



RF Exposure Updates

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Contents

- 1. Accessories and Peripherals**
- 2. Checklist for the ANTTUN PAG Item**
- 3. Minimum Test Separation Distance**
- 4. RF Exposure Testing Near Complex Surfaces**
- 5. Conclusions**



Section 1

Accessories and Peripherals



Connecting “Accessories” to other RF devices

Published Guidance

- Guiding principle discussed in KDB 680106v04*
- In summary, for Equipment Authorization purposes:
 - Emissions due to **other independently authorized** transmitters (e.g., “accessories”) do not need to be considered to account for possible cumulative effects with the emissions from the device under test DUT.
 - However, testing in all “typical” operating conditions for establishing DUT compliance must account for the **presence of passive structures** external to the DUT, since they may alter the emission patterns.

* See Section 4 “OPERATIONS OF WPT DEVICES CO-LOCATED WITH OTHER RF DEVICES”). While KDB 680106 refers to WPT devices, as stated in section 4, that specific guidance is applicable to any RF device. That was re-iterated in the presentation [4.1 Apr. 2024 TCB Workshop](#) (slide 5). More general guidance updating is in progress.



Authorization Process for Accessories (I)

Two Approaches – The Default Process

- The default process (per mentioned KDB 680106, Section 4) refers to the case where the connected device (accessory or peripheral) has been **independently authorized** (w/ FCC ID or via SDoC).
- Essentially, the main point is that the FCC authorization refers to **one device** in its operating conditions. That includes the physical presence of another connected device, but it does not require the consideration of RF emissions from “nearby”, connected or not, transmitters.
- For instance, there could be two RF devices connected via Bluetooth, Wi-Fi, etc., or using a connector or wire. One could also consider independent devices, with completely uncorrelated use/transmissions, such as a laptop being used on Wi-Fi next to a cell phone transmitting on LTE/5G, etc.



Authorization Process for Accessories (II)

(...Continued) The Default Process

- In all these mentioned cases, while the user is exposed to the sum of all the emissions (that can be evaluated as the sum of *rms* values), the RF exposure compliance is always related to each single device.
- It would be **virtually unmanageable** to consider all the possible combinations of these events (often not predictable, related to devices that may have not been conceived yet) in the certification phase.
- Therefore, the present guidance applies to each **independently authorized** device, while connected and operating as required by design, but **without** the need to consider simultaneous transmissions from **other RF devices**.
- In other words, the equipment authorization pertains solely to the DUT, not to the pre-existing, externally determined, **electromagnetic environment** where it may operate.



Accessories and Peripherals to RF Devices (III)

Optional Process

- A second, optional, approach is available, where a manufacturer may consider the simultaneous transmissions of two (or more) **specific RF devices** that can be connected to the accessory-DUT.
- These specific additional devices, and the result of these specific simultaneous transmission testing, can be mentioned in the grant notes (for certified accessory devices) and in product literature, such as the user's manual, etc.
- This approach may provide a competitive advantage since the manufacturer may **leverage that simultaneous testing** to emphasize a more safety-oriented approach in the design of their products.



Section 2

Checklist for the ANTTUN PAG Item



Checklist for ANTTUN PAG Item

- The following checklist shall be used for the ANTTUN PAG Item
- This procedure is based on Apr. 2019 Workshop
- The checklist will be included in the next revision of 388624-D02.



Checklist for ANTTUN PAG Item

General Context

- SAR is measured according to required procedures for each mode of operation with the dynamic tuner active, allowing the DUT to automatically tune and find the best impedance match.
- The auto-tune state determined by device during normal SAR measurement shall be verified and listed in the reported SAR results.
- This process is based on single point SAR evaluations to verify that the conditions leading to the largest SAR have been captured. The SAR probe shall remain stationary for the entire series of measurements.
- The functionality of the tuner configurations is checked to ensure that the tuned state corresponds to the maximum SAR for that particular transmission configuration.



Checklist for ANTTUN PAG Item (II)

Checklist Items

1. The setup requires that the tuner state can be **controlled remotely** so that the DUT position is **not perturbed** for the entire series of single-point SAR measurements.
2. For **each** mode of operation/setup combination,
 - 2.1 The DUT is positioned near the phantom as required, the auto-tune feature is turned on, and an **area scan** to identify the location of the highest measured SAR is performed.
 - 2.2 The SAR evaluation system is set for **single-point measurements** at the peak SAR location of the highest measured SAR configuration. The **max. SAR** is recorded.



Checklist for ANTTUN PAG Item (II)

(...Continued) Checklist Items

- 2.3 The **auto-tune** is turned **off**, a different tune state (randomly, at least one) is selected, and the single SAR variation is recorded.
 - 2.3.1 The new value is expected to be **less or equal** to previously recorded **max. SAR**, within applicable tolerance margin)
 - 2.3.2 If the new value is **larger** than the previously recorded **max. SAR** (beyond the documented tolerance), then the auto-tune feature is deemed **not suitable for compliance**. The procedure and/or system may need to be rechecked to yield consistent results.
- 2.4 The **auto-tune** is turned back **on**, and the previous maximum SAR value shall be recovered (documented tolerance is acceptable).



Section 3

Minimum Test Separation Distance

KDB 447498 Guidance Refresher for Portable Devices



Devices Tested with up to 25 mm for Body Exposure (I)

General Concept

- Present KDB 447498-D01-v06 guidance requires that devices tested for 2.1093-*Portable* conditions require **5 mm or less test separation distance**, unless...
- ... a **documented and identified** “holder” or body-worn accessory (available on the market) is identified and available for on-body use (in which case the distance can be **up to 25 mm**).
- Test exhibits, grant comments and user’s instructions/documents shall **include a description** of the holder that has been considered.



Moving Forward

- Manufacturers are encouraged to use **5 mm or less test separation distance** to support a more robust compliance design outlook.
- Work is in progress to restructure present RF Exposure guidance to
 - improve consistency across different RF devices,
 - enable a design process that would yield a predictable compliance outcome based on quantitative criteria



Devices Tested with up to 25 mm for Body Exposure (II)

Present guidance (in effect since 2015), KDB 447498-D01-v06 (page 11)

This distance is determined by the handset manufacturer according to the **typical body-worn accessories** users may acquire **at the time of equipment certification**, but not more than 2.5 cm, to enable users to purchase aftermarket body-worn accessories **with the required minimum separation**.²³

The selected *test separation distance* **must be clearly explained** in the SAR report to support the body-worn accessory test configurations.²⁴

Devices that are designed to **operate on the body of users** using lanyards and straps **or without requiring additional body-worn accessories** **must be tested** for SAR compliance using a conservative minimum *test separation distance* \leq **5 mm** to support compliance.²⁵

²⁵ The test distance **must not exceed 5 mm**, and must also support compliance for the exposure and use conditions required by the device.



Devices Tested with up to 25 mm for Body Exposure (III)

(...Continued) Present guidance (in effect since 2015), KDB 447498-D01-v06 (page 11)

d) Specific information **must be included** in the operating manuals to enable users to select **body-worn accessories that meet the minimum *test separation distance*** requirements. Users must be **fully informed** of the operating requirements and restrictions, to the extent that the typical user can easily understand the information, to acquire the required body-worn accessories **to maintain compliance**. Instructions on how to place and orient a device in body-worn accessories, in accordance with the test results, should also be **included in the user instructions**. All supported body-worn accessory operating configurations must be clearly disclosed to users, through **conspicuous instructions** in the user guide and user manual, to ensure **unsupported operations are avoided**. All body-worn accessories containing metallic components must be tested for compliance and clearly identified in the operating manual. The instructions **must inform** users to avoid using other body-worn accessories containing metallic components, to ensure RF exposure compliance.



Section 4

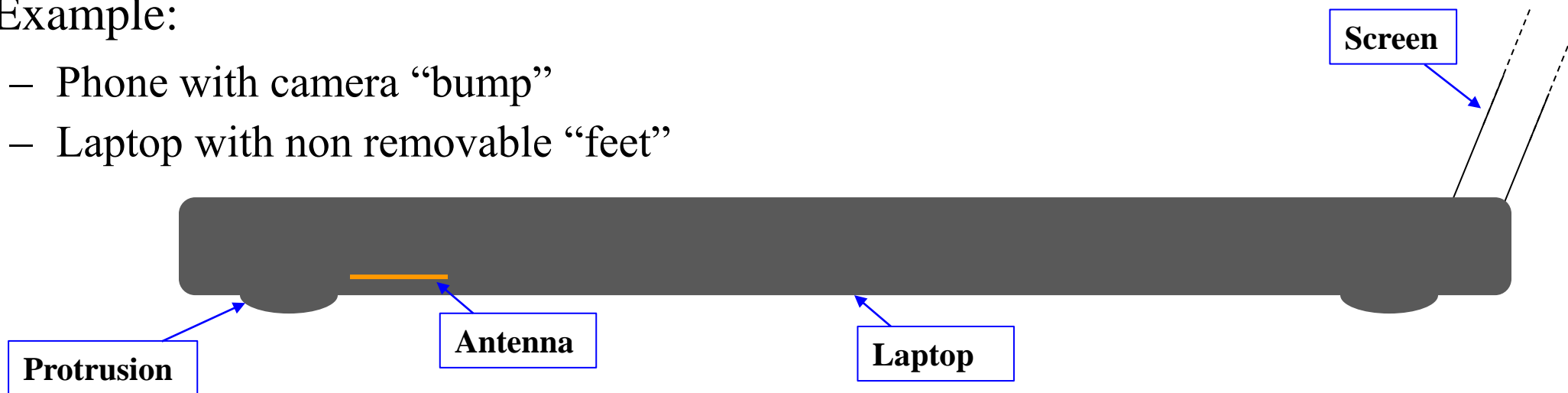
RF Exposure Testing Near Complex Surfaces

SAR and Power Density Measurements



RFX Testing for Complex Shapes

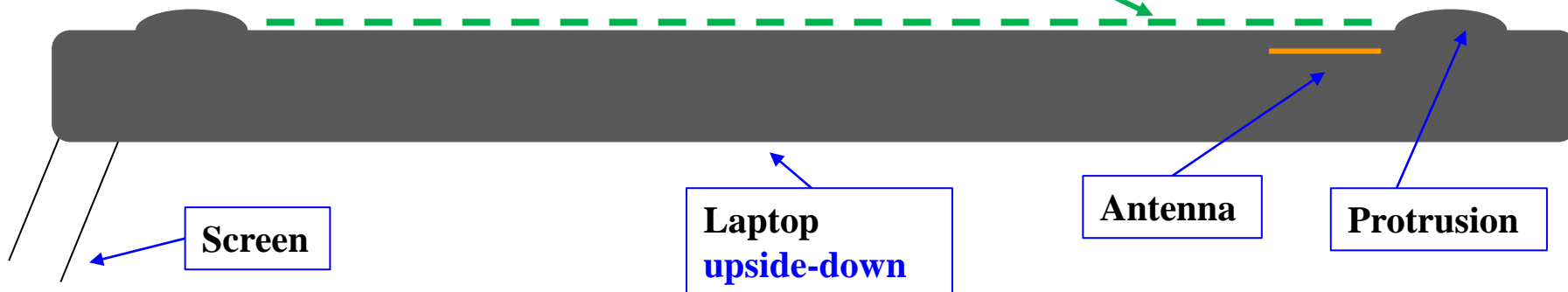
- Complex-shape devices featuring **protrusions** that may **prevent positioning** of probes sufficiently close to DUT antennas.
- Some probes may be delicate and expensive: robotic **scanning too close** to the surface may lead to collisions and damages.
- Example:
 - Phone with camera “bump”
 - Laptop with non removable “feet”



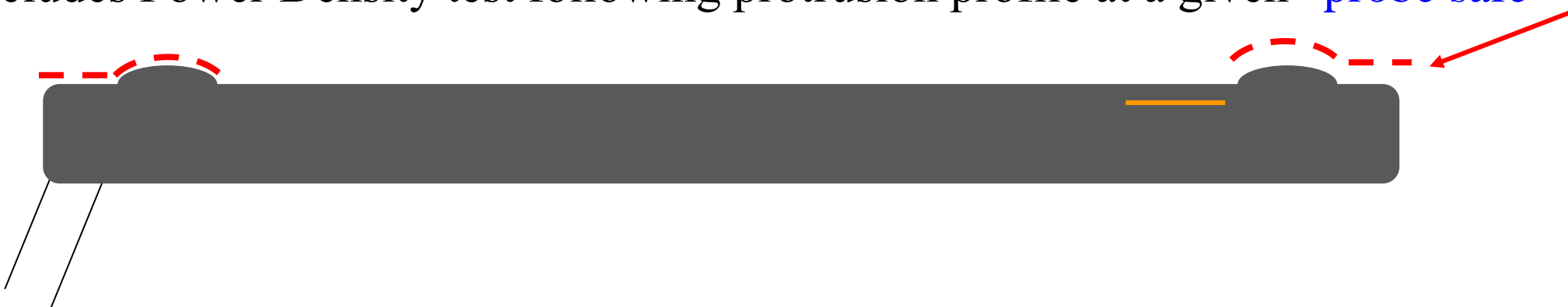


RFX Testing for Complex Shapes

- **Present guidance:** RF Exposure scan on **flat surface** following the DUT profile



- **New guidance** tailored for consistency among several cases of devices with **protrusions**; includes Power Density test following protrusion profile at a given “**probe safe**” distance.





SAR Evaluation for Complex Shapes (II)

- Per KDB 447498:
 - A test separation distance **as low as 5 mm** may be required for **body SAR** evaluation.
 - **Head SAR** evaluation at contact (0 mm separation) is required only for DUT supporting held-to-the ear operations (typically cellular handsets) and is conducted on the front face of the device, thus **unlikely** to be impacted by the presence of protrusions.
 - For **extremity exposure**, due to its larger compliance limit and the typical variability of the DUT positioning during extremity use, it is reasonable to state that extremity exposure can be **conservatively covered by SAR testing at 5 mm** for body exposure.
- These considerations support SAR testing near protrusions scanning over a surface that follows the shape of the protrusion **at the test separation distance required for the DUT**, or **as low as 5 mm** from the protrusion surface.



SAR Evaluation for Complex Shapes (I)

New Guidance

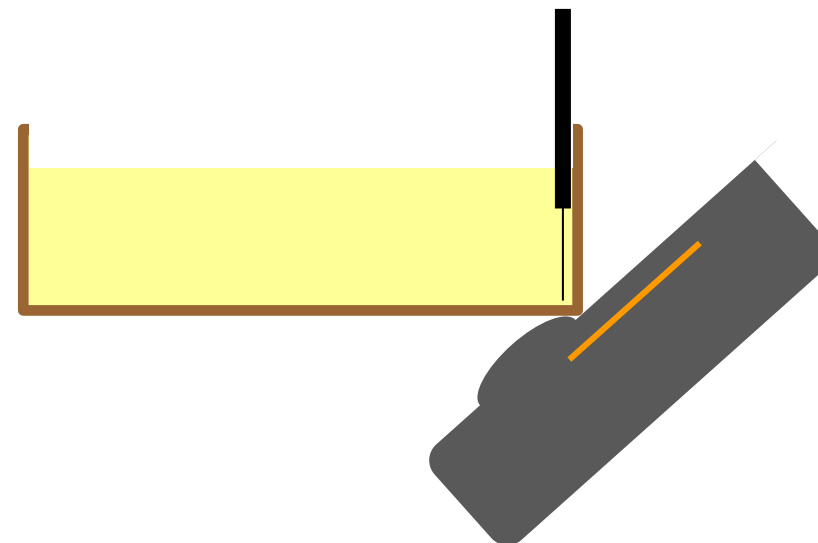
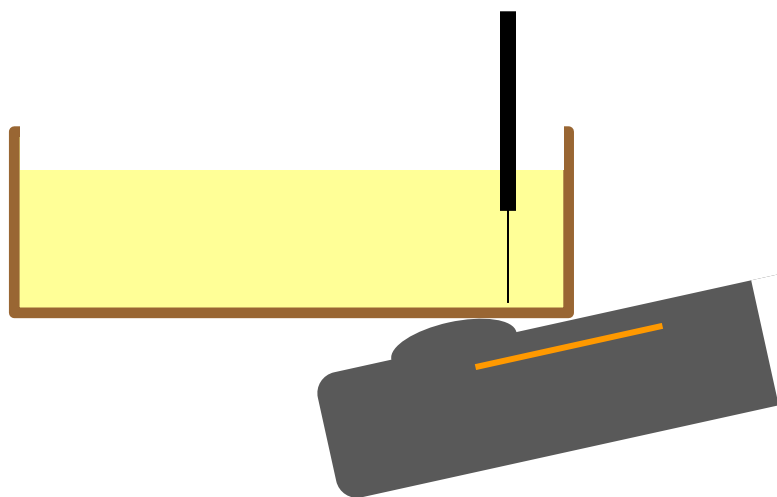
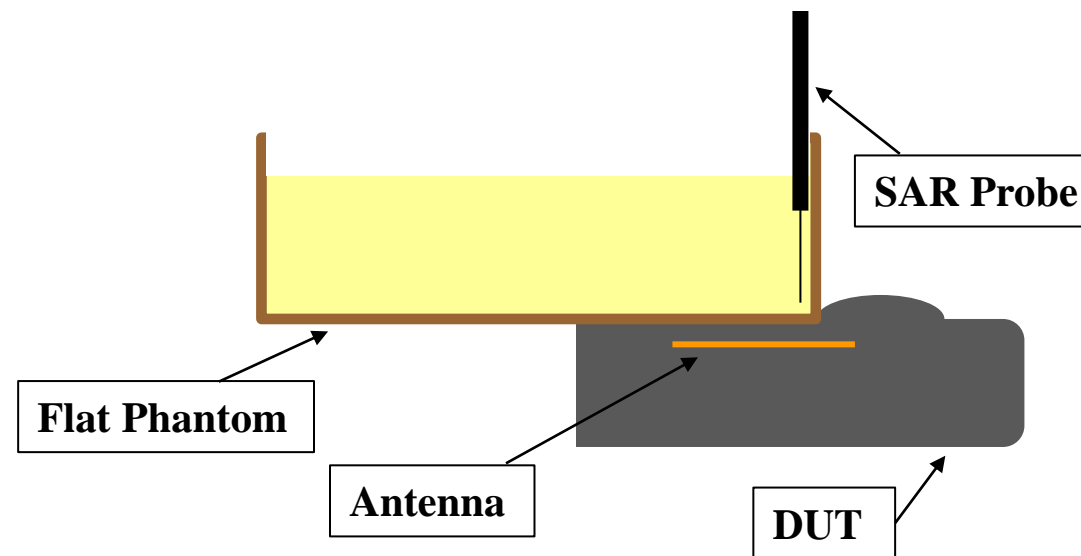
- Extending from the (specialized) past guidance of KDB 616217, **new guidance** is hereby issued, **for all devices** featuring complex shapes (including laptops/notebooks, etc.)
- The preferred approach is to **remove protrusions**, to the maximum extent possible
- When protrusions cannot be removed:
 - Place the DUT near a flat phantom, including positions at best obtainable angles for probe scan, in order to reach required areas near DUT protrusions
 - Compliance SAR evaluation data is acceptable for SAR scans performed over the required protrusion surfaces, up to the **test separation distance** from the antenna **as allowed for the DUT**, or as close as **5 mm** from the antenna. **KDB is not required** even if SAR >1.2 W/kg.
 - If the SAR scan cannot reach **a required area** (e.g., near a protrusion corner) at a sufficiently close distance, the **PHNTOM PAG** is required.
 - New **Power Density** probe guidance (see slides further below).



SAR Evaluation for Complex Shapes (II)

Example 1 – Typical Test Scenarios

- Position the protrusion near the flat phantom bottom edge corner.
- Position the DUT protrusion at the best obtainable angles for the probe scan.

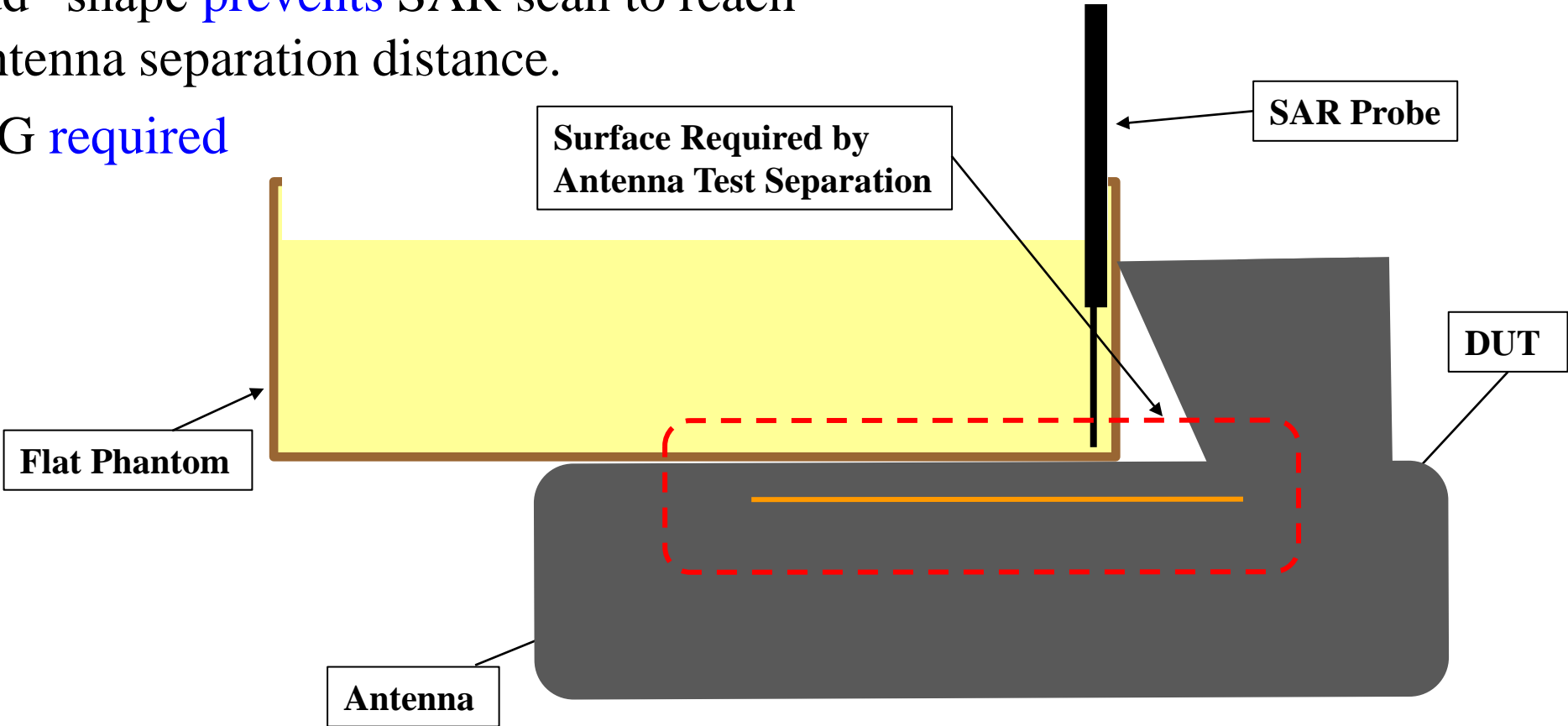




SAR Evaluation for Complex Shapes (III)

Example 2 - Difficult test scenario

- Protrusion “odd” shape prevents SAR scan to reach the required antenna separation distance.
- PHNTOM PAG required

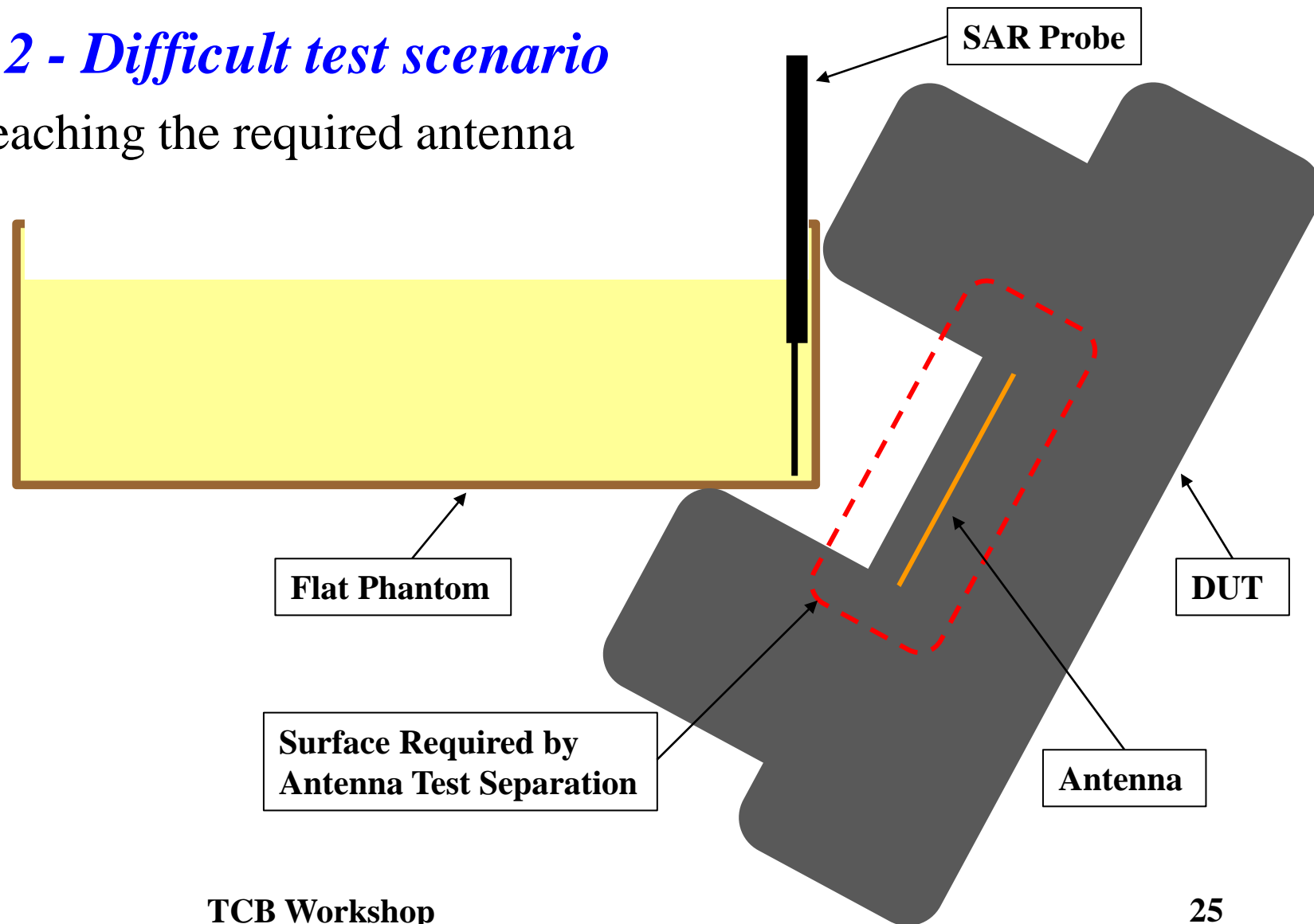




SAR Evaluation for Complex Shapes (VI)

(...Continued) Example 2 - Difficult test scenario

- Two protrusions prevent reaching the required antenna separation distance.
- PHNTOM PAG required

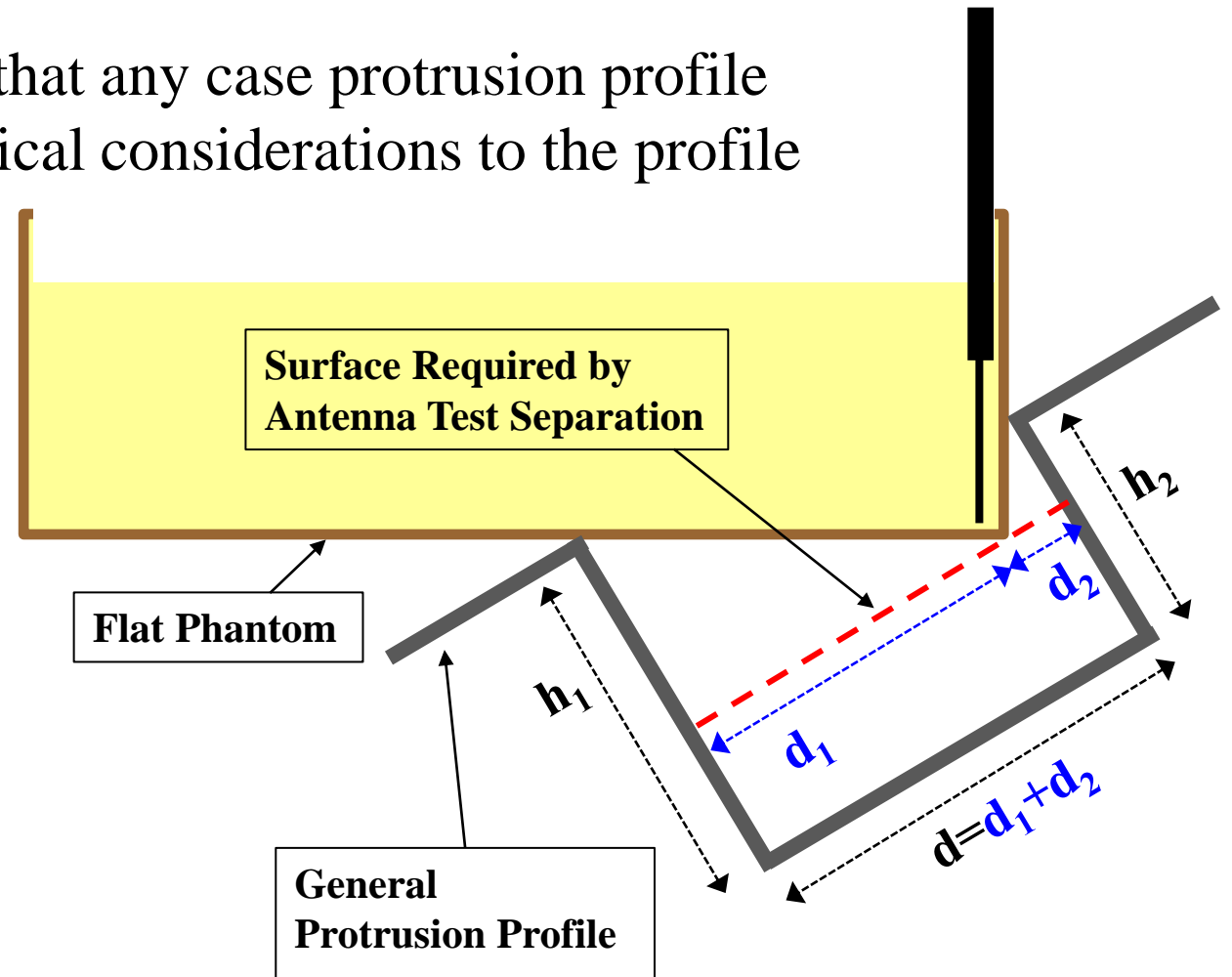




SAR Evaluation for Complex Shapes (V)

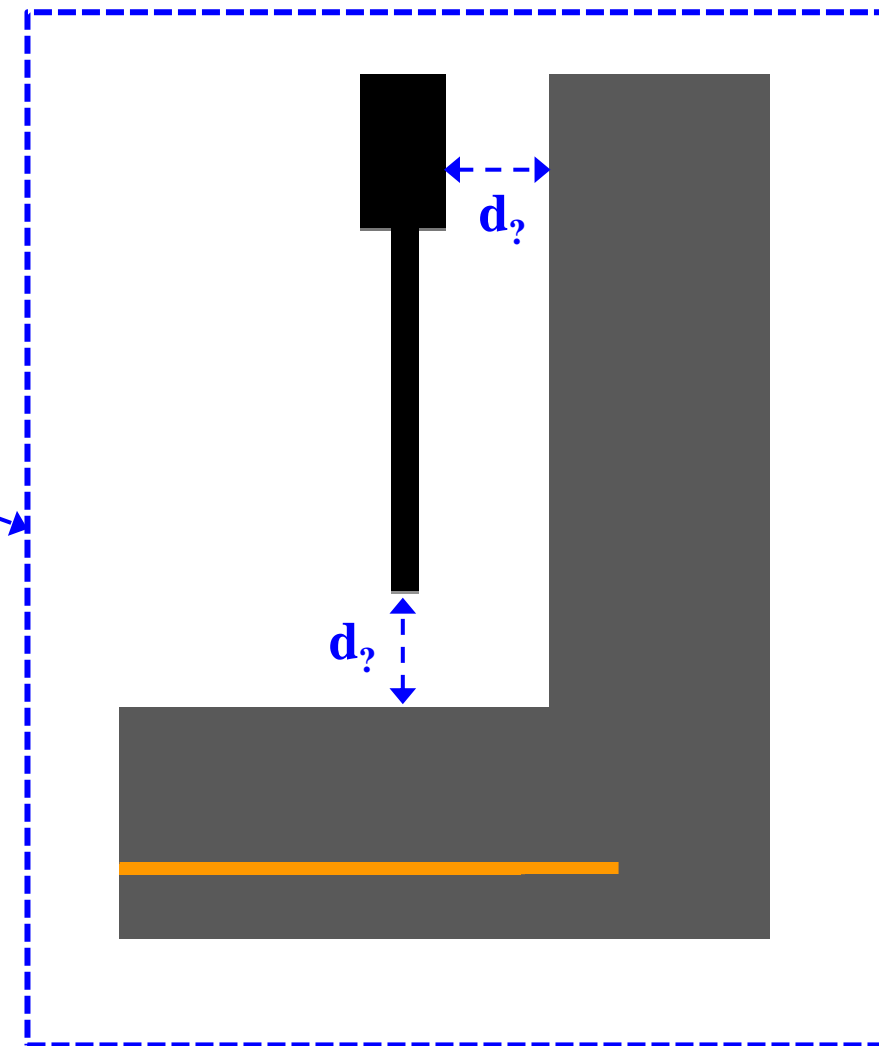
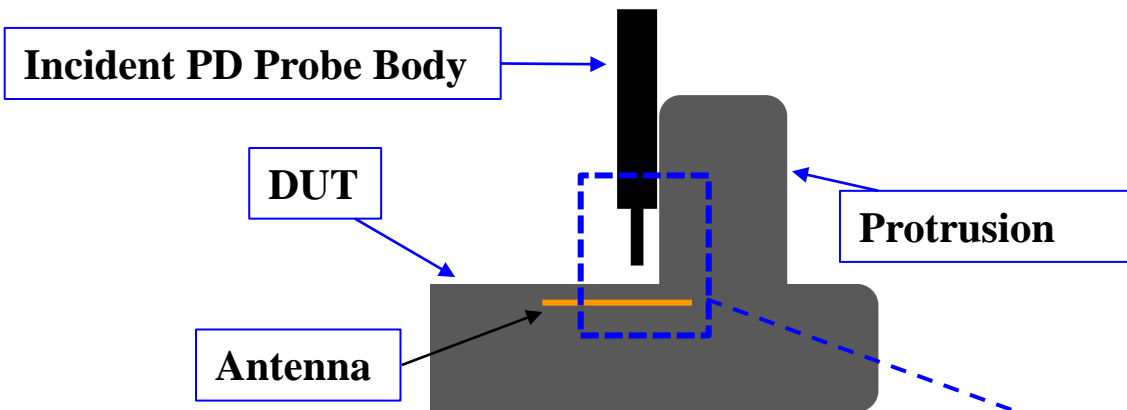
General, Two-Protrusion Case

- **Two-protrusion profile:** it can be shown that any case protrusion profile case can be analyzed via simple geometrical considerations to the profile shown in the figure below.
- Finding the intersection between the scan surface (--- line) and the bottom edge corner may yield:
 - **Two solutions:** defining the range of allowable scan.
 - **One solution:** the scan can only reach one point (case shown \rightarrow)
 - **No solutions** (imaginary values), when the scan surface cannot be reached





Power Density Testing for Complex Shapes (I)



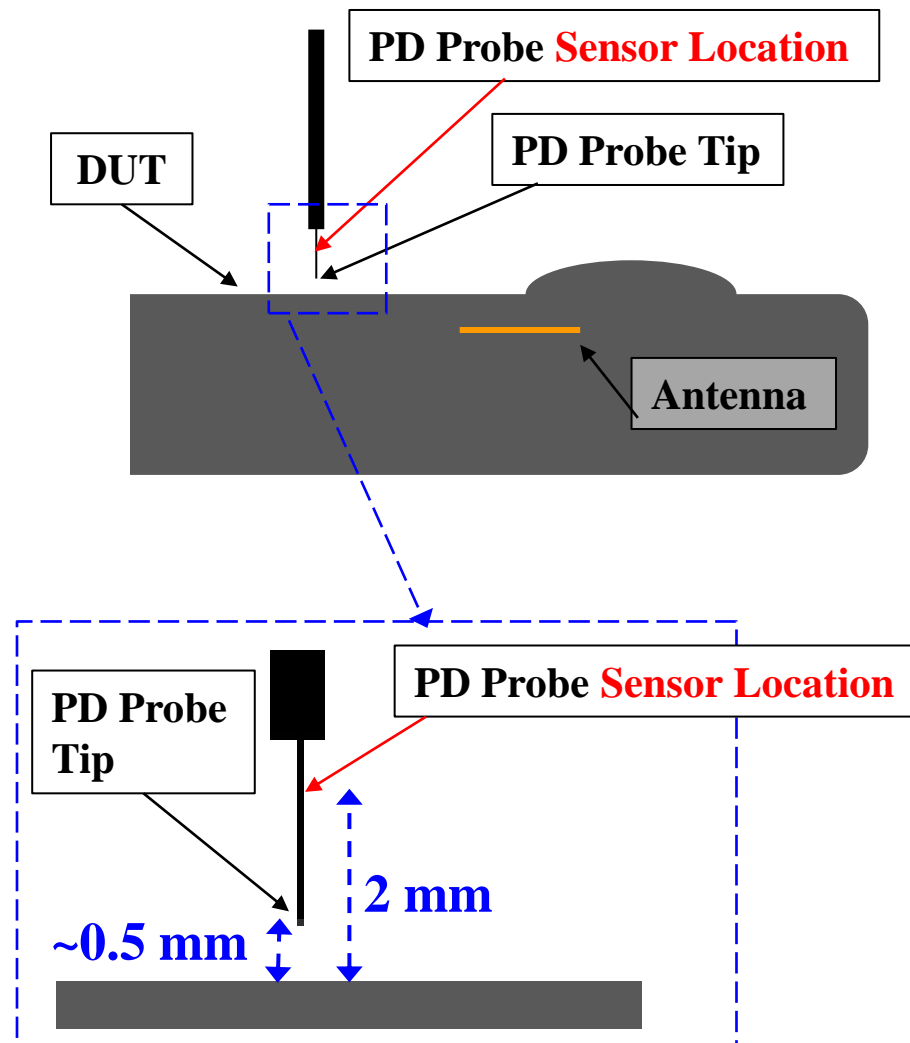
- Considering a scanning **worst-case scenario**, where the IPD probe cannot reach the corner.
- Positioning the probe at the minimum “safe” distance $d_?$, both horizontally and vertically from the beginning of the protrusion.
- Positioning may have to include the probe body.



IPD for Complex Shapes (II)

IPD Scan on Flat-Profile Surfaces

- Guidance from [TCB Workshop Nov. 2017](#) for Incident Power Density (IPD) measurements:
 - Perform the IPD scan along DUT flat areas outside any visible protrusion or low-rise surfaces
 - Position the probe so that the internal **sensor is at 2 mm** from the surface.
 - The probe tip may be **lower** (very near to the surface)
- Note: in general, testing of **all six sides** of a DUT is required (as for SAR). Exceptions (e.g., know directive antenna pattern) must be documented.





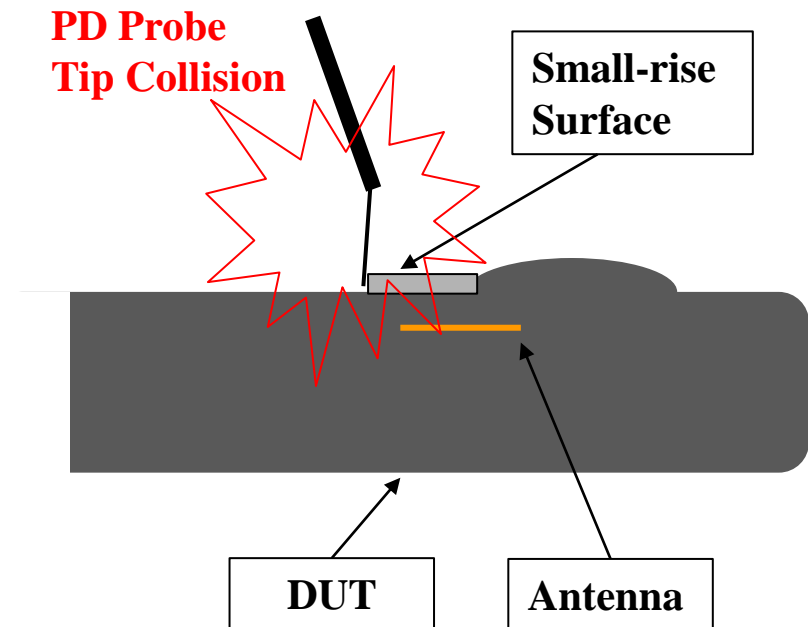
IPD Evaluation for Complex Shapes (III)

Concerns

- Near-surface scanning in the presence of protrusions may lead to **collision and damages**, even for very small-rise profile variations.

New Guidance (Extending from 2017 Workshop)

- Probe tip position acceptable as low as 0.5 mm on the flat-profile scan
- Other positioning is allowed if supported by **numerical simulations** (PAG NUMSIM applies)
- **5 mm clearance** allowed near protrusion (next slide)

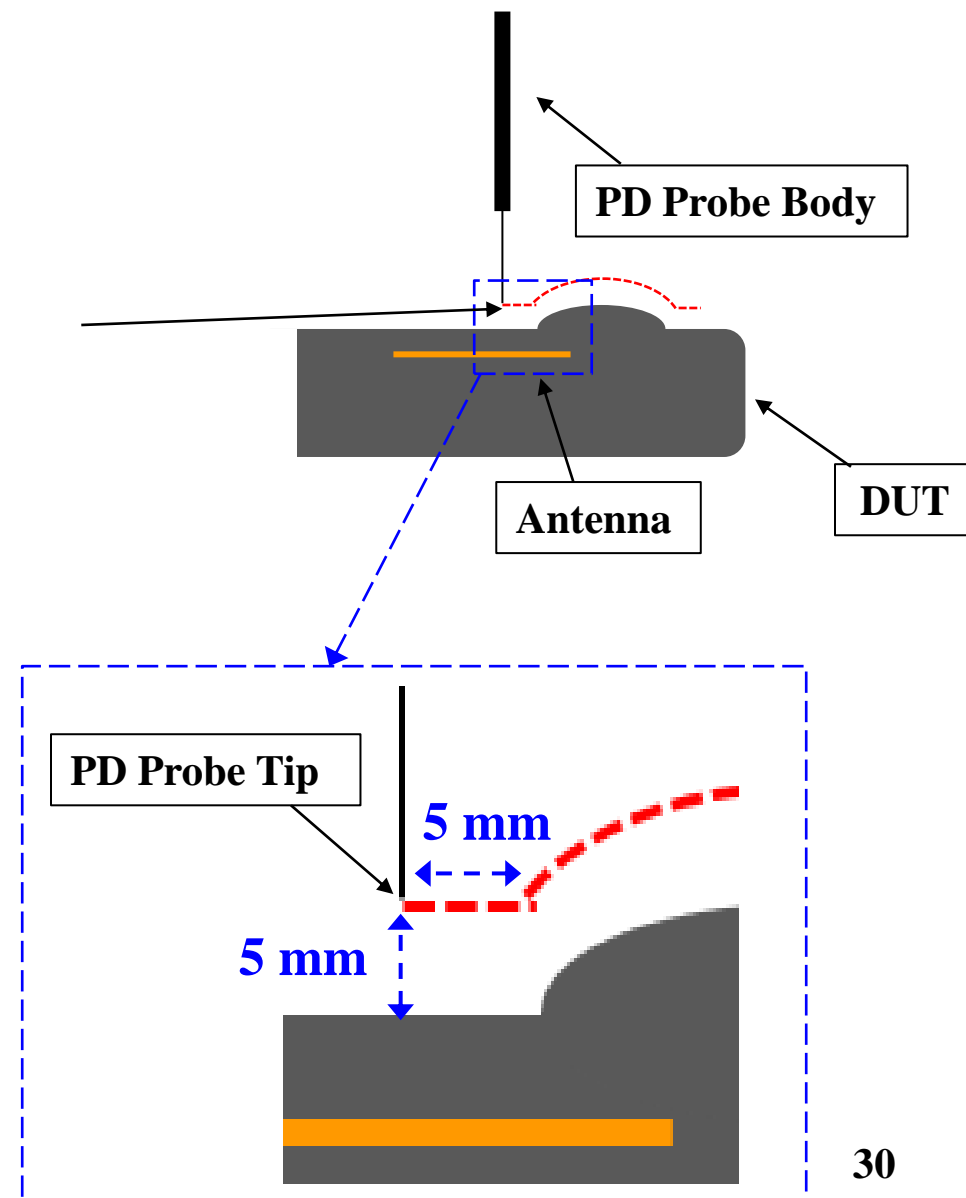




IPD for Complex Shapes (IV)

(...Continued) New Guidance

- Clearance near protrusion areas provided via “probe-safe” distance.
- Implementation: identify the boundary area where the protrusion begins with an added 5 mm margin.
 - Scan PD following the protrusion boundary area with the 5 mm extra spacing (closer measurements allowed but not required) to collect the IPD data for establishing compliance.





Section 5

Conclusions

- New material is in preparation to be included in forthcoming RF exposure publications.
- Investigations on additional topics in progress to be presented at the next workshop.