

# Digital Television Broadcasting Systems Testing in Brazil

**Kiev, Ukraine - 13-15 November 2000**

**Interregional Seminar on the Transition from SECAM to Digital TV  
Broadcasting**

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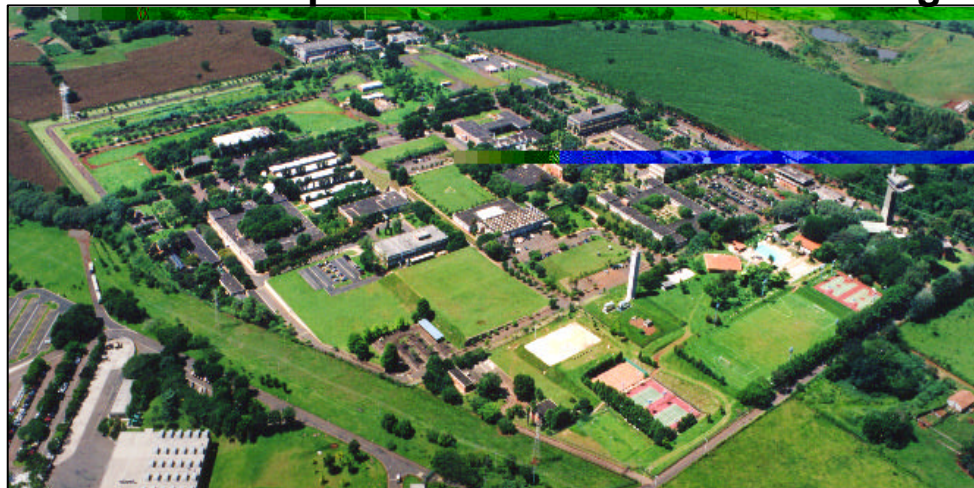
## Organization of the tests

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- Entities and roles
  - **ANATEL** - National Agency of Telecommunications - Brazilian regulating authority
    - Conducts the process of defining a DTV standard for Brazil
    - Authorized (after a public consultation) the realization of the field tests
    - Contracted CPqD as consultant in the process
    - Will define the DTV standard based on the tests results and other technical and non-technical aspects
  - **SET** - (Brazilian) Society of Television Engineering
  - **ABERT** - Brazilian Association of Radio and Television Broadcasters
    - SET/ABERT studies the evolution of DTV standards since 1994, and has structured task groups to carry on the tests
    - Makes planning studies to consider digital channels along with analog channels
    - Technological agreement with Instituto Mackenzie - Human resources
  - **Instituto Mackenzie** - a Brazilian private University, in São Paulo
    - Tests methodologies
    - Acquired test equipment, set up the laboratory and field tests installations
    - Executed the tests and reported the results to ANATEL, together with SET/ABERT

## Organization of the tests

- Entities and roles (cont)
  - **CPqD** - Private foundation with expertise in Telecommunications
    - support in systems aspects - CPqD works in multiple areas in telecommunications
    - analysis and consolidation of the laboratory tests methodology
    - development of ambiences for systems simulations
    - analysis and consolidation of the field tests methodology
    - checking and support in the laboratory and field tests
    - development of tools for planning studies
    - analysis of the tests results
    - advice on other aspects of the introduction of Digital TV in Brazil



~1100 employees  
600 000 m<sup>2</sup>

## Laboratory and Field Tests

- Tests objectives: Compare terrestrial DTV systems with respect to the transmission layer
- **Laboratory Tests** - robustness/capacity analysis of the systems under controlled conditions
  - Interference - A to D, D to A, D to D, CW and FM: planning
  - Robustness to impulsive noise
  - Multipath performance
    - **static, single and multiple echoes**
    - **dynamic, Doppler shift, mobility**
  - BER x C/N performance in white noise (AWGN) - modulation, planning, transmitter power

# Interference: Protection Ratios

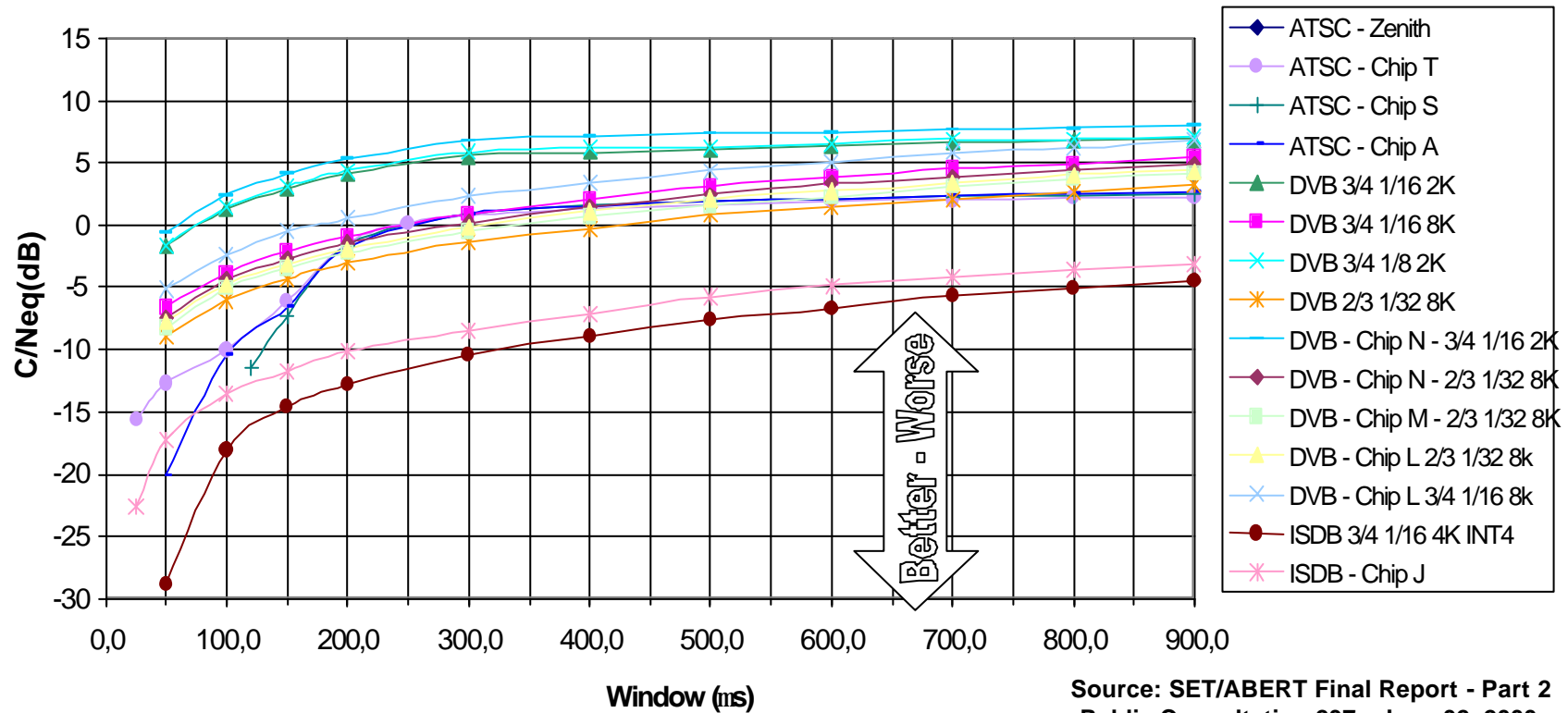
**D/U = Desired/Undesired Signal power ratio (dB)**  
**Lower ratios  $\Rightarrow$  more robustness**

<b>Digital into Analogue (*)</b>	<b>ATSC</b>	<b>DVB - 2K</b>	<b>DVB - 8K</b>	<b>ISDB</b>
<b>Co-channel</b>	<b>37</b>	<b>38</b>	<b>38</b>	<b>38</b>
<b>Upper adjacent</b>	<b>-9</b>	<b>-9</b>	<b>-9</b>	<b>-9</b>
<b>Lower adjacent</b>	<b>-7</b>	<b>-7</b>	<b>-7</b>	<b>-11</b>
<b>Analogue into Digital</b>	<b>ATSC</b>	<b>DVB - 2K</b>	<b>DVB - 8K</b>	<b>ISDB</b>
<b>Co-channel</b>	<b>5</b>	<b>7</b>	<b>7</b>	<b>6</b>
<b>Upper adjacent</b>	<b>-32</b>	<b>-31</b>	<b>-26</b>	<b>-34</b>
<b>Lower adjacent</b>	<b>-40</b>	<b>-27</b>	<b>-32</b>	<b>-34</b>
<b>Digital into Digital</b>	<b>ATSC</b>	<b>DVB - 2K</b>	<b>DVB - 8K</b>	<b>ISDB</b>
<b>Co-channel</b>	<b>15</b>	<b>20</b>	<b>20</b>	<b>18</b>
<b>Upper adjacent</b>	<b>-27</b>	<b>-25</b>	<b>-25</b>	<b>-29</b>
<b>Lower adjacent</b>	<b>-27</b>	<b>-25</b>	<b>-24</b>	<b>-24</b>

**(\*) CCIR 4: 37,5 dB**  
**Taboo channels interference: irrelevant**

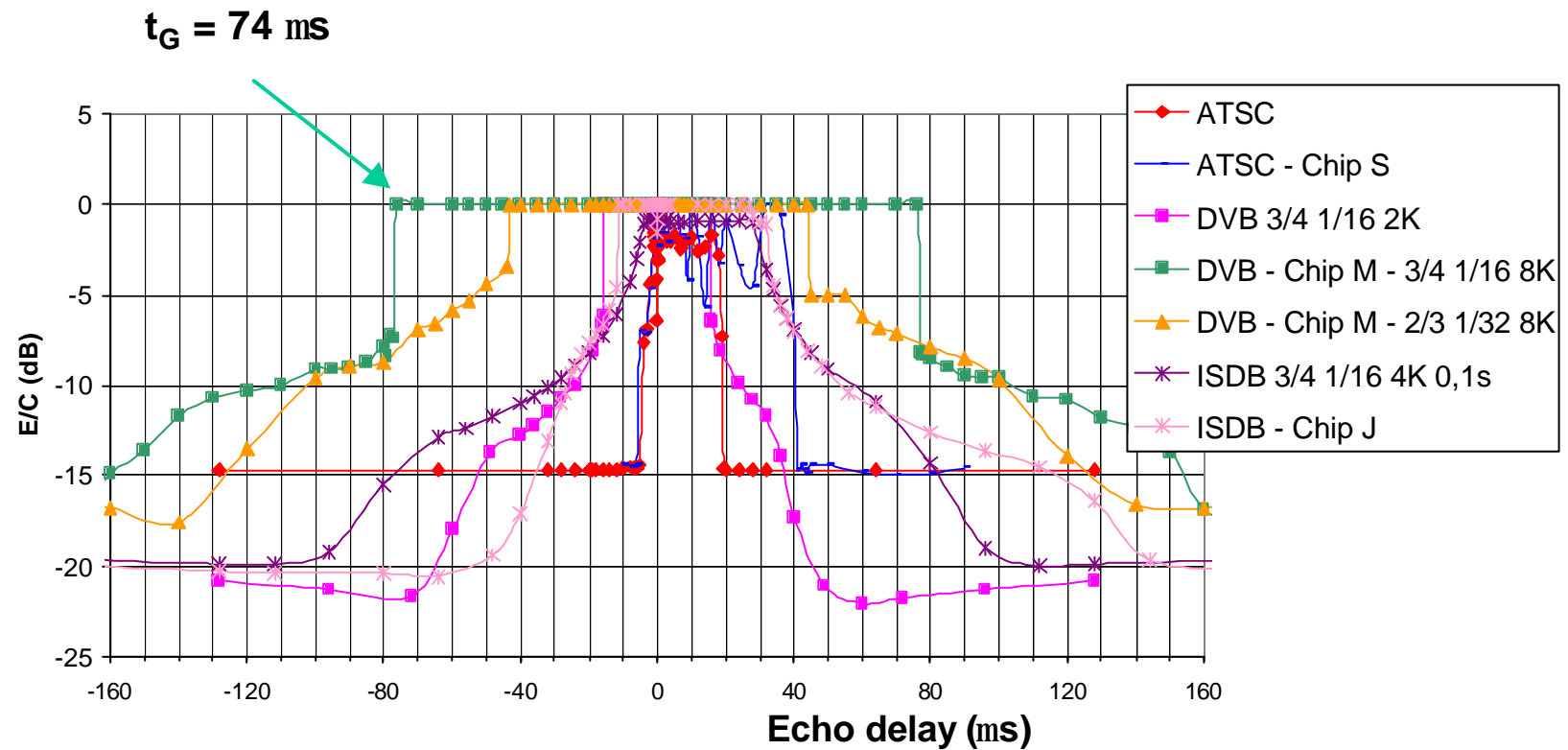
# Robustness to Impulsive Noise

Digital signal + gated Noise  $\bar{P}$  C/Neq  
 Gate: 30s cycle, 12,5 Hz to 100 Hz, fixed  $T_w$   
 BER <  $3 \times 10^{-6}$  within 2 minutes counting



Source: SET/ABERT Final Report - Part 2  
 Public Consultation 237 - June 02, 2000

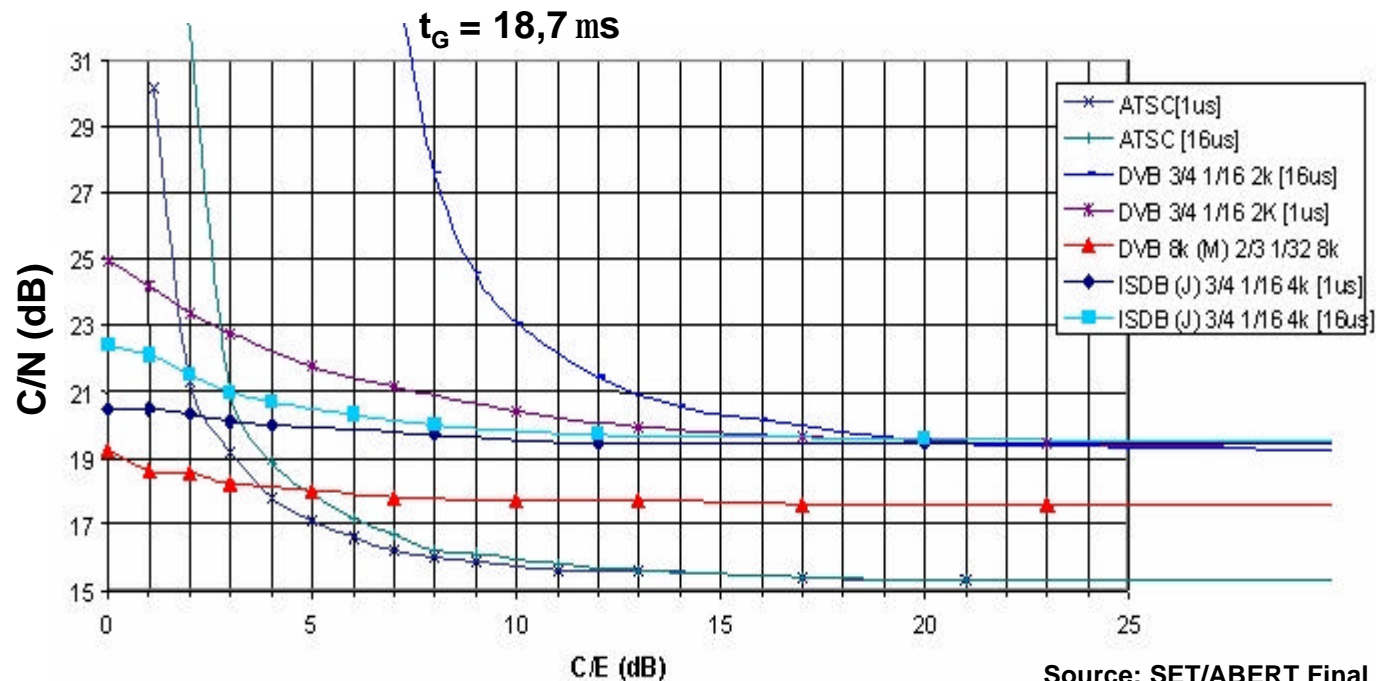
# Multipath - single static echo



Source: SET/ABERT Final Report - Part 2  
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# C/N degradation with single echo

- Increased echo amplitude requires higher C/N (imposes penalty)
- DVB-T and ISDB demodulators showed evolution along the tests
- COFDM: guard interval
- ATSC cannot stand strong echoes: ~2 dB with high penalties
- 8VSB: (long, complex) transversal equalizers



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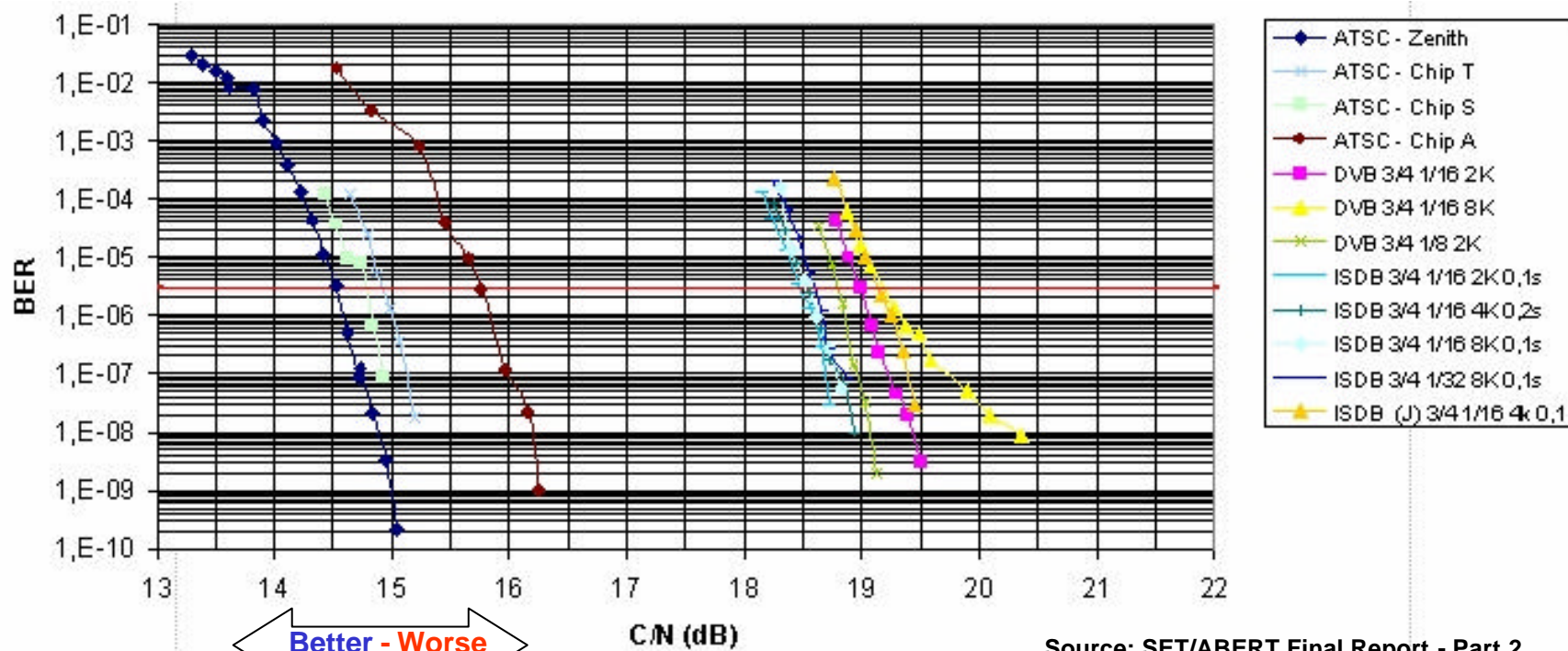


# BER x C/N performance

C/N @ BER =  $3 \times 10^{-6}$

- ATSC Zenith: 14.5 dB
- DVB-T chip M 2/3 1/32 8K: 16.9 dB @ LOP
- DVB-T NDS 3/4 1/8 2K: 18.8 dB
- ISDB-T DiBEG 3/4 1/16 2K/4K/8K: 18.5 dB

**COFDM:** robustness x payload



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- **Field tests** - robustness/capacity analysis under real reception conditions
  - Coverage - real world reception includes white noise, multipath, interference from other channels and impulsive noise
  - Gap filler - recover coverage on a shadowed spot
  - Indoor reception - high attenuation and time varying multipath
  - Mobility - Doppler frequency shift - some trajects in São Paulo, near the transmitter

## Field Tests - TX Site

- São Paulo
  - Biggest market in Brazil: 40% GNP
  - Economical potential
  - "Acid test": difficult coverage
    - Topographic conditions - gap filler
    - High density of buildings in some regions
  - UHF channel 34 (593 Hz center frequency)



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- TX station
  - Site definition for TV Cultura tower: coverage, infrastructure and space for equipments and for antenna in tower
  - Transmitter: Harris DCD20PL1, operated at 2,5 KW for all systems
  - Antenna: 104 m agl; 9.3 dBd; 12 KW max. ERP

## Field Tests - RX Site

- RX Van
- mast 10 m agl
- Antenna: Scaffner, 2.6 dBd
- Pre-amplifier, hybrids
- Noise Generator
- Receivers - availability
- MPEG 3 Decoder
- Spectrum Analyzer

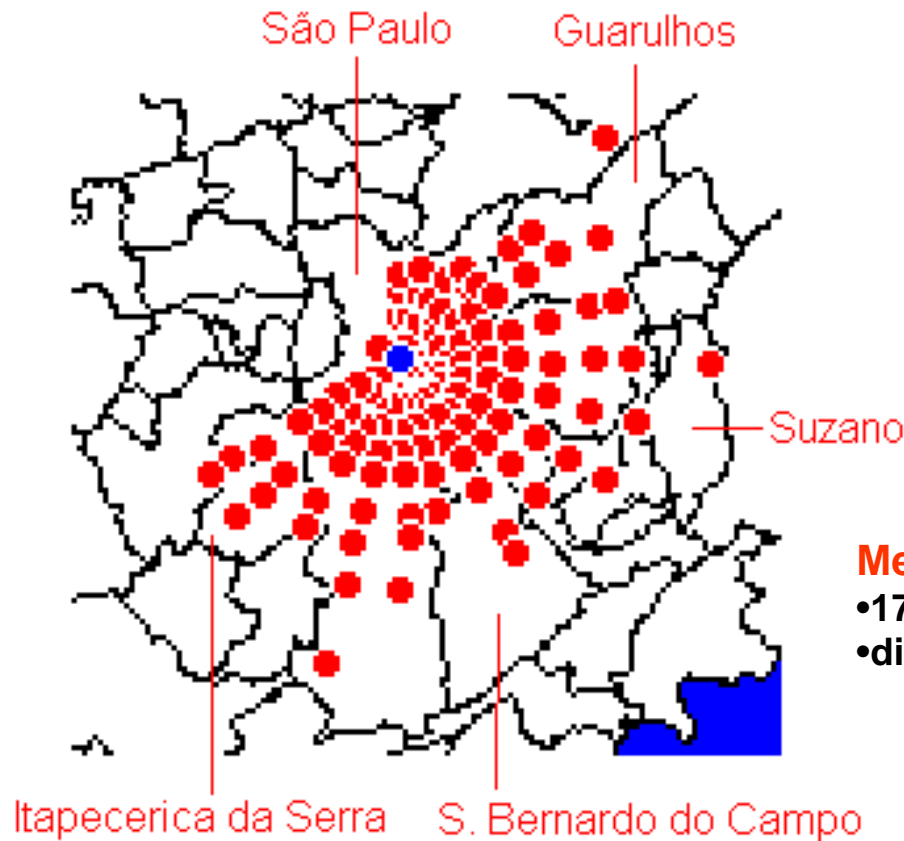


Source: SET/ABERT Final Report - Part 2  
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**Measurement period: Nov 9, 1999 to Abril 28, 2000**

Source: SET/ABERT Final Report - Part 2  
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# RX Test sites in São Paulo



## Measurement Procedure

- **Point RX antenna** to obtain best reception
- Measure received C/N @ C = -30 dBm
- Add external noise up to BER Threshold or artifacts;
- Calculate available margin, electric field, etc

C = Signal Power

N = Noise power in channel bandwidth

C/N = Signal to noise ratio

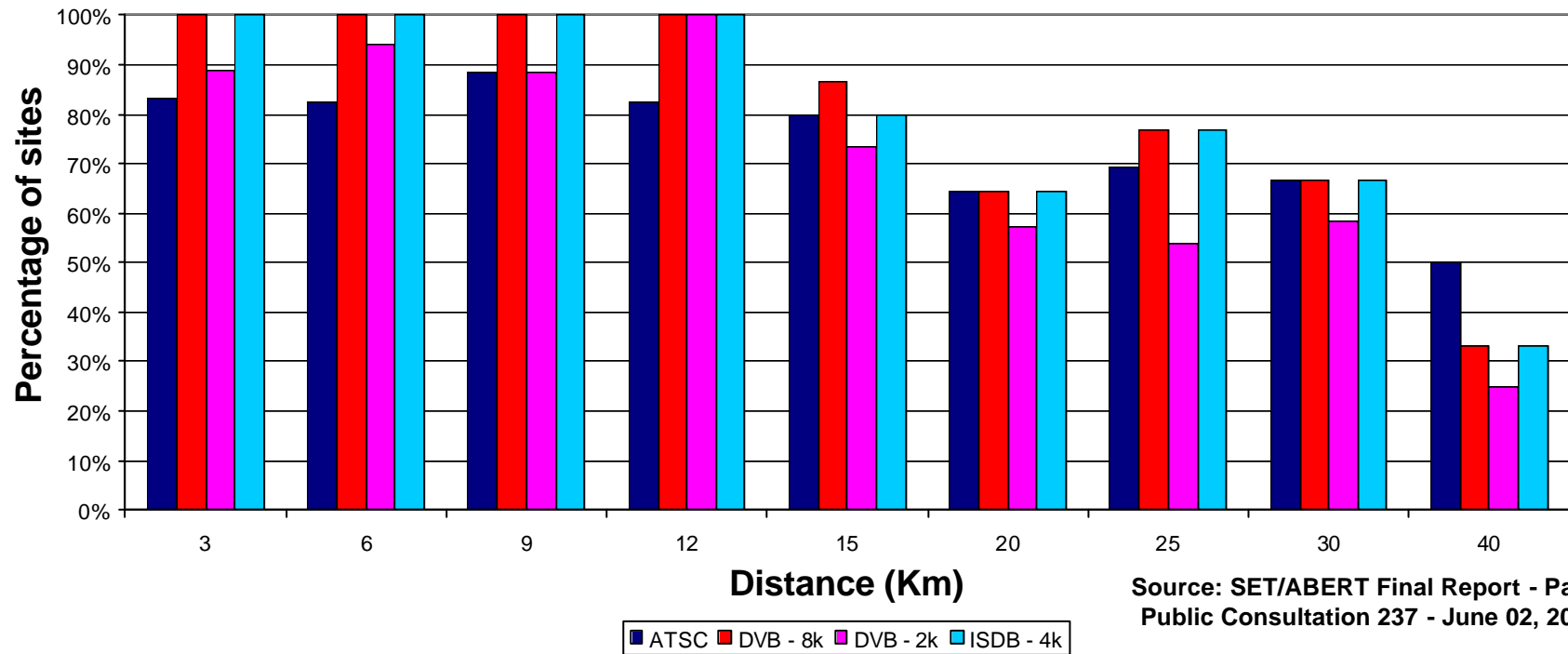
## Measured points

- 17 radials 15° apart
- distances: 3, 6, 9, 12, 15, 20, 25, 30, 40 Km

# Field Tests - Coverage

127 test points: ATSC and DVB-T 2K

Criterion: Margin > 0 dB

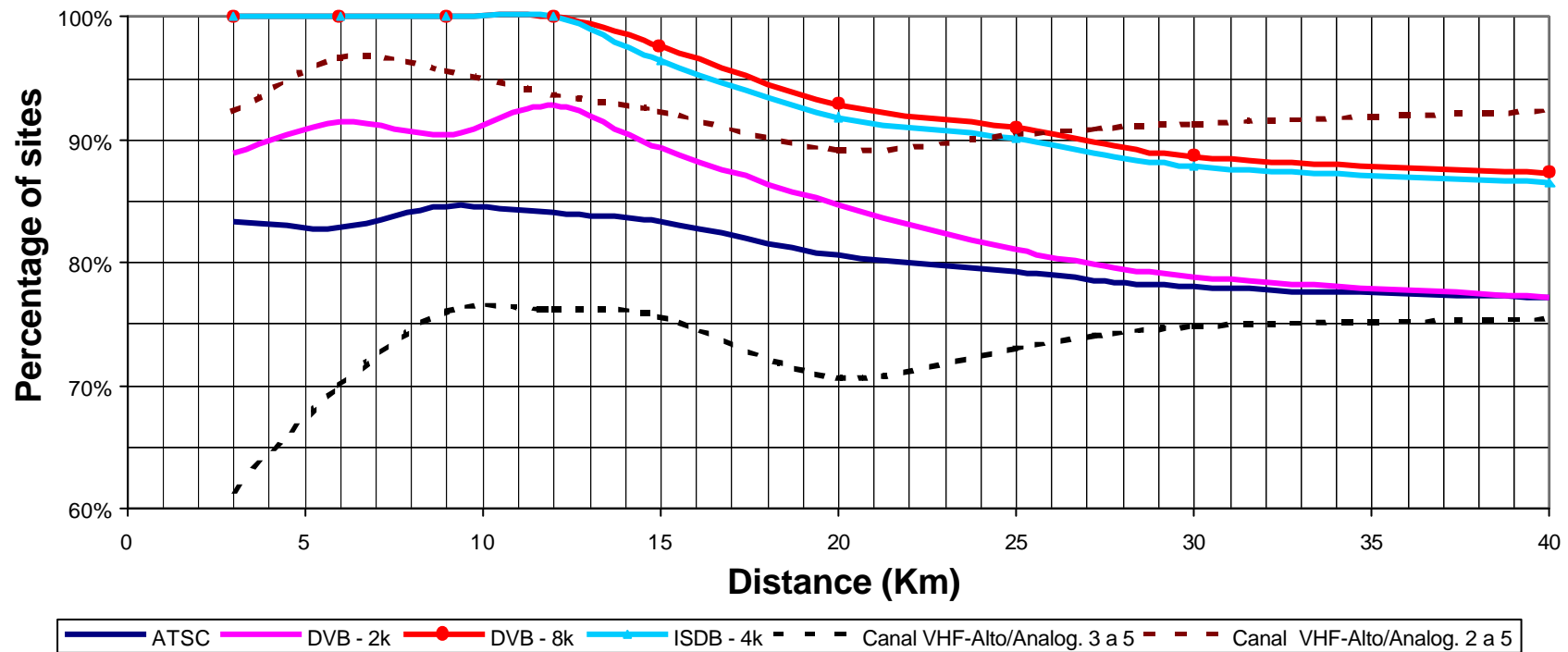


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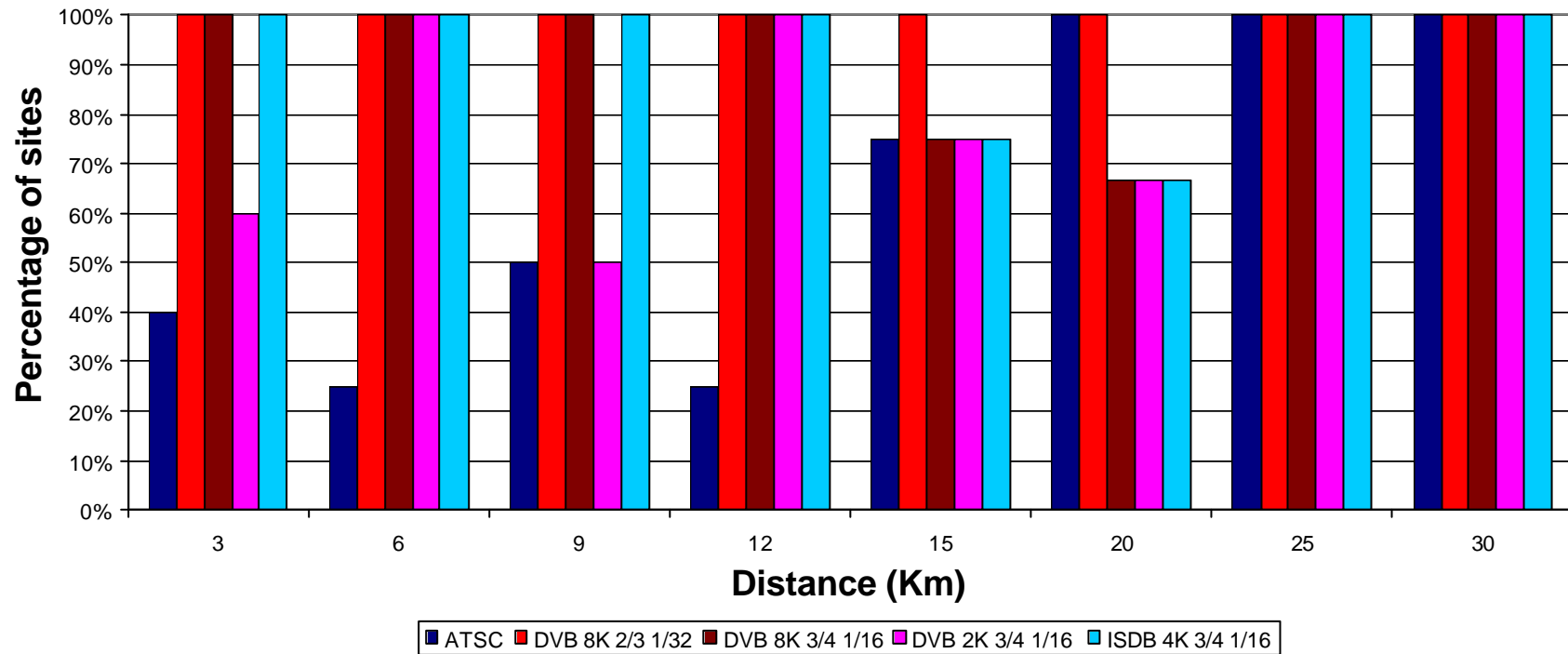


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# Field Tests - Coverage

27 test points: ATSC, DVB-T 2K,

Criterion: Margin > 0 dB

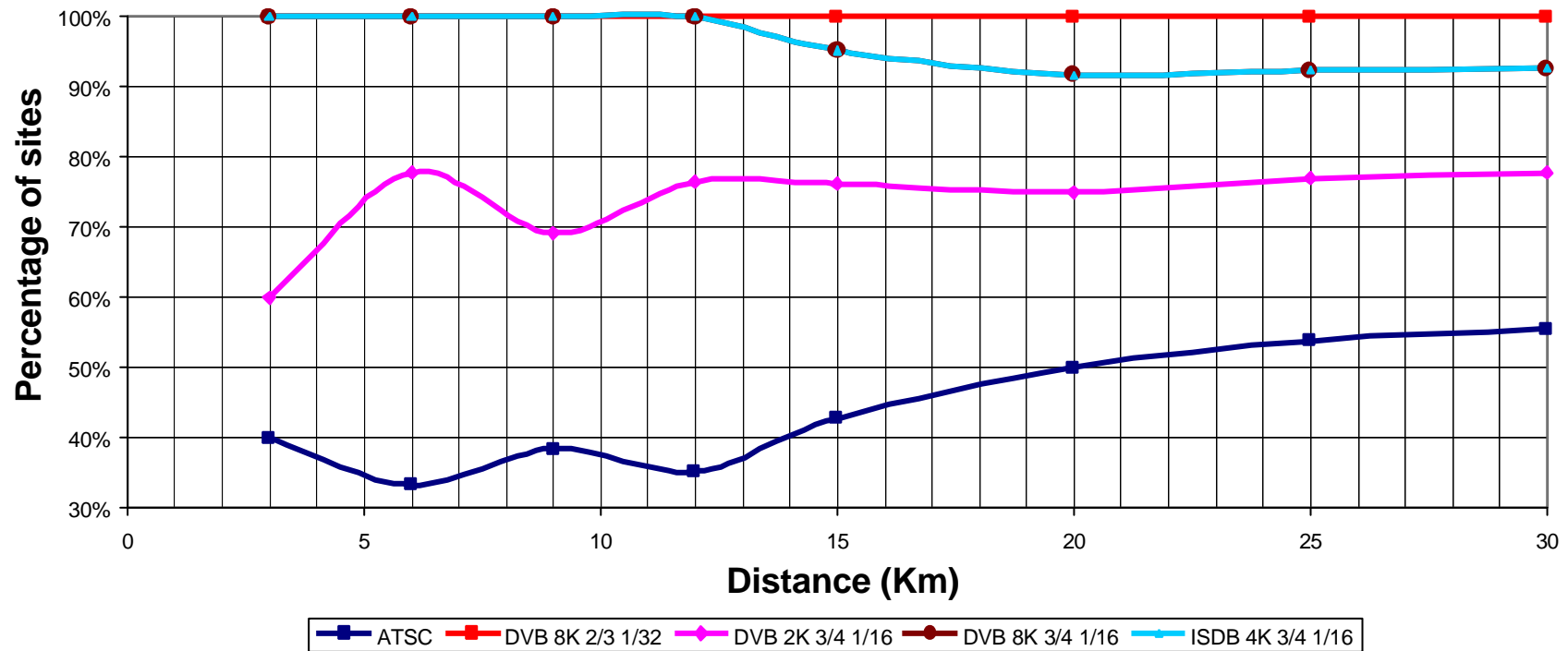


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# Field Tests - Coverage

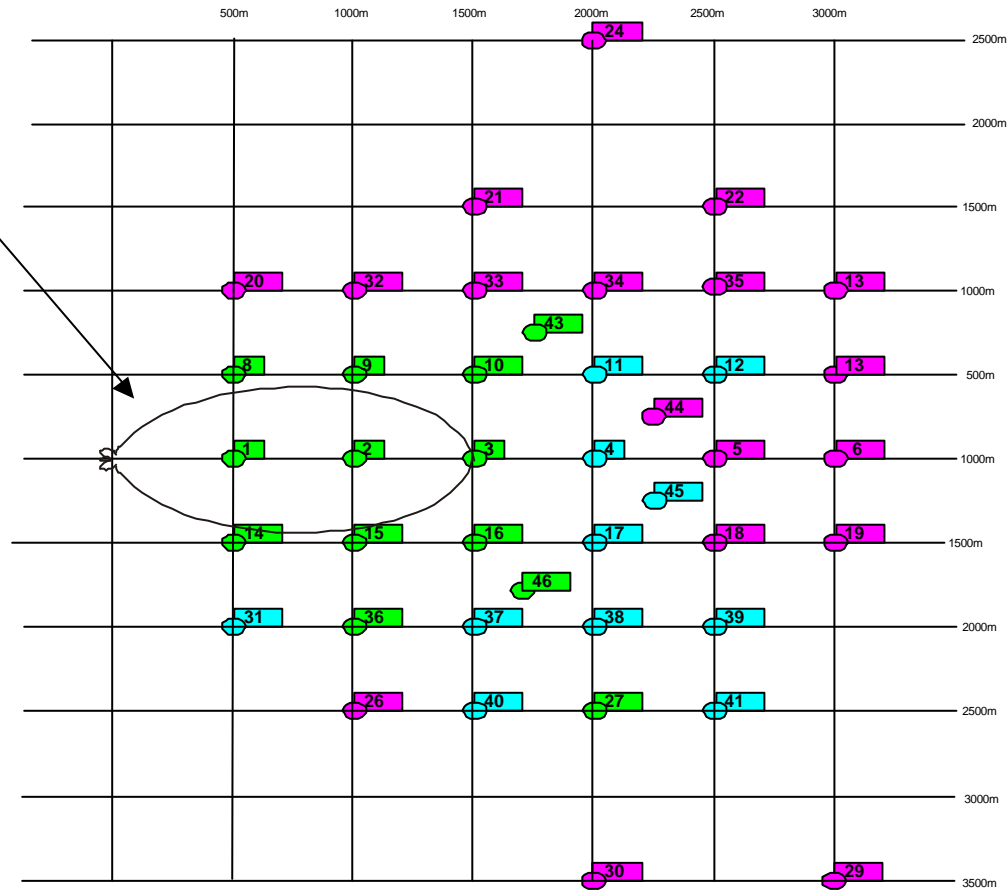
Criterion: Margin > 0 dB



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# Gap filler measurement sites

- Gap filler
- Radiation pattern
- Tilted beam

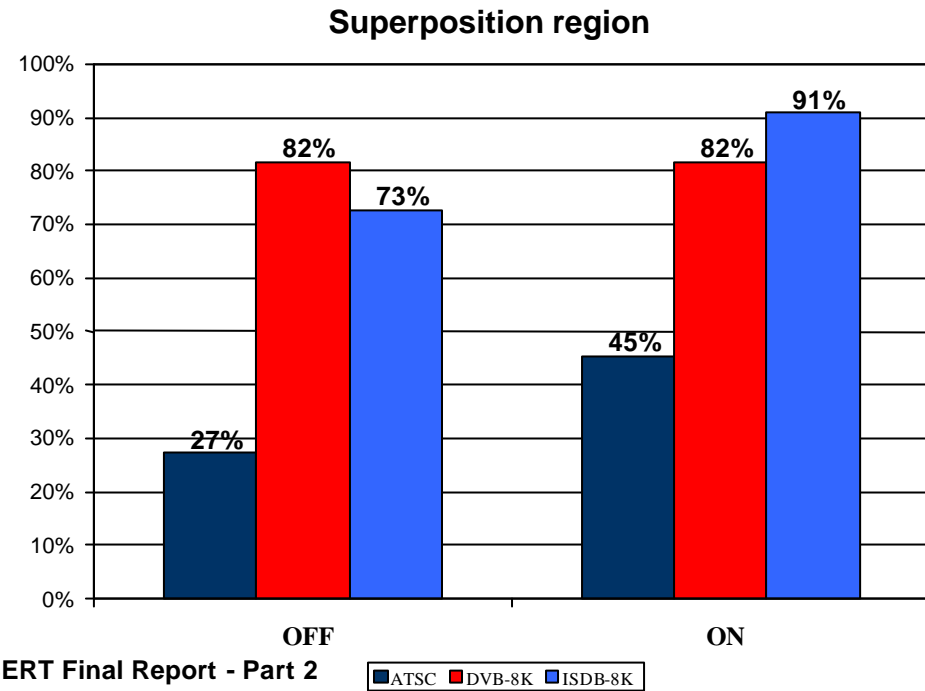
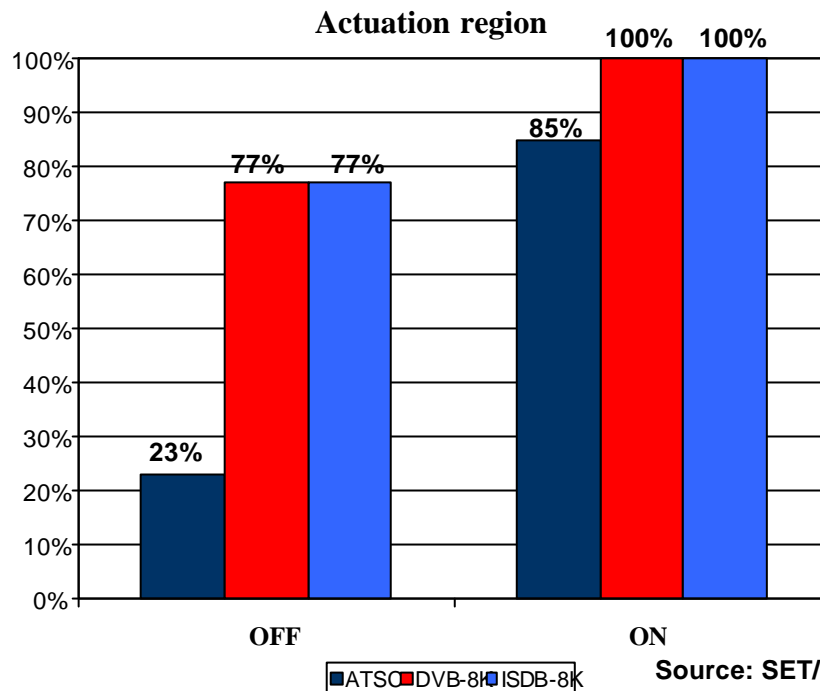


- Actuation
- Superposition
- Out of range

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# Outdoor Reception - Gap Filler

Improvement of reception with gap filler  
 Antenna is re-oriented with gap filler on/off  
 Distance from main transmitter ~5,6 Km -> ~19 ms

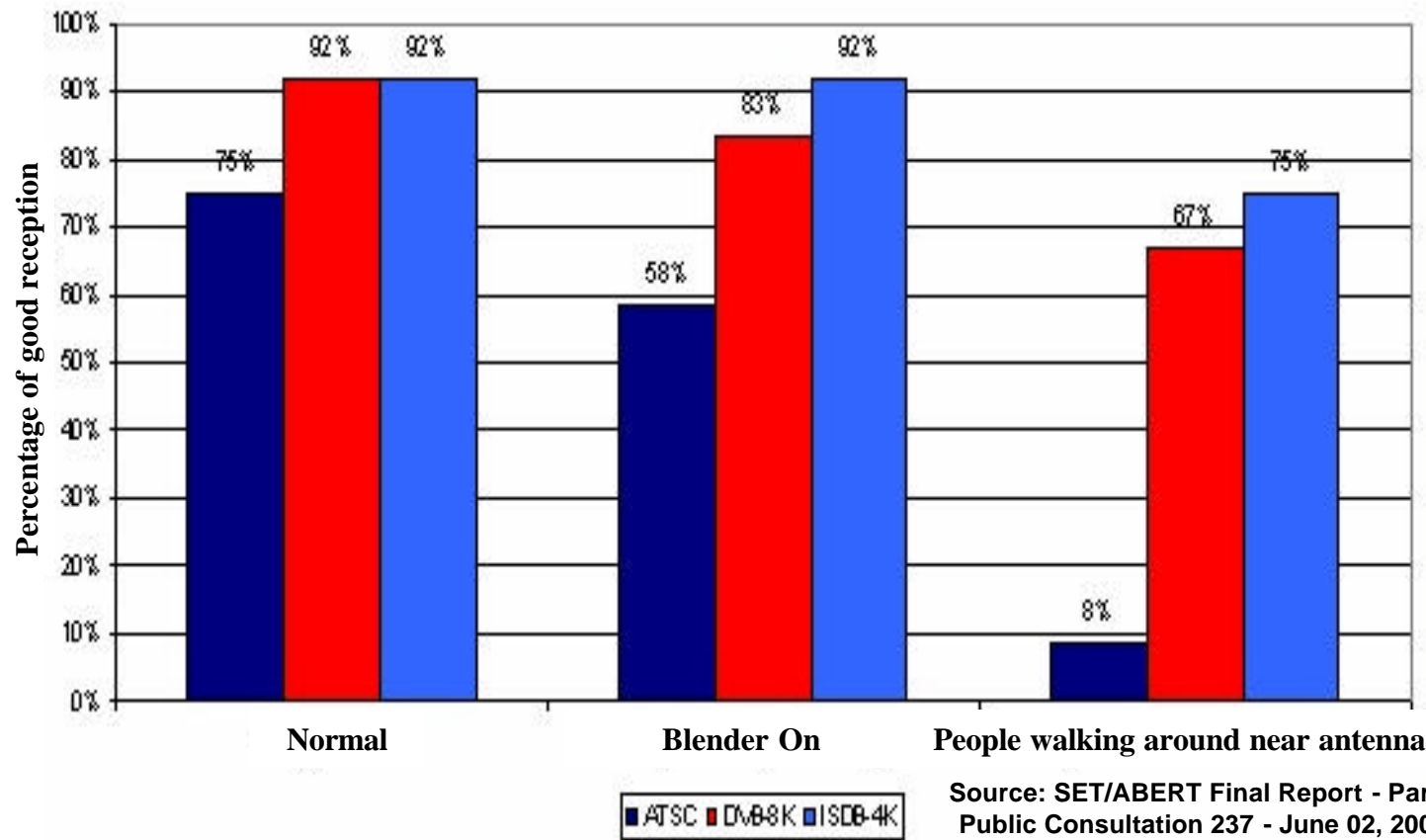


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# Indoor Reception

12 sites where the 3 systems were tested under identical conditions

Indoor antenna: UHF log-periodic - Silver Sensor



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Public Consultation 237 - June 02, 2000

## SET/ABERT Reports

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The data, tables and graphs presented here were extracted mainly from the SET/ABERT Final Report - Part 2, that is available in Portuguese and in English at: [www.anatel.gov.br](http://www.anatel.gov.br)

These results express the conclusions arrived at by SET/ABERT, and do not express ANATEL's viewpoint.

Thank you for your attention