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The Argonne Double Electron Coincidence β -Spectrometer*

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MASTER

An iron-free toroidal β coincidence spectrometer¹ has been completed.

Performance results for one toroid: (trans. T, % of 4π , measured; resolution R, full width at half max.): 1/8" source, T = 18%, R = 0.6%; T = 2.8%, R = 0.21%; 1/4" source, T = 15%, R = 0.56%; 1 mm source, T = 16%, R = 0.22%; T = 9.5%, R = 0.10%. For tandem operation (two toroids in series): 1 mm source, T = 12.0%, R = 0.12%; T = 4.3%, R = 0.068%; 3/8" source, T = 12.0%, R = 0.46%.

Maximum relative intensity for ghost peaks has been measured to be $\leq 3 \times 10^{-5}$ ($\leq 2 \times 10^{-5}$ in tandem). The energy range is 4 mev - 1 kev (earth's field compensated to 10^{-4} Oe., maintaining ratio $T_{4 \text{ mev}}/T_{1 \text{ kev}} = 1 \pm 10^{-4}$). When focusing 1.8 mev electrons in one spectrometer, the effective shift of a 1 kev line focused in the other spectrometer was measured as $3 \pm 5 \times 10^{-4}$. Experiments on Cm²⁴¹ (e^-e^- coincidences) and Th²²⁹ ($e^- \alpha$ coincidences, using solid state α detector) are in progress and will be discussed.

*Based on work performed under the auspices of the U. S. Atomic Energy Commission.

¹M. S. Freedman, et al. Nuc. Inst. and Meth. 8, 255 (1960).

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We have completed construction of an iron-free toroidal β -coincidence spectrometer designed for high transmission and luminosity and fairly high resolution. The instrument consists of 2 one hundred gap Kofoed-Hansen "sliced-orange" type spectrometers mounted co-axially in a common vacuum chamber with provisions for introducing a third detector for γ 's, α 's, or electrons in the vicinity of the source. Externally controlled baffles permit the selection of the angles of acceptance of each spectrometer separately allowing angular correlation experiments to be made between electrons in the two spectrometers or between electrons in one spectrometer and γ , or α in the third counter.

SLIDE ONE - Slide number one shows a schematic cross section of the spectrometer.

- (1) Point out vacuum chamber, 100 turn coils resulting in $1/r$ azimuthal field, field free space (1 part in 10^5 of field inside at 3 cm from conductor).
- (2) Discuss trajectories, effect of cylindrical lens, shape of image.
- (3) Point out detector baffle perpendicular to axis, high angles of incidence, size of effectual aperture versus angle.
- (4) Point out --
 α angle and antitrochoidal baffle

SLIDE TWO -- Slide number two shows the line shape for various α ranges for a one mm diameter source.

- (1) 1 mm detector baffle - note - lower transmission for 60° - 70° showing effect of high angle trajectories on effective D.B. Transmission for this mode 9% showing image larger than 1.5 mm due to cylindrical lens effect.
- (2) 5 mm detector baffle - note full transmission for 60° - 70° -- flat top lines for lower α angles length of flat increasing with lower α showing angular dispersion vs. α angle.

SLIDE THREE -- Slide number three shows measured transmission versus resolution for various size sources.

Note -- the drop-off of transmission as the detector baffle is closed, and increase of resolution -- to a limiting value depending on source size.

Note -- all points for full angle except highest resolution case.

SLIDE FOUR -- Table of results compared to Chalk River. Note comparable luminosity -- but much higher transmission in Argonne case gives increased performance for coincidence work.

SLIDE FIVE -- View of spectrometer

- Note --
- (1) water and current leads.
 - (2) detector.
 - (3) side detector.
 - (4) earth's field cancelling coils
field reduced to 2×10^{-4} oe over trajectories

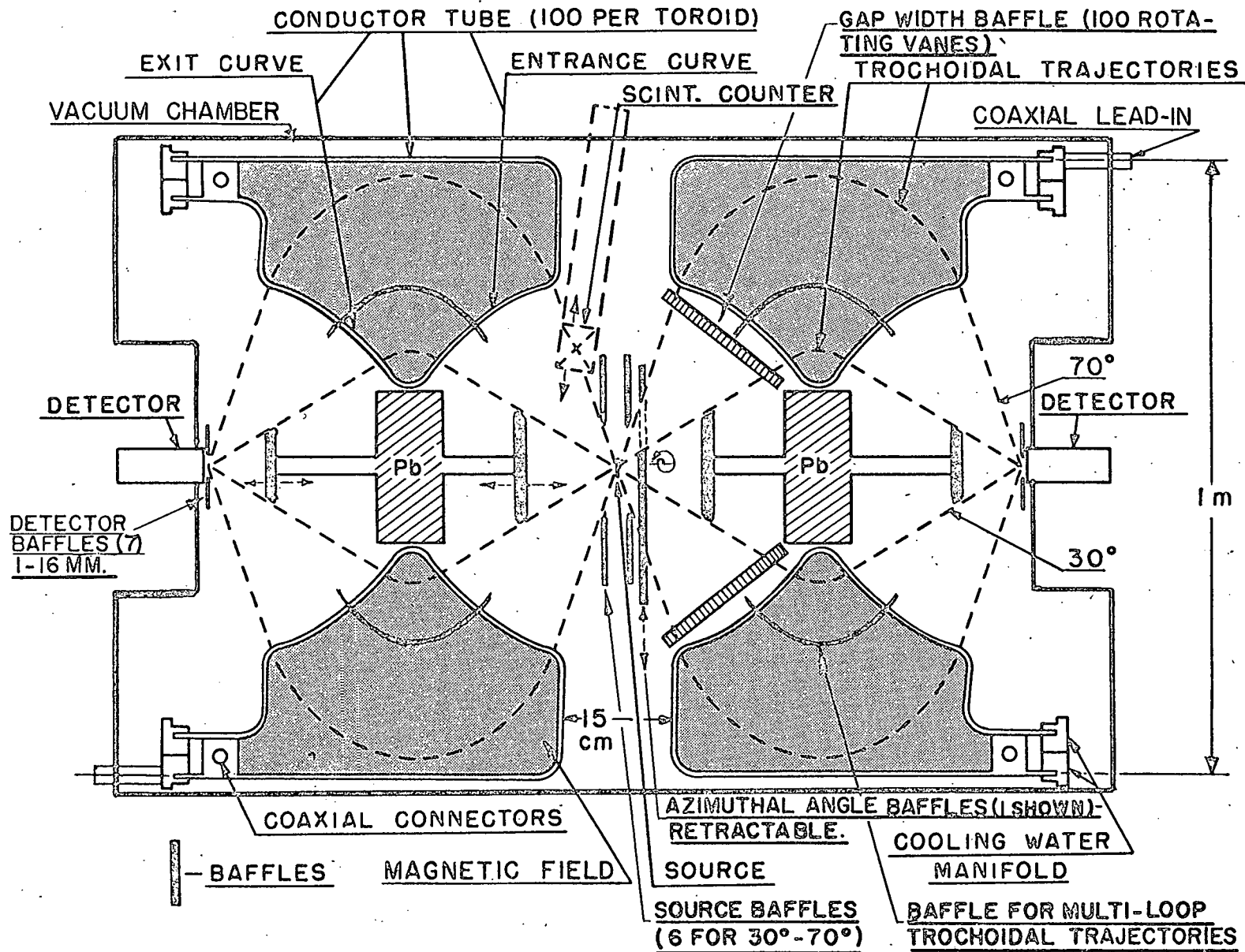
SLIDE SIX -- View of coil, door open

- Note -- (1) Copper entrance curves.
(2) Coaxial leads.

SLIDE SEVEN -- View of source plane inside vacuum chamber.

- Note -- (1) Source holder.
(2) Side counter.
(3) Baffles.

*Note - Reprints of Slides 1-4 included
slides 5, 6, & 7 photographs of the instrument.*



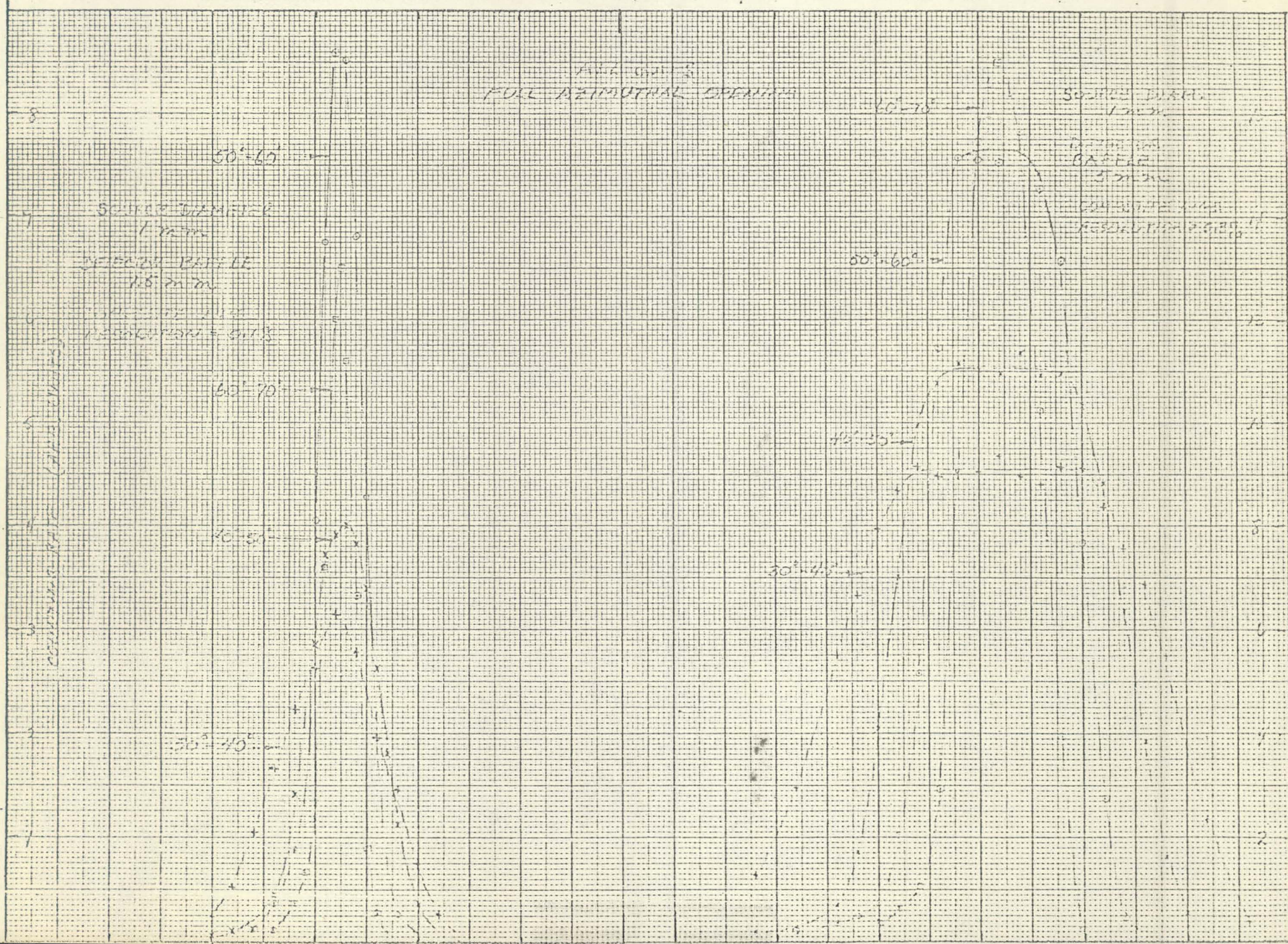
TOROIDAL BETA-BETA SPECTROMETER.

Side #1

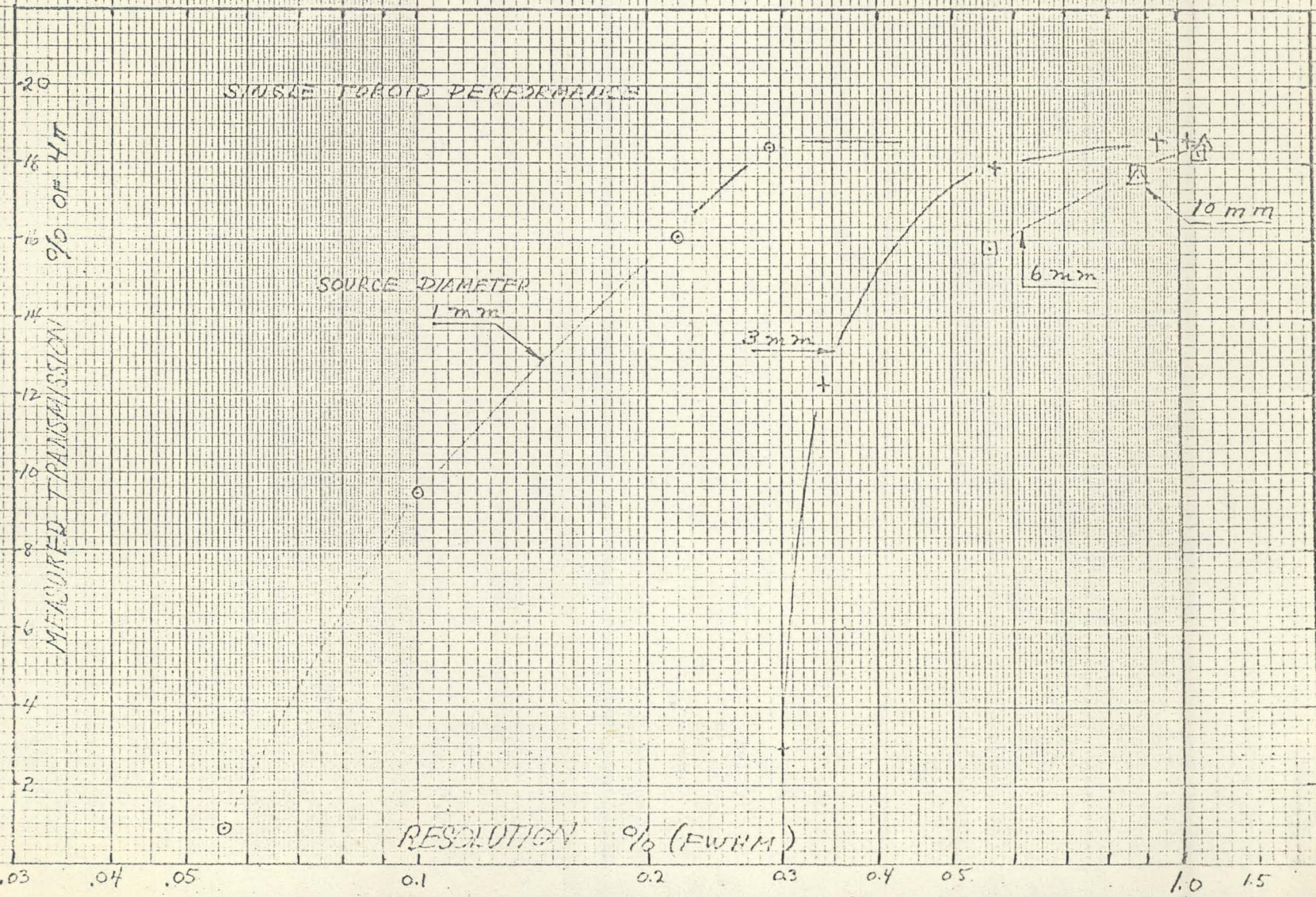


Slide #2

FULL AZIMUTHAL SPINNING



Slide # 3



PERFORMANCE OF TOROIDAL SPECTROMETER

	Source Diameter	Transmission % of 4π (Measured)	Luminosity % x mm ²	Resolution % FWHM
Single Toroid	3/8 in.	16	1140	0.88
	1/4 in.	16	510	0.56
	1/8 in.	18	140	0.57
	1/8 in.	2.8	22	0.21
	1 mm	16	12.5	0.22
	1 mm	9.5	7.5	0.10
Two Toroids In Tandem	3/8 in.	12	850	0.46
	1 mm	12	9.4	0.12
	1 mm	4.3	3.4	0.068

CHALK RIVER IRON-FREE $\pi \sqrt{2}$ SPECTROMETER

Single Beta Spectrometer	20 x 50 mm ²	1	1000	1.0
	20 x 20 mm ²	0.3	12	0.1
	0.2 x 12 mm ²	0.07	0.17	0.01