Passive Intermodulation Products Radiated from an Antenna Reflector: Theory and Experiments

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Outline

1. Context
2. Theory
3. Test bench
4. Results
5. Conclusions and perspectives

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1. Context

- Main concerns about radiated passive intermodulation products
  - In a transmit-receive multi-horn reflector antenna, PIM products generated by signals transmitted from two or more horns could be reflected either to another horn and its receiver or in a direction outside the antenna coverage
  - PIM theory and measurement should consider this effect and take it into account in the reflector material specification
  - A PIM test bench could be designed to radiate PIM products in a direction different from that of signals to improve the dynamic of the test bench
- Theoretical study then measurements of radiated PIM products

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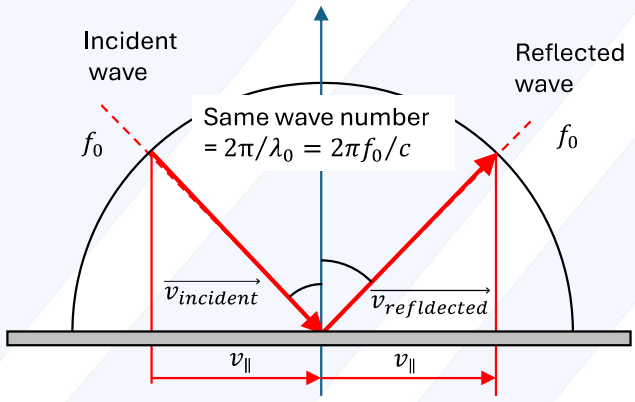
2. Theory – Plane reflector (1)

- Reflection of one incident wave
- Classical ray optics
- Wavevector length are the same
- Projections of wavevectors on the reflector plane are the same
- Result in reflection angle equal to incident angle



Same projections of wavevectors on sample surface

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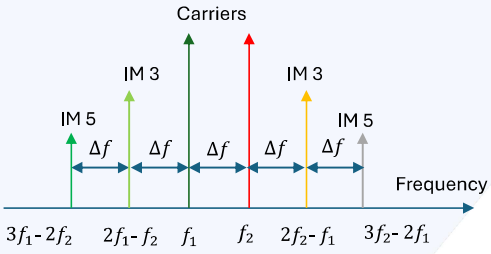
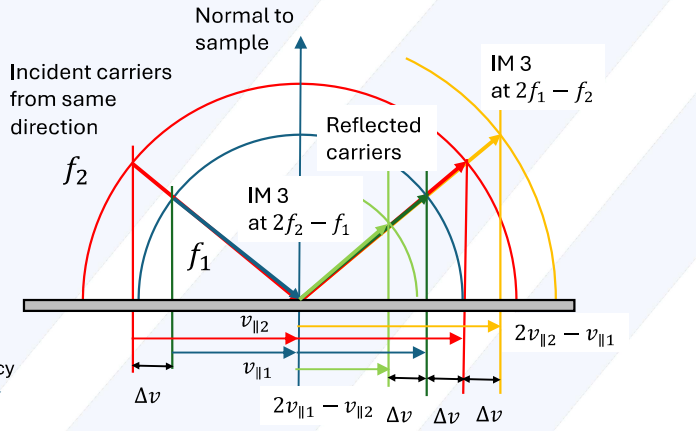
2. Theory – Plane reflector (2)

- Reflection of two incident waves coming from the same direction and radiated PIM products



Frequencies of carriers and PIM products



Projections of wavevectors on sample surface and their differences Δv

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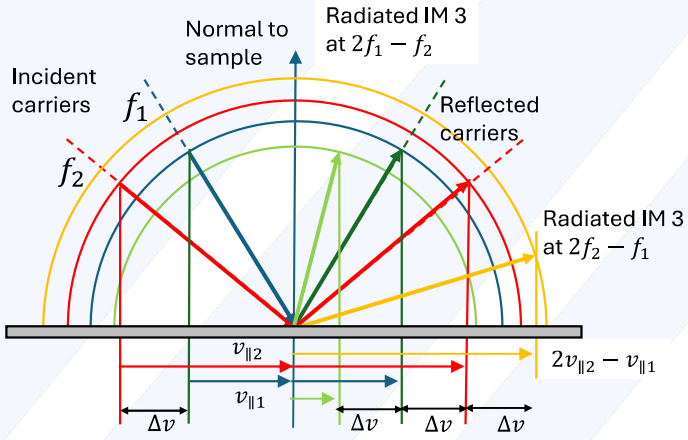
2. Theory – Plane reflector (3)

- Reflection of two incident waves coming from the different directions and radiated PIM products



Projections of wavevectors on sample surface and their differences Δv

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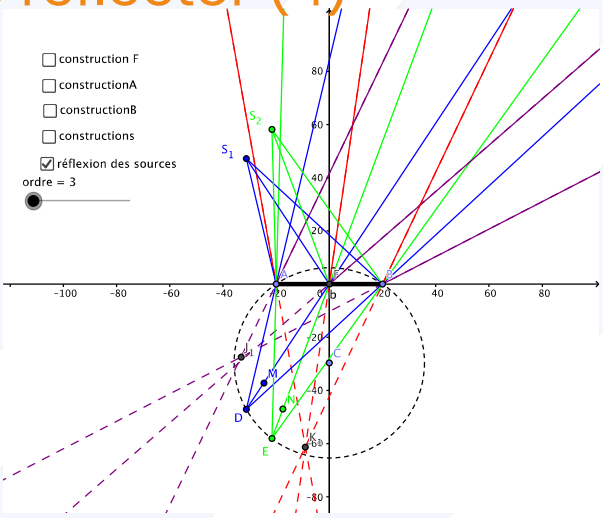
2. Theory – Plane reflector (4)

- Reflection of two incident waves coming from the different directions and radiated order 3 PIM products
- PIM product seem to come from2 virtual sources on each side of real sources
- Drawing with Geogebra software



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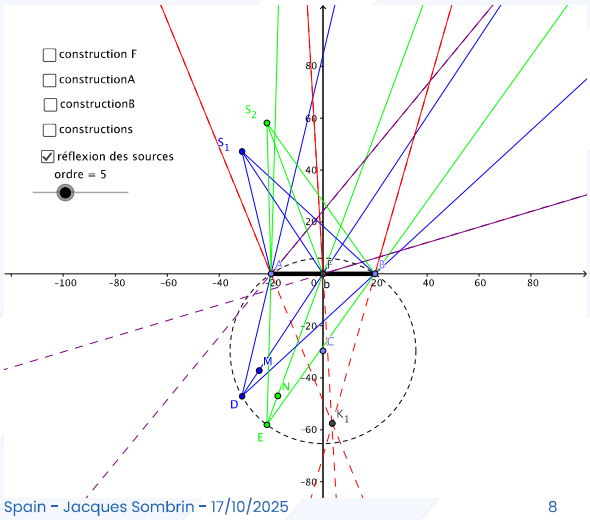
2. Theory – Plane reflector (5)

- Reflection of two incident waves coming from the different directions and radiated order 5 PIM products
- PIM product seem to come from2 virtual sources on each side of real sources
- One disappears because the wavevector is smaller than its projection
- Drawing with Geogebra software



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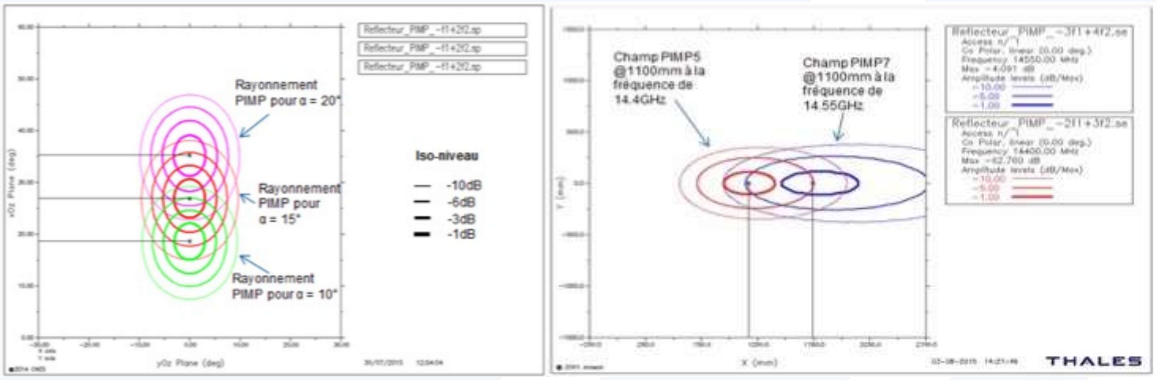
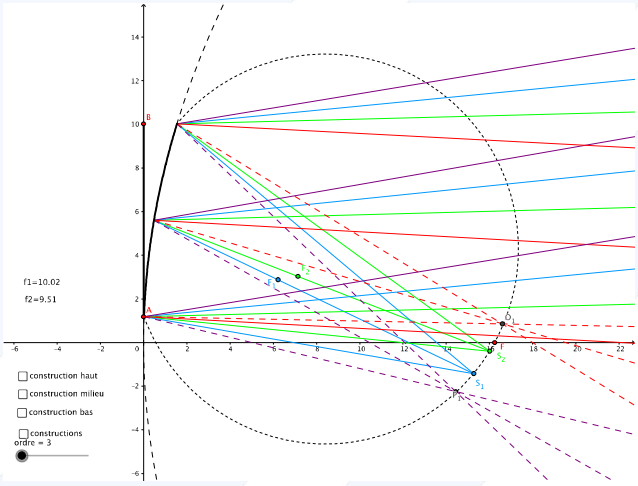
2. Theory – Plane reflector (6)



- Computation of order 3, 5 and 7 PIM diagrams with an EM software

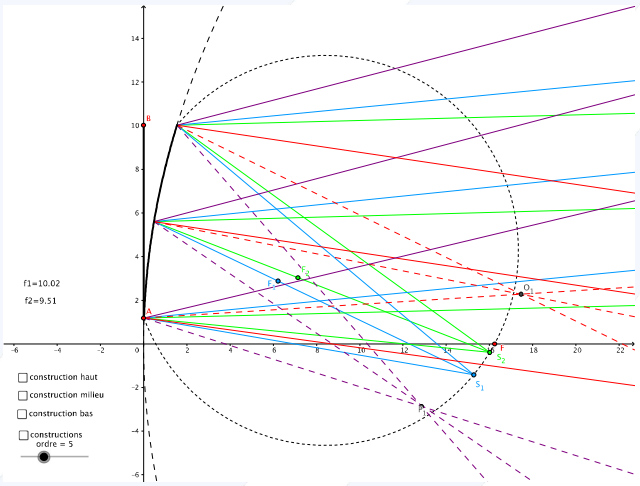
2. Theory – Parabolic reflector (1)

- Reflection of two incident waves coming from 2 different horns and radiated order 3 PIM products
- PIM product seem to come from2 virtual sources on each side of real sources
- Drawing with Geogebra software

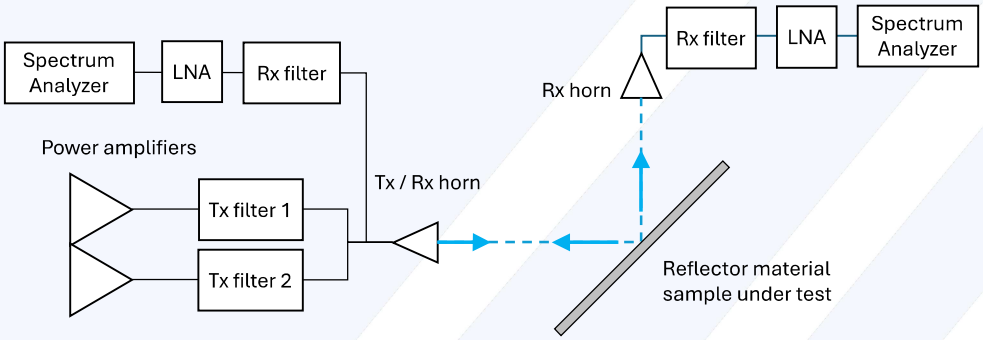


2. Theory – Parabolic reflector (2)

- Reflection of two incident waves coming from 2 different horns and radiated order 5 PIM products
- PIM product seem to come from2 virtual sources on each side of real sources
- Farther apart than for order 3 PIM
- One PIM beam intercepts the bloc of real sources
- Drawing with Geogebra software

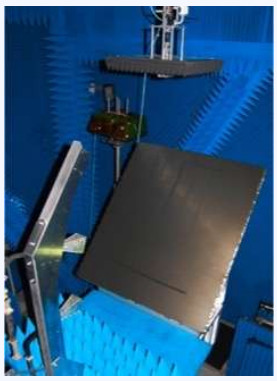


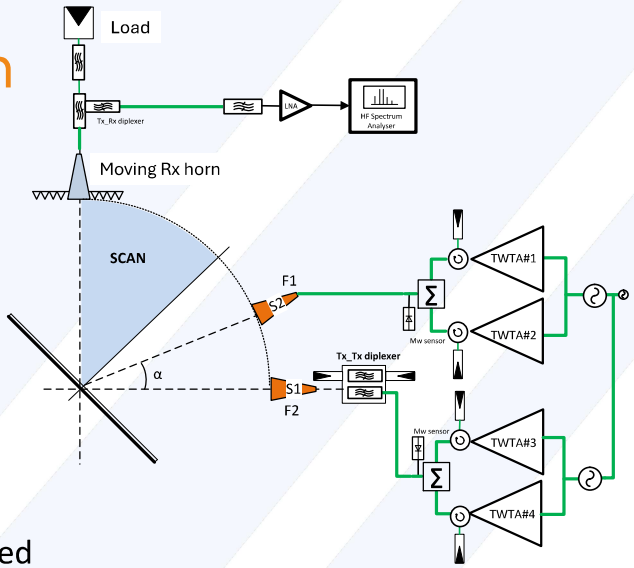
3. Classical test bench



- Classical test bench for the measurement of PIM from a sample of reflector material

3. New test bench





- Two transmission horns
- The reception horn can be moved

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4. Results – PIM levels and slopes

IM order	Transmitted level at 50 dBm per carrier (dBm)	Reflected level at 50 dBm per carrier (dBm)	Slope of radiated IM	Slope of reflected IM
3	-106.9	-118.2	1.74	1.33
5	-126.3	-133.2	2.09	1.87
7	-135.2	-142.4	2.27	2.22

- With only one -transmit horn
- PIM levels follow habitual laws, slope around 2
- Slightly different slopes for reflected and transmitted PIM

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4. Results – radiated PIM angle

Order	Angle of receive horn (°)	
	Theory	Measured
3	25,65	26
3	26,65	33
3	26,31	26
3	-16,13	-16
5	35,59	31
5	36,68	41
7	45,5	48

Order	Angle of receive horn (°)	
	Theory	Measured
3	14,29	16 (10)
3	14,29	10
3	26	24
5	13,64	15
5	24,88	12
5	0	19 (15)
5	36	29 (25)

Good results for all orders with 2 carriers

More differences for order 5 with 3 carriers

Problem with diffraction of the radiated PIM beams, many peaks

5. Conclusion and perspectives

- Ray optics give the correct main direction for the beams of radiated PIM products
- Diffraction about the same as for nominal beams
- PIM can be radiated in the direction of sources and send more power than predicted into receivers
- Higher dynamic possible in new test benches, around 10 dB obtained

Further work:

- Measurement on a complete parabolic reflector with multisource
- Test bench available for measurements