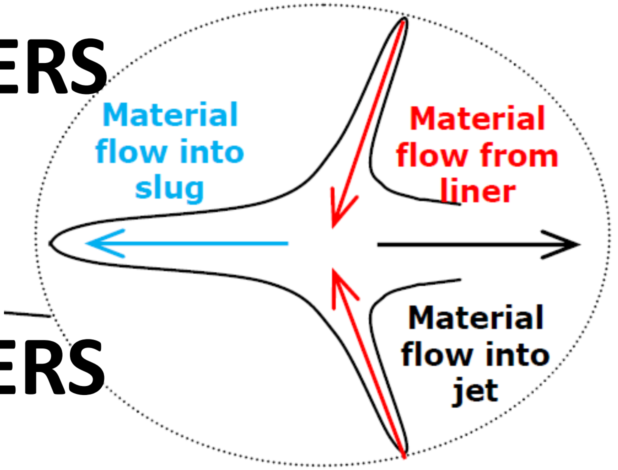
STINGER

SOFTWARE FOR

CALCULATION OF SHAPED CHARGE WARHEAD JET PARAMETERS

AND

PENETRATION PARAMETERS



Method

Combined method:

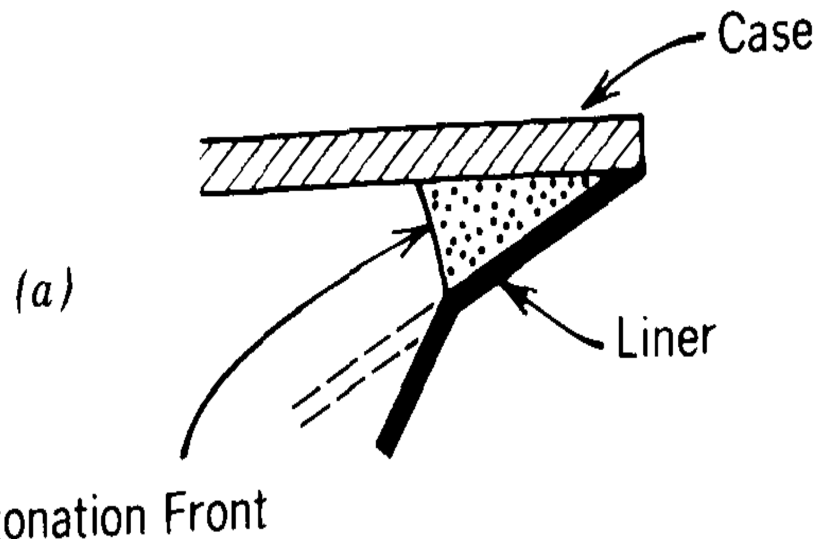
- **Analytical based on :**
  - **PER (Pugh, Eichelberger, and Rostoker) jet formation theory**
  - **Modified version of the M. Defouneaux metal acceleration model for final plate velocity,**
  - **The shaped-charge penetration theory of DSM (DiPersio, Simon and Merendino) for penetration-standoff curves.**
  - **The piece wise penetration of Defourneaux for hole profiles,**
- **Semi-empirical techniques based on published collected data**

Method – Cont.

Formation of jet:

Warhead is divided in axial direction into zones (zonal elements) of constant thickness.

Upon the action of detonation wave liner element is accelerated toward the liner axis with collapsing velocity, where, after interaction with opposite element, form axial jet toward the base of the liner and slug toward the apex of the liner.



Uncertainty: Depends on configuration, up to 10 %

Capability

Accurate prediction of:

- jet and Jet-tip velocity and mass
- slug velocity and mass,
- collapse velocity,
- lead pellet formation.

Calculation of penetration parameters in homogeneous steel:

- hole radius,
- penetration depth,
- variation of total penetration depth with standoff distance

The program is fast, robust and reliable. Compression to experiments as well as to more sophisticated hydrodynamic computer codes show good agreement.

Purpose

Detail calculation of all parameters of shape charge jet and penetration process.

Analysis of the influence of various design parameters on the jet penetrability:

- **Charge characteristics**
- **Liner thickness**
- **Liner cone angle,**
- **Initiation point,**
- **Standoff distance,**
- **Confinement characteristics,**
- **Target characteristics**

Ranges of Basic Input Quantities

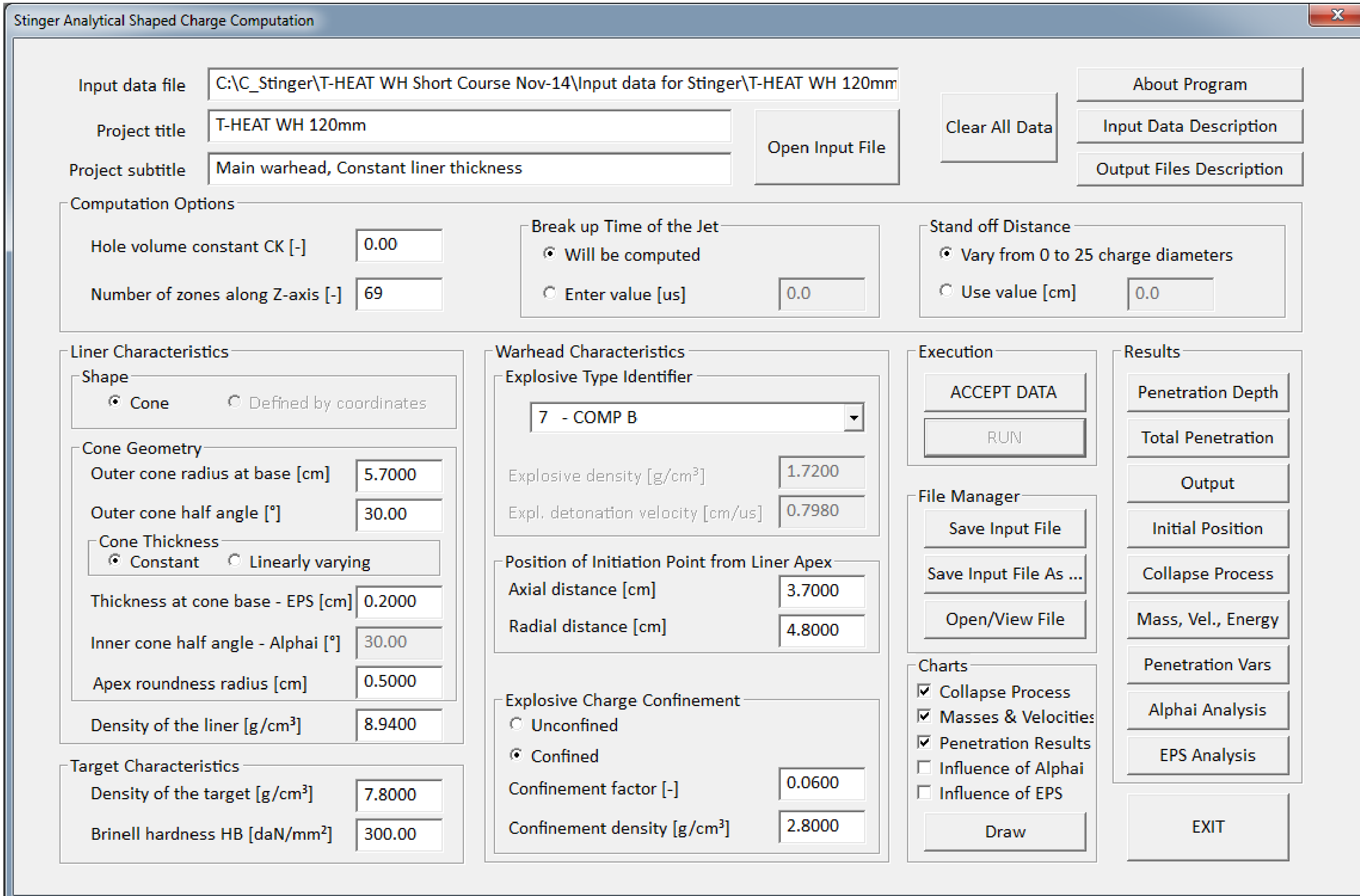
- **Caliber: 20÷200mm**
- **Charge shape: cylinder, cylinder – cone.**
- **Charge confinement: In cylindrical case**
- **Charge material: 24 predefined, plus user define possibility.**
- **Liner shape: cone and rounded apex cone with linearly varying thickness.**
- **Liner material: defined by density.**
- **Initiation point: defined by coordinates.**
- **Target material: Metal defined by density and Brinell hardness**
- **Brake up time: Automatically determined or specified.**

Limitations

The current version of the Program requires several empirically determined constants. Some values of these constants were determined upon the fitting the results of various experiments, and they are stored in the Program. But, it is recommended that for each real case user determine these constant from the experiment.

The current version of the Program does not support definition of the liner by coordinates. This option is under construction.

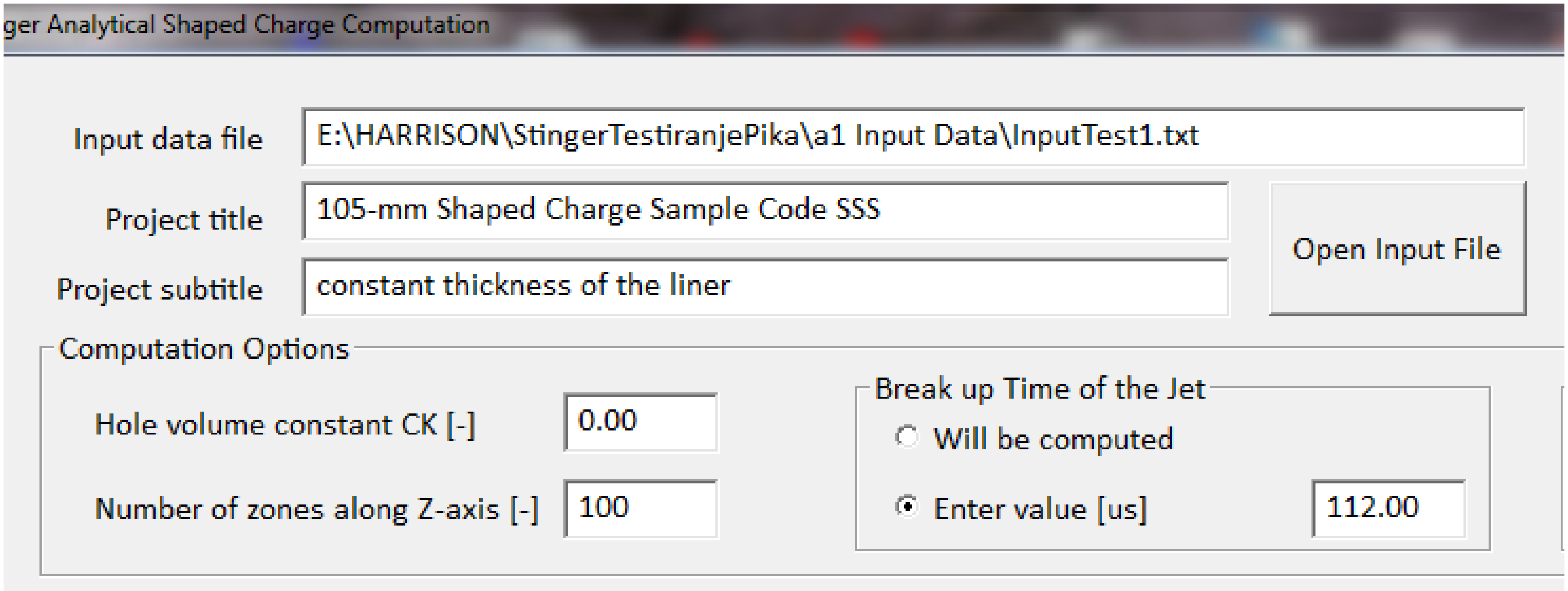
Main Menu


Stinger Analytical Shaped Charge Computation
Input data file
C:\C_Stinger\T-HEAT WH Short Course Nov-14\Input data for Stinger\T-HEAT WH 120mm
Project title
T-HEAT WH 120mm
Project subtitle
Main warhead, Constant liner thickness
Open Input File
Clear All Data
About Program
Input Data Description
Output Files Description
Computation Options
Hole volume constant CK [-]
0.00
Number of zones along Z-axis [-]
69
Break up Time of the Jet
Will be computed
Enter value [us]
0.0
Stand off Distance
Vary from 0 to 25 charge diameters
Use value [cm]
0.0
Liner Characteristics
Shape
Cone
Defined by coordinates
Cone Geometry
Outer cone radius at base [cm]
5.7000
Outer cone half angle [°]
30.00
Cone Thickness
Constant
Linearly varying
Thickness at cone base - EPS [cm]
0.2000
Inner cone half angle - Alphai [°]
30.00
Apex roundness radius [cm]
0.5000
Density of the liner [g/cm³]
8.9400
Target Characteristics
Density of the target [g/cm³]
7.8000
Brinell hardness HB [daN/mm²]
300.00
Warhead Characteristics
Explosive Type Identifier
7 - COMP B
Explosive density [g/cm³]
1.7200
Expl. detonation velocity [cm/us]
0.7980
Position of Initiation Point from Liner Apex
Axial distance [cm]
3.7000
Radial distance [cm]
4.8000
Explosive Charge Confinement
Unconfined
Confined
Confinement factor [-]
0.0600
Confinement density [g/cm³]
2.8000
Execution
ACCEPT DATA
RUN
File Manager
Save Input File
Save Input File As ...
Open/View File
Charts
Collapse Process
Masses & Velocities
Penetration Results
Influence of Alphai
Influence of EPS
Draw
Results
Penetration Depth
Total Penetration
Output
Initial Position
Collapse Process
Mass, Vel., Energy
Penetration Vars
Alphai Analysis
EPS Analysis
EXIT

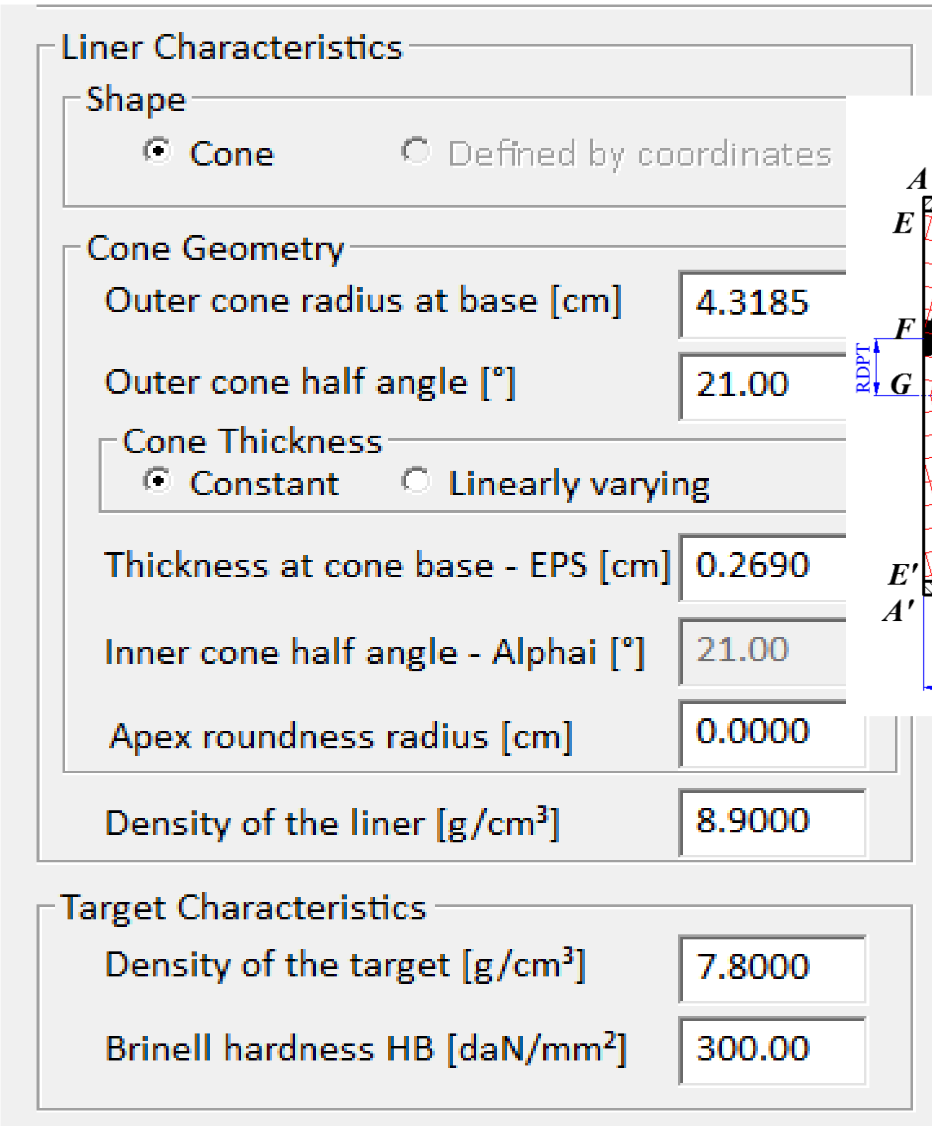
Results

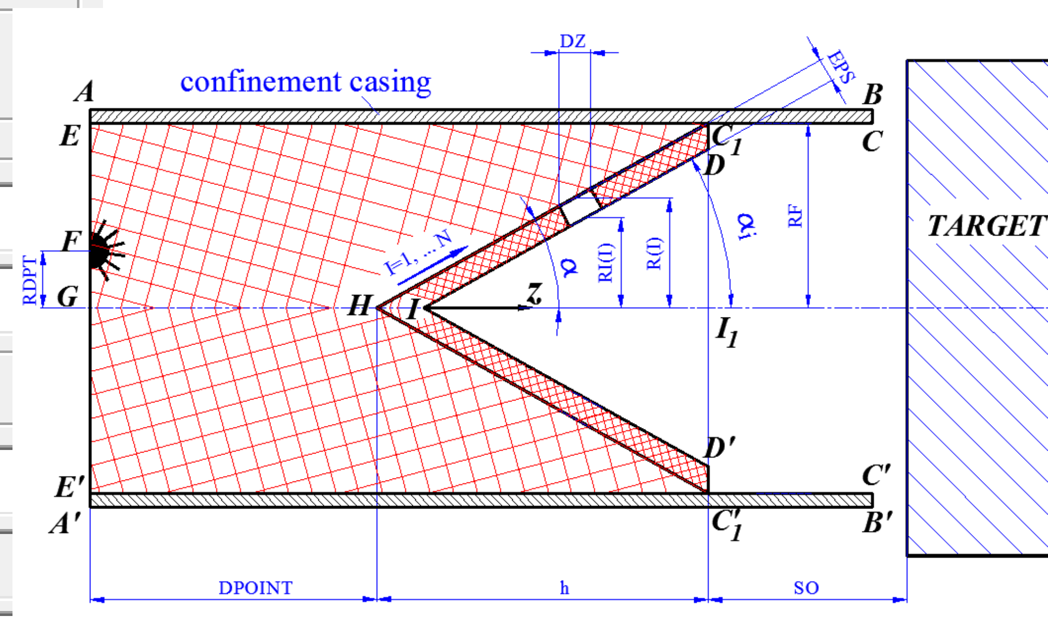
- Sketch (drawing) of projectile
- Files and diagrams with calculated jet parameters
- Files and diagrams with calculated penetration parameters

General Data and Computation Options

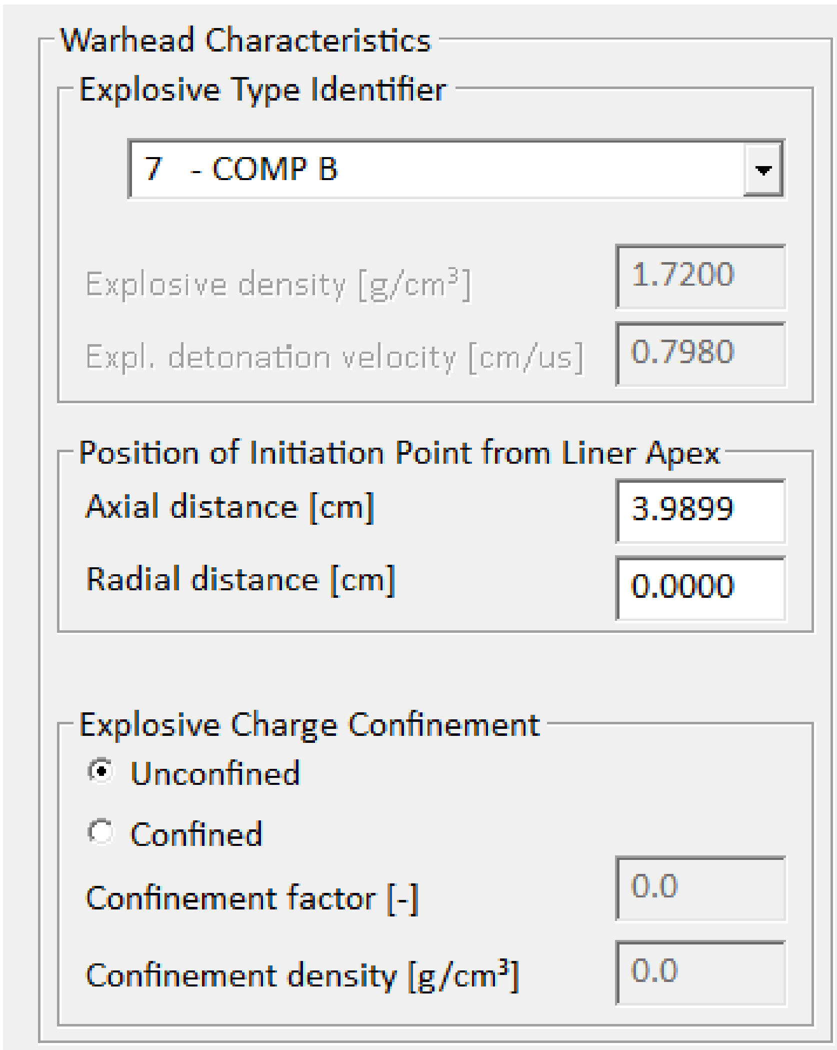


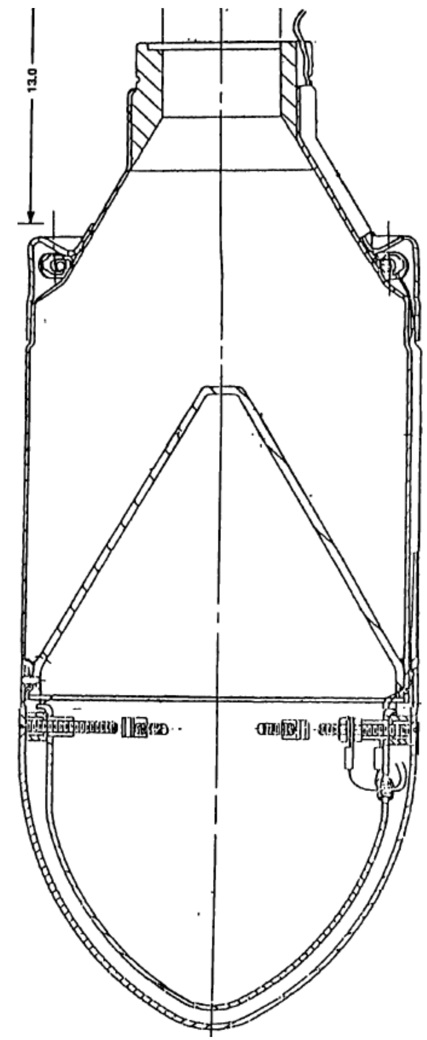
Liner & Target Characteristics



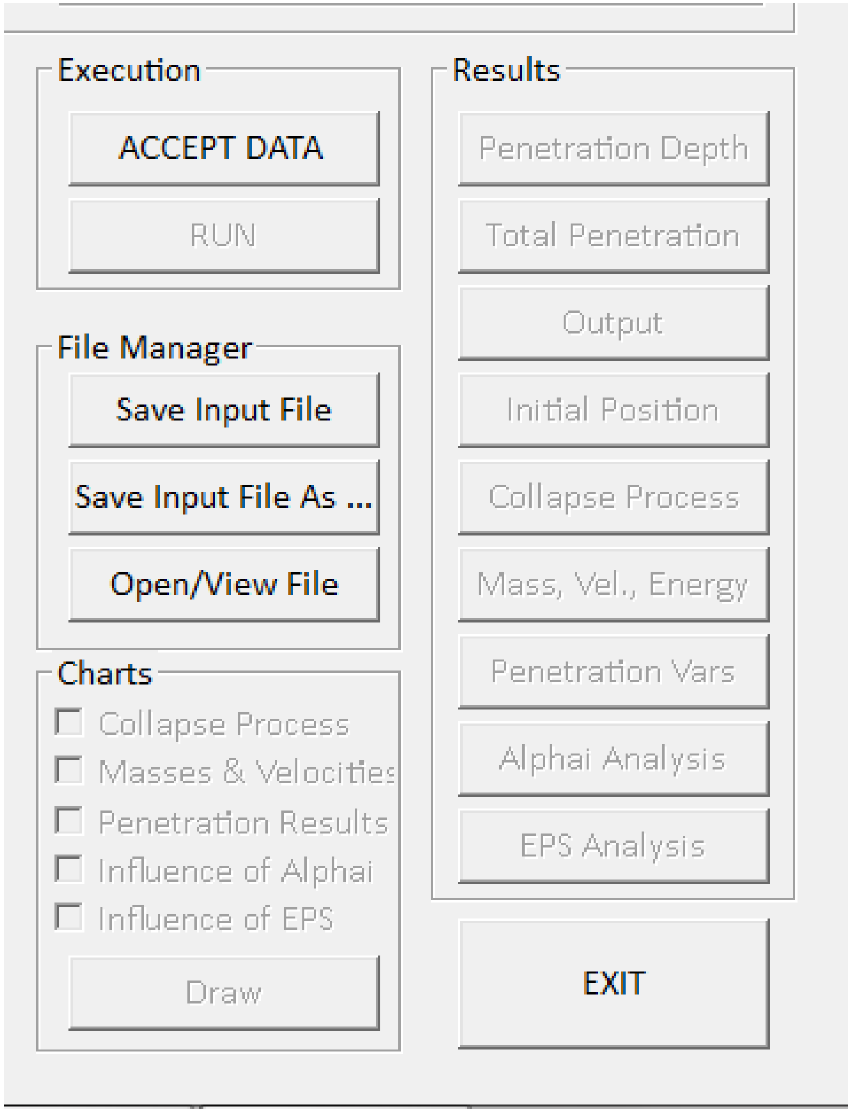


Warhead Characteristics

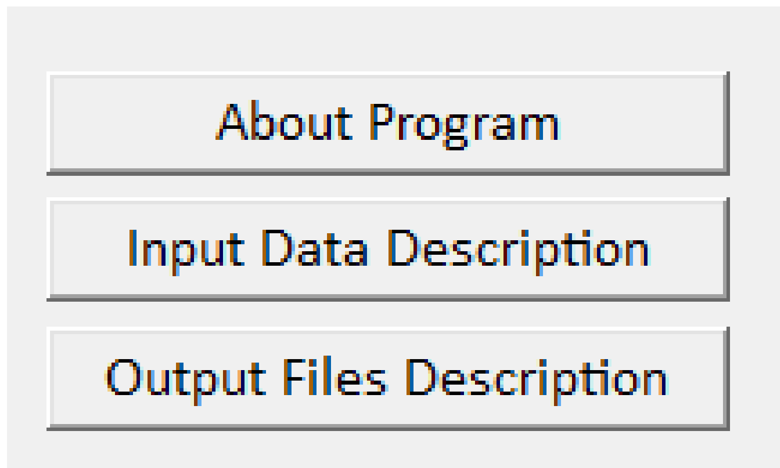




Control Buttons

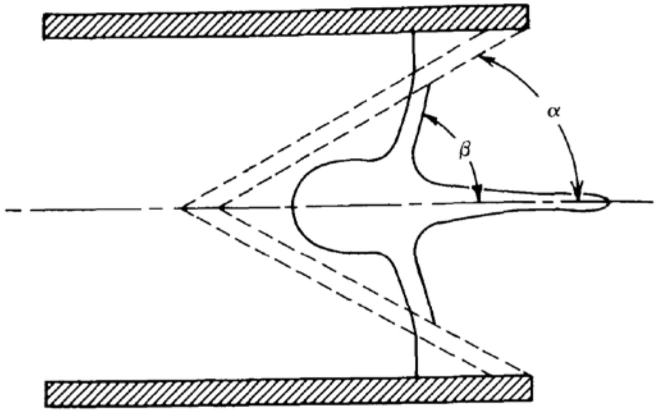


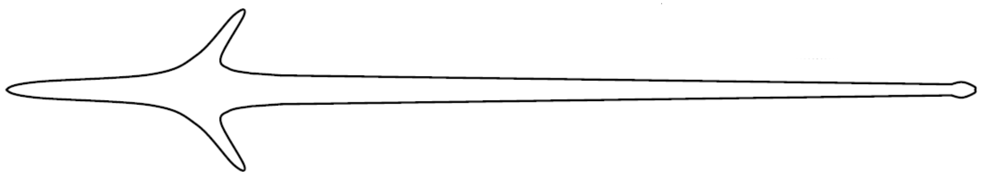
Help Buttons



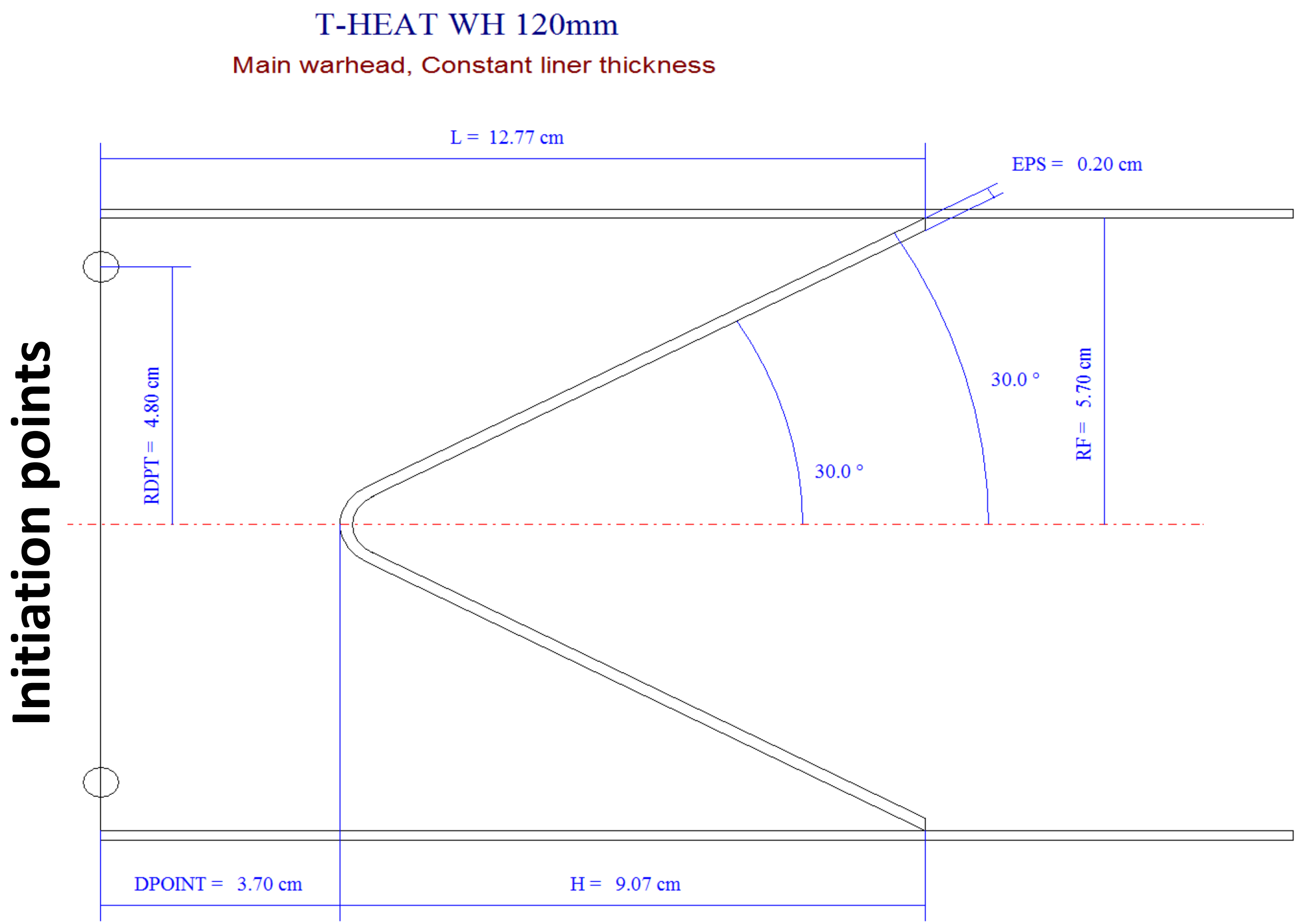
Results

- Sketch (drawing) of projectile
- Files and diagrams with calculated jet parameters
- Files and diagrams with calculated penetration parameters

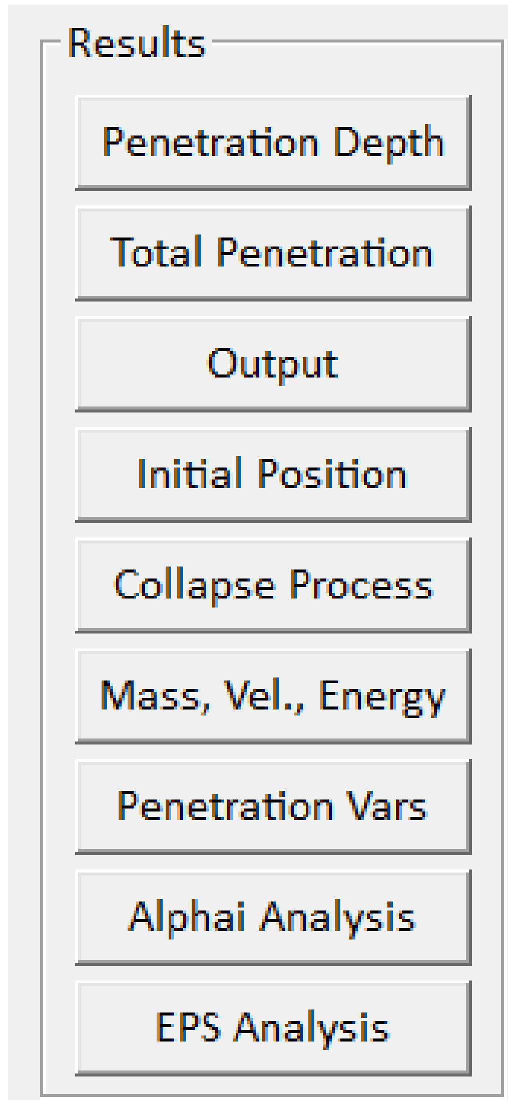




Sketch of the Warhead



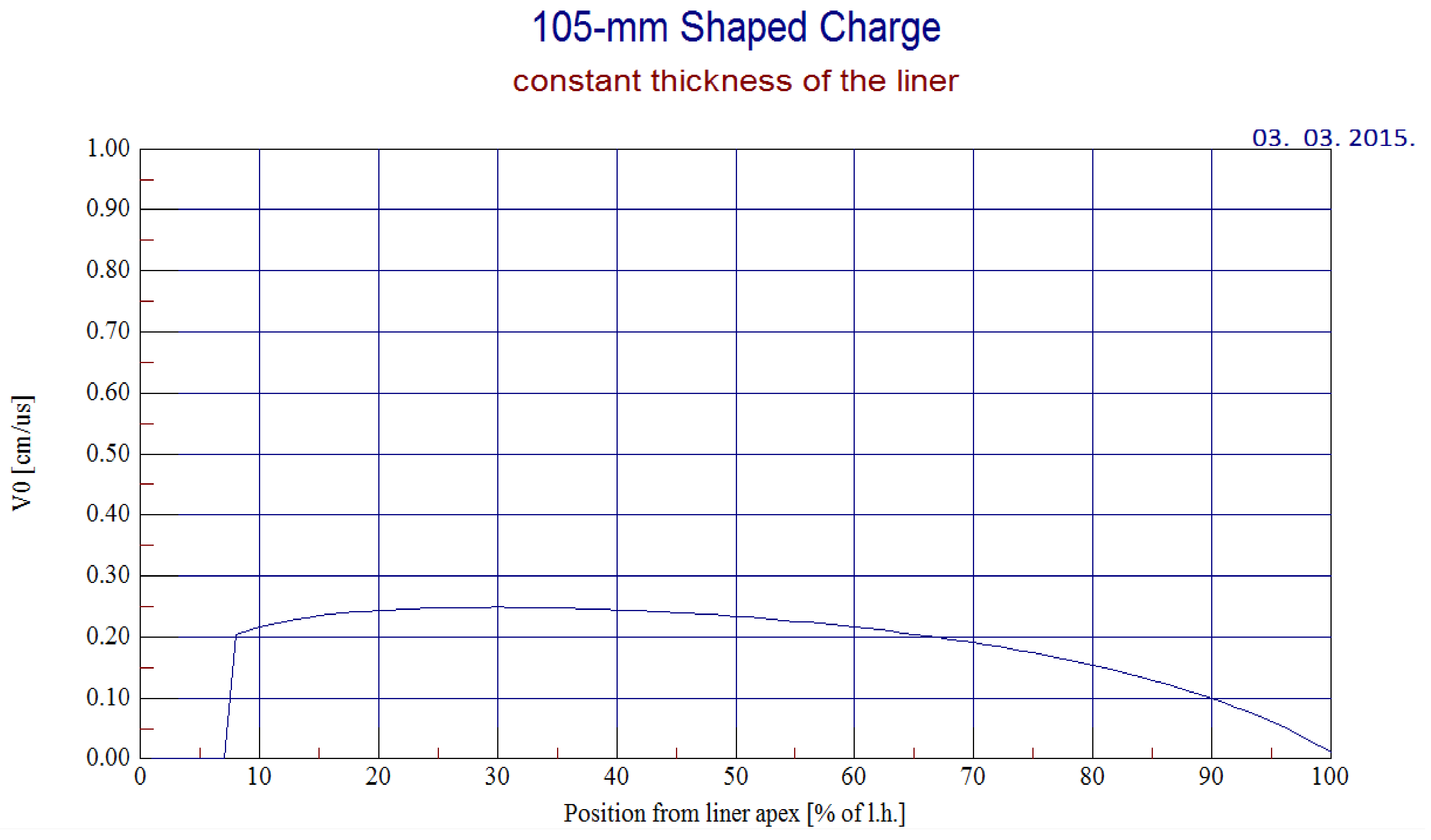
Output Files



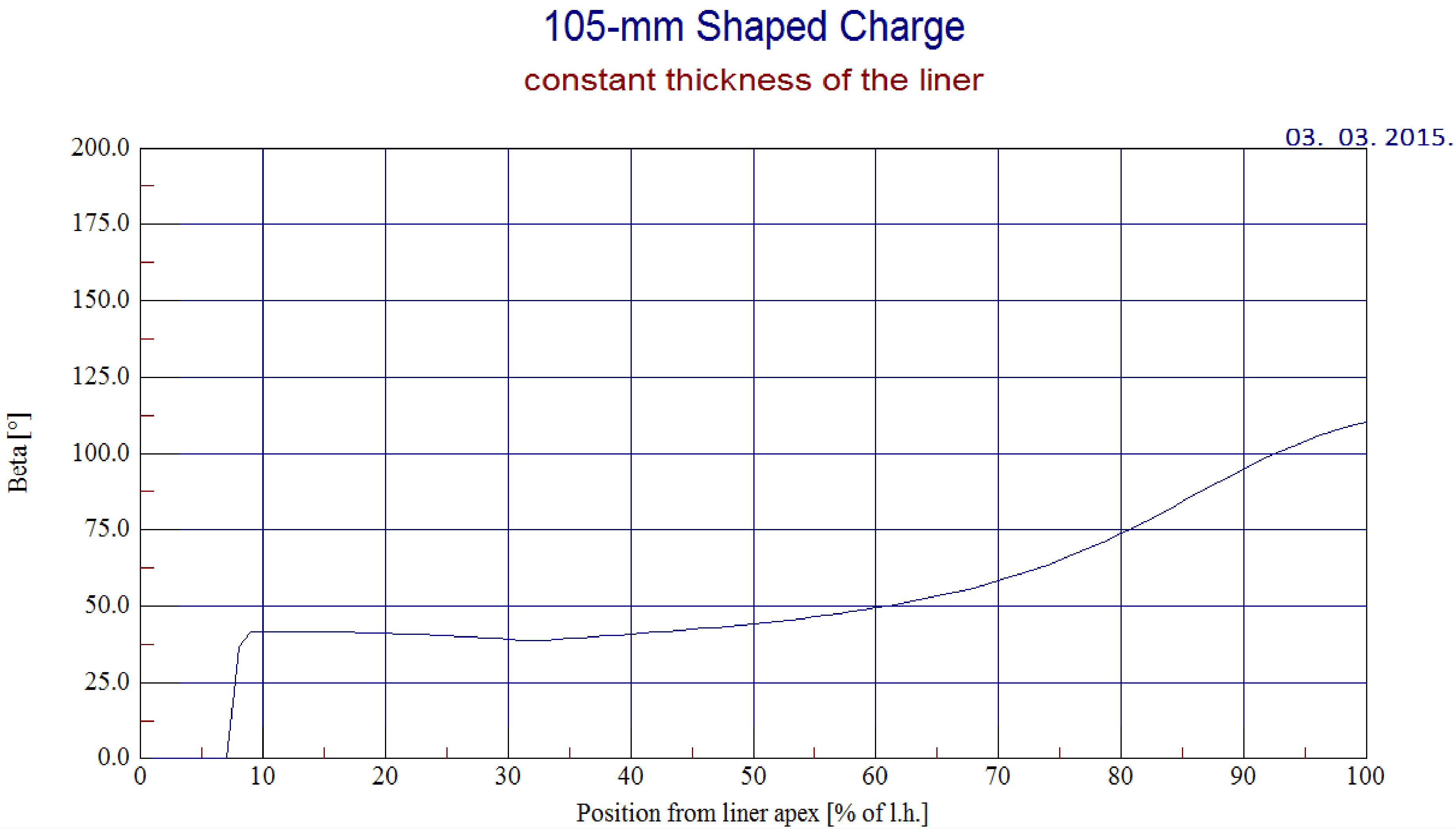
Output Files – Cont.

FILE NAME	DESCRIPTION
Output.txt	Input data and various calculated quantities.
InitialPosition.txt	Charge and liner characteristics vs. axial position of the cone zonal elements.
CollapsePrVar.txt	Data which describes collapse process of the liner
MassesVelEn.txt	Data about masses and velocities of the liner, jet and slug.
PenetrationPhVar.txt	Various parameters which describe penetration process of the jet through target.
PenetrationDepth.txt	Data of depth of penetration and the radius of the hole inside target corresponding with the number of zones towards liner axis.
TotalPenetration.txt	Values of total penetration into target in function of standoff distance between liner base and target.
AlphaiAnalysis.txt	Penetration parameters for different inner liner cone half angle.
EPSAnalysis.txt	Penetration parameters for different liner thickness at cone base.

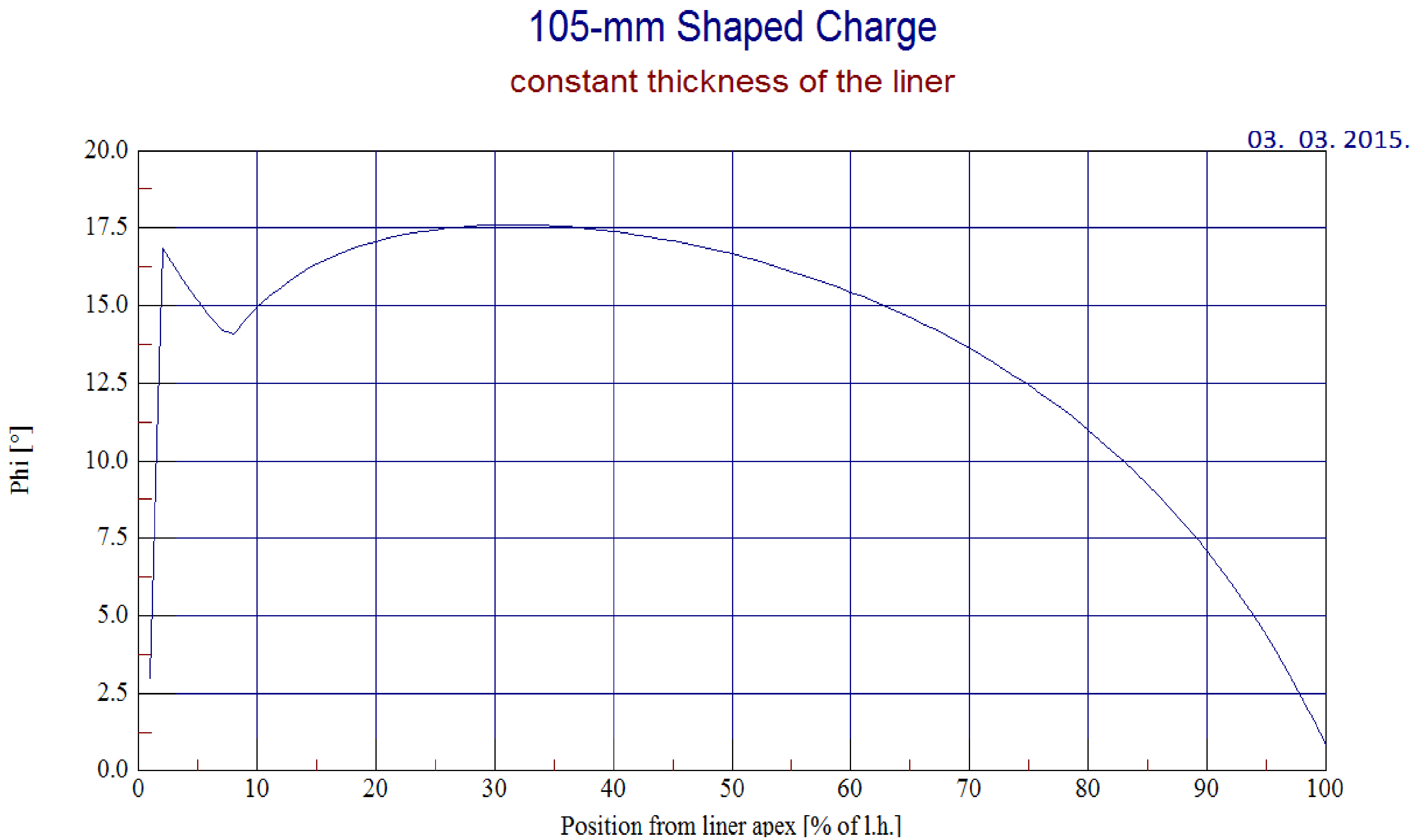
Collapse Velocity



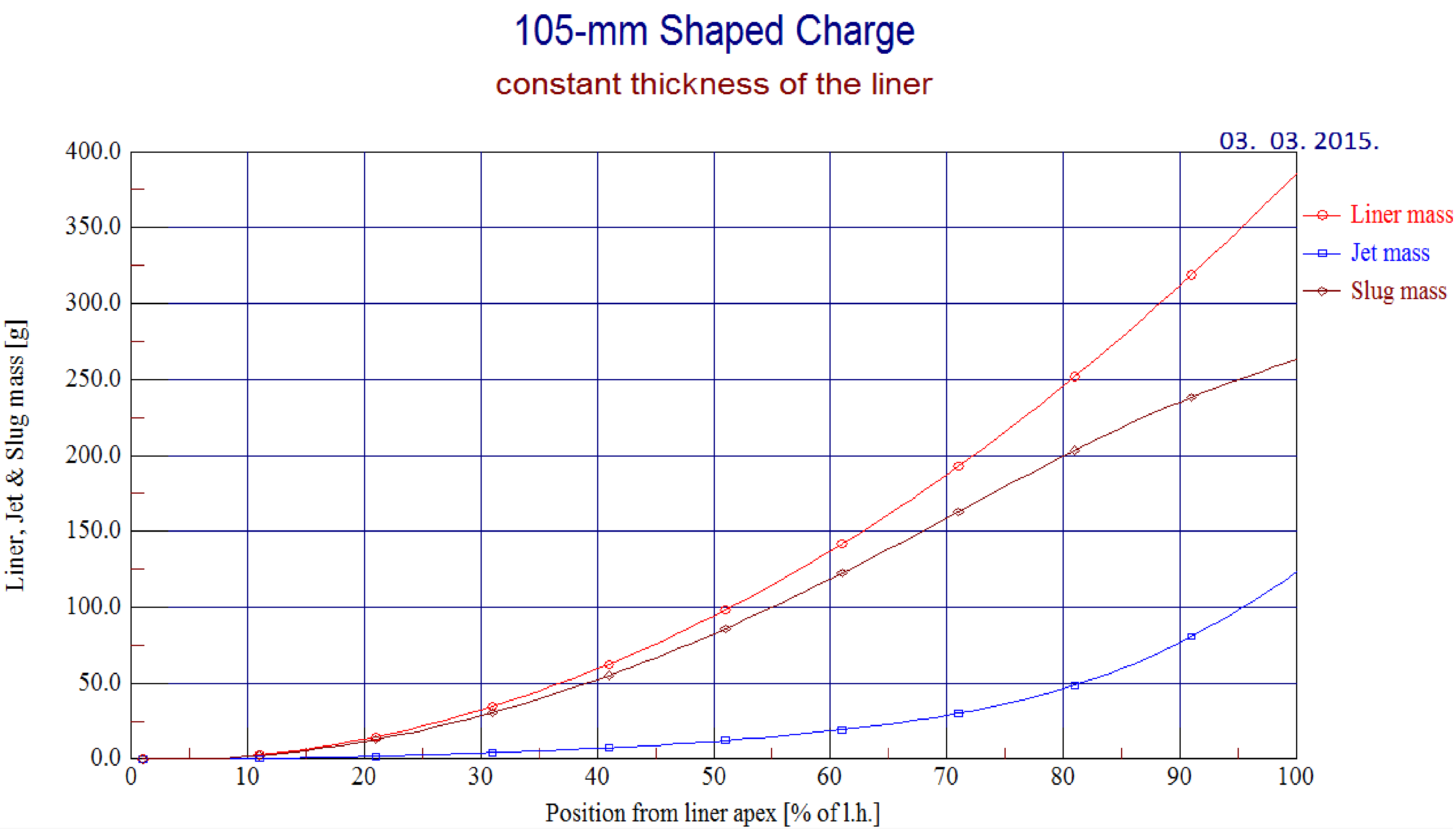
Collapse Angle



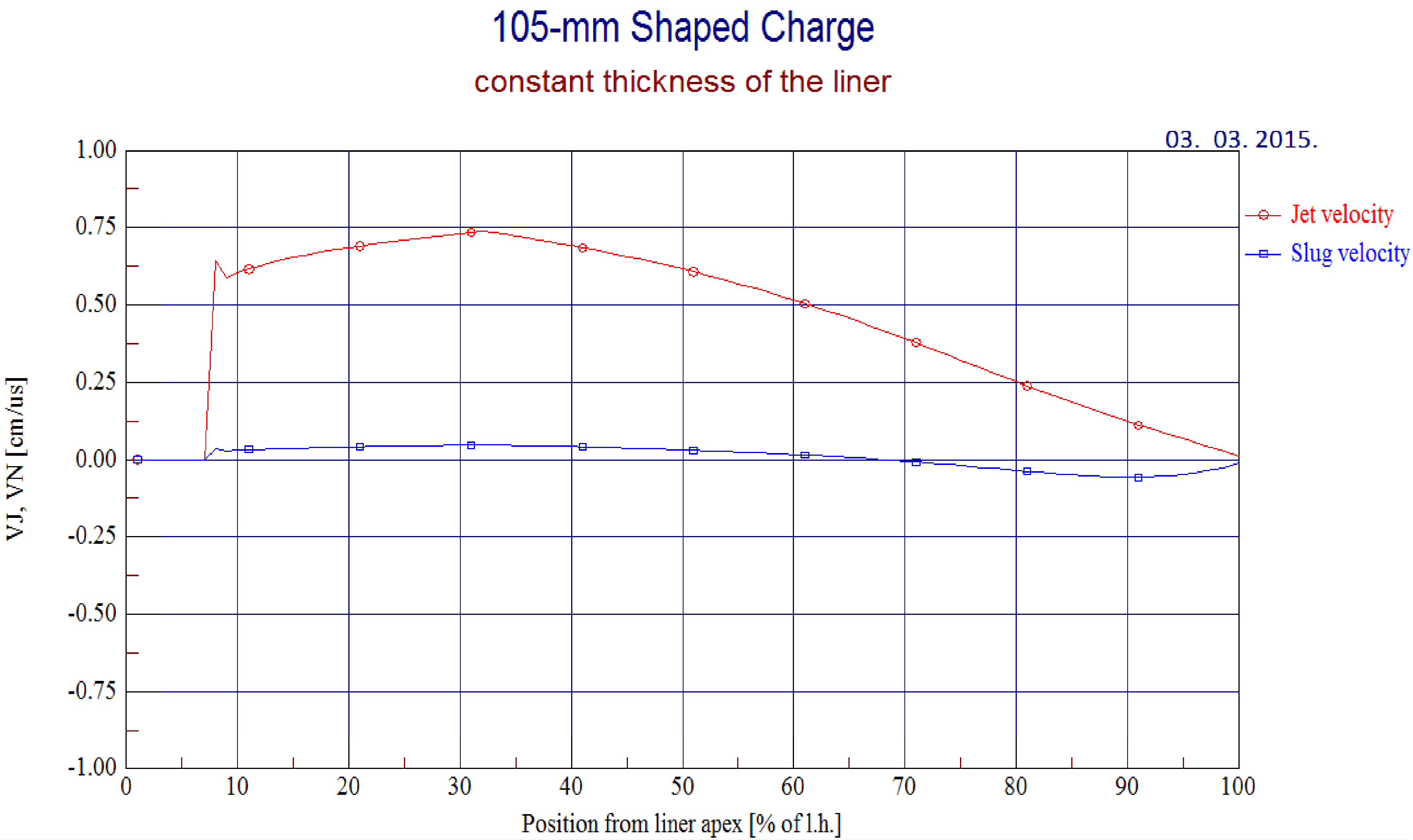
Bending Angle



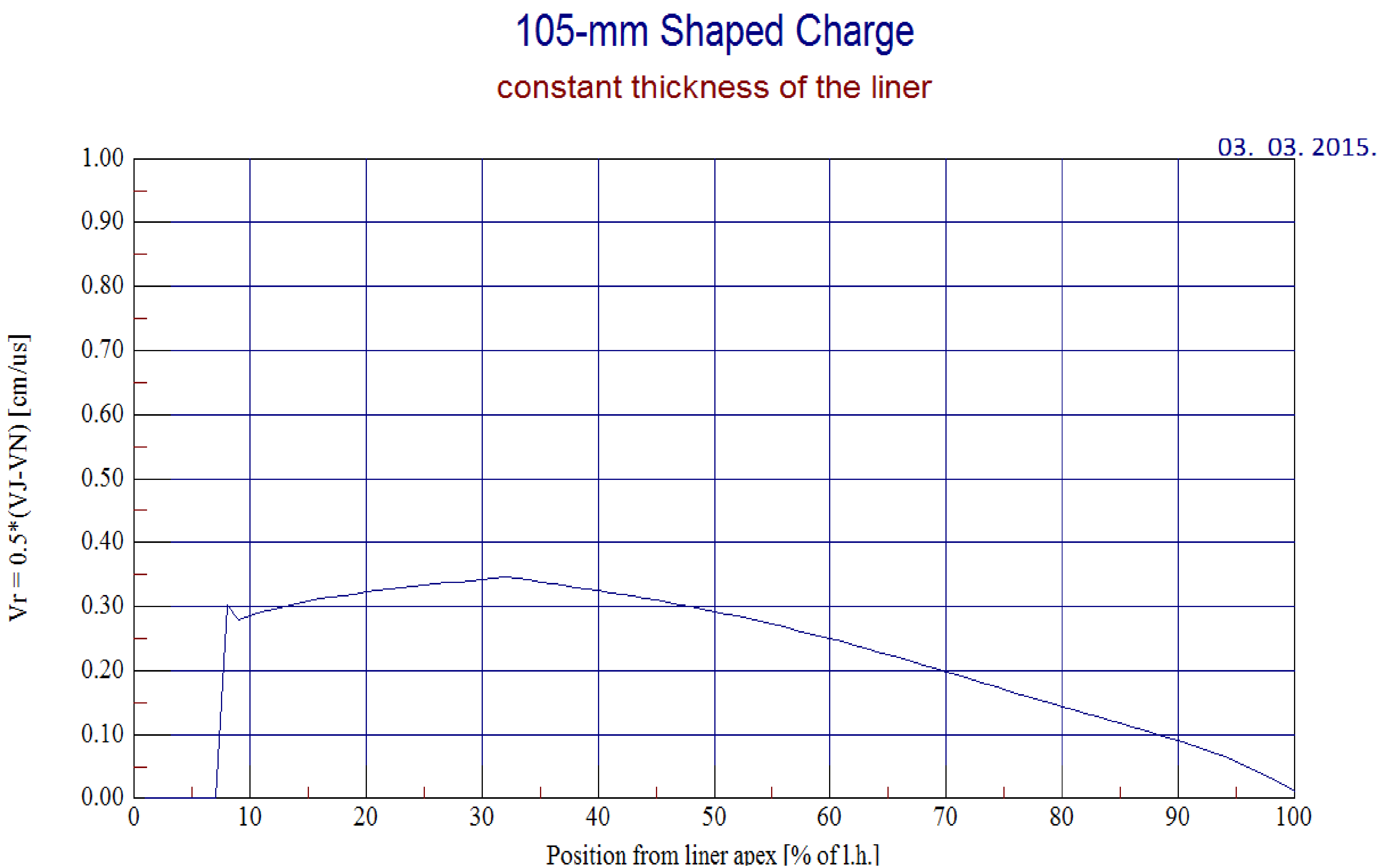
Liner, Jet & Slug Mass



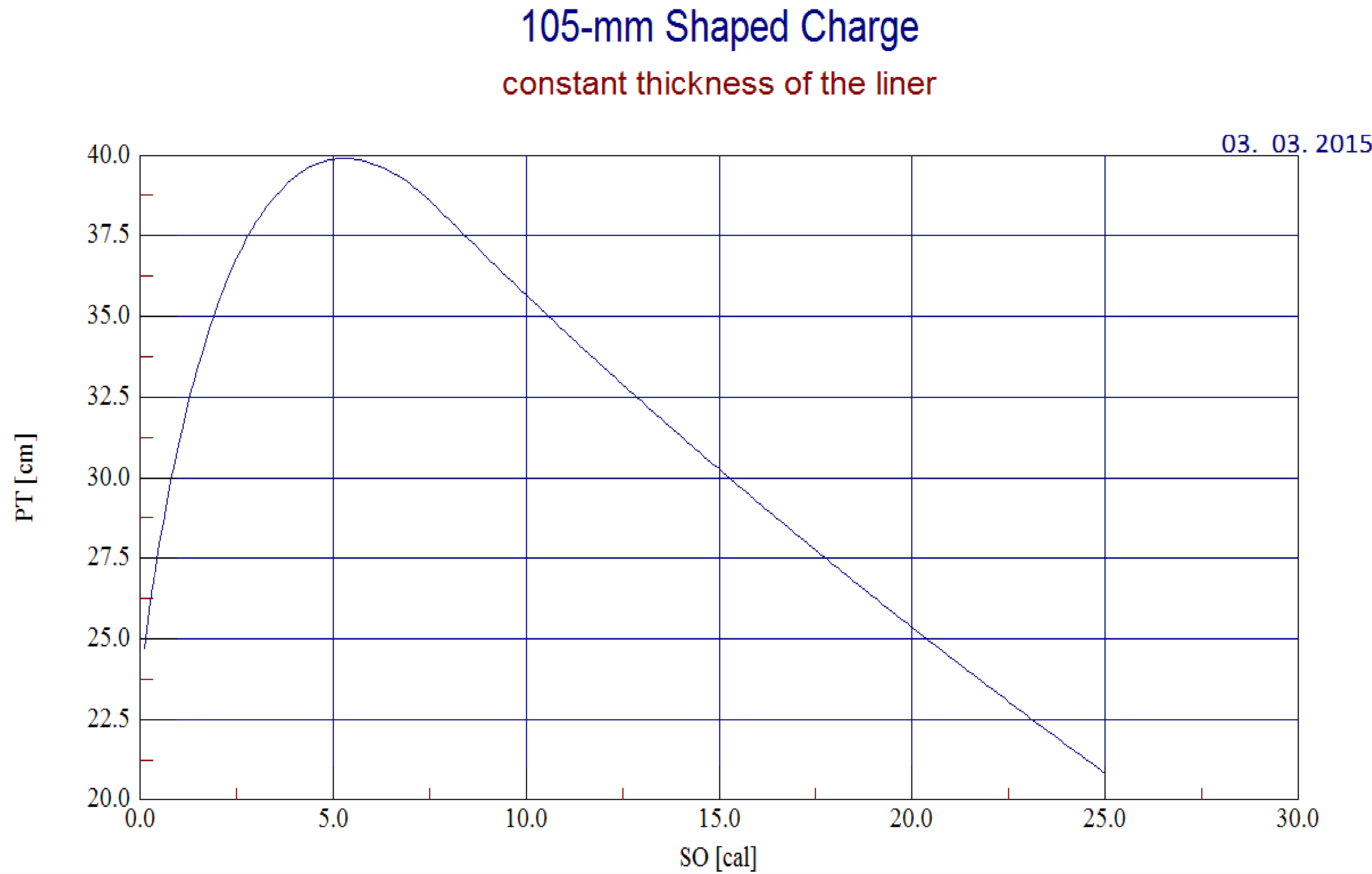
Jet and Slug Velocity



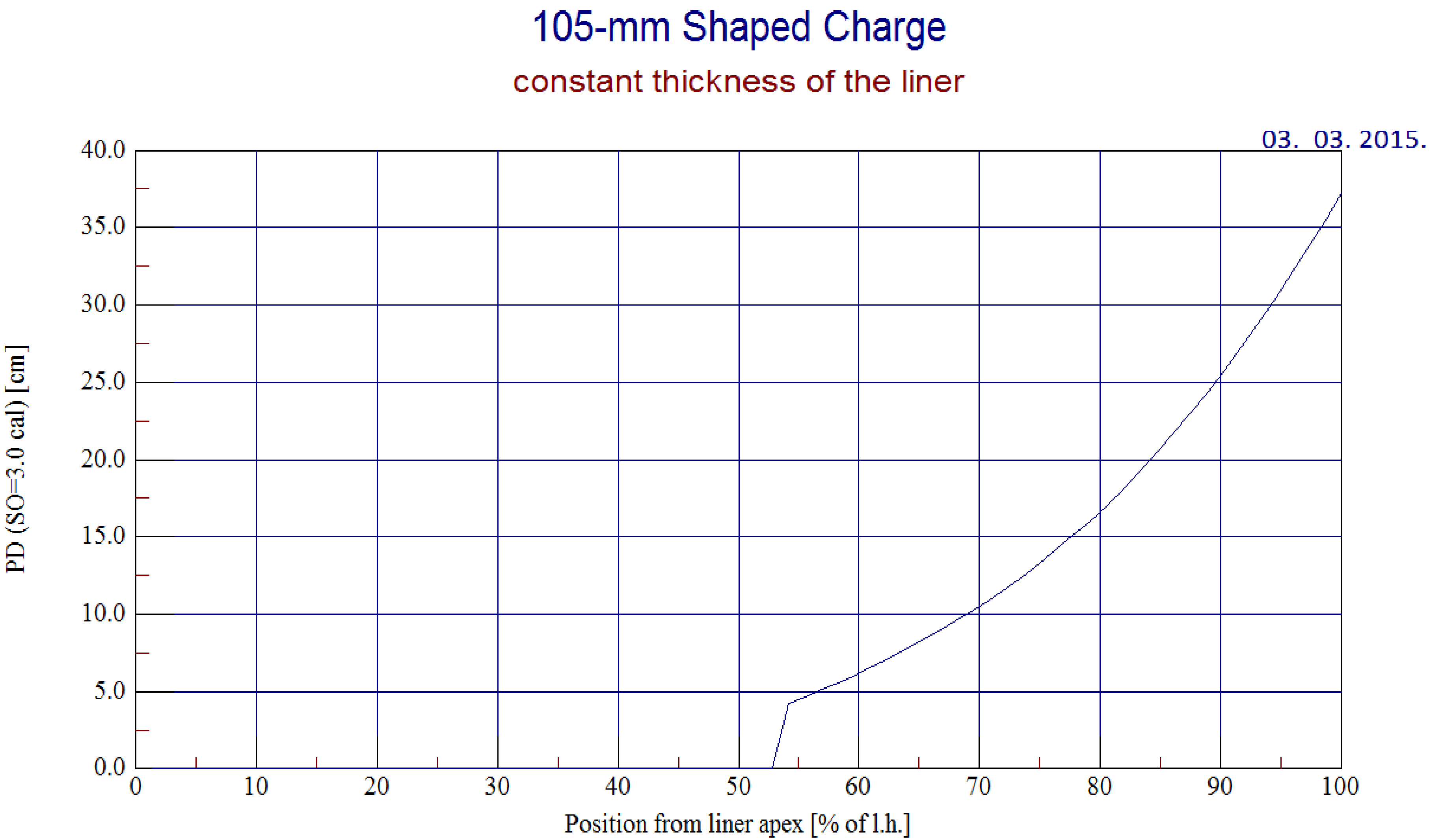
Relative Velocity



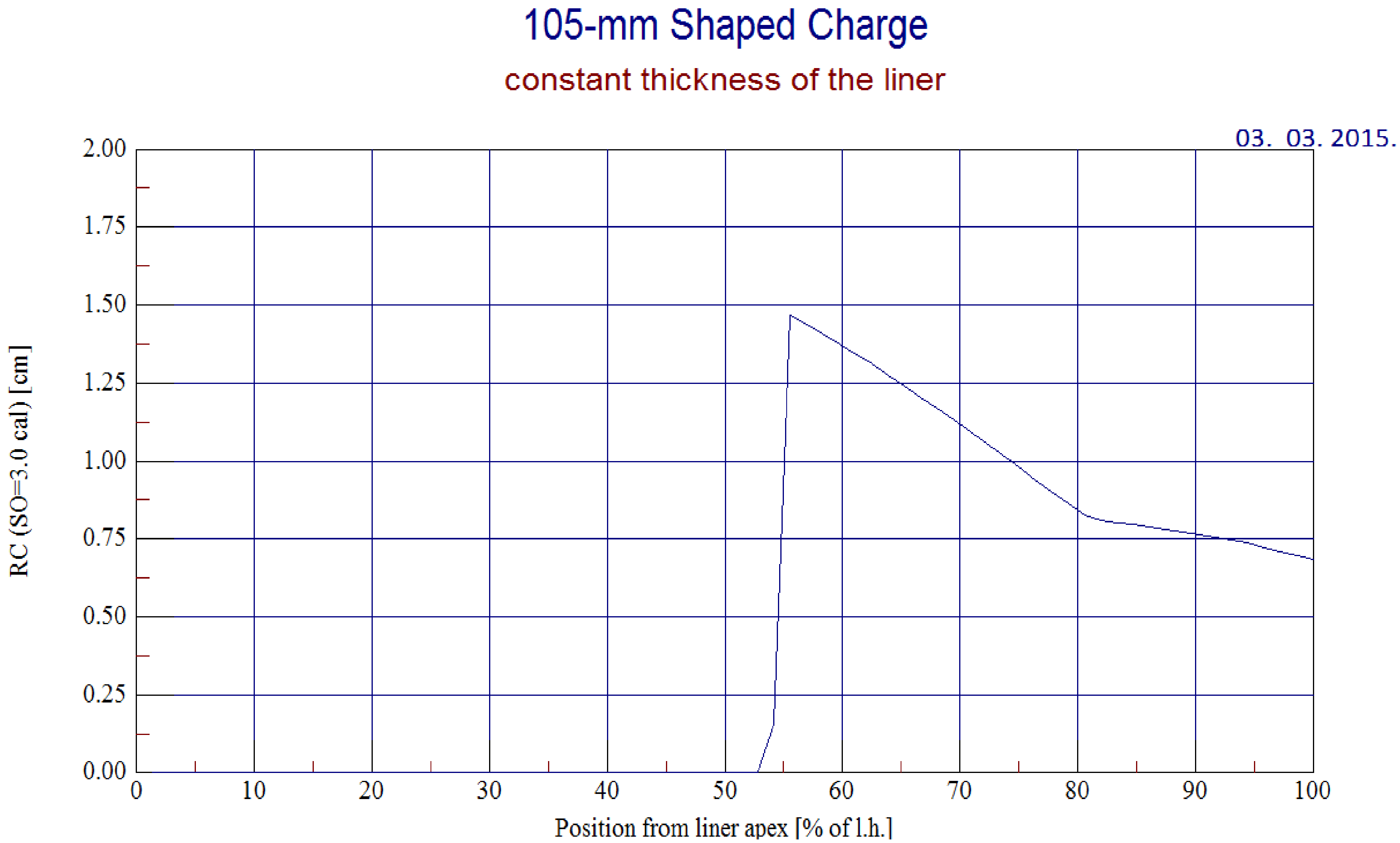
Total Penetration



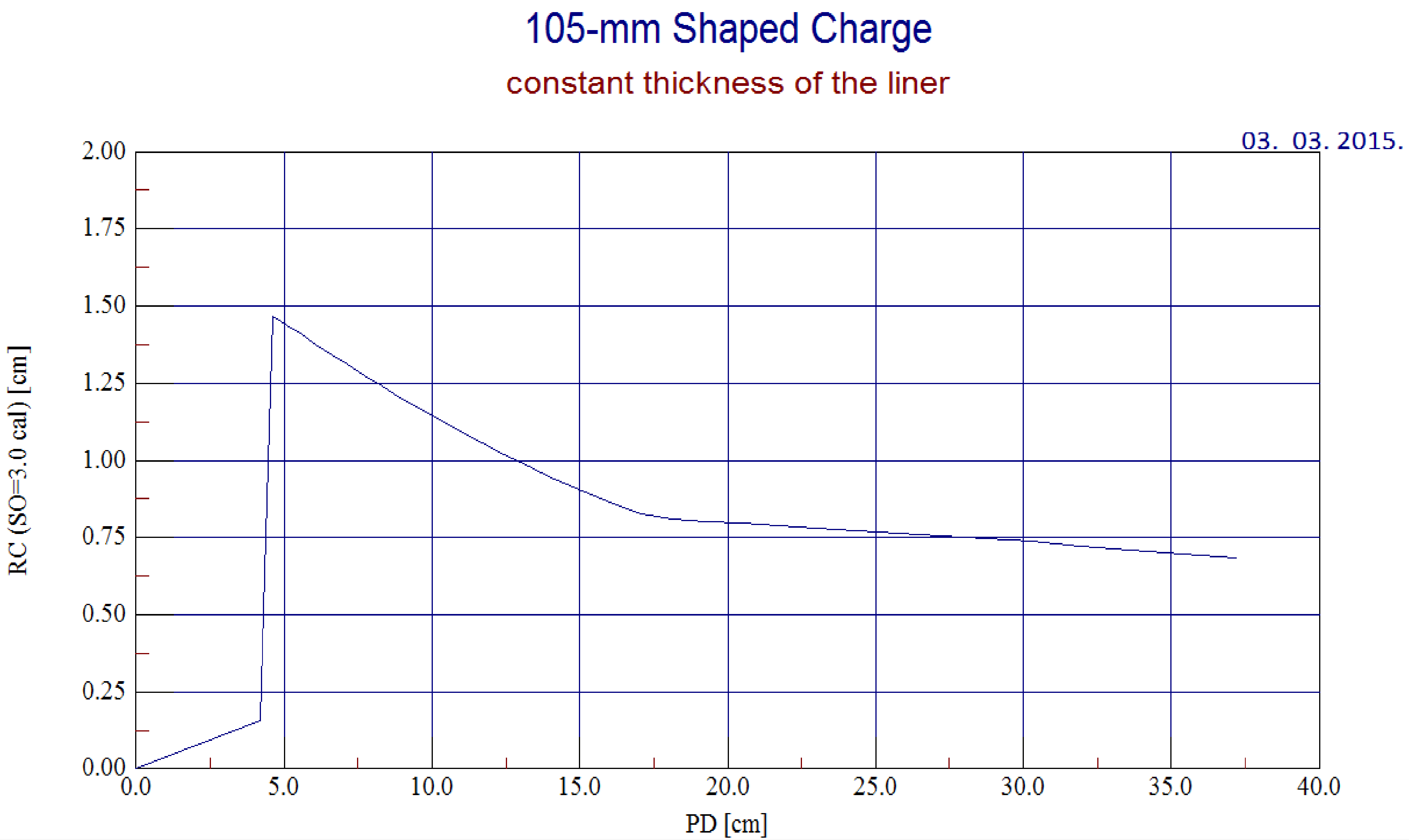
Penetration Depth



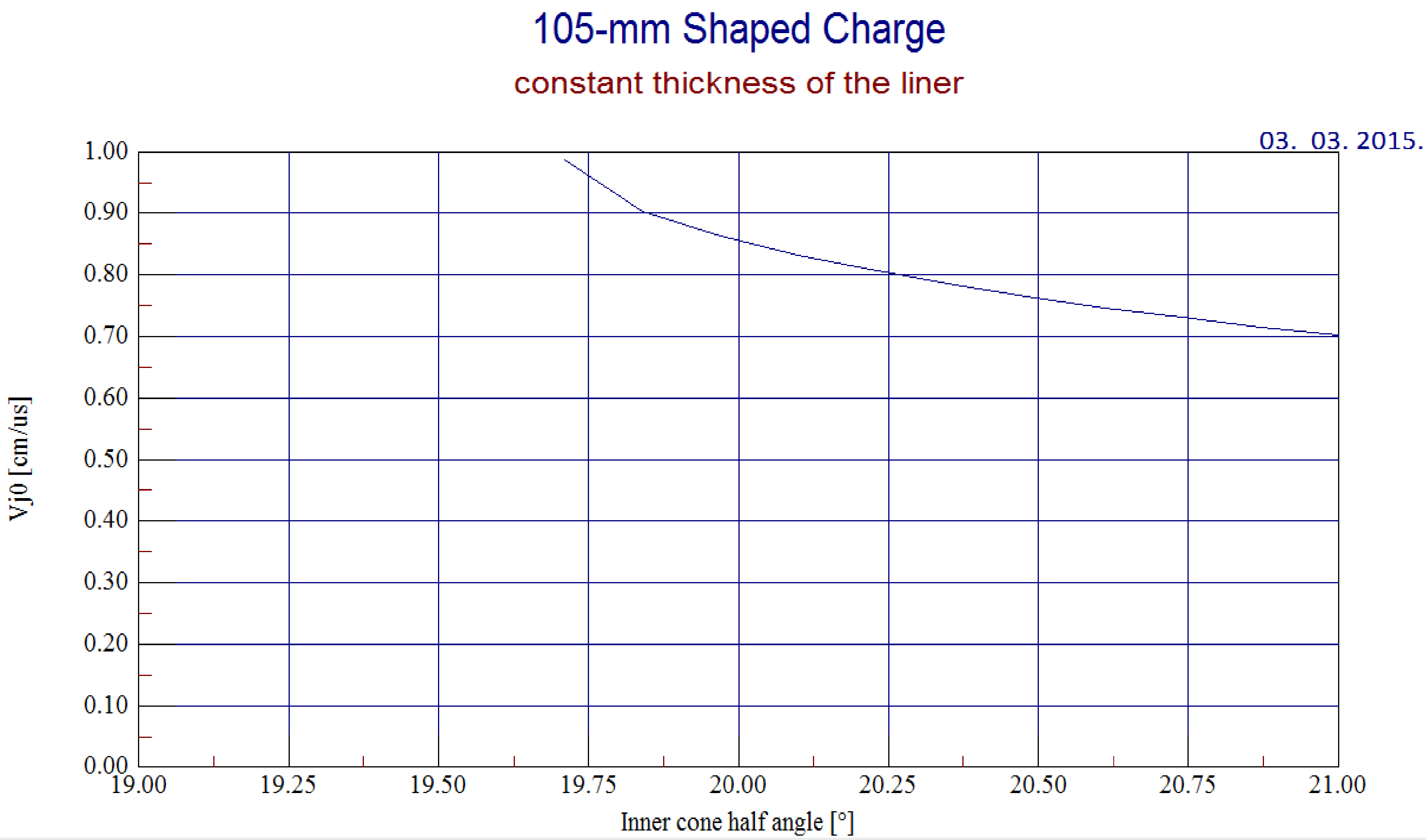
Hole Radius


105-mm Shaped Charge
constant thickness of the liner
03. 03. 2015.
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0
10
20
30
40
50
60
70
80
90
100
RC (SO=3.0 cal) [cm]
Position from liner apex [% of l.h.]

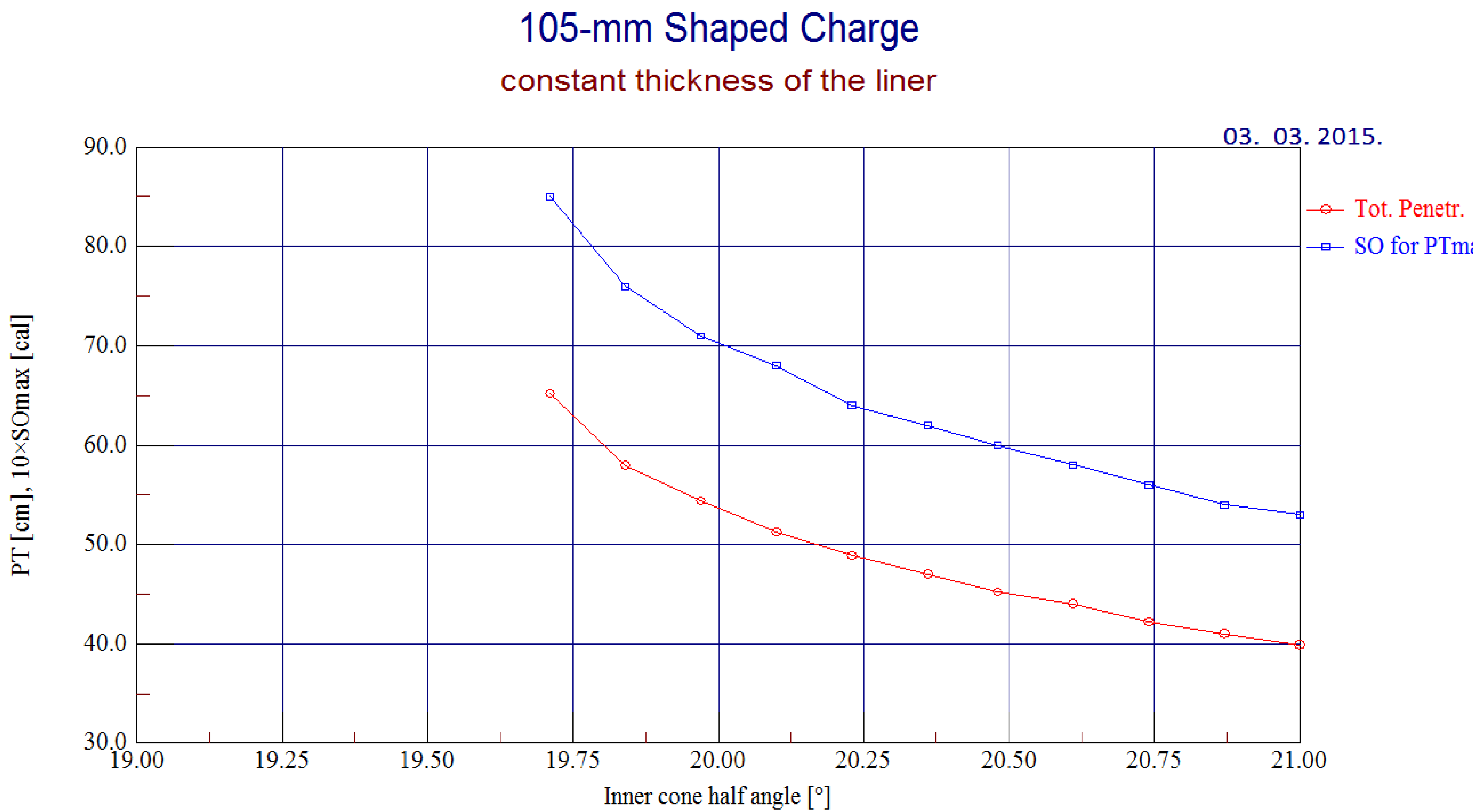
Hole Radius vs. Penetration Depth



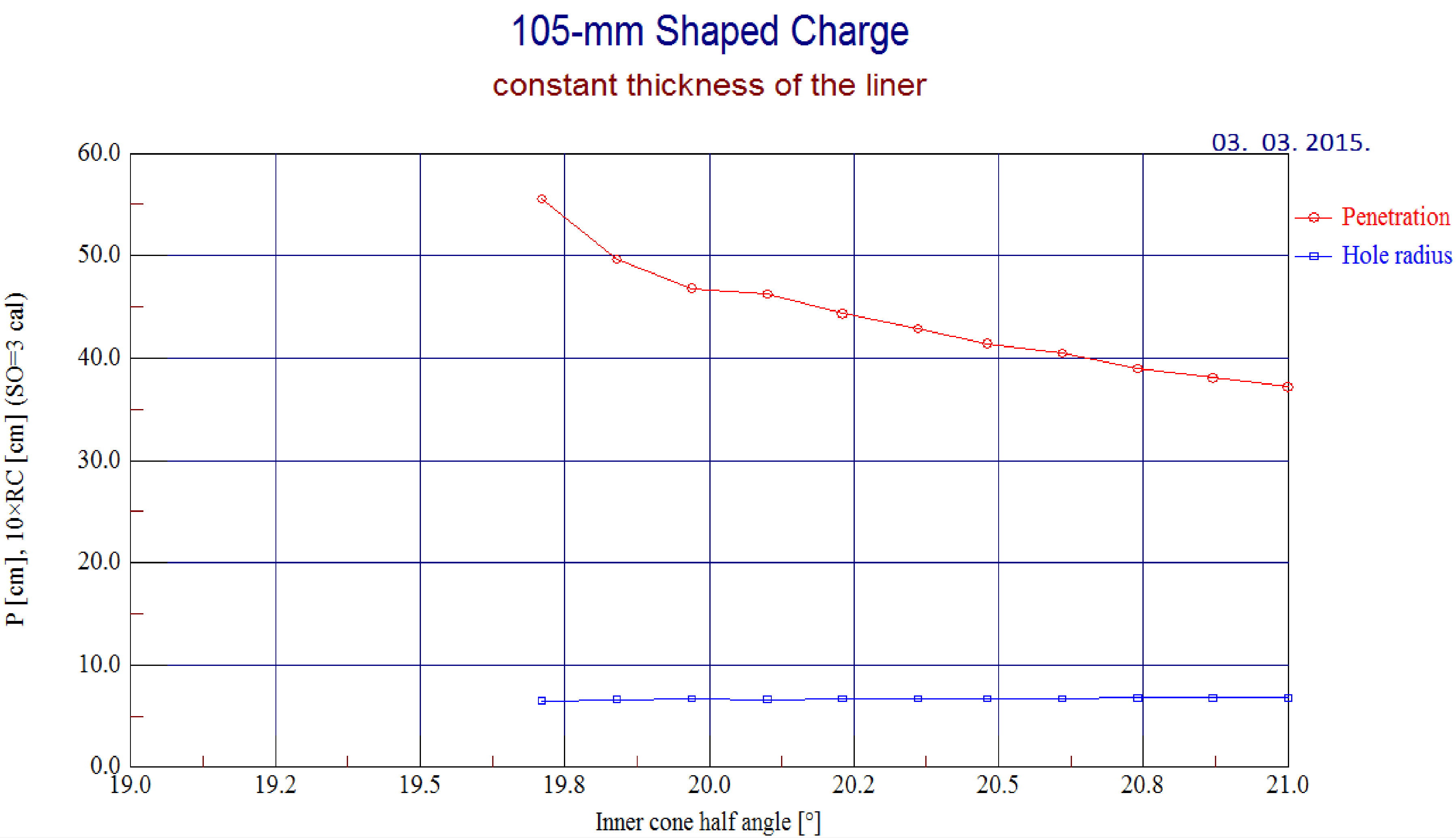
Influence of Cone Angle on Jet Tip Velocity



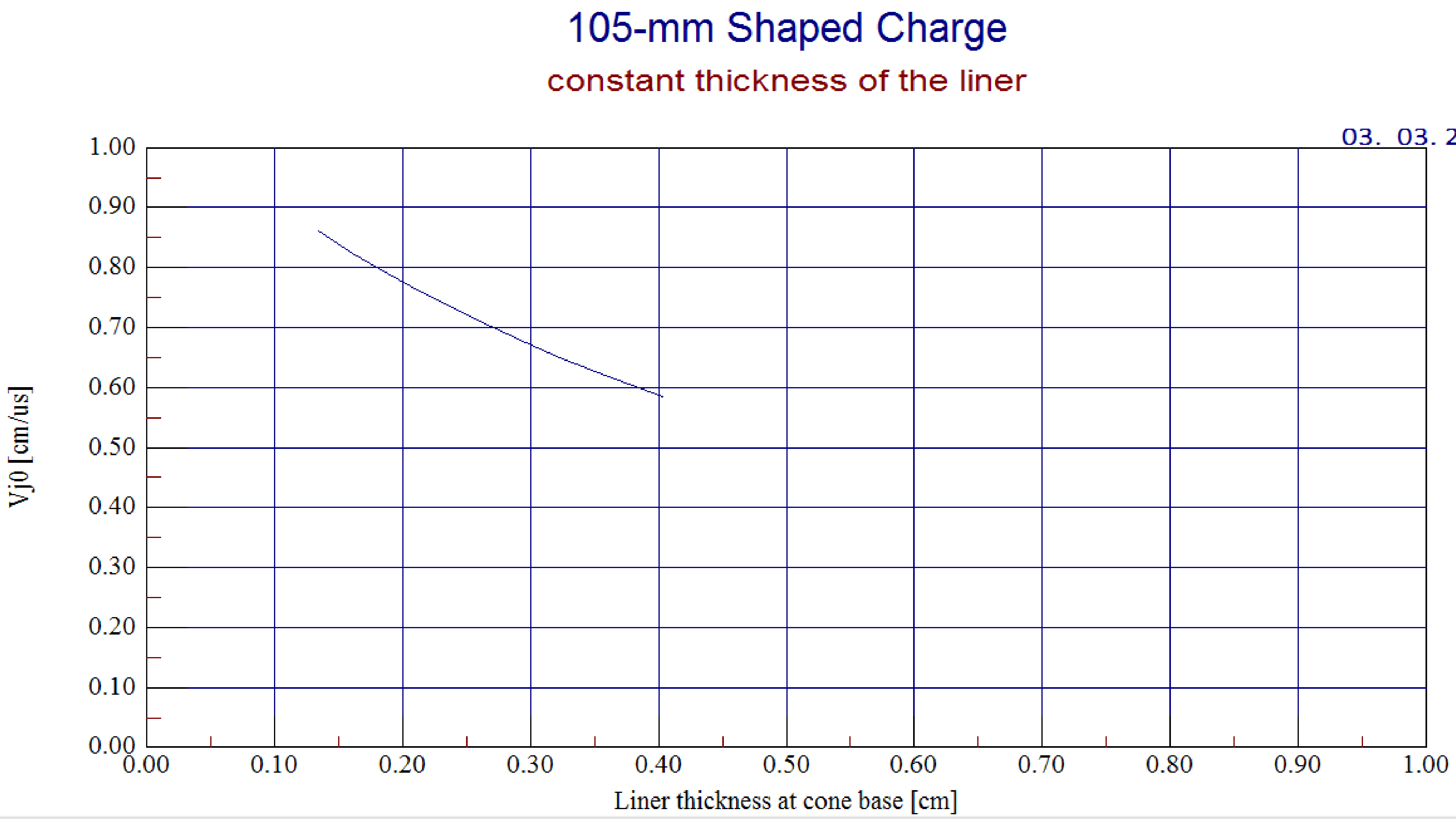
Influence of Cone Angle on Total Penetration & SO for PT_{max}



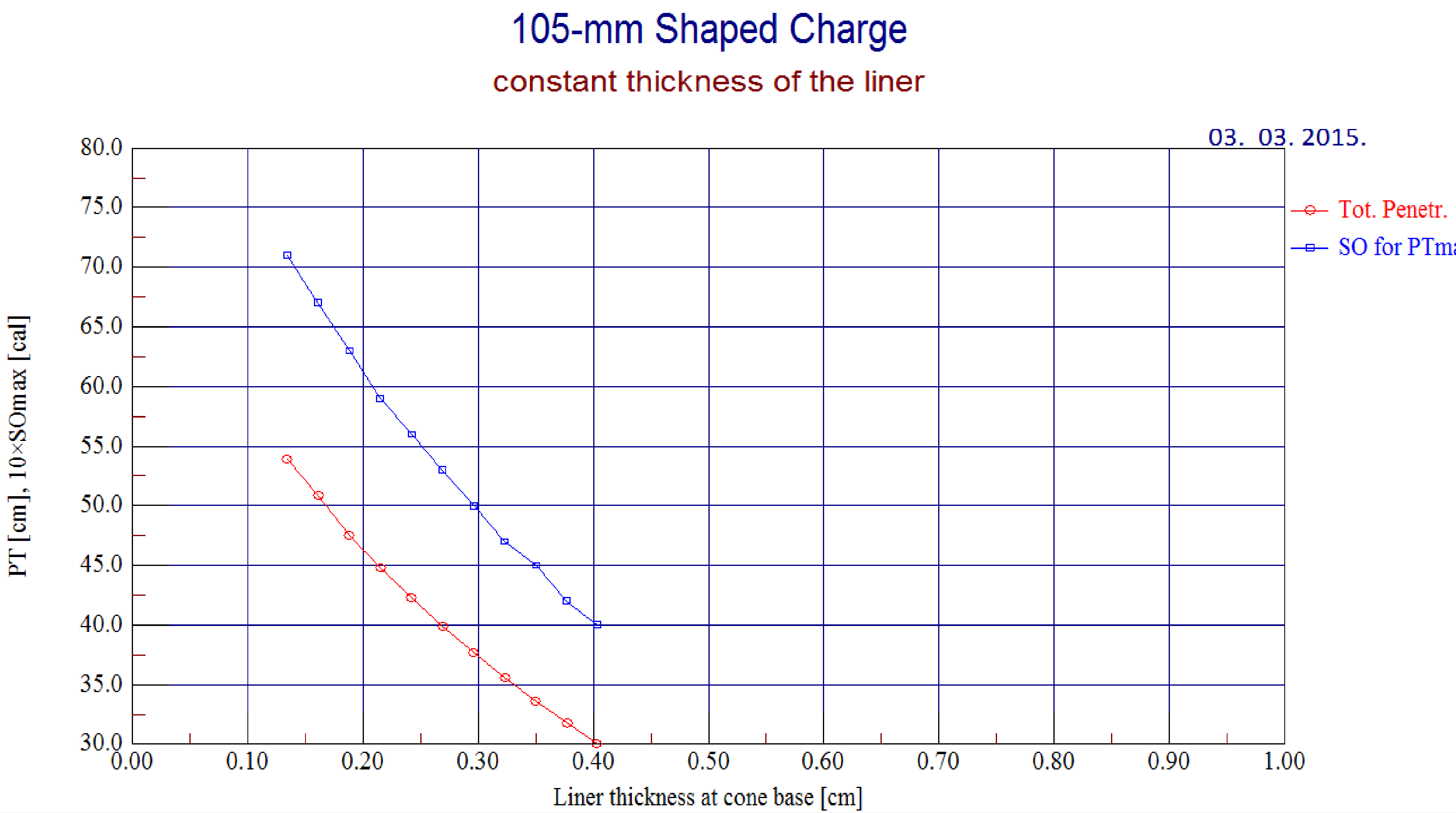
Influence of Cone Angle on Penetration & Hole Radius



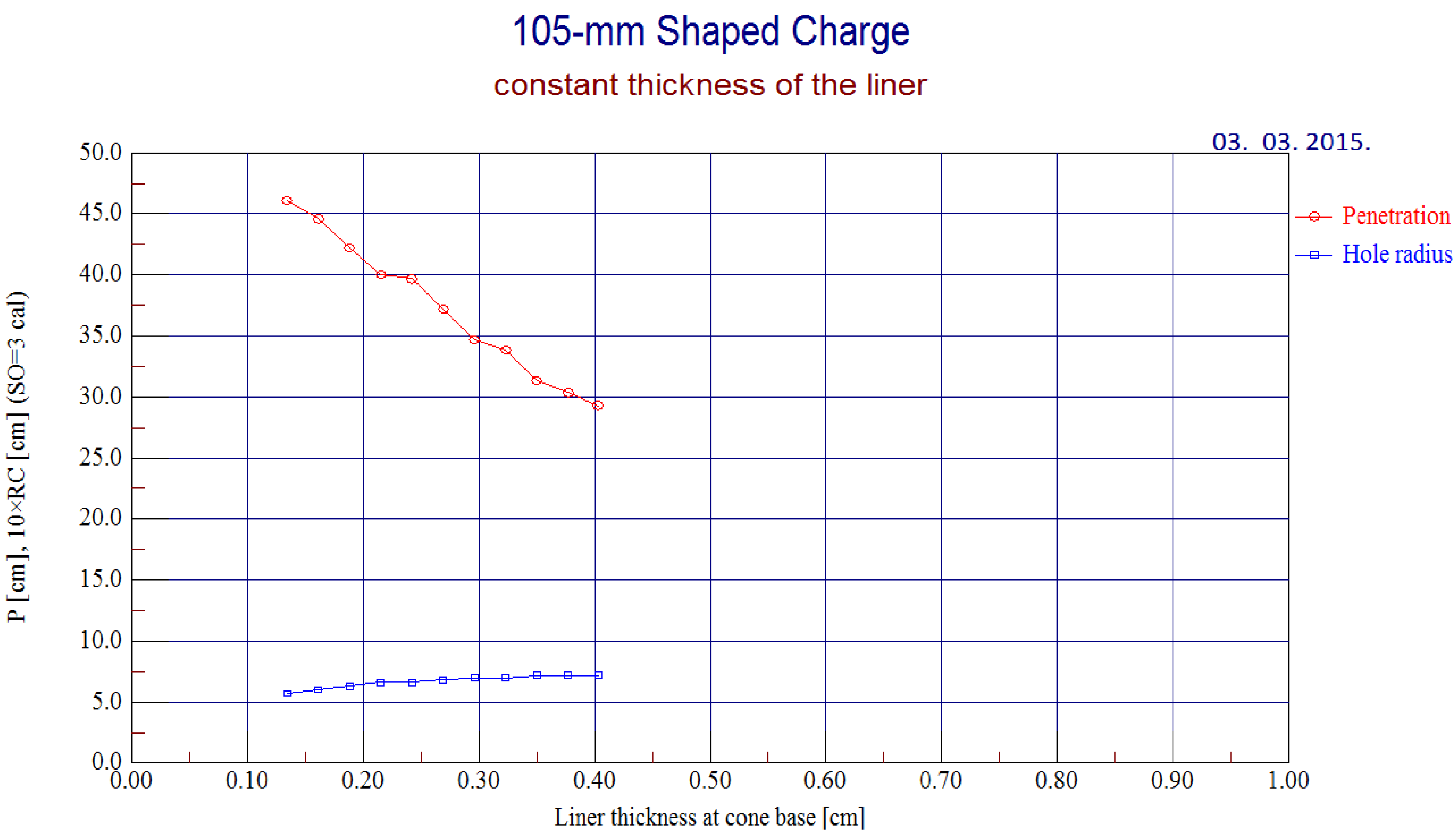
Influence of Liner Thickness on Jet Tip Velocity



Influence of Liner Thickness on Total penetration & SO for PT_{max}



Influence of Liner Thickness on Penetration & Hole Radius



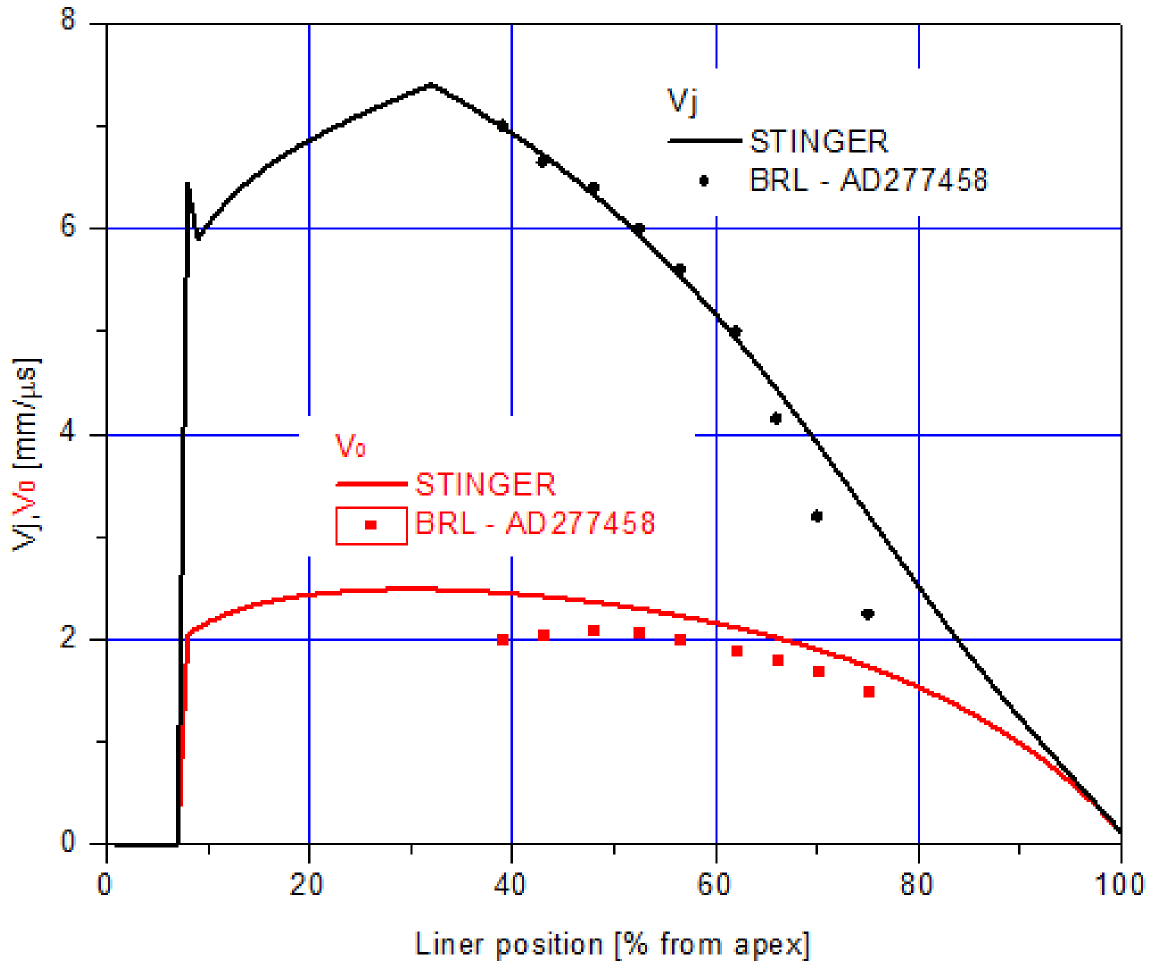
Comparison With Experiments

On the next diagrams comparison of the calculation results with some other sources are shown for the following sketches:

1. Experiment, 105 mm Shaped Charge, AD-277458
2. Experiment, BRL AD-246352
3. Calculation by program SCAP

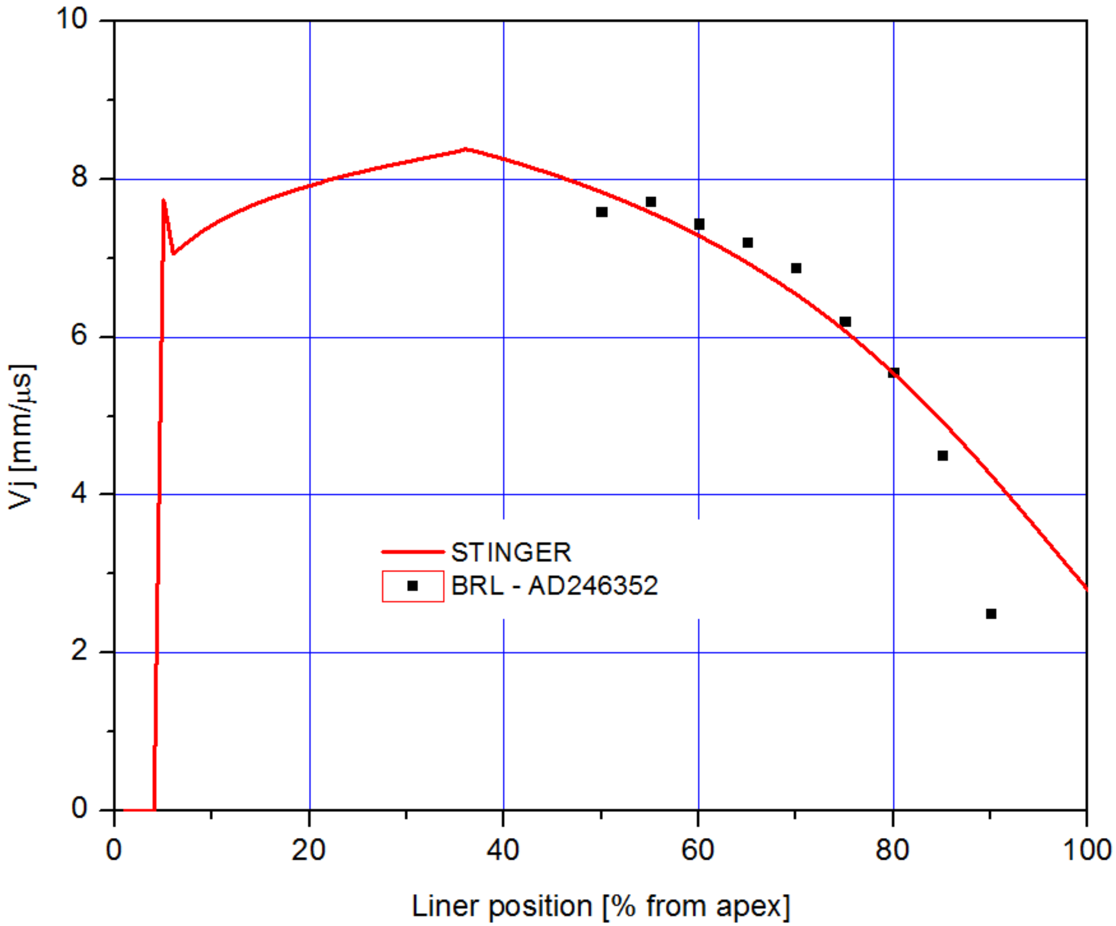
Comparison with 105 mm Shaped Charge, AD277458

Jet and slug velocity vs. relative liner position



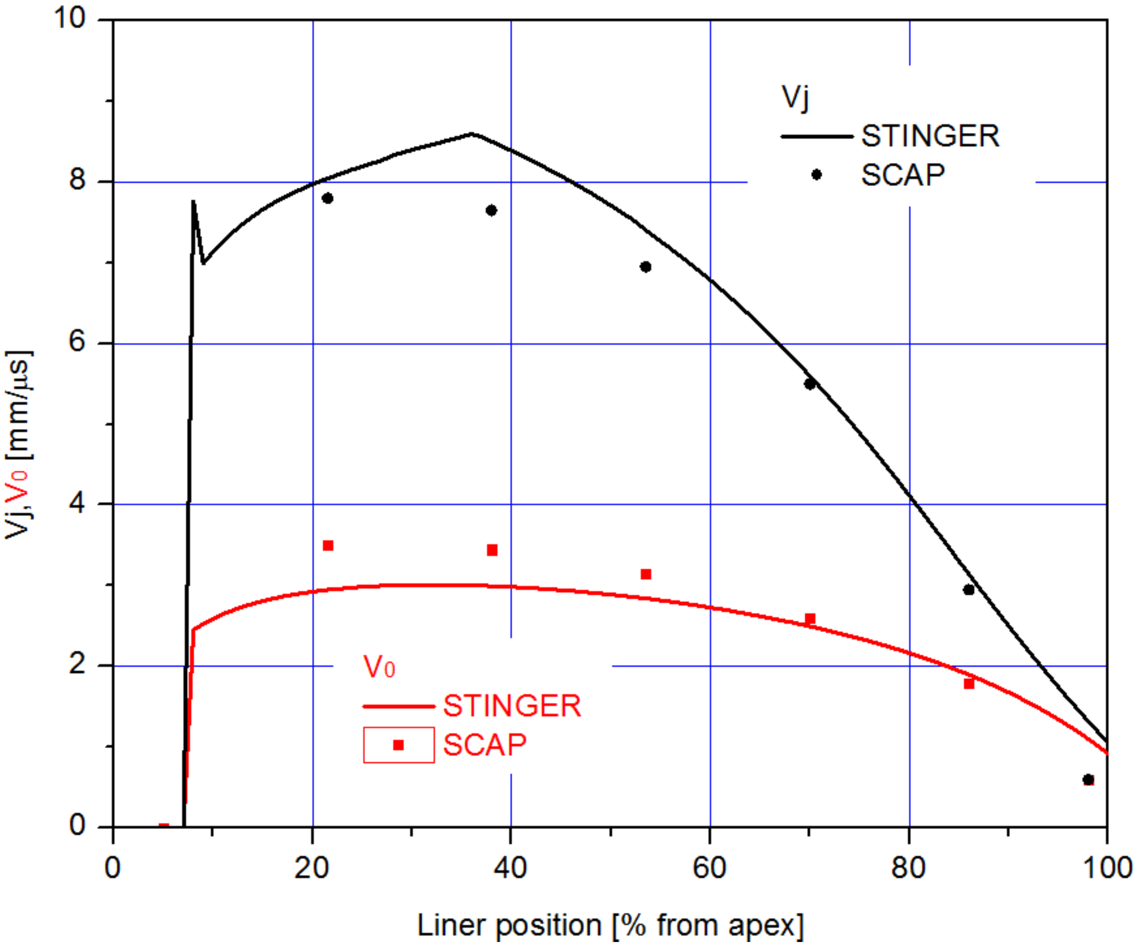
Comparison with Experiment
BRL AD-246352

Jet velocity vs. relative liner position



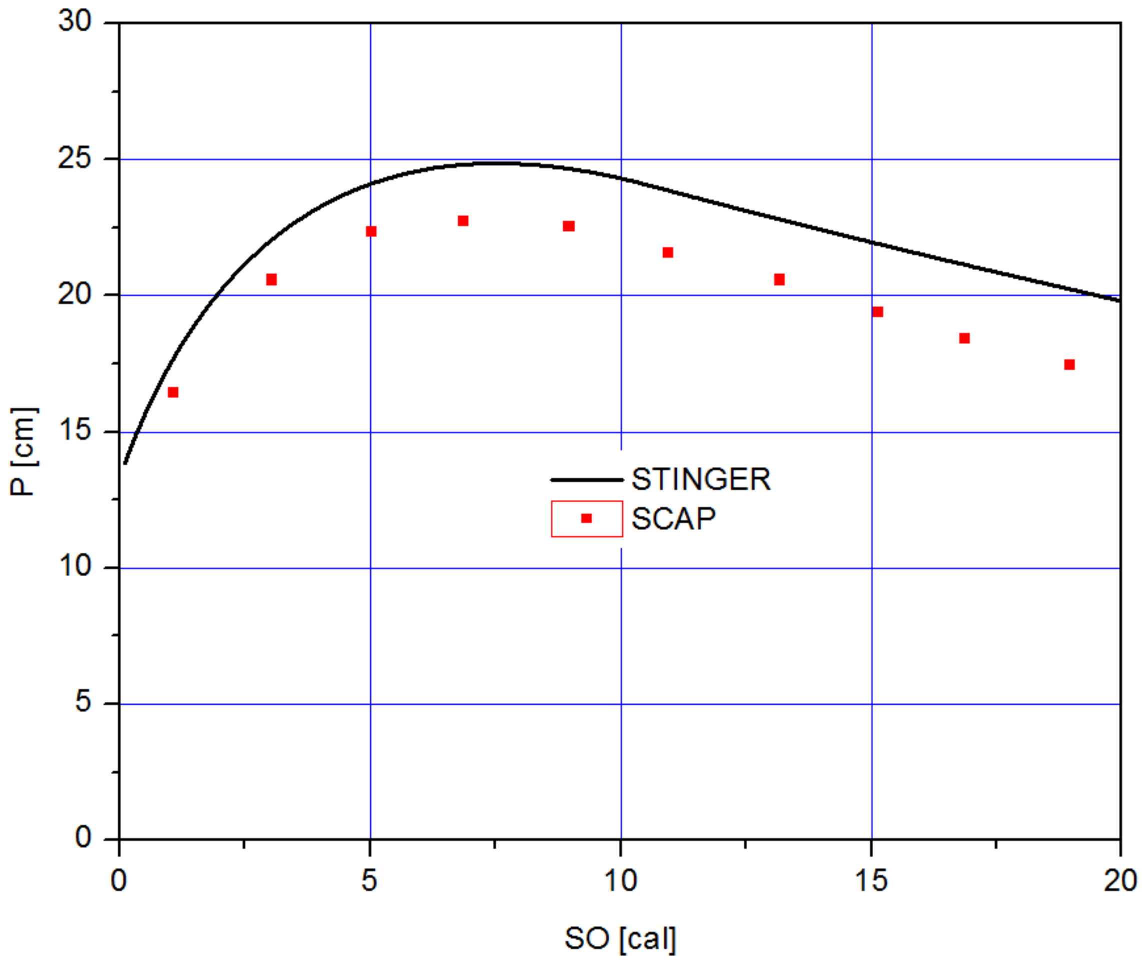
Comparison with Calculation of Program SCAP

Jet velocity and collapse velocity vs. relative liner position



Comparison with Calculation of Program SCAP - Cont. 1

Penetration vs. standoff distance.



Comparison with Calculation of Program SCAP - Cont. 2

Penetration vs. relative liner position