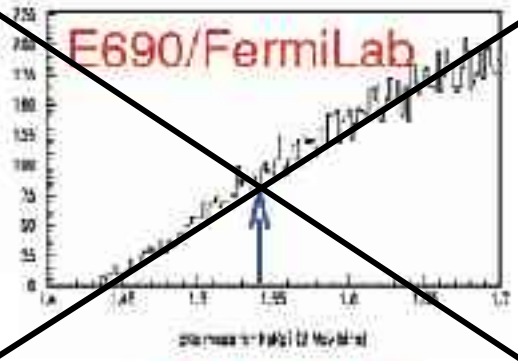
… and unsuccessful search

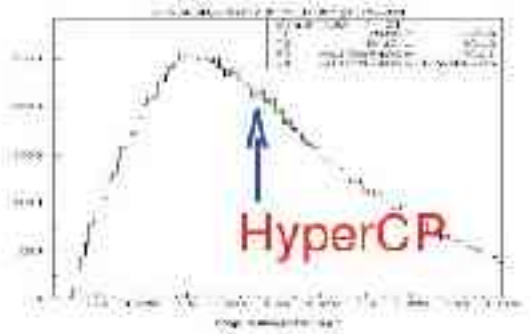


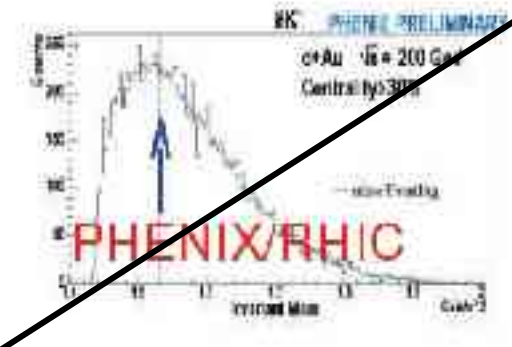




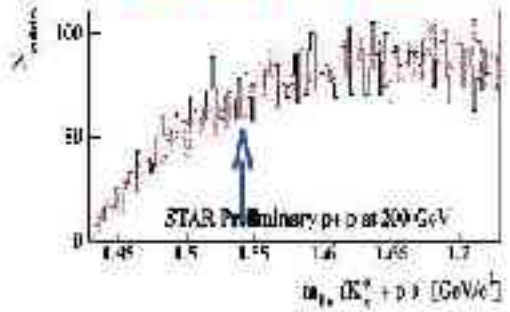




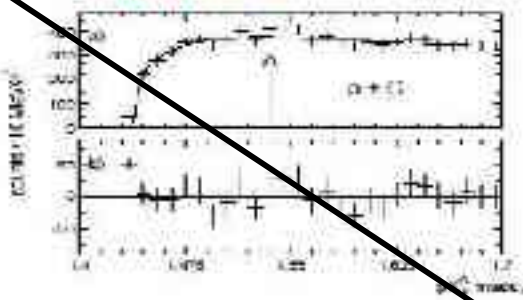




STAR/RHIC



HERA-B



(Michael Ostrick, PI, Uni-Bonn)

A Method to Determine the Parity of the Θ^+ Pentaquark

A.W. Thomas , K. Hicks , A. Hosaka, *Prog.Theor.Phys.111 (2004) 291-293*

Θ^+ production in the threshold region:

- Fermi statistics of the two nucleons and threshold kinematics
- Conservation of total angular momentum, parity and isospin in the strong interaction

$$\vec{p} + \vec{p} \rightarrow \Sigma^+ + \Theta^+$$

IF $\Theta+$ has positive parity $\Rightarrow$ pp spins anti-aligned ($^1S_0$)

IF $\Theta+$ has negative parity $\Rightarrow$ pp spins aligned ($^3P_{0,1}$)

How to measure the parity of the Θ^+ in *pp* collisions

C. Hanhart et al., *Physics Letters B 590 (2004) 39-44*

spin correlation coefficients: project on individual initial spin states

$$
\begin{aligned}
{}^1\sigma_0 &= \sigma_0(1 - A_{xx} - A_{yy} - A_{zz}),\\
{}^3\sigma_0 &= \sigma_0(1 + A_{xx} + A_{yy} - A_{zz}),\\
{}^3\sigma_1 &= \sigma_0(1 + A_{zz}),
\end{aligned}
$$

$$
{}^3\sigma_\Sigma = \frac{1}{2}\left({}^3\sigma_0 + {}^3\sigma_1\right) = \frac{1}{2}\sigma_0(2 + A_{xx} + A_{yy}).
$$

positive parity: A_{xx} and A_{yy} go to -1

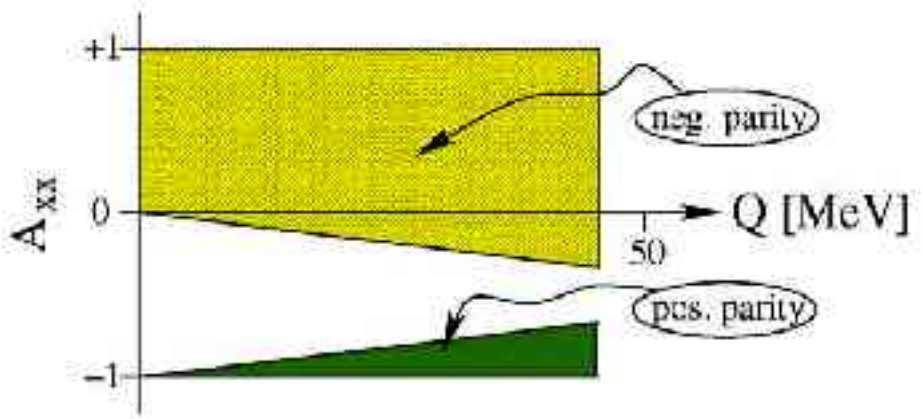
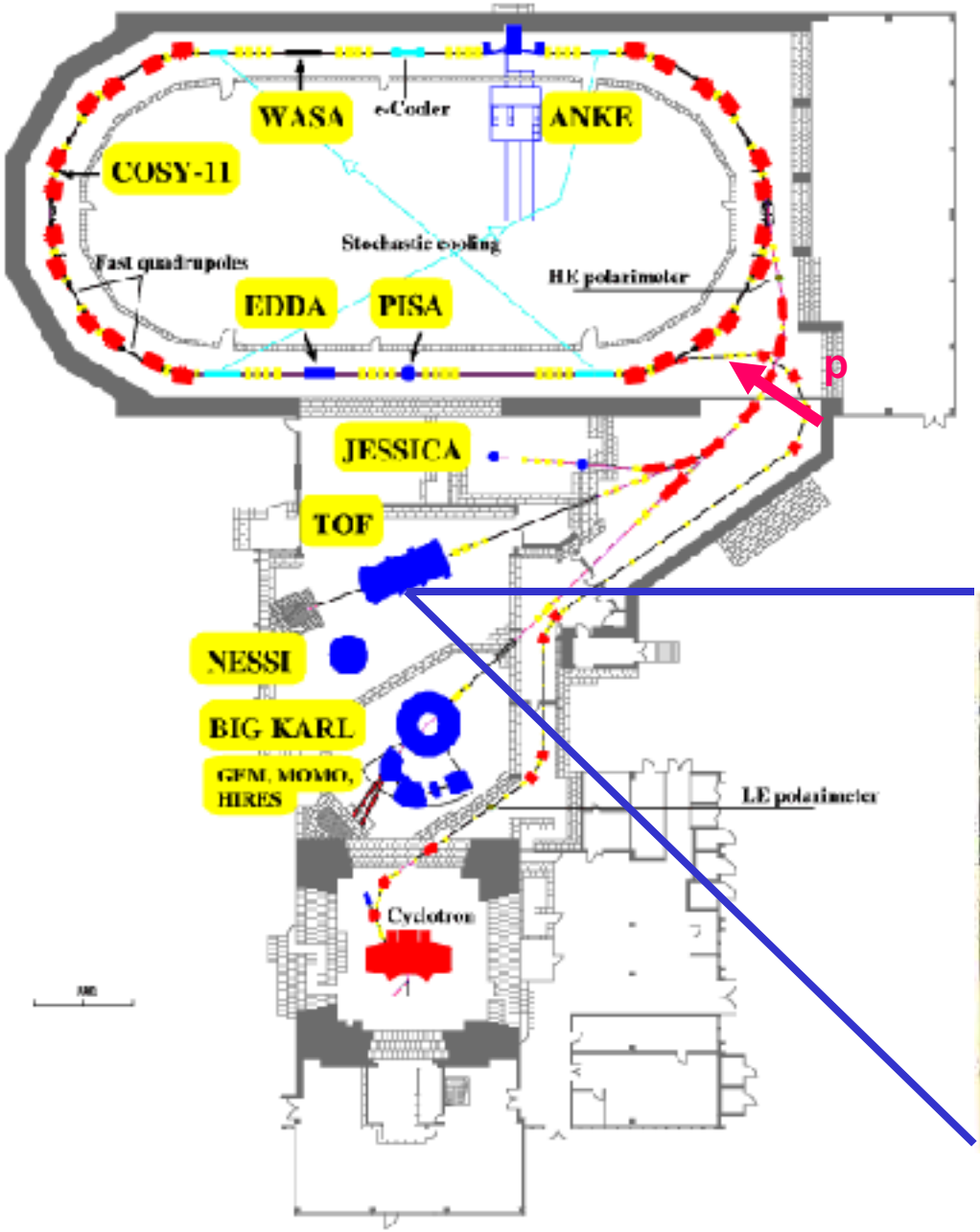


Fig. 2. Schematic presentation of the result for A_{xx} for the two possible parity states of the Θ^+. For either option realized the corresponding data should fall into the area indicated. In case of a negative parity the threshold value depends on the ratio of the strength of the two possible s-wave amplitudes.

sign of A_{xx} is opposite to parity near threshold

COSY Facility



Forschungszentrum Jülich
in der Helmholtz-Gemeinschaft

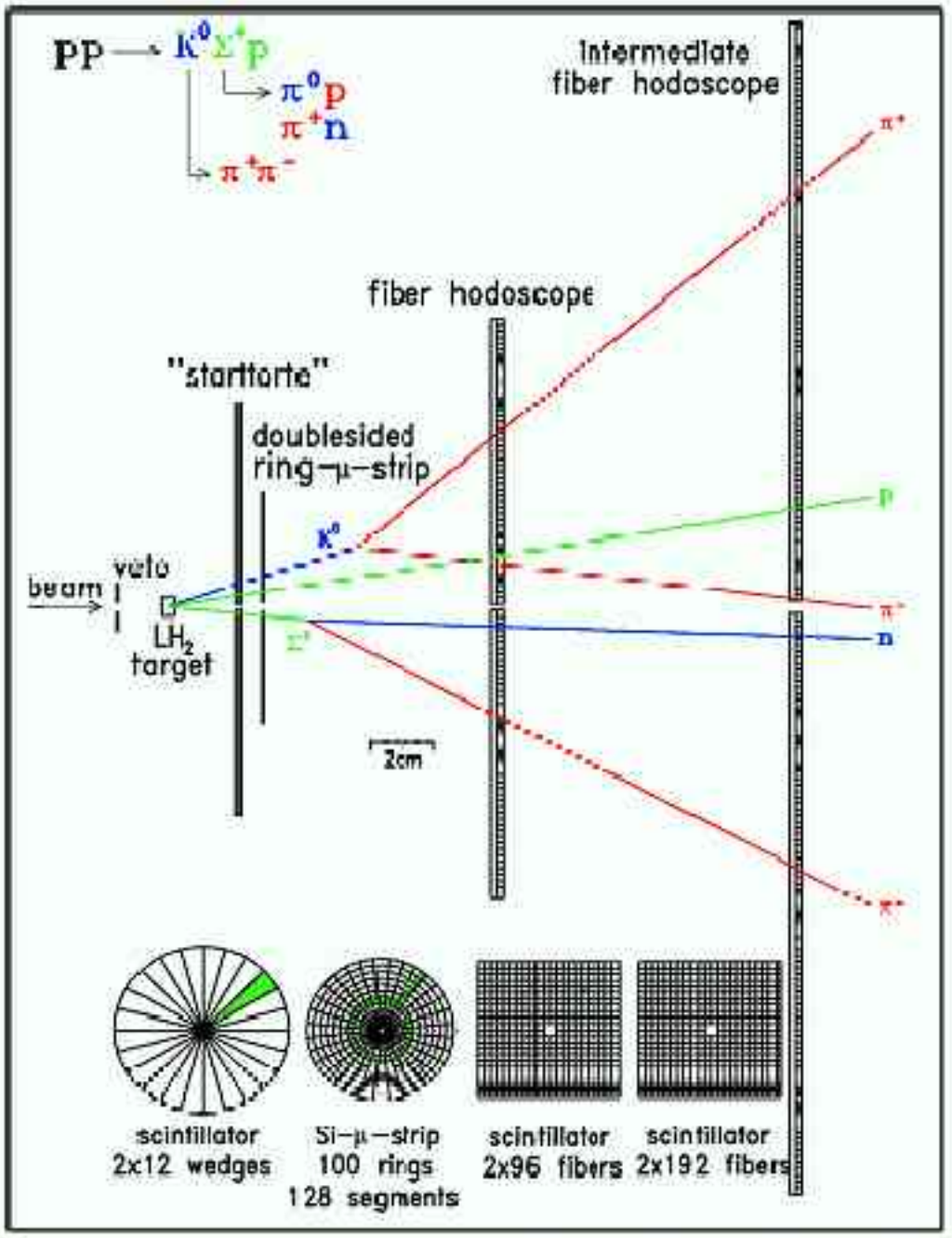
The COSY-TOF Detector

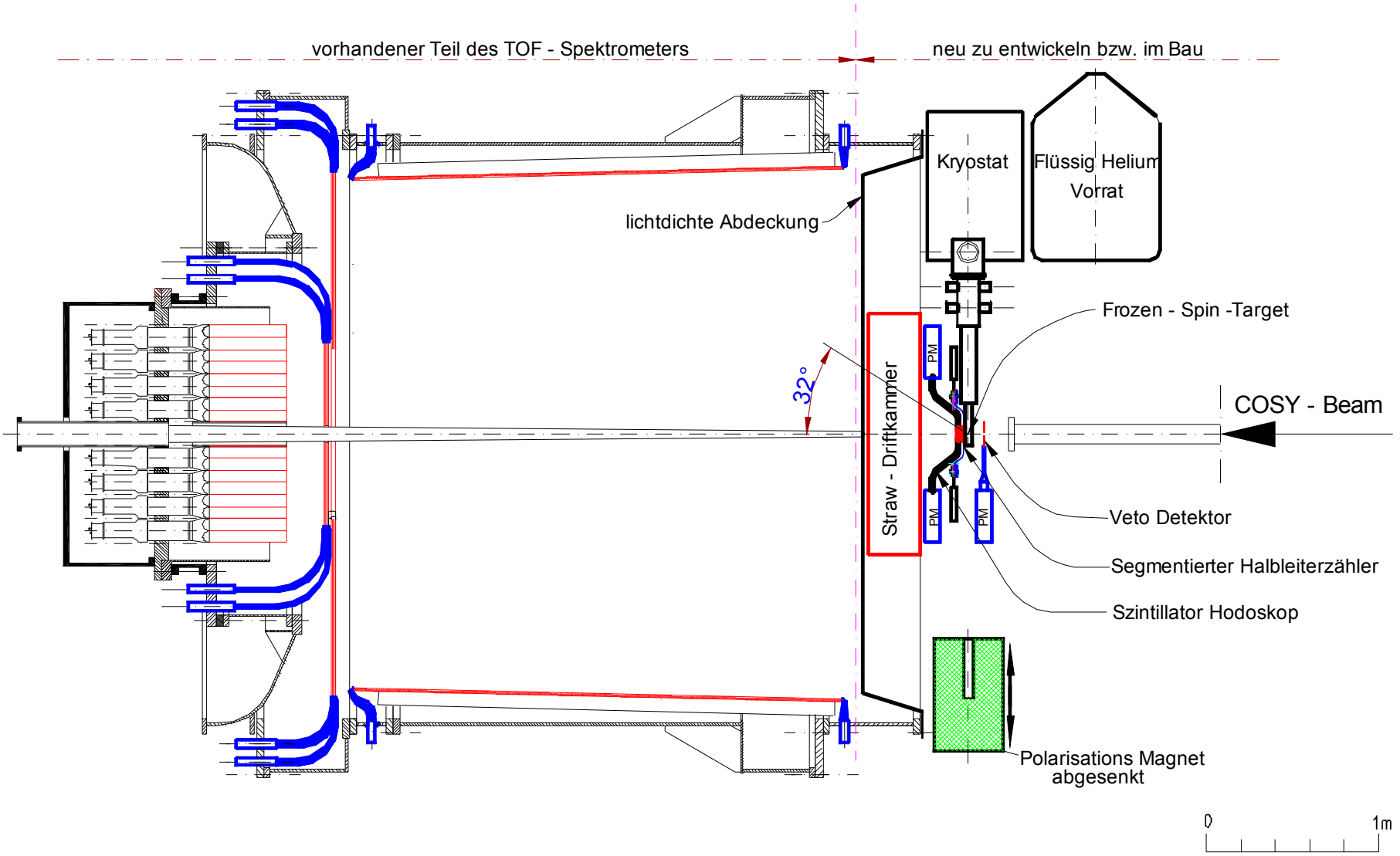
$$pp \rightarrow \Sigma^{+}\Theta^{+} \rightarrow \Sigma^{+}K^{o}p$$

Accurate determination of the interaction point:

- highly collimated beam
- detection of Σ^{+} ($c\tau \approx 2.4$cm)

- Mechanical accuracy
- Challenge on the PT





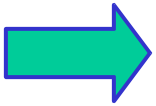
T O F - Detektor mit Frozen - Spin - Target

(N.Paul, IKP-Jülich)

Is it possible to run the COSY PT in frozen spin mode?

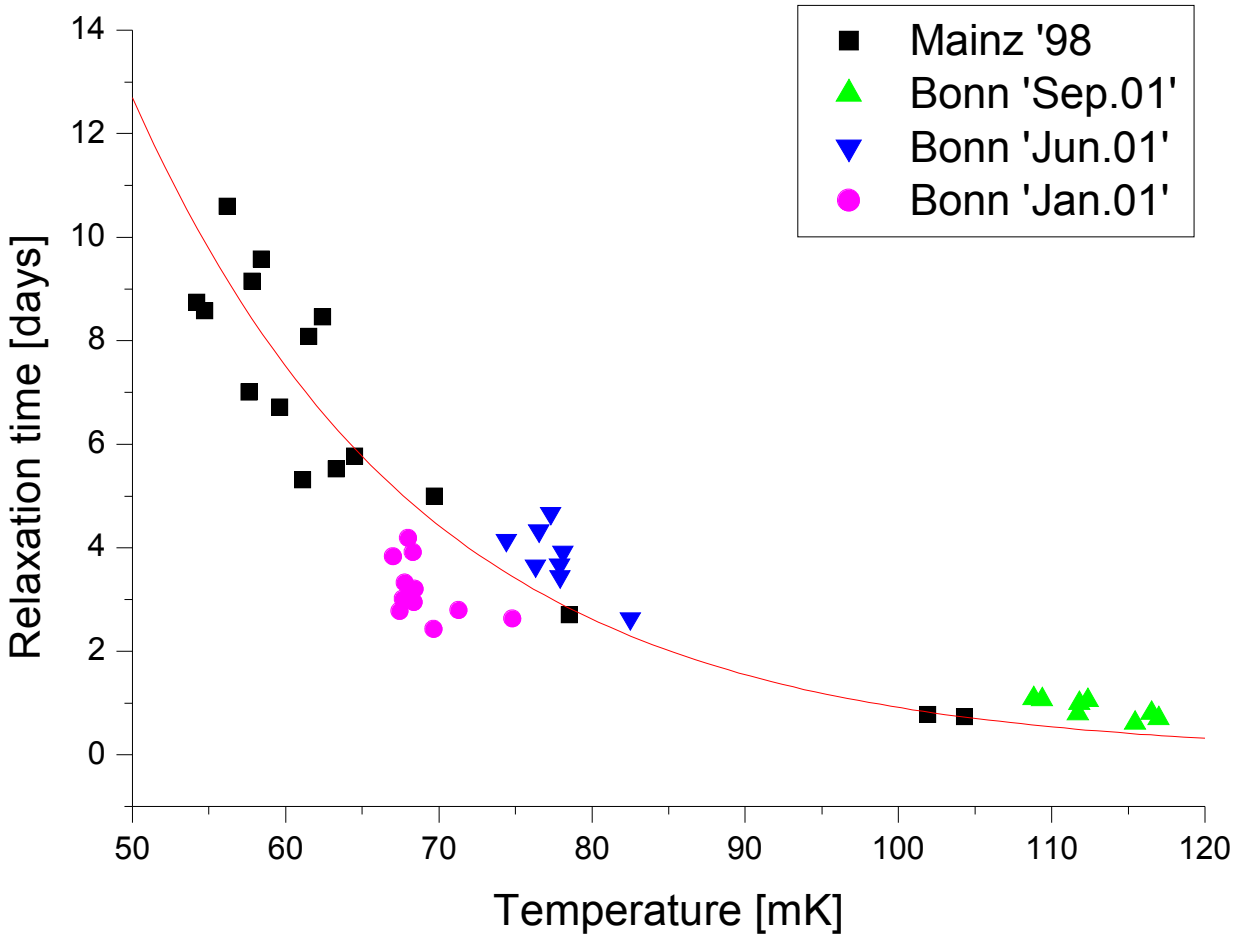
1 mm^2, 10^7 particles/s beam:

- Radiation resistance
- Relaxation time
- Polarization measurements

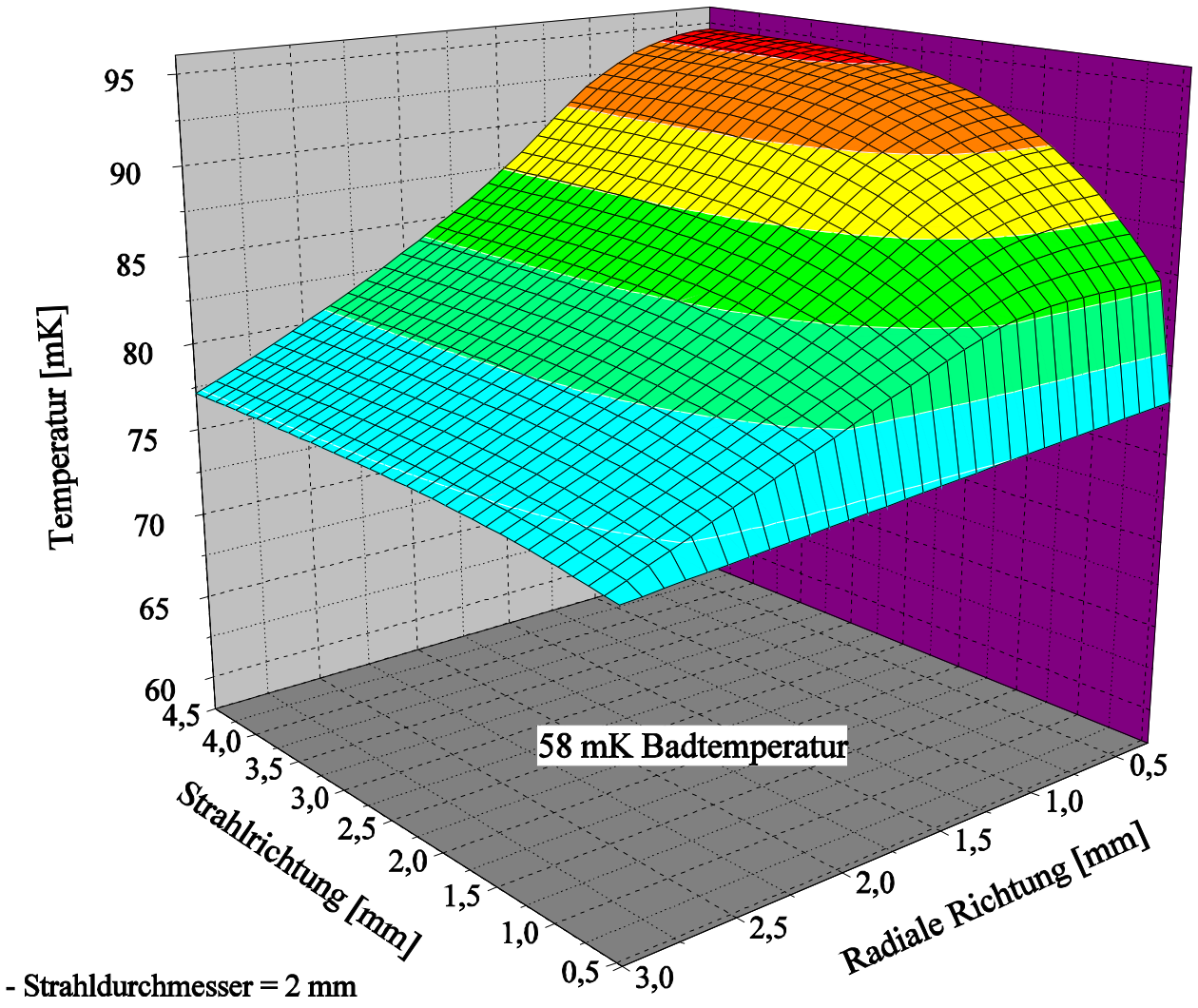


- Estimate Kapitza resistance
- Estimate temperature profile within the target
- Choose suitable geometry and size
- Select target material

Typical relaxation times in Butanol

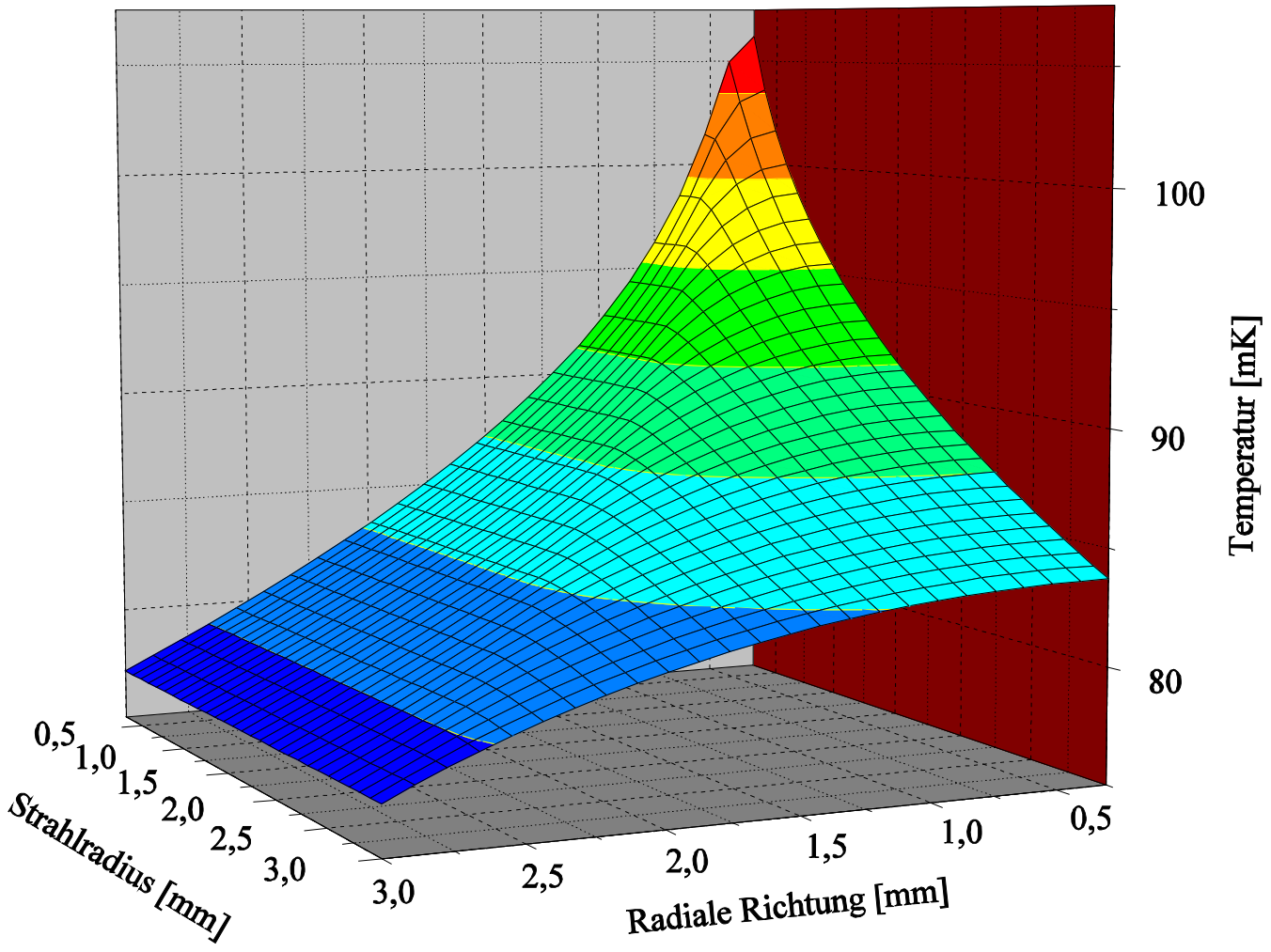


Temperature profile in the target material (1)

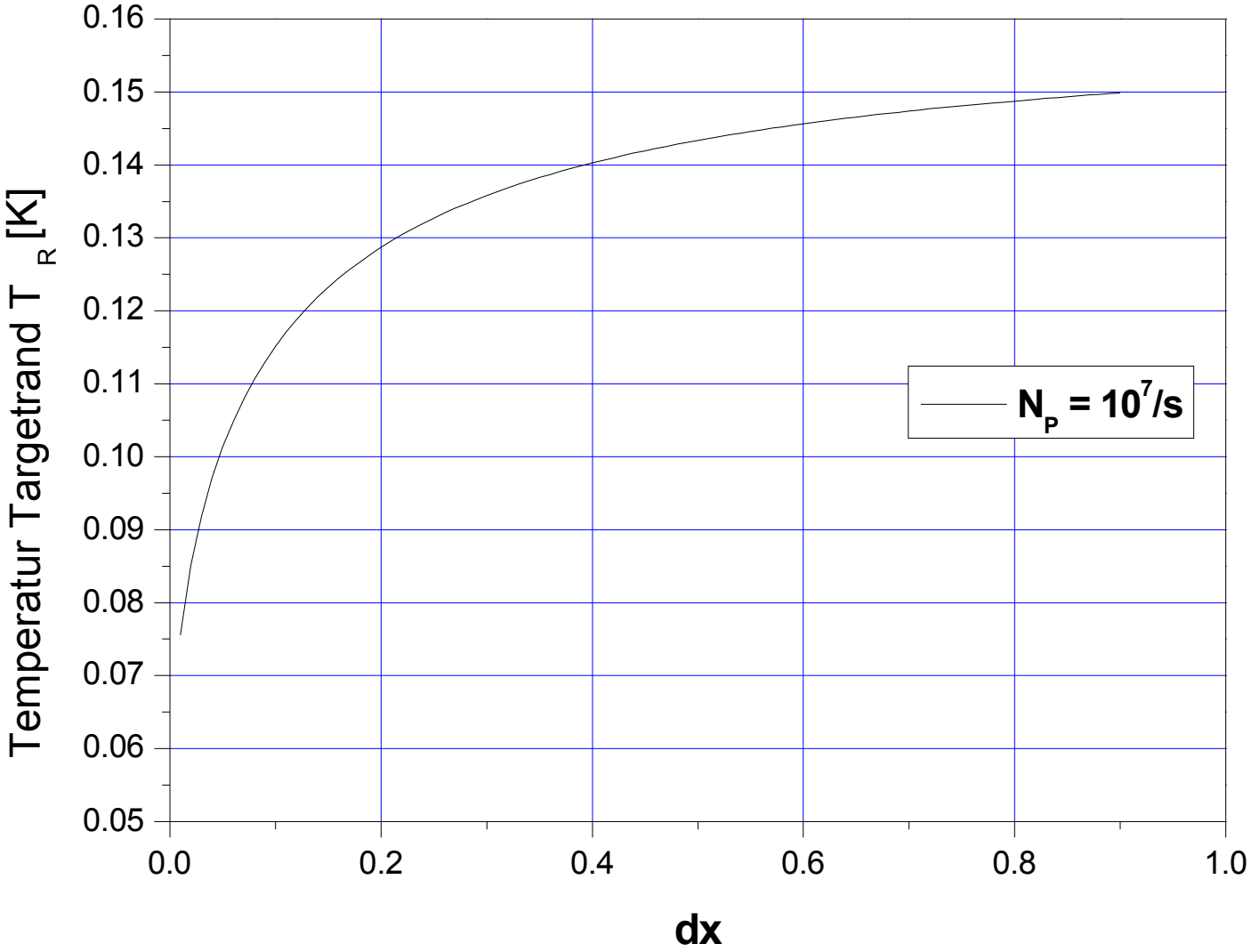


- Strahldurchmesser = 2 mm

Temperature profile in the target material (2)

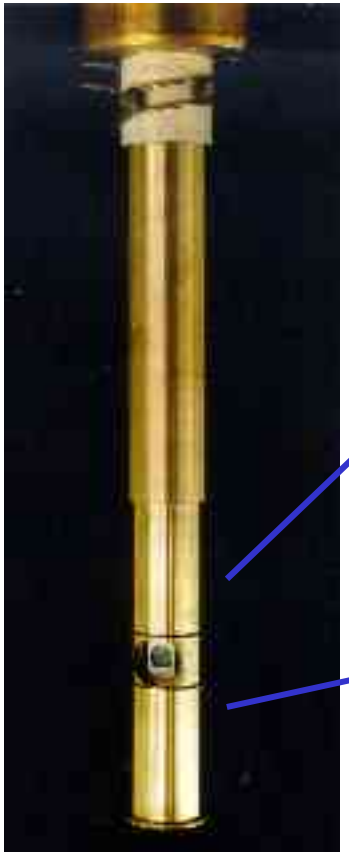


Temperature on target border vs. target thickness

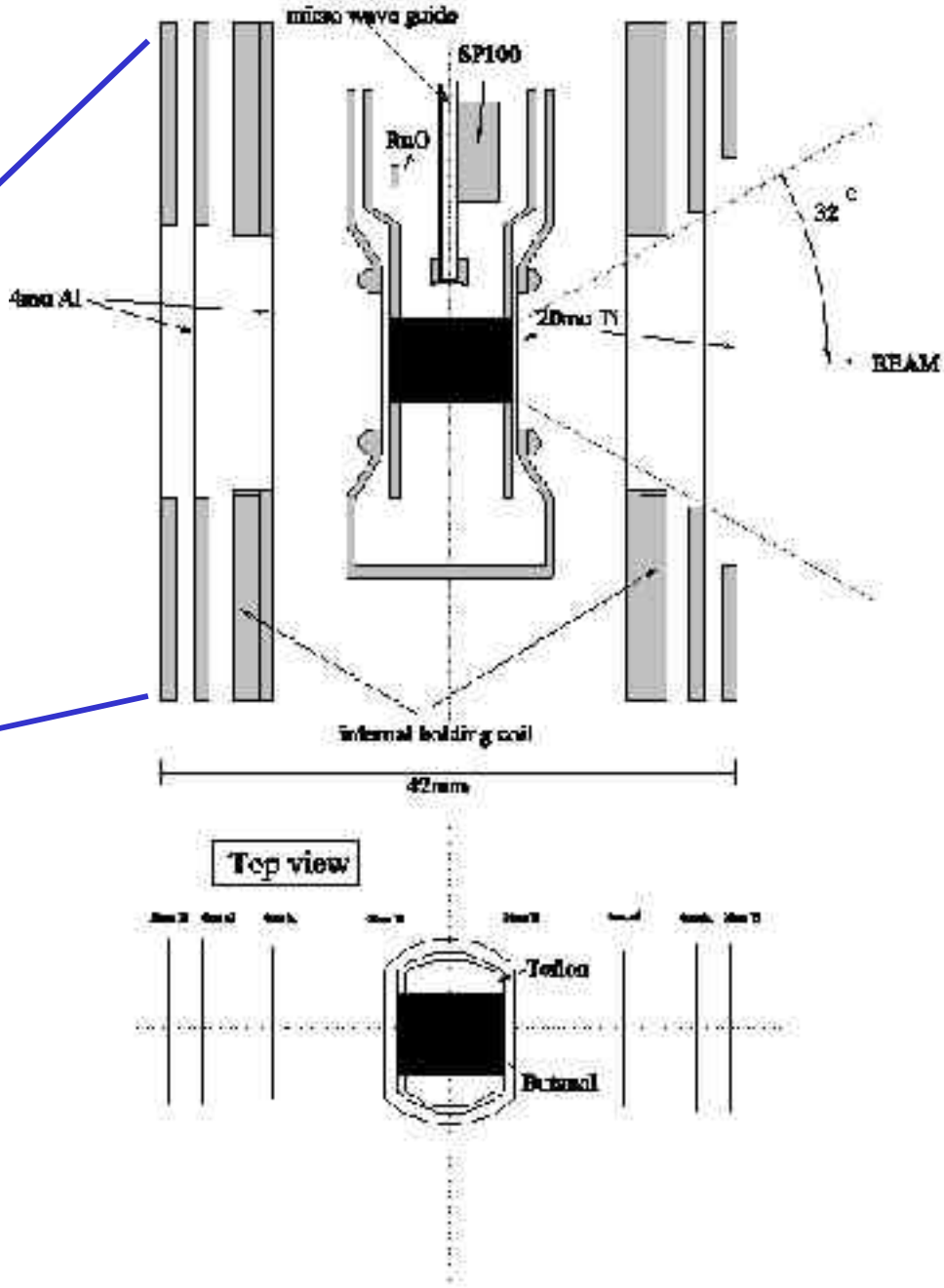


$T_R \leq 90\ \mathrm{mK}$ $dx \approx 0.02\ \mathrm{cm}$

Vertical Target System for PS 185/3 @ LEAR



Target region with Butanol target



Acceptance:	± 32°
Target dimensions :	l = 9mm
	∅ = 6mm
P_{max} (butanol)	p ~ 80%

The dilution cryostat is currently being renewed, reassembled and leak checked.

New:

- tubing
- needle valves
- thermometers (AB)
- radiation shields

PT @ COSY-TOF

- PS185/3 setup will be used for the measurement of the Θ^+ parity
- test of the target material by the Bochum PT group
- installation of the components in the Bonn PT - lab
- test of the complete system in summer 2005
- installation of the polarized system at TOF
- measurements start in fall 2005