

# **Five Decades of Physics**

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**Cramer Symposium**  
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# 1957-1969

- Non-Conservation of Parity in the Beta Decay of  $^8\text{Li}$  (Rice Univ., Sigma-Xi Award winning MA Thesis, 1959)
- Conserved Vector Current in the Beta Decays of  $^{12}\text{B}$  and  $^{12}\text{N}$  (Rice Univ., PhD Thesis, 1961)
- Angular Correlation in the  $(\alpha, \alpha' \gamma)$  Reaction on Even-Even Nuclei (explained angle dependence) (Indiana University)
- Bringing the UW Tandem 3-Stage Tandem Van de Graaff and SDS-930 Online Computer System into operation (UW)
- Phase Correlations in Alpha Particle Inelastic Scattering (direct-reaction compound-nucleus competition) (UW)
- Isobaric Analogue Resonances in Closed-Shell Nuclei (UW)

# 1969-1979

- Inelastic Scattering to  $1^-$  States through Isobaric Analogue Resonances (UW)
- Proposal, Design, and Construction of the UW Lamb-Shift Polarized Ion Source (UW)
- Polarized Proton Scattering through Isobaric Analogue Resonances (UW)
- Isospin Reactions with Heavy Ions (UW)
- ( $^{12}\text{C}$ ,  $^8\text{Be}$ ) Transfer Reactions (U Munich, UW)
- Antimatter supernovas PRL (1977)
- Energy-Dependent Heavy Ion Elastic Scattering (global optical potentials) (UW, ORNL)

# 1979-1989

- Nuclear Rainbow Scattering with Heavy Ions and the “Notch-Test” (UW, LBNL, HMI-Berlin, MSU)
- Sub-Coulomb  $^{16}\text{O}$  Scattering and Wave-Equation Tests (UW)
- The Transition from Light to Heavy Ion Scattering (UW, LBNL, HMI-Berlin, MSU)
- The Transactional Interpretation of Quantum Mechanics (HMI-Berlin, UW)
- Begin writing bi-monthly “Alternate View” popular science columns for *Analog Science Fiction/Fact Magazine* (AV#01-36).
- Proposal, Design, and Construction of the UW Superconducting Booster (UW, 1984-1987)
- Hard SF Novel **Twistor** (Wm. Morrow, 1989)

# 1989-1999

- Experiment NA35 (LBNL, CERN)
- Experiment NA49 (MPI-Munich, CERN)
- Proposal, Design, and Construction of the STAR Experiment (UW, LBNL, BNL)
- Natural Wormholes & Gravitational Lensing (1995)
- Formation of the HBT Physics Working Group in STAR
- Theoretical investigations of HBT-related phenomena (MPI, UW)
- Nuclear Science Wall Chart & Teacher's Manual (1997)
- Continue writing bi-monthly “Alternate View” popular science columns for Analog Science Fiction/Fact Magazine (AV#37-98)
- Hard SF Novel **Einstein's Bridge** (Avon, 1998)

# 1999-2009

- Theoretical investigations of HBT-related Phenomena
- Data Collection from the STAR Experiment (BNL)
- “Sound of the Big Bang” (2003)
- The HBT Analysis of STAR and NA49 Data
- The DWEF Model of Ultra-relativistic Heavy Ion Collisions
- Continue writing bi-monthly “Alternate View” popular science columns for Analog Science Fiction/Fact Magazine (AV#99-150)
- Quantum Optics and Retrocausality: Investigation of the Possibility of Nonlocal Quantum Communication with Momentum-Entangled Photon Pairs (1997-now)

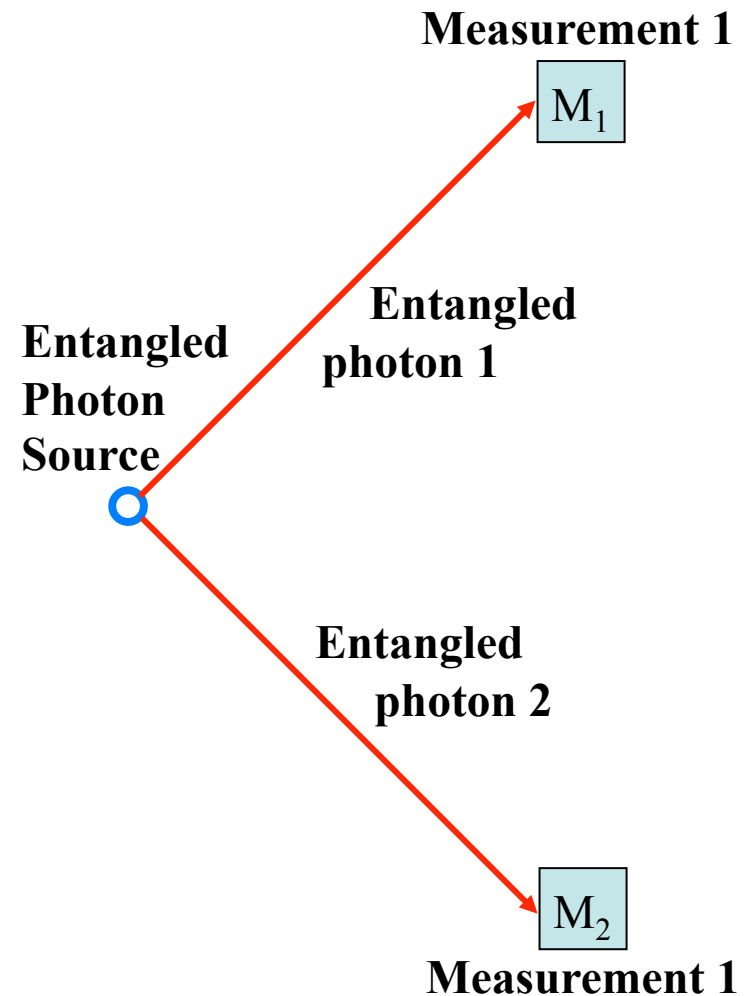
# **Status of the UW Test of Nonlocal Quantum Communication with Momentum-Entangled Photon Pairs**

# Entanglement and Nonlocality

**Entanglement:** The separated but “entangled” parts of the same quantum system can only be described by referencing the state of other part.

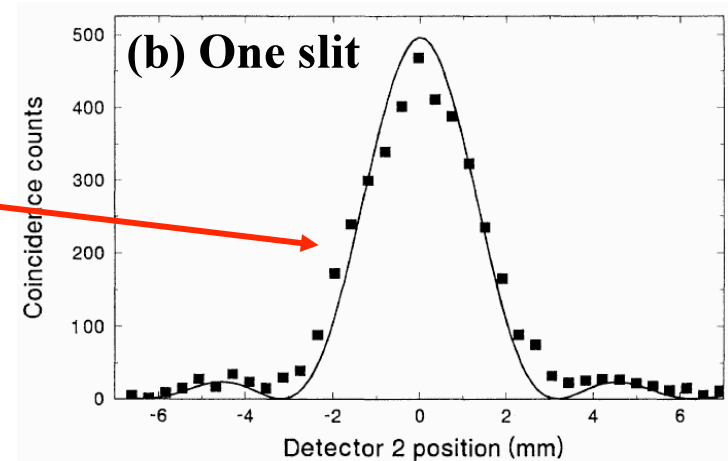
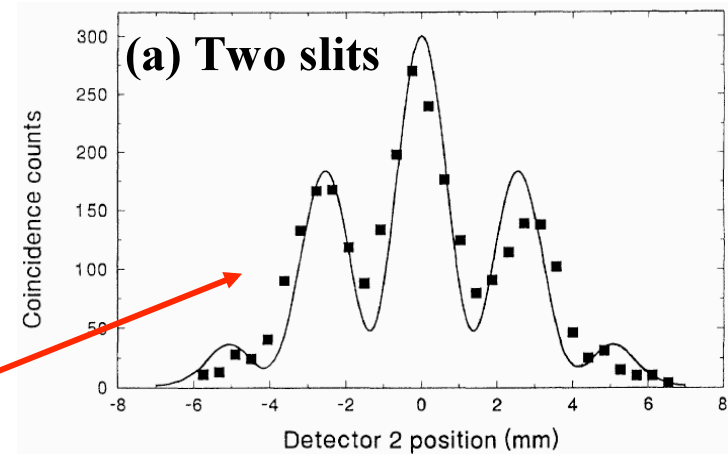
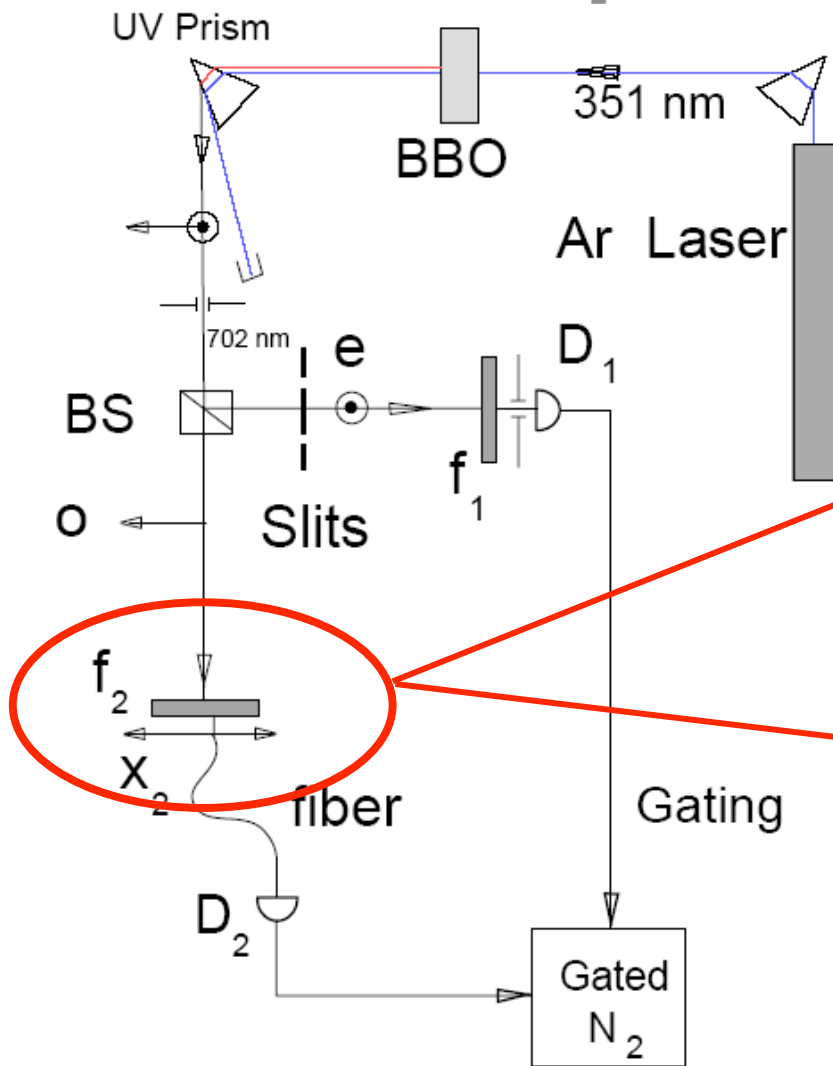
The possible outcomes of measurement  $M_2$  depend of the results of measurement  $M_1$ , and *vice versa*. This is usually a consequence of conservation laws.

**Nonlocality:** This “connectedness” between the separated system parts is called **quantum nonlocality**. It should act even if the system parts are separated by light years. Einstein called this “spooky actions at a distance.”

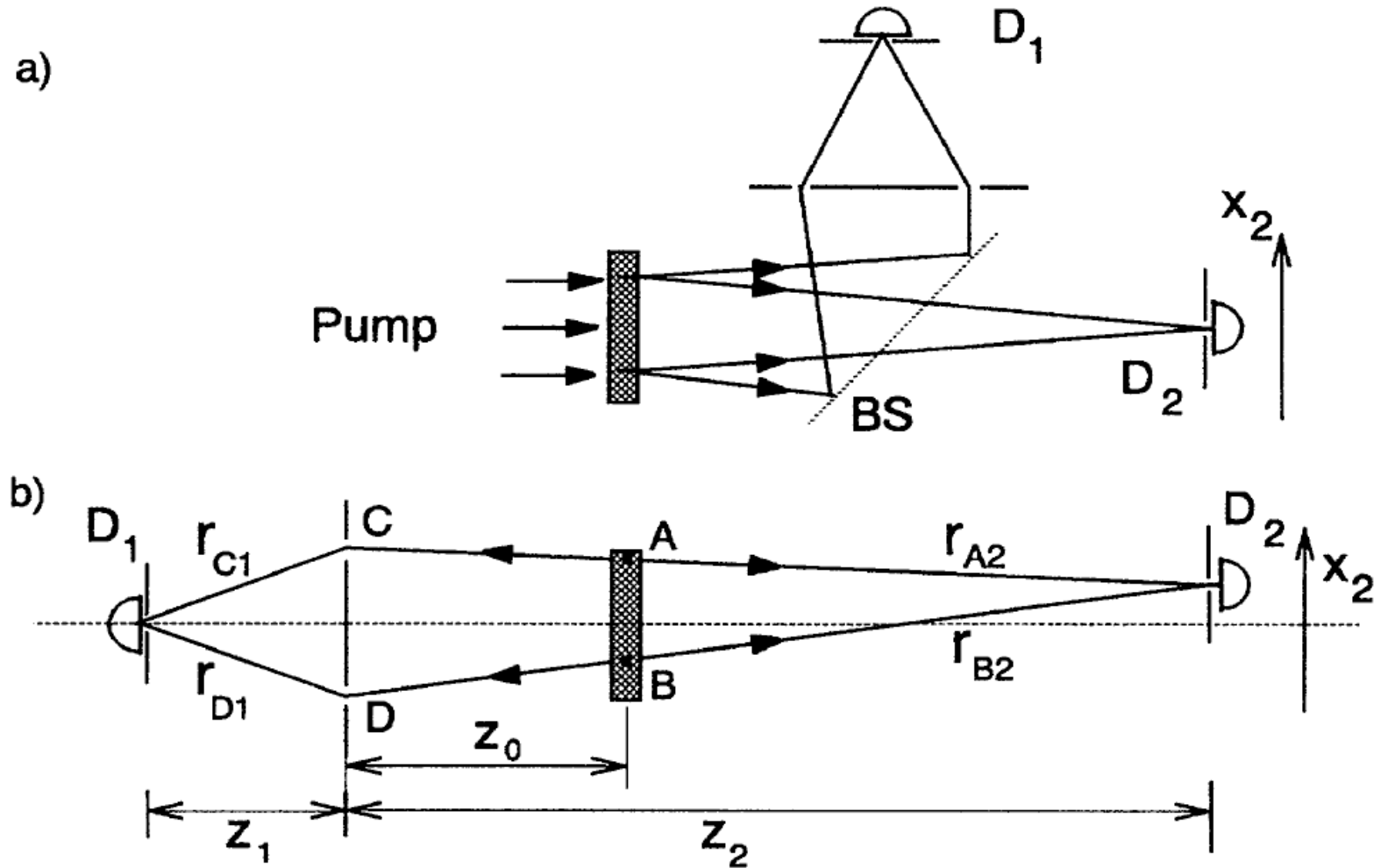




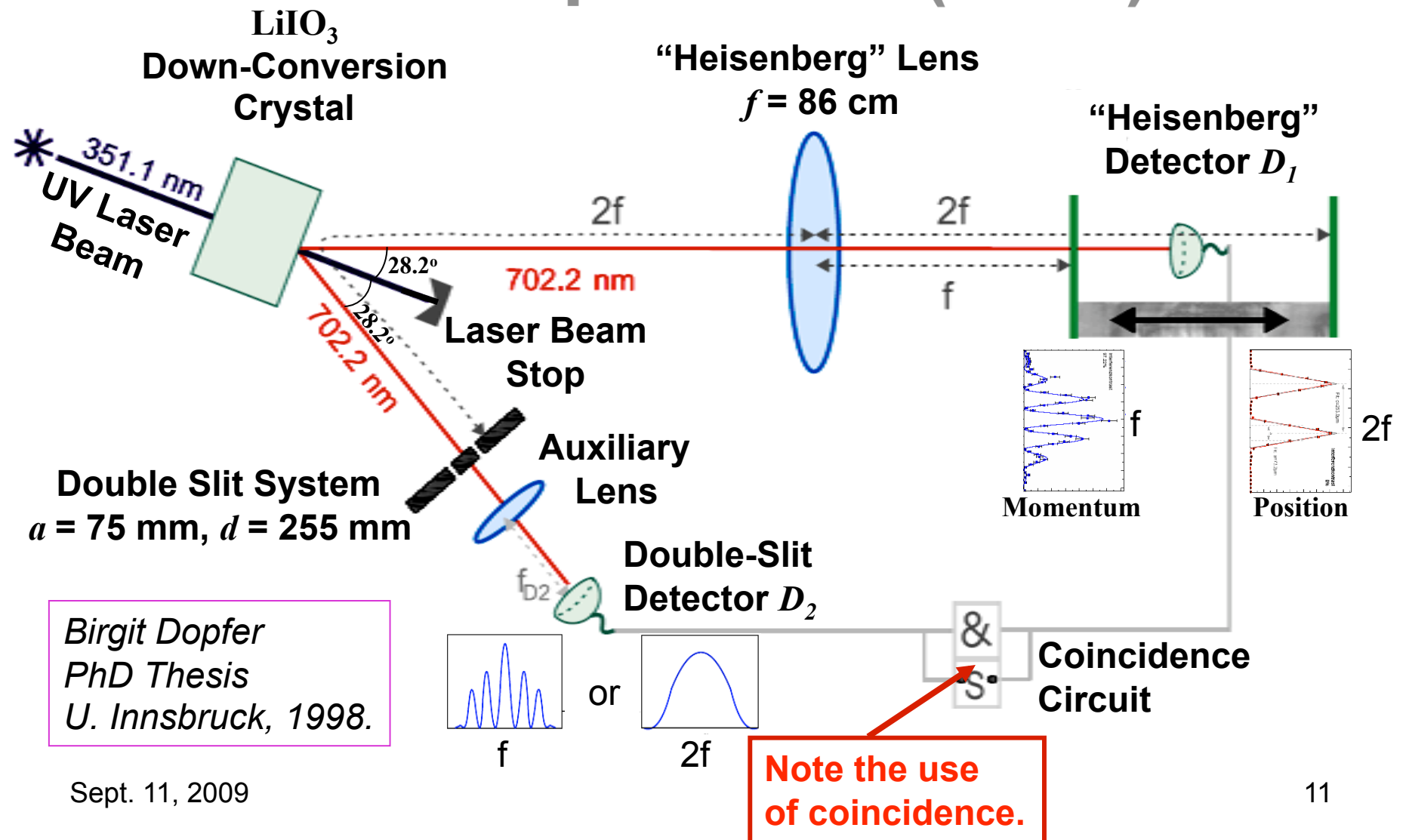
# Shih Ghost Interference Experiment (1995)



# Klyshko Reflection



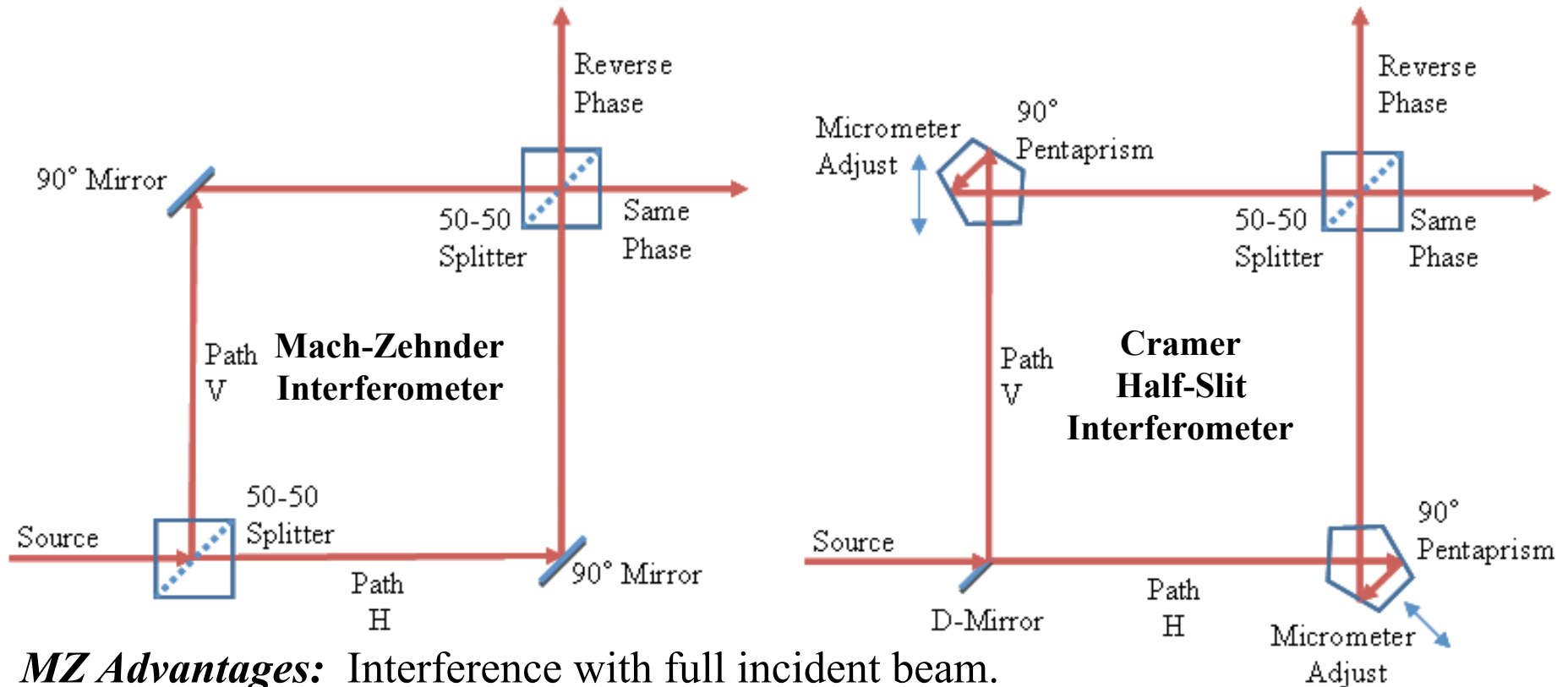
# Dopfer Position-Momentum EPR Experiment (1998)



Birgit Dopfer  
PhD Thesis  
U. Innsbruck, 1998.

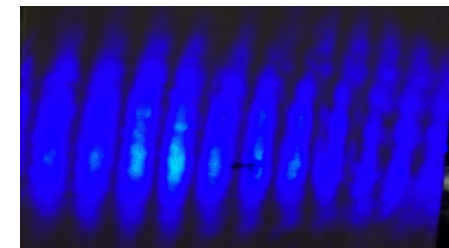
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# Interference Detection



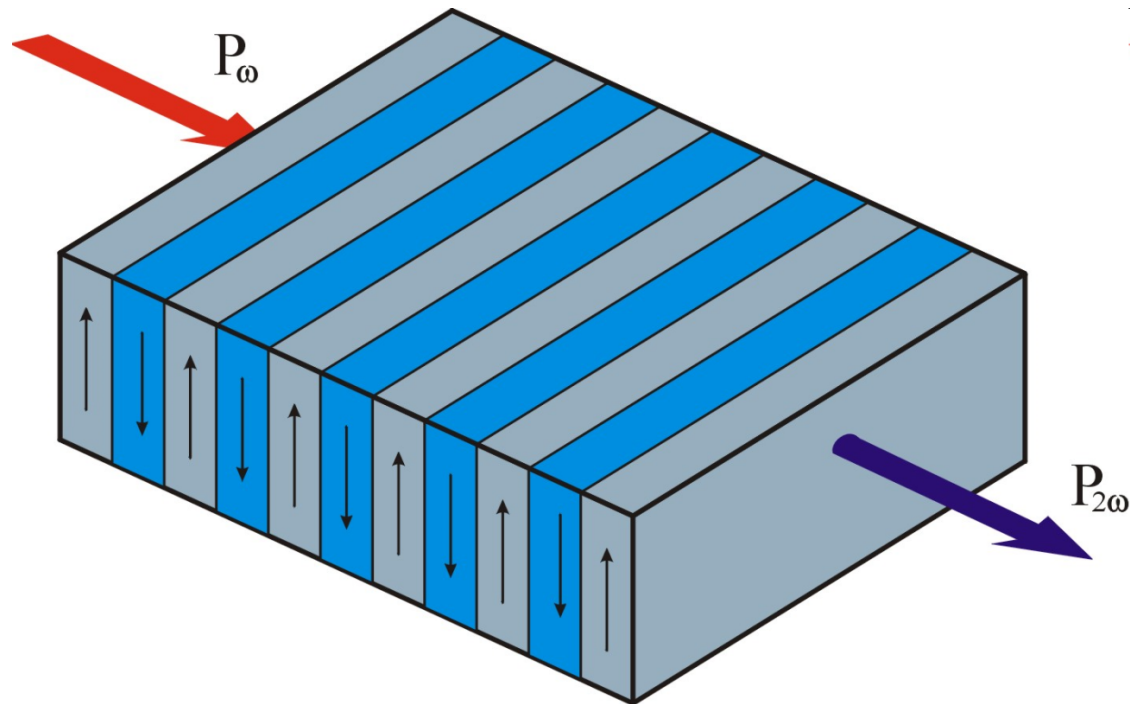
**MZ Advantages:** Interference with full incident beam.

**MZ Disadvantages:** extremely difficult to align (4 reflecting surfaces aligned to wavelength-scale precision); path is momentum-independent.



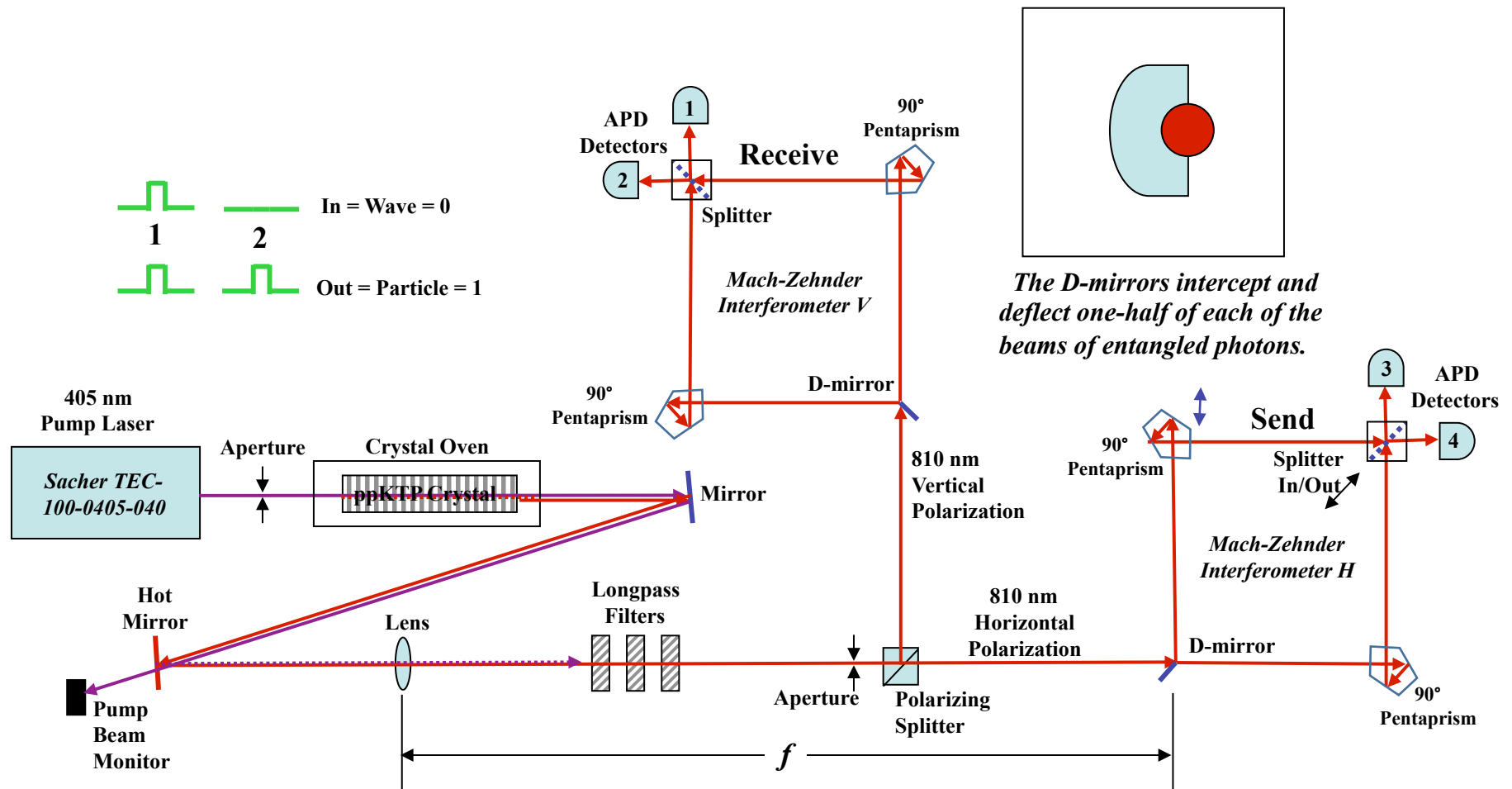
# Periodically Poled Nonlinear Crystal

ppKTP = periodically poled KTiOPO<sub>4</sub>



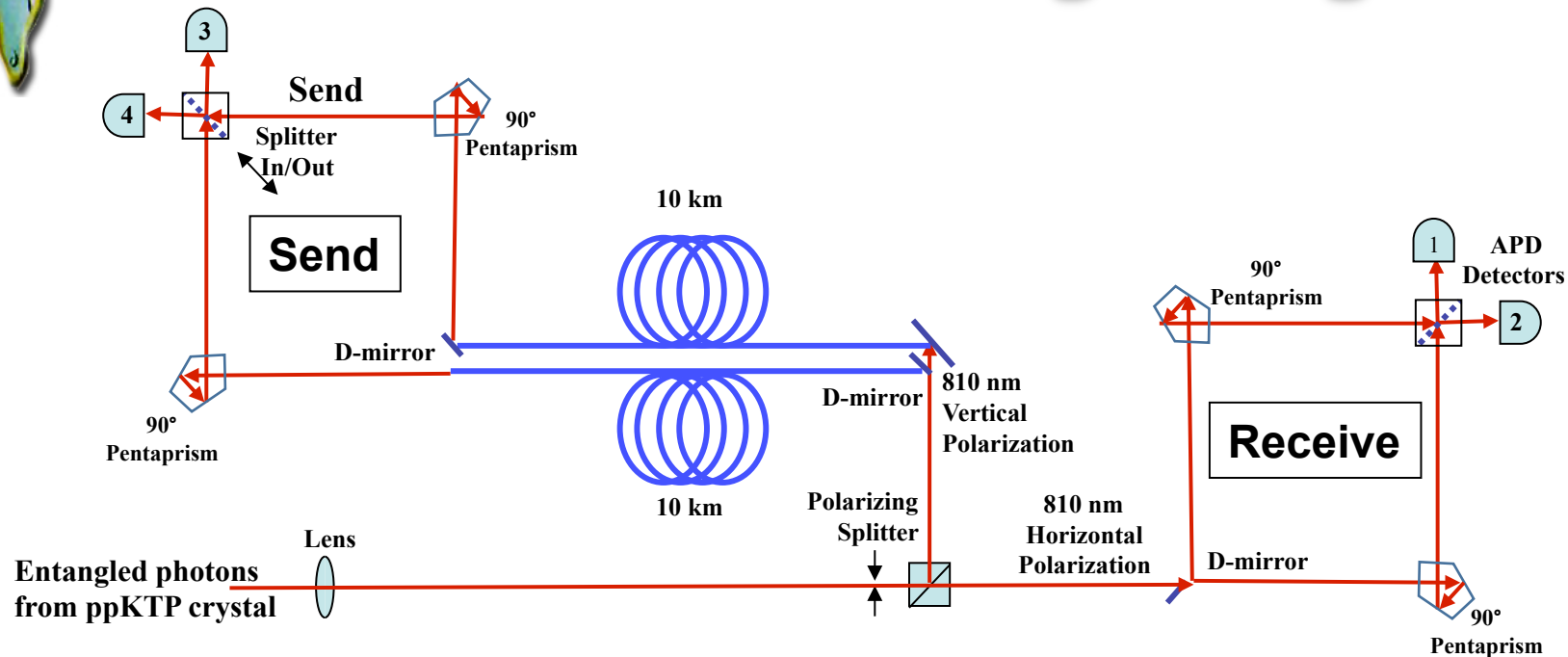
$$\text{Phase Matching: } k_p = k_s + k_i + 2p/L$$

# Mark III Nonlocal Quantum Communication Test



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# Retrocausal Signaling



We have 10 km of high quality optical fiber coiled in the corner of the laboratory. We split the V-polarized entangled photon beam with a D-mirror, and pass each of the two paths of entangled photons through 10 km of fiber.

The H-polarized entangled photons have no optical delay, and the signal is received as soon as these photons are detected at  $D_{1,2}$ , which is about 50 ms *before* the signal is transmitted, when the twin entangled photons arrive at  $D_{3,4}$ .

***The  
End***